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Background Investigation Work Plan

for

Indian Head and Stump Neck Annex Naval Surface Warfare Center

Indian Head, Maryland

Engineering Field Activity Chesapeake
Naval Facilities Engineering Command

Contract Number N62472-90-D-1298

Contract Task Order 0287

October 1997

Brown & Root Environmental

A Division of Halliburton NUS Corporation

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BACKGROUND INVESTIGATION WORK PLAN

for

INDIAN HEAD AND STUMP NECK ANNEX
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

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OCTOBER 1997

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ACRONYMS

ASTM	American Society for Testing and Materials
BI	Background Investigation
BIWP	Background Investigation Work Plan
CLEAN	Comprehensive Long-Term Environmental Action Navy
COC	Chain of Custody
CTO	Contract Task Order
EOD	Explosive Ordnance Disposal
EODS	Explosive Ordnance Disposal School
EPA	United States Environmental Protection Agency
FOL	Field Operations Leader
FSAP	Field Sampling and Analysis Plan
ft AMSL	Feet above mean sea level
HASP	Health and Safety Plan
HMX	Cyclotetramethylene tetranitramine; Octogen; Homocyclonite
IDW	Investigative Derived Wastes
IED	Improvised Explosive Devices
IHDIVNAVSURFWARCEN	Indian Head Division, Naval Surface Warfare Center
IOD	Inert Ordnance Disposal
NAVEODTECHDIV	Naval Explosive Ordnance Disposal Technology Division
NC	Nitrocellulose
NFESC	Naval Facilities Engineering Service Center
NG	Nitroglycerine
NQ	Nitroguanidine
OVA	Organic vapor analyzer
PCBs	Polychlorinated biphenyls
PETN	Pentaerythritol tetranitrate
PID	Photo-ionization detector
PVC	Polyvinyl chloride
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RDX	Cyclonite; trimethylenetrinitramine
Semi-VOCs	Semivolatile organic compounds
SOP	Standard operating procedure

ACRONYMS (Continued)

SWMU	Solid Waste Management Unit
TAL	Target Analyte List
TCL	Target Compound List
TKN	Total Kjeldahl nitrogen
TNT	2,4,6-Trinitrotoluene
TOC	Total Organic Carbon
TOX	Total organic halides
TPH	Total petroleum hydrocarbons
USCS	Unified Soil Classification System
VOCs	Volatile organic compounds

EXECUTIVE SUMMARY

The Background Investigation study presented in this work plan is conducted to support on-going and future environmental investigations at the Naval Surface Warfare Center. There are two primary objectives of the Background Investigation (BI) planned for Indian Head and Stump Neck Annex:

- Determine background concentrations of organic and inorganic constituents in groundwater, soil (subsurface and surface), and freshwater sediment. Background data are used in environmental investigations to differentiate between chemical concentrations in environmental media which are site related and those that reflect naturally occurring or typical anthropogenic background.

- Collect analytical data of a quality that will meet requirements established by EPA Region III, the State of Maryland, CERCLA, RCRA, and the Navy.

To accomplish these objectives, the work plan presents:

- an overview of the site
- the objectives of the investigation and the investigative approach
- the field sampling plan
- the data evaluation approach, and
- the project management approach

This work plan incorporates recommendations made by the Navy and the United States Geological Survey (USGS) during two meetings and numerous telephone calls held to discuss project - specific activities. It has also been prepared in concert with the master planning documents for the Station.

1.0 INTRODUCTION

This Background Investigation Work Plan (BIWP) was prepared for the Naval Surface Warfare Center (Station) in Indian Head, Maryland, and the Engineering Field Activity Chesapeake (EFACHES), under the Comprehensive Long-term Environmental Action Navy (CLEAN), Contract Number N62467-90-D-1298, Contract Task Order (CTO) 0287. This BIWP presents specific protocol to collect background groundwater, subsurface soil, surface soil, and sediment samples. Data collected during the Background Investigation will be used during environmental investigations to differentiate site-related environmental contamination from naturally occurring and anthropogenic background concentratons of organic and inorganic constituents. All information deemed necessary for conducting the specific tasks required has been included in this document.

1.1 SITE LOCATION AND DESCRIPTION

The Naval Surface Warfare Center is located in the northwestern section of Charles County, Maryland, approximately 25 miles south of Washington D.C. The Station consists of two areas: the main area, or Indian Head, and the Stump Neck Annex. The two areas are located on two separate peninsulas along the eastern shore of the Potomac River. The main area is on the Cornwallis Neck Peninsula, and the annex is on the Stump Neck Peninsula. Figure 1-1 illustrates the general location of the Station and Figure 1-2 illustrates the 7.5 minute USGS Indian Head Quadrangle. The main area 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.

Table 1-1 lists the Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs) for Indian Head and Stump Neck Annex. The site numbers listed in this table are shown on the proposed background sampling location maps presented in Section 2 of this work plan. Site numbers 30 to 38 (nine in total) on the Indian Head table were listed as being SWMUs/AOCs at Stump Neck Annex. The number of sites listed at Stump Neck is also 9, however their correlation with site numbers 30-38 has yet to be determined. For this work plan, the Stump Neck sites are simply listed as 1 through 9. Should their correlation with corresponding site numbers (30-38) be determined, they will be cross-referenced with the 1-9 identifiers for the Stump Neck sites.

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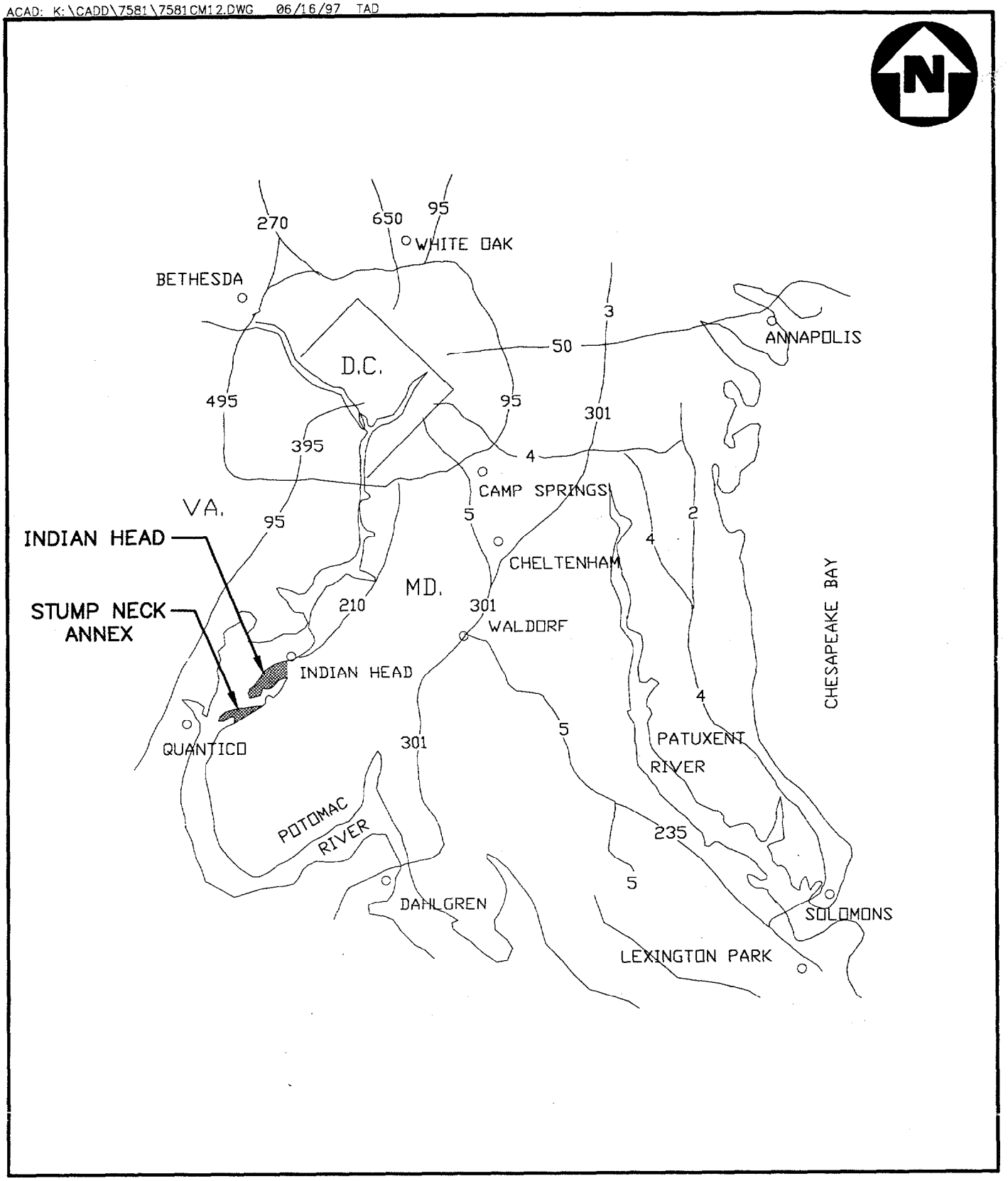


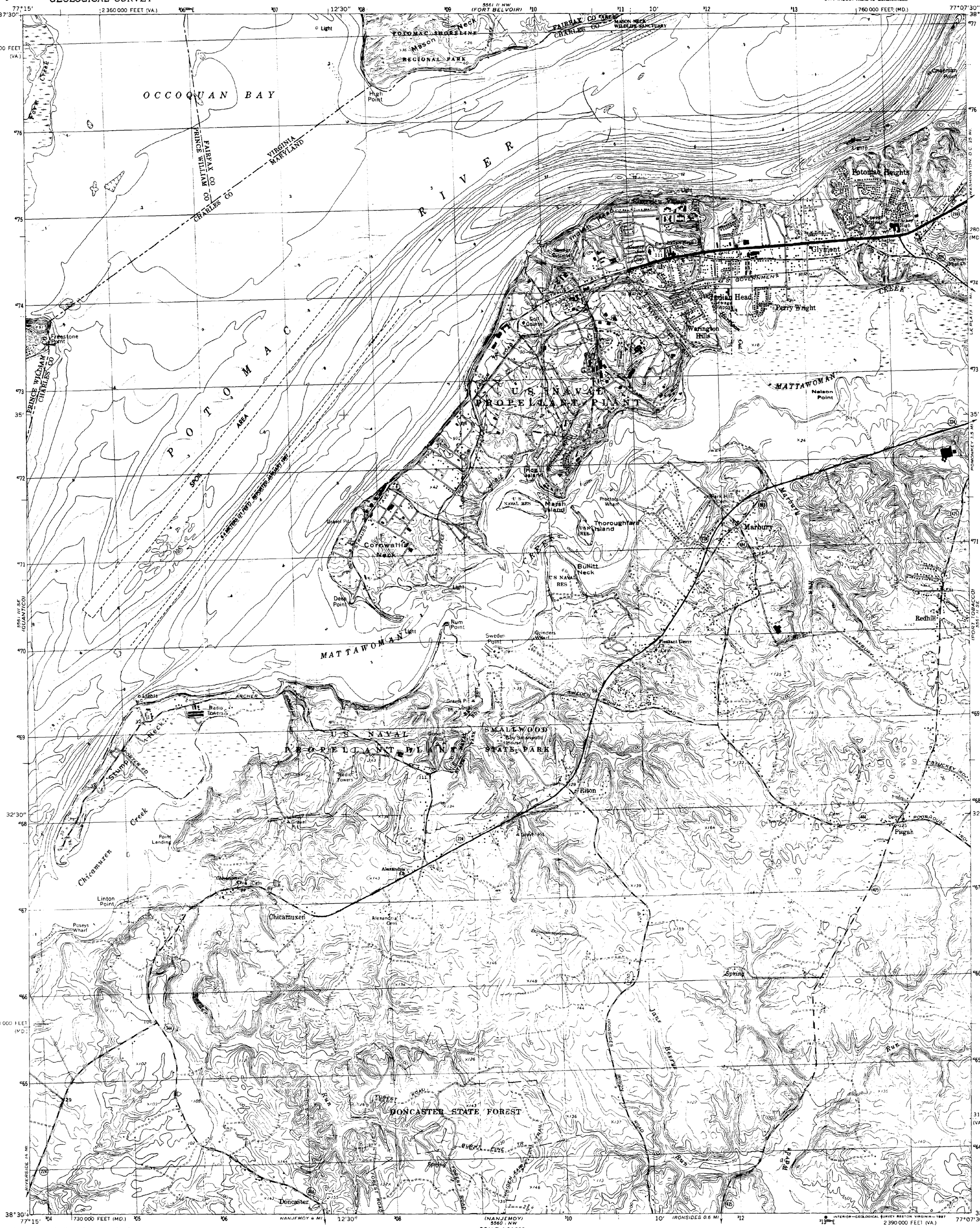
FIGURE 1-1

VICINITY MAP
INDIAN HEAD AND STUMP NECK ANNEX
INDIAN HEAD, MD

Brown & Root Environmental

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

INDIAN HEAD QUADRANGLE
MARYLAND–VIRGINIA
7.5 MINUTE SERIES (TOPOGRAPHIC–BATHYMETRIC)
SW/4 INDIAN HEAD 15' QUADRANGLE



Mapped by the Defense Mapping Agency
Edited and published by the Geological Survey and the National Ocean Survey

Control by USGS, NOS/NOAA, and USCE

Topography by photogrammetric methods from aerial photographs taken 1950. Field checked 1956. Revised by the Geological Survey 1966

Bathymetry compiled by the National Ocean Survey from tide-coordinated hydrographic surveys. This information is not intended for navigational purposes

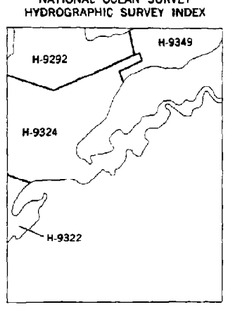
Mean low water (dotted) line and mean high water (heavy solid) line compiled by NOS from tide-coordinated aerial photographs. Apparent shoreline (outer edge of vegetation) shown by light solid line

Polyconic projection. 10,000-foot grid ticks based on Maryland coordinate system, and Virginia coordinate system, north zone
1000-meter Universal Transverse Mercator grid, zone 18
1927 North American Datum
To place on the predicted North American Datum 1983 move the projection lines 9 meters south and 26 meters west as shown by dashed corner ticks

There may be private inholdings within the boundaries of the National or State reservations shown on this map

Revisions shown in purple compiled by the Geological Survey in cooperation with the Commonwealth of Virginia agencies from aerial photographs taken 1977 and other sources. This information not field checked. Map edited 1978

NATIONAL OCEAN SURVEY
HYDROGRAPHIC SURVEY INDEX



HYDROGRAPHIC SURVEY INFORMATION

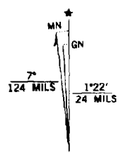
Survey Number	Survey Date	Survey Scale	Survey Line spacing (Naut. Miles)
H-9292	1973	1:10,000	.02–.05
H-9322	1972	1:10,000	.01–.06
H-9324	1972–74	1:10,000	.01–.05
H-9349	1973	1:10,000	.01–.05

SCALE 1:24 000

1 MILE — 7000 FEET — 1 KILOMETER

CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929
BATHYMETRIC CONTOUR INTERVAL 1 METER WITH SUPPLEMENTARY 0.5 METER CONTOURS—DATUM IS MEAN LOW WATER
THE RELATIONSHIP BETWEEN THE TWO DATUMS IS VARIABLE
THE MEAN RANGE OF TIDE IS APPROXIMATELY 0.5 METER

QUADRANGLE LOCATION



UTM GRID AND 1978 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

BASE MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
BATHYMETRIC SURVEY DATA COMPLIES WITH INTERNATIONAL HYDROGRAPHIC ORGANIZATION (IHO) SPECIAL PUBLICATION 44 ACCURACY STANDARDS AND/OR STANDARDS USED AT THE DATE OF THE SURVEY
FOR SALE BY U. S. GEOLOGICAL SURVEY
DENVER, COLORADO 80225, OR RESTON, VIRGINIA 22092
NATIONAL OCEAN SERVICE, ROCKVILLE, MARYLAND 20852
AND VIRGINIA DIVISION OF MINERAL RESOURCES, CHARLOTTESVILLE, VIRGINIA 22903
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

ROAD CLASSIFICATION

Heavy-duty — Light-duty
Medium-duty — Unimproved dirt
State Route

INDIAN HEAD, MD.–VA.
SW/4 INDIAN HEAD 15' QUADRANGLE
38077-E2-TB-024

1966
PHOTOREVISED 1978
BATHYMETRY ADDED 1982
DMA 5561 II SW–SERIES V833

FIGURE 1–2

00516A01X

TABLE 1-1

SOLID WASTE MANAGEMENT UNITS AND AREAS OF CONCERN
BACKGROUND STUDY WORK PLAN
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND
PAGE 1 OF 3

Site No.	Indian Head Site Name
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	Building 682, HMX Spill
8	Building 766, Mercury Deposits
9	Patterson Avenue, Oil Spill
10	Single-base Propellant Grains Spill
11	Caffee Road Landfill
12	Town Gut Landfill
13	Paint Solvents Disposal Ground
14	Waste Acid Disposal Pit
15	Mercury Deposits in Manhole, Fluorine Lab
16	Laboratory Chemical Disposal
17	Disposal Metal Parts Along Shoreline
18	Hog Island
19	Catch Basins at Chip Collection Houses
20	Single-base Powder Facilities
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
30-38	(Stump Neck Annex Sites - see page 3)
39	Organics Plant
40	Palladium Catalyst in Sediments

TABLE 1-1

SOLID WASTE MANAGEMENT UNITS AND AREAS OF CONCERN
BACKGROUND STUDY WORK PLAN
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND
PAGE 2 OF 3

Site No.	Indian Head Site Name
41	Scrap Yard
42	Olson 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 Area
50	Building 103, Crawl Space
51	Building 101, Dry Well
52	Building 102, Dry Well
53	Mercury Contamination of the Sewage System
54	Building 101
55	Building 102
56	IW87 - Lead Contamination
57	TCE Building 292 Area

TABLE 1-1

SOLID WASTE MANAGEMENT UNITS AND AREAS OF CONCERN
BACKGROUND STUDY WORK PLAN
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND
PAGE 3 OF 3

Site No.	Stump Neck Annex Site Name
1	Rum Point Landfill - Site 38
2	Range 3
3	Chicamuxen Creek's Edge Dump Site A
4	Chicamuxen Creek's Edge Dump Site B
5	Range 6
6	Air Blast Pond
7	Scrap Metal Pit - Site 33
8	Tool Burial Site - Site 34
9	Torpedo Burial Site - Site 35
10	Inactive Disposal Site - Site 36
11	Suspected Tool Burial Site - Site 32
12	Waste Oil Storage Site
13	Pink Water Treatment Tank and Trenches
14	Photographic Lab Septic Tank System
15	Spent Photographic Solution Storage
16	Thermal Treatment Tank
17	Building 2015 - Chemistry Lab Accumulation Area
18	Waste Pile
19	Disposal Area #1
20	Disposal Area #2
21	Drum Storage Area
22	Stump Neck Impact Area - Site 30
23	Old Demolition Range - Site 31
24	Causeway - Site 37
25	Area 8
26	IOD Site
27	IED Site
28	Skeet Range
29	Old Pistol Range
30	Building 2015 Dry Well

The primary 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.

- Execute other responsibilities assigned by the Commander of the Station.

The primary mission on the Stump Neck Annex area of the Station is to:

- Provide Explosive Ordnance Disposal (EOD) technology and logistics management.

- Develop war-essential elements of intelligence, equipment, and procedures to counter munitions, both U.S. and foreign, as required to support Department of Defense components and the peacetime security needs of other agencies.

1.2 PHYSIOGRAPHY AND TOPOGRAPHY

The Indian Head and Stump Neck Annex Peninsulas lie within the Atlantic Coastal Plain physiographic province, approximately 8-10 miles east of the Fall Line. These peninsulas have gently rolling to undulating topography with elevations ranging from sea level to 111 feet. The higher elevations exist in the northern portion of the Station. Generally, the land surface slopes to the east and southeast with slopes of 5 percent or less. The western coast of Indian Head along the Potomac River is characterized by 40 to 50 foot bluffs, whereas the eastern coast along the Mattawoman Creek is more gradational except for a few areas with several 10 to 40 foot bluffs (Hart, 1983).

1.3 METEOROLOGY

The Indian Head and Stump Neck Annex Peninsulas experience 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, while the Potomac River and Atlantic Ocean contribute to more moderate temperatures but higher humidity.

The temperature mean (1958-1987) is 58°F (NOAA, 1987). The warmest month is typically July with an average temperature of 79°F, while January is the coldest month with an average temperature of 35°F.

The area receives approximately 39 inches of precipitation and approximately 17 inches of snow. Precipitation is uniformly distributed throughout the year (NOAA, 1987).

1.4 SOILS

The dominant soil series on the Indian Head Peninsula are the Beltsville, Keyport, and Elkton Silt Loams (Hart, 1983; USDA, 1974). The Beltsville Silt Loam is found primarily in the upland elevations of the northern end of the Station, roughly north of Bronson Road. The Beltsville series consists of silt and sand with moderate amounts of clay. They are nearly level to moderately sloping and slowly permeable but well drained (USDA, 1974). In addition to the Beltsville Silt Loam, areas of cut-and-fill soils are found in the northern end of the Station. 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 end of the Station, roughly south of Bronson Road. They are both clayey silt loam soils. Both series are slowly permeable; however, the Elkton series is less permeable than the Keyport series.

The areas along streams and bordering the major waterways are predominantly cut-and-fill lands, gravelly lands, and tidal marshes. The gravelly lands consist of gravelly deposits with soil types unidentifiable due to erosion. Tidal marshes consist of sand to clay and some peat (Hart, 1983).

A general soil map for Charles County, Maryland is provided in Figure 1-3. There are three soil associations relevant to Indian Head and Stump Neck Annex. Indian Head is composed of associations number 1 and 9. Stump Neck Annex is composed of associations number 9 and 10. Descriptions for these associations (as shown in the legend of Figure 1-3) are provided in the following table.

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FIGURE 1–3

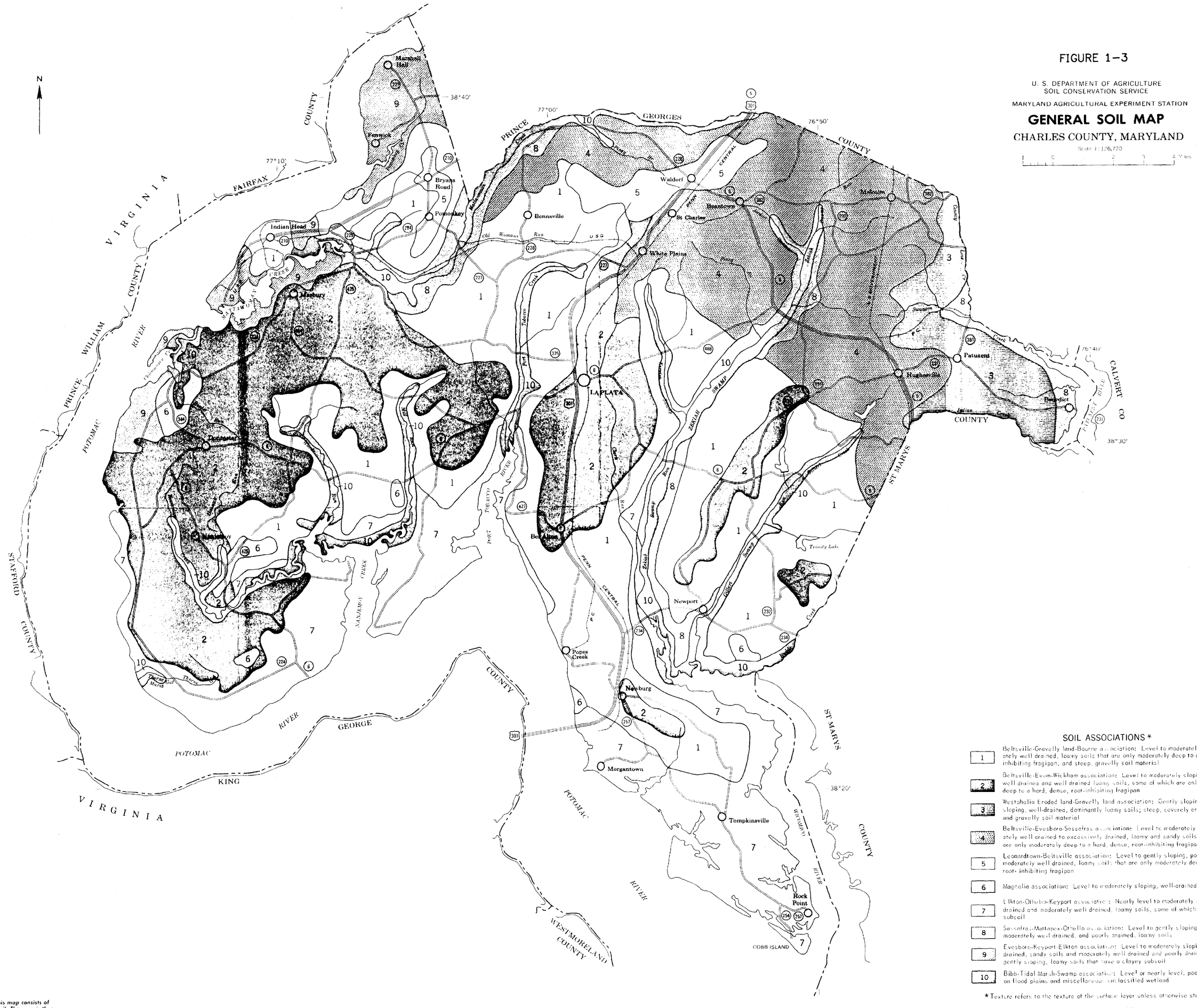
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

MARYLAND AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

CHARLES COUNTY, MARYLAND

Scale 1:126,720



SOIL ASSOCIATIONS *

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
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
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
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
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
6	Magnolia association: Level to moderately sloping, well-drained, loamy soils
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
8	Sassafras-Mattapex-Othello association: Level to gently sloping, well drained, moderately well drained, and poorly drained, loamy soils
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
10	Bibb-Tidal Marsh-Swamp association: Level or nearly level, poorly drained soils on flood plains and miscellaneous unclassified wetland

* Texture refers to the texture of the surface layer unless otherwise stated.

Compiled 1972

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

INDIAN HEAD AND STUMP NECK ANNEX SOIL ASSOCIATIONS

Soil Association Number	Description
1	Beltsville-Gravelly land-Bourne: 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
9	Evesboro-Keyport-Elkton: 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.
10	Bibb-Tidal Marsh-Swamp: Level or nearly level, poorly drained soils on flood plains and miscellaneous unclassified wetland.

1.5 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 to 900 feet (Vroblesky, 1991). It lies unconformably on the crystalline basement rock surface, which dips to the east. In stratigraphically ascending order, the sedimentary units underlying Indian Head are the Cretaceous Potomac Group, the Tertiary Aquia and Park Hall Formations, and Quaternary fluvial and estuarine deposits.

The Potomac Group consists of three units (in descending stratigraphic order): the Patapsco Formation, the Arundel Formation, and the Patuxent Formation. The lithology of the Potomac Group is 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 upper 100 feet of the Patapsco Formation outcrops along the western bluffs of the peninsula along the Potomac River. The middle and lower units of the Patapsco subcrop below the Potomac River (Hiortdahl, 1990). The Arundel Formation and Patuxent Formation consist of clays with interbedded sand units.

The Aquia Formation consists of glauconitic sand interbedded with sand, silt, and clay. The unit is Tertiary in age and generally less than 20 feet in thickness. The other Tertiary unit in the area is the Park Hall Formation. It is fluvial and estuarine deposits of sand and clay interbedded with sand with gravel. It is overlain unconformably by Quaternary deposits (McCarten, 1989).

Quaternary deposits at Indian Head consist of Pleistocene paleochannel deposits and Holocene alluvial deposits (Hiortdahl, 1990). These deposits are not expected to exceed 40 feet in thickness (AWARE, 1982). They consist of sand, silt, and clay mixtures with irregular bedding (Hart, 1983).

1.6 HYDROGEOLOGY

The Patapsco and Patuxent Formations of the Potomac Group are the main groundwater aquifers used in the area. The Patapsco Formation is the principal aquifer for Charles County. The three principal water-bearing zones within the 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 are laterally discontinuous sand zones. Recharge of the Patuxent Formation occurs in Virginia, where it outcrops.

Groundwater elevations of the Potomac Group measured in 1990 indicate a cone of depression in the Indian Head Peninsula area (Hiortdahl, 1990). The area of influence extends for approximately six miles in the northeast and southwest direction and approximately 2-3 miles in the northwest and southeast direction. The cone of depression is a result of the heavy pumping on the peninsula for the past 90 years. Under natural conditions, groundwater would flow east-southeast, following the dip of the formations in the area.

Figure 1-4 presents a generalized cross-sectional view of the Indian Head peninsula. A generalized cross-sectional view of the Stump Neck peninsula is not yet available.

1.7 STATION HYDROLOGY

The three principal waterways in the vicinity of the Station are the Potomac River, the Mattawoman Creek, and the Chicamuxen Creek. The Potomac River is a tidally-influenced estuary and slightly brackish. Mattawoman and Chicamuxen Creeks are tributaries to the Potomac River and are also tidally influenced. Tidal marshes exist along the Mattawoman and Chicamuxen Creeks.

Station waste waters from Indian Head are discharged directly to the Potomac River or Mattawoman Creek and from outfalls throughout the Station to tributaries of the Potomac River or Mattawoman Creek. The waste waters consist of industrial, sanitary, and storm effluents, or combinations thereof (Hart, 1983). Station waste waters from Stump Neck Annex are discharged directly to the Potomac River or Chicamuxen Creek and from outfalls to tributaries of the Potomac River or Chicamuxen Creek.

Shallow, unconfined ground water at the Station occurs from near surface to approximately 20 feet. Typically, the shallow groundwater occurs in perched water-bearing zones and is recharged from infiltration (Hart, 1983; Slaughter and Otton, 1968). At some lowland areas at the edge of the surrounding

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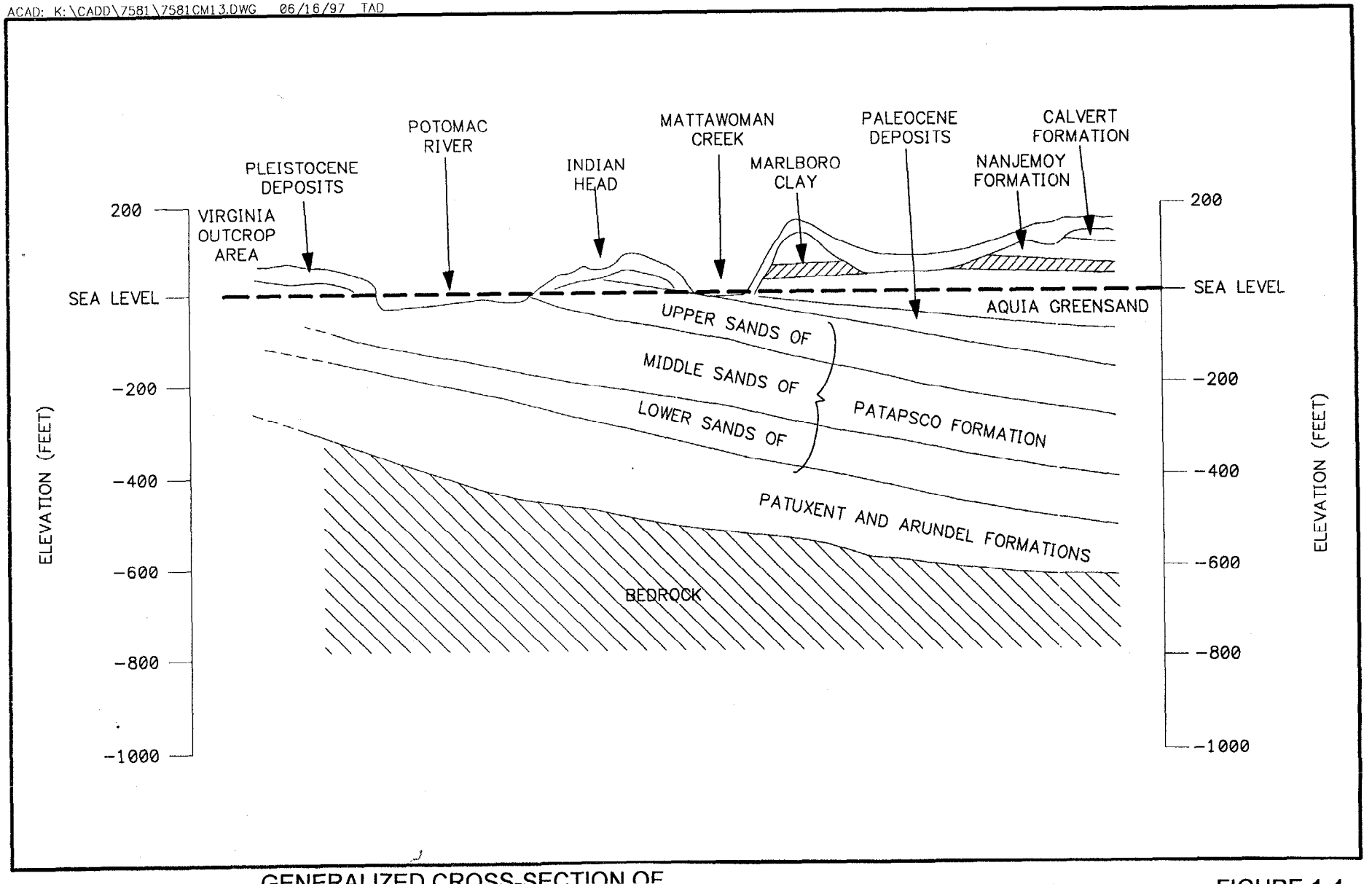


GENERALIZED CROSS-SECTION OF
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

0 5,000 10,000
SCALE IN FEET

FIGURE 1-4

Brown & Root Environmental

bodies of water, surface water intrusion may be an additional source of recharge of the shallow aquifer. In lieu of comprehensive shallow ground water level data, it is assumed shallow ground water flow follows topography.

1.8 ORGANIZATION OF THE WORK PLAN

This Background Investigation Work Plan is organized into five sections and seven appendices. Section 1 provides an introduction, including brief discussions regarding site characteristics, and physical descriptions of the environment. Section 2 provides objectives of the investigation and investigative approaches. Section 3 describes the field sampling plan. Section 4 describes how the background data collected as part of this investigation will be reported. Section 5 outlines the project management approach for this background investigation.

Appendix A contains the Health and Safety Plan (HASP) for the proposed activities
Appendix B contains the forms to be used for the field investigation for the proposed activities
Appendix C contains the standard operating procedures for the proposed activities
Appendix D contains the quality assurance project plan (QAPP) for the proposed activities
Appendix E contains background data from the February 1996 Verification Investigation Report
Appendix F contains background data from the January 1993 Engineering Evaluation Cost Report
Appendix G contains the statistical approach for dealing with environmental laboratory data

2.0 OBJECTIVES OF THE INVESTIGATION AND INVESTIGATIVE APPROACH

The objectives of the Background Investigation planned for the Naval Surface Warfare Center, Indian Head are twofold:

- Determine background concentrations of organic and inorganic constituents in groundwater, soil (subsurface and surface), and freshwater sediment. Background data are used in environmental investigations to differentiate between chemical concentrations in environmental media which are site related and those that reflect naturally occurring or typical anthropogenic background.

- Collect analytical data of a quality that will meet requirements established by EPA Region III, the State of Maryland, CERCLA, RCRA, and the Navy.

In overview, 5 new monitoring wells will be installed at the Naval Surface Warfare Center. A maximum of 10 groundwater samples will be collected from newly installed and existing monitoring wells. Surface and subsurface soil samples will be collected at a minimum of 10 locations (a combination of monitoring well and soil boring locations) and at a maximum of 20 locations. The decision to collect soils at 10 or 20 locations will depend on the diversity of soil types observed at the first 10 locations sampled. (These locations will be a mix of upland and lowland locations.) If the field geologist observes reasonably similar soil types at the first 10 locations sampled, the maximum number of locations sampled will be 10. Otherwise, surface and subsurface soils will be collected at 20 locations. A maximum of 10 freshwater sediment samples will be collected.

These objectives will be achieved by:

- A background environmental sampling program that targets areas that, based on historical information available for the Naval Surface Warfare Center, Indian Head, are most likely to represent uncontaminated areas at Indian Head and Stump Neck Annex.

- Collection and analysis of samples, and subsequent validation of analytical data per protocol acceptable to the Navy, Region III of the Environmental Protection Agency, and the State of Maryland.

This section identifies data needs for the Background Investigation and presents the investigative approach to accomplish the objectives of the Background Investigation. Four subsections are presented covering the following:

- Summary/Evaluation of Existing Background Data
- Investigative Approach for Sampling at Indian Head
- Investigative Approach for Sampling at Stump Neck Annex
- Investigative Approach for Sampling Off Base
- Background Analytical Program

2.1 SUMMARY/EVALUATION OF EXISTING BACKGROUND DATA

There has never been a concerted effort to collect site-wide background data at Indian Head or Stump Neck Annex. During the preparation of this work plan, existing background data were reviewed for possible incorporation into this Background Investigation (BI) study. Although data have been collected in the past, a complete analytical suite has not always been obtained. Furthermore, the validation status of some of the existing data cannot be confirmed. Additionally, most existing "background" data are actually from samples taken upgradient of existing SWMUs. Despite these limitations, available reports for the following studies were reviewed and data potentially relevant for this BI are summarized below.

CTO	Report Description	Useable Background Data	Copies of Data Tables Contained In
222	Verification Investigation Report - Naval EOD School Sites - February 1996	Yes	Appendix E
99	Post-Removal Action Report - Site 8 - Nitroglycerin Plant Office - April 1995	No	Not Available
64	Engineering Evaluation Cost Analysis Report - Site 8 - Nitroglycerin Plant Office - January 1993	Yes	Appendix F (one table)

Evaluation of these background and upgradient data will take place during preparation of the background investigation report discussed in Section 4. Appropriate statistical and data validation evaluations will be conducted to ensure adequate use of these data along with the newly collected data that will be obtained per the protocol established in this work plan.

2.2 INVESTIGATIVE APPROACH FOR SAMPLING AT INDIAN HEAD

This section presents the approach for obtaining the required background data at Indian Head. Section 2.3 will discuss the approach for Stump Neck Annex, and Section 2.4 will discuss the approach for off base samples. Because new background monitoring wells will be installed, groundwater issues will be presented first. (Subsurface soil samples will be collected during well installation). Subsurface soils sampling will be discussed second, followed by surface soils and freshwater sediment sampling. Figure 2-1 shows the potential groundwater, soil (subsurface and surface), and freshwater sediment sampling locations for Indian Head.

Table 2-1 describes the candidate sampling locations and types of samples to be collected at each location for the background investigation. (Additional soil sampling locations will be selected if the field geologist reports heterogeneous soil types.) Final selection of sampling locations will take place following discussions with Navy personnel and field determinations, as necessary. All samples collected will be analyzed for the chemical parameters and physical properties described in Section 2.5.

2.2.1 Groundwater Sampling

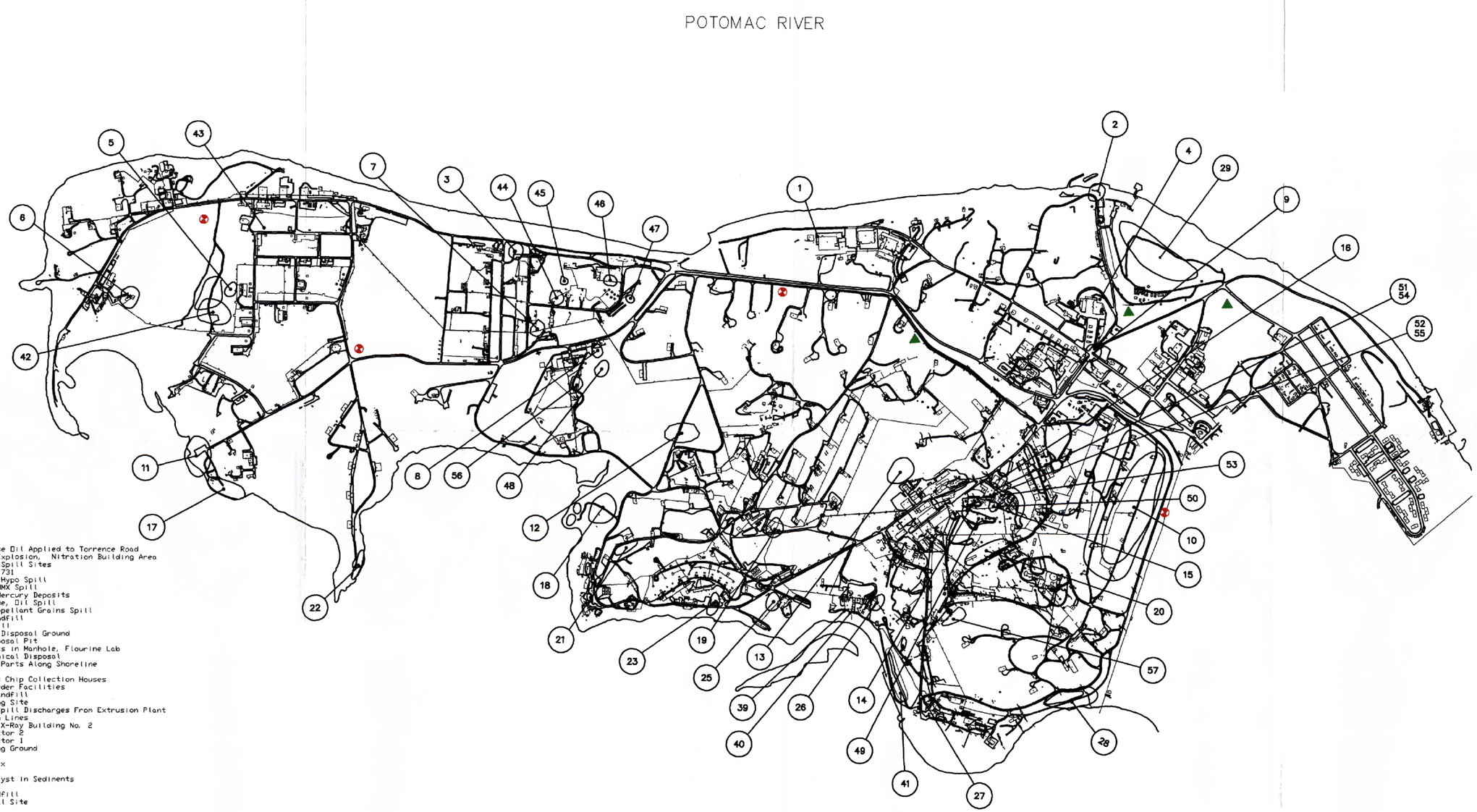
A maximum of four monitoring wells will be installed as part of the Background Investigation for Indian Head. The final well locations will depend on Navy comments and field determinations. Proposed locations have been described in previous sections (Table 2-1) and are shown on Figure 2-1. As the potential locations were carefully selected to avoid known areas of site activity (undisturbed to the greatest extent possible to represent site background), it is not anticipated that unexploded ordnance (UXO) will be a problem. The health and safety plan (Appendix A) does, however have provisions in case UXO is encountered. Each well location will be checked for the presence of underground utilities prior to drilling operations, and the locations modified as necessary to avoid any utilities present. Given the topography and location of proposed well locations, groundwater may be encountered as shallow as 6 to 20 feet below ground surface. The monitoring wells will be installed in accordance with the specifications described in Section 3.0 of this Work Plan.

One groundwater sample will be collected from each monitoring well and analyzed at a fixed-base laboratory for the aqueous parameters listed in Section 2.5 of this work plan. Synoptic water-level measurements will also be collected.

TABLE 2-1

BACKGROUND STUDY WORK PLAN
POTENTIAL INDIAN HEAD BACKGROUND SAMPLE LOCATIONS AND TYPES
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

Monitoring Wells (MW), Subsurface Soil (SB), and Surface Soil (SS) (Shown On Figure As Red And White Quadrant Circle)	**Location Description as shown on Figure 2-1**
MW + SB + SS	~2700' due east from Site 11 near the intersection of Strauss Road and Caffee Road
MW + SB + SS	~800' southeast of Site 43 at the northwest of the intersection of an undeveloped road and Strauss Road
MW + SB + SS	~900' southwest of Site 1 just off Farnum
MW + SB + SS	~400' southeast of Site 10 near property boundary
Freshwater Sediment (SD) (Shown On Figure As A Green Triangle)	**Location Description As Shown On Figure 2-1**
SD	~2000' southwest of Site 1
SD	~400' southeast of Site 4
SD	~1200' southeast of Site 29



LEGEND

NUMBER	SITE NAME
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	Building 682, HMX Spill
8	Building 766, Mercury Deposits
9	Patterson Avenue, Oil Spill
10	Single-base Propellant Grains Spill
11	Coffee Road Landfill
12	Town Gut Landfill
13	Paint Solvents Disposal Ground
14	Waste Acid Disposal Pit
15	Mercury Deposits in Manhole, Flourine Lab
16	Laboratory Chemical Disposal
17	Disposal Metal Parts Along Shoreline
18	Hog Island
19	Catch Basins at Chip Collection Houses
20	Single-base Powder Facilities
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
30-38	Stump Neck Annex
39	Organics Plant
40	Palladium Catalyst in Sediments
41	Scrap Yard
42	Olson 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 Area
50	Building 103, Crawl Space
51	Building 101, Dry Wall
52	Building 102, Dry Wall
53	Mercury Contamination of the Sewage System
54	Building 101
55	Building 102
56	IW87 - Lead Contamination
57	TCE Building 292 Area

Proposed Soil Boring Sample Site
Proposed MW Installation Site
Proposed Freshwater Sediment Site

0 800 1600
SCALE IN FEET

ACAD: K:\CADD\7581\7581CM03.DWG 06/18/97 TAD VIEW=DWG SITE.LAY XREF O:\DATA\CADD\2299\SMP-P01 THROUGH SMP-P17 AND STOR.DWGS COLORS.PGP

REV.	DESCRIPTION	PREP BY	DATE	APPRVD

Halliburton NUS CORPORATION
PITTSBURGH, PA. 15220

DSGN: DR: CHK:
SUPV: CH. ENG:
SUBMITTED BY: (FIRM MEMBER) (TITLE) (DATE)
CHK'D'BY HD: DM: HD: PPE: DR:
OFFICER IN CHARGE DATE
APPROVED

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
ENGINEERING FIELD ACTIVITY CHESAPEAKE
WASHINGTON, DC
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MD

INDIAN HEAD BACKGROUND INVESTIGATION

SAMPLE LOCATIONS

SEAL AREA

SAT TO DATE
CODE I.D. NO. 80091
SCALE : AS SHOWN
SPEC. NO. 04 - NA
CONSTRN. CONTR. NO. NA
NAVFAC DRAWING NO. NA
SHEET 1 OF 1
SIZE: D
DIS. SH. NO. FIG. 2-1

2.2.2 Subsurface Soil Sampling

Subsurface soil sampling and analysis will be conducted to determine background concentrations of parameters listed in Section 2.5. Subsurface samples will be obtained at all newly installed well locations (a maximum of 4 proposed as described above) as shown in Figure 2-1. The subsurface soil samples will be collected at the soil interval 3 to 5 feet below ground surface (bgs) or the soil interval just above the water table if the water table is very shallow.

The subsurface soil samples will be analyzed at a fixed-base laboratory for the parameters listed in Section 2.5 of this work plan.

2.2.3 Surface Soil Sampling

Surface soil sampling and analysis will be conducted to determine background concentrations of parameters listed in Section 2.4. Surface samples will be obtained at all newly installed well locations (a maximum of 4 proposed as described above) as shown in Figure 2-1. These surface soil samples will be collected at the soil interval 0 to 1 foot below ground surface.

The surface soil samples will be analyzed at a fixed-base laboratory for the parameters listed in Section 2.5 of this work plan.

2.2.4 Freshwater Sediment Sampling

Freshwater sediment sampling and analysis will be conducted to determine background concentrations of parameters listed in Section 2.5. Freshwater sediment samples will be obtained at locations (3) shown in Figure 2-1.

The freshwater sediment samples will be analyzed at a fixed-base laboratory for the solid sample parameters listed in Section 2.5 of this work plan.

2.3 INVESTIGATIVE APPROACH FOR SAMPLING AT STUMP NECK ANNEX

This section presents the approach for obtaining the required background data at Stump Neck Annex. Because new background monitoring wells will be installed, groundwater issues will be presented first. (Subsurface soil samples will be collected during monitoring well installation.) Subsurface soils sampling will be discussed second, followed by surface soils and freshwater sediment sampling. Figure 2-2 shows the

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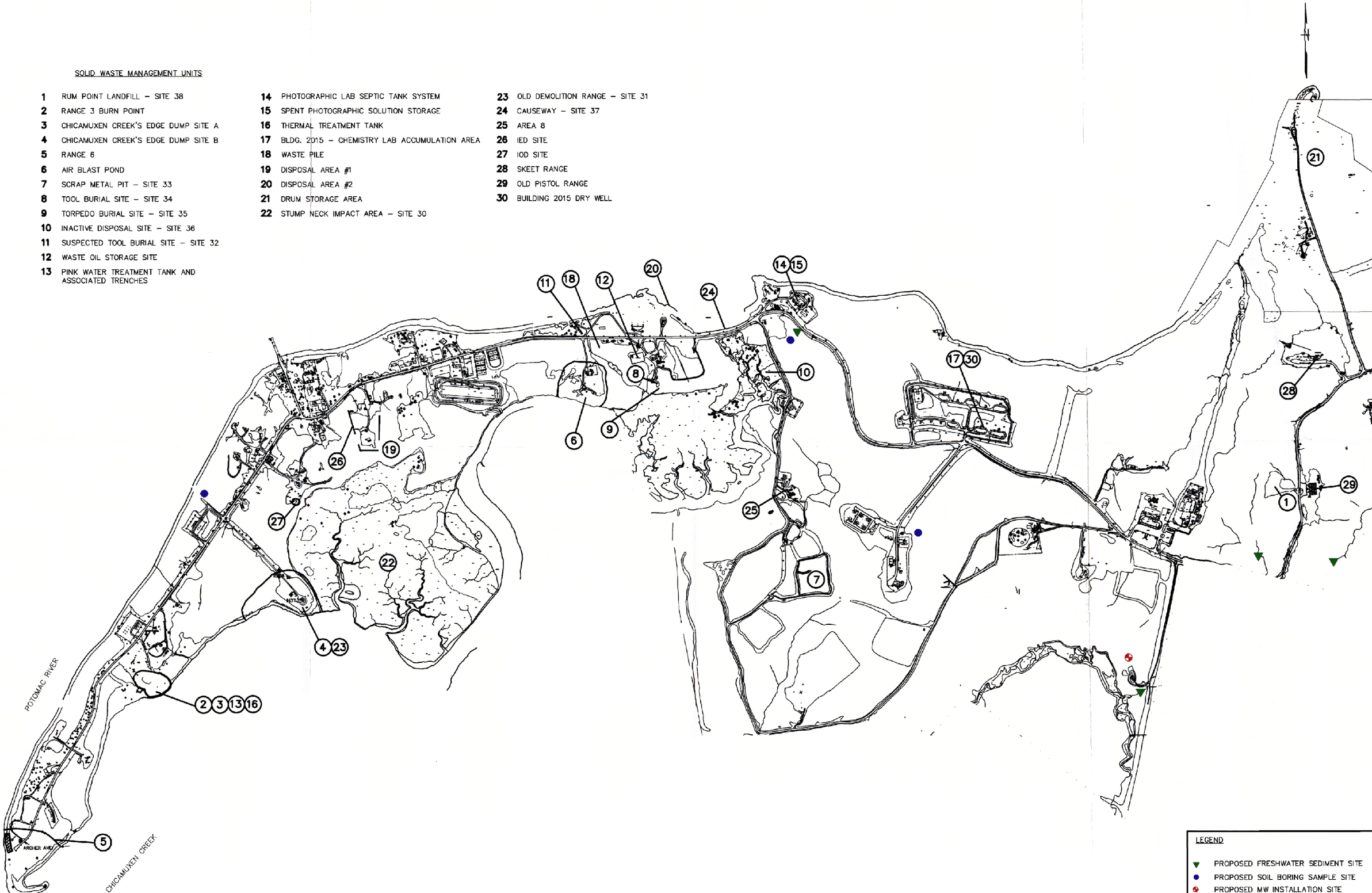
SOLID WASTE MANAGEMENT UNITS

1 RUM POINT LANDFILL – SITE 38
2 RANGE 3 BURN POINT
3 CHICAMUXEN CREEK'S EDGE DUMP SITE A
4 CHICAMUXEN CREEK'S EDGE DUMP SITE B
5 RANGE 6
6 AIR BLAST POND
7 SCRAP METAL PIT – SITE 33
8 TOOL BURIAL SITE – SITE 34
9 TORPEDO BURIAL SITE – SITE 35
10 INACTIVE DISPOSAL SITE – SITE 36
11 SUSPECTED TOOL BURIAL SITE – SITE 32
12 WASTE OIL STORAGE SITE
13 PINK WATER TREATMENT TANK AND ASSOCIATED TRENCHES
14 PHOTOGRAPHIC LAB SEPTIC TANK SYSTEM
15 SPENT PHOTOGRAPHIC SOLUTION STORAGE
16 THERMAL TREATMENT TANK
17 BLDG. 2015 – CHEMISTRY LAB ACCUMULATION AREA
18 WASTE PILE
19 DISPOSAL AREA #1
20 DISPOSAL AREA #2
21 DRUM STORAGE AREA
22 STUMP NECK IMPACT AREA – SITE 30
23 OLD DEMOLITION RANGE – SITE 31
24 CAUSEWAY – SITE 37
25 AREA 8
26 IED SITE
27 IOD SITE
28 SKEET RANGE
29 OLD PISTOL RANGE
30 BUILDING 2015 DRY WELL



LEGEND

▼ PROPOSED FRESHWATER SEDIMENT SITE
● PROPOSED SOIL BORING SAMPLE SITE
PROPOSED MW INSTALLATION SITE

0 550 1100
SCALE IN FEET

ACAD: H:\CADD\7581\7581OM09.DWG 09/23/97 MF

Baltimore District
CORPS OF ENGINEERS
PITTSBURGH, PA 15222

DSGN: DR: CH ENG:
SUPP'S: CHK:
SUBMITTED BY: (FIRM NAME/REP) (TITLE)
CHECKED BY: Dsn: PPE: NO: NO: DR:
OFFICER IN CHARGE APPROVED (DATE)

REV.	DESCRIPTION	PREP BY	DATE	APPRVD
			10-2-97	STR
			10-2-97	

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
ENGINEERING FIELD ACTIVITY CHESAPEAKE
WASHINGTON, DC
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MD

STUMP NECK ANNEX BACKGROUND INVESTIGATION

SAMPLE LOCATIONS

SEAL AREA

SAT TO DATE
CODE I.D. NO. 80091
SCALE : AS SHOWN
SPEC. NO. 04 – NA
CONSTRN. CONTR. NO. NA
NAVFAC DRAWING NO. NA
SHEET 1 OF 1
SIZE: D
DIS. SH. NO. FIG. 2–2

proposed groundwater, soil (subsurface and surface), and freshwater sediment sampling locations for Stump Neck Annex.

Table 2-2 describes the candidate sampling locations and types of samples to be collected at each location for the background investigation. (Additional soil sampling locations will be selected if the field geologist reports heterogeneous soil types.) Final selection of sampling locations will take place following discussions with Navy and regulatory personnel and field determinations, as necessary. All samples collected will be analyzed for the chemical parameters and physical properties described in Section 2.5.

2.3.1 Groundwater Sampling

Only one new monitoring well location has been proposed as part of the background investigation for Stump Neck Annex. This monitoring well location will be finalized based on Navy and regulatory comments to this work plan and based on field determinations (i.e., logistical constraints in the field). The proposed location was described in previous sections and is shown on Figure 2-2. As the locations have been carefully selected to avoid known areas of site activity (undisturbed to the greatest extent possible to represent site background), it is not anticipated that unexploded ordnance (UXO) will be a problem. The health and safety plan (Appendix A) does, however have provisions in case UXO is encountered. Each well location will be checked for the presence of underground utilities prior to drilling operations, and the locations modified as necessary to avoid any utilities present. Given the topography and location of these wells, groundwater may be encountered as shallow as 15 to 20 feet below ground surface. The monitoring wells will be installed in accordance with the specifications described in Section 3.0 of this Work Plan.

One groundwater sample will be collected from the monitoring well and analyzed at a fixed-base laboratory for the aqueous parameters listed in Section 2.5 of this work plan. A slug test will be performed on all newly installed monitoring wells to determine permeability characteristics of the aquifer. Synoptic water-level measurements will also be collected.

2.3.2 Subsurface Soil Sampling

Subsurface soil sampling and analysis will be conducted to determine background concentrations of parameters listed in Section 2.5. A subsurface sample will be obtained at the newly installed well location (as described above) and the soil boring locations (a maximum of 3 proposed) shown in Figure 2-2. The subsurface soil samples will be collected at the soil interval 3 to 5 feet below ground surface or the soil interval just above the water table if the water table is very shallow.

TABLE 2-2

BACKGROUND STUDY WORK PLAN
POTENTIAL STUMP NECK ANNEX BACKGROUND SAMPLE LOCATIONS AND TYPES
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

Monitoring Wells (MW), Subsurface Soil (SB), And Surface Soil (SS) (Shown On Figure As Red And White Quadrant Circle)	**Location Description As Shown On Figure 2-2**
MW + SB + SS	~1700' south of the main gate just off the cul-de-sac in the wildlife viewing area
SUBSURFACE SOIL (SB) AND SURFACE SOIL (SS) (Shown On Figure As A Solid Blue Circle)	**Location Description As Shown On Figure 2-2**
SB + SS	~1100' west northwest of Site 27 just northeast of unpaved road
SB + SS	~1100' southeast of the intersection of Archer Avenue and Roach Road
SB + SS	~250' east of the Marshall Road and Sopchick Road intersection near munitions disassembly bldg.
Freshwater Sediment (SD) (Shown on Figure As A Green Triangle)	**Location Description As Shown On Figure 2-2**
SD	~500' east southeast of the Archer Avenue and Roach Road intersection
SD	~825' south southeast of Site 38 west off Rum Point Road
SD	~1375' southeast of Site 38 east of Rum Point Road
SD	~1700' south of the main gate and south of the cul-de-sac in the wildlife viewing area

The subsurface soil samples will be analyzed at a fixed-base laboratory for the parameters listed in Section 2.5 of this work plan.

2.3.3 Surface Soil Sampling

Surface soil sampling and analysis will be conducted to determine background concentrations of parameters listed in Section 2.5. Surface samples will be obtained at the newly installed well location (as described above) and the soil boring locations (a maximum of 3 proposed) shown in Figure 2-2. These surface soil samples will be collected at the soil interval 0 to 1 foot below ground surface.

The surface soil samples will be analyzed at a fixed-base laboratory for the parameters listed in Section 2.5 of this work plan.

2.3.4 Freshwater Sediment Sampling

Freshwater sediment sampling and analysis will be conducted to determine background concentrations of parameters listed in Section 2.5. Freshwater sediment samples will be obtained at locations (4) shown in Figure 2-2.

The freshwater sediment samples will be analyzed at a fixed-base laboratory for the parameters listed in Section 2.5 of this work plan.

2.4 INVESTIGATIVE APPROACH FOR SAMPLING OFF BASE

This section presents the approach for obtaining off-base soil and sediment samples for the background study at Indian Head. These off-base sample locations were added to the investigation to supplement those locations selected for Indian Head and Stump Neck Annex. Subsurface soils sampling will be discussed first, followed by surface soils and freshwater sediment sampling. Figure 2-3 shows the potential soil (subsurface and surface), and freshwater sediment sampling locations for off-base samples.

Table 2-3 describes the candidate sampling locations and types of samples to be collected at each location for the background investigation. Final selection of sampling locations will take place following discussions with Navy personnel and field determinations, as necessary. All samples collected will be analyzed for the chemical parameters and physical properties described in Section 2.5

TABLE 2-3

BACKGROUND STUDY WORK PLAN
POTENTIAL OFF-BASE BACKGROUND SAMPLE LOCATIONS AND TYPES
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

SUBSURFACE SOIL (SB) AND SURFACE SOIL (SS) (Shown On Figure As A Solid Blue Circle)	**Location Description As Shown On Figure 2-3**
SB + SS	Smallwood State Park, ~2000' west of state Route 224 just off Sweden Point Road
SB + SS	Smallwood State Park, ~3000' northwest of the state Route 224 and Ironsides Rison Road intersection
Freshwater Sediment (SD) (Shown on Figure As A Green Triangle)	**Location Description As Shown On Figure 2-3**
SD	Smallwood State Park, ~2000' west of state Route 224 just off Sweden Point Road
SD	Smallwood State Park, ~3000' northwest of the state Route 224 and Ironsides Rison Road intersection
SD	Doncaster State Forest, ~1400' north of Maryland Route 6 and ~40' east of Forest Road

2.4.1 Subsurface Soil Sampling

Subsurface soil sampling and analysis will be conducted to determine background concentrations of parameters listed in Section 2.5. Subsurface samples will be obtained at the two proposed locations as shown in Figure 2-3. The subsurface soil samples will be collected at the soil interval 3 to 5 feet below ground surface (bgs) or the soil interval just above the water table if the water table is very shallow.

2.4.2 Surface Soil Sampling

Surface soil sampling and analysis will be conducted to determine background concentrations of parameters listed in Section 2.5. Surface samples will be obtained from the two proposed soil boring locations as shown in Figure 2-3. These surface soil samples will be collected at the soil interval 0 to 1 foot below ground surface.

The surface soil samples will be analyzed at a fixed-base laboratory for the parameters listed in Section 2.5 of this work plan.

2.4.3 Freshwater Sediment Sampling

Freshwater sediment sampling and analysis will be conducted to determine background concentrations of parameters listed in Section 2.5. Freshwater sediment samples will be obtained at locations (3) shown in Figure 2-3.

The freshwater sediment samples will be analyzed at a fixed-base laboratory for the parameters listed in Section 2.5 of this work plan.

2.5 BACKGROUND ANALYTICAL PROGRAM

The purpose of the background investigation is to collect background data usable in any environmental investigation conducted at the Naval Surface Warfare Center, Indian Head. The QAPP (Appendix D) lists detailed analytes and requirements for aqueous and solid matrix background environmental samples to be collected as part of this work plan.

The following sections provide a brief overview of the analyses to be performed.

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NSWC INDIAN HEAD BACKGROUND INVESTIGATION

OFF BASE SAMPLE LOCATIONS

● Proposed Soil Boring Sample Site

▲ Proposed Freshwater Sediment Sample Site

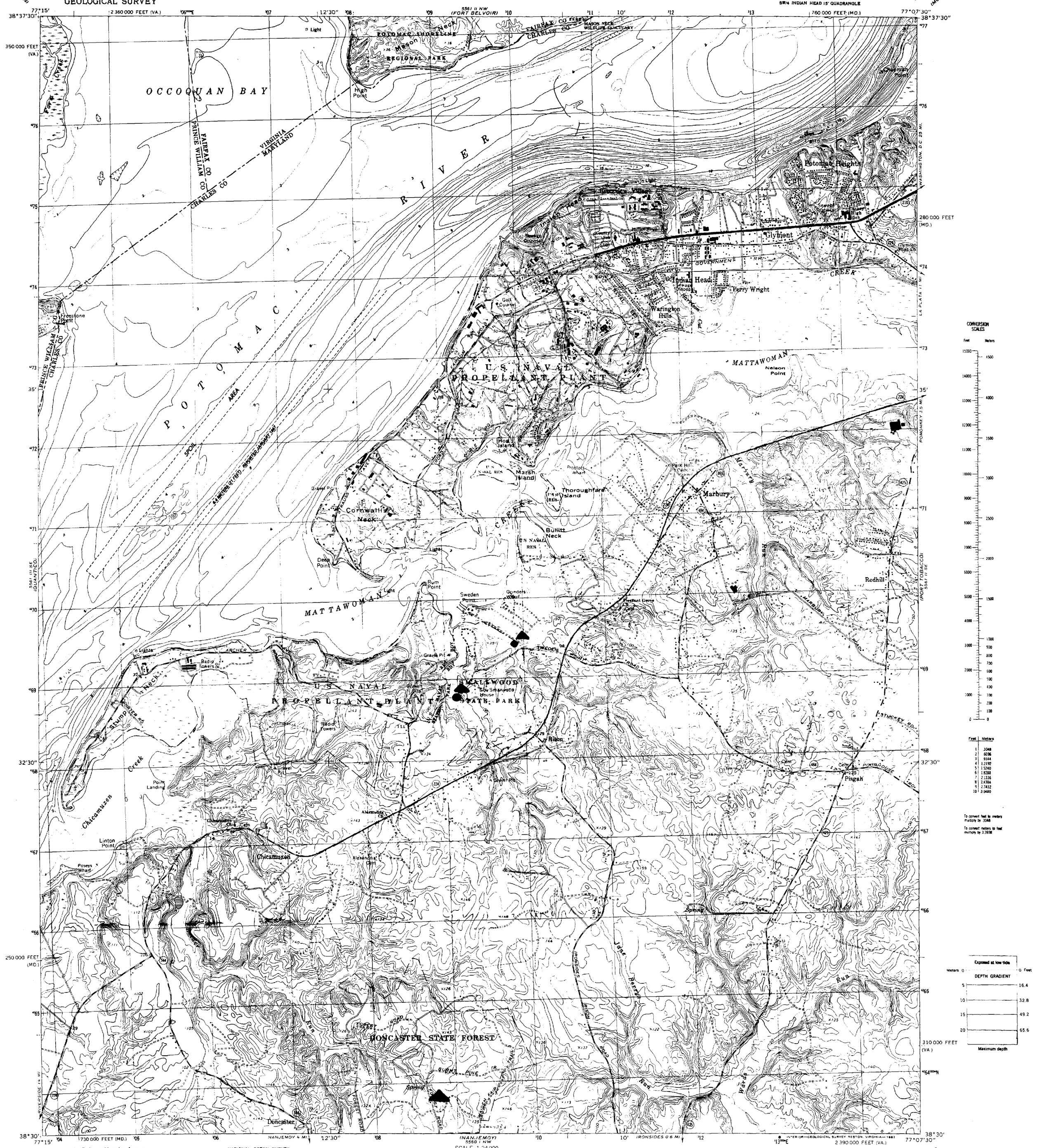
FIGURE 2-3

10-2-97 MC

10-2-97 BUR

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

INDIAN HEAD QUADRANGLE
MARYLAND–VIRGINIA
7.5 MINUTE SERIES (TOPOGRAPHIC–BATHYMETRIC)
SW/4 INDIAN HEAD 15' QUADRANGLE



Mapped by the Defense Mapping Agency
Edited and published by the Geological Survey and the National Ocean Survey

Control by USGS, NOS/NOAA, and USCE

Topography by photogrammetric methods from aerial photographs taken 1950. Field checked 1956. Revised by the Geological Survey 1966

Bathymetry compiled by the National Ocean Survey from tide-coordinated hydrographic surveys. This information is not intended for navigational purposes

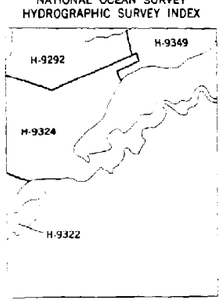
Mean low water (dotted) line and mean high water (heavy solid) line compiled by NOS from tide-coordinated aerial photographs. Apparent shoreline (outer edge of vegetation) shown by light solid line

Polyconic projection. 10,000-foot grid ticks based on Maryland coordinate system, and Virginia coordinate system, north zone
1000-meter Universal Transverse Mercator grid, zone 18
1927 North American Datum
To place on the predicted North American Datum 1983 move the projection lines 9 meters south and 26 meters west as shown by dashed corner ticks

There may be private inholdings within the boundaries of the National or State reservations shown on this map

Revisions shown in purple compiled by the Geological Survey in cooperation with the Commonwealth of Virginia agencies from aerial photographs taken 1977 and other sources. This information not field checked. Map edited 1978

NATIONAL OCEAN SURVEY
HYDROGRAPHIC SURVEY INDEX



HYDROGRAPHIC SURVEY INFORMATION

Survey Number	Survey Date	Survey Scale	Survey Line spacing (Naut. Miles)
H-9292	1973	1:10,000	.02–.05
H-9322	1972	1:10,000	.01–.06
H-9324	1972–74	1:10,000	.01–.05
H-9349	1973	1:10,000	.01–.05

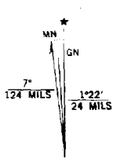
SCALE 1:24 000

1 MILE — 7000 FEET — 1 KILOMETER

CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929
BATHYMETRIC CONTOUR INTERVAL 1 METER WITH SUPPLEMENTARY 0.5 METER CONTOURS—DATUM IS MEAN LOW WATER
THE RELATIONSHIP BETWEEN THE TWO DATUMS IS VARIABLE
THE MEAN RANGE OF TIDE IS APPROXIMATELY 0.5 METER

BASE MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
BATHYMETRIC SURVEY DATA COMPLIES WITH INTERNATIONAL HYDROGRAPHIC ORGANIZATION (IHO) SPECIAL PUBLICATION 44 ACCURACY STANDARDS AND/OR STANDARDS USED AT THE DATE OF THE SURVEY
FOR SALE BY U. S. GEOLOGICAL SURVEY
DENVER, COLORADO 80225, OR RESTON, VIRGINIA 22092
NATIONAL OCEAN SERVICE, ROCKVILLE, MARYLAND 20852
AND VIRGINIA DIVISION OF MINERAL RESOURCES, CHARLOTTESVILLE, VIRGINIA 22903
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

QUADRANGLE LOCATION



UTM GRID AND 1978 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

ROAD CLASSIFICATION

Heavy-duty — Light-duty
Medium-duty — Unimproved dirt
State Route

INDIAN HEAD, MD.–VA.
SW/4 INDIAN HEAD 15' QUADRANGLE
38077-E2-TB-024

1966
PHOTOREVISED 1978
BATHYMETRY ADDED 1982
DMA 5561 II SW–SERIES V833

00516A05X

2.5.1 Aqueous Sample Analytical Parameters and Methods

All aqueous samples collected for this Background Investigation will be analyzed for the same parameters. The detailed lists of parameters are provided in the QAPP (Appendix D). The table below provides a brief summary of the analyses to be performed.

AQUEOUS SAMPLE PARAMETERS AND ANALYTICAL METHODS

Media	Parameter	Method
Aqueous	Target Compound List (TCL) Pesticide/PCB Organic Compounds	SW-846 Method 8081
	Target Analyte List (TAL) Metals and Tin	SW-846 Method 6010A/ 7000 Series
	Dissolved Target Analyte List (TAL) Metals and Tin	SW-846 Method 6010A/ 7000 Series
	Total Organic Carbon (TOC)	SW-846 Method 9060
	Total Organic Halogens (TOX)	SW-846 Method 9020B
	Anions (SO_4, Cl, NO_3, NO_2, PO_4, F)	EPA Method 300.0
	Total Dissolved Solids (TDS)	EPA Method 160.1
	Total Suspended Solids (TSS)	EPA Method 160.2
	Ammonia	EPA Method 350.2

2.5.2 Solid Sample Analytical Parameters and Methods

All solid samples collected for this Background Investigation will be analyzed for the same parameters. The detailed lists of parameters are provided in the QAPP (Appendix D). The table below provides a brief summary of the analyses to be performed.

SOLID SAMPLE PARAMETERS AND ANALYTICAL METHODS

Media	Parameter	Method
Solid	Target Compound List (TCL) Pesticide/PCB Organic Compounds	SW-846 Method 8081
	Target Analyte List (TAL) Metals and Tin	SW-846 Method 6010A/ 7000 Series
	Total Organic Halogens (TOX)	SW-846 Method 9020B
	Total Organic Carbon (TOC)	Lloyd Kahn
	Grain Size Distribution	ASTM D422

3.0 FIELD SAMPLING AND ANALYSIS PLAN

3.1 FIELD OPERATIONS

3.1.1 Field Operations Summary

The field background investigation (BI) to be performed at Indian Head and Stump Neck Annex will consist of groundwater, soil, and sediment environmental sampling at locations shown in Figures 2-1 and 2-2. The scope of services for the field investigation will include installation and sampling of groundwater monitoring wells, soil borings, and sediment sampling, groundwater monitoring, well development, groundwater monitoring-well tagging, and surveying services.

A maximum of 10 groundwater samples, 40 soil samples, and 10 sediment samples will be collected during this investigation. As few as 20 soil samples may be collected if the field geologists observes that soil types collected at an initial 10 sampling locations are similar. A minimum of 5 and a maximum of 10 groundwater samples will be collected from 5 newly installed monitoring wells and 5 existing monitoring wells. Background/upgradient monitoring wells installed as a result of environmental investigations conducted under CTO 222 and the underground storage tanks (UST) program are being considered as suitable monitoring wells for this background investigation. Proposed sampling locations were identified in Section 2.0.

3.1.2 Mobilization/Demobilization

Following approval of the BI Work Plan, B&R Environmental will prepare drilling specifications, obtain a drilling subcontractor, and begin mobilization activities. All field team members will review the Work Plan, Health and Safety Plan (HASP) (Appendix A) and Quality Assurance/Quality Control (QA/QC) Plan (Appendix D) In addition, a field team orientation meeting will be held to familiarize personnel with the scope of the field activities.

The Field Operations Leader (FOL) will be responsible for the day-to-day operations regarding all site activities. The FOL will coordinate the mobilization activities upon arrival at the facility. The FOL will also make any equipment purchases required to conduct the field investigation. The equipment required for the field activities will be driven or shipped to the site by the FOL and a technician/geologist. After field activities are completed, project personnel will demobilize the equipment.

3.1.3 Soil Boring/Monitoring Well Soil Samples

Soil samples will be obtained from two intervals at each monitoring well and soil boring location. Soil samples will be collected at depths of 0 to 1 foot below surface and from 3 feet to 5 feet below surface.

A drilling subcontractor will be utilized during installation of the groundwater monitoring wells and the excavation of the soil borings. Hollow-stem auger methods will be used for advancing the soil borings. Soil samples will be collected using split-spoon sampling techniques and following American Society for Testing and Materials (ASTM) Method 1586 procedures. Split-spoon samples will be collected continuously from the ground surface to the water table. Drilling fluids will not be used during soil boring activities. Split-spoon samplers will be decontaminated between samples as described in Section 3.1.6. Sample handling and chain-of-custody requirements are addressed in Sections 3.2.2 and 3.2.4. All pertinent field data will be recorded using the appropriate sample log sheet and the field log book.

A lithologic description will be completed for each split-spoon sample and a complete log of each boring will be maintained in accordance with B&R Environmental SOP GH-1.5, Sections 5.2, 5.4, and 5.5. A sample Soil Boring Log is attached in Appendix B. At a minimum, the boring log will contain the following information:

- Sample numbers and types
- Sample depths
- Standard Penetration Test data
- Sample recovery/sample interval
- Soil density or cohesiveness
- Soil color and moisture
- Unified Soil Classification System (USCS) material description and symbol

In addition, depths of changes in lithology, depth to water, OVA/HNu readings (if appropriate), drilling methods, and total depth of each borehole will be included on each boring log. The driller will prepare a separate, written, boring log for each boring drilled, to be submitted to the field geologist at the conclusion of the field activities. All activities will be recorded within field log books maintained by site personnel.

Tables 3-1 and 3-2 summarize the aqueous and soil sampling programs. Samples will be preserved in accordance with B&R Environmental SOP SA-6.1. Sample handling and preservation requirements are shown in Table 3-3.

TABLE 3-1

BACKGROUND STUDY WORK PLAN
AQUEOUS SAMPLING PROGRAM
INDIAN HEAD AND STUMP NECK ANNEX
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

Parameter	Method	No. of Samples (1)	No. of Equipment Blanks(3)	No. of Field Blanks(3)	No. of Field Duplicates	No. of MS/MSDs	Total No. of Samples
TCL Pesticide/PCB Organic Compounds	SW-846 Method 8081	10	5	2	1	1	19
TAL Metals and Tin	SW-846 Method 6010A/ 7000 Series	10	5	2	1	1	19
Dissolved TAL Metals and Tin	SW-846 Method 6010A/ 7000 Series	10	5	2	1	1	19
TOC	SW-846 Method 9060	10	5	2	1	1	19
TOX	SW-846 Method 9020B	10	5	2	1	1	19
Anions (SO_4, Cl, NO_3, NO_2, PO_4, F)	EPA Method 300.0	10	5	2	1	1	19
Total Dissolved Solids	EPA Method 160.1	10	5	2	1	1	19
Total Suspended Solids	EPA Method 160.2	10	5	2	1	NA(4)	18

1 Assumed maximum number of groundwater samples.
2 Number is estimated - see Section 3.2.3 for details regarding frequency of collection.
3 Matrix spike analysis is not applicable. However, laboratory duplicate analysis will be performed.

TABLE 3-2

BACKGROUND STUDY WORK PLAN
SOILS AND SEDIMENT SAMPLING PROGRAM
INDIAN HEAD AND STUMP NECK ANNEX
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

Parameter	Method	No. of Samples (1)	No. of Equipment Blanks(3)	No. of Field Blanks(3)	No. of Field Duplicates	No. of MS/MSDs	Total No. of Samples
TCL Pesticide/PCB Organic Compounds	SW-846 Method 8081	47	5	2	5	1	60
TAL Metals and Tin	SW-846 Method 6010A/ 7000 Series	47	5	2	5	1	60
TOC	SW-846 Method 9060	47	5	2	5	1	60
TOX	SW-846 Method 9020B	47	5	2	5	1	60
Grain Size Distribution	ASTM D422	47	NA	NA	5	NA	52

1 Assumed maximum number of 20 surface soil, 20 subsurface soil, and 7 sediment samples.
2 Number is estimated - see Section 3.2.3 for details regarding frequency of collection.

TABLE 3-3

BACKGROUND STUDY WORK PLAN
SAMPLE CONTAINERS, PRESERVATION METHODS, AND HOLDING TIMES
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND
PAGE 1 OF 2

Analytical Method	Parameter	Container Material	Container Volume[1]	Preservation[2]	Holding Time[3]
Aqueous Samples					
SW-846 8081	TCL Organochlorine Pesticides/PCBs	Amber glass with Teflon-lined cap	Two 1 Liter	4°C	Extract 7 days; Analyze 40 days
SW-846 6010A/7000 Series	TAL Metals + Tin (total and dissolved)	Polyethylene bottle, plastic cap	1 Liter	HNO_3 to pH < 2	6 months; Mercury - 28 days
EPA 350.2	Ammonia	Polyethylene bottle, plastic cap	1 Liter	4°C; H_2SO_4 to pH < 2	28 days
EPA 300.0	Sulfate	Polyethylene bottle, plastic cap	1 Liter[5]	4°C	28 days
EPA 300.0	Chloride	Polyethylene bottle, plastic cap	1 Liter[5]	4°C	28 days
EPA 300.0	Nitrate	Polyethylene bottle, plastic cap	1 Liter[5]	4°C	48 hours
EPA 300.0	Nitrite	Polyethylene bottle, plastic cap	1 Liter[5]	4°C	48 hours
EPA 300.0	Total Phosphate	Polyethylene bottle, plastic cap	1 Liter[5]	4°C	48 hours
EPA 300.0	Fluoride	Polyethylene bottle, plastic cap	1 Liter[5]	None required	28 days
EPA 160.1	Total Dissolved Solids	Polyethylene bottle, plastic cap	250 mL	4°C	7 days
EPA 160.2	Total Suspended Solids (TSS)	Polyethylene bottle, plastic cap	250 mL	4°C	7 days
SW-846 9060	Total Organic Carbon (TOC)	Polyethylene bottle, plastic cap	250 mL	4°C	28 days
SW-846 9020B	Total Organic Halides (TOX)	Amber glass with Teflon-lined cap	500 mL	4°C; H_2SO_4 to pH < 2	28 days
Solid Samples					
SW-846 8081	TCL Organochlorine Pesticides/PCBs	Wide-mouth glass jar with Teflon-lined lid	240 mL (8 oz.)	4°C	Extract 7 days; Analyze 40 days
SW-846 6010A/ 7000 Series	TAL Metals + Tin	Wide-mouth glass jar with Teflon-lined lid	240 mL (8 oz.)	4°C	6 months; Mercury - 28 days
ASTM D422	Grain Size	Wide-mouth glass jar with Teflon-lined lid	120 mL (4 oz.)	None required	None
Lloyd Kahn	Total Organic Carbon (TOC)	Wide-mouth glass jar with Teflon-lined lid	120 mL (4 oz.)	4°C	14 days

TABLE 3-3

BACKGROUND STUDY WORK PLAN
SAMPLE CONTAINERS, PRESERVATION METHODS, AND HOLDING TIMES
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND
PAGE 2 OF 2

Analytical Method	Parameter	Container Material	Container Volume(1)	Preservation(2)	Holding Time(3)
SW 9020	Total Organic Halides (TOX)	Wide-mouth glass jar with Teflon-lined lid	120 mL (4 oz.)	4°C	28 days

1 Container volume may vary based on laboratory.
2 H_2SO_4 = Sulfuric acid; HNO_3 = Nitric acid
3 Measured from time of sample collection.
4 For aqueous samples, one 1 Liter container will provide sufficient sample volume for all anions to be measured by EPA Method 300.0.

3.1.4 Monitoring Well Construction and Sampling

3.1.4.1 Groundwater Monitoring Well Installation

A maximum of five groundwater monitoring wells will be installed during the background environmental investigation of Indian Head and Stump Neck Annex. The final locations will be based upon comments received from the Navy and field determinations. All regulatory requirements will be met concerning the application for, permitting of, construction of, and completion of all monitoring wells. A typical well is shown on Figure 3-1.

Well Installation/Permits

The monitoring wells will be installed by a Maryland-licensed well driller. The well driller will apply for and obtain permits from the Charles County Health Department prior to well installation.

Well Casing/Screen Construction

Monitoring wells will be constructed using 2-inch I.D. schedule 40 polyvinyl chloride (PVC). Slotted PVC well screens will be used for this project. The slot size for the screens for this project are to be 10 (thousandths of an inch) and will not exceed 20 (thousandths of an inch).

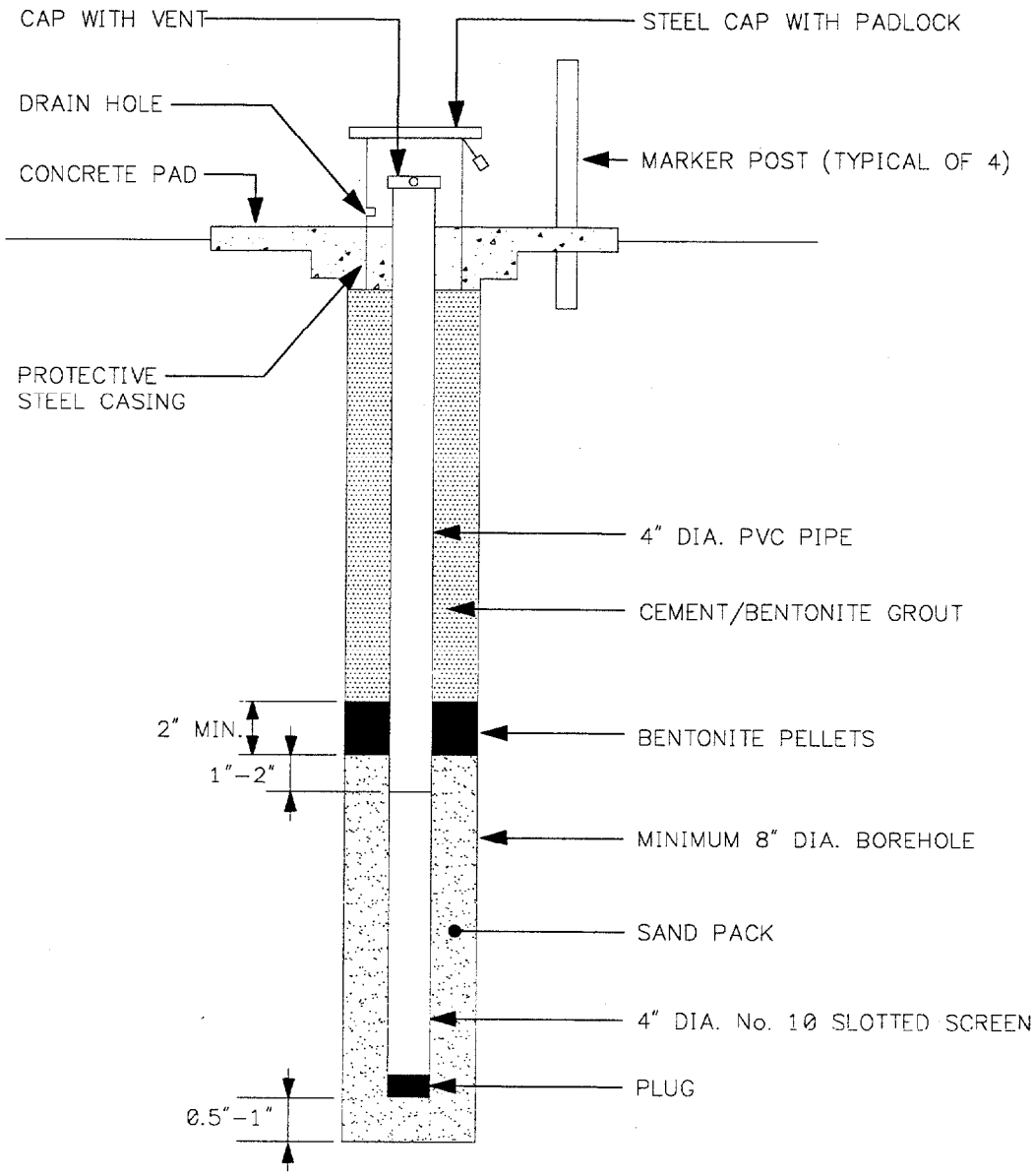
Screened Interval

Well screens will be 10 feet in length. The groundwater monitoring wells will be installed such that the screened interval straddles the water table with the screen 8 feet within the saturated zone. It is anticipated that the total well depth of the screened interval will be approximately 12 to 15 feet below ground surface. After the borings are drilled to the desired depth the well screen and riser pipe will be installed through the augers or temporary casing to the desired depth.

Boring Diameter

Well borings will be drilled at a minimum of 8-inches in diameter to allow adequate annular space between the well screen/casing and borehole sides. This will allow sufficient space for proper placement of the sand pack, bentonite pellet seal, and cement-bentonite grout.

ACAD: K:\CADD\7581\7581CM14.DWG 06/18/97 TAD



DRAWN BY TAD DATE 6/97	Brown & Root Environmental	CONTRACT NO. 7581	OWNER NO. ———
CHECKED BY DATE	DETAIL OF TYPICAL MONITORING WELL NAVAL SURFACE WARFARE CENTER INDIAN HEAD, MD	APPROVED BY DATE	
COST/SCHED-AREA		APPROVED BY DATE	
SCALE AS NOTED		DRAWING NO. FIGURE 3-1	REV. 0

FORM CADD NO. SOUTH_AV.DWG - REV 0 - 02/07/97

Centralizers

Centralizers will not be used for the well installations. Because of the shallow depths of the wells (estimated maximum 15 feet) the use of centralizers is not necessary to ensure proper alignment of the wells in the borings.

Annular Space Packing

The annulus of the boring around the well screen, and 1 to 2 feet above the well screen, will be backfilled with clean silica sand (No. 20 to 30 U.S. Standard Sieve size or as determined by the site geologist). A bentonite pellet seal with 2-foot minimum thickness will then be installed above the sand pack and allowed to hydrate as per the manufacturer's recommendations.

Annular Space Grouting

The remainder of the boring annulus, from the seal to the ground surface, will then be backfilled with cement/bentonite grout placed using a tremie pipe. The depths of all backfill materials will be constantly monitored during the well installation process by means of a weighted stainless steel or plastic tape. Because of the anticipated shallow depth to groundwater and the resulting shallow depths of the wells, the thickness of the backfill materials above the well may require adjustment in the field.

Well Protection

A minimum 6-inch diameter or 4-inch square protective steel casing equipped with a locking steel cap will be installed around each well. The casings will be grouted a minimum of 3 feet into the ground, will have at least one drain hole positioned approximately 0.5 feet above the ground surface, and will extend approximately 2 feet (±0.5 feet) above the top of the surrounding concrete pad. A 0.5-foot thick concrete apron measuring 3 feet by 3 feet will be constructed, equally portioned around the casing of each well, with the base set at least 3 inches below ground surface. Upon completion of groundwater sampling from monitoring wells, the protective casing will be painted glow-orange. All monitoring wells will be locked and will be identically keyed.

3.1.4.2 Well Development

The groundwater monitoring wells will be developed after installation to remove fine textured material and sediments from the area around the well screens and to remove drill cuttings and residual fluids from the area around the monitored interval of the boring. Wells will be developed by bailing and surging, or by pumping, as determined by the field geologist. Wells will be developed until water removed is visibly clear of suspended solids or until approved by the field geologist. This will be done in compliance with SOP GH-2.8,

which is included in Appendix C. Disposal of development and purge water removed from monitoring wells will be performed as discussed in Section 3.1.7.

3.1.4.3 Water Level Measurements

One complete round of water level measurements will be obtained from all monitoring wells. This round will be obtained either during high tide or during low tide conditions. The round of water level measurements will be taken within a 2-hour period of consistent weather conditions to minimize atmospheric/precipitation effects on groundwater levels. Measurements will be taken with an electronic water level indicator using a marked or notched location on the top of the well casing as the reference point for determining depths to water. Water level measurements will be recorded to the nearest 0.01 foot in the appropriate field logbook and on Groundwater Level Measurement Forms (attached in Appendix B).

3.1.4.4 Groundwater Sampling

One round of groundwater samples will be obtained from the newly installed and existing groundwater monitoring wells selected for this Background Investigation. All groundwater wells will be sampled in accordance with B&R Environmental SOP SA-1.1, included in Appendix C.

Prior to obtaining samples, water levels will be measured and the wells will be purged using a low flow pumping technique. Approximately three to six well volumes will be purged. If the wells are purged dry with less than three well volumes removed, the water level in the well will be allowed to recover to at least 70 percent of the original level prior to sampling. In the event that recovery is slow, samples will be collected within 24 hours of purging. Field measurements of pH, temperature, turbidity, dissolved oxygen, salinity, and specific conductance will be taken for each well volume during purging according to B&R Environmental SOP SA-1.1, Section 5, included in Appendix C. Stabilization is defined as follows: temperature ± 1°C, pH ± 0.2 units, specific conductivity ± 5 percent. If these parameters do not stabilize after three volumes, up to six volumes may be removed, as determined by the field geologist. Low flow pumping techniques will be used for well sampling instead of bailers. Water samples will be pumped directly into the appropriate sample containers for laboratory analysis. This technique is used to minimize turbidity, drawdown, and reduce loss of volatile organics when they are sampled.

All pertinent field data shall be recorded using the appropriate sample log sheet and the field log book (see B&R Environmental SOP SA-6.3, included in Appendix C). A Monitoring Well Log Sheet is attached in Appendix B.

Tables 3-1 and 3-2 summarize target analytes for the Background Investigation study which are further detailed in the QAPP (Appendix D). Samples will be preserved in accordance with B&R Environmental SOP SA-6.1, included in Appendix C. Sample handling and preservation requirements are shown in Table 3-3. Chain-of-custody requirements are discussed in Section 3.2.4 and in the Quality Assurance/Quality Control (QA/QC) Plan attached as Appendix D.

3.1.4.5 Well Tagging

All wells will be tagged with the well construction permit number clearly visible from the outside of the well.

Well completion reports will be completed for each well installed, and a copy of the well completion report forms will be submitted to the Charles County Health Department and to the State of Maryland within 30 days of well completion. A project summary describing the installation procedure will accompany the copies of the completion reports, and will contain an accurate map depicting the precise location of all wells installed at the site in relation to known landmarks; a detailed description of the construction of the wells installed including casing, screen, gravel pack and grout intervals; the elevation of the top of the concrete pad installed at the base of the protective outer well casing; the top-of-casing elevation; and both the static and pumping water levels to the nearest 1/100th of a foot.

3.1.4.6 Well Abandonment Procedures

In the event it becomes necessary to abandon any groundwater monitoring well, it will be filled and sealed in such a way that it will not act as a channel for the interchange of waters of undesirable quality with waters of desirable quality and will not present a hazard to humans or animals. Any abandoned well will be sealed by or under the supervision of a well driller licensed by the Maryland State Board of Well Drillers.

Materials for sealing wells will comply with COMAR 26.04.04.11(E). Procedures for sealing wells will comply with the requirements of COMAR 26.04.04.11(F). Placement of material used in abandoning wells will comply with COMAR 26.04.04.11(G).

3.1.5 Surveying

All monitoring well locations will be surveyed following installation or collection. Soil boring and sediment sampling locations will not be surveyed, because the data will not be used to define the nature and extent of contamination. However, the locations can be reproduced based on the field log and descriptions in this plan. Existing survey monuments and site grids within Indian Head and Stump Neck Annex will be utilized as reference points if applicable. The horizontal locations of all points will be surveyed to the nearest 0.1 foot.

Vertical elevations will be referenced to the 1929 North American Datum. The elevation of the monitoring wells shall be surveyed to the nearest 0.01 foot at the measuring point where the uncapped riser pipe is notched. Ground surface elevations will also be surveyed to the nearest 0.01 foot.

3.1.6 Decontamination of Equipment

The equipment involved in field sampling activities will be decontaminated prior to and during drilling and sampling activities. This equipment includes drilling rigs, downhole tools, augers, well casing and screens, and all sampling equipment (with the exception of the dedicated bailers and rope used to obtain groundwater samples).

3.1.6.1 Major Equipment

All downhole drilling equipment and sampling tools shall be steam cleaned prior to beginning work, between well borings, any time the drilling rig leaves the site prior to completing a boring, and at the completion of the drilling program. In addition, well casing and screens shall be steam cleaned prior to being installed into the borings.

These decontamination operations will consist of washing the equipment using a high-pressure steam wash. All decontamination activities will take place at a location determined during mobilization. It is assumed that the facility will provide a suitable location for decontamination operations along with potable water and electricity. B&R Environmental will coordinate with site personnel in advance of field operations to determine the appropriate location of decontamination operations. Because this is a Background Investigation, the water generated from the steam cleaning process will be returned to the site. Additional requirements for drilling equipment decontamination can be found in B&R Environmental SOP SA-7.1, Section 5 attached in Appendix C.

3.1.6.2 Sampling Equipment

With the exception of the dedicated bailers and rope used to obtain groundwater samples, all equipment used for collecting samples will be decontaminated both prior to beginning field sampling and between samples. The following decontamination steps will be taken:

- Potable water rinse
- Alconox or liquinox detergent wash
- Potable water rinse
- Distilled/deionized water rinse

- HCl acid rinse
- Distilled/deionized water rinse
- Isopropanol rinse
- Distilled/deionized water rinse
- Air dry

Field analytical equipment such as pH, conductivity, and temperature instrument probes will be rinsed first with analyte-free water, then with the sample liquid. Decontamination of sampling equipment will be done in accordance with B&R Environmental SOP SA-7.1, Section 5. B&R Environmental will provide all decontamination fluids except potable water for rinsing. All wash and rinse water shall be containerized, labeled as to its contents, and dated using indelible ink.

3.1.7 Handling of Investigative Derived Waste

Because this is a background environmental study, chemical parameter concentrations are expected to be very low. Therefore, all development and purge liquids will be returned to the surface soils unless directed otherwise by the Activity. Likewise, all drill cuttings will also be returned to the surface soils unless directed otherwise by the Activity. Decontamination fluids (other than water) will be collected, containerized, and stored in DOT-approved (specification 17-C) 55-gallon drums. All drums will be sealed and labeled with site location, drum contents, well/boring number, and date in indelible ink. Personnel of B&R Environmental, the Naval School Explosive Ordnance Disposal, NAVEODTECHDIV, and IHDIVNAVSURFWARCEN will coordinate regarding the management of investigation derived waste prior to initiation of field activities.

3.1.8 Field Equipment Calibration and Maintenance

Field equipment, such as pH, temperature and specific conductance meters or organic vapor analyzers (OVA) and photo-ionization detectors (PID's) will be calibrated and maintained according to the manufacturer's SOP and SOP SA-1.1. Field equipment for which SOP's are not available will be calibrated and operated in accordance with the manufacturer's recommendations.

3.2 SAMPLE HANDLING AND ANALYSIS

3.2.1 Sample Analysis Summary

Samples collected during the background field investigation will be submitted for analysis as presented in Tables 3-1 and 3-2 and in accordance with the requirements specified in the QAPP (Appendix D). These tables include the analytical parameters, preservation methods, holding times, bottle requirements and

analytical method for each sample. The majority of the samples collected will be analyzed by the analytical laboratory using a thirty (30) day turnaround time. Quality assurance samples (e.g., duplicates, trip blanks, equipment blanks, etc.) will be collected and analyzed per Naval Facilities Engineering Service Center (NFESC) requirements.

3.2.2 Sample Handling

Each sample collected during the field operation will be assigned a unique sample tracking number. The sample tracking number will consist of a 12-segment, alpha-numeric code that identifies the (1) site number, (2) sample type, (3) location, and (4) the sample depth (in the case of sediment and soil samples), and (5) sample round. Any other pertinent information regarding sample identification will be recorded in the field logbooks and on sample log-sheets.

3.2.2.1 Sampling Identification System

The alpha-numeric coding to be used in the sample numbering system is explained in the following diagram and the subsequent definitions:

Site Number	Sample Type	Sample Location	Sample Depth	Sample Round
NNN	AA	NNN	NN	NN

Character type:

A = Alpha

N = Numeric

Site Number:

IBG = Indian Head Background Sample

SBG = Stump Neck Annex Background Sample

Sample Type:

SB = Soil boring sample

SS = Surface soil sample

SD = Sediment sample

MW= Groundwater monitoring well sample

SW= Surface water sample

TB = Trip Blank

FB = Field Blank

RB = Equipment Rinsate Blank

Sample Location:

Sample station locations of a given medium will be numbered sequentially beginning with "001" for all media.

Sample Depth:

Sample depths will represent the horizon from which the sample was obtained. For example, if ten split-spoon samples were collected from a boring, they would be numbered 01 through 10. This field will also be used for the designation of filtered and unfiltered samples. An unfiltered groundwater sample shall be designated as 1U. The corresponding filtered sample shall be designated as 1F.

Ten percent of all samples sent to the fixed-based laboratory for analysis shall be submitted as field duplicates to monitor precision of sample acquisition and laboratory analysis techniques. Field duplicates will be submitted with blinded identification.

3.2.2.2 Example of Sample Labeling System

The following is an example of the sample identification scheme:

The first unfiltered groundwater sample collected from a background monitoring well BGMW01 located on the Indian Head facility would be labeled: IBG MW0011U01.

3.2.3 Quality Control Samples

In addition to regular calibration of field equipment and appropriate documentation, quality control (QC) samples will be collected or generated during environmental sampling activities. QC samples include trip blanks, field duplicates, field blanks, and equipment rinsate blanks. Tables 3-1 and 3-2 present the type and number of required QC samples. Each type of field QC sample is defined as follows:

- **Field Duplicates**. Field duplicates are two samples collected either: (1) independently at a sampling location in the case of groundwater or surface water; or (2) as a single sample split into two portions in the case of soil or sediment. Duplicates are obtained during a single act of sampling and are used to assess the overall precision of the sampling and analysis program. Ten percent of all samples for each media shall be field duplicates. Duplicates shall be analyzed for the same parameters in the laboratory as the original sample.

- **Equipment Rinsate Blanks**. Equipment rinsate blanks are obtained under representative field conditions by running analyte-free water through sample collection equipment (split-spoon, corer, etc.) after decontamination and placing it in the appropriate sample containers for analysis. Equipment rinsate blanks will be used to assess the effectiveness of decontamination procedures and are analyzed for the same suite of parameters as the associated samples.

Equipment rinsate blanks will be collected for each type of non-dedicated sampling equipment used and will be submitted at a frequency of one per day per media. However, only the equipment blanks obtained every other day will be analyzed. Those not analyzed will be retained by the laboratory until completion of field activities. It will be the responsibility of the FOL to communicate to the laboratory whether an equipment blank is, or is not, to be analyzed as stated above.

- **Field Blanks.** Field blanks are obtained by sampling the water(s) used for decontamination during the field investigation. Samples consist of source water used in (1) steam cleaning of large equipment; and (2) analyte-free water used for decontamination of sampling equipment. Field blanks will be used to confirm the effectiveness of decontamination procedures and to determine whether the analyte-free water or the potable water (used for steam cleaning) may be contributing to sample contamination. Field blanks will be collected for each type of water used for decontamination and will be submitted at a frequency of one per sampling event. Field blanks are analyzed for the entire suite of parameters (as applicable) identified in the project.

- **Matrix Spike/Duplicates.** Matrix spike/matrix spike duplicate analyses are performed as internal QC checks. For organic analyses, the matrix spike (MS) is analyzed in duplicate (MSD). For inorganic analyses, an MS is analyzed as well as an (unspiked) laboratory duplicate (LD). To accommodate these laboratory QC analyses, the field crew must provide extra aliquots of sample, as required. With the exception of VOC MS/MSDs, these samples will be homogenized before being split into three aliquots. These extra sample aliquots are identified with the same sample location information as the selected environmental sample but are designated for MS/MSD analysis in the "comments" section on the chain-of-custody. Extra aliquots for MS/MSD analysis will be provided to the laboratory with a frequency of one set per 20 samples of similar matrix.

3.2.4 Sample Custody

Custody of samples will be maintained and documented at all times. Chain of custody begins with the collection of the samples in the field. A sample is in custody if:

- It is in the field investigator's or the transferee's actual possession.
- It is in the field investigator's or the transferee's view, after being in his/her physical possession.
- It was in the field investigator's or the transferee's physical possession and then secured to prevent tampering.

- It is placed in a designated secure area.

A chain-of-custody record form shall be used to record the custody of all samples collected and maintained by B&R Environmental personnel. The chain of custody (COC) also serves as a sample logging mechanism for the laboratory. Section 5.3 of B&R Environmental SOP SA-6.3, contained in Appendix C, provides a description of the COC procedures that will be followed. An example of the COC record form is included in Appendix B.

Samples will be packaged and shipped in accordance with Section 5.4 of SOP SA-6.1, contained in Appendix C. The field operations leader will be responsible for contacting the laboratory for notification of shipment and will report the following:

- Site name/code
- Number(s), matrix, and concentration(s) of samples shipped
- Method of shipment (e.g., hand delivered, overnight carrier)
- Date of shipment
- Suspected hazards associated with the samples or site

3.2.5 Sampling Forms

3.2.5.1 Sample Labels

One label will be filled out for each sample container sent for onsite and fixed-base laboratory analysis. The sample label description and procedures for completion are found in B&R Environmental SOP SA-6.3 Section 5.2 (see Appendix C).

3.2.5.2 Chain-of-Custody Record

The chain-of-custody record form accompanies a sample (or group of samples) as it is transferred from person to person. This form must be used for any sample collected for chemical or geotechnical analysis, whether on site or off site. An example of the chain-of-custody record form is included in Appendix B. Procedures for using this form are contained in SOP SA-6.3 (see Appendix C). At the completion of field activities, the chain-of-custody record form will be placed in the project file.

3.2.5.3 Custody Seal

The Custody Seal is a 1-inch by 3-inch adhesive backed label. It is part of a chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field. It is used whenever samples are shipped to an offsite laboratory with an accompanying chain-of-custody record form. Procedures for using chain-of-custody seals are described in SOP SA-6.3 (see Appendix C).

3.2.5.4 Sample Logsheet and Logbook

A sample logsheet will be filled out for each sample collected during the field investigation. The data recorded on these sheets are useful in describing the sample as well as pointing out any problems encountered during sampling. Sample information, such as container source and description, sample description type, and disposition, as well as time, date, and sample method, are recorded on this form. All QA/QC samples (duplicates, rinsates, trip blanks, and field blanks) will have separate sample log sheets listing sample date and time, sample location, and any other important sample data. Appendix B contains an example of a sample logsheet for various sample media. The sample logsheets are sequentially numbered when placed in the sample logbook, and the sample number and logsheet page numbers are recorded in the sample logbook table of contents (placed at the front of the logbook) for easy reference and access. At the completion of field activities, the sample logbook containing all sample logsheets will be placed in the project file.

3.2.5.5 Equipment Calibration Log Form

Each B&R Environmental field instrument requiring calibration will have a separate equipment calibration log form (see Appendix B) which documents that the manufacturer's instructions were followed for calibration of the equipment, including frequency and type of standard or calibration device. The information placed on the form documents the accuracy, precision or sensitivity of the measurement, and, if necessary, will be used to determine if correction should be applied to the readings. A separate form will be established and maintained for each of the field instruments used during this sampling activity. Field monitoring and measuring equipment will be calibrated daily (at a minimum) and as needed if calibration problems with the instruments are noted. All forms will be maintained in a secured central file. At the completion of field activities the notebook containing the forms will be placed in the project file.

4.0 BACKGROUND INVESTIGATION REPORT

As specified in the Cost Impact Letter No. 1 for CTO No. 287, a Background Investigation (BI) for Indian Head and Stump Neck Annex is required. The results of the background environmental investigation described in Sections 2.0 and 3.0 of this Work Plan will be summarized in a BI Report. This section describes the subtasks which will be performed during the preparation of the DRAFT and FINAL BI reports.

4.1 DATA TRACKING AND VALIDATION

Upon completion of laboratory analysis and receipt of laboratory data by B&R Environmental, the analytical data will undergo a full data validation quality assurance/quality control review. B&R Environmental chemists will validate 100 percent of the analytical data generated by the fixed-based laboratory. The most recently promulgated EPA Region III validation protocol will be used to validate the analytical data.

Data validation is a systemic process of reviewing a body of data to provide assurance that the analytical results are adequate for their intended use. This process includes, but is not limited to, the following activities:

- Auditing measurement system calibration and calibration verification.
- Auditing quality control activities
- Screening data sets for outliers and assigning applicable data qualifiers
- Reviewing data for technical credibility
- Checking intermediate calculations
- Evaluating data with reference to the results of laboratory and field quality assurance/quality control samples

Data validation chemists will work with the Field Operations Leader to assure that analytical results have been received for all samples collected during the field investigation and listed on the chain-of-custody forms generated during the field investigation. A complete, validated, and accurate electronic database will be the product of this subtask.

Background data from other studies conducted by B&R Environmental may be used if appropriate confidence in validation status can be obtained. Data from sources evaluated will not be considered unless the data validation history can be obtained.

4.2 DATA EVALUATION/INTERPRETATION

Data evaluation and interpretation will be initiated upon the receipt of validated data. Data will be summarized into a useable format for data manipulation and presentation. Tables and drawings (as appropriate) will be created to exhibit data and contaminant concentrations. Data evaluation and interpretation includes, but is not limited to, the following items:

- Evaluation/interpretation of the nature of background concentrations based on the results of the analysis of groundwater, soil, and sediment samples collected during the field investigation.

- Evaluation of hydrogeological data (i.e., water level measurements) collected for background locations during the field investigation.

Additionally, two technical memorandum will be prepared and forwarded to the Navy (and all other appropriate reviewers) detailing, (1) statistical protocol used to evaluate the background data sets and (2) evaluation protocol used to accept the background data collected at the various locations as representative of background conditions at the Naval Surface Warfare Center.

4.3 REPORT PREPARATION

The results of the data validation, data evaluation, and data interpretation tasks described in Sections 4.1 and 4.2 will be presented in DRAFT and FINAL BI Reports. The BI report will:

- Document the investigative activities conducted during the field background investigations conducted at Indian Head and Stump Neck Annex.

- Consolidate the results of the investigative activities conducted during the field background investigations conducted at Indian Head and Stump Neck Annex.

- Present the conclusions of the data evaluation and interpretation.

- Identify any potential data gaps evident at the conclusion of the Background Investigation implemented via this Work Plan.

The project manager will present the results and conclusions of the BI Report at a meeting with the Navy and EPA.

5.0 PROJECT MANAGEMENT APPROACH

This section describes the project management and organization and provides a schedule identifying the project milestones.

5.1 PROJECT ORGANIZATION

The proposed project organization for the Background Investigations (BI) at Indian Head and Stump Neck is shown in Figure 5-1.

The Program Manager, Mr. John Trepanowski, and the Deputy Program Manager, Mr. Daryl Hutson, are responsible for the overall quality of work performed under CLEAN Contract No. N62472-90-D-1298. Mr. Trepanowski and Mr. Hutson will be responsible for all contract negotiations with the Navy and the subcontractors; will maintain client relationships; and will assume overall responsibility for staffing, maintenance of schedule, adherence to budget, and quality of technical work performed. They are B&R Environmental's designated authority to commit resources to this effort. Mr. Trepanowski, Mr. Hutson, and the Project Manager are the focal points of all project activities; they will be immediately accessible to the Navy.

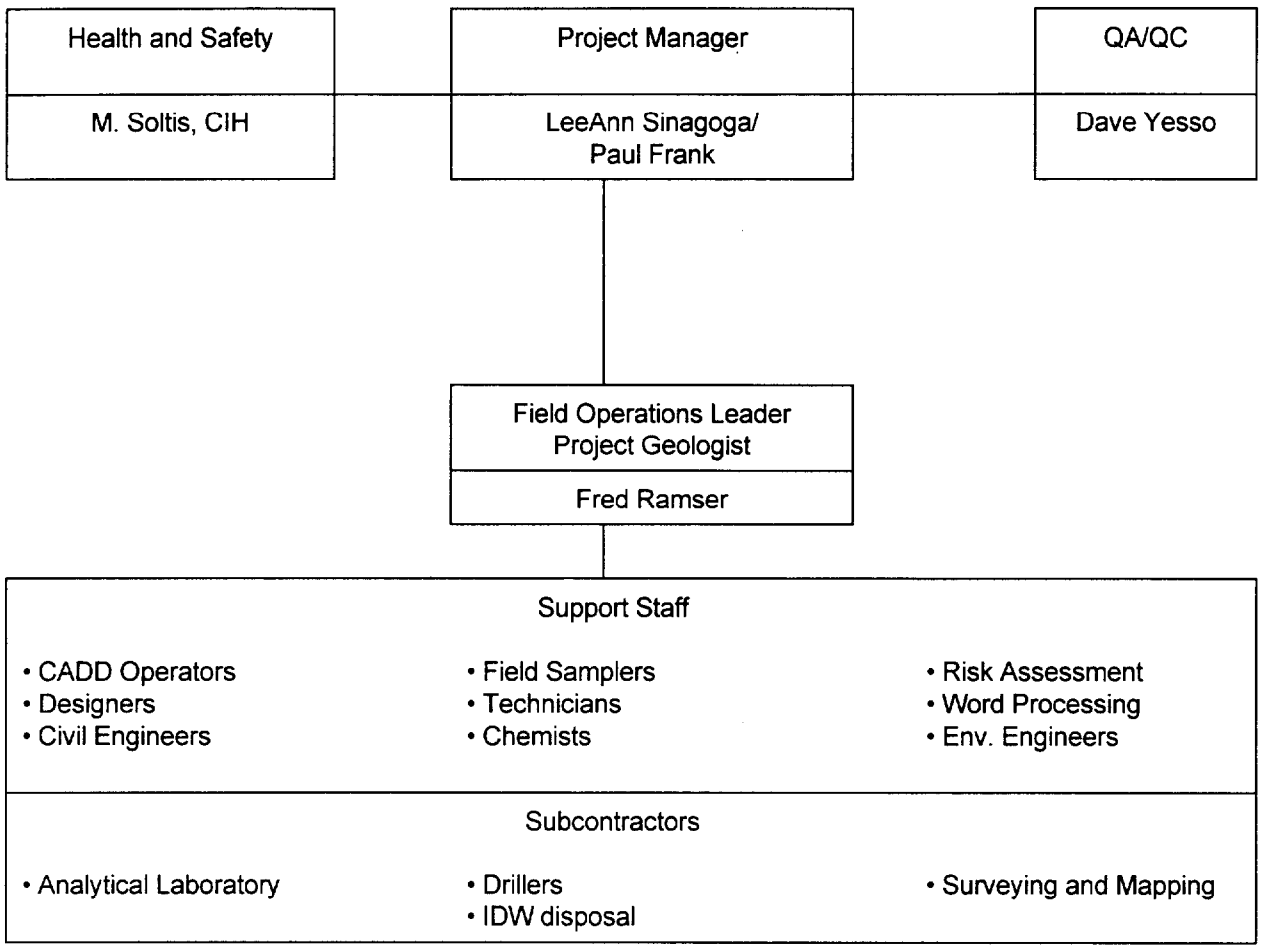
Ms. LeeAnn Sinagoga will serve as the Project Manager (PM). Mr. Paul Frank will act as Deputy Project Manager (DPM). The PM and DPM have primary responsibility for implementing and executing the BI Work Plan. Ms. Sinagoga and Mr. Frank will coordinate and manage the day-to-day technical aspects of the project and project team activities, and will be responsible for maintenance and tracking of project schedule and budget, coordination and preparation of all required reports, assignment of technical responsibilities to appropriate Task Leaders and subcontractors, and administrative support activities. Their technical responsibilities include overall direction of the staff in the performance of the BI and associated activities. The PM and DPM will also review and/or prepare input for Work Plans/proposals and reports, and coordinate with subcontractors, as appropriate, to obtain necessary input to analyses and reports.

Supporting the PM and DPM are the Contracting Officer (Ms. Margaret Price), the Quality Assurance Manager (Dr. David Yesso), the Health and Safety Manager (Mr. Matt Soltis), the Field Operations Leader (FOL), and other technical staff.

Subcontractors will be required for the fieldwork portions of this BI Work Plan. The subcontractors required will be a driller, a surveyor, an analytical laboratory to analyze the samples collected, and an investigation derived waste (IDW) disposal contractor. The B&R Environmental Program Manager will

FIGURE 5-1

BACKGROUND INVESTIGATION PROJECT ORGANIZATION CHART
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND



maintain ultimate control and accountability for the project by means of formal subcontract agreements with subcontractors and through directives and communication with the subcontractors' program and project management staff. The B&R Environmental Project Manager will have management and administrative authority for the subcontracts under authority of the Program Manager.

5.2 PROJECT SCHEDULE AND BUDGET

Figure 5-2 depicts the schedule of tasks and activities for the BI Work Plan. The schedule for the investigation assumes that minimal site restrictions will be encountered and is dependent on Navy and EPA approval of this work plan and subsequent deliverables.

In addition to the milestones shown in Figure 5-2, additional task milestones are as follows:

Monthly Reports	7th working day of each month
Summary meeting minutes	5 working days after each meeting

CTO 287 SCHEDULE

Task	CTO Plan Begin	Act. Begin	CTO Plan End	Act. End	% Comp.
Task 0400 - Background Investigation	6/3/97	6/3/97	2/23/98	NA	61%
Data Review Meeting No. 1	5/19/97	6/3/97	5/22/97	6/3/97	100%
Prepare Draft Work Plan	6/5/97	6/5/97	6/20/97	6/20/97	100%
Submit Draft Work Plan	***6/20/97***	***6/20/97***	***6/20/97***	***6/20/97***	***100%***
Regulatory Review	6/21/97	6/21/97	7/18/97	9/22/97	100%
Prepare Final Work Plan	9/23/97	9/23/97	10/2/97	10/2/97	100%
Submit Final Work Plan	***10/3/97***	***10/3/97***	***10/3/97***	***10/3/97***	***100%***
Field Work	6/16/97	7/7/97	8/15/97	8/18/97	100%
Lab Analysis	6/27/97	7/9/97	9/15/97	9/23/97	100%
Data Validation	8/15/97	8/15/97	10/15/97	NA	30%
Database/Statistics	10/16/97	NA	11/14/97	NA	0%
Prepare Draft Background Report	11/17/97	NA	12/17/97	NA	0%
Submit Draft Background Report	***12/17/97***	***NA***	***12/17/97***	***NA***	***0%***
Data Review Meeting No. 2	1/7/98	NA	1/7/98	NA	0%
Regulatory Review	12/18/97	NA	1/19/98	NA	0%
Prepare Final Background Report	1/20/98	NA	2/23/98	NA	0%
Submit Final Background Report	***2/23/98***	***NA***	***2/23/98***	***NA***	***0%***

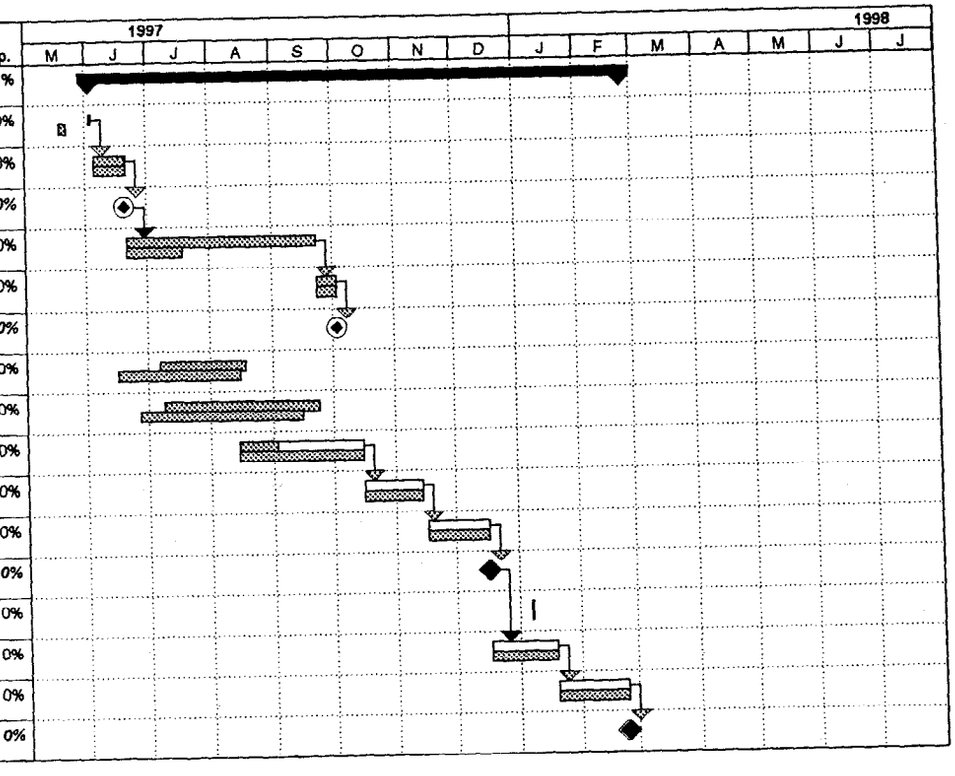


FIGURE 5-2

SCHEDULE FOR CTO 287
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

Brown & Root Environmental

Critical Path Item - Anticipated Progress
Critical Path Item - Actual Progress
Noncritical Path Item - Anticipated Progress
Noncritical Path Item - Actual Progress
CTO Schedule

CTO Schedule Milestone
Anticipated Milestone
Actual Milestone
Summary

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APPENDIX A

HEALTH AND SAFETY PLAN

Project Specific Health and Safety Plan

for

Background Investigation Indian Head & Stump Neck Annex Naval Surface Warfare Center Indian Head, Maryland

Engineering Field Activity Chesapeake
Naval Facilities Engineering Command
Northern Division Contract No. N62472-90-D-1298
Contract Task Order 0287

October 1997

PROJECT SPECIFIC
HEALTH AND SAFETY PLAN
FOR
BACKGROUND INVESTIGATION
INDIAN HEAD AND STUMP NECK ANNEX, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Engineering Field Activity Chesapeake
Environmental Branch Code 181
Naval Facilities Engineering Command
Washington Navy Yard, Building 212
Washington, D.C. 20374-2121

Submitted by:
Brown & Root Environmental
600 Clark Avenue, Suite 3
King of Prussia, PA 19406-1433

NORTHERN DIVISION CONTRACT NO. N62472-90-D-1298
CONTRACT TASK ORDER 0287

OCTOBER 1997

SUBMITTED BY:

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ATTACHMENTS

Attachment 1 Tick Control and Lyme Disease

1.0 INTRODUCTION

The objective of this Health and Safety Plan (HASP) is to provide the minimum safety practices and procedures for Brown & Root Environmental (B&R Environmental) and subcontractor personnel engaged in proposed background investigation activities that are to be conducted at the Indian Head and Stump Neck Annex areas of the Naval Surface Warfare Center (NSWC) facility, 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. This HASP has been designed to be used in conjunction with the Brown & Root Environmental 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 B&R Environmental standard operating procedures. It is recommended that both documents 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 3.0. Should the proposed work site conditions and/or suspected hazards change, or if new information becomes available this document will be modified. All changes to the HASP will be made with the approval of the B&R Environmental CLEAN Health and Safety Manager (HSM) and the Project Manager (PM). The PM will notify all affected personnel of all changes. Revision indicators within the plan and Section 14.0 Document Status will record all changes to this plan.

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." The information contained in this plan, as well as policies on conducting on site operations, have been obtained from the B&R Environmental Health and Safety Program and Indian Head Division NSWC policies and procedures.

1.1 AUTHORITY

This Contract Task Order (CTO) 287 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. N62472-90-D-1298.

1.2 KEY PROJECT PERSONNEL AND ORGANIZATION

This section defines responsibility for site safety and health for B&R Environmental and subcontractor employees engaged in on site activities. Personnel assigned to these positions shall exercise the primary responsibility for all 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 B&R Environmental PM is responsible for the overall direction and implementation of health and safety for this project.

- The B&R Environmental 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 all aspects of health and safety on site. These duties may include the following:

  - Coordinates all 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 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 all on site personnel.

- Compliance with these requirements is monitored by the Project Health and Safety Officer (PHSO) and is coordinated through the HSM.

1.3 SITE INFORMATION AND PERSONNEL ASSIGNMENTS

Site Name: Indian Head and Stump Neck Annex, NSWC **Address:** Indian Head, Maryland

Site Point of Contact: Mr. Shawn Jorgensen **Phone Number:** (301) 743-6745

Purpose of Site Visit: Collection of background samples including surface and subsurface soils, groundwater, and sediment samples.

Proposed Dates of Work: TBD

Project Team:

B&R Environmental Personnel:	Discipline/Tasks Assigned:
Ms. Lee Ann Sinagoga	Project Manager (PM)
Mr. Paul V. Frank	Deputy Project Manager (DPM)
Mr. Fred Ramser	Health and Safety Manager (HSM)
TBD	Site Safety Officer (SSO)
Donald J. Westerhoff, CSP	Project Health and Safety Officer (PHSO)

Non-B&R Environmental Personnel	Affiliation/Discipline/Tasks Assigned
TBD	
TBD	
TBD	

Prepared by: Donald J. Westerhoff, CSP

Reviewed and Approved by:

Lee Ann Sinagoga
Project Manager

Matthew M. Soltis, CIH, CSP
CLEAN Health & Safety Manager

2.0 EMERGENCY ACTION PLAN

2.1 INTRODUCTION

This section has been developed as part of a preplanning effort to direct and guide field personnel in the event of an emergency. Since a majority of potential emergency situations will require assistance from outside emergency responders, B&R Environmental and subcontractor personnel will not provide emergency response support for significant emergency events beyond the capabilities of on site personnel. In the event of emergencies that cannot be handled by on site personnel, an evacuation will be initiated. In an evacuation, site personnel will move to a safe place of refuge and the appropriate emergency response agencies will be notified. 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 operations, which ensures adequate emergency response time. This emergency action plan conforms to the requirements of OSHA Standard 29 CFR 1910.38(a), as allowed in OSHA 29 CFR 1910.120(l)(1)(ii).

B&R Environmental personnel will through the necessary actions provide incidental response measures for incidents such as:

- Incipient spill control and containment measures and prevention
- Removal of personnel from emergency situations
- Provision of initial medical support for injury/illnesses requiring only first-aid level support
- Provision of site control and security measures, as necessary

2.2 PRE-EMERGENCY PLANNING

Through the initial hazard/risk assessment effort, injury or illnesses resulting from exposure to chemical or physical hazards or fire are the most probable emergencies that could be encountered during site activities. To minimize and eliminate these potential emergency situations, pre-emergency planning activities associated with this project shall be implemented. The SSO and/or the FOL are responsible for:

- Coordinating response actions with Indian Head Division NSWC Emergency Services personnel to ensure that B&R Environmental emergency action activities are compatible with existing facility emergency response procedures.

- Site surveying and preparation of investigation areas prior to sending equipment and personnel in to initiate proposed activities. In this manner potential physical hazards can be identified, blocked or barricaded, or removed prior to exposing field personnel.

- Periodic site safety surveys of work activities performed by B&R Environmental FOL and/or the SSO, and subcontractor supervisory representative to identify potential hazards and emergency situations.

- 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 List (for substances used on site), with Material Safety Data Sheets.
  - On site personnel medical records (medical data sheets).
  - A logbook identifying personnel on site each day.
  - A copy of this HASP.
  - A copy of the B&R Environmental Health and Safety Guidance Manual.

- 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.

- Drilling and practicing incidental response measures periodically.

It will be the responsibility of the B&R Environmental FOL to ensure that this information is available and present at the site.

2.3 EMERGENCY RECOGNITION AND PREVENTION

2.3.1 Recognition

Foreseeable emergency situations that may be encountered during site activities will generally be recognizable by visual observation. Visual observation will be the principal method of identifying physical hazards that may be associated with the proposed scope of work. Visual observations may also play a role in detecting some chemical exposures. These potential hazards, the activities with which they have been associated, and the recommended control methods are discussed in detail in Sections 5.0 and 6.0 of

this document. Additionally, as stated above, early recognition will be supported by periodic site surveys to eliminate any situation predisposed to an emergency. The FOL, SSO, and subcontractor supervisory personnel will constitute the site evaluation team responsible for these periodic surveys. Site surveys will be conducted at least once a week during the initiation of this effort.

The above actions will provide for the early recognition of potential emergency situations. B&R Environmental will only provide incipient stage (i.e., early stage spill response) support. Should an incident take place, B&R Environmental will take defensive and offensive measures to control these situations depending on the nature and extent of the incident. However, if the FOL and the SSO determine that an incident has progressed to a serious emergency situation, B&R Environmental will withdraw, and notify the appropriate response agencies using Table 2-1.

2.3.2 Prevention

B&R Environmental and subcontractor personnel will minimize the potential for emergencies by ensuring compliance with the HASP, the Health and Safety Guidance Manual, applicable OSHA regulations, and by following directions given by those persons responsible for the health, safety, and welfare of the field crews.

2.4 SAFE DISTANCES AND PLACES OF REFUGE

In the event that the site must be evacuated, all personnel will immediately stop activities and report to a safe place of refuge at the support zone area. The safe place of refuge may also serve as the telephone communication point, as communication with emergency response agencies may be necessary. Telephone communication points and safe places of refuge will be determined prior to the commencement of site activities and will be conveyed to personnel as part of issuing the Safe Work Permits to be issued for all exclusion zones activities on a daily basis. Places of refuge and evacuation routes are identified in Section VII, of the Safe Work Permit (See Section 9.4). Upon reporting to the refuge location, personnel will remain there until directed otherwise by the B&R Environmental FOL, SSO, or the On-Scene Incident Commander. The FOL or the SSO will take a head count at this location to confirm the presence of all site personnel. The site logbook will be used to take the head count. Emergency response agencies will be notified of any unaccounted for personnel.

2.5 EVACUATION ROUTES AND PROCEDURES

Once an evacuation is initiated, personnel will terminate site activities and proceed immediately to the designated place of refuge as identified on the Safe Work Permit for activities conducted within that area, unless doing so would further jeopardize the welfare of workers. In such an event, personnel will proceed to a designated alternate location and remain there until further notification from the FOL. The use of these locations as assembly points provides communication and a direction point for emergency services, should they be needed.

Evacuation procedures will be discussed prior to the initiation of any work at the site. Primary and secondary evacuation routes will be conveyed to site personnel each day as part of issuing the Safe Work Permits for a particular task and area. Evacuation routes from the site 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) will influence the designation of evacuation routes. As a result, assembly points will be selected, and will be proceeded to by field personnel in the event of an emergency by the most direct route possible without further endangering themselves.

2.6 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.

TABLE 2-1
EMERGENCY REFERENCE
INDIAN HEAD AND STUMP NECK ANNEX NSWC,
INDIAN HEAD, MARYLAND

AGENCY	TELEPHONE
EMERGENCY	911
NSWC Fire Department	(301) 743-4281
NSWC Police Department	(301) 743-4333
NSWC Rescue or Ambulance	(301) 743-4449
Site Point of Contact Shawn Jorgensen	(301) 743-6745
Hospital: Physicians Memorial Hospital	(301) 645-0100
Hospital: Southern Maryland Hospital	(301) 868-8000
Chemtrec National Response Center	(800) 424-9300 (800) 424-8802
B&R Environmental, Pittsburgh Office	(412) 921-7090
Health and Safety Manager Matthew M. Soltis, CIH, CSP	(412) 921-8912
Project Health and Safety Officer Donald J. Westerhoff, CSP	(412) 921-7281
Deputy Project Manager, Paul V. Frank	(412) 921-8950
Project Manager Lee Ann Sinagoga	(412) 921-8887

2.7 EMERGENCY ALERTING AND ACTION/RESPONSE PROCEDURES

Since B&R Environmental personnel will not always be working in close proximity to each other, hand signals, voice commands, air horns, and two-way radios will comprise the mechanisms to alert site personnel of an emergency.

If an incident occurs, site personnel will initiate the following procedures:

- Initiate incident alerting procedures (if needed) verbally, by air horn, or using two-way radios.
- Describe to the FOL (who will serve as the Incident Coordinator) what has occurred and as many details as possible. Once all personnel are evacuated, incipient response procedures will be enacted to control the situation.
- If the FOL and/or the SSO determine that the situation is beyond the capabilities of the site personnel emergency services will be contact using the emergency reference information listed in Table 2-1. Explain the situation and the appropriate emergency services will be dispatched. **Stay on the phone and follow the instructions of the emergency dispatcher.**

2.8 PERSONAL PROTECTIVE EQUIPMENT (PPE) AND EMERGENCY EQUIPMENT

A first-aid kit, stretcher, fire extinguishers (strategically placed), and fire blanket will be maintained on site and shall be immediately available for use in the event of an incident. The PPE used in support of everyday activities will serve as the first line of defense in an emergency. This PPE will be required in all work areas of the site and will be accessible to authorized personnel.

2.9 EMERGENCY CONTACTS

Prior to performing work at the site, all personnel will be thoroughly briefed on the emergency procedures to be followed in the event of an accident. A mobile phone shall be available on site, if a telephone communications point near the area of operation is not available or if telephone service to the site trailer is not provided. As indicated earlier, Table 2-1 provides a list of emergency contacts and their corresponding telephone numbers. This table must be posted on site where it is readily available to all site personnel.

2.10 EMERGENCY ROUTE TO HOSPITAL

The closest hospital to NSWC is Physicians Memorial Hospital in La Plata, Maryland. The alternate hospital is Southern Maryland Hospital in Clinton, Maryland. Area maps showing the proximity of the NSWC to both of the hospitals shall be incorporated into this HASP as in Figures 2-1 and 2-2. Directions to the both Physicians Memorial Hospital and Southern Maryland Hospital are provided below:

Physicians Memorial Hospital:

Take Indian Head Highway (MD Route 210) North to MD Route 225. Turn right on 225 and follow until junction with MD Route 301. Turn right on 301. Turn left at the first traffic light. The hospital is on the right, about 1/2 block past the railroad tracks.

Southern Maryland Hospital:

Take Indian Head Highway (MD Route 210) North to MD Route 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.

FIGURE 2-1
Directions to Physicians Memorial Hospital

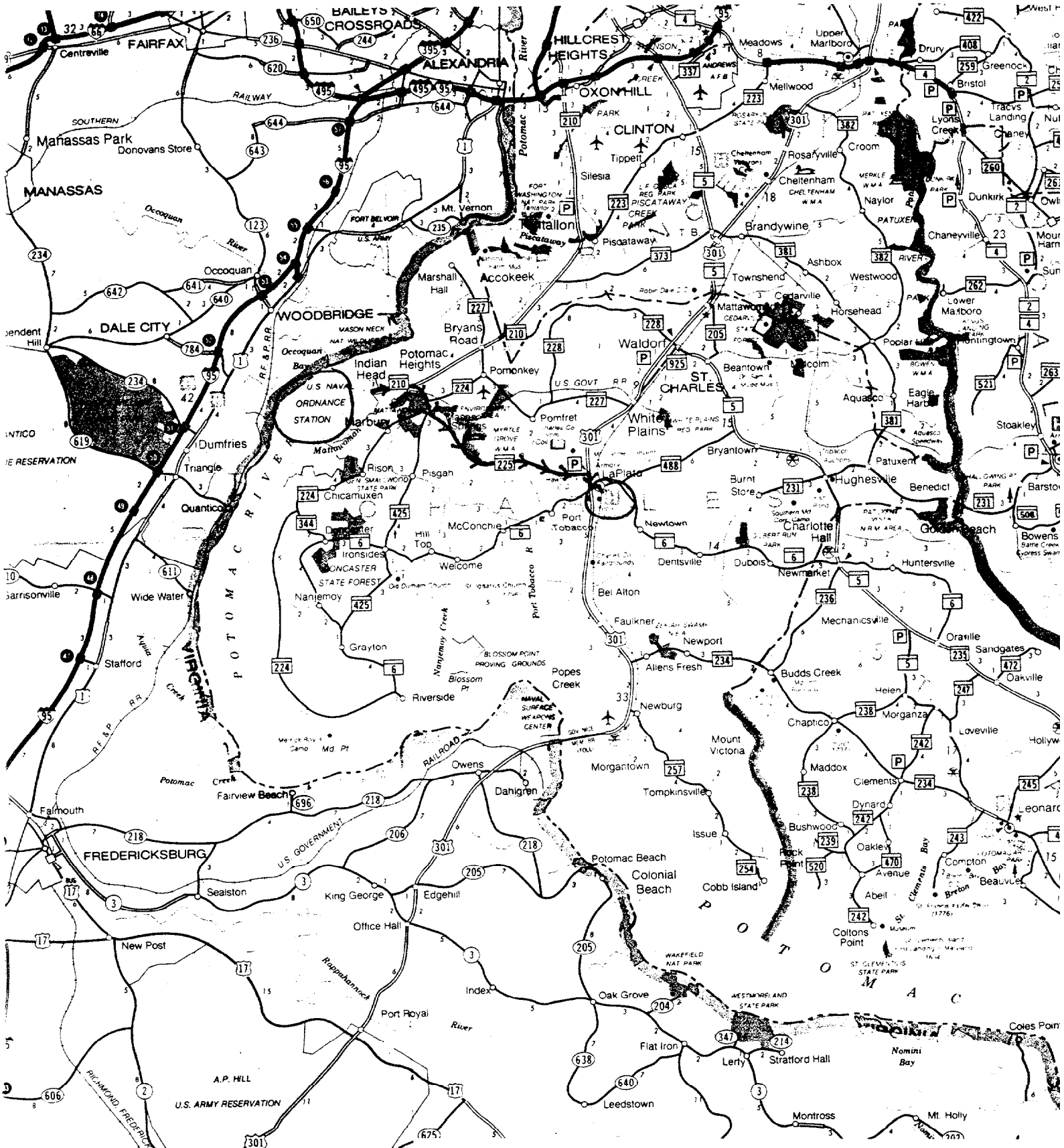
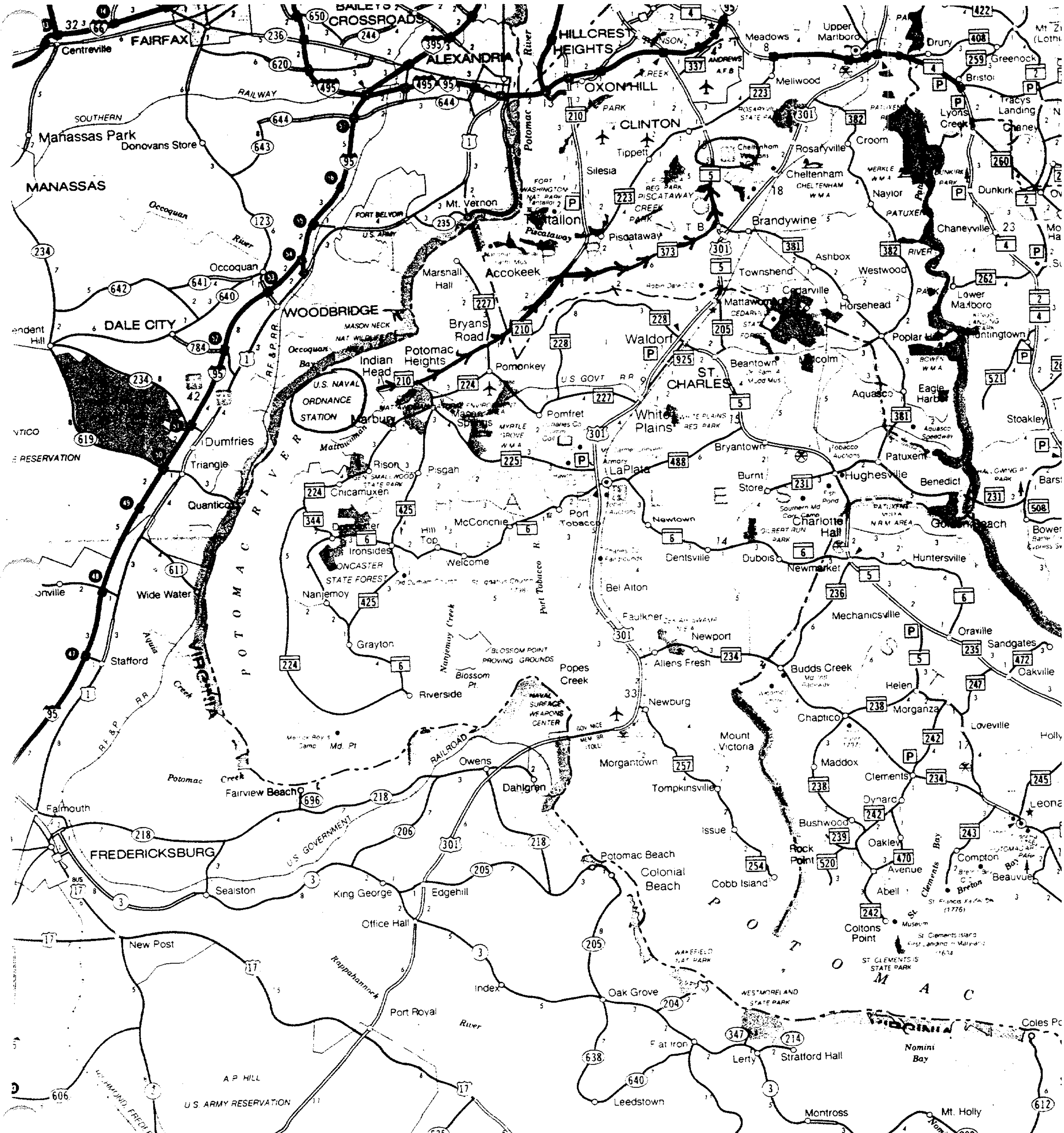


FIGURE 2-2
Directions To Southern Maryland Hospital



Bowling Green

CTO 0287
(Background Investigation)

3.0 SITE BACKGROUND

3.1 FACILITY HISTORY

Indian Head and Stump Neck Annex, Naval Surface Warfare Center are located in the northwestern section of Charles County, Maryland, approximately 25 miles south of Washington D.C. The Station consists of two areas: the main area and Stump Neck Annex. The two areas are located on two separate peninsulas along the eastern shore of the Potomac River. The main areas is on the Cornwallis Neck Peninisula. It 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 primary 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.

- Execute other responsibilities assigned by the Commander of the Station.

The primary mission on the Stump Neck Annex area of the Station is to:

- Provide Explosive Ordnance Disposal (EOD) technology and logistics management.

- Develop war-essential elements of intelligence, equipment, and procedures to counter munitions, both U.S. and foreign, as required to support Department of Defense components and the peacetime security needs of other agencies.

3.2 SITE ACTIVITIES

The purpose of the Background Investigation is to collect background groundwater, subsurface soil, surface soil, and sediment samples. Background sampling locations have been selected based on historical information which suggest uncontaminated areas at Indian Head and Stump Neck Annex.

3.2.1 Monitoring Well Installation and Groundwater Sampling

Various monitoring wells will be installed (using hollow-stem augering techniques) as part of the background investigation at the Indian Head and Stump Neck Annex. The locations of the monitoring wells have been selected to avoid known areas of site activity. As a result, it is not anticipated that soils and groundwater associated with the monitoring wells will contain any potential site contaminants. Furthermore, Unexploded Ordnance (UXO) previously identified as a hazard associated with other areas of the site, are not anticipated to be present during the Background Investigation.

One groundwater sample will be collected from each monitoring well and analyzed at a fixed-based laboratory. Slug tests will be performed on all newly installed monitoring wells to determine permeability characteristics of the acquifer. Synoptic water-level measurements will also be collected.

3.2.2 Subsurface Soil Sampling

Subsurface soil sampling and analysis will be conducted to determine background concentrations. Subsurface soil samples will be obtained at all newly installed well locations. The subsurface soil samples will be collected at the soil interval 3 to 5 feet below ground surface or the soil interval just above the water table if the water table is very shallow.

3.2.3 Surface Soil Sampling

Surface soil sampling and analysis will be conducted to determine background concentrations. Surface soil samples will be obtained at all newly installed well locations and soil boring locations.

3.2.4 Sediment Sampling

Sediment sampling and analysis will be conducted to determine background concentrations. Locations of sediment samples are provided in Figure 2-1 of the Work Plan. All sample analyses will be performed at a fixed-based laboratory.

4.0 SCOPE OF WORK

This section of the HASP addresses all proposed site activities that are to be conducted at the Indian Head and Stump Neck Annex, NSWC facility. This site-specific HASP, particularly Table 5-1, provides information related to each of those tasks to be performed as part of the scope of work. If other tasks, other than those identified, are to be performed at this site this HASP will have to be modified.

The activities to be conducted as part of the scope of work include mobilization and demobilization; subsurface soils collected through hollow-stem augering and split-spoon sampling techniques, surface soil, groundwater, and sediment sampling; and soil boring and monitoring well installations.

The above listings represent a summary of the identified tasks as they apply to the scope and application of this HASP. For a more detailed description of associated tasks see the Work Plan (WP) or the Sampling and Analysis Plan.

5.0 TASKS/HAZARDS/ASSOCIATED CONTROL MEASURES SUMMARIZATION

Table 5-1 of this section serves as the primary portion of this site-specific HASP, addressing the tasks that are to be performed. The anticipated hazards, recommended control measures, air monitoring recommendations, required PPE, and decontamination measures for each site task are discussed in detail in this table. This table and the associated control measures shall be changed if the scope of work, contaminants of concern, or site conditions change. Through using the table, the FOL and field personnel can determine which hazards are associated with each task, what hazards are present at each site area, and what associated control measures are necessary to minimize potentials for personnel exposure or injuries.

TABLE 5-1

TASKS/HAZARDS/CONTROL MEASURES COMPENDIUM
FOR INDIAN HEAD AND STUMP NECK ANNEX, NSWC, MARYLAND BACKGROUND INVESTIGATION

Tasks/Operation/ Locations	Anticipated Hazards	Recommended Control Measures	Air Monitoring Type/Action Levels	Personal Protective Equipment	Decontamination Procedures
Mobilization/ Demobilization	***Chemical hazards:*** Exposure to chemcial hazards 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: 1) Lifting (muscle strains and pulls) 2) Pinches and compressions 3) Slip, trips, and falls 4) Moving machinery 5) Natural hazards (Insect/animal bites and stings) 6) Vehicular and foot traffic	***Chemical Hazards:*** To eliminate potential chemical hazards associated with this task ensure the following: - A chemical inventory list is generated for all chemicals brought on site (Complete Section 5.0 of the B&R Health and Safety Guidance Manual). - Material Safety Data Sheets must be available for all chemicals brought on site (Complete Section 5.0 of the B&R Health and Safety Guidance Manual). - Materials are stored in accordance with recommended practices and according to compatibility (See MSDS for storage and compatibility recommendations). ***Physical hazards:*** 1) Employ machinery or multiple personnel for heavy lifts. - Use proper lifting techniques. 2) Use pinch bars or other equipment to keep hands from the point of operation. 3) Preview and prepare work locations where unstable/uneven terrain exists. Barricade all excavations deeper than 2 feet from access closer than two feet from the edge from foot and vehicular traffic. 4) All equipment to be employed will be - Inspected in accordance with OSHA, and manufacturers design. The inspection will include the completion of the Equipment Record Sheet documenting the review and acceptance/failure of safety devices, guards, emergency stops. The Equipment Record Sheet may be found in Section 10.0 of the B&R Environmental Health and Safety Guidance Manual. - Operated by knowledgeable operators, and knowledgeable ground crew, as applicable. - Establish safe zones of approach (i.e., Boom + 3 feet). - Secure all loose articles to avoid possible entanglement. 5) Avoid insect nesting areas, employ repellents (Do NOT use repellents during sampling activities). Report potential hazards to the SSO. Frequently inspect clothing and persons during and after activities in wooded areas for ticks and other vectors. 6) Identify all access/egress routes and locations to within established areas of operation. - All equipment capable of self propelled movement will be equipped with movement alarms as applicable. - Traffic regulations for NSWC are to be followed as posted. - Traffic regulations for B&R Environmental, operational areas will be posted by the SSO as required.	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 (Long sleeve shirt; long pants; or coveralls) - Safety shoes (Boots with steel toe/shank) - 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. 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 until the SSO can quantify the potential hazard through sound level measurements or noise dosimetry. **Note:** The Safe Work Permit(s) (See Section 9.4) 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. All 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. All 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. All equipment permitted to pass on/off site will be documented using an Equipment Record Sheet indicating the equipment serial number, description, brief history of the other sites the equipment has been on, and the results of the inspection. This form may be found within Section 10.0 of the B&R Environmental Health and Safety Guidance Manual.

TABLE 5-1
TASKS/HAZARDS/CONTROL MEASURES COMPENDIUM
FOR INDIAN HEAD AND STUMP NECK ANNEX, NSWC, INDIAN HEAD, MARYLAND BACKGROUND INVESTIGATION

Tasks/Operation/ Location	Anticipated Hazards	Recommended Control Measures	Air Monitoring	Personal Protective Equipment	Decontamination Procedures
Soil Borings and Monitoring Well Installations. A total of 5 monitoring wells are planned at the Indian Head and Stump Neck Annex.	***Chemical hazards*** 1) Air/particulate/water borne contaminants are not anticipated to be present at background locations. However, as a precautionary measure, air monitoring activities will be performed. If necessary, dust suppression methods such as area wetting techniques will be used to minimize the generation of airborne dusts. ***Physical hazards*** 3) Rotating machinery (entanglement) 4) Noise 5) Energized systems 6) Lifting 7) Slips, trips, and falls 8) Natural hazards (poisonous plants, animals, and insects, especially ticks). Ticks are particularly prevalent at this site and the use of repellents (where appropriate) and PPE is recommended. 9) Unexploded Ordnance (UXO) is not anticipated to be encountered at proposed areas of background investigation. However, since Explosive Ordnance Disposal (EOD) operations were performed at other areas of the NSWC, any suspicious debris or objects will be reported to the base EOD specialist and will require site activities to be suspended. Additionally, since these site activities will be performed in coordination with the VI/RI, a B&R Environmental EOD specialist will be onsite if needed.	***Chemical hazards*** 1) Use real-time monitoring instrumentation and action levels to assess any exposure potentials. Utilize required PPE to minimize contact with potentially contaminated soils. 2) Decontaminate all equipment and supplies between drilling events and prior to leaving the site. ***Physical hazards*** 3) All 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 Record Sheet (See Section 10.0 of the B&R Environmental Health and Safety Guidance Manual. - Operated by Certified operators, and knowledgeable ground crew. - Only manufacturer approved equipment may be used in conjunction with equipment repair procedures (i.e., pins for auger flights etc.). In addition to the equipment considerations, the following standard operating procedures will be employed: - All personnel not directly supporting the drilling operation will remain at least 25 feet from the point of operation. - All loose clothing/protective equipment will be secured to avoid possible entanglement. - Hand signals will be established prior to the commencement of drilling. - The driller and helper can simultaneously handle moving augers or flights only when there is a standby person to activate the emergency stop device. - The driller must never leave the controls while tools are rotating unless all personnel are clear of the rotating equipment. - A long handled shovel or equivalent shall be used to clear away drill cuttings from the hole and rotating equipment. Hands or feet shall **not** be used for this purpose. - A remote sampling device must be used to sample drill cuttings near rotating tools. The driller shall shutdown operations if the sampler is near the tools. - Never climb a drill mast while equipment is rotating. - Use ANSI approved fall protection (i.e., belts, lanyards and a fall protection slide rail) or portable ladders which meet OSHA's requirements when climbing drill masts. - Work areas will be kept clear of clutter. - All 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 insure its operational status. - Areas will be inspected prior to the movement of drill rigs and support vehicle to eliminate any physical hazards. This will be the responsibility of the FOL and/or SSO. - Drill rigs and support vehicles will be moved no closer to banks, ditches, and other excavations than 3 feet unless the wall is supported. 4) 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 until sound level measurements and/or noise dosimetry may be conducted to quantify the associated noise levels. 5) All utility clearances shall be obtained in writing prior to subsurface activities. The locations of all underground utilities will be identified and marked prior to all 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 surveys to at least 6 feet. - Drilling, drill masts or other projecting devices shall be at least 20 feet from overhead power lines and a minimum of 3 feet from identified underground locations. 6) Employ machinery or multiple personnel for heavy lifts. - Use proper lifting techniques. 7) Traffic and equipment considerations are to include the following: - Establish safe zones of approach (i.e. Boom + 3 feet). - All equipment shall be equipped with movement warning systems. - All 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. Traffic patterns will be dictated supporting on site activities. However, regulated patterns in and about the work zones and support thereof will be established to safely control the flow patterns of mechanized vehicles and pedestrians. 8) Avoid potential nesting areas or suspicious plants. Wear appropriate clothing (light colored long sleeve shirts and pants with a hat) and periodically inspect clothing and body for ticks or rashes. When necessary use repellent (except when sampling) and protective equipment (chaps, Tyvek coveralls, etc.). For extra protection wear rubber boots and tyvek coveralls with taped ankle and wrist seams. 9) Report any suspicious objects or debris and notify the onsite EOD specialists	**Site contaminants are not anticipated to be present at background locations. As a result, elevated airborne concentrations impacting the field crews or downwind receptors are not anticipated. The following information is provided as a contingency action only.** A direct reading instrument such as a photoionization detector w/10.6 eV and/or flame ionization detector will be employed to detect any potential volatile organic compounds. These instruments will be employed as a screening device to be employed in the following manner: 1) Source monitoring of the borehole 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 reading above background in the breathing zone of the at-risk employees requires the person (SSO/sampler, etc.) monitoring to: - Suspend site operations and report to an unaffected area. Work may only resume when breathing zone levels return to background levels or the contaminant of concern is identified and proper control measures are implemented. 4) The SSO may perform noise dosimetry to ensure the drilling, and any contributional levels associated with the operation do not surpass the noise attenuation factors associated with the hearing protection selected. 5) When utilities cannot be identified a procedure permitting downhole magnetometer surveys every 2 feet to a total of 6 feet.	All drilling operations are to be initiated in Level D protection. Level D protection constitutes the following minimum protection - Standard field dress (long pants long sleeve shirts - Steel toe/shank safety shoes The following items will be incorporated during drilling operations: - Protective gloves (leather or cotton gloves). Nitrile gloves may be substituted. - Hardhat, safety glasses, and earplugs or muffs. - *Tyvek coveralls are recommended when working in areas where ticks are a problem or when there is a possibility of soiling work attire* - *Impermeable boot covers* - *PVC or PE coated tyvek will be incorporated if there is a potential for saturation of work attire.* ***(Italicized items are optional as conditions dictate)*** Level C protection upgrade is not anticipated given the nature of the background investigation and the unlikely event that contaminated media will be encountered. If air monitoring determines the presence of airborne concentrations of an unidentified contaminant, the HSM will be notified and the criteria for upgrading the level of protection and the need for additional monitoring will be evaluated. As site conditions may change the following equipment will be maintained during all on site activities - Fire Extinguishers (Strategically placed) - Basket stretcher, blankets, and first-aid kit	**Personnel Decontamination** - will primarily consist of washing of the hands and face prior to performing hand to mouth activities. If necessary, a soap/water wash and rinse for outer protective equipment (e.g., boots, gloves, etc.) will be used to remove dirt and mud. Disposable PPE items such as Tyvek coveralls can be removed and disposed. This function will take place at an area adjacent to the drilling operations bordering the support zone. This decontamination procedure for **Level D** protection will consist of - Equipment drop - Soap/water wash and rinse of outer gloves and outer boots, as applicable - Soap/water wash and rinse of the outer splash suit, as applicable - Wash hands and face, leave contamination reduction zone **Equipment Decontamination** - All equipment decontamination will be performed in accordance with the WP and SAP. Heavy equipment such as drill rigs, will have the wheels and tires cleaned along with any loose debris removed, prior to transporting to the central decontamination area. All site vehicles will be restricted access to exclusion zones, or also 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 on site activity. All 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 and that which is to leave the site. No equipment will be authorized access or exit without this authorization. Evaluation will consist of - Visual inspection - Scanning equipment with monitoring instruments

TABLE 5-1
TASKS/HAZARDS/CONTROL MEASURES COMPENDIUM
FOR INDIAN HEAD AND STUMP NECK ANNEX, NSWC, MARYLAND BACKGROUND INVESTIGATION

Task/Operation/ Location	Anticipated Hazards	Recommended Control Measures	Air Monitoring Type/Action Levels	Personal Protective Equipment	Decontamination Procedures
Multi-media sampling including surface and subsurface soil sampling from split-spoon or hand augers groundwater and sediment sampling. Miscellaneous site activities such as water level measurements and aquifer testing.	***Chemical hazards:*** 1) Air/particulate/water borne contaminants are not anticipated to be present at background locations. However, as a precautionary measure, air monitoring activities will be performed. If necessary, dust suppression methods such as area wetting techniques will be used to minimize the generation of airborne dusts. ***Physical hazards:*** 3) Noise 4) Lifting (muscle strains and pulls) 5) Pinches and compressions 6) Slip, trips, and falls 7) Natural hazards (Insect (tick) / animal bites and stings). Ticks are particularly prevalent at this site and the use of repellents (where appropriate) and PPE is recommended. 8) Unexploded Ordnance (UXO) is not anticipated to be encountered at proposed areas of background investigation. However, since Explosive Ordnance Disposal (EOD) operations were performed at other areas of the NSWC, any suspicious debris or objects will be reported to the base EOD specialist and will require site activities to be suspended. Additionally, since these site activities will be performed in coordination with the VI/RI, a B&R Environmental EOD specialist will be onsite if needed.	***Chemical hazards:*** 1) As a precautionary measure real-time monitoring instrumentation will be used to assess any exposure potentials. Additionally, PPE will be worn to protect workers from potential physical hazards.and to minimize contact with media which is not anticipated to be contamianted. 2) If necessary, decontaminate all equipment and supplies between drilling events as per the WP and SAP, and prior to leaving the site. ***Physical hazards:*** 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. Therefore, personnel will be required to employ hearing protection in these situations until sound level measurements and/or noise dosimetry may be conducted to quantify the associated noise levels. 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. Barricade all excavations deeper than 2 feet from access closer than 2 feet from the edge. Avoid bodies of water and marshy areas to the greatest extent possible. If work activities require personnel to be situated in areas where the potential for drowning or entrapment exist, site personnel must use U.S. Coast Guard approved personal floatation devices and/or life lines. 7) Avoid insect nesting areas (Do NOT use insect repellents during sampling activities). Report potential hazards to the SSO. Wear appropriate clothing and personal protective equipment (Tyvek coveralls, snake chaps, etc.) 8) Report any suspicious objects or debris and notify the onsite EOD specialists	**Site contaminants are not anticipated to be present at background locations. As a result, elevated airborne concentrations impacting the field crews or downwind receptors are not anticipated. The following information is provided as a contingency action only.** Using photoionization detectors w/10.6 eV and/or flame ionization detectors 1) Source monitoring will be conducted at regular intervals to be determined by the SSO. Positive sustained results at a source location which may impact operations crew will require the following actions: - Monitor the breathing zone of high risk employees. Any sustained reading above background in the breathing zone of the at-risk employees requires the person (SSO/sampler, etc.) monitoring to: - - Suspend site operations and report to an unaffected area. Work may only resume when breathing zone levels return to background levels or the contaminant of concern is identified and proper control measures are implemented.	All sampling activities are anticipated to proceed in a modified Level D protection, or as specified on the Safe Work Permit. Level D - (Minimum Requirements) For sampling activities: - Standard field attire (long sleeve shirt; long pants) - Safety shoes (Steel toe/shank) - Safety glasses - Hard hat (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. - Layered surgical style gloves (Clean pair for each sample location) *- Tyvek coveralls are recommended when working in areas where ticks are a problem or when there is a possibility of soiling work attire* *- Impermeable boot covers* *- PVC or PE coated tyvek will be incorporated if there is a potential for saturation of work attire.* ***(Italicized items are optional as conditions dictate)*** Level C protection upgrade is not anticipated given the nature of the background investigation and the unlikely event that contaminated media will be encountered. If air monitoring determines the presence of airborne concentrations of an unidentified contaminant, the HSM will be notified and the criteria for upgrading the level of protection and the need for additional monitoring will be evaluated.	Decontaminate sample containers in accordance with the QA/QC Plan and/or the SAP. **Personnel decontamination:** - Wash and rinse outer protective garments - Remove outer protection garments and containerize for disposal - Wash hands and face, leave contamination reduction zone. **Equipment decontamination:** All sampling equipment will undergo a soap/water wash and rinse utilizing a suitable potable water source until visibly clean. Sampling equipment may also be high pressure soap/water wash and rinse or steam cleaned. All chemical decontamination will proceed in accordance with the other site documents such as QA/QC and/or the Sampling Analysis Plan.

6.0 HAZARD ASSESSMENT

This section provides information regarding the chemical and physical hazards associated with the Indian Head and Stump Neck Annex sites associated with Background Investigation at the NSWC. The intent of the Background Investigation is to identify cleanup goals and criteria. Background sampling locations have been selected in areas of the site that have not been previously disturbed which are believed to have no contamination. As a result, exposures to site contaminants identified in other areas of the NSWC are not anticipated to occur during the performance of site activities associated with the Background Investigation. As a precautionary measure, air monitoring using direct reading instruments (see Table 5-1 and Section 7.0 of this HASP) will be performed to confirm the absence of airborne contaminants and control measures to minimize the generation of airborne dusts will be implemented. Physical hazards (discussed in Section 6.2) associated with drilling and sampling activities are of primary concern.

6.1 CHEMICAL HAZARDS

As discussed above, exposure to chemical hazards associated with site contaminants identified in other areas of the NSWC is not anticipated given the selected background locations for the investigation. Proposed sample areas of the investigation have been selected based on their undisturbed status. It is therefore unlikely that proposed sample areas have any contamination association with them.

It should be noted that many decontamination efforts require the use of various solvents (i.e., isobutylene, methanol, hexane, nitric acid). If decontamination using solvents is performed during the Background Investigation the greatest potential for chemical exposure will occur during these activities. Additionally, sample containers may contain preservatives such as hydrochloric acid, sulfuric acid, nitric acid and sodium hydroxide. Personnel who are anticipated to handle solvents, sample preservatives, and other chemicals used onsite will be required to obtain and reference manufacturer's Material Safety Data Sheets (MSDS) to determine appropriate control measures, PPE requirements, and safe handling procedures.

6.2 PHYSICAL HAZARDS

Of primary concern are the following physical hazards which may be present during the performance of site activities associated with the Background Investigation.

- Contact / entanglement with rotating equipment or machinery.
- Slips, trips, and falls.

- Contact with underground or overhead utilities (electric lines, gas lines, water lines, etc.).
- Strain from heavy lifting.
- Pinch / compression points.
- Noise in excess of 85 decibels (dBA).
- Heat stress and inclement weather (depending on season)
- Contact with poisonous plants and disease carrying animals and insects.
- Water hazards and unstable terrain associated with marshy areas.

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 greater detail in the B&R Environmental Health and Safety Guidance Manual.

6.3 OTHER POTENTIAL SITE CONCERNS

Previous site activities at the NSWC included Explosive Ordnance Disposal (EOD) activities. As a result Unexploded Ordnance (UXO) hazards have been previously identified at various areas of the NSWC. It is unlikely that UXO will be present in the areas of proposed work associated with the Background Investigation. However, if site personnel observe suspicious debris or materials or if base EOD personnel determine that UXO concerns exist at proposed investigation areas, this HASP will be modified and provisions will be made to provide EOD support personnel.

7.0 AIR MONITORING

Monitoring devices such as Direct Reading Instruments (DRIs), will be employed during the Background Investigation to ensure that airborne concentrations of unanticipated volatile contaminants are not present during site activities. The specific type of monitoring and the associated instruments, frequency of use, and applicable action levels are dependent upon the specific scope of work and the contaminants of concern. As a result, specific air monitoring measures and requirements have been established in Table 5-1 of this site-specific HASP. Additionally, Section 1.0 of the B&R Environmental Health and Safety Guidance Manual contains detailed information regarding direct reading instrumentation and personal and area air sampling procedures, as well as general calibration procedures of various instruments.

Although contaminants are not anticipated to be present during the Background Investigation, it whould be noted that many contaminants are unable to be detected or are difficult to detect with the use of direct reading instruments. These contaminants may be present in the form of particulates or bound to particulates. The greatest potential for exposure to contaminants in this form is through inhalation or ingestion of contaminant laden particulates (dusts). As a result, any observations of airborne particulates will indicate a potential for exposure and shall require control measures such as area wetting. Given the proposed activities, it is not anticipated that any contaminants will be encountered. However, as a precaution, monitoring instruments will be used in an attempt to identify and quantify any potential contaminants. Additionally, potential exposures and hazards associated with site contaminants will be minimized through adherence to the requirements of this HASP (site control measures, decontamination efforts, safe work practices, etc.).

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 B&R Environmental and subcontractor personnel participating in on site activities.

8.1.1 Requirements for B&R Environmental Personnel

All B&R Environmental personnel must complete 40 hours of introductory hazardous waste site training prior to performing work at the Indian Head and Stump Neck Annex NSWC facility. B&R Environmental personnel who have had introductory training more than 12 months prior to site work must have completed 8 hours of refresher training within 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 B&R Environmental introductory, supervisory, and refresher training as well as site-specific training will be maintained at the site. Copies of certificates or other official documentation will be used to fulfill this requirement.

B&R Environmental will conduct a brief meeting daily to discuss operations planned for that day and to issue Safe Work Permits (See Section 9.4) for those operations.

8.1.2 Requirements for Subcontractors

Identified B&R Environmental subcontractor personnel must have completed introductory hazardous waste site training or equivalent work experience as defined in OSHA Standard 29 CFR 1910.120(e) and 8 hours of refresher training meeting the requirements of 29 CFR 1910.120(e)(8) prior to performing field work at the NSWC facility. B&R Environmental subcontractors must certify that each employee has had such training by sending B&R Environmental a letter, on company letterhead, containing the information in the example letter provided in Figure 8-1. This letter will be accompanied by training certificates or some other form of official documentation for all subcontractor personnel participating in site activities.

FIGURE 8-1

TRAINING LETTER

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

Ms. Lee Ann Sinagoga
Project Manager
B&R Environmental
Foster Plaza 7, 661 Andersen Drive
Pittsburgh, Pennsylvania 15220

Subject: HAZWOPER Training for Indian Head and Stump Neck Annex Naval Surface Warfare Center, Indian Head, Maryland

Dear Ms. Sinagoga:

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 all 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 an 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 required by 29 CFR 1910.120(e)(8) and 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)

8.2 SITE-SPECIFIC TRAINING

B&R Environmental will provide site-specific training to all B&R Environmental and subcontractor personnel who will perform work on this project. Site-specific training will also be provided to all personnel (DOD, OSHA, EPA, Navy personnel, and other authorized visitors) 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
- Work practices to minimize risks from hazards
- Safe use of engineering controls and equipment
- Medical surveillance requirements
- Signs and symptoms of overexposure to site contaminants
- Contents of the Health and Safety Plan
- Emergency response procedures (evacuation and assembly points)
- Spill response procedures
- Review of the contents of relevant Material Safety Data Sheets
- Associated hazards and restricted areas within the NSWC.

Site-specific documentation will be established through the use of Figure 8-2. All site personnel and visitors must sign this document upon receiving site-specific training.

8.3 MEDICAL SURVEILLANCE

8.3.1 Medical Surveillance Requirements for B&R Environmental Personnel

All B&R Environmental personnel participating in project field activities will have had a physical examination meeting the requirements of B&R Environmental'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 B&R Environmental 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 activities at Indian Head and Stump Neck Annex Naval Surface Warfare Center, Indian Head, Maryland, 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
- Work practices to minimize risks from hazards
- Safe use of engineering controls and equipment
- Medical surveillance requirements
- Signs and symptoms of overexposure to site contaminants
- Contents of the Health and Safety Plan
- Emergency response procedures (evacuation and assembly points)
- Spill response procedures
- Review of contents of relevant Material Safety Data Sheets
- Associated hazards and restricted areas within the NSWC.

I further state that I have been given the opportunity to ask questions and that all of my questions have been answered to my satisfaction.

I further state, by the presence of my signature below that, the date of my training (introductory, refresher, and supervisory, as applicable) and my medical surveillance requirements are accurate and correct to the best of my knowledge.

Name	40-Hour General Site Worker Training (Date)	8-Hour Refresher Training (Date)	8-Hour Supervisory Training (Date)	Date of Medical Surveillance	SIGNATURE

8.3.2 Medical Surveillance Requirements for Subcontractors

Identified 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" with a letter, on company letterhead, containing all of the information in the example letter presented in Figure 8-4 of this HASP.

8.3.3 Requirements for All 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 the Medical Data Sheet found in the B&R Environmental 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

In situations in which the exclusion zone is not entered or when there is no potential for exposure to site contaminants, subcontractor personnel may be exempt from some of the training and medical surveillance requirements. All subcontractors and visiting personnel are required to receive site-specific training (as discussed in Section 8.2) regarding information provided in this HASP. Examples of subcontractors who may be exempt from training and medical surveillance requirements may include surveyors who perform surveying activities in areas were there is no potential for exposure to site contaminants. Typically, surveying activities are performed after intrusive activities are completed. Additionally, surveying activities generally do not require contact with any media that is potentially contaminated.

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 Indian Head and Stump Neck Annex NSWC work site
   ( ) not qualified to perform work at the Indian Head and Stump Neck Annex NSWC 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

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 Indian Head and Stump Neck Annex Naval Surface Warfare Center 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

Ms. Lee Ann Sinagoga
Task Order Manager
B&R Environmental Corp.
Foster Plaza 7, 661 Andersen Drive
Pittsburgh, Pennsylvania 15220

Subject: Medical Surveillance for Indian Head and Stump Neck Annex Naval Surface Warfare Center Indian Head, Maryland

Dear Ms. Sinagoga:

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 Indian Head and Stump Neck Annex Naval Surface Warfare Center, Indian Head Maryland 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

Even though contaminated media is not anticipated to be encountered as part of this Background Investigation, this section outlines the means by which B&R Environmental will delineate work zones to prevent the spread of potential contaminants into previously unaffected areas of the site. A three-zone approach will be used during work at this site. This three zone approach will utilize an exclusion zone, a contamination reduction zone, and a support zone. In this particular case, the use of a three zone approach is used as a control measure to control access to site work areas. Use of such controls will restrict the general public, minimize the potential for the spread of contaminants, and protect individuals who are not cleared to enter work areas.

9.1 EXCLUSION ZONE

Typically, exclusion zones are considered those areas of the site with known or suspected contamination. For the Background Investigation, the exclusion zones will be limited to those areas of the site where active work is being performed plus a designated area surrounding the point of operation (see Table 5-1 for specific operation). The exclusion zone for most site activities will be fragmented to represent the areas where the soils are disturbed through drilling or sampling activities. All exclusion zones will be delineated using barrier tape, cones and/or drive poles, and postings to inform and direct facility personnel.

9.1.1 Exclusion Zone Clearance

A pre-startup site visit will be conducted by members of the identified field team in an effort to identify proposed subsurface investigation locations, obtain utility clearances, and provide upfront notices concerning scheduled activities within the facility.

In all cases, no subsurface activities will proceed without utility clearance. In the event that a utility is struck during a subsurface investigative activity, the emergency numbers provided in Section 2.9, Table 2-1 will be notified.

If base personnel are working within the proximity of this investigation, they will be moved or their operation temporarily discontinued to remove them from potential hazards associated with this operation.

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. A limited personnel and equipment decontamination may take place in this area, to the extent required to move equipment or personnel as necessary to a central decontamination location. This area will also serve as a focal point in supporting exclusion zone activities. This area will be delineated using barrier tape, cones and/or drive poles, and postings to inform and direct facility personnel.

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. In all cases, 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

All exclusion zone activities conducted in support of this project will be done so using this HASP as a reference guide and Safe Work Permits to incorporate site-specific information to guide and direct field crews on a task by task basis. An example of the Safe Work Permit to be used during site activities is illustrated in Figure 9-1.

All permits will be issued by the SSO or his/her on site representative in the morning prior to the commencement of on site activities.

All personnel identified on the permit as participating in the task will be made aware of its contents by the supervisor accepting the permit. Any problems which occurred throughout the task will be documented by the supervisor on the permit.

All permits will be returned to the FOL or the SSO at the end of the day.

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 _____ _____
B&RE

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 ☐
Half face APR ☐
SKA-PAC SAR ☐
Skid Rig ☐
Escape Pack ☐
SCBA ☐
Bottle Trailer ☐
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 suite/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	☐	☐

VII. Equipment Preparation

	Yes	NA
Equipment drained/depressured	☐	☐
Equipment purged/cleaned	☐	☐
Isolation checklist completed	☐	☐
Electrical lockout required/field switch tested	☐	☐
Blinds/misalignments/blocks & bleeds in place	☐	☐
Hazardous materials on walls/behind liners considered	☐	☐

VIII. Additional Permits required (Hot work, encl PMed entry, excavation etc.) ☐ Yes ☐ No
If yes, fill out appropriate section(s) on safety work permit addendum

IX. 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 B&R Environmental
- Regulatory personnel (i.e., DOD, EPA, OSHA)
- Northern Division Navy Personnel
- Other authorized visitors

All non-DOD personnel working on this project are required to gain initial access to the base by coordinating with the B&R Environmental FOL or designee and following established base access procedures.

Once access to the base is obtained, all personnel who require site access into areas of ongoing operations will be required to obtain permission from the FOL and the Base Contact. Upon gaining access to the site, all site visitors wishing to observe operations in progress will be escorted by a B&R Environmental representative and shall be required to meet the minimum requirements discussed below:

- All site visitors will be routed to the FOL, who will sign them into the field logbook. Information to be recorded in the logbook will include the individual's name (proper identification required), the entity which they represent, and the purpose of the visit.

- All site visitors will be required to produce the necessary information supporting clearance to the site. This shall include information attesting to applicable training and medical surveillance as stipulated in Section 8.0 of this document. In addition, to enter the site operational zones during planned activities, all visitors will be required to first go through site-specific training covering the topics stipulated in Section 8.2 of this HASP.

Once the site visitors have completed the above items, they will be permitted to enter the operational zone. All visitors are required to observe the protective equipment and site restrictions in effect at the site at the time of their visit. Any and all 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 the termination of all on site activities until the unauthorized visitor is removed from the premises. Removal of unauthorized visitors will be

accomplished with support from the Base Contact. If necessary, the Base Contact will be notified of any unauthorized visitors.

9.6 SITE SECURITY

Site security will be accomplished using B&R Environmental field personnel. B&R Environmental will retain complete control over active operational areas. As this activity takes place at a Navy facility, the first line of security will take place at the base gate restricting the general public. The second line of security will take place at the work site referring interested parties to the Base Contact. The Base Contact will serve as a focal point for base personnel, interested parties, and serve and 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. 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 all personnel involved in this operation.

9.9 MATERIAL SAFETY DATA SHEET (MSDS) REQUIREMENTS

B&R Environmental and subcontractor personnel will provide MSDSs for all 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 all 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 may not always be working in proximity to one another during field activities, a supported means of communication between field crews will be used as necessary. Two-way radio communication devices will be submitted for approval by NSWC for use while at the facility. Any communications devices used by site personnel must meet approval of EOD personnel.

External communication will be accomplished by using the telephones at predetermined and approved locations or through cellular phones. External communication will primarily be used for the purpose of resource and emergency resource communications. Prior to the commencement of activities at the NSWC, the FOL will determine and arrange for telephone communications, if it is determined a cellular means will not be used.

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 as part of this scope of work. It is also not anticipated that any spillage would constitute a danger to human health or the environment. However, as the job progresses, the potential for accumulating Investigative Derived Wastes (IDW), such as decontamination fluids, soil cuttings, purge waters from well development, etc. in a central staging area does exist. Once these materials are characterized, they can be removed from this area and be properly disposed of. Because these IDW remain uncharacterized while in the staging area, a spill containment program will be developed and instituted as part of this HASP.

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

At this junction, it is anticipated all IDW generated as a result of this scope of work will be containerized, labeled, and staged to await further analyses. The results of this analysis will determine the method of disposal.

10.3 LEAK AND SPILL DETECTION

To establish an early detection of potential spills or leaks, a periodic walk-around by the personnel staging or disposing of drums will be conducted during working hours to visually determine that storage vessels are not leaking. If a liquid leak is detected, the contents will be transferred into a new vessel using a hand pump. The leak will then be collected and contained using absorbents such as Oil-dry, vermiculite, or sand. The absorbents will be stored at the vulnerable areas in a conspicuously marked

drum. This used absorbent material will also be containerized for disposal pending analysis. All inspections will be documented in the project logbook.

10.4 PERSONNEL TRAINING AND SPILL PREVENTION

All personnel will be instructed in the procedures for 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 will be maintained at the staging area at all times 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
- Hand-operated drum pump with hose
- Container labels

10.6 SPILL CONTROL PLAN

This section describes the procedures the B&R Environmental field crew members will employ upon the detection of a spill or leak.

1. Notify the SSO or FOL immediately upon the detection of a leak or spill.

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 or disposal options.

4. Re-containerize spills, including 2-inches of top cover affected by the spill. Await test results for treatment or disposal options.

It is not anticipated that a spill will occur that the field crews 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 B&R Environmental Field Operations Leader (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
- Material Safety Data Sheets for all chemicals brought on site, including decontamination solutions, fuels, sample preservatives, calibration gases, etc.
- Follow-up Reports (to be completed by the FOL)
- A full-size OSHA Job Safety and Health Poster (posted in the site trailer)
- Training/Medical Surveillance Documentation Form (Blank)
- First-Aid Supply Usage Form
- Emergency Reference Form (Section 2.0, extra copy for posting)
- Drilling Log Forms

12.1 MATERIALS TO BE POSTED AT THE SITE

The following documentation is to be posted 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 separated and be immediately accessible to site personnel.

Chemical Inventory Listing - This list represents all 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) - The MSDSs should also be in a central area accessible to all site personnel. These documents should match all the listings on the chemical inventory list for all 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 - 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.

Site Clearance Posting - This listing is found within the training section of the HASP (See Figure 8-1). This list identifies all site personnel, dates of training (including site-specific training), and medical surveillance. This lists 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) - This list of numbers and the directions will be maintained at all phone communications points and in each site vehicle.

Medical Data Sheets/Cards - Medical Data Sheets will be filled out by all on site 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 all personnel to be carried on their person.

Hearing Conservation Standard (29 CFR 1910.95) - This standard will be posted anytime hearing protection or other noise abatement procedures are employed.

Personnel Monitoring - All results generated through personnel sampling (levels of airborne toxins, noise levels, etc.) will be posted to inform individuals of the results of that effort.

Placards and Labels - Where chemical inventories have been separated, because of quantities and incompatibilities, these areas will be conspicuously marked using Department of Transportation (DOT) placards and acceptable [Hazard Communication 29 CFR 1910.1200 (f)] labels.

13.0 ACRONYMS / ABBREVIATIONS

ACGIH	American Conference of Governmental Industrial Hygienists
ACM	Asbestos Containing Material
APR	Air-Purifying Respirator
ASP	Associate Safety Professional
ASVE	Air Sparging Vapor Extraction
CFR	Code of Federal Regulations
CIH	Certified Industrial Hygienist
CNS	Central Nervous System
CRZ	Contamination Reduction Zone
CSP	Certified Safety Professional
CQP	Construction Quality Plan
dBA	Decibels measured on the A-scale
DRI	Direct Reading Instrument
eV	electron Volts
FID	Flame Ionization Detector
FOL	Field Operations Leader
FTL	Field Team Leader
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
HEPA	High Efficiency Particulate Air
HSM	Health and Safety Manager
IDLH	Immediately Dangerous to Life and Health
IDW	Investigative Derived Wastes
MSDS	Material Safety Data Sheet
NSWC	Naval Surface Warfare Center
N/A	Not Available
NIOSH	National Institute for Occupational Safety and Health
NPDES	National Pollution Discharge Elimination System
OSHA	Occupational Safety and Health Administration (U.S. Department of Labor)
PCB	Polychlorinated Byphenyls
PEL	Permissible Exposure Limit
PHSO	Project Health and Safety Officer

PID	Photoionization Detector
PM	Project Manager
PPE	Personal Protective Equipment
PPM	parts per million
PVC	poly vinyl chloride
SAP	Sampling and Analyses Plan
SCBA	Self-Contained Breathing Apparatus
SOPs	Standard Operating Procedures
SSO	Site Safety Officer
STEL	Short Term Exposure Limit
TBD	To be determined
TSD	Treatment Storage and Disposal Facility
TWA	Time-Weighted Average
UV	Ultra violet
WP	Work Plan

14.0 DOCUMENT STATUS REPORT

Revision Requested:	By Whom:	Date:
Revisions Made:	Approval: PM: HSM	

ATTACHMENT 1

TICK CONTROL
AND
LYME DISEASE

TICK CONTROL
AND
LYME DISEASE

The occurrence of Lyme disease has become a worldwide problem since its identification in 1976. This disease is characteristically recognized as being transmitted by ticks, which may be encountered by field personnel while working at this site. As a result, this discussion has been included with this Health and Safety Plan to provide for adequate recognition, evaluation, and control efforts to minimize the occurrence and effects of this potential hazard.

The discovery of Lyme disease is credited to Dr. Allen Steere of Yale University Medical School, and is named after the community where it was (reportedly) first encountered, Lyme, Connecticut. This disease can be transmitted to man through the bite of ticks that are infected with a cork screw-shaped microbe (spirochete). The spread of this disease has been so rapid that in 1984 it surpassed Rocky Mountain Spotted fever as the most common tick-borne disease in the United States. In this country, most of the incidents of this disease have been recorded in the Northeast, and the tick species most commonly attributed with its spread is the deer tick.

Recognition

This hazard potential exists primarily in the spring and summer months, as these are the seasons that tick populations and activity flourish. In fact, 90 percent of the reported cases have occurred from early June through September. Also, this concern exists primarily in heavily vegetated areas. Therefore, recognition of these factors can aid in the awareness and control of this threat.

To aid in the recognition and identification of these insects, an example illustration of the tick species common to the region where this site is located has been included with this discussion. This species (the American Dog tick) is common in the eastern half of the United States, and typically exists in areas covered with grass or underbrush. These insects will attach themselves to animals (including man) that pass through the area and rub against them. After finding a host, the tick inserts its mouthparts and sucks blood until it is fully engorged. This requires a time period of three to twelve days, then the tick will drop off. In addition to Lyme disease concerns, this tick has also been identified as a transmitter of Rocky Mountain Spotted Fever, and the organisms of tularemia and possibly relapsing fever. The wounds left by tick bites can be painful, and can also have a paralyzing effect commonly referred to as tick paralysis.

The earliest symptom of the onset of this disease is the occurrence of an unusual red skin rash. This is commonly the first indication since it has been evidenced that many persons who have contracted this disease were, in fact, unaware that they had been bitten. This rash can appear at the site of the bite anywhere from several days to a few weeks after the bite. It typically starts as a small red spot, and then expands as the spirochetes expand from the bite location. Rash sizes can vary, but have been most commonly associated in a 2 to 3 inch diameter size range. This rash will fade (with or without treatment) after a few weeks. Close inspection is necessary to detect this symptom as the rashes are easy to miss because they're

often very faint. Body sites where rashes frequently occur include the thigh areas, groin, and armpits. Also, it is not uncommon for a rash to develop in more than one place.

Other early symptoms include profound fatigue, a stiff neck, and flu-like symptoms such as headache, chills, fever, and muscle aches. Recognition of the onset of any of these symptoms is important since tick bites do not always produce a rash. If left untreated, the disease will progress to its second stage within weeks or months after the infection. This stage involves effects to the heart and nervous system. A common second stage symptom is a paralysis on one or both sides of the face. Others include severe headache, encephalitis, or meningitis. The third and final stage involves the development of chronic inflammatory arthritis, which can occur up to a year or more after the bite.

Evaluation

Evaluation of this hazard potential principally involves field personnel performing close self-inspections for the presence of ticks each time they leave the site. This should involve careful examination, especially of the individuals' heads. Personnel should be aware that when a tick attaches itself to its host, it inserts its entire head under the surface of the skin.

Control

Control of this threat involves several components. First, field personnel must be aware of the climate and area conditions which are commonly associated with being conducive to tick infestation. Second, when working in or walking through potential infested areas, personnel must ensure that they do not have exposed body parts (i.e. at least long sleeved shirts and long pants, particularly when protective coveralls are not worn). In heavily vegetated areas where infestation is likely, Tyvek coveralls will be required to minimize this hazard potential. Also, several commercial products have been demonstrated as being effective in repelling ticks. Examples include Permanone, Off!, and Cutter. These types of repellents will be used at the direction and discretion of the Brown & Root Environmental Health and Safety Officer, and only in accordance and observation of manufacturer's recommendations. In most instances, however, such repellents are typically applied to the outside surfaces of clothing (and not directly onto the skin), and should be applied also to shoe tops, socks, pants cuffs, and other areas most susceptible to ticks.

Tick Removal

In the event that a tick is discovered to be attached to a member of the field team, timely removal of the insect is critical to reducing the potential for contracting the disease. According to available information and research, there is apparently a grace period of at least a few hours from the time of the bite before the tick transmits the microbe (the spirochetes are not present in the mouth parts of the tick). However, the incident of a tick bite is frequently unnoticed, and the discovery of the tick may not occur until after this suspected grace period has already elapsed. Therefore, timely removal is very important. The preferred method of tick removal is to pull it out using tweezers or small forceps. In this method, the tick should be grasped as close to the mouth as possible, and then pulled steadily upward. Care must be exercised so as not to pull in a jerking motion as this can result in the head becoming detached. After the tick has been removed, disinfect the bite with rubbing alcohol or povidone iodine (Betadine). The tick must not be handled as the microbes can enter the body through any breaks in intact

skin. The bite should be checked occasionally for at least a two-week period to see if a rash forms. If it does, medical attention must be promptly sought.

In order to provide for proper and timely response to the occurrence of a tick bite, the Health and Safety Officer will ensure that the site First Aid kit is properly equipped with medical forceps and rubbing alcohol, in addition to the standard kit contents. Also, an adequate supply of commercial insect (tick) repellents will be maintained onsite, and all personnel will be trained in its proper application and will be required to use it, at the direction of the Health and Safety Officer.

APPENDIX B

FORMS FOR FIELD INVESTIGATION
FOR
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

- Groundwater Level Measurement Form
- Chain of Custody Record
- Groundwater Sample Log Sheet
- Soil and Sediment Sample Log Sheet
- Equipment Calibration Log
- Boring Log
- Monitoring Well Development Record

GROUNDWATER LEVEL MEASUREMENT SHEET

Page ___ of ___

PROJECT NAME: _____ LOCATION: _____
PROJECT NUMBER: _____ MEASURING DEVICE: _____
PERSONNEL: _____ ADJUSTMENT FACTOR: _____
DATE: _____ REMARKS: _____
WEATHER CONDITIONS: _____

Well or Piezometer Number	Time	Elevation of Reference Point (Feet)*	Water Level Indicator Reading (Feet)*	Groundwater Elevation (Feet)*	Comments

*Measurements to nearest 0.01 foot.

Signature(s): _____

CHAIN OF CUSTODY RECORD

PROJECT NO.:	SITE NAME:
SAMPLERS (SIGNATURE):	

STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CON-TAINERS							REMARKS

RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY(SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY(SIGNATURE):
RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY(SIGNATURE):
RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED FOR LABORATORY BY (SIGNATURE):	DATE / TIME:	REMARKS:	

Order No. 70440

GROUNDWATER SAMPLE LOG SHEET

Page___ of ___

Project Site Name: _____
Project No.: _____

[] Domestic Well Data
[] Monitoring Well Data
[] Other Well Type: _____
[] QA Sample Type: _____

Sample ID No.: _____
Sample Location: _____
Sampled By: _____
C.O.C. No.: _____
Type of Sample:
[] Low Concentration
[] High Concentration

SAMPLING DATA:

Date:	Color	pH	S.C.	Temp.	Turbidity	DO	Salinity	Other
Time:	Visual	Standard	mS/cm	Degrees C	NTU	mg/l	%	NA
Method:								

PURGE DATA:

Date:	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	Other
Method:	Initial							
Monitor Reading (ppm):	1							
Well Casing Diameter & Material	2							
Type:	3							
Total Well Depth (TD):								
Static Water Level (WL):								
One Casing Volume(gal/L):								
Start Purge (hrs):								
End Purge (hrs):								
Total Purge Time (min):								
Total Vol. Purged (gal/L):								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected

OBSERVATIONS / NOTES:

Circle if Applicable:

MS/MSD	Duplicate ID No.:

Signature(s):

SOIL & SEDIMENT SAMPLE LOG SHEET

Page___ of ___

Project Site Name: _____
Project No.: _____

[] Surface Soil
[] Subsurface Soil
[] Sediment
[] Other: _____
[] QA Sample Type: _____

Sample ID No.: _____
Sample Location: _____
Sampled By: _____
C.O.C. No.: _____

Type of Sample:
[] Low Concentration
[] High Concentration

GRAB SAMPLE DATA:

Date:	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Time:			
Method:			
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

OBSERVATIONS / NOTES:

MAP:

Circle if Applicable:

MS/MSD	Duplicate ID No.:

Signature(s):

EQUIPMENT CALIBRATION LOG

INSTRUMENT NAME/MODEL : _____ PROJECT NAME : _____

MANUFACTURER : _____ PROJECT NUMBER : _____

CALIBRATION DATE	INITIAL SETTINGS	STANDARDS USED	PROCEDURE	ADJUSTMENTS MADE	FINAL SETTINGS	SIGNATURE	COMMENTS

BORING LOG

PROJECT NAME: _____ BORING NUMBER: _____
PROJECT NUMBER: _____ DATE: _____
DRILLING COMPANY: _____ GEOLOGIST: _____
DRILLING RIG: _____ DRILLER: _____

Sample No. and Type or RQD	Depth (FL) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/FL) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	MATERIAL DESCRIPTION: Color	MATERIAL DESCRIPTION: Material Classification	USCS *	Remarks	PID/FID: Sample	PID/FID: Sampler BZ	PID/FID: Borehole**

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated response read.

Drilling Area Background (ppm): _____

Remarks: _____

Converted to Well: Yes _____ No _____ Well I.D. #: _____

MONITORING WELL DEVELOPMENT RECORD

Page ___ of ____

Well: _____
Site: _____
Date Installed: _____
Date Developed: _____
Dev. Method: _____
Pump Type: _____

Depth to Bottom (ft.): _____
Static Water Level Before (ft.): _____
Static Water Level After (ft.): _____
Screen Length (ft.): _____
Specific Capacity: _____
Casing ID (in.): _____

Responsible Personnel: _____
Drilling Co.: _____
Project Name: _____
Project Number: _____

Time	Estimated Sediment Thickness (Ft.)	Cumulative Water Volume (Gal.)	Water Level Readings (Ft. below TOC)	Temperature (Degrees C)	pH	Specific Conductance (Units ____)	Turbidity (NTU)	Remarks (odor, color, etc.)

APPENDIX C

STANDARD OPERATING PROCEDURES
FOR
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

- CT-03: Data Validation
- CT-05: Database Records and Quality Assurance
- GH-1.5: Borehole and Sample Logging
- GH-2.8: Groundwater Monitoring Point Installation
- SA-1.1: Groundwater Sample Acquisition and Onsite Water Quality Testing
- SA-6.1: Non-Radiological Sample Handling
- SA-6.3: Field Documentation
- SA-7.1: Decontamination of Field Equipment and Waste Handling

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1.0 CLP ORGANICS FOR SOLID AND AQUEOUS MATRICES

1.1 CLP Organics by GC/MS

1.1.1 Volatiles (USEPA CLP Statement of Work (SOW) 3/90)

1.1.1.1 Applicability

CLP 3/90 volatile methodology is used to determine organic compounds in most matrices including groundwater, sludges, caustic liquors, acid liquors, waste solvents, oily wastes, mousses, tars, fibrous wastes, polymeric emulsions, filter cakes, spent carbons, spent catalysts, soils, and sediments.

The CLP 3/90 volatile Target Compound List (TCL) includes the following substances:

Acetone	Chloromethane	Methylene Chloride
Benzene	Dibromochloromethane	4-Methyl-2-Pentanone
Bromodichloromethane	1,1-Dichloroethane	Styrene
Bromoform	1,2-Dichloroethane	1,1,2,2-Tetrachloroethane
Bromomethane	1,1-Dichloroethene	Tetrachloroethene
2-Butanone	1,2-Dichloroethene (total)	Toluene
Carbon Disulfide	1,2-Dichloropropane	1,1,1-Trichloroethane
Carbon Tetrachloride	cis-1,3-Dichloropropene	1,1,2-Trichloroethane
Chlorobenzene	trans-1,3-Dichloropropene	Trichloroethene
Chloroethane	Ethyl Benzene	Vinyl Chloride
Chloroform	2-Hexanone	Xylenes (total)

This method is based upon a purge-and-trap, gas chromatographic/mass spectrometric (GC/MS) procedure. Prior to analysis, samples must be prepared according to the SOW.

1.1.1.2 Interferences

Samples can be contaminated by diffusion of volatile organics (particularly chlorofluorocarbons and methylene chloride) through the sample container septum during shipment and storage. Associated field quality control blanks are analyzed in order to monitor this.

Contamination by carryover can occur whenever high-level and low-level samples are sequentially analyzed. To reduce carryover, the sample syringe or purging device is rinsed with reagent water between samples. Whenever an unusually concentrated sample is encountered, it should be followed by an analysis of reagent water to check for cross contamination.

If sample or matrix interferences are encountered, a secondary or alternate analytical column may be used to resolve the compounds of interest.

1.1.1.3 General Laboratory Practices

A method blank consisting of organic free water spiked with surrogates and internal standards should be analyzed immediately following each daily calibration, and also after the analysis of every high concentration sample.

Matrix Spike/Matrix Spike Duplicate (MS/MSD) analyses should be conducted to determine the effects of sample matrix upon the compounds of interest.

1.1.1.4 Sample Preparation

A purge- and -trap procedure is performed to prepare and extract volatile compounds from samples and to introduce those compounds into the GC/MS.

For highly volatile matrices, direct injection preceded by dilution should be used to prevent gross contamination of the instrumentation. For pastes, dilution of the sample until it becomes free-flowing is used to ensure adequate interfacial area. The success of this method depends on the level of interferences in the sample; results may vary due to the large variability and complicated matrices of solid waste samples.

1.1.1.5 Data Overview Prior to Validation

Before commencing validation, the reviewer must preview the associated Chain-of-Custody (COC) reports to determine:

- If the appropriate number of samples are present in the data package and if each sample was correctly analyzed for the parameters and methods specified.
- The identity of all associated field quality control blanks and field duplicate pairs.

Because many samples may have required dilutions, re-extractions and/or re-analyses, the validator should preview the data package contents to determine which analyses represent the better quality data.

Unless specifically directed by client protocol, never annotate the laboratory data package. Before beginning evaluation, prepare working copies (i.e., photocopies) of all Form I reports (including those for samples, laboratory method blanks and MS/MSD analyses), and all laboratory quality control summary forms (including all initial and continuing calibration summary statistics).

1.1.1.6 Technical Evaluation Summary

All data evaluations must be conducted in accordance with applicable USEPA Regional protocols and/or specific client contract requirements. The applicable documents must be referenced during the data evaluation process as this S.O.P. is only intended as a general procedure for the data validation tasks.

General parameters such as Data Completeness, Overall System Performance, Chromatographic Quality, Detection Limits and Compound Identification are evaluated concurrently with the parameters discussed in the following subsections.

1.1.1.6.1 Holding Times

Holding times are evaluated by reviewing the COC reports, the individual sample Form I reports, and the associated laboratory raw data. Holding times are calculated from date of collection to date of analysis.

For unpreserved aqueous samples, generally a 7-day maximum holding time allowance for aromatic compounds, along with a 14-day maximum holding time allowance for chlorinated hydrocarbons is used.

The technical maximum holding time allowance for aqueous samples preserved with hydrochloric acid (HCl) is 14 days.

No technical holding times have been for solid matrices promulgated; a 14-day maximum holding time allowance is currently being used.

Positive results in affected samples are generally qualified as estimated (J); nondetects (UJ). These results are biased low. Some USEPA Regions apply the bias qualifiers, L and UL, instead. If the holding times are exceeded by a factor of 2 or more, the holding time exceedance is considered to be gross, and positive results are generally qualified as estimated (J); nondetects are generally considered to be unreliable and are qualified (R). Results for which the holding time was grossly exceeded are biased very low.

1.1.1.6.2 Calibration

Check that an initial calibration was performed for each instrument used for analysis and that all calibrations were performed at all appropriate concentration levels within 12 hours of the associated instrument tuning.

Review the data package Form Vs (tuning) using the applicable USEPA Regional Functional Guidelines, and qualify the data as appropriate.

Review initial calibration Form VIs and the associated laboratory raw data. Determine which compounds have average Relative Response Factors (RRFs) <0.050 and which compounds have Percent Relative Standard Deviations (%RSDs) >50 and between 30%-50%. Circle these noncompliances on your working copies of these Forms. Spot-check (i.e., recalculate) a few of the RRFs and %RSDs to verify the laboratory's computation.

Determine which samples are affected by reviewing the continuing calibration Form VIIs. Check the initial calibration date(s) noted in the headings of the Form VIIs to determine which continuing calibrations are associated with which initial calibrations. Next, review the sample listings given on the data package Form Vs. Match the indicated continuing calibration run with the appropriate Form VII by matching the laboratory file ID numbers. Write the affected samples (those listed on the matched Form V) on your working copies of the appropriate Form VI and VII.

Review the continuing calibration Form VIIs and the associated laboratory raw data. Determine which compounds have RRFs <0.050 and which compounds have Percent Differences (%Ds) >50, and between 25%-50%; circle the noncompliances on your working copies of these Forms. Spot-check (i.e., recalculate) a few of the RRFs and %Ds to verify the laboratory's computation.

Generally, affected positive results for compounds for which RRFs are <0.050 are qualified as estimated (J); nondetects are rejected (R). In accordance with some USEPA Regional protocol, the (L) qualifier may be used instead of (J) when qualifying positive results. Bias for these results is very low.

Generally, positive results for compounds for which %RSD exceeds 50% or %D exceeds 25% are qualified as estimated (J); nondetects (UJ). Check the specific applicable data validation protocol for further guidance as there are some protocols which reject nondetects if the %RSD or %D is excessive. Bias for these results cannot be determined.

Generally, positive results for compounds for which %RSD is between 30%-50% are qualified as estimated, (J). Qualification of nondetects is protocol-specific. Follow the rules given in the appropriate validation protocol.

1.1.1.6.3 Blank Contamination

When using the information given below and in the appropriate USEPA Regional Functional Guidelines, keep in mind that the validation action levels derived are sample specific and must be adjusted for dilution, sample aliquot used for analysis, and sample moisture content (when applicable).

The rules for qualifying data based on the occurrence of blank contamination vary based on regional protocols. The guidelines provided in the appropriate protocol should be followed.

Generally the blank contamination review process is completed by first considering the maximum amount of a particular contaminant occurring in the laboratory method blanks. (Do not consider lab blanks run after high concentration samples for purposes of determining carryover as laboratory method blanks!) Then repeat the process for contaminants occurring in the associated field quality control blanks. Action levels for qualification (10X or 5X depending upon whether or not the contaminant is a common contaminant) are then set. The list of common contaminants may vary among protocols. Additionally, some hierarchy among the field quality control blanks apply, and the manner in which the qualifiers are applied vary [i.e. use of (U) or (B); replacement by CRQL, etc.]. Refer to appropriate protocol for specific guidance.

1.1.1.6.4 Surrogates

Surrogates are evaluated by reviewing the laboratory data package Form II reports and the laboratory raw data. The quality control ranges are given on the laboratory data package Form IIs; circle any noncompliances on your working copies of these Forms.

Results for all compounds in an affected sample are qualified if any one of the surrogate spike compounds fail to meet the quality control criteria provided. Generally, for samples having a surrogate recovery <10%, positive results are qualified as estimated (J), nondetects are rejected (R). These results are biased low. For samples having a surrogate recovery which is low but >10%, positive results are generally qualified as estimated (J); nondetects (UJ). The bias qualifiers (L, UL) may be used instead, depending upon the specific USEPA Regional guidance. For samples having a surrogate recovery which is high, positive results are generally qualified as estimated (J, K) based on regional guidance; nondetects are not qualified based on high surrogate recoveries.

1.1.1.6.5 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

Generally, no data are qualified based upon MS/MSD results alone. If qualification does occur, generally only the result for that particular noncompliant compound is qualified in the original unspiked sample. Refer to the applicable data validation protocol for specific procedures for appropriately evaluating MS/MSD analyses.

1.1.1.6.6 Internal Standards

Internal standards are evaluated by reviewing the data package Form VIIIs and the laboratory raw data. The quality control ranges are given on the Form VIIIs. Circle any noncompliances on your working copies of these forms; evaluate and qualify as stipulated in the appropriate data validation protocol.

1.1.1.6.7 Tentatively Identified Compounds (TICs)

TICs are evaluated using the laboratory data package Form I VOA-TIC reports and the laboratory raw data. The guidance given in the March 1990 National Functional Guidelines for USEPA Region III is very concise; use the information in this document to evaluate and qualify accordingly.

1.1.1.6.8 Other Considerations

Laboratory precision can be evaluated by comparing the unspiked sample results with MS/MSD analyses results for unspiked compounds. Consider nondetects and results reported at concentrations less than the Contract Required Quantitation Limit (CRQL) to be in agreement. Use professional judgment in determining whether to qualify sample results based on the comparison.

Likewise, compare the positive compound results for field duplicate samples. Generally, the Relative Percent Difference (RPD) between field duplicate results for the aqueous matrix should be <35%; for soil matrix results, <50%. Qualification of the sample data is limited to the specific field duplicate pair. Positive results for compounds showing imprecision are qualified as estimated (J); nondetects (UJ). Bias for these results cannot be determined.

In some USEPA Regions, a "Percent Solids" rule applies. For example, if a sediment sample contains <50% solids in USEPA Region II, all associated data are considered to be estimated and are qualified accordingly. Follow the appropriate protocol guidance when applicable.

1.1.1.6.9 Quantitation

Verify and record the quantitation of at least one compound per analytical fraction. If no positive results are reported, use the MS/MSD data to confirm proper computation by the laboratory. Validator and laboratory quantitations must agree within 10 percent.

1.1.1.7 Deliverables Guidance

In addition to any specific USEPA Regional requirements (e.g. data validation memorandum, data summary spreadsheets, Regional worksheets), all laboratory data package quality control summary forms, sample Form I reports, method blank Form Is, and the Chain-of-Custody report must be given to the Data Validation Quality Assurance Officer (DV/QAO) for quality assurance review.

The validator should ensure that the format of the data validation deliverable is complete and correct (in accordance with the appropriate USEPA Regional or client requirements) and that the validation narrative is free of transcription and typographical errors before submitting all requested items for DV/QAO review.

1.1.2 Semivolatiles (USEPA CLP Statement of Work (SOW) 3/90)

1.1.2.1 Applicability

CLP 3/90 semivolatile methodology is applicable to nearly all types of samples, regardless of water content, including groundwater, aqueous sludges, caustic liquors, acid liquors, waste solvents, oily wastes, mousses, tars, fibrous wastes, polymeric emulsions, filter cakes, spent carbons, spent catalysts, soils, and sediments. Method 8250 can be used to analyze groundwater samples as well.

The semivolatile TCL includes the following compounds:

Acenaphthene
Acenaphthylene
Anthracene
Benzo(a)anthracene
Benzo(b)fluoranthene
Benzo(k)fluoranthene
Benzo(g,h,i)perylene
Benzo(a)pyrene
4-Bromophenyl-phenylether
Butylbenzylphthalate
Carbazole
4-Chloroaniline
bis(2-Chloroethoxy)methane
bis(2-Chloroethyl)ether
4-Chloro-3-methylphenol
2-Chloronaphthalene
2-Chlorophenol
4-Chlorophenyl-phenylether
2,2'-oxybis(1-Chloropropane)
Chrysene
Dibenzo(a,h)anthracene
Dibenzofuran
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
3,3'-Dichlorobenzidine
2,4-Dichlorophenol
Diethylphthalate
2,4-Dimethylphenol
Dimethylphthalate
Di-n-butylphthalate
4,6-Dinitro-2-methylphenol
2,4-Dinitrophenol
2,4-Dinitrotoluene
2,6-Dinitrotoluene
Di-n-octylphthalate
bis(2-Ethylhexyl)phthalate
Fluoranthene
Fluorene
Hexachlorobenzene
Hexachlorobutadiene
Hexachlorocyclopentadiene
Hexachloroethane
Indeno(1,2,3-cd)pyrene
Isophorone
2-Methylnaphthalene
2-Methylphenol
4-Methylphenol
Naphthalene
2-Nitroaniline
3-Nitroaniline
4-Nitroaniline
Nitrobenzene
2-Nitrophenol
4-Nitrophenol
N-Nitroso-di-n-propylamine
N-Nitroso-diphenylamine
Pentachlorophenol
Phenanthrene
Phenol
Pyrene
1,2,4-Trichlorobenzene
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol

The preceding method is based upon solvent extractions followed by gas chromatographic/mass spectrometric (GC/MS) procedures.

1.1.2.2 Interferences

Solvents, reagents, glassware, and other sample processing hardware may yield discrete artifacts and/or elevated baselines causing misinterpretation of chromatograms. All these materials must be demonstrated to be free from interferences under the conditions of the analysis by running method blanks. The use of high purity reagents and solvents helps to minimize interference problems; purification of solvents by distillation in all-glass systems may be required.

Interferences co-extracted from the samples will vary considerably from source to source depending upon the diversity of the industrial complex or waste being sampled.

1.1.2.3 General Laboratory Practices

An extraction blank should be prepared with each batch of samples extracted.

Matrix Spike/Matrix Spike Duplicate (MS/MSD) analyses should be conducted to determine the effects of sample matrix upon the compounds of interest.

1.1.2.4 Sample Preparation

Prior to GC/MS analysis, aqueous samples are acidified to pH 2 and extracted with methylene chloride using a continuous liquid-liquid extractor. Both neat and diluted organic liquids may be analyzed by direct injection. Solid samples are extracted with 1:1 methylene chloride/acetone using a sonication procedure. Cleanup by Gel Permeation Chromatography (GPC) is required for solid sample extracts.

1.1.2.5 Data Overview to Validation

Before commencing validation, the reviewer must preview the associated Chain-of-Custody (COC) reports to determine:

- If the appropriate number of samples are present in the data package and if each sample was correctly analyzed for the parameters and methods specified.
- The identity of all associated field quality control blanks and field duplicate pairs.

Because many samples may have required dilutions, re-extraction and/or reanalyses, the data validator should preview the data package contents to determine which analyses represent the better quality data.

The data package should never be annotated unless specifically directed by client protocol. All Form I reports (including those for samples, laboratory method blanks, and MS/MSD analyses) and all laboratory quality control summary forms (including all initial and continuing calibration summary statistics) should be photocopied for use as working copies.

1.1.2.6 Technical Evaluation Summary

All data evaluations must be conducted in accordance with the appropriate USEPA Regional protocols (when applicable) and/or specified client contract requirements. The applicable documents must be referenced during the data validation process as this S.O.P. is only intended as a general procedure for all data validation tasks.

General parameters such as Data Completeness, Overall System Performance, Chromatographic Quality, Detection Limits and Compound Identification are evaluated concurrently with the parameters discussed in the following subsections.

1.1.2.6.1 Holding Times

Holding times are evaluated by reviewing the COC reports, the individual sample Form I reports, and the associated laboratory raw data. Holding times for extraction are calculated from date of collection to date of extraction.

The technical holding times for aqueous and solid matrices are as follows:

- Extraction: 7 days
- Analysis: 40 days from date of extraction

Affected positive results are generally qualified as estimated (J), nondetects (UJ). Alternately, the L or UL bias qualifiers may be used dependent upon the applicable USEPA Regional Guidance. If the sample was extracted beyond 14 days from collection, the holding time exceedance is considered to be gross and positive results are qualified as estimated (J) or (L); nondetects are rejected (R). Generally, if the holding time until extraction is exceeded, the affected sample results are considered to be biased low. If the holding time until analysis is exceeded (and potentially, some of the extract may have evaporated), the affected sample results may be considered to be biased high. Follow the qualification guidance given in the appropriate data validation protocol.

1.1.2.6.2 Calibration

Check that an initial calibration was performed for each instrument used for analysis and that all calibrations were performed at all appropriate concentration levels within 12 hours of the associated instrument tuning.

Review the data package Form Vs (tuning) using the applicable USEPA Regional Functional Guidelines, and qualify the data as appropriate.

Review initial calibration Form VIs and the associated laboratory raw data. Determine which compounds have average Relative Response Factors (RRFs) <0.050 and which compounds have Percent Relative Standard Deviations (%RSDs) >50 and between 30%-50%. Circle these noncompliances on your working copies of these Forms. Spot-check (i.e., recalculate) a few of the RRFs and %RSDs to verify the laboratory's computation.

Determine which samples are affected by reviewing the continuing calibration Form VIIs. Check the initial calibration date(s) noted in the headings of the Form VIIs to determine which continuing calibrations are associated with which initial calibrations. Next, review the sample listings given on the data package Form Vs. Match the indicated continuing calibration run with the appropriate Form VII by matching the laboratory file ID numbers. Write the affected samples (those listed on the matched Form V) on your working copies of the appropriate Form VI and VII.

Review the continuing calibration Form VIIs and the associated laboratory raw data. Determine which compounds have RRFs <0.050 and which compounds have Percent Differences (%Ds) >50, and between 25%-50%; circle the noncompliances on your working copies of these Forms. Spot-check (i.e., recalculate) a few of the RRFs and %Ds to verify the laboratory's computation.

Generally, affected positive results for compounds for which RRFs are <0.050 are qualified as estimated (J); nondetects are rejected (R). In accordance with some USEPA Regional protocol, the (L) qualifier may be used instead of (J) when qualifying positive results. Bias for these results is low.

Generally, positive results for compounds for which %RSD or %D exceeds 50% are qualified as estimated (J); nondetects (UJ). Check the specific applicable data validation protocol for further guidance as there are some protocol which reject nondetects if the %RSD or %D is excessive. Bias for these results cannot be determined.

Generally, positive results for compounds for which %RSD is between 30%-50% or %D is between 25%-50% are qualified as estimated (J). Qualification of nondetects is protocol-specific. Follow the rules given in the appropriate validation protocol.

1.1.2.6.3 Blank Contamination

Note that unlike VOA fraction analyses, a laboratory method blank does not have to be analyzed after every continuing calibration standard. Be very sure, however, that one semivolatile method blank was extracted for each day that associated samples were extracted (with a maximum of 20 samples per batch).

The action levels for qualification are 10X the maximum amount of phthalates found in the blanks (phthalates are common contaminants) and 5X the maximum amount of other contaminants found in the blanks. The actual action level applied is sample-specific and must be adjusted for dilution, sample aliquot used for analysis, and moisture content. The type and manner in which the qualifiers are applied

vary with protocol [i.e., use of (U) or (B); replacement by CRQL, etc.]. Refer to appropriate data validation protocol for specific guidance.

1.1.2.6.4 Surrogates

Surrogates are evaluated by reviewing the laboratory data package Form II reports and the associated laboratory raw data. The quality control ranges are given on the laboratory data package Form IIs; circle any noncompliances on your working copies of these Forms.

Semivolatile compounds are divided into two classes, base-neutral compounds and acid-extractable compounds. Each class of compounds has its own associated surrogates. If the recovery is <10% for any one surrogate, positive results for all compounds in that class in the affected sample are qualified as estimated, (J) or (L), and nondetects are rejected, (R). These results are biased low.

No qualification actions are taken for samples having any one surrogate recovery which is noncompliant but >10%.

If the recoveries for any two surrogates of the same class are noncompliant but above 10%, all sample results for that class of compounds in the affected sample are qualified. If the recoveries are low, positive results are generally qualified as estimated (J); nondetects (UJ). In some Regions, the bias qualifiers, L and UL, may be used instead. If the recoveries for any two surrogates of the same class are high, positive results for all compounds in that class in the affected sample are qualified, J or K, depending upon the appropriate USEPA Regional guidance; nondetects are not qualified based on high surrogate recoveries.

1.1.2.6.5 Matrix Spike/Matrix Spike Duplicates

Generally, no data are qualified based upon MS/MSD results alone. If qualification does occur, generally only the result for that particular noncompliant compound is qualified in the original unspiked sample. Refer to the appropriate validation guidelines for specific procedures for evaluating MS/MSD analyses.

1.1.2.6.6 Internal Standards

Internal standards are evaluated by reviewing the data package Form VIIIs and the laboratory raw data. The quality control ranges are given on the Form VIIIs. Circle any noncompliances on your working copies of these forms; evaluate and qualify as stipulated in the appropriate protocol.

1.1.2.6.7 Tentatively Identified Compounds (TICs)

TICs are evaluated using the laboratory data package Form I BNA-TIC reports, and the laboratory raw data. The guidance given in the 3/90 National Functional Guidelines for USEPA Region III is very concise; evaluate and qualify accordingly.

1.1.2.6.8 Other Considerations

Laboratory precision can be evaluated by comparing MS/MSD sample results for unspiked compounds with the unspiked sample results. Consider nondetects and results reported at concentration levels less than the Contract Required Quantitation Limit (CRQL) to be in agreement. Use professional judgment in determining whether to qualify sample results based on the comparison.

Likewise, compare the positive compound results for field duplicate samples. Generally the Relative Percent Difference (RPD) between field duplicate results for the aqueous matrix should be less than 35%; for soil matrix results, less than 50%. Qualification of sample data is limited to that specific field duplicate pair. Positive results for compounds showing imprecision are qualified as estimated (J); and nondetects (UJ). Bias for these results cannot be determined.

In some USEPA regions a "Percent Solids" rule applies. For example, if a sediment contains less than 50% solids in USEPA Region II, all associated data are considered to be estimated and are qualified accordingly. Follow the appropriate protocol guidance when applicable.

1.1.2.6.9 Quantitation

Verify and record quantitation of at least one compound per analytical fraction. If no positive results are reported, use the MS/MSD data to confirm proper computation by the laboratory. Validator and laboratory quantitations must agree within 10 percent.

1.1.2.7 Deliverables Guidance

In addition to any specific USEPA Regional requirements (e.g., data validation memorandum, data summary spreadsheets, USEPA Regional worksheets), all laboratory data package quality control summary forms, sample Form I reports, method blank Form Is, and the Chain-of-Custody report must be given to the Data Validation Quality Assurance Officer (DV/QAO) for quality assurance review.

The validator should ensure that the format of the data validation deliverable is complete and correct (in accordance with the appropriate USEPA Regional or client requirements) and that the validation narrative is free of transcription and typographical errors before submitting all requested items for DV/QAO review.

1.2 CLP Organics by GC

1.2.1 Organochlorine Pesticides and Polychlorinated Biphenyls (PCBs) (USEPA CLP Statement of Work (SOW) 3/90)

1.2.1.1 Applicability

CLP 3/90 methodology is used to determine the concentration of certain organochlorine pesticides and polychlorinated biphenyls (PCBs) in groundwater, liquid, and solid sample matrices. Specifically, the CLP 3/90 TCL includes the following substances:

Aldrin	Dieldrin	Methoxychlor
alpha-BHC	Endosulfan I	Toxaphene
beta-BHC	Endosulfan II	Aroclor-1016
delta-BHC	Endosulfan sulfate	Aroclor-1221
gamma-BHC (Lindane)	Endrin	Aroclor-1232
Chlordane	Endrin aldehyde	Aroclor-1242
4,4'-DDD	Endrin ketone	Aroclor-1248
4,4'-DDE	Heptachlor	Aroclor-1254
4,4'-DDT	Heptachlor epoxide	Aroclor-1260

CLP 3/90 methodology for organochlorine pesticides and PCBs is a Gas Chromatographic (GC) procedure in which samples are first extracted and then analyzed by direct injection. The compounds

of interest are analyzed via GC/ECD (Electron Capture Detector; an equivalent Halogen-Specific Detector may also be used).

1.2.1.2 Interferences

The sensitivity of these methods usually depends on the level of interferences rather than on instrumental limitations. Solvents, reagents, glassware, and other sample processing hardware may yield discrete artifacts and/or elevated baselines causing misinterpretation of gas chromatograms. The use of high purity reagents and solvents helps to minimize these interference problems. Extraction blanks are analyzed as method blanks in order to monitor the occurrences of interferences.

Interferences co-extracted from the sample will vary considerably and will dictate the nature and extent of clean-up procedures used. Phthalate esters are a common interference to organochlorine pesticide analyses; phenols and organic acids may act as interferents when analyzing for chlorinated herbicides.

1.2.1.3 General Laboratory Practices

An extraction blank should be prepared with each batch of samples extracted.

Matrix Spike/Matrix Spike Duplicate (MS/MSD) analyses should be conducted to determine the effects of sample matrix upon the compounds of interest.

Standard quality assurance practices such as the analyses of field replicates should also be employed.

1.2.1.4 Sample Preparation

Prior to GC analysis, aqueous samples are extracted at a neutral pH with methylene chloride as a solvent using a separatory funnel or a continuous liquid-liquid extractor. Solid samples are extracted with hexane:acetone (1:1) using sonication procedures.

1.2.1.5 Data Overview Prior to Validation

Before commencing validation, the reviewer must preview the associated Chain-of-Custody (COC) reports to determine:

- If the appropriate number of samples are present in the data package and if each sample was correctly analyzed for the parameters and methods specified.
- The identity of all associated field quality control blanks and field duplicate pairs.

Because many samples may have required dilutions, re-extractions and/or re-analyses, the validator should preview the data package contents to determine which analyses represent the better quality data.

Unless specifically directed by client protocol, never annotate the laboratory data package. Before beginning evaluation, prepare working copies (i.e., photocopies) of all Form I reports (including those for samples, laboratory method blanks and MS/MSD analyses) and all laboratory quality control summary forms.

1.2.1.6 Technical Evaluation Summary

All data evaluations must be conducted in accordance with applicable USEPA Regional protocols (when applicable) and/or specific client contract requirements. The applicable documents must be referenced during the data evaluation process as this S.O.P. is only intended as a general procedure for the data validation tasks.

General parameters such as Data Completeness, Overall System Performance, Chromatographic Quality, Detection Limits, and Compound Identification are evaluated concurrently with the parameters discussed in the following subsections.

1.2.1.6.1 Holding Times

Holding times are evaluated by reviewing the COC reports, the individual sample Form I reports, and the associated laboratory raw data. Holding times are calculated from date of collection to date of extraction/analysis.

All samples to be analyzed for pesticides, PCBs and/or herbicides must be extracted within 7 days of collection regardless of matrix and analyzed within 40 days of extraction.

When the holding time criteria are not met, positive results in affected samples are generally qualified as estimated (J); nondetects (UJ). These results are biased low. Some USEPA Regions apply the bias qualifiers, L and UL, instead. If the holding times are exceeded by a factor of 2 or more, the holding time exceedance is considered to be gross, and positive results are generally qualified as estimated (J); nondetects are generally considered to be unreliable and are rejected (R). These results are biased low.

1.2.1.6.2 Calibration

Data pertaining to the initial calibration (i.e., evaluation check for linearity) is found on the data package Form VIs. Check that the initial calibration was performed for each instrument used and at all appropriate concentration levels.

Generally, positive results for compounds whose Percent Relative Standard Deviation (%RSD) exceeds 20% are qualified as estimated (J). Check the pesticide analytical sequence (Form VIII) to determine which samples are affected. Check the specific applicable data validation protocol for further guidance as there are some protocol which reject nondetects if the %RSD or %D is excessive. Bias for these results cannot be determined. Follow the rules given in the appropriate data validation protocol.

Verify that a resolution check mixture, Performance Evaluation Mixture (PEM), Individual Standard Mixtures A and B, and multicomponent target compounds were analyzed at the proper frequency (see Form VIII) on each GC analytical column. Retention times for PEM target compounds and Individual Standard Mixtures A and B target compounds should be within the established retention time windows. If a compound is outside of the retention time window, further evaluation of the sample chromatograms is necessary. In addition, check that the Relative Percent Difference (RPD) (recorded on Forms VII-D and VII-E) between the calculated amount and true amount for each pesticide is $\leq$25%. If this criterion is not met, positive results and nondetects for the affected compounds are qualified as estimated, (J) and (UJ), respectively.

The DDT/Endrin Breakdown for each PEM should not exceed 20% (recorded on Form VII-D). Generally, if % breakdown for DDT exceeds 20%, estimate (J) all positive results for DDT, DDE and DDD following the last in-control standard until the next acceptable PEM (see analytical sequence); acceptability of the

next individual A/B mix may also be considered when qualifying data for DDT breakdown. If there are no positive results for DDT but there are positive results for DDD or DDE then reject (R) nondetects for DDT in associated samples. Generally, if Endrin % Breakdown exceeds 20%, estimate (J) positive results for Endrin, Endrin Aldehyde, and Endrin Ketone in all samples following the last in-control standard until the next acceptable PEM; acceptability of the next individual A/B mix may also be considered when qualifying data for Endrin breakdown. If there are positive results for Endrin Aldehyde or Endrin Ketone but none for Endrin, reject (R) nondetect Endrin results.

1.2.1.6.3 Blank Contamination

When using the information provided below and in the appropriate data validation guidelines, keep in mind that the validation action levels derived are sample-specific and must be adjusted for dilution, sample aliquot used for analysis, and sample moisture content (when applicable).

The rules for qualifying data based on the occurrence of blank contamination vary based on regional protocols. Guidelines provided in the appropriate data validation protocol should be followed.

An action level of 5X the maximum amount of contaminant found is used to evaluate the sample data. The manner in which the qualifiers are applied vary [i.e. use of (U) or (B); replacement by CRQL, etc.]. Refer to appropriate validation protocol for specific guidance.

1.2.1.6.4 Surrogates

Surrogates are evaluated by reviewing the laboratory data package Form II reports and the associated laboratory raw data. The advisory limits are given on the laboratory data package Form IIs; circle any recoveries outside these limits on your working copies of these Forms.

No qualifications are made for surrogates which show zero recoveries because they were "diluted out." Generally, positive results affected by low surrogate recovery are qualified as estimated (J), or the (L) bias qualifier is used when applicable; nondetects are qualified (UJ) or (UL), accordingly. If a positive sample result is affected by high surrogate recovery, the result is qualified as estimated (J) or the (K) bias qualifier is used when applicable; nondetects are not qualified based on high surrogate recovery. Because the surrogate recovery limits for this fraction are advisory, generally no results are rejected.

The decachlorobiphenyl (DCB) and tetrachloro-m-xylene (TCX) retention times found on data package Form VIII must be ± 0.10 for DCB and ± 0.05 for TCX. If DCB and TCX retention time criteria are not met, the raw data must be checked for misidentified GC peaks. The validator's professional judgment for qualifications should be used.

1.2.1.6.5 Matrix Spike/Matrix Spike Duplicates

Generally, no data are qualified based upon MS/MSD results alone. If qualification does occur, generally only the result for that particular noncompliant compound is qualified in the original unspiked sample. Refer to the appropriate data validation guidelines for the specific procedures for evaluating MS/MSD analyses.

1.2.1.6.6 Other Considerations

Laboratory precision can be evaluated by comparing the unspiked sample results with MS/MSD analyses results for unspiked compounds. Consider nondetect results and results reported at concentrations less

than the Contract Required Quantitation Limit (CRQL) to be in agreement. Use professional judgment in determining whether to qualify sample results based on the comparison.

Likewise, compare the positive compound results for field duplicate samples. Generally, the Relative Percent Difference (RPD) between field duplicate results for the aqueous matrix should be <35%; for soil matrix results, <50%. Qualification of the sample data is limited to the specific field duplicate pair. Positive results for compounds showing imprecision are qualified as estimated (J); nondetects (UJ). Bias for these results cannot be determined.

In some USEPA Regions, a "Percent Solids" rule applies. For example, if a sediment sample contains <50% solids in USEPA Region II, all associated data are considered to be estimated, and are qualified accordingly. Follow the appropriate protocol guidance when applicable.

1.2.1.6.7 Quantitation

Verify and record the quantitation of at least one compound per analytical fraction. If no positive results are reported, use the MS/MSD data to confirm proper computation by the laboratory. Validator and laboratory quantitations must agree within 10%.

1.2.1.7 Deliverables Guidance

In addition to any specific USEPA Regional requirements (e.g., data validation memorandum, data summary spreadsheets, USEPA Regional worksheets), all laboratory data package quality control summary forms, sample Form I reports, method blank Form Is, and the Chain-of-Custody report must be given to the Data Validation Quality Assurance Officer (DV/QAO) for quality assurance review.

The validator should ensure that the format of the data validation deliverable is complete and correct (in accordance with the appropriate USEPA Regional or client requirements) and that the validation narrative is free of transcription and typographical errors before submitting all requested items for DV/QAO review.

2.0 NON-CLP ORGANICS FOR SOLID MATRICES

2.1 SW-846 Organics by GC/MS

2.1.1 Volatiles (Method 8240B, 8260A)

2.1.1.1 Applicability

Method 8240 is used to determine volatile organic compounds in most waste matrices including groundwater, sludges, caustic liquors, acid liquors, waste solvents, oily wastes, mousses, tars, fibrous wastes, polymeric emulsions, filter cakes, spent carbons, spent catalysts, soils, and sediments.

Method 8240 analyte list includes of the volatile CLP 3/90 Target Compound List (TCL) (Section 1.1.1) plus the following compounds*:

Acetonitrile	trans-1,2-Dichloroethene
Acrolein	Ethyl methacrylate
Acrylonitrile	Iodomethane
Allyl chloride	Methacrylonitrile
Chloropropene	Methyl methacrylate
1,2-Dibromo-3-chloropropane	2-Picoline
1,2-Dibromoethane	Pyridine
Dibromomethane	Trichlorofluoromethane
trans-1,4-Dichloro-2-butene	1,2,3-Trichloropropane
Dichlorodifluoromethane	Vinyl acetate

* Appendix IX target compounds

Method 8240 is based upon a purge-and-trap, gas chromatographic/mass spectrometric (GC/MS) procedure. Prior to analysis, samples must be prepared by Method 5030.

2.1.1.2 Interferences

Samples can be contaminated by diffusion of volatile organics (particularly chlorofluorocarbons and methylene chloride) through the sample container septum during shipment and storage. Associated field quality control blanks are analyzed in order to monitor this.

Contamination by carryover can occur whenever high-level and low-level samples are sequentially analyzed. To reduce carryover, the sample syringe or purging device is rinsed out between samples with reagent water. Whenever an unusually concentrated sample is encountered, it should be followed by an analysis of reagent water to check for cross contamination.

If sample or matrix interferences are encountered, a secondary or alternate analytical column may be used to resolve the compounds of interest.

2.1.1.3 General Laboratory Practices

A method blank consisting of organic free water spiked with surrogates and internal standards should be analyzed immediately following each daily calibration and also after the analysis of every high concentration sample.

Matrix Spike/Matrix Spike Duplicate (MS/MSD) analyses should be conducted to determine the effects of sample matrix upon the compounds of interest.

2.1.1.4 Sample Preparation

Method 5030 is a purge-and-trap procedure performed to prepare and extract volatile compounds from samples and introduce those compounds into the GC/MS.

For highly volatile matrices, direct injection preceded by dilution should be used to prevent gross contamination of the instrumentation. For pastes, dilution of the sample until it becomes free-flowing is used to ensure adequate interfacial area. The success of this method depends on the level of interferences in the sample; results may vary due to the large variability and complicated matrices of solid waste samples.

2.1.1.5 Data Overview Prior to Validation

Before commencing validation, the reviewer must preview the associated Chain-of-Custody (COC) reports to determine:

- If the appropriate number of samples are present in the data package and if each sample was correctly analyzed for the parameters and methods specified.
- The identity of all associated field quality control blanks and field duplicate pairs.

Because many samples may have required dilutions, re-extractions and/or re-analyses, the validator should preview the data package contents to determine which analyses represent the better quality data.

Unless specifically directed by client protocol, never annotate the laboratory data package. Before beginning evaluation, prepare working copies (i.e., photocopies) of all Form I reports (including those for samples, laboratory method blanks and MS/MSD analyses) and all laboratory quality control summary forms (including all initial and continuing calibration summary statistics).

2.1.1.6 Technical Evaluation Summary

All data evaluations must be conducted in accordance with applicable USEPA Regional protocols and/or specific client contract requirements. The applicable documents must be referenced during the data evaluation process as this S.O.P. is only intended as a general procedure for the data validation tasks.

General parameters such as Data Completeness, Overall System Performance, Chromatographic Quality, Detection Limits and Compound Identification are evaluated concurrently with the parameters discussed in the following subsections.

2.1.1.6.1 Holding Times

Holding times are evaluated by reviewing the COC reports, the individual sample Form I reports, and the associated laboratory raw data. Holding times are calculated from date of collection to date of analysis.

The technical maximum holding time allowance for aqueous samples preserved with hydrochloric acid (HCL) is 14 days.

No technical holding times for solid matrices have been promulgated; a 14-day maximum holding time allowance is currently being used.

For unpreserved aqueous samples, generally a 7-day maximum holding time allowance for aromatic compounds, along with a 14-day maximum holding time allowance for chlorinated hydrocarbons is used.

Positive results in affected samples are generally qualified as estimated (J); nondetects (UJ). These results are biased low. Some USEPA Regions apply the bias qualifiers, L and UL, instead. If the holding times are exceeded by a factor of 2 or more, the holding time exceedance is considered to be gross and positive results are generally qualified as estimated (J): nondetects are generally considered to be unreliable and are qualified (R). Results for which the holding time was grossly exceeded are biased low.

2.1.1.6.2 Calibration

Check that an initial calibration was performed for each instrument used for analysis and that all calibrations were performed at all appropriate concentration levels within 12 hours of the associated instrument tuning.

Review the data package Form Vs (tuning) using the applicable USEPA Regional Functional Guidelines, and qualify the data as appropriate.

Review initial calibration Form VIs and the associated laboratory raw data. Determine which compounds have average Relative Response Factors (RRFs) <0.050 and which compounds have Percent Relative Standard Deviations (%RSDs) >50% and between 30% and 50%. Circle these noncompliances on your working copies of these Forms. Spot-check (i.e., recalculate) a few of the RRFs and %RSDs to verify the laboratory's computation.

Determine which samples are affected by reviewing the continuing calibration Form VIIs. Check the initial calibration date(s) noted in the headings of the Form VIIs to determine which continuing calibrations are associated with which initial calibrations. Next, review the sample listings given on the data package Form Vs. Match the indicated continuing calibration run with the appropriate Form VII by matching the laboratory file ID numbers. Write the affected samples (those listed on the matched Form V) on your working copies of the appropriate Form VI and VII. Spot-check (i.e., recalculate) a few of the RRFs and %Ds to verify the laboratory's computation.

Review the continuing calibration Form VIIs and the associated laboratory raw data. Determine which compounds have RRFs <0.050 and which compounds have Percent Differences (%Ds) >25%; circle the noncompliances on your working copies of these Forms.

Generally, affected positive results for compounds whose RRFs are <0.050 are qualified as estimated (J); nondetects are rejected (R). In accordance with some USEPA Regional protocol, the (L) qualifier may be used instead of (J), when qualifying positive results. Bias for these results is low.

Generally, positive results for compounds for which %RSD exceeds 50% or %D exceeds 25% are qualified as estimated (J); nondetects (UJ). Check the specific applicable data validation protocol for further guidance as there are some protocol which reject nondetects if the %RSD or %D is excessive. Bias for these results cannot be determined.

Generally, positive results for compounds for which %RSD is between 30%-50% are qualified as estimated (J). Qualification of nondetects is protocol-specific. Follow the rules given in the appropriate validation protocol.

2.1.1.6.3 Blank Contamination

When using the information given below and in the appropriate USEPA Regional Functional Guidelines, keep in mind that the validation action levels derived are sample-specific and must be adjusted for dilution, sample aliquot used for analysis, and sample moisture content (when applicable).

The rules for qualifying data based on the occurrence of blank contamination vary based on regional protocols. The guidelines provided in the appropriate protocol should be followed.

Generally the blank contamination review process is completed by first considering the maximum amount of a particular contaminant occurring in the laboratory method blanks. (Do not consider lab blanks run after high concentration samples for purposes of determining carryover as laboratory method blanks!) Then repeat the process for contaminants occurring in the associated field quality control blanks. Action levels for qualification (10X or 5X depending upon whether or not the contaminant is a common contaminant) are then set. The list of common contaminants may vary among protocols. Additionally, some hierarchy among the field quality control blanks apply, and the manner in which the qualifiers are applied vary [i.e. use of (U) or (B); replacement by CRQL, etc.]. Refer to appropriate protocol for specific guidance.

2.1.1.6.4 Surrogates

Surrogates are evaluated by reviewing the laboratory data package Form II reports and the laboratory raw data. The quality control ranges are given on the laboratory data package Form IIs; circle any noncompliances on your working copies of these Forms.

Results for all compounds in an affected sample are qualified if any one of the surrogate spike compounds fail to meet the quality control criteria provided. Generally, for samples having a surrogate recovery <10%, positive results are qualified as estimated (J), nondetects are rejected (R). These results are biased low. For samples having a surrogate recovery which is low but >10%, positive results are generally qualified as estimated (J); nondetects (UJ). The bias qualifiers (L, UL) may be used instead, depending upon the specific USEPA Regional guidance. For samples having a surrogate recovery which is high, positive results are generally qualified as estimated (J, K) based on regional guidance, nondetects are not qualified based on high surrogate recovery.

2.1.1.6.5 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

Generally, no data are qualified based upon MS/MSD results alone. If qualification does occur, generally only the result for that particular noncompliant compound is qualified in the original unspiked sample. Refer to the applicable data validation protocol for specific procedures for appropriately evaluating MS/MSD analyses.

2.1.1.6.6 Internal Standards

Internal standards are evaluated by reviewing the data package Form VIIIs and the laboratory raw data. The quality control ranges are given on the Form VIIIs. Circle any noncompliances on your working copies of these forms; evaluate and qualify as stipulated in the appropriate data validation protocol.

2.1.1.6.7 Tentatively Identified Compounds (TICs)

TICs are evaluated using the laboratory data package Form I VOA-TIC reports and the laboratory raw data. The guidance given in the March 1990 National Functional Guidelines for USEPA Region III is very concise; use the information in this document to evaluate and qualify accordingly.

2.1.1.6.8 Other Considerations

Laboratory precision can be evaluated by comparing the unspiked sample results with MS/MSD analyses results for unspiked compounds. Consider nondetects and results reported at concentrations less than the Contract Required Quantitation Limit (CRQL) to be in agreement. Use professional judgment in determining whether to qualify sample results based on the comparison.

Likewise, compare the positive compound results for field duplicate samples. Generally, the Relative Percent Difference (RPD) between field duplicate results for the aqueous matrix should be <35%; for soil matrix results, <50%. Qualification of the sample data is limited to the specific field duplicate pair. Positive results for compounds showing imprecision are qualified as estimated (J); nondetects (UJ). Bias for these results cannot be determined.

In some USEPA Regions, a "Percent Solids" rule applies. For example, if a sediment sample contains <50% solids in USEPA Region II, all associated data are considered to be estimated and are qualified accordingly. Follow the appropriate protocol guidance when applicable.

2.1.1.6.9 Quantitation

Verify and record the quantitation of at least one compound per analytical fraction. If no positive results are reported, use the MS/MSD data to confirm proper computation by the laboratory. Validator and laboratory quantitations must agree within 10 percent.

2.1.1.7 Deliverables Guidance

In addition to any specific USEPA Regional requirements (e.g. data validation memorandum, data summary spreadsheets, Regional worksheets), all laboratory data package quality control summary forms, sample Form I reports, method blank Form Is, and the Chain-of-Custody report must be given to the Data Validation Quality Assurance Officer (DV/QAO) for quality assurance review.

The validator should ensure that the format of the data validation deliverable is complete and correct (in accordance with the appropriate USEPA Regional or client requirements) and that the validation narrative is free of transcription and typographical errors before submitting all requested items for DV/QAO review.

2.1.2 Semivolatiles (Method SW8250A, 8270B)

2.1.2.1 Applicability

Methods 8250 and 8270 are applicable to most types of samples, regardless of water content, including groundwater, aqueous sludges, caustic liquors, acid liquors, waste solvents, oily wastes, mousses, tars, fibrous wastes, polymeric emulsions, filter cakes, spent carbons, spent catalysts, soils, and sediments. Method 8250 can be used to analyze groundwater samples as well.

These methods can be used to quantify most neutral, acidic, and basic organic compounds that are soluble in methylene chloride and capable of elution without derivatization as sharp peaks from a gas

chromatographic column. Such compounds include polynuclear aromatic hydrocarbons, chlorinated hydrocarbons and pesticides, phthalate esters, organophosphate esters, nitrosamines, haloethers, aldehydes, ethers, ketones, anilines, pyridines, quinolines, aromatic nitro compounds, and phenols, including nitrophenols.

The above methods specifically analyze for the semivolatile CLP 3/90 Target Compound List (TCL) (Section 1.1.2) plus the following compounds*:

Acetophenone	Hexachlorophene	N-nitrosodimethylethylamine
Aniline	Hexachloropropene	N-nitroso-di-n-butylamine
Benzyl alcohol	Isodrin	N-nitrosomorpholine
Bis(2-chloroisopropyl)ether	Isosafrole	N-nitrosopiperidine
Chlorobenzilate	Kepone	Pentachlorobenzene
Diallate	Methapyrilene	Pentachloronitrobenzene
2,6-Dichlorophenol	3-Methylcholanthrene	Phenacetin
Dimethoate	Methyl methanesulfonate	p-Phenylenediamine
p-Dimethylaminoazobenzene	3-Methylphenol	Phorate
7,12-Dimethylbenz(a)anthracene	1,4-Naphthoquinone	2-Picoline
3,3'-Dimethylbenzidine	4-Nitroquinoline-1-oxide	Pronamide
a,a-Dimethylphenylamine	1-Naphthylamine	Safrole
1,3-Dinitrobenzene	2-Naphthylamine	1,2,4,5-Tetrachlorobenzene
Diphenylamine	5-Nitro-o-toluidine	Thionazin
Ethyl methanesulfonate	N-nitrosodiethylamine	o,o,o-Triethylphosphorothioate
Famphur	N-nitrosodimethylamine	1,3,5-Trinitrobenzene

* Appendix IX target compounds

The preceding methods are based upon solvent extractions followed by gas chromatographic/mass spectrometric (GC/MS) procedures, Method 8250 being a GC/MS method using the packed column technique, and Method 8270 using GC/MS capillary column technique.

2.1.2.2 Interferences

Solvents, reagents, glassware, and other sample processing hardware may yield discrete artifacts and/or elevated baselines causing misinterpretation of chromatograms. All these materials must be demonstrated to be free from interferences under the conditions of the analysis by running method blanks. The use of high purity reagents and solvents helps to minimize interference problems; purification of solvents by distillation in all-glass systems may be required.

Interferences co-extracted from the samples will vary considerably from source to source, depending upon the diversity of the industrial complex or waste being sampled.

2.1.2.3 General Laboratory Practices

An extraction blank should be prepared with each batch of samples extracted.

Matrix Spike/Matrix Spike Duplicate (MS/MSD) analyses should be conducted to determine the effects of sample matrix upon the compounds of interest.

2.1.2.4 Sample Preparation

Prior to analysis, the samples must be extracted using the appropriate techniques. Aqueous samples are extracted at the appropriate pH with methylene chloride as a solvent using a separatory funnel (Method 3510) or a continuous liquid-liquid extractor (Method 3520). Both neat and diluted organic liquids may be analyzed by direct injection. Solid samples are extracted at the appropriate pH with methylene chloride using either Soxhlet Extraction (Method 3540) or sonication (Method 3550) procedures.

2.1.2.5 Data Overview to Validation

Before commencing validation, the reviewer must preview the associated Chain-of-Custody (COC) reports to determine:

- If the appropriate number of samples are present in the data package and if each sample was correctly analyzed for the parameters and methods specified.
- The identity of all associated field quality control blanks and field duplicate pairs.

Because many samples may have required dilutions, re-extraction and/or reanalyses, the data validator should preview the data package contents to determine which analyses represent the better quality data.

The data package should never be annotated unless specifically directed by client protocol. All Form I reports (including those for samples, laboratory method blanks, and MS/MSD analyses) and all laboratory quality control summary forms (including all initial and continuing calibration summary statistics) should be photocopied for use as working copies.

2.1.2.6 Technical Evaluation Summary

All data evaluations must be conducted in accordance with the appropriate USEPA Regional protocols and/or specified client contract requirements. The applicable documents must be referenced during the data validation process as this S.O.P. is only intended as a general procedure for all data validation tasks.

General parameters such as Data Completeness, Overall System Performance, Chromatographic Quality, Detection Limits and Compound Identification are evaluated concurrently with the parameters discussed in the following subsections.

2.1.2.6.1 Holding Times

Holding times are evaluated by reviewing the COC reports, the individual sample Form I reports, and the associated laboratory raw data. Holding times for extraction are calculated from date of collection to date of extraction.

The technical holding times for aqueous and solid matrices are as follows:

- Extraction:
  - Water samples: 7 days
  - Solid samples: 14 days
- Analysis: 40 days from date of extraction

Affected positive results are generally qualified as estimated (J), nondetects (UJ). Alternately, the L or UL bias qualifiers may be used dependent upon the applicable USEPA Regional Guidance. If the sample was extracted beyond 14 days from collection (28 days for solid samples), the holding time exceedance is considered to be gross and positive results are qualified as estimated (J) or (L); nondetects are rejected (R). Generally, if the holding time until extraction is exceeded, the affected sample results are considered to be biased low. If the holding time until analysis has been exceeded (and potentially, some of the extract may have evaporated), the affected sample results may be considered to be biased high. Follow the qualification guidance given in the appropriate data validation protocol.

2.1.2.6.2 Calibration

Check that an initial calibration was performed for each instrument used for analysis and that all calibrations were performed at all appropriate concentration levels within 12 hours of the associated instrument tuning.

Review the data package Form Vs (tuning) using the applicable USEPA Regional Functional Guidelines, and qualify the data as appropriate.

Review initial calibration Form VIs and the associated laboratory raw data. Determine which compounds have average Relative Response Factors (RRFs) <0.050 and which compounds have Percent Relative Standard Deviations (%RSDs) >50% and between 30% and 50%. Circle these noncompliances on your working copies of these Forms. Spot-check (i.e., recalculate) a few of the RRFs and %RSDs to verify the laboratory's computation.

Determine which samples are affected by reviewing the continuing calibration Form VIIs. Check the initial calibration date(s) noted in the headings of the Form VIIs to determine which continuing calibrations are associated with which initial calibrations. Next, review the sample listings given on the data package Form Vs. Match the indicated continuing calibration run with the appropriate Form VII by matching the laboratory file ID numbers. Write the affected samples (those listed on the matched Form V) on your working copies of the appropriate Form VI and VII. Spot-check (i.e., recalculate) a few of the RRFs and %Ds to verify the laboratory's computation.

Review the continuing calibration Form VIIs, and the associated laboratory raw data. Determine which compounds have RRFs <0.050 and which compounds have Percent Differences (%Ds) >30%; circle the noncompliances on your working copies of these Forms.

Generally, affected positive results for compounds for which RRFs are <0.050 are qualified as estimated (J); nondetects are rejected (R). In accordance with some USEPA Regional protocol, the (L) qualifier may be used instead of (J) when qualifying positive results. Bias for these results is low.

Generally, positive results for compounds for which %RSD exceeds 50% or %D exceeds 30%, are qualified as estimated (J); nondetects (UJ). Check the specific applicable data validation protocol for further guidance as there are some protocol which reject nondetects if the %RSD or %D is excessive. Bias for these results cannot be determined.

Generally, positive results for compounds for which %RSD is between 30%-50% are qualified as estimated (J). Qualification of nondetects is protocol-specific. Follow the rules given in the appropriate validation protocol.

2.1.2.6.3 Blank Contamination

Note that unlike VOA fraction analyses, a laboratory method blank does not have to be analyzed after every continuing calibration standard. Be very sure, however, that one semivolatile method blank was extracted for each day that associated samples were extracted (with a maximum of 20 samples per batch).

The action levels for qualification are 10X the maximum amount of phthalates found in the blanks (phthalates are common contaminants) and 5X the maximum amount of other contaminants found in the blanks. The actual action level applied is sample-specific and must be adjusted for dilution, sample aliquot used for analysis, and moisture content. The type and manner in which the qualifiers are applied vary with protocol [i.e., use of (U) or (B); replacement by CRQL, etc.]. Refer to appropriate data validation protocol for specific guidance.

2.1.2.6.4 Surrogates

Surrogates are evaluated by reviewing the laboratory data package Form II reports and the associated laboratory raw data. The quality control ranges are given on the laboratory data package Form IIs; circle any noncompliances on your working copies of these Forms.

Semivolatile compounds are divided into two classes, base-neutral compounds and acid-extractable compounds. Each class of compounds has its own associated surrogates. If the recovery is <10% for any one surrogate, positive results for all compounds in that class in the affected sample are qualified as estimated, (J) or (L), and nondetects are rejected, (R). These results are biased low.

No qualification actions are taken for samples having any one surrogate recovery which is noncompliant but >10%.

If the recoveries for any two surrogates of the same class are noncompliant but above 10%, all sample results for that class of compounds in the affected sample are qualified. If the recoveries are low, positive results are generally qualified as estimated (J); nondetects (UJ). In some Regions, the bias qualifiers, L and UL, may be used instead. If the recoveries for any two surrogates of the same class are high, positive results for all compounds in that class in the affected sample are qualified, J or K, depending upon the appropriate USEPA Regional guidance; nondetects are not qualified based on high surrogate recoveries.

2.1.2.6.5 Matrix Spike/Matrix Spike Duplicates

Generally, no data are qualified based upon MS/MSD results alone. If qualification does occur, generally only the result for that particular noncompliant compound is qualified in the original unspiked sample analysis. Refer to the appropriate validation guidelines for specific procedures for evaluating MS/MSD analyses.

2.1.2.6.6 Internal Standards

Internal standards are evaluated by reviewing the data package Form VIIIs and the laboratory raw data. The quality control ranges are given on the Form VIIIs. Circle any noncompliances on your working copies of these forms; evaluate and qualify as stipulated in the appropriate protocol.

2.1.2.6.7 Tentatively Identified Compounds (TICs)

TICs are evaluated using the laboratory data package Form I BNA-TIC reports and the laboratory raw data. The guidance given in the 3/90 National Functional Guidelines for USEPA Region III is very concise; evaluate and qualify accordingly.

2.1.2.6.8 Other Considerations

Laboratory precision can be evaluated by comparing MS/MSD sample results for unspiked compounds with the unspiked sample results. Consider nondetects and results reported at concentration levels less than the Contract Required Quantitation Limit (CRQL) to be in agreement. Use professional judgment in determining whether to qualify sample results based on the comparison.

Likewise, compare the positive compound results for field duplicate samples. Generally the Relative Percent Difference (RPD) between field duplicate results for the aqueous matrix should be less than 35%; for soil matrix results, less than 50%. Qualification of sample data is limited to that specific field duplicate pair. Positive results for compounds showing imprecision are qualified as estimated (J); and nondetects (UJ). Bias for these results cannot be determined.

In some USEPA regions a "Percent Solids" rule applies. For example, if a sediment contains less than 50% solids in USEPA Region II, all associated data are considered to be estimated and are qualified accordingly. Follow the appropriate protocol guidance when applicable.

2.1.2.6.9 Quantitation

Verify and record quantitation of at least one compound per analytical fraction. If no positive results are reported, use the MS/MSD data to confirm proper computation by the laboratory. Validator and laboratory quantitations must agree within 10 percent.

2.1.2.7 Deliverables Guidance

In addition to any specific USEPA Regional requirements (e.g., data validation memorandum, data summary spreadsheets, USEPA Regional worksheets), all laboratory data package quality control summary forms, sample Form I reports, method blank Form Is, and the Chain-of-Custody report, must be given to the Data Validation Quality Assurance Officer (DV/QAO) for quality assurance review.

The validator should ensure that the format of the data validation deliverable is complete and correct (in accordance with the appropriate USEPA Regional or client requirements) and that the validation narrative is free of transcription and typographical errors before submitting all requested items for DV/QAO review.

2.2 SW846 Non-CLP Organics by Gas Chromatography

2.2.1 Volatiles (SW 5030/SW 8010B, 8015A, 8020A, 8030A)

2.2.1.1 Applicability

Method 8010B is used to determine the concentration of the following halogenated volatile organic compounds in groundwater, liquid, and solid matrices:

Allyl chloride
Benzyl chloride

Bis (2-chloroethoxy)methane
Bis (2-chloroisopropyl)ether
Bromoacetone
Bromobenzene
Bromodichloromethane
Bromoform
Bromomethane
Carbon tetrachloride
Chlorobenzene
Chloroethane
2-Chloroethanol
Chloroform
1-Chlorohexane
2-Chloroethyl vinyl ether
Chloromethane
Chloromethyl methyl ether
Chloroprene
4-Chlorotoluene
Dibromochloromethane
1,2-Dibromo-3-chloropropane
Dibromomethane
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
Dichlorodifluoromethane
1,1-Dichloroethane
1,2-Dichloroethane
1,1-Dichloroethylene (Vinylidene chloride)
trans-1,2-Dichloroethylene
Dichloromethane
1,2-Dichloropropane
1,3-Dichloro-2-propanol
cis-1,3-Dichloropropene
trans-1,3-Dichloropropene
Epichlorhydrin
Ethylene dibromide
Methyl iodide
1,1,2,2-Tetrachloroethane
1,1,1,2-Tetrachloroethane
Tetrachloroethylene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
Trichloroethylene
Trichlorofluoromethane
1,2,3-Trichloropropane
Vinyl chloride

Method 8015A is used to determine the concentration of the following nonhalogenated volatile organic compounds in groundwater, liquid, and solid matrices:

Diethyl ether
Ethanol
Methyl ethyl ketone (MEK)
Methyl isobutyl ketone (MIBK)

Method 8020A is used to determine the concentration of the following aromatic volatile organic compounds in groundwater, liquid, and solid matrices:

Benzene
Chlorobenzene
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
Toluene
Ethyl benzene
Xylenes (Dimethyl benzenes)

Method 8030A is used to determine the concentration of the following volatile organic compounds in groundwater, liquid, and solid matrices:

Acrolein (Propenal)
Acrylonitrile

All of the above Methods are gas chromatographic (GC) only (i.e., no mass spectrometer detector is employed). Method 8010B analyzes for halogenated volatile organics via GC/HSD (Halide-Specific Detector), Method 8015A analyzes for nonhalogenated volatile organics via GC/FID (Flame Ionization Detector), Method 8020A analyzes for aromatic Volatile organics via GC/PID (Photo-ionization Detector), and Method 8030A analyzes for the compounds acrolein and acrylonitrile using GC/FID. Samples can be analyzed by these methods using direct injection, the headspace method (Method 5020) or the purge-and-trap method (Method 5030). Groundwater samples should be determined using Method 5030.

2.2.1.2 Interferences

Samples can be contaminated by diffusion of volatile organics (particularly chlorofluorocarbons and methylene chloride) through the sample container septum during shipment and storage. Associated field quality control blanks are analyzed in order to monitor this.

Contamination by carryover can occur whenever high-level and low-level samples are sequentially analyzed. To reduce carryover, the sample syringe or purging device is rinsed with reagent water between samples. Whenever an unusually concentrated sample is encountered, it should be followed by an analysis of reagent water to check for cross contamination.

If sample or matrix interferences are encountered, a secondary or alternate analytical column may be used to resolve the compounds of interest.

2.2.1.3 General Laboratory Practices

A method blank consisting of organic free water spiked with surrogates and internal standards should be analyzed immediately following each daily calibration, and also after the analysis of every high concentration sample.

Matrix Spike/Matrix Spike Duplicate (MS/MSD) analyses should be conducted to determine the effects of sample matrix upon the compounds of interest.

2.2.1.4 Sample Preparation

Method 5020 is a static headspace technique for extracting volatile organic compounds in pastes, solids, and liquids. Because of the large variability and complicated matrices of waste samples detection limits for this method may vary widely among samples.

Method 5030 is a purge-and-trap method applicable to nearly all types of samples, regardless of water content, including aqueous sludges, caustic liquors, acid liquors, waste solvents, oily wastes, groundwater, mousses, tars, fibrous wastes, polymeric emulsions, filter cakes, spent carbons, spent catalysts, soils, and sediments.

For highly volatile matrices, direct injection preceded by dilution should be used to prevent gross contamination of the instrumentation. For pastes, dilution of the sample until it becomes free-flowing is used to ensure adequate interfacial area. The success of this method depends on the level of interferences in the sample; results may vary due to the large variability and complicated matrices of solid waste samples.

2.2.1.5 Data Overview Prior to Validation

Before commencing validation, the reviewer must preview the associated Chain-of-Custody (COC) reports to determine:

- If the appropriate number of samples are present in the data package and if each sample was correctly analyzed for the parameters and methods specified.
- The identity of all associated field quality control blanks and field duplicate pairs.

Because many samples may have required dilutions, re-extractions and/or re-analyses, the validator should preview the data package contents to determine which analyses represent the better quality data.

Unless specifically directed by client protocol, never annotate the laboratory data package. Before beginning evaluation, prepare working copies (i.e. photocopies) of all Form I reports (including those for samples, laboratory method blanks and MS/MSD analyses) and all laboratory quality control summary forms (including all initial and continuing calibration summary statistics).

2.2.1.6 Technical Evaluation Summary

All data evaluations must be conducted in accordance with applicable USEPA Regional protocols and/or specific client contract requirements. The applicable documents must be referenced during the data evaluation process as this S.O.P. is only intended as a general procedure for the data validation tasks.

General parameters such as Data Completeness, Overall System Performance, Chromatographic Quality, Detection Limits and Compound Identification are evaluated concurrently with the parameters discussed in the following subsections.

2.2.1.6.1 Holding Times

Holding times are evaluated by reviewing the COC reports, the individual sample Form I reports, and the associated laboratory raw data. Holding times are calculated from date of collection to date of analysis.

The technical maximum holding time allowance for aqueous samples preserved with hydrochloric acid (HCL) is 14 days.

No technical holding times for solid matrices have been promulgated; a 14-day maximum holding time allowance is currently being used.

For unpreserved aqueous samples, generally a 7-day maximum holding time allowance for aromatic compounds, along with a 14-day maximum holding time allowance for chlorinated hydrocarbons is used.

Positive results in affected samples are generally qualified as estimated (J); nondetects (UJ). These results are biased low. Some USEPA Regions apply the bias qualifiers, L and UL, instead. If the holding times are exceeded by a factor of 2 or more, the holding time exceedance is considered to be gross and positive results are generally qualified as estimated (J); nondetects are generally considered to be unreliable and are qualified (R). Results for which the holding time was grossly exceeded are biased low.

2.2.1.6.2 Calibration

Check that an initial calibration was performed for each instrument used for analysis and that all calibrations were performed at all appropriate concentration levels.

In general, either the correlation coefficient (R) or the Percent Relative Standard Deviation (%RSD) is evaluated in the data validation. If the correlation coefficient is chosen by the laboratory, the calibration curve should be checked for linearity. Generally, associated sample data are qualified as estimated (J, UJ) if the calibration curve correlation coefficient is <0.995. Professional judgment should be used to qualify sample data in cases when sample results fall outside the linear portion of the calibration curve. If the %RSD is used, determine which compounds have Percent Relative Standard Deviations (%RSDs) >40% and between 20%-40%. Circle these noncompliances on your working copies of these Forms. Spot-check (i.e., recalculate) a few of the %RSDs to verify the laboratory's computation.

Determine which samples are affected by reviewing the continuing calibration forms. Determine which continuing calibrations are associated with which initial calibrations. Write the affected samples on your working copies of the appropriate continuing calibration forms. Spot-check (i.e., recalculate) a few of the %Ds to verify the laboratory's computation.

Review the continuing calibration form and the associated laboratory raw data. Determine which compounds have Percent Differences (%Ds) >30% and between 15%-30%; circle the noncompliances on your working copies of these forms.

Generally, positive results for compounds for which %RSD or %D exceeds 40% or 30%, respectively, are qualified as estimated (J); nondetects (UJ). Check the specific applicable data validation protocol for further guidance as there are some protocol which reject nondetects if the %RSD or %D is excessive. Bias for these results cannot be determined.

Generally, positive results for compounds for which %RSD is between 20%-40% or %D is between 15%-30% are qualified as estimated (J). Qualification of nondetects is protocol-specific. Follow the rules provided in the appropriate validation protocol.

2.2.1.6.3 Blank Contamination

When using the information given below and in the appropriate USEPA Regional Functional Guidelines, keep in mind that the validation action levels derived are sample-specific and must be adjusted for dilution, sample aliquot used for analysis, and sample moisture content (when applicable).

The rules for qualifying data based on the occurrence of blank contamination vary based on regional protocols; the guidelines provided in the appropriate protocol should be followed.

Generally the blank contamination review process is completed by first considering the maximum amount of a particular contaminant occurring in the laboratory method blanks. (Do not consider lab blanks run after high concentration samples for purposes of determining carryover as laboratory method blanks!). Then repeat the process for contaminants occurring in the associated field quality control blanks. Action levels for qualification (10X or 5X depending upon whether or not the contaminant is a common contaminant) are then set. The list of common contaminants may vary among protocols. Additionally, some hierarchy among the field quality control blanks apply and the manner in which the qualifiers are applied vary [i.e. use of (U) or (B); replacement by CRQL, etc.]. Refer to appropriate protocol for specific guidance.

2.2.1.6.4 Surrogates

Surrogates are evaluated by reviewing the laboratory data package Form II reports and the laboratory raw data. The quality control ranges are given on the laboratory data package Form IIs; circle any noncompliances on your working copies of these Forms.

All results for all compounds in an affected sample are qualified if any one of the surrogate spike compounds fails to meet the quality control criteria provided. Generally, for samples having a surrogate recovery < 10%, positive results are qualified as estimated (J), nondetects are rejected (R). These results are biased low. For samples having a surrogate recovery which is low but > 10%, positive results are generally qualified as estimated (J); nondetects (UJ). The bias qualifiers (L, UL) may be used instead, depending upon the specific USEPA Regional guidance. For samples having a surrogate recovery which is high, positive results are generally qualified as estimated (J, K) based on regional guidance; these results are biased high. Nondetects are not qualified based on high surrogate recoveries.

2.2.1.6.5 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

Generally, no data are qualified based upon MS/MSD results alone. If qualification does occur, generally only the result for that particular noncompliant compound is qualified in the original unspiked sample analysis. Refer to the applicable data validation protocol for specific procedures for evaluating MS/MSD analyses.

2.2.1.6.6 Other Considerations

Laboratory precision can be evaluated by comparing the unspiked sample results with MS/MSD analyses results for unspiked compounds. Consider nondetects and results reported at concentrations less than

the Contract Required Quantitation Limit (CRQL) to be in agreement. Use professional judgment in determining whether to qualify sample results based on the comparison.

Likewise, compare the positive compound results for field duplicate samples. Generally, the Relative Percent Difference (RPD) between field duplicate results for the aqueous matrix should be <35%; for soil matrix results, <50%. Qualification of the sample data is limited to the specific field duplicate pair. Positive results for compounds showing imprecision are qualified as estimated (J); nondetects (UJ). Bias for these results cannot be determined.

In some USEPA Regions, a "Percent Solids" rule applies. For example, if a sediment sample contains <50% solids in USEPA Region II, all associated data are considered to be estimated and are qualified accordingly. Follow the appropriate protocol guidance when applicable.

2.2.1.6.7 Quantitation

Verify and record the quantitation of at least one compound per analytical fraction. If no positive results are reported, use the MS/MSD data to confirm proper computation by the laboratory. Validator and laboratory quantitations must agree within 10 percent.

2.2.1.7 Deliverables Guidance

In addition to any specific USEPA Regional requirements (e.g. data validation memorandum, data summary spreadsheets, Regional worksheets), all laboratory data package quality control summary forms, sample Form I reports, method blank Form Is, and the Chain-of-Custody report must be given to the Data Validation Quality Assurance Officer (DV/QAO) for quality assurance review.

The validator should ensure that the format of the data validation deliverable is complete and correct (in accordance with the appropriate USEPA Regional or client requirements) and that the validation narrative is free of transcription and typographical errors before submitting all requested items for DV/QAO review.

2.2.2 Semivolatiles (SW8040A, 8060, 8090, 8100)

2.2.2.1 Applicability

Method 8040A is used to determine the concentration of the following phenolic compounds in groundwater, liquid, and solid matrices:

Phenol
2-Chlorophenol
2,4-Dichlorophenol
2,6-Dichlorophenol
Trichlorophenols
Tetrachlorophenols
Pentachlorophenol
Cresols (methyl phenols)
4-Chloro-3-methylphenol
2,4-Dimethylphenol
2-Nitrophenol
4-Nitrophenol
2,4-Dinitrophenol
2-sec-Butyl-4,6-dinitrophenol (DNBP)

2-Cyclohexyl-4,6-dinitrophenol
2-Methyl-4,6-dinitrophenol

Method 8060 is used to determine the concentration of the following phthalate esters in groundwater, liquid, and solid sample matrices:

Benzyl butyl phthalate
Bis(2-ethylhexyl)phthalate
Di-n-butyl phthalate
Di-n-octyl phthalate
Diethyl phthalate
Dimethyl phthalate

Method 8090 is used to determine the concentration of the following nitroaromatic and cyclic ketone compounds in groundwater, liquid, and solid sample matrices:

Nitrobenzene
Dinitrobenzene
2,4-Dinitrotoluene
2,6-Dinitrotoluene
Isophorone
Naphthoquinone

Method 8100 is used to determine the concentration of the following polynuclear aromatic hydrocarbons (PAHs) in liquid and solid sample matrices:

Acenaphthene
Acenaphthylene
Anthracene
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b)fluoranthene
Benzo(ghi)perylene
Benzo(j)fluoranthene
Benzo(k)fluoranthene
Chrysene
Dibenzo(a,h)anthracene
Dibenz(a,h)acridine
Dibenz(a,j)acridine
7H-Dibenzo(c,g)carbazole
Dibenzo(a,e)pyrene
Dibenzo(a,h)pyrene
Dibenzo(a,i)pyrene
Fluoranthene
Fluorene
Indeno(1,2,3-cd)pyrene
3-Methylcholanthrene
Naphthalene
Phenanthrene
Pyrene

All of the above methods are gas chromatographic (GC) only (i.e., no mass spectrometer detector is employed). These methods use either an electron capture detector (ECD) or a flame ionization detector (FID).

2.2.2.2 Interferences

Solvents, reagents, glassware, and other sample-processing hardware may yield discrete artifacts and/or elevated baselines causing misinterpretation of gas chromatograms. All these materials must be demonstrated to be free from interferences under the conditions of the analysis by running method blanks. Specific selection of reagents and purification of solvents by distillation in all-glass systems may be required.

Interferences co-extracted from samples will vary considerably from source to source depending upon the waste being sampled. While general cleanup techniques such as Method 3530 are provided as part of these methods, unique samples may require additional cleanup.

If sample or matrix interferences occur, a secondary column may be employed in addition to the primary column so as to resolve any questionable compound results.

2.2.2.3 General Laboratory Practices

An extraction blank should be prepared with each batch of samples extracted.

Matrix Spike/Matrix Spike Duplicate (MS/MSD) analyses should be conducted to determine the effects of sample matrix upon the compounds of interest.

2.2.2.4 Sample Preparation

Prior to analysis, the samples must be extracted using the appropriate techniques. Aqueous samples are extracted at the appropriate pH with methylene chloride as a solvent using Method 3510 (separatory funnel extraction) or Method 3520 (continuous liquid-liquid extraction). Both neat and diluted organic liquids may be analyzed by direct injection. Solid samples are extracted at the appropriate pH with methylene chloride using either Soxhlet Extraction (Method 3540) or Sonication (Method 3550) procedures.

2.2.2.5 Data Overview Prior to Validation

Before commencing validation the reviewer must preview the associated Chain-of-Custody (COC) reports to determine:

- If the appropriate number of samples are present in the data package and if each sample was correctly analyzed for the parameters and methods specified.
- The identity of all associated field quality control blanks and field duplicate pairs.

Because many samples may have required dilutions, re-extractions and/or reanalyses, the data validator should preview the data package contents to determine which analyses represent the better quality data.

The data package should never be annotated unless specifically directed by client protocol. All Form I reports (including those for samples, laboratory method blanks, and MS/MSD analyses) and all

laboratory quality control summary forms (including all initial and continuing calibration summary statistics) should be photocopied for use as working copies.

2.2.2.6 Technical Evaluation Summary

All data evaluations must be conducted in accordance with the appropriate USEPA Regional protocols and/or specified client contract requirements. The applicable documents must be referenced during the data validation process as this S.O.P. is only intended as a general procedure for the data validation tasks.

General parameters such as Data Completeness, Overall System Performance, Chromatographic Quality, Detection Limits and Compound Identification are evaluated concurrently with the parameters discussed in the following subsections.

2.2.2.6.1 Holding Times

Holding times are evaluated by reviewing the COC reports, the individual sample Form I reports, and the associated laboratory raw data. Holding times for extraction are calculated from date of collection to date of extraction.

The technical holding times for aqueous and solid matrices are as follows:

- Extraction:
  - Water samples: 7 days
  - Solid samples: 14 days
- Analysis: 40 days from date of extraction

Generally, positive results affected by noncompliances are qualified as estimated (J); nondetects (UJ). These results are considered to be biased low. Alternately, the bias qualifiers L and UL may be used. Nondetects may be rejected (R) when the sample was extracted after 14 days (28 days for solid samples). If the holding time until analysis has been exceeded (and potentially, some of the extract may have evaporated), the affected sample results may be considered to be biased high. Refer to the appropriate data validation protocol for specific guidance.

2.2.2.6.2 Calibration

Check that an initial calibration was performed for each instrument used for analysis and that all calibrations were performed at all appropriate concentration levels.

In general, either the correlation coefficient (R) or the Percent Relative Standard Deviation (%RSD) is evaluated in the data validation. If the correlation coefficient is chosen by the laboratory, the calibration curve should be checked for linearity. Generally, associated sample data are qualified as estimated (J, UJ) if the calibration curve correlation coefficient is <0.995. Professional judgment should be used to qualify sample data in cases when sample results fall outside the linear portion of the calibration curve. If the %RSD is used, determine which compounds have Percent Relative Standard Deviations (%RSDs) >40% and between 20%-40%. Circle these noncompliances on your working copies of these Forms. Spot-check (i.e., recalculate) a few of the %RSDs to verify the laboratory's computation.

Determine which samples are affected by reviewing the continuing calibration forms. Determine which continuing calibrations are associated with which initial calibrations. Write the affected samples on your

working copies of the appropriate continuing calibration forms. Spot-check (i.e., recalculate) a few of the %Ds to verify the laboratory's computation.

Review the continuing calibration form and the associated laboratory raw data. Determine which compounds have Percent Differences (%Ds) >30%, and between 15%-30%; circle the noncompliances on your working copies of these forms.

Generally, positive results for compounds for which %RSD or %D exceeds 40% or 30%, respectively, are qualified as estimated (J); nondetects (UJ). Check the specific applicable data validation protocol for further guidance as there are some protocol which reject nondetects if the %RSD or %D is excessive. Bias for these results cannot be determined.

Generally, positive results for compounds for which %RSD is between 20%-40% or whose %D is between 15%-30% are qualified as estimated (J). Qualification of nondetects is protocol-specific. Follow the rules provided in the appropriate validation protocol.

2.2.2.6.3 Blank Contamination

When using the information given below and in the appropriate USEPA Regional Functional Guidelines, keep in mind that the validation action levels derived are sample-specific and must be adjusted for dilution, sample aliquot used for analysis, and sample moisture content (when applicable).

The rules for qualifying data based on the occurrence of blank contamination vary based on regional protocols; the guidelines provided in the appropriate protocol should be followed.

Generally the blank contamination review process is completed by first considering the maximum amount of a particular contaminant occurring in the laboratory method blanks. (Do not consider lab blanks run after high concentration samples for purposes of determining carryover as laboratory method blanks!) Then repeat the process for contaminants occurring in the associated field quality control blanks. Action levels for qualification (10X or 5X depending upon whether or not the contaminant is a common contaminant) are then set. The list of common contaminants may vary among protocols. Additionally, some hierarchy among the field quality control blanks apply and the manner in which the qualifiers are applied vary [i.e. use of (U) or (B); replacement by CRQL, etc.]. Refer to appropriate protocol for specific guidance.

2.2.2.6.4 Surrogates

Surrogates are evaluated by reviewing the laboratory data package Form II reports and the laboratory raw data. The quality control ranges are given on the laboratory data package Form IIs; circle any noncompliances on your working copies of these Forms.

All results for all compounds in an affected sample are qualified if any one of the surrogate spike compounds fails to meet the quality control criteria provided. Generally, for samples having a surrogate recovery <10%, positive results are qualified as estimated (J), nondetects are rejected (R). These results are biased low. For samples having a surrogate recovery which is low but >10%, positive results are generally qualified as estimated (J); nondetects (UJ). The bias qualifiers (L, UL) may be used instead, depending upon the specific USEPA Regional guidance. For samples having a surrogate recovery which is high, positive results are generally qualified as estimated (J, K) based on regional guidance; these results are biased high. Nondetects are not qualified based on high surrogate recovery.

2.2.2.6.5 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

Generally, no data are qualified based upon MS/MSD results alone. If qualification does occur, generally only the result for that particular noncompliant compound is qualified in the original unspiked sample. Refer to the applicable data validation protocol for specific procedures for evaluating MS/MSD analyses.

2.2.2.6.6 Other Considerations

Laboratory precision can be evaluated by comparing the unspiked sample results with MS/MSD analyses results for unspiked compounds. Consider nondetects and results reported at concentrations less than the Contract Required Quantitation Limit (CRQL) to be in agreement. Use professional judgment in determining whether to qualify sample results based on the comparison.

Likewise, compare the positive compound results for field duplicate samples. Generally, the Relative Percent Difference (RPD) between field duplicate results for the aqueous matrix should be <35%; for soil matrix results, <50%. Qualification of the sample data is limited to the specific field duplicate pair. Positive results for compounds showing imprecision are qualified as estimated (J); nondetects (UJ). Bias for these results cannot be determined.

In some USEPA Regions, a "Percent Solids" rule applies. For example, if a sediment sample contains <50% solids in USEPA Region II, all associated data are considered to be estimated, and are qualified accordingly. Follow the appropriate protocol guidance when applicable.

2.2.2.6.7 Quantitation

Verify and record the quantitation of at least one compound per analytical fraction. If no positive results are reported, use the MS/MSD data to confirm proper computation by the laboratory. Validator and laboratory quantitations must agree within 10 percent.

2.2.2.7 Deliverables Guidance

In addition to any specific USEPA Regional requirements (e.g. data validation memorandum, data summary spreadsheets, Regional worksheets), all laboratory data package quality control summary forms, sample Form I reports, method blank Form Is, and the Chain-of-Custody report, must be given to the Data Validation Quality Assurance Officer (DV/QAO) for quality assurance review.

The validator should ensure that the format of the data validation deliverable is complete and correct (in accordance with the appropriate USEPA Regional or client requirements), and that the validation narrative is free of transcription and typographical errors before submitting all requested items for DV/QAO review.

2.2.3 Organochlorine Pesticides and Polychlorinated Biphenyls (PCBs), Organophosphorous Pesticides, Chlorinated Herbicides (SW 8080B, 8140, 8150B)

2.2.3.1 Applicability

Method 8080B is used to determine the concentration of the following organochlorine pesticides and polychlorinated biphenyls (PCBs) in groundwater, liquid, and solid sample matrices:

Aldrin
alpha-BHC
beta-BHC

delta-BHC
gamma-BHC (Lindane)
Chlordane
4,4'-DDD
4,4'-DDE
4,4'-DDT
Dieldrin
Endosulfan I
Endosulfan II
Endosulfan sulfate
Endrin
Endrin aldehyde
Heptachlor
Heptachlor epoxide
Methoxychlor
Toxaphene
Aroclor-1016
Aroclor-1221
Aroclor-1232
Aroclor-1242
Aroclor-1248
Aroclor-1254
Aroclor-1260

Similarly, Method 8140 is used to determine the following pesticides in groundwater and waste samples:

Azinphos methyl
Bolstar (Sulprofos)
Chlorpyrifos
Coumaphos
Demeton-O
Demeton-S
Diazinon
Dichlorvos
Disulfoton
Ethoprop
Fensulfothion
Fenthion
Merphos
Mevinphos
Naled
Parathion methyl
Phorate
Ronnel
Stirophos (Tetrachlorvinphos)
Tokuthion (Prothiofos)
Trichloronate

Note that when Method 8140 is used to analyze unfamiliar samples, compound identifications should be supported by at least one additional qualitative technique if mass spectroscopy is not employed.

Method 8150B is used to determine the following chlorinated acid herbicides in groundwater and waste samples:

2,4-D
2,4-DB
2,4,5-T
2,4,5-TP (Silvex)
Dalapon
Dicamba
Dichloroprop
Dinoseb
MCPA
MCPP

Since these compounds are produced and used in various forms (i.e., acid, salt, ester, etc.), Method 8150 includes a hydrolysis step to convert the herbicide to the acid form prior to analysis. When Method 8150 is used to analyze unfamiliar samples, compound identifications should be supported by at least one additional qualitative technique. This method describes analytical conditions for a second gas chromatographic column that can be used to confirm measurements made with the primary column; alternately, the compounds of interest can be confirmed by detection via a mass spectrometer.

All of the above Methods are Gas Chromatographic (GC) in which sample extracts are analyzed by direct injection. Method 8080 analyzes for organochlorine pesticide compounds and PCBs via GC/ECD (Electron Capture Detector; an equivalent Halogen-Specific Detector may also be used). Method 8140 analyzes for organophosphorous pesticide compounds via GC/FID (Flame Ionization Detector), and Method 8150 analyzes for chlorinated herbicide compounds via GC/ECD (alternately, a Microcoulometric Detector or Hall Electrolytic Conductivity Detector may be used).

2.2.3.2 Interferences

The sensitivity of these methods usually depends on the level of interferences rather than on instrumental limitations. Solvents, reagents, glassware, and other sample processing hardware may yield discrete artifacts and/or elevated baselines causing misinterpretation of gas chromatograms. The use of high purity reagents and solvents helps to minimize these interference problems. Extraction blanks are analyzed as method blanks in order to monitor the occurrences of interferences.

Interferences co-extracted from the sample will vary considerably, and will dictate the nature and extent of clean-up procedures used. Phthalate esters are a common interference to organochlorine pesticide analyses; phenols and organic acids may act as interferents when analyzing for chlorinated herbicides.

2.2.3.3 General Laboratory Practices

Matrix Spike/Matrix Spike Duplicate (MS/MSD) analyses should be conducted to determine the effects of sample matrix upon the compounds of interest.

Standard quality assurance practices such as the analyses of field replicate and laboratory duplicates should also be employed.

Note that herbicides, being strong organic acids, react readily with alkaline substances and may be lost during analysis. Therefore, when performing Method 8150, glassware and glass wool must be acid-rinsed and sodium sulfate must be acidified with sulfuric acid prior to use to avoid this possibility.

2.2.3.4 Sample Preparation

Prior to the use of Method 8080 and 8140, aqueous samples are extracted at a neutral pH with methylene chloride as a solvent using a separatory funnel (Method 3510) or a continuous liquid- liquid extractor (Method 3520). Solid samples are extracted with hexane:acetone (1:1) using either the Soxhlet extraction (Method 3540) or sonication (Method 3550) procedures.

Method 8150 provides its own specific preparation procedures for aqueous and solid samples which include extraction with acetone and diethyl ether followed by esterification using diazomethane as a derivatizing agent.

2.2.3.5 Data Overview Prior to Validation

Before commencing validation, the reviewer must preview the associated Chain-of-Custody (COC) reports to determine:

- If the appropriate number of samples are present in the data package and if each sample was correctly analyzed for the parameters and methods specified.
- The identity of all associated field quality control blanks and field duplicate pairs.

Because many samples may have required dilutions, re-extractions and/or re-analyses, the validator should preview the data package contents to determine which analyses represent the better quality data.

Unless specifically directed by client protocol, never annotate the laboratory data package. Before beginning evaluation, prepare working copies (i.e., photocopies) of all Form I reports (including those for samples, laboratory method blanks and MS/MSD analyses) and all laboratory quality control summary forms.

2.2.3.6 Technical Evaluation Summary

All data evaluations must be conducted in accordance with applicable USEPA Regional protocols and/or specific client contract requirements. The applicable documents must be referenced during the data evaluation process as this S.O.P. is only intended as a general procedure for the data validation tasks.

General parameters such as Data Completeness, Overall System Performance, Chromatographic Quality, Detection Limits, and Compound Identification are evaluated concurrently with the parameters discussed in the following subsections.

2.2.3.6.1 Holding Times

Holding times are evaluated by reviewing the COC reports, the individual sample Form I reports, and the associated laboratory raw data. Holding times for extraction are calculated from date of collection to date of extraction.

The technical holding times for aqueous and solid matrices are as follows:

- Extraction:
  - Water samples: 7 days
  - Solid samples: 14 days
- Analysis: 40 days from date of extraction

When the holding time criteria are not met, positive results in affected samples are generally qualified as estimated (J); nondetects (UJ). These results are biased low. Some USEPA Regions apply the bias qualifiers, L and UL, instead. If the holding times are exceeded by a factor of 2 or more, the holding time exceedance is considered to be gross and positive results are generally qualified as estimated (J); nondetects are generally considered to be unreliable and are rejected (R). These results are biased very low.

2.2.3.6.2 Calibration

Data pertaining to the initial calibration (i.e., evaluation check for linearity) is found on the data package Form VIs or equivalent. Check that an initial calibration was performed for each instrument used and at all appropriate concentration levels.

In general, either the correlation coefficient (R) or the Percent Relative Standard Deviation (%RSD) is evaluated in the data validation. If the correlation coefficient is chosen by the laboratory, the calibration curve should be checked for linearity. Generally, associated sample data are qualified as estimated (J, UJ) if the calibration curve correlation coefficient is <0.995. Professional judgment should be used to qualify sample data in cases when sample results fall outside the linear portion of the calibration curve. If the %RSD is used, determine which compounds have Percent Relative Standard Deviations (%RSDs) >40% and between 20%-40%. Circle these noncompliances on your working copies of these Forms. Spot-check (i.e., recalculate) a few of the %RSDs to verify the laboratory's computation.

Determine which samples are affected by reviewing the continuing calibration forms. Determine which continuing calibrations are associated with which initial calibrations. Write the affected samples on your working copies of the appropriate continuing calibration forms. Spot-check (i.e., recalculate) a few of the %Ds to verify the laboratory's computation.

Review the continuing calibration form and the associated laboratory raw data. Determine which compounds have Percent Differences (%Ds) >30% and between 15%-30%; circle the noncompliances on your working copies of these forms.

Generally, positive results for compounds for which %RSD or %D exceeds 40% or 30%, respectively, are qualified as estimated (J); nondetects (UJ). Check the specific applicable data validation protocol for further guidance as there are some protocol which reject nondetects if the %RSD or %D is excessive. Bias for these results cannot be determined.

Generally, positive results for compounds for which %RSD is between 20%-40% or %D is between 15%-30% are qualified as estimated (J). Qualification of nondetects is protocol-specific. Follow the rules provided in the appropriate validation protocol.

Method 8080A requires analysis of a DDT/Endrin breakdown check standard. The DDT/Endrin Breakdown should not exceed 20%. Generally, if % breakdown for DDT exceeds 20%, estimate (J) all positive results for DDT, DDE and DDD following the in-last control standard until the next in-control standard (see analytical sequence). If there are no positive results for DDT but there are positive results for DDD or DDE then reject (R) nondetects for DDT in associated samples. Generally, if Endrin % Breakdown exceeds 20%, estimate (J) positive results for Endrin, Endrin Aldehyde, and Endrin Ketone in all samples following the last in-control standard until the next acceptable standard. If there are positive results for Endrin Aldehyde or Endrin Ketone but none for Endrin, reject (R) nondetect Endrin results.

2.2.3.6.3 Blank Contamination

When using the information provided below and in the appropriate USEPA Regional Functional Guidelines, keep in mind that the validation action levels derived are sample-specific, and must be adjusted for dilution, sample aliquot used for analysis, and sample moisture content (when applicable).

The rules for qualifying data based on the occurrence of blank contamination vary based on regional protocols; guidelines provided in the appropriate data validation protocol should be followed.

An action level of 5X the maximum amount of contaminant found is used to evaluate the sample data. The manner in which the qualifiers are applied vary [i.e. use of (U) or (B); replacement by CRQL, etc.]. Refer to appropriate validation protocol for specific guidance.

2.2.3.6.4 Surrogates

Surrogates are evaluated by reviewing the laboratory data package Form II reports and the associated laboratory raw data. The advisory limits are given on the laboratory data package Form IIs; circle any recoveries outside these limits on your working copies of these Forms.

No qualifications are made for surrogates which show zero recoveries because they were "diluted out." Generally, positive results affected by low surrogate recovery are qualified as estimated (J) or the (L) bias qualifier is used when applicable; nondetects are qualified (UJ) or (UL), accordingly. If a positive sample result is affected by high surrogate recovery, the result is qualified as estimated (J) or the (K) bias qualifier is used when applicable; nondetects are not qualified based on high surrogate recovery. Because the surrogate recovery limits for these fractions are advisory, generally no results are rejected.

The pesticide/PCB surrogates decachlorobiphenyl (DCB) and tetrachloro-m-xylene (TCX) retention times found on data package Form VIII or equivalent must be ± 0.10 for DCB and ± 0.05 for TCX. If DCB and TCX retention time criteria are not met, the raw data must be checked for misidentified GC peak. The validator's professional judgment for qualifications should be used.

2.2.3.6.5 Matrix Spike/Matrix Spike Duplicates

Generally, no data are qualified based upon MS/MSD results alone. If qualification does occur, generally only the result for that particular noncompliant compound is qualified in the original unspiked sample analysis. Refer to the appropriate data validation guidelines for specific procedures for evaluating MS/MSD analyses.

2.2.3.6.6 Other Considerations

Laboratory precision can be evaluated by comparing the unspiked sample results with MS/MSD analyses results for unspiked compounds. Consider nondetects and results reported at concentrations less than the Contract Required Quantitation Limit (CRQL) to be in agreement. Use professional judgment in determining whether to qualify sample results based on the comparison.

Likewise, compare the positive compound results for field duplicate samples. Generally, the Relative Percent Difference (RPD) between field duplicate results for the aqueous matrix should be <35%; for soil matrix results, <50%. Qualification of the sample data is limited to the specific field duplicate pair. Positive results for compounds showing imprecision are qualified as estimated (J); nondetects (UJ). Bias for these results cannot be determined.

In some USEPA Regions, a "Percent Solids" rule applies. For example, if a sediment sample contains <50% solids in USEPA Region II, all associated data are considered to be estimated and are qualified accordingly. Follow the appropriate protocol guidance when applicable.

2.2.3.6.7 Quantitation

Verify and record the quantitation of at least one compound per analytical fraction. If no positive results are reported, use the MS/MSD data to confirm proper computation by the laboratory. Validator and laboratory quantitations must agree within 10%.

2.2.3.7 Deliverables Guidance

In addition to any specific USEPA Regional requirements (e.g. data validation memorandum, data summary spreadsheets, USEPA Regional worksheets), all laboratory data package quality control summary forms, sample Form I reports, method blank Form Is, and the Chain-of-Custody report, must be given to the Data Validation Quality Assurance Officer (DV/QAO) for quality assurance review.

The validator should ensure that the format of the data validation deliverable is complete and correct (in accordance with the appropriate USEPA Regional or client requirements), and that the validation narrative is free of transcription and typographical errors before submitting all requested items for DV/QAO review.

3.0 CLP INORGANICS FOR SOLID AND AQUEOUS MATRICES

3.1 Inorganics (CLP Statement of Work (SOW) ILM03.0)

Inductively Coupled Plasma Emission Spectroscopy (ICP) - Analytes commonly analyzed using ICP include: aluminum, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, magnesium, manganese, nickel, potassium, silver, sodium, vanadium, and zinc.

Graphite Furnace Atomic Absorption Spectroscopy (GFAA) - Analytes commonly analyzed using GFAA include: antimony, arsenic, lead, selenium, and thallium

Cold Vapor Methodology - Mercury is commonly analyzed using cold vapor methodology.

Automated Colorimetric Technique - Cyanide is commonly analyzed using automated colorimetric methodology.

3.1.1 Applicability

This method is applicable to a large number of matrices including EP extracts, TCLP extracts, industrial wastes, soils, groundwater, aqueous samples, sludges, sediments, and other solid wastes. All matrices require digestion prior to analysis.

3.1.2 Data Overview Prior to Validation Process

3.1.2.1 Data Completeness

The data reviewer must initially verify that all CLP Forms are present and complete (i.e., Forms 1 through 14 must be provided). Areas of special attention when accounting for required CLP Forms will include:

- Verify at least one Initial and Continuing Calibration Verification (ICV/CCV) Percent Recovery (%R) calculation as noted on the Form 2A.

- When reviewing Form 2B, verify that all atomic absorption (GFAA) analytes are present in the CRDL standard at concentrations at the CRDL. Verify that all ICP analytes (with the exceptions of Al, Ba, Ca, Fe, Mg, Na and K) are present in the CRDL standard at concentrations of 2X CRDL.

- Verify that a matrix-specific laboratory generated preparation blank has been analyzed for each respective matrix as noted on the Form 3 (note that filtered and unfiltered aqueous matrices are to be treated as distinctly different matrices).

- Verify that all ICP analytes are present in both ICSA and ICSAB solutions. (Note that 3/90 SOW ILM03.0 does not require that antimony, sodium, and potassium be present in these solutions). Also verify from the raw data that the laboratory reported all analytes present in solution A to the nearest whole number. It is not uncommon for laboratories to incorrectly report "zeros" or simply leave blank the appropriate solution A columns. Furthermore, %Rs for solution AB are to be reported to one decimal place on the Form 4.

- Check that one matrix spike was analyzed for each particular matrix per analytical batch. Laboratories typically will not include an aqueous matrix for waters if the only aqueous samples contained in the SDG are field quality control blanks (i.e., equipment rinsate blanks

and/or field blanks). This is generally accepted without data validation letter text comment. Additionally, the data reviewer may want to verify spiking levels as noted on pg. E-20 of ILM03.0 3/90 Inorganic SOW.

- Verify that laboratory duplicate analyses were performed for each matrix. **NOTE**: Field quality control blanks are never to be designated for quality control analyses.

- Check that one Laboratory Control Sample (LCS) was analyzed for each batch of samples per matrix within an SDG. **NOTE**: An aqueous LCS is not required for mercury and cyanide analysis.

- The Method of Standard Additions (MSA) Form 8 may or may not be present as dictated by Post Digestion Spike (PDS) %Rs. See Section 3.1.3.11 for further details.

- Verify that at least one ICP serial dilution analysis was performed for each matrix within an SDG. **NOTE**: Typically one serial dilution will serve to monitor a given set of samples within an SDG. However, special contractual requirements may necessitate one serial dilution analysis per sample. Ascertain atypical serial dilution frequency requirements through the project manager.

- Simply check that the Form 11 ICP Interelement Correction Factors (Annually) is present.

- Verify that all ICP analytical results fall within the ICP Quarterly Linear Ranges provided on the Form 12. Verify that no GFAA analytical results exceed the highest standard used in the associated GFAA calibration.

- Verify that the Form 13 Preparation Log accounts for aqueous/soil ICP, AA, mercury, and cyanide digestions/distillations as applicable.

- Examine the Form 14s to verify that one and only one "X" flag has been used to signify each reported field sample result or quality control sample result. Laboratories are often careless when entering the "X" flag. An incorrectly entered "X" flag can lead to reporting errors for the sample and its associated QC. The validator must verify reported results in instances of discrepancies, amend appropriate forms, and mention in letter text.

Actions - Notify the appropriate laboratory contact of required resubmittals when discrepancies are noted on the forms discussed above.

3.1.3 Technical Evaluation Summary

All data evaluations must be conducted in accordance with current and applicable USEPA Regional protocols and/or specific client contractual requirements and obligations. The applicable documents must be referenced to during the data evaluation process as this Standard Operating Procedure (S.O.P) is intended as proprietary in-house guidance for general inorganic validation practices only.

General parameters such as Data Completeness, Overall System Performance, and Detection Limits must be evaluated concurrently with the parameters discussed below.

3.1.3.1 Holding Times

Holding times are calculated from date of sample collection to date of sample analysis. The date of sample collection must be obtained from the Chain-of-Custody (COC) form. The date of sample analysis is best retrieved from the raw data but may also be obtained from the Form 14.

Sample preservation and holding time requirements are as follows:

- Metals - 6 months; pH <2
- Mercury - 28 days; pH <2
- Cyanide - 14 days; pH >12

Preservation requirements as noted above are applicable to aqueous samples only; solid samples do not receive preservative, but require maintenance at 4°C (±2°C) during shipment and storage.

Actions - Holding time exceedances result in potentially low-biased results; thus, positive results and nondetects shall be qualified as estimated, (J) and (UJ), respectively. **NOTE:** Gross holding time noncompliances are defined as holding times which are exceeded by a factor or 2X. In these extreme cases, it is practice to reject (R) nondetects while positive results are qualified based upon professional judgment regarding the reliability of the associated data.

3.1.3.2 Initial Calibration Requirements

Calibration must be initiated daily and prior to sample analysis. The following calibration standard requirements must be verified:

- **ICP analyses** - must employ a blank and at least one standard.
- **GFAA analyses** - must employ a blank and at least three standards. One of the standards must be at the CRDL. Additionally, the calibration correlation coefficient (r) must be checked for linearity for each GFAA analysis performed (i.e., r = 0.995 or greater).
- **Mercury analyses** - must employ a blank and at least four standards (r = 0.995 or greater).
- **Cyanide analyses** - must employ a blank and at least three standards (r = 0.995 or greater). **NOTE:** The midpoint standard for cyanide analyses must be distilled; verify this via distillation logs.

3.1.3.3 Initial and Continuing Calibration Verification (ICV/CCV)

Review Initial and Continuing Calibration Verification Form 2As and associated raw data. The ICV/CCV %R quality control limits are 90-110% for metals, 80-120% for mercury, and 85-115% for cyanide.

Actions - If ICV/CCV %Rs are low, qualify as estimated (J) positive results and (UJ) nondetects. If ICV/CCV %Rs are high, qualify as estimated (J) positive results; nondetects are not affected. Gross exceedance, as defined by applicable data validation protocol, may require rejection (R) of results. **NOTE:** Qualify results of only those samples associated with the noncompliant ICB or CCV (generally, those samples immediately preceding or following the noncompliant standard until the nearest in-control standard).

3.1.3.4 CRDL Standard Analysis

Review CRDL Standard Form 2Bs and associated new data. The CRDL Standard analysis %R quality control limits are 80-120% for all metals.

Actions - If CRDL %Rs are low, qualify as estimated (J) positive results <3X CRDL and (UJ) nondetects. Generally, if CRDL %Rs are high, qualify as estimated (J) positive results <3X CRDL; nondetects remain unaffected. Note that when using EPA Region I validation guidelines, nondetects will receive qualification based upon high CRDL Standard analysis recovery. **NOTE:** The data reviewer need not specify affected samples; common practice is to apply data qualifications "across-the-board" based upon LOE time constraints.

3.1.3.5 Laboratory Method and Field Quality Control Blanks

Verify that a preparation blank was analyzed for each matrix and for each batch of 20 samples or each sample batch digested, whichever is more frequent. Continuing Calibration Blanks (CCBs) must be run at a frequency of 10% or every 2 hours whichever is more frequent.

The data reviewer will select the maximum contaminant level for each analyte in a particular matrix from which shall be calculated an "action level." The action level shall be established as 5X the maximum contaminant level but must be adjusted for dilution factor, moisture content, and sample weight prior to application.

ICB/CCB contamination shall be applied to all samples within an SDG. Preparation blank contamination shall be applied to samples of the same matrix only. Common practice shall be to qualify as nondetected (U) any contaminant present in sample which is considered a laboratory artifact (i.e., < the established action level). Professional judgment must be employed when discerning the validity of a concentration present in a field quality control blank. In many instances, contamination present in these blanks can be attributable to "dirty" laboratory practice and not actual field contaminant conditions.

Negative concentrations detected in the laboratory method blanks are indicative of instrumental problems and base-line drifting. Generally, any negative concentration > IDL shall warrant estimation [(J) positives and (UJ) nondetects] of the associated sample data regardless of matrix. Action levels shall not be established for negative concentration levels.

Actions - Qualify as nondetected (U) any positive result within the action level. Qualify as estimated (J) positive results and (UJ) nondetects for analytes for which negative concentrations were noted in the laboratory method blanks (i.e., ICBs, CCBs, and/or preparation blanks).

3.1.3.6 ICP Interference Check Sample (ICS) Results

Review ICP Interference Check Sample Form 4 and associated raw data. Verify that all recoveries for the ICP ICS solution fall within the 80-120% quality control window established for the ICS AB solution.

Actions - For ICS %Rs <80%, qualify as estimated (J) positive results and (UJ) nondetects in affected samples. For ICS %Rs >120%, qualify as estimated (J) positive results in affected samples; nondetects are unaffected by high ICS solution AB recovery. **NOTE:** Affected samples include all samples analyzed between the initial and final solutions (or within the eight hour working shift, whichever occurs more frequently) which contain Al, Ca, Fe, or Mg at levels >50% of the respective concentration of Al, Ca, Fe, or Mg in the ICS True Solution A.

Next, review concentrations of the four common interfering analytes (aluminum, calcium, iron, and magnesium) in the environmental samples. Any aforementioned interferant present in the environmental samples at concentrations which exceed 50% of those present in the ICS solution for that same analyte will require calculation of estimated elemental interference stemming from high interfering analyte concentration. If the previous condition is met; review the ICP/ICS Form 4 and note any analytes present in the ICS solution A at levels which exceed the IDL and which are not present in the ICS True solution A. Positive results in the ICS solution A indicate potentially elevated results for this analyte in the affected sample while negative results in the ICS solution A indicate potentially suppressed results for this analyte in the affected sample.

Next, an estimated elemental interference must be calculated for each analyte > IDL present in the ICS solution A which is not present in the ICS True solution A. The following equation shall be employed:

$$\textit{Estimated elemental intf.} = \frac{[\textit{Conc. affected analyte in ICS Soln A}] \times [\textit{Interferent}]\ [\textit{Conc. in Sample}]}{\textit{Interferent Conc. in ICS Soln A}}$$

It is advisable, although not necessary, to routinely choose the lowest concentration for the interferant level in the ICS so as to calculate the highest estimated interference possible. This method lends itself to a more conservative overall data quality review.

Estimated interferences for each affected analyte > IDL in the ICSA solution must now be compared to the reported environmental sample result for that particular analyte.

Actions - For estimated interferences <10% of the reported sample concentration for a particular affected analyte, take no action; interference is considered negligible. For estimated interferences >10% of the reported sample concentration for a particular affected analyte, qualify (J) positive result and/or (UJ) nondetect for affected analyte in affected sample. (**NOTE**: Calculation of an estimated positive (potentially elevated) interference will have no effect on a reported nondetect; thus, no action is necessary).

3.1.3.7 Matrix Spike Sample Analysis (Pre-digestion)

Review Spike Sample Recovery Form 5A and associated raw data. Verify that at least one matrix spike was performed for each matrix for a given set of samples within an SDG. **NOTE:** Filtered and unfiltered samples are to be treated as distinctly different sample matrices and qualified accordingly. Refer to ILM03.0, 3/90 Inorganic SOW, Table 3, "SPIKING LEVELS FOR SPIKING SAMPLE ANALYSIS," page 20, Section E, for proper analyte spiking concentrations and requirements. Any deviations from the SOW shall be noted and require laboratory contact for correction.

Aqueous and soil Matrix Spike (MS) recoveries must be within the 75-125% quality control window in instances where the initial sample result is <4X amount spiked. If the initial sample result is >4X the amount spiked and the MS %R is noncompliant; no actions shall be taken.

Actions - For MS %Rs <30%, qualify as estimated (J) positive results and reject (R) nondetects in affected samples. For MS %Rs <75% but >30%, qualify as estimated (J) positive results and (UJ) nondetects in affected samples. For MS %Rs >125%, qualify as estimated (J) positive results in affected samples; nondetects are not compromised by high MS recovery; thus, no actions are warranted.

3.1.3.8 Laboratory Duplicate Precision

Review Duplicates Form 6 and associated raw data. Verify that one duplicate sample analysis was performed for each group of samples of a similar matrix within an SDG. Control criteria used to evaluate aqueous laboratory duplicates are as follows:

- a control limit of ±20% for relative percent difference when sample and duplicate results are >5X CRDL
- a control limit of ±1X CRDL for the difference between the sample values when sample and/or duplicate results are <5X CRDL

Control criteria used to evaluate solid laboratory duplicates are as follows:

- a control limit of ±35% for relative percent difference when sample and duplicate results are >5X CRDL
- a control limit of ±2X CRDL for the difference between the sample values when sample and/or duplicate results are <5X CRDL

NOTE: Review the CLP Form 6 carefully and verify that the laboratory has in fact reported a %RPD of 200% and not simply recorded the %RPD as noncalculable (in instances where the sample result is positive but the duplicate result is nondetect). Overlooking this minor point may result in incomplete sample data qualification in some instances.

Actions - For any situation involving laboratory duplicate imprecision, qualify as estimated (J) positive results and (UJ) nondetects in affected samples. **NOTE:** It is important to note in the letter text the cause of laboratory duplicate imprecision (i.e., noncompliant %RPD or noncompliant difference between sample and duplicate results).

3.1.3.9 Field Duplicate Precision

Field duplicates can be determined via Project Manager informational documents (i.e., sampling logs) or obtained from Chain-of-Custody (COC) forms. Field duplicates are generally identified as samples having identical sample collection times and dates. In instances were field duplicate samples are included with the sample data set, the following control criteria are generally used to evaluate aqueous field duplicates:

- a control limit of ±30% for relative percent difference when sample and duplicate results are >5X CRDL
- a control limit of ±2X CRDL for the difference between the sample values when sample and/or duplicate results are <5X CRDL

Similarly, the following control criteria are generally used to evaluate solid field duplicates:

- a control limit of ±50% for the relative percent difference when sample and duplicate results are >5X CRDL
- a control limit of ±4X CRDL for the difference between the sample values when sample and/or duplicate results are <5X CRDL

NOTE: The %RPD should reflect a difference of 200% and should not simply be recorded as noncalculable in instances where the sample result is positive but the field duplicate result is nondetect. Overlooking this minor point may result in incomplete sample data qualification in some instances.

Actions - For any situation involving field duplicate imprecision, qualify as estimated (J) positive results and (UJ) nondetects in affected samples. **NOTE:** It is important to note in the letter text the cause of field duplicate imprecision (i.e., noncompliant %RPD or noncompliant difference between sample and duplicate results). Furthermore, laboratory duplicate data qualifications, as per Brown & Root Environmental convention, shall be matrix-specific but otherwise "across-the-board" for TAL inorganic analyses. However, field duplicate data validation qualifications shall be limited to the field duplicate pair only.

3.1.3.10 Laboratory Control Sample (LCS) Results

Review Laboratory Control Sample Form 7 and associated raw data. Verify that an LCS was analyzed for each matrix and for each batch of twenty samples or batch of samples digested (whichever is more frequent) within an SDG. The quality control criteria established for evaluation of aqueous LCS analyses are 80-120%. NOTE: An aqueous LCS is not required for mercury and cyanide analysis, and silver and antimony are not subject to quality control criteria. Verify that all solid "found values" fall within the EPA established control limits for soils.

Actions - Aqueous LCS: In instances where aqueous LCS %R <80%, qualify as estimated (J) positive results and (UJ) nondetects. If aqueous LCS %R >120, qualify as estimated (J) positive results. Solid LCS: In instances where solid found value is below lower quality control limit, qualify as estimated (J) positive results and (UJ) nondetects. If solid LCS found value exceeds EPA upper limit for soils, qualify as estimated (J) positive results.

3.1.3.11 Method of Standard Additions (MSA)

Review MSA Form 8 and verify instrument linearity by checking that all calibration correlation coefficients (r) are greater than or equal to 0.995. MSAs for a particular analyte in a particular sample may be run more than once. Check reanalyses in instances where initial MSA analysis yields (r) <0.995. It is good practice to review one or two GFAA post-digestion spike (PDS) %Rs via reviewing unspiked and spiked sample concentrations and associated PDS recovery to verify that the Furnace Atomic Absorption Analysis Scheme has been followed as per directional guidance noted on page E-28, document ILM03.0.

Actions - If calibration correlation coefficient (r) <0.995, qualify as estimated (J) positive result and/ or (UJ) nondetect in affected sample. NOTE: The "Q" column on the Form 1 of the affected sample should contain an "S" flag for that particular analyte to indicate that the result was obtained using MSA. A "+" flag should also be recorded when the MSA correlation coefficient (r) <0.995. Review the appropriate Form I and amend if necessary.

3.1.3.12 ICP Serial Dilution Analysis

Review ICP Serial Dilutions Form 9 and associated raw data. Verify that a serial dilution was performed for each matrix and that all ICP analytes are included on the Form 9 with corresponding recovery calculations. Check the calculated Percent Difference (%D) column in instances where the diluted sample result is nondetected. In this situation, the laboratory should report a %D of 100% and not simply list the %D as noncalculable. Overlooking this minor point may result in incomplete sample data qualification in some instances. Amend the Form 9 if necessary. All %Ds for ICP serial dilution analyses

should be <10% when concentrations of corresponding analytes in the original (undiluted) sample are minimally a factor of 50X IDL.

Actions - If %D >10% for an analyte, and the corresponding sample concentration is >50x IDL, qualify as estimated (J) positive results for that analyte in all samples of the same matrix. NOTE: The possibility of negative interference exists when the ICP serial dilution %D >10% and the diluted sample result is significantly > original (undiluted) sample result. Qualify as estimated (J) positive results and (UJ) nondetects in such instances.

3.1.3.13 EPA Analysis Run Logs Form 14s

The Form 14 serves several useful functions. It can be used to obtain sample analysis dates as noted in the heading of the page. Secondly, it is used to record any dilutions as applicable to ICP, GFAA, mercury, and cyanide analyses. And finally, it can be used to verify that GFAA PDS percent recoveries are within the 85-115% quality control limits. Additionally, the data reviewer should be careful to note that one and only one "X" flag has been used to indicate each reported field sample result or quality control sample result; this can be an area of frequent laboratory error.

Actions - If the PDS %R is <85%, qualify as estimated (J) the corresponding positive result and/or (UJ) nondetect in affected sample. If the PDS %R is >115%, qualify as estimated (J) the corresponding positive result in the affected sample; nondetects are not qualified based on high PDS %R.

3.1.3.14 Further GFAA Evaluations

It is necessary to review the raw data for GFAA analyses and verify that all Coefficients of Variation or Relative Standard Deviations (%RSDs) are <20% for reported sample results which exceed the CRDL.

Actions - If the CV or %RSD exceeds 20% and the reported sample result is > CRDL, qualify as estimated (J) positive result in affected sample.

3.1.4 Deliverables Guidance

In addition to any specific USEPA Regional requirements (e.g. data validation memorandum, data summary spreadsheets, USEPA Regional worksheets), all laboratory data package quality control summary forms, sample Form I reports, method blank Form Is, and the Chain-of-Custody report must be given to the Data Validation Quality Assurance Officer (DV/QAO) for quality assurance review.

The validator should ensure that the format of the data validation deliverable is complete and correct (in accordance with the appropriate USEPA Regional or client requirements) and that the validation narrative is free of transcription and typographical errors before submitting all requested items for DV/QAO review.

4.0 NON-CLP INORGANICS FOR SOLID AND AQUEOUS MATRICES

4.1 Inorganics (SW-846 6010/7470/9010)

Inductively Coupled Plasma Emission Spectroscopy (ICP) - Analytes commonly analyzed using ICP include: aluminum, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, magnesium, manganese, nickel, potassium, silver, sodium, vanadium, and zinc.

Graphite Furnace Atomic Absorption Spectroscopy (GFAA) - Analytes commonly analyzed using GFAA include: antimony, arsenic, lead, selenium, and thallium.

Cold Vapor Methodology - Mercury is commonly analyzed using cold vapor methodology.

Automated Colorimetric Technique - Cyanide is commonly analyzed using automated colorimetric methodology.

4.1.1 Applicability

These methods are applicable to a large number of matrices including EP extracts, TCLP extracts, industrial wastes, soils, groundwater, aqueous samples, sludges, sediments, and other solid wastes. All matrices require digestion prior to analysis.

Detection limits for analytes are established on a quarterly basis and are both laboratory and instrument specific.

4.1.2 Data Overview Prior to Validation Process

4.1.2.1 Data Completeness

The data reviewer must initially verify that all forms are present and complete (i.e., Forms 1 through 14 must be provided). Areas of special attention when accounting for required forms will include:

- Verify at least one Initial and Continuing Calibration Verification (ICV/CCV) Percent Recovery (%R) calculation as noted on the Calibration Summary (Form 2A or equivalent).
- Verify that a matrix-specific laboratory generated preparation blank has been analyzed for each respective matrix as noted on the blank summary (Form 3 or equivalent) (note, filtered and unfiltered aqueous matrices are to be treated as distinctly different matrices).
- Verify that all ICP analytes are present in both ICSA and ICSAB solutions. Also, verify from the raw data that the laboratory reported all analytes present in solution A to the nearest whole number. It is not uncommon for laboratories to incorrectly report "zeros" or simply leave blank the appropriate solution A columns.
- Check that one matrix spike was analyzed for each particular matrix per analytical batch. Laboratories typically will not include an aqueous matrix for waters if the only aqueous samples contained in the SDG are field quality control blanks (i.e., equipment rinsate blanks and/or field blanks). This is generally accepted without data validation letter text comment. Additionally, the data reviewer may want to verify spiking levels.

- Verify that laboratory duplicate analyses were performed for each matrix. **NOTE**: Field quality control blanks are never to be designated for quality control analyses.

- Check that one Laboratory Control Sample (LCS) was analyzed for each batch of samples per matrix within an SDG. **NOTE**: An aqueous LCS is not required for mercury and cyanide analysis.

- The Method of Standard Additions (MSA) (Form 8 or equivalent) may or may not be present as dictated by Post Digestion Spike (PDS) %Rs. See Section 4.1.3.11 for further details.

- Verify that at least one ICP serial dilution analysis was performed for each matrix within an SDG. **NOTE**: Typically one serial dilution will serve to monitor a given set of samples within an SDG. However, special contractual requirements may necessitate one serial dilution analysis per sample. Ascertain atypical serial dilution frequency requirements through the project manager.

- Simply check that the Form 11 ICP Interelement Correction Factors (Annually) is present.

- Verify that all ICP analytical results fall within the ICP Quarterly Linear Ranges provided on the Form 12 (or equivalent). Verify that no GFAA analytical results exceed the highest standard in the associated GFAA calibration.

- Verify that the Preparation Log accounts for aqueous/soil ICP, AA, mercury, and cyanide digestions/distillation as applicable.

- Examine the Form 14s (or equivalent) to verify that one and only one "X" flag has been used to signify each reported field sample result or quality control sample result. Laboratories are often careless when entering the "X" flag. The validator must verify reported results in instances of discrepancies, amend appropriate forms, and mention in letter text.

Actions - Notify the appropriate laboratory contact of required resubmittals when discrepancies are noted on the forms discussed above.

4.1.3 Technical Evaluation Summary

All data evaluations must be conducted in accordance with current and applicable USEPA Regional protocols and/or specific client contractual requirements and obligations. The applicable documents must be referenced to during the data evaluation process as this Standard Operating Procedure (S.O.P) is intended as proprietary in-house guidance for general inorganic validation practices only.

General parameters such as Data Completeness, Overall System Performance, and Detection Limits must be evaluated concurrently with the parameters discussed below.

4.1.3.1 Holding Times

Holding times are calculated from date of sample collection to date of sample analysis. The date of sample collection must be obtained from the Chain-of-Custody (COC) form. The date of sample analysis is best retrieved from the raw data but may also be obtained from the Form 14.

Sample preservation and holding time requirements are as follows:

- Metals - 6 months; pH <2
- Mercury - 28 days; pH <2
- Cyanide - 14 days; pH >12

Preservation requirements as noted above are applicable to aqueous samples only. Solid samples do not receive preservative but require maintenance at 4°C (±2°C) during shipment and storage.

The above holding times do not apply to leachate analyses. It is suggested that the data reviewer reference SW-846 Method 1311 for any questions regarding TCLP quality control requirements and analytical procedural requirements; these vary significantly from non-TCLP analyses.

Actions - Holding time exceedances result in potentially low-biased results; thus, positive results and nondetects shall be qualified as estimated, (J) and (UJ), respectively. **NOTE**: Gross holding time noncompliances are defined as holding times which are exceeded by a factor or 2X. In these extreme cases, it is practice to reject (R) nondetects while positive results are qualified based upon professional judgment regarding the reliability of the associated data.

4.1.3.2 Initial Calibration Requirements

Calibration must be initiated daily and prior to sample analysis. The following calibration standard requirements must be verified:

- **ICP analyses** - must employ a blank and at least one standard

- **GFAA analyses** - must employ a blank and at least three standards. Additionally, the calibration correlation coefficient (r) must be checked for linearity for each GFAA analysis performed (i.e. r = 0.995 or greater)

- **Mercury analyses** - must employ a blank and at least three standards (r = 0.995 or greater).

- **Cyanide analyses** - must employ a blank and at least three standards (r = 0.995 or greater). **NOTE:** At least two additional standards (a high or low) must be distilled and compared to similar values on the curve. Values of distilled standards should agree within ±10% of undistilled standards.

4.1.3.3 Initial and Continuing Calibration Verification (ICV/CCV)

The ICV/CCV %R quality control limits are 90-110% for ICP metals, 80-120% for GFAA metals and mercury, and 85-115% for cyanide.

Actions - If ICV/CCV %Rs are low, qualify as estimated, (J) positive results and (UJ) nondetects. If ICV/CCV %Rs are high, qualify as estimated (J) positive results; nondetects remain unaffected. **NOTE:** Qualify results of only those samples associated with the noncompliant ICV or CCV (generally, those samples immediately preceding or following the noncompliant standard until the nearest in-control standard).

4.1.3.4 Laboratory Method and Field Quality Control Blanks

Verify that a preparation blank was analyzed for each matrix and for each batch of 20 samples or each sample batch digested, whichever is more frequent. Continuing Calibration Blanks (CCBs) must be run at a frequency of 10% or every 2 hours which ever is more frequent.

The data reviewer will select the maximum contaminant level for each analyte in a particular matrix from which shall be calculated an "action level." The action level shall be established as 5X the maximum contaminant level but must be adjusted for dilution factor, moisture content, and sample weight prior to application.

ICB/CCB contamination shall be applied to all samples within an SDG. Preparation blank contamination shall be applied to samples of the same matrix only. Common practice shall be to qualify as nondetected (U) any contaminant present in a sample which is considered a laboratory artifact (i.e., < the established action level). Professional judgment must be employed when discerning the validity of a concentration present in a field quality control blank. In many instances, contamination present in these blanks can be attributable to "dirty" laboratory practice and not actual field contaminant conditions.

Negative concentrations detected in the laboratory method blanks are indicative of instrumental problems and base-line drifting. Generally, any negative concentration > IDL shall warrant estimation [(J) positives and (UJ) nondetects] of the associated sample data regardless of matrix. Action levels shall not be established for negative concentration levels.

Actions - Qualify as nondetected (U) any positive result within the action level. Qualify as estimated (J) positive results and (UJ) nondetects for analytes for which negative concentrations were noted in the laboratory method blanks (i.e., ICBs, CCBs, and/or preparation blanks).

4.1.3.5 ICP Interference Check Sample Results

Verify that all recoveries for the ICP ICS solution fall within the 80-120% quality control window established for the ICS AB solution.

Actions - For ICS %Rs <80%, qualify as estimated (J) positive results and (UJ) nondetects in affected samples. For ICS %Rs >120%, qualify as estimated (J) positive results in affected samples; nondetects are unaffected by high ICS solution AB recovery. **NOTE:** Affected samples include all samples analyzed between the initial and final solutions or within the eight hour working shift whichever occurs more frequently) which contain Al, Ca, Fe, or Mg at levels >50% of the respective concentration of Al, Ca, Fe, or Mg in the ICS True Solution A.

Next, review concentrations of the four common interfering analytes (aluminum, calcium, iron, and magnesium) in the environmental samples. Any aforementioned interferant present in the environmental samples at concentrations which exceed those present in the ICS solution for that same analyte will require calculation of estimated elemental interference stemming from high interfering analyte concentration. If the previous condition is met; review the ICP/ICS Form 4 or equivalent and note any analytes present in the ICS solution A at levels which exceed the IDL and which are not present in the ICS True solution A. Positive results in the ICS solution A indicate potentially elevated results for this analyte in the affected sample, while negative results in the ICS solution A indicate potentially suppressed results for this analyte in the affected sample.

Next, an estimated elemental interference must be calculated for each analyte > IDL present in the ICS solution A which is not present in the ICS True solution A. The following equation shall be employed:

$$\text{Estimated elemental intf.} = \frac{[\text{Conc. affected analyte in ICS Soln A}] \times [\text{Interferent}]\ [\text{Conc. Sample}]}{\text{Interferent Conc. in ICS Soln A}}$$

It is advisable, although not necessary, to routinely choose the lowest concentration for the interferant level in the ICS so as to calculate the highest estimated interference possible. This method lends itself to a more conservative overall data quality review.

Estimated interferences for each affected analyte > IDL in the ICSA solution must now be compared to the reported environmental sample result for that particular analyte.

Actions - For estimated interferences <10% of the reported sample concentration for a particular affected analyte, take no action; interference is considered negligible. For estimated interferences >10% of the reported sample concentration for a particular affected analyte, qualify (J) positive result and/or (UJ) nondetect for affected analyte in affected sample. (**NOTE**: Calculation of an estimated positive (potentially elevated) interference will have no effect on a reported nondetect; thus, no action is necessary).

4.1.3.6 Matrix Spike Sample Analysis (Pre-digestion)

Verify that at least one matrix spike was performed for each matrix for a given set of samples (maximum of 20 samples) within an SDG. **NOTE:** Filtered and unfiltered samples are to be treated as distinctly different sample matrices and qualified accordingly. Any deviations from the referenced method shall be noted and require laboratory contact for correction.

Aqueous and soil Matrix Spike (MS) recoveries must be within the 75-125% quality control window in instances where the initial sample result is <4X amount spiked. If the initial sample result is >4X the amount spiked and the MS %R is noncompliant, no actions shall be taken.

Actions - For MS %Rs <30%, qualify as estimated (J) positive results and reject (R) nondetects in affected samples. For MS %Rs <75% but >30%, qualify as estimated (J) positive results and (UJ) nondetects in affected samples. For MS %Rs >125%, qualify as estimated (J) positive results in affected samples; nondetects are not compromised by high MS recovery; thus, no actions are warranted.

4.1.3.7 Laboratory Duplicate Precision

Verify that one duplicate sample analysis was performed for each group of samples (maximum of 20 samples) of a similar matrix within an SDG. Control criteria used to evaluate the aqueous laboratory duplicates are as follows:

- a control limit of ±20% for relative percent difference when sample and duplicate results are >5X CRDL
- a control limit of ±1X CRDL for the difference between the sample values when sample and/or duplicate results are <5X CRDL

Control criteria used to evaluate solid laboratory duplicates are as follows:

- a control limit of ±35% for relative percent difference when sample and duplicate results are >5X CRDL

- a control limit of ±2X CRDL for the difference between the sample values when sample and/or duplicate results are <5X CRDL

NOTE: Review Duplicate Summary (Form 6 or equivalent) carefully and verify that the laboratory has in fact reported a %RPD of 200% and not simply recorded the %RPD as noncalculable (in instances where the sample result is positive but the duplicate result is nondetect). Overlooking this minor point may result in incomplete sample data qualification in some instances.

Actions - For any situation involving laboratory duplicate imprecision, qualify as estimated (J) positive results and (UJ) nondetects in affected samples. **NOTE:** It is important to note in the letter text the cause of laboratory duplicate imprecision (i.e., noncompliant %RPD or noncompliant difference between sample and duplicate results).

4.1.3.8 Field Duplicate Precision

Field duplicates can be determined via Project Manager informational documents (i.e., sampling logs) or obtained from Chain-of-Custody (COC) forms. Field duplicates are generally identified as samples having identical sample collection times and dates. In instances were field duplicate samples are included with the sample data set, the following control criteria are generally used to evaluate aqueous field duplicates:

- a control limit of ±30% for relative percent difference when sample and duplicate results are >5X CRDL

- a control limit of ±2X CRDL for the difference between the sample values when sample and/or duplicate results are <5X CRDL

Similarly, the following control criteria are generally used to evaluate solid field duplicates:

- a control limit of ±50% for relative percent difference when sample and duplicate results are >5X CRDL

- a control limit of ±4X CRDL for the difference between the sample values when sample and/or duplicate results are <5X CRDL

NOTE: The %RPD should reflect a difference of 200% and should not simply be recorded as noncalculable in instances where the sample result is positive but the field duplicate result is nondetect. Overlooking this minor point may result in incomplete sample data qualification in some instances.

Actions - For any situation involving field duplicate imprecision, qualify as estimated (J) positive results and (UJ) nondetects in affected samples. **NOTE:** It is important to note in the letter text the cause of field duplicate imprecision (i.e., noncompliant %RPD or noncompliant difference between sample and duplicate results). Furthermore, field duplicate data qualifications, as per Brown & Root Environmental convention, shall be matrix-specific but otherwise "across-the-board" for TAL inorganic analyses.

4.1.3.9 Laboratory Control Sample Results

Verify that an LCS was analyzed for each matrix and for each batch of twenty samples or batch of samples digested (whichever is more frequent) within an SDG. The quality control criteria established for evaluation of aqueous LCS analyses are 80-120%. NOTE: An aqueous LCS is not required for

mercury and cyanide analysis. Verify that all solid "found values" fall within the EPA established control limits for soils.

Actions - Aqueous LCS: In instances where aqueous LCS %R <80%, qualify as estimated (J) positive results and (UJ) nondetects, If aqueous LCS %R >120, qualify as estimated (J) positive results. Solid LCS: In instances where solid found value is below lower quality control limit, qualify as estimated (J) positive results and (UJ) nondetects. If solid LCS found value exceeds EPA upper limit for soils, qualify as estimated (J) positive results.

4.1.3.10 Method of Standard Additions (MSA)

Review MSA Form 8 or equivalent and verify instrument linearity by checking that all calibration correlation coefficients (r) are greater than or equal to 0.995. MSAs for a particular analyte in a particular sample may be run more than once. Check reanalyses in instances where initial MSA analysis yields (r) <0.995. It is good practice to review one or two GFAA post-digestion spike (PDS) %Rs via reviewing unspiked and spiked sample concentrations and associated PDS recovery to verify that the Furnace Atomic Absorption Analysis Scheme has been followed as per directional guidance in the method.

Actions - If calibration correlation coefficient (r) <0.995, qualify as estimated (J) positive result and/ or (UJ) nondetect in affected sample.

4.1.3.11 ICP Serial Dilution Analysis

Verify that all ICP analytes are included on the Form 9 (or equivalent) with corresponding recovery calculations. Check the calculated Percent Difference (%D) column in instances where the diluted sample result is nondetected. In this situation, the laboratory should report a %D of 100% and not simply list the %D as noncalculable. Overlooking this minor point may result in incomplete sample data qualification in some instances. Amend the Form 9 if necessary. All %Ds for ICP serial dilution analyses should be <10% when concentrations of corresponding analytes in the original (undiluted) sample are minimally a factor of 50X IDL.

Actions - If %D >10% for an analyte, and the corresponding sample concentration is >50 IDL, qualify as estimated (J) positive results for that analyte in all samples of the same matrix. NOTE: The possibility of suppressed results exists when the ICP serial dilution %D >10% and the diluted sample result is significantly > original (undiluted) sample result. Qualify as estimated (J) positive results and (UJ) nondetects in such instances.

4.1.3.12 Analysis Run Logs Form 14

The Form 14 or equivalent serves several useful functions. It can be used to obtain sample analysis dates as noted in the heading of the page. Secondly, it is used to record any dilutions as applicable to ICP, GFAA, mercury, and cyanide analyses. And finally, it can be used to verify GFAA PDS percent recoveries within the 85-115% quality control limits. Additionally, the data reviewer should be careful to note that one and only one "X" flag has been used to indicate each reported sample result or quality control sample result; this can be an area of frequent laboratory error.

Actions - If the PDS %R is <85%, qualify as estimated (J) the corresponding positive result and/or (UJ) nondetect in affected sample. If the PDS %R is >115%, qualify as estimated (J) the corresponding positive result in the affected sample; nondetects are not qualified based on high PDS % R.

4.1.3.13 Further GFAA Evaluations

It is necessary to review the raw data for GFAA analyses and verify that all Coefficients of Variation Relative Standard Deviations (%RSDs) are <20% for reported sample results which exceed the CRDL.

Actions - If the CV or %RSD exceeds 20% and the reported sample result is > CRDL, qualify as estimated (J) positive result in affected sample.

4.1.4 Deliverables Guidance

In addition to any specific USEPA Regional requirements (e.g., data validation memorandum, data summary spreadsheets, USEPA Regional worksheets), all laboratory data package quality control summary forms, sample Form I reports, method blank Form Is, and the Chain-of-Custody report must be given to the Data Validation Quality Assurance Officer (DV/QAO) for quality assurance review.

The validator should ensure that the format of the data validation deliverable is complete and correct (in accordance with the appropriate USEPA Regional or client requirements) and that the validation narrative is free of transcription and typographical errors before submitting all requested items for DV/QAO review.

5.0 TOXICITY CHARACTERISTIC LEACHING PROCEDURE

5.1 SW-846 Method 1311

5.1.1 Applicability

Method 1311, the Toxicity Characteristic Leaching Procedure (TCLP), is used to determine the mobility/leaching potential of inorganic and organic contaminants in liquid, solid and multi-phase wastes and identify and characterize the waste as hazardous or nonhazardous. Wastes are extracted using two different methods. One method is used prior to the determination of metals, pesticides, and semivolatiles, while another method, zero headspace extraction (ZHE), is used prior to volatile organic analysis.

5.2 Interferences

Besides interferences noted for the specific analytical procedures and extractions, the primary concern is the loss of volatiles via aeration prior to organic determinations.

5.3 Holding Times

Preservatives are not added to samples before extraction. Samples should be stored at 4°C unless refrigeration results in irreversible physical change to the samples. Teflon-lined septum capped vials should be used for samples for volatile analysis. After extraction and prior to analysis, the pH of a TCLP extract should be adjusted to <2 if metallic concentrations are to be measured. Extracts should be preserved for other analytes according to guidance given in the individual analysis methods.

The following holding times apply to TCLP analyses:

Parameter	From Sample Collection to TCLP Extraction	From TCLP Extraction to Preparative Extraction	From Extraction to Analysis
Volatiles (VOAs)	14	Not applicable	14
Semivolatiles (BNAs)	14	7	40
Mercury (Hg)	28	Not applicable	28
All other Metals	180	Not applicable	180

Chain of Custodies (COCs) and raw data are reviewed to determine if holding times were met for all samples. If holding times were not met, all sample data will be qualified as estimated, (J) and (UJ). Nondetects in affected samples will be qualified as rejected, (R), if the holding time was exceeded by a factor of 2 or more.

5.4 Sample Preparation

The selection of extraction reagents is critical to the efficiency of the leaching potential of inorganic and organic chemicals. The extraction fluids must be prepared at pH 4.93 ±0.05 and 2.88 ±0.05 in order to properly leach contaminants in waste samples.

The determination of sample aliquot size for extraction is specified in Method 1311. The determination of percent solids must also be considered in the preparation stage.

5.5 Quality Control

The data package will be reviewed to ensure that the following TCLP quality control (QC) requirements plus the requirements dictated by the specific analytical method have been met.

5.5.1 Blanks

At a minimum, one TCLP extraction blank should be performed for every 20 extractions that have been conducted in an extraction vessel. TCLP extraction blanks should be subjected to the same analytical equipment and preparation reagents used to extract all associated samples. Contamination observed in extraction blanks should be considered when evaluating the sample data for introduced contamination.

5.5.2 Spikes

A minimum of one matrix spike per analytical batch (maximum 20 samples) must be performed for each waste type (e.g., wastewater treatment sludge, contaminated soil, etc.) unless it is already known that the constituents of the waste exceed regulatory levels. In most cases, matrix spikes should be added at a concentration equivalent to the corresponding regulatory level, following the matrix spike addition guidance provided in the analytical method as a minimum.

Internal calibration quantitation methods (such as the method of standard additions) must be employed for a metallic contaminant when the spike %R is <50% and the concentration does not exceed the regulatory level or when the detected concentration is within 20% of the regulatory level. Associated sample results will be qualified as estimated, (J) and (UJ), if internal calibration quantitation methods were not performed when required.

Inorganic contaminant concentrations for TCLP extracts must be quantitated by the method of standard additions (MSA) if analytical methods are determined to be inadequate. MSA curves should be checked for linearity. Positive sample results will qualified as estimated, (J), if the MSA correlation coefficient is <0.995.

5.5.3 Deliverables Guidance

In addition to any work-request requirements (e.g., data validation memorandum), all laboratory data package quality control summary forms, laboratory summaries of sample results and laboratory method blanks, and COCs must be provided for the Data Validation Quality Assurance Officer (DV/QAO) for quality assurance review.

The validator should ensure that the format of the data validation deliverable is complete and correct and that the validation narrative is free of transcription and typographical errors before submitting all requested items for DV/QAO review.

6.0 POLYCHLORINATED DIOXINS AND FURANS FOR SOLID AND AQUEOUS MATRICES

6.1 CLP/SW-846 Method 8280

6.1.1 Applicability

Method 8280 and CLP SOW DFLM1.1 are applicable for the determination of the tetra-, penta-, hexa-, hepta-, and octachlorinated congeners of dibenzo-p-dioxins (PCDDs) and dibenzofurans (PCDFs) (by Gas Chromatography/Mass Spectrometry (GC/MS) via selective ion monitoring) in chemical wastes including fuel oils, sludges, fly ash, still bottoms, reactor residues, soil, and water.

6.1.2 Dioxin Data Package Deliverable Minimum Requirements

The following information must be present in data package prior to the validation effort:

- Appropriate Chain-of-Custody (COC) Form(s)
- Laboratory Case Narrative documenting any particular analytical anomalies encountered and sample description information (i.e., sample cross-reference identifications)
- Calibration Summaries
- Laboratory Control Sample and Duplicate forms
- Single Control Samples and Method Blank Results
- Matrix Spike/Matrix Spike Duplicates
- Retention Time Marker Solutions
- Internal and Recovery Standard Area Summaries

The appropriate laboratory liaison must be contacted immediately if any of the above items have been omitted from the data package.

6.1.3 Technical Data Evaluation

NOTE: Analysis of a fortified standard and blank may be submitted as evidence of compliant Performance Evaluation (PE) analyses as per region-specific requirements. The fortified standard will contain 2,3,7,8-TCDD at a known quantity while the fortified blank will contain 1,2,3,4-TCDD plus other known interferents. The recovery for 2,3,7,8-TCDD recognition must be within the EPA's 99% confidence interval.

6.1.4 Quality Control

6.1.4.1 Holding Times and Sample Preservation

All samples are to be extracted within 30 days of sample collection, and all subsequent analyses are to be conducted within 45 days from the date of collection. **NOTE**: Data qualification based upon holding time noncompliances is rare due to the minor effect of extended storage time on PCDD/PCDF quantitation resulting from the inherent persistence and known stability of these compounds. However, estimation of associated sample data based on holding time shall be subject to the professional judgment of the data validator.

Sample preservation shall be checked by referencing the appropriate Chain-of-Custody (COC) form(s) and verifying that all samples receiving PCDD/PCDF analysis were cooled to and stored at 4°C.

6.1.4.2 Initial Calibration Verification

Review the average Relative Response Factors (RRFs) for all dioxin congeners by recalculating approximately 10% of the reported RRFs while also verifying proper use of quantitation ions. The following ions are specified for selective ion monitoring for PCDDs and PCDFs:

Analyte		Quantitation Ion	Confirmation Ions
PCDDs	Tetra	322	320
	Penta	356	354; 358
	Hexa	390	388; 392
	Hepta	424	422; 426
	Octa	460	458
PCDFs	Tetra	306	304
	Penta	340	338; 342
	Hexa	374	372; 376
	Hepta	408	406; 410
	Octa	444	442

Internal Standards

Analyte	Quantitation Ion	Confirmation Ion
13C12-2,3,7,8-TCDD	334	332
13C12-1,2,3,6,7,8-H_xCDD	404	402
13C12-OCDD	472	470
13C12-2,3,7,8-TCDF	318	316
13C12-1,2,3,4,6,7,8-H_pCDF	420	422

Recovery Standards

Analyte	Quantitation Ion	Confirmation Ion
13C12-1,2,3,4-TCDD	334	332
13C12-1,2,3,7,8,9-H_xCDD	404	402

Next verify the acceptability of isotopic ratios as outlined in the following table:

Analyte		Selected Ions	Relative m/z
PCDDs	Tetra	320/322	0.65-0.89
	Penta	356/358	1.24-1.86
	Hexa	390/392	1.05-1.43
	Hepta	424/426	0.88-1.20
	Octa	458/460	0.76-1.02
PCDFs	Tetra	304/306	0.65-0.89
	Penta	340/342	1.24-1.86
	Hexa	374/376	1.05-1.43
	Hepta	408/410	0.88-1.20
	Octa	442/444	0.76-1.02

Internal Standards

Analyte	Selected Ions	Relative m/z
13C12-2,3,7,8-TCDD	332/334	0.65-0.89
13C12-1,2,3,6,7,8-H_xCDD	402/404	1.05-1.43
13C12-OCDD	470/472	0.76-1.02
13C12-2,3,7,8-TCDF	316/318	0.65-0.89
13C12-1,2,3,4,6,7,8-H_pCDF	420/422	0.88-1.20

Recovery Standards

Analyte	Selected Ions	Relative m/z
13C12-1,2,3,4-TCDD	332/334	0.65-0.89
13C12-1,2,3,7,8,9-H_xCDD	402/404	1.05-1.43

Typically, the data reviewer can expect to associate the following congeners with their associated internal standards as follows:

Internal Standard #1 (13C12-2,3,7,8-TCDD)	TCDD, PeCDD
Internal Standard #2 (13C12-1,2,3,6,7,8-HxCDD)	HxCDD, HpCDD
Internal Standard #3 (13C-OCDD)	OCDD, OCDF
Internal Standard #4 (13C12-TCDF)	TCDF, PeCDF
Internal Standard #5 (13C12-HpCDF)	HxCDF, HpCDF

Additionally, verify that the Relative Standard Deviation (%RSD) for all target compounds and internal standards is ≤15%.

Actions - Qualify as estimated, (J) positive results and (UJ) nondetects in affected samples if RSD is >15%.

Window Defining Mix

This is a retention time check which must be run prior to the continuing calibration. The composition of the window defining mix may or may not be known. Review the following criteria:

- Peak separation must be ≤25% valley criterion for TCDD isomers
- Peak separation must be ≤ the 50% valley criterion for HxCDD isomers
- Multiple ion detection mass chromatograms and reconstructed ion chromatograms should be present for the window defining mix

Actions - Professional judgment (weighted primarily upon chromatographic expertise) must be employed when assigning data qualifications.

6.1.4.3 Continuing Calibration Verification

Evaluation of the CCV involves evaluating the Daily Standard (which is a standard that contains the required target compounds plus internal standards), versus the initial standard.

Verify that a Continuing Calibration Verification (CCV) was analyzed prior to sample analysis and at the beginning of each subsequent 12-hour period. A CCV must also be analyzed at the end of the final analysis period.

The Signal-to-Noise ratio (S/N) for all internal standards must be >10:1. No quality control criteria exist to govern internal standard recovery; however, internal standard advisory recovery limits of 40-120% were established in earlier EPA validation protocol.

Verify that the internal standard area count in the sample is -50% to +100% of the internal standard area count in the associated daily standard.

Complete one Percent Recovery ($\%R_{is}$) calculation for an internal standard as outlined in **equation A** below:

Equation A:

$$\%R_{is} = \frac{(A_{is})\ (Q_{rs})}{(A_{rs})\ (RRF_{is})\ (Q_{is})} \times 100$$

where:

A_{is} = area of the quantitation ion of the internal standard
A_{rs} = area of the quantitation ion of the recovery standard
Q_{is} = ng of internal standard
Q_{rs} = ng of recovery standard
RRF_{is} = Relative Response Factor for the internal standard as determined from the associated continuing calibration

An RRF shall be calculated for each congener in the CCV solution. A Percent Difference (%D) of 30% from the average RRF must be accomplished for the CCV. **NOTE**: Recalculate some (approximately 10%) of the continuing calibration RRFs for thoroughness.

Actions - Qualify associated sample data as estimated, i.e., (J) positive results and (UJ) nondetects in affected samples in instances where CCV %D >30%. Qualify as rejected (R) all associated sample data in instances where the internal standard S/N ratio <10:1.

6.1.4.4 Laboratory Method Blank Evaluations

Verify that a laboratory generated method blank was analyzed prior to sample analysis and for each matrix and extraction batch for all samples within an SDG. The laboratory method blanks should be free from contamination and/or interferences stemming from glassware involved in sample preparation and subsequent analytical procedures, associated reagents and solvents, etc. The following criteria shall be employed for evaluation of contaminant levels present in laboratory method blanks:

- The signal of any confirmed analyte present in a method blank must be <2% of the signal of the associated internal standard (based on peak height or peak area). Comparison of contaminants present in the blanks at levels below the calibration range (i.e., contaminants present at levels which constitute <2% of the respective internal standard) shall not require reanalyses as stipulated by the method.

- An action level of 5X the maximum contaminant level shall be used in instances of positive detections.

- The data reviewer should complete a detection limit verification calculation.

- Detection limits are sample-specific dependent upon the concentration of a given analyte to produce a signal with a peak height ≥2.5 X the background signal.

- The data reviewer shall consider all applicable sample weight, moisture content, and dilution factors prior to application of the aforementioned action level.

- The data reviewer shall recalculate at least one Detection Limit (DL) using **equation B** as follows:

Equation B:

$$DL = \frac{(2.5)\ (H_x)\ (Q_{is})}{(A_{is})\ (RRF_A)\ (W)}$$

where:

A_{is}	=	area of the quantitation ion of the internal standard
Q_{is}	=	ng of internal standard
H_x	=	peak height of noise for the analyte's quantitation ion
RRF_{is}	=	Relative Response Factor for the analyte as determined from the associated continuing calibration
W	=	dry weight of the sample (g)

Actions - Effects on sample data and subsequent data qualifications shall be upon the professional judgment of the data reviewer, but the following general qualifying guidance shall be employed; Qualify as nondetected (U) any positive result less than the corresponding action level.

6.1.4.5 Duplicate Control Samples

The Duplicate Control Sample (DCS) is a well-characterized matrix which is spiked and analyzed at approximately 10% of the sample load in order to establish method-specific quality control limits. The DCS spike recovery quality control limits of 60-140% shall be employed. Additionally, the RPDs between control sample and duplicate shall be below 50%.

Actions - Qualify as estimated (J) positive results in affected samples when DCS spike recoveries are >140%. Qualify as estimated (J) positive results and (UJ) nondetects in affected samples when DCS spike recoveries are <60%. Qualify as estimated (J) positive results and (UJ) nondetects in affected samples when %RPD between control and duplicate sample exceeds 50%.

6.1.4.6 Matrix Spike/Matrix Spike Duplicate Review

Verify that a matrix spike has been analyzed for each matrix and batch of samples within an SDG.

Verify that the %RSD between matrix spike and duplicate injections is ≤50%. Additionally, the following recovery limits shall be employed for the respective congeners:

Congener	Recovery Limits
TCDD	50-150%
PCDD	50-150%
HxCDD	50-150%
HpCDD	50-150%
OCDD	50-150%
TCDF	50-150%
PeCDF	50-150%
HxCDF	50-150%
HpCDF	50-150%
OCDF	50-150%

Actions - Qualify as estimated (J) only positive results in affected samples when the recovery exceeds the upper quality control limit. Qualify as estimated, (J) positive results and (UJ) nondetects in affected samples when the recovery is below the lower quality control limit.

6.1.4.7 Chromatographic Performance and Evaluation

Verify that the recovery standard area counts are within -50% to +100% of the area counts in the respective daily check standard.

Examine chromatographic acceptability by checking the chromatographic base-line for fluctuation (i.e., raising or lowering), peak shape and resolution. Proper peak resolution between 13C-2,3,7,8-TCDD and

13C-1,2,3,4-TCDD (or 13C-2,3,7,8-TCDD and its closest eluting isomer), shall be attained at a threshold acceptability level of <25%.

Actions - Data qualification shall be based upon the professional judgment of the data reviewer.

6.1.4.8 Sample Quantitation

Confirm the quantitation of at least one Estimated Maximum Positive Concentration (EMPC). The laboratory will report an EMPC as opposed to a confirmed, definite positive hit in instances where the S/N $\geq$2.5 for both the quantitation ion and confirmation ion for a given target isomer/analyte. The following equation shall be used to verify at least one EMPC calculation:

$$EMPC = \frac{(A_x)\ (Q_{is})}{(A_{is})\ (RRF_A)\ (W)}$$

where: A_x = area of the quantitation or confirmation ion, whichever is lower
Q_{is}, A_{is}, RRF_A, and W are defined in the previous equation.

The data reviewer will also confirm at least one positive detection using the following equation:

$$C_A = \frac{(A_A)\ (Q_{is})}{(A_{is})\ (RRF_A)\ (W)}$$

where: A_{is}, Q_{is}, RRF_A, and W are defined in previous equations
C_A = analyte concentration (ng/g or ug/kg)
A_A = analyte quantitation ion area

NOTE: EMPC values are estimates by definition. If these values are used for risk assessment, it must be understood that an EMPC value is "less certain" that positive results which are qualified (J), since the qualified results meet identification criteria while EMPCs do not.

6.1.5 Deliverables

In addition to any work-request requirements (e.g., data validation memorandum), all laboratory data package quality control summary forms, laboratory summaries of sample results and laboratory method blanks, and COCs must be provided to the Data Validation Quality Assurance Officer (DV/QAO) for quality assurance review.

The validator should ensure that the format of the data validation deliverable is complete and correct, and that the validation narrative is free of transcription and typographical errors before submitting all requested items for DV/QAO review.

7.0 MISCELLANEOUS ORGANICS

7.1 Biochemical Oxygen Demand (SM 5210B, EPA 405.1)

7.1.1 Applicability

This method determines oxygen requirements of municipal and industrial wastewaters by measuring the oxygen required for the biochemical degradation of organic material and the oxygen used to oxidize inorganic material such as sulfides and ferrous ion. It may also measure the oxygen used to oxidize forms of nitrogen unless their oxidation is prevented by an inhibitor. Results from this test may be used for the development of engineering criteria for the design of wastewater treatment plants.

7.1.2 Interferences

BOD results can be affected by contamination of the dilution water used in the analysis, the presence of toxicants, or by use of a poor seeding material. Insuring the purity of the dilution water will reduce misleading BOD results. Samples containing toxic substances may require special treatment before analysis.

7.1.3 Holding Times

Samples designated for BOD analysis are collected in high-density polyethylene bottles and stored at 4°C until analysis (unless samples are analyzed within 2 hours of collection). A 24 hour holding time is recommended for this method, however, the maximum holding time for BOD analyzed via EPA method 405.1 is 48 hours. If the holding time is exceeded the sample results are qualified as estimated, (J) and (UJ). Gross exceedance (>2X holding time) may warrant the rejection, (R), of nondetects.

7.1.4 Quality Control

7.1.4.1 Blanks

At a minimum, one laboratory method blank should be analyzed per sample batch (maximum 20 samples). The COCs should be consulted to determine if any field quality control blanks (field, rinsate, equipment, etc.) are associated with the samples. If contamination is noted in the associated blanks, positive sample results < the maximum amount detected in the blanks will be qualified as undetected, (U).

7.1.4.2 Glucose-glutamic Acid Check Standard

BOD is determined from a check standard containing a seed, and a glucose-glutamic acid solution. If the BOD value for this check standard is outside the range of 200 ±37 mg/L, BOD determinations made with the seed and diluted water are rejected.

7.1.5 Deliverables Guidance

The content and format of the data package generated for BOD analysis may vary significantly depending upon the work request.

In addition to any work-request requirements (e.g., data validation memorandum), all laboratory data package quality control summary forms, laboratory summaries of sample results and laboratory method

blanks, and COCs must be provided to the Data Validation Quality Assurance Officer (DV/QAO) for quality assurance review.

The validator should ensure that the format of the data validation deliverable is complete and correct and that the validation narrative is free of transcription and typographical errors before submitting all requested items for DV/QAO review.

7.2 Chemical Oxygen Demand (EPA Method 410.1/410.2)

7.2.1 Applicability

Methods 410.1 and 410.2 determine the quantity of oxygen required to oxidize organic matter in a domestic or industrial waste sample under specific conditions of oxidizing agent, temperature, and time. Method 410.1 is applicable to samples containing an organic carbon concentration greater than 50 mg/L, which Method 410.2 is applied to samples containing an organic carbon concentration in the range of 5 to 50 mg/L.

7.2.2 Interferences

Traces of organic material, rise in temperature, or high concentrations of chloride may cause error in determination of COD. Glassware used in the procedure would be conditioned by running blank procedures to eliminate traces of organic material, and contamination of the distilled water used in the procedure must be avoided. Loss of volatile substances may be minimized by cooling the flask used in the analysis during the addition of the sulfuric acid solution. Positive interferences caused by chlorides are eliminated with the addition of mercuric sulfate.

7.2.3 Holding Times

Glass bottles are recommended for sample collection, although plastic may be permissible if the containers are free of organic material contamination. Samples are preserved with sulfuric acid to a pH <2 and stored at 4°C until analysis. The maximum holding time specified (from sample collection to analysis) is 28 days. (The method does recommend that biologically active samples be tested as soon as possible.) Sample results will be qualified as estimated, (J) and (UJ), if this holding time is exceeded. Gross holding time exceedances (>2X holding time) will warrant rejection (R); of nondetects.

7.2.4 Quality Control

7.2.4.1 Blanks

A low COD water blank must be run simultaneously with the environmental sample to quantitate the amount of COD present in the environmental sample. Additionally, one laboratory method blank should be analyzed per sample batch. The COCs should be consulted to determine if any field quality control blanks (field, rinsate, equipment, etc.) are associated with the samples. If contamination is noted in the associated blanks, positive sample results < the maximum amount detected in the blanks will be qualified as undetected, (U).

7.2.5 Deliverables Guidance

The content and format of the data package generated for COD analysis may vary significantly depending upon the work request.

In addition to any work-request requirements (e.g., data validation memorandum), all laboratory data package quality control summary forms, laboratory summaries of sample results and laboratory method blanks, and COCs must be provided to the Data Validation Quality Assurance Officer (DV/QAO) for quality assurance review.

The validator should ensure that the format of the data validation deliverable is complete and correct and that the validation narrative is free of transcription and typographical errors before submitting all requested items for DV/QAO review.

7.3 Total Recoverable Petroleum Hydrocarbons (EPA 418.1)

7.3.1 Applicability

EPA Method 418.1 is used to measure the amount of fluorocarbon-113 extractable petroleum hydrocarbons from aqueous matrices. With modification, solid waste petroleum hydrocarbons can also be measured. Infrared analysis of a waste sample extract is performed by direct comparison with a calibration standard plot.

7.3.2 Interferences

The measurement of petroleum hydrocarbons by infrared analysis is subject to interference. The addition of silica gel to the sample reduces the effects of interference.

7.3.3 Holding Times

Samples are collected in glass bottles. Aqueous samples are preserved with hydrochloric acid to a pH <2 and are cooled to 4°C. Solid samples are stored at 4°C until analysis.

A 28-day holding time is used to evaluate the samples. Chain of Custodies (COCs) and raw data are reviewed to determine if holding times were met for all samples. Samples results will be qualified as estimated, (J) and (UJ), if holding times are exceeded. Gross holding time violations (>2X holding time) will warrant rejection, (R), of nondetects.

7.3.4 Quality Control

Quality control criteria are not specified in Method 418.1. However, if quality control analyses are performed by the laboratory, the following criteria will be used to evaluate the associated data.

7.3.4.1 Calibration

The calibration curve of absorbance versus concentration of petroleum hydrocarbons in known standards should be checked for linearity. Generally, associated sample data are qualified as estimated, (J) and (UJ), if the calibration curve correlation coefficient is <0.995. Professional judgment should be used to qualify sample data in cases when sample results fall outside the linear portion of the calibration curve.

If analyzed, the percent recovery (%R) of a continuing calibration verification (CCV) standard will be evaluated using an 85-115% quality control range. Associated sample data will be qualified as estimated, (J) and (UJ), if the CCV %R is <85%. Only positive results in the affected samples will be qualified as estimated, (J), if the CCV %R is >115%.

7.3.4.2 Blanks

Laboratory method blanks, if analyzed, should be evaluated for contamination. The COCs should be consulted to determine if any field quality control blanks (field, rinsate, equipment, etc.) are associated with the samples. If contamination is noted in any of the associated blanks, positive sample results < the maximum amount detected in the blanks will be qualified as undetected, (U). Sample aliquot and moisture content factors will be taken into consideration when qualifying the associated sample data.

7.3.4.3 Spikes/Duplicates

If a spiked sample is analyzed, a 75-125% quality control range will be used to evaluate the spike %R. Associated sample data will be qualified as estimated, (J) and (UJ), when the spiked sample %R is <75%. When the %R is >125%, only positive results are impacted and qualified as estimated, (J). If a spike %R is <30%, associated nondetects will be qualified as rejected, (R), and positive results will be qualified as estimated, (J).

7.3.4.4 Duplicates

Qualification of sample data based on duplicate precision is left to the professional judgment of the validator. Generally, a ±20% aqueous quality control limit and a ±30% solid quality control limit are used to evaluate the Relative Percent Difference (RPD) between the sample and laboratory duplicate results; a ±30% aqueous quality control limit and a ±50% solid quality control limit are generally used to evaluate the RPD between field duplicate results; qualification based on field duplicate imprecision is applied only to the field duplicate pair for general chemistry parameters.

7.3.4.5 Sample Quantitation

All reported sample concentrations should fall within the range of the calibration curve. If samples containing concentrations > the highest calibration standard were not diluted and reanalyzed, the associated sample data will be qualified as estimated, (J).

Verify that sample results were properly quantitated.

7.3.5 Deliverables Guidance

The content and format of the data package generated for petroleum hydrocarbon analysis may vary significantly depending upon the work request.

In addition to any work-request requirements (e.g., data validation memorandum), all laboratory data package quality control summary forms, laboratory summaries of sample results and laboratory method blanks, and COCs must be provided to the Data Validation Quality Assurance Officer (DV/QAO) for quality assurance review.

The validator should ensure that the format of the data validation deliverable is complete and correct and that the validation narrative is free of transcription and typographical errors before submitting all requested items for DV/QAO review.

7.4 Total Organic Carbon (EPA SW846 Method 9060)

7.4.1 Applicability

Method 9060 is used to measure concentrations of total organic carbon (TOC) in excess of 1 mg/L in domestic and industrial wastes, groundwater, and surface and saline waters. The organic carbon is first converted to carbon dioxide; the CO_2 is then measured directly using an infrared detector or converted to methane and measured by a flame ionization detector.

7.4.2 Interferences

The presence of inorganic carbon (i.e., carbonate and bicarbonate) must be considered. These substances can be accounted for in the sample calculation or eliminated by acidification and degassing before analysis. If degassing is utilized, volatilization of organic carbon can occur.

7.4.3 Holding Times

Although it is preferable that samples are collected in glass bottles, plastic containers may be used if it is established that the containers do not contribute contaminating organics to the samples. Samples are preserved with hydrochloric or sulfuric acid to a pH <2 and are cooled to 4°C. Protection from light is important for TOC analysis.

Although a precise holding time (elapsed time period from sample collection to analysis) is not stated in the method, a 28-day holding time will be used to evaluate the samples. Chain of Custodies (COCs) and raw data are reviewed to determine if holding times were met for all samples. Samples results will be qualified as estimated, (J) and (UJ), if holding times are exceeded. Gross holding time violations (>2X holding time) will warrant rejection, (R), of nondetects.

7.4.4 Quality Control

7.4.4.1 Calibration

A calibration curve should be prepared comparing concentrations of known standards to actual TOC readings. (Samples should be analyzed in quadruplicate; the average value and the range of readings should be reported.) The calibration curve should be checked for linearity. Generally, associated sample data are qualified as estimated, (J) and (UJ), if the calibration curve correlation coefficient is <0.995. Professional judgment should be used to qualify sample data in cases when sample results fall outside the linear portion of the calibration curve.

The method requires that a continuing calibration verification (CCV) standard be analyzed every 15 samples. An 85-115% quality control range will be used to evaluate the percent recovery (%R) of the CCV. Associated sample data will be qualified as estimated, (J) and (UJ), if the CCV %R is <85%. Only positive results in the affected samples will be qualified as estimated, (J), if the CCV %R is >115%.

7.4.4.2 Blanks

At a minimum, one laboratory method blank (other than the blank used for the calibration curve) should be analyzed per sample batch (maximum of 20 samples). The COCs should be consulted to determine if any field quality control blanks (field, rinsate, equipment, etc.) are associated with the samples. If contamination is noted in the associated blanks, positive sample results < the maximum amount

detected in the blanks will be qualified as undetected, (U). Sample digestion and moisture content factors will be taken into consideration when qualifying the associated sample data.

7.4.4.3 Spikes/Duplicates

A spiked sample and spiked duplicate sample should be analyzed for every 10 samples. If a spike or duplicate spike %R is <75%, the associated sample data will be qualified as estimated, (J) and (UJ). If the %R is >125%, only positive results are impacted and qualified as estimated, (J). If a spike %R is <30%, associated nondetects will be qualified as rejected, (R), and positive results will be qualified as estimated, (J).

Qualification of sample data based on duplicate precision is left to the professional judgment of the validator. Generally, a ±20% aqueous quality control limit and a ±30% solid quality control limit are used to evaluate the relative percent difference (RPD) between the spiked sample and spiked duplicate sample results. A ±30% aqueous control limit and a ±50% solid quality control limit are generally used to evaluate the RPD between field duplicate results; qualification based on field duplicate imprecision is applied only to the field duplicate pair for general chemistry parameters.

7.4.4.4 Sample Quantitation

All reported sample concentrations should fall within the range of the calibration curve. If samples having concentrations > the highest calibration standard were not diluted and reanalyzed, the associated sample data will be qualified as estimated, (J).

Verify that sample results were properly quantitated.

7.4.5 Deliverables Guidance

The content and format of the data package generated for TOC analysis may vary significantly depending upon the work request.

In addition to any work-request requirements (e.g., data validation memorandum), all laboratory data package quality control summary forms, laboratory summaries of sample results and laboratory method blanks, and COCs must be provided to the Data Validation Quality Assurance Officer (DV/QAO) for quality assurance review.

The validator should ensure that the format of the data validation deliverable is complete and correct, and that the validation narrative is free of transcription and typographical errors before submitting all requested items for DV/QAO review.

7.5 Total Organic Halides (EPA SW-846 Method 9020B)

7.5.1 Applicability

Method 9020B uses carbon adsorption with a microcoulometric-titration detector to measure the concentration of total organic halides (TOX) as chloride in drinking and ground waters. This method detects all organic halides containing chlorine, bromine, and iodine.

- Organic halides containing fluorine cannot be measured.
- TOX adsorbed to undissolved solids cannot be measured.

- The concentration of inorganic halides in the sample can not exceed the organic halide concentration by a factor >20,000.

7.5.2 Interferences

Interferences from contaminated reagents, glassware, activated carbon, and other laboratory devices must be minimized. Special care must be taken to clean, dry, and store materials used during analysis to protect against contamination from halogenated organic vapors and oily residue.

Suspended matter, which can clog adsorption columns, must be eliminated prior to sample analysis by decanting the aqueous phase or centrifuging to separate undissolved materials.

7.5.3 Holding Times

Samples should be collected in duplicate, preserved with sulfuric acid to a pH <2, and cooled to 4°C. Plastic or glass containers may be used. All samples must be protected from light.

Samples must be analyzed within 28 days of collection. Chain of Custodies (COCs) and raw data are reviewed to determine if holding times were met for all samples. Samples results will be qualified as estimated, (J) and (UJ), if holding times are exceeded. Gross holding time violations (>2X holding time) will warrant rejection (R), of nondetects.

7.5.4 Quality Control

7.5.4.1 Calibration

Pyrolyzation

The following requirements must be met during the pyrolysis stage:

- The adsorption efficiency of the activated carbon must be checked. The percent recovery (%R) of a standard should be within ±10%.
- A nitrate-wash blank must be run after every 10 pyrolyzations.
- Pyrolysis instrument calibration standards, which should be run after every 10 determinations, must be analyzed in duplicate. The %R for these standards must be within ±10% of the true value.

If any of these requirements have not been met, associated sample data will be qualified as estimated, (J) and (UJ).

Microcoulometric Analysis

The method requires that a continuing calibration verification (CCV) standard be analyzed every 15 samples. Although the method does not specify criteria to evaluate the CCV, an 85-115% quality control range will be used for validation purposes. Affected sample data will be qualified as estimated, (J) and (UJ), if the CCV %R is <85%. Only positive results in the affected samples will be qualified as estimated, (J), if the CCV %R is >115%.

7.5.4.2 Blanks

A minimum of two method blanks (other than the blanks used for the calibration and pyrolyzation) should be analyzed to establish the repeatability of the method background and the background should be monitored by analyzing method blanks after every eight samples. The COCs should be consulted to determine if any field quality control blanks (field, rinsate, equipment, etc.) are associated with the samples. If contamination is noted in the associated blanks, positive sample results < the maximum amount detected in the blanks will be qualified as undetected, (U). Dilution factors will be taken into consideration when qualifying the associated sample data. (Nitrate-wash blanks, which are considered to be laboratory method blanks, should not be used to qualify sample results since contamination in these blanks is already accounted for in the sample calculation.)

7.5.4.3 Spikes/Duplicates

A spiked sample should be analyzed between every 10 samples. If a spike or duplicate spike %R is not within 75-125%, the associated sample data will be qualified as estimated, (J) and (UJ). If the %R is >125%, only positive results are impacted and qualified as estimated, (J). If a spike %R is <30%, associated nondetects will be qualified as rejected, (R), and positive results will be qualified as estimated, (J).

The method requires that all samples be seen in duplicate. Qualification of sample data based on duplicate precision is left to the professional judgment of the validator. Generally, a ±20% aqueous quality control limit and a ±30% solid quality control limit are used to evaluate the relative percent difference (RPD) between the sample and laboratory duplicate sample results. A ±30% aqueous quality control limit and a ±50% solid quality control limit are generally used to evaluate the RPD between field duplicate results; qualification based on field duplicate results for general chemistry parameters are applied to the field duplicate pair only.

7.5.4.4 Breakthrough

Check the extent of organohalide breakthrough from the first column. The second column measurement should not exceed 10% of the sum of the measurements from both columns. Positive results will be estimated, (J), if the 10% quality control limit was exceeded.

7.5.4.5 Sample Quantitation

The following equation is used to calculate TOX:

$$TOX\ (\mu g/L) = \frac{(conc_1 - conc_{blank}) + (conc_2 - conc_{blank})}{vol_{sample}}$$

where:

$conc_1$	=	concentration of chloride measured on first column (μg)
$conc_2$	=	concentration of chloride measured on second column (μg)
$conc_{blank}$	=	average, daily concentration in nitrate-wash blanks (μg)
vol	=	volume of sample aliquot (L)

Verify that sample results were accurately quantitated.

7.5.5 Deliverables Guidance

The content and format of the data package generated for TOX analysis may vary significantly depending upon the work request.

In addition to any work-request requirements (e.g., data validation memorandum), all laboratory data package quality control summary forms, laboratory summaries of sample results and laboratory method blanks, and COCs must be provided to the Data Validation Quality Assurance Officer (DV/QAO) for quality assurance review.

The validator should ensure that the format of the data validation deliverable is complete and correct and that the validation narrative is free of transcription and typographical errors before submitting all requested items for DV/QAO review.

8.0 MISCELLANEOUS INORGANICS

8.1 Carbonate/Bicarbonate Alkalinity (EPA 600 Series Method 310.2)

8.1.1 Applicability

Method 310.2 is an automated method used to measure alkalinity (as $CaCO_3$) at concentrations ranging from 10 to 200 mg/L in domestic and industrial effluents, and drinking, surface and saline waters.

8.1.2 Interferences

Since the method of analysis is colorimetric, primary interferences for this method include turbidity and color. Samples can be filtered prior to analysis to reduce interferences from turbidity.

8.1.3 Holding Times

Samples should be collected in plastic or glass containers and cooled to 4°C. No preservative is needed.

Holding time is defined as the elapsed time period from sample collection to analysis. The holding time for this method is 14 days. Chain of Custodies (COCs) and raw data are reviewed to determine if holding times were met for all samples. Positive results and nondetects will be qualified as estimated, (J) and (UJ), respectively, if holding times were exceeded. Gross holding time violations (>2X holding time) will warrant rejection, (R), of nondetects.

8.1.4 Quality Control

Quality control analyses and criteria (i.e., calibrations, blanks, spikes, etc.) are not specified in Method 310.2. However, if these analyses were performed by the laboratory, the following criteria will be used to evaluate the associated sample data.

8.1.4.1 Calibration

According to the method, a calibration curve should be prepared by plotting peak heights of standards to known concentrations. This curve should be checked for linearity. Generally, associated sample data are qualified as estimated, (J) and (UJ), if the calibration curve correlation coefficient is <0.995. Professional judgment should be used to qualify sample data in cases when sample results fall outside the linear portion of the calibration curve.

If analyzed, the percent recovery (%R) of a continuing calibration verification (CCV) standard will be evaluated using an 85-115% quality control range. Associated sample data will be qualified as estimated, (J) and (UJ), if the CCV %R is <85%. Only positive results in the affected samples will be qualified as estimated, (J), if the CCV %R is >115%.

8.1.4.2 Blanks

Laboratory method and field quality control blanks, if analyzed, should be identified and assessed for introduced contamination. Field quality control blanks (field, rinsate, equipment, etc.) can be identified by consulting the COCs. If contamination is noted in the associated blanks, positive sample results < the maximum amount detected in the blanks will be qualified as undetected, (U). Sample digestion and moisture content factors will be taken into consideration when qualifying the associated sample data.

8.1.4.3 Spikes

If a spiked sample is analyzed, a 75-125% quality control range will be used to evaluate the spike %R. Associated sample data will be qualified as estimated, (J) and (UJ), when the spiked sample %R is <75%. When the %R is >125%, only positive results are impacted and qualified as estimated, (J). If a spike %R is <30%, associated nondetects will be qualified as rejected, (R), and positive results will be qualified as estimated, (J).

8.1.4.4 Duplicates

Qualification of sample data based on duplicate precision is left to the professional judgment of the validator. Generally, an aqueous quality control limit of ±20% and a solid quality control limit of ±30% is used to evaluate the relative percent difference (RPD) between the sample and laboratory duplicate results. An aqueous quality control limit of ±30% and a solid quality control limit of ±50% are generally used to evaluate the RPD between field duplicate results; qualification based on field duplicate imprecision for general chemistry parameters is applied to the field duplicate pair only.

8.1.4.5 Sample Quantitation

All reported sample concentrations should fall within the range of the calibration curve. If samples having detected concentrations > the highest calibration standard were not diluted and reanalyzed, associated sample data will be qualified as estimated, (J).

The validator should verify that sample results were properly quantitated.

8.1.5 Deliverables Guidance

The content and format of the data package generated for alkalinity analysis may vary significantly depending upon the work request.

In addition to any work-request requirements (e.g., data validation memorandum), all laboratory data package quality control summary forms, laboratory summaries of sample results and laboratory method blanks, and COCs must be provided to the Data Validation Quality Assurance Officer (DV/QAO) for quality assurance review.

The validator should ensure that the format of the data validation deliverable is complete and correct and that the validation narrative is free of transcription and typographical errors before submitting all requested items for DV/QAO review.

8.2 Anions (EPA Method 300.0)

The Determination of Inorganic Anions in Water by Ion Chromatography

8.2.1 Applicability

Method 300.0 is a Ion Chromatographic (IC) Procedure used to determine the inorganic anions chloride, fluoride, nitrate (as nitrogen), nitrite (as nitrogen), ortho-phosphate (as phosphorus), and sulfate in drinking water, surface water, and mixed domestic and industrial wastewater.

8.2.2 Interferences

Interferences may be caused by particulates or other substances present in the sample that may have retention times similar to the particular anion of interest. Also, a large concentration of one anion may mask the resolution of an adjacent anion. Sample dilution and/or spiking (to generate a sample-specific calibration) may be employed to resolve these problems. Additionally, method interferences may be caused by contaminants in reagent water, reagents, glassware, and other elements of sample processing.

The fluoride peak, in particular, may be affected by a water dip (a negative peak) that elutes near it. This problem can be eliminated by the addition of 1 mL of concentrated sodium carbonate eluent solution to 100 mL of each standard and sample.

8.2.3 General Laboratory Practices

The laboratory should spike and analyze a minimum of 10% of all samples to monitor continuing laboratory performance. Field and laboratory duplicates should also be analyzed.

Validation: The validator should check the work request to ascertain what contracted quality control analyses are required. Likewise, the validator should check with the project manager to determine which samples (if any) are field duplicates or field quality control blanks.

Before any analyses are performed the laboratory must demonstrate the ability to generate acceptable accuracy and precision using a blank spike sample (laboratory control sample; LCS), which is a reagent water blank spiked with a known concentration of stock standard solutions at the concentrations stipulated in EPA Method 300.0, Sections 8.2.2 through 8.3.1.

Analysis of this blank spike sample will indicate the accuracy of the measurement via the calculation of Percent Recovery (%R). Upper and lower control limits for %Rs should be calculated. These control limits can then be used to construct control charts that may be useful in observing trends in performance. This blank spike sample should also be duplicated and analyzed to indicate precision of the measurements between identical samples through comparison of the recoveries generated via the blank spike and blank spike duplicate analyses. The blank spike/blank spike duplicate analyses should be performed with the same frequency as matrix spike/matrix spike duplicate analyses.

Validation: The data reviewer shall examine The %Rs to determine if they are within the laboratory generated control limits. If %Rs are below the control limits positive results will be qualified (J) and nondetected results will be qualified (UJ). If %Rs are above the control limits only positive results will be qualified (J). If %Rs are extremely low (less than 10%) the laboratory should reanalyze the blank spike and blank spike duplicate samples. If the laboratory does not reanalyze these samples then qualifications are necessary. Positive results will be qualified as estimated (J) and nondetects will be rejected (R), when %Rs are less than 10%.

The reviewer should also examine the Relative Percent Difference (RPD) between the calculated %Rs. If the RPD is above an acceptable level qualify positive results (J) and use professional judgment to determine if nondetects should be qualified (UJ).

8.2.4 Holding Times

The following table indicates sample preservation and holding time requirements:

Analyte	Preservation	Holding time
Chloride	None required	28 days
Fluoride	None require	28 days
Nitrate-N	Cool to 4°C	48 hours
Nitrite-N	Cool to 4°C	48 hours
o-Phosphate-P	Filter & cool to 4°C	48 hours
Sulfate	Cool to 4°C	28 days

Validation: Holding times are calculated from time of collection obtained from Chain-of-Custody (COC) forms to time of analysis. Positive results in samples analyzed past holding times are qualified as estimated (J); nondetects (UJ). If holding times are exceeded by a factor of 2 or more it is considered to be a gross exceedance; positive results are qualified as estimated, (J), and nondetects are rejected, (R). Results are considered to be biased low when holding times are exceeded.

8.2.5 Sample Preparation

Samples containing particles greater than 0.45 microns and reagent solutions containing particles greater than 0.20 microns require filtration to prevent damage to the instrument columns and flow systems.

8.2.6 Calibration and Testing

Per each analyte of interest, calibration standards at a minimum of 3 concentration levels should be prepared (generated from a stock solution and diluted appropriately) and analyzed along with a blank. One of the standard concentrations must be near but above the MDL. A sufficient number of standards should be analyzed to accurately define a calibration curve.

A consistent aliquot (injections of 0.1 to 1.0 mL) for samples and standards must be used. An automated constant volume injection system may be employed.

Calibration for each analyte should be verified daily, or whenever the anion eluent is changed, and after every 20 samples. Retention times must agree within ±10%. If agreement is not met a new calibration curve should be generated for that analyte.

Validation: The validator will evaluate the 3-point calibration and verify that one of the points was at a concentration near the MDL. Next, the retention times will be examined to ensure that they agree within ±10%. If the retention time is outside the ±10% window, the result for the affected analyte will be qualified as estimated; (J) positive results and (UJ) nondetects.

If peak response exceeds the linear calibration range of the instrument, the sample should be diluted with the appropriate amount of reagent water and reanalyzed. If the chromatogram does not produce adequate resolution or if identification of the chromatographic peaks are questionable, the sample should be spiked with the appropriate amount of standard and reanalyzed.

Validation: The validator will review chromatograms to verify the absence of a water dip (see Section 8.2.2) and to verify that peak responses are within the linear range and that adequate resolution was achieved. If any noncompliances exist they should be noted. Qualifications will be made per situation, based upon professional judgment.

8.2.7 Blank Contamination

Method blanks (reagent water) should be analyzed at the beginning of each sample batch (maximum of 20 samples) to ensure that there is no carryover or contamination from glassware and/or reagents.

Validation: Blank results should be reported for each sample data set. If contamination is noted in the blanks, the maximum concentration of each contaminant should be used to set action. Action levels are set using professional judgment based upon comparability of the sample result with concentration of the blank contaminant. Results reported for contaminants found in samples that are greater than the detection limit and within the action level are qualified as undetected, (U). The same process is repeated for field quality control blanks.

8.2.8 Sample Quantitation

A standard curve should be generated by plotting anion peak size in area units against standard anion solution concentration values. Sample concentration can then be calculated by comparing sample peak response with the standard curve. Sample data results should be reported in mg/L.

Validation: The validator shall compare sample results against standard results to confirm that the samples were properly quantitated.

8.2.9 Deliverables Guidance

The content and format of the data package generated for anion analysis may vary significantly dependent upon the work request.

In addition to any work-request requirements (e.g., data validation memorandum, data spread sheet), all laboratory data package quality control summary forms, laboratory summaries of sample data results and method blank analyses and the chain-of-custody report must be given to the Data Validation Quality Assurance Officer (DV/QAO) for quality assurance review.

The validator should ensure that the format of the data validation deliverable is complete and correct and that the validation narrative is free of transcription and typographical errors before submitting all requested items for DV/QAO review.

8.3 Bromide (EPA 600 Series Method 320.1)

8.3.1 Applicability

Method 320.1 is a titrimetric method used to determine the concentration of bromide in domestic and industrial effluents, and drinking, surface and saline waters. Bromide concentrations ranging from 2 to 20 mg/L can be measured by this method.

8.3.2 Interferences

Interferences can be caused by the presence of organic matter, iron, and manganese. Pretreatment of samples with calcium oxide removes or reduces these interferences to insignificant concentrations.

Color interferes with the observation of indicator and bromine-water color changes. Steps can be taken during analysis to eliminate this interference (e.g., the use of a pH meter instead of a pH indicator).

8.3.3 Holding Times

Samples should be collected in plastic or glass bottles and cooled to 4°C. No preservative is needed.

Holding time is defined as the elapsed time period from sample collection to analysis. A 28-day holding time is specified for analysis. Chain of Custodies (COCs) and raw data are reviewed to determine if holding times were met for all samples. Positive results and nondetects will be qualified as estimated, (J) and (UJ), respectively, if holding times were exceeded. Gross holding time violations (>2X holding time) will warrant rejection, (R), of nondetects.

8.3.4 Quality Control

Quality control analyses (i.e., blanks, spikes, etc.) are not specified in Method 320.1. However, if these analyses were performed by the laboratory, the following criteria will be used to evaluate the associated sample data.

8.3.4.1 Verification Standard

The percent recovery (%R) of a verification standard, if analyzed, will be evaluated using an 85-115% quality control criteria. Associated sample data will be qualified as estimated, (J) and (UJ), if the %R is <85%. Only positive results in the affected samples will be qualified as estimated, (J), if the %R is >115%.

8.3.4.2 Blanks

Laboratory method and field quality control blanks, if analyzed, should be evaluated for contamination. Field quality control blanks (field, rinsate, equipment, etc.) can be identified by consulting the COCs. If contamination is noted in the associated blanks, positive sample results < the maximum amount detected in the blanks will be qualified as undetected, (U). Sample digestion and moisture content factors will be taken into consideration when qualifying the associated sample data.

8.3.4.3 Spikes

If a spiked sample is analyzed, a 75-125% quality control range will be used to evaluate the spike %R. Associated sample data will be qualified as estimated, (J) and (UJ), when the spiked sample %R is <75%. When the %R is >125%, only positive results are impacted and qualified as estimated, (J). If a spike %R is <30%, associated nondetects will be qualified as rejected, (R), and positive results will be qualified as estimated, (J).

8.3.4.4 Duplicates

Qualification of sample data based on duplicate precision is left to the professional judgment of the validator. Generally, an aqueous quality control limit of ±20% and a solid quality control limit of ±30% is used to evaluate the relative percent difference (RPD) between the sample and laboratory duplicate results. An aqueous quality control limit of ±30% and a solid quality control limit of ±50% are generally used to evaluate the RPD between field duplicate results; qualification based on field duplicate imprecision for general chemistry parameters is applied to the field duplicate pair only.

8.3.4.5 Sample Quantitation

All reported sample concentrations should fall within the range of 2 to 20 mg/L. If samples having detected concentrations >20 mg/L were not diluted and reanalyzed, the associated sample data will be qualified as estimated, (J).

The validator should verify that sample results were properly quantitated.

8.3.5 Deliverables Guidance

The content and format of the data package generated for bromide analysis may vary significantly depending upon the work request.

In addition to any work-request requirements (e.g., data validation memorandum), all laboratory data package quality control summary forms, laboratory summaries of sample results and laboratory method blanks, and COCs must be provided to the Data Validation Quality Assurance Officer (DV/QAO) for quality assurance review.

The validator should ensure that the format of the data validation deliverable is complete and correct and that the validation narrative is free of transcription and typographical errors before submitting all requested items for DV/QAO review.

8.4 Fluoride (EPA 600 Series Method 340.2)

8.4.1 Applicability

Method 340.2 is a potentiometric method which uses an ion selective electrode to measure concentrations of fluoride in domestic and industrial effluents, and drinking, surface and saline waters. The practical range of determination is 0.1 to 1,000 mg/L.

8.4.2 Interferences

The pH of samples can cause significant interferences. The ideal pH range of a sample is between 5 and 9.

Complexing cations, such as Si^{+4}, Fe^{+3}, and Al^{+3}, can produce additional interferences during fluoride determinations. Samples can be treated with a pH 5.0 buffer containing a strong chelating agent to eliminate these interferences.

8.4.3 Holding Times

Samples are to be collected in plastic bottles. No preservative is required.

A 28-day holding time (elapsed time period from sample collection to analysis) is specified for analysis. Chain of Custodies (COCs) and raw data are reviewed to determine if holding times were met for all samples. Sample data will be qualified as estimated, (J) and (UJ), if holding times were exceeded. Gross holding time violations (>2X holding time) will warrant rejection, (R), of nondetects.

8.4.4 Quality Control

Quality control analyses (i.e., calibrations, blanks, spikes, etc.) are not specified in Method 340.2. However, if these analyses were performed by the laboratory, the following criteria will be used to evaluate the associated sample data.

8.4.4.1 Calibration

According to the method, the calibration curve should consist of standards ranging in concentration from 0 to 2 mg/L. Semi-logarithmic graph paper should be used to plot the known concentration of the standard versus the electrode potential.

If a continuing calibration verification (CCV) standard is analyzed, the percent recovery of the standard will be evaluated using 85-115% quality control limits. Associated sample data will be qualified as estimated, (J) and (UJ), if the CCV %R is <85%. Only positive results in the affected samples will be qualified as estimated, (J), if the CCV %R is >115%.

8.4.4.2 Blanks

Laboratory method and field quality control blanks, if analyzed, should be assessed for introduced contamination. Field quality control blanks (field, rinsate, equipment, etc.) can be identified by consulting the COCs. If contamination is noted in the associated blanks, positive sample results < the maximum amount detected in the blanks will be qualified as undetected, (U). Sample digestion and moisture content factors will be taken into consideration when qualifying the associated sample data.

8.4.4.3 Spikes

If a spiked sample is analyzed, a 75-125% quality control range will be used to evaluate the spike %R. Associated sample data will be qualified as estimated, (J) and (UJ), when the spiked sample %R is <75%. If the %R is >125%, only positive results are impacted and qualified as estimated, (J). If a spike %R is <30%, associated nondetects will be qualified as rejected, (R), and positive results will be qualified as estimated, (J).

8.4.4.4 Duplicates

Qualification of sample data based on duplicate precision is left to the professional judgment of the validator. Generally, an aqueous quality control limit of ±20% and a solid quality control limit of ±30% is used to evaluate the relative percent difference (RPD) between the sample and laboratory duplicate results. An aqueous quality control limit of ±30% and a solid quality control limit of ±50% is used to evaluate the RPD between field duplicate results; qualification based on field duplicate imprecision for general chemistry parameters is applied to the field duplicate pair only.

8.4.4.5 Sample Quantitation

All reported sample concentrations should fall in the range of the calibration curve. If samples having detected concentrations > the highest calibration standard were not diluted and reanalyzed, associated sample data will be qualified as estimated, (J).

The validator should verify that sample results were properly quantitated.

8.4.5 Deliverables Guidance

The content and format of the data package generated for fluoride analysis may vary significantly depending upon the work request.

In addition to any work-request requirements (e.g., data validation memorandum), all laboratory data package quality control summary forms, laboratory summaries of sample results and laboratory method blanks, and COCs must be provided to the Data Validation Quality Assurance Officer (DV/QAO) for quality assurance review.

The validator should ensure that the format of the data validation deliverable is complete and correct and that the validation narrative is free of transcription and typographical errors before submitting all requested items for DV/QAO review.

8.5 Nitrogen (Various)

8.5.1 Nitrate-Nitrogen (EPA 300 Series Method 352.1)

8.5.1.1 Applicability

Method 352.1 is a brucine, colorimetric method used to measure nitrate-nitrogen at concentrations ranging from 0.1 to 2 mg/L in domestic and industrial effluents, and drinking, surface and saline waters.

8.5.1.2 Interferences

The following is a list of interferences observed for this method:

- Uniform temperature control is extremely critical during the color development stage. Erratic heating can produce inconsistent results.
- Strong oxidizing or reducing agents, residual chloride, ferrous and ferric iron, quadrivalent manganese, and salinity in samples can create interferences.
- Interferences from naturally colored samples and dissolved organic matter can affect color during heating and produce erroneous results.

8.5.1.3 Holding Times

Samples should be collected in plastic or glass containers and cooled to 4°C.

The holding time, elapsed time period from sample collection to analysis, for this method is 48 hours. Chain of Custodies (COCs) and raw data are reviewed to determine if holding times were met for all samples. Positive results and nondetects will be qualified as estimated, (J) and (UJ), respectively, if holding times were exceeded. Gross holding time violations (>2X holding time) will warrant rejection, (R), of nondetects.

8.5.1.4 Quality Control

Quality control analyses (i.e., calibrations, blanks, spikes, etc.) are not specified in this method. However, if these analyses were performed by the laboratory, the following criteria will be used to evaluate the associated sample data.

Calibration

A calibration curve should be prepared by plotting absorbances of standards against known concentrations. Because the color reaction does not always obey Beer's Law, qualification of sample data based on nonlinear calibration curves may be inappropriate. Professional judgment should be used to qualify sample data when nonlinearity (calibration curve correlation coefficient <0.995) is encountered.

The percent recovery (%R) of a continuing calibration verification (CCV) standard, if analyzed, will be evaluated using an 85-115% quality control criteria. If the %R is <85%, associated sample data will be qualified as estimated, (J) and (UJ). Only positive results in the affected samples will be qualified as estimated, (J), if the CCV %R is >115%.

Blanks

If analyzed, laboratory method and field quality control blanks should be assessed for contamination. Field quality control blanks (field, rinsate, equipment, etc.) can be identified by consulting the COCs. If contamination is noted in the associated blanks, positive sample results < the maximum amount detected in the blanks will be qualified as undetected, "U." Sample digestion and moisture content factors will be taken into consideration when qualifying the associated sample data.

Spikes

A 75-125% quality control range will be used to evaluate %Rs if a spiked sample was analyzed. Associated sample results will be qualified as estimated, (J) and (UJ), when the spiked sample %R is <75%. If the %R is >125%, only positive results are impacted and qualified as estimated, (J). Associated nondetects will be qualified as rejected, (R), and positive results will be qualified as estimated, (J), if the spike %R is <30%.

Duplicates

Qualification of sample data based on duplicate precision is left to the professional judgment of the validator. Generally, an aqueous quality control limit of ±20% and a solid quality control limit of ±30% is used to evaluate the relative percent difference (RPD) between the sample and laboratory duplicate results. An aqueous quality control limit of ±30% and a solid quality control limit of ±50% is used to evaluate the RPD between field duplicate results; qualification based on field duplicate imprecision for general parameters is applied to the field duplicate pair only.

Sample Quantitation

All reported sample concentrations should fall within the range of the calibration curve. If samples having detected concentrations > the highest calibration standard were not diluted and reanalyzed, associated sample data will be qualified as estimated, (J).

The validator should verify that sample results were properly quantitated.

8.5.1.5 Deliverables Guidance

The content and format of the data package generated for this method of analysis may vary significantly depending upon the work request.

In addition to any work-request requirements (e.g., data validation memorandum), all laboratory data package quality control summary forms, laboratory summaries of sample results and laboratory method blanks, and COCs must be provided to the Data Validation Quality Assurance Officer (DV/QAO) for quality assurance review.

The validator should ensure that the format of the data validation deliverable is complete and correct and that the validation narrative is free of transcription and typographical errors before submitting all requested items for DV/QAO review.

8.5.2 Nitrate-Nitrite or Nitrite (EPA 300 Series Method 353.2)

8.5.2.1 Applicability

Method 353.2 is a cadmium reduction, automated colorimetric method used to determine the concentration of either nitrite or combined nitrate and nitrite in domestic and industrial effluents, and surface and saline waters. The applicable range of this method is 0.05 to 10 mg/L.

8.5.2.2 Interferences

The presence of suspended matter and high concentrations of oil and grease and some metals (i.e., iron, copper) can create interferences with this method. Samples can be filtered before analysis to minimize the problem of restricted sample flow caused by suspended matter. An organic solvent extraction and the addition of EDTA to samples can eliminate interferences from oil and grease and problematic metals, respectively.

8.5.2.3 Holding Times

Samples should be collected in plastic or glass bottles, preserved with sulfuric acid to a pH <2, and cooled to 4°C.

A 28-day holding time (elapsed time period from sample collection to analysis) is specified for analysis. Chain of Custodies (COCs) and raw data are reviewed to determine if holding times were met for all samples. Positive results and nondetects will be qualified as estimated, (J) and (UJ), respectively, if holding times were exceeded. Gross holding time violations (>2X holding time) will warrant rejection, (R), of nondetects.

8.5.2.4 Quality Control

The method does not specify the analysis of quality control measures (i.e., calibrations, blanks, spikes, etc.). However, if these analyses were performed by the laboratory, the following criteria will be used to evaluate the associated sample data.

Calibration

The calibration curve should be checked for linearity (correlation coefficient curve >0.995). In general, associated sample data are qualified as estimated, (J) and (UJ), when calibration curves are not linear. However, professional judgment should be used to qualify sample data when a nonlinear curve is encountered.

If analyzed, the percent recovery (%R) of a continuing calibration verification (CCV) standard will be evaluated using an 85-115% quality control criteria. If the %R is <85%, associated sample data will be

qualified as estimated. (J) and (UJ). Only positive results in the affected samples will be qualified as estimated, (J), if the CCV %R is >115%.

Blanks

Laboratory method and field quality control blanks, if analyzed, should be evaluated for contamination. Field quality control blanks (field, rinsate, equipment, etc.) can be identified by consulting the COCs. If contamination is noted in the associated blanks, positive sample results < the maximum amount detected in the blanks will be qualified as undetected, (U). Sample digestion and moisture content factors will be taken into consideration when qualifying the associated sample data.

Spikes

If a spiked sample was analyzed, a 75-125% quality control range will be used to evaluate %Rs. Associated sample results will be qualified as estimated, (J) and (UJ), when the spiked sample %R is <75%. If the %R is >125%, only positive results are impacted and qualified as estimated, (J). Associated nondetects will be qualified as rejected, (R), and positive results will be qualified as estimated, (J), if the spike %R is <30%.

Duplicates

Qualification of sample data based on duplicate precision is left to the professional judgment of the validator. Generally, an aqueous quality control limit of ±20% and a solid quality control limit of ±30% is used to evaluate the relative percent difference (RPD) between the sample and laboratory duplicate results. An aqueous quality control limit of ±30% and a solid quality control limit of ±50% is used to evaluate the RPD between field duplicate results; qualification based on field duplicate imprecision for general chemistry parameters is applied to the field duplicate pair only.

Sample Quantitation

All reported sample concentrations should fall within the range of the calibration curve. If samples having detected concentrations the calibration range were not diluted and reanalyzed, associated sample data will be qualified as estimated, (J).

The validator should verify that sample results were properly quantitated.

8.5.2.5 Deliverables Guidance

The content and format of the data package generated for this method of analysis may vary significantly depending upon the work request.

In addition to any work-request requirements (e.g., data validation memorandum), all laboratory data package quality control summary forms, laboratory summaries of sample results and laboratory method blanks, and COCs must be provided to the Data Validation Quality Assurance Officer (DV/QAO) for quality assurance review.

The validator should ensure that the format of the data validation deliverable is complete and correct and that the validation narrative is free of transcription and typographical errors before submitting all requested items for DV/QAO review.

8.6 Phosphorus (EPA 600 Series Method 365.4)

8.6.1 Applicability

Method 365.4 is a colorimetric method used to measure the concentration of total phosphorus in domestic and industrial effluents, and drinking and surface waters. The practical range of determination is 0.01 to 20 mg/L.

8.6.2 Interferences

No interferences noted in the method.

8.6.3 Holding Times

Samples are to be collected in plastic or glass containers, preserved to a pH <2 with sulfuric acid, and cooled to 4°C.

A 28-day holding time between sample collection and analysis is specified. Chain of Custodies (COCs) and raw data are reviewed to determine if holding times were met for all samples. Sample data will be qualified as estimated, (J) and (UJ), if holding times were exceeded. Gross holding time violations (>2X holding time) will warrant rejection, (R), of nondetects.

8.6.4 Quality Control

Quality control analyses (i.e., calibrations, blanks, spikes, etc.) are not specified in Method 365.4. However, if these analyses were performed by the laboratory, the following criteria will be used to evaluate the associated sample data.

8.6.4.1 Calibration

The calibration curve should be checked for linearity (correlation coefficient >0.995). In general, associated sample data are qualified as estimated, (J) and (UJ), when calibration curves are not linear.

If a continuing calibration verification (CCV) standard is analyzed, the percent recovery (%R) of the CCV will be evaluated using 85-115% quality control limits. Associated sample data will be qualified as estimated, (J) and (UJ), if the CCV %R is <85%. Only positive results in the affected samples will be qualified as estimated, (J), if the CCV %R is >115%.

8.6.4.2 Blanks

Laboratory method and field quality control blanks, if analyzed, should be evaluated for contamination. Field quality control blanks (field, rinsate, equipment, etc.) can be identified by consulting the COCs. If contamination is noted in the associated blanks, positive sample results < the maximum amount detected in the blanks will be qualified as undetected, (U). Sample digestion and moisture content factors will be taken into consideration when qualifying the associated sample data.

8.6.4.3 Spikes

If a spiked sample is analyzed, a 75-125% quality control range will be used to evaluate the spike %R. Associated sample data will be qualified as estimated, (J) and (UJ), when the spiked sample %R is <75%. If the %R is >125%, only positive results are impacted and qualified as estimated, (J). If a spike

%R is <30%, associated nondetects will be qualified as rejected, (R), and positive results will be qualified as estimated, (J).

8.6.4.4 Duplicates

Qualification of sample data based on duplicate precision is left to the professional judgment of the validator. Generally, an aqueous quality control limit of ±20% and a solid quality control limit of ±30% is used to evaluate the relative percent difference (RPD) between the sample and laboratory duplicate results. An aqueous quality control limit of ±30% and a solid quality control limit of ±50% is used to evaluate the RPD between field duplicate results; qualification based on field duplicate imprecision for general chemistry parameters is applied to the field duplicate pair only.

8.6.4.5 Sample Quantitation

All reported sample concentrations should fall within the range of the calibration curve. If samples having detected concentrations > the highest calibration standard were not diluted and reanalyzed, associated sample data will be qualified as estimated, (J).

The validator should verify that sample results were properly quantitated.

8.6.5 Deliverables Guidance

The content and format of the data package generated for phosphorus analysis may vary significantly depending upon the work request.

In addition to any work-request requirements (e.g., data validation memorandum), all laboratory data package quality control summary forms, laboratory summaries of sample results and laboratory method blanks, and COCs must be provided to the Data Validation Quality Assurance Officer (DV/QAO) for quality assurance review.

The validator should ensure that the format of the data validation deliverable is complete and correct and that the validation narrative is free of transcription and typographical errors before submitting all requested items for DV/QAO review.

8.7 Sulfate (EPA 600 Series Method 375.4)

8.7.1 Applicability

Method 375.4 is used to determine the concentration of sulfate in domestic and industrial effluents, and drinking and surface waters. Although all sulfate concentration ranges can be measured by this turbidimetric method, a sample aliquot should not contain more than 40 mg/L of sulfate since the suspensions lose stability at concentrations >50 mg/L. The minimum detection limit for this method is 1 mg/L.

8.7.2 Interferences

Interferences are noted from silica concentrations >500 mg/L, suspended matter, and color in samples.

8.7.3 Holding Times

Samples should be collected in plastic or glass bottles and cooled to 4°C. No preservative is necessary.

Holding time, which is specified as 28 days for this method, is defined as the elapsed time period from sample collection to analysis. Chain of Custodies (COCs) and raw data are reviewed to determine if holding times were met for all samples. Sample data will be qualified as estimated, (J) and (UJ), if holding times were exceeded. Gross holding time violations (>2X holding time) will warrant rejection, (R), of nondetects.

8.7.4 Quality Control

8.7.4.1 Calibration

The raw data will be reviewed to ensure that the following calibration requirements have been met:

- The calibration curve used for sample quantitation should consist of standards at increments of 5 mg/L in the 0 to 40 mg/L sulfate range.
- A continuing calibration verification (CCV) standard is analyzed every 3 or 4 samples.

Associated sample data will be qualified as estimated, (J) and (UJ), if the above requirements have not been met.

The calibration curve should be checked for linearity (correlation coefficient >0.995). In general, sample results associated with nonlinear calibration curves are qualified as estimated, (J) and (UJ). Professional judgment should be used to qualify sample data in instances where sample results fall outside a linear portion of the calibration curve.

The percent recovery (%R) of the CCV should be within an 85-115% quality control range. Associated sample data will be qualified as estimated, (J) and (UJ), if the CCV %R is <85%. Only positive results in the affected samples will be qualified as estimated, (J), if the CCV %R is >115%.

8.7.4.2 Blanks

Laboratory method blanks (other than the blank used for the calibration curve) should be analyzed and evaluated for contamination. The COCs should be consulted to determine if any field quality control blanks (field, rinsate, equipment, etc.) are associated with the samples. If contamination is noted in the associated blanks, positive sample results < the maximum amount detected in the blanks will be qualified as undetected, (U). Sample digestion and moisture content factors will be taken into consideration when qualifying the associated sample data.

8.7.4.3 Spikes/Duplicates

The method does not require the analysis of spikes or duplicates. However, if these quality control (QC) analyses were performed by the laboratory the following criteria will be used to evaluate the associated sample data.

QC Parameter	Control Limits
Spike %R	75 - 125%
Duplicate RPD	±20% for waters or ±30% for solids

If the spike %R is <75%, the associated sample data will be qualified as estimated, (J) and (UJ). Only positive results will be qualified as estimated, (J), when the spike %R is >125%. Associated nondetects will be qualified as rejected, (R), and positive results will be qualified as estimated, (J), in the event that the spike %R is <30%.

Generally, associated sample results are qualified as estimated, (J) and (UJ), if the relative percent difference (RPD) between the sample and laboratory duplicate results did not meet the quality control criterion. However, in some cases, qualification of sample data based on duplicate precision is left to the professional judgment of the validator. An aqueous quality control limit of ±30% and a solid quality control limit of ±50% is used to evaluate the RPD between field duplicate results; qualification based on field duplicate imprecision for general chemistry parameters is applied to the field duplicate pair only.

8.7.4.4 Sample Quantitation

All reported sample concentrations should fall within the range of the calibration curve. If samples having detected concentrations > the highest calibration standard were not diluted and reanalyzed, the associated sample data will be qualified as estimated, (J).

The validator will verify that sample results were correctly quantitated.

8.7.5 Deliverables Guidance

The content and format of the data package generated for sulfate analysis may vary significantly depending upon the work request.

In addition to any work-request requirements (e.g., data validation memorandum), all laboratory data package quality control summary forms, laboratory summaries of sample results and laboratory method blanks, and COCs must be provided to the Data Validation Quality Assurance Officer (DV/QAO) for quality assurance review.

The validator should ensure that the format of the data validation deliverable is complete and correct and that the validation narrative is free of transcription and typographical errors before submitting all requested items for DV/QAO review.

8.8 Sulfides (EPA SW-846 Method 9030)

8.8.1 Applicability

Method 9030 is iodometric method used to determine the concentration of total and dissolved sulfides in excess of 1 mg/L in drinking, surface and saline waters. Acid-insoluble sulfides, such as copper sulfide, can not be measured by this titrimetric method.

8.8.2 Interferences

A main source of interference for this method is the reduction of iodine by various chemicals (thiosulfate, sulfite, and organic compounds). Samples are treated at collection with zinc acetate and sodium hydroxide to minimize interferences.

In addition, sulfides are susceptible to volatilization and reaction with oxygen which can form unmeasurable states of sulfides. Aeration should be minimized during sample collection.

8.8.3 Holding Times

Samples are preserved with zinc acetate, treated with sodium hydroxide to a pH >9, and cooled to 4°C.

Holding time is defined as the elapsed time period from sample collection to analysis. The following holding times apply to sulfide analyses:

- Unpreserved samples: Immediate analysis
- Preserved samples: 7 days

Chain of Custodies (COCs) and raw data are reviewed to determine if holding times were met for all samples. In the event that holding times are exceeded, positive results and nondetects will be qualified as estimated, (J) and (UJ), respectively. Gross holding time violations (>2X holding time) will warrant rejection, (R), of nondetects.

8.8.4 Quality Control

8.8.4.1 Calibration

The raw data will be reviewed to ensure that the following calibration requirements have been met:

- The calibration curve should consist of a blank and three standards (at a minimum).
- A new calibration curve should be performed for every hour of continuous sample analysis.
- A continuing calibration verification (CCV) standard should be analyzed every 15 samples.

Associated sample data will be qualified as estimated, (J) and (UJ), if the above requirements have not been met.

The calibration curve should be checked for linearity. Generally, associated sample data is qualified as estimated, (J) and (UJ), if the calibration curve correlation coefficient is <0.995. Professional judgment should be used to qualify sample data in cases when sample results fall outside a linear portion of the calibration curve.

An 85-115% quality control range will be used to evaluate the percent recovery (%R) of a CCV. Associated sample data will be qualified as estimated, (J) and (UJ), if the CCV %R is <85%. Only positive results in the affected samples will be qualified as estimated, (J), if the CCV %R is >115%.

8.8.4.2 Blanks

At a minimum, one laboratory method blank (other than the blank used for the calibration curve) should be analyzed per sample batch (maximum of 20 samples). The COCs should be consulted to determine if any field quality control blanks (field, rinsate, equipment, etc.) are associated with the samples. If contamination is noted in the associated blanks, positive sample results < the maximum amount detected in the blanks will be qualified as undetected, (U). Sample dilution and moisture content factors will be taken into consideration when qualifying the associated sample data.

8.8.4.3 Spikes/Duplicates

A spiked sample and spiked duplicate sample should be analyzed for every 10 samples. If a spike or duplicate spike %R is <75%, associated sample data will be qualified as estimated, (J) and (UJ). If the %R is >125%, only positive results are impacted and qualified as estimated, (J). If a spike %R is <30%, associated nondetects will be qualified as rejected, (R), and positive results will be qualified as estimated, (J).

Qualification of sample data based on duplicate precision is left to the professional judgment of the validator. Generally, a ±20% aqueous quality control limit and a ±30% solid quality control limit are used to evaluate the relative percent difference (RPD) between the spiked sample and spiked duplicate sample results. An aqueous quality control limit of ±30% and a solid quality control limit of ±50% is used to evaluate the RPD between field duplicate results; qualification based on field duplicate imprecision for general chemistry parameters is applied to the field duplicate pair only.

8.8.4.4 Sample Quantitation

All reported sample concentrations should fall within the range of the calibration curve. If samples having detected concentrations > the highest calibration standard were not diluted and reanalyzed, the associated sample data will be qualified as estimated, (J).

The validator will verify that sample results were properly quantitated.

8.8.5 Deliverables Guidance

The content and format of the data package generated for sulfide analysis may vary significantly depending upon the work request.

In addition to any work-request requirements (e.g., data validation memorandum), all laboratory data package quality control summary forms, laboratory summaries of sample results and laboratory method blanks, and COCs must be provided to the Data Validation Quality Assurance Officer (DV/QAO) for quality assurance review.

The validator should ensure that the format of the data validation deliverable is complete and correct and that the validation narrative is free of transcription and typographical errors before submitting all requested items for DV/QAO review.

8.9 Total Suspended Solids (EPA 600 Series Method 160.2)

8.9.1 Applicability

Method 160.2 is a gravimetric method used to determined nonfilterable residue (total suspended solids) in domestic and industrial wastes, and drinking, surface and saline waters. The optimum range of total suspended solids (TSS) determined by this method is 4 to 20,000 mg/L.

8.9.2 Interferences

Requirements for appartities and analytical techniques are specified in the method to eliminate or reduce procedural interferences. Saline waters, brines, and samples high in dissolved solids must be analyzed carefully to minimize elevated sample results.

8.9.3 Holding Times

Samples should be collected in plastic or glass containers and cooled to 4°C to reduce microbiological decomposition of solids. No preservative is needed.

Holding time is defined as the elapsed time period from sample collection to analysis. Chain of Custodies (COCs) and sample data are reviewed to determine if the 7-day holding time required by this method was met for all samples. Positive results and nondetects will be qualified as estimated, (J) and (UJ), respectively, if holding times were exceeded. Gross holding time violations (>2X holding time) will warrant rejection, (R), of nondetects.

8.9.4 Quality Control

Method 160.2 does not require specific quality control analyses (i.e., blanks, duplicates, etc.). However, if these analyses were performed by the laboratory, the following criteria will be used to evaluate the associated sample data.

8.9.4.1 Verification

If a verification standard is analyzed, the percent recovery (%R) of the standard should be within a quality control range of 90-110%. Associated sample data will be qualified as estimated, (J) and (UJ), if the verification %R is <90%. Positive sample results will be qualified as estimated, (J), if the verification %R is >110%; nondetects are not impacted.

8.9.4.2 Blanks

Laboratory method and field quality control blanks, if analyzed, should be evaluated for contamination. Field quality control blanks (field, rinsate, equipment, etc.) can be identified by consulting the COCs. Positive sample results for TSS < the maximum amount detected in the blanks will be qualified as undetected, (U).

8.9.4.3 Duplicates

Qualification of sample data based on duplicate precision is left to the professional judgment of the validator. Generally, a quality control limit of ±20% is used to evaluate the relative percent difference (RPD) between the sample and duplicate results. An aqueous quality control limit of ±30% and a solid quality control limit of ±50% is used to evaluate the RPD between field duplicate results; qualification

based on field duplicate imprecision for general chemistry parameters is applied to the field duplicate pair only.

8.9.4.4 Sample Quantitation

The validator should verify that sample results were calculated accurately. The following equation is used to calculate TSS:

$$TSS\ (mg/L) = \frac{wt_{crucible+residue} - wt_{crucible}}{vol_{sample\ aliquot\ used}} \times \frac{1{,}000\ mL}{1\ L}$$

where: wt = weight (mg)
vol = volume (mL)

8.9.5 Deliverables Guidance

In addition to any work-request requirements (e.g., data validation memorandum), all laboratory data package quality control summary forms, laboratory summaries of sample results and laboratory method blanks, and COCs must be provided to the Data Validation Quality Assurance Officer (DV/QAO) for quality assurance review.

The validator should ensure that the format of the data validation deliverable is complete and correct and that the validation narrative is free of transcription and typographical errors before submitting all requested items for DV/QAO review.

8.10 Total Dissolved Solids (EPA 600 Series Method 160.1)

8.10.1 Applicability

Method 160.1 is a gravimetric method used to determined filterable residue (total dissolved solids) in domestic and industrial wastes, and drinking, surface and saline waters. The optimum range of total dissolved solids (TDS) determined by this method is 10 to 20,000 mg/L.

8.10.2 Interferences

Interferences during the drying stages of the analytical procedure are observed. Samples containing high concentrations of calcium, magnesium, chloride, sulfate and bicarbonate may require longer desiccation and drying times to minimize interferences. Total residue should be limited to 200 mg to prevent entrapment of water in the evaporating dish.

8.10.3 Holding Times

Samples should be collected in plastic or glass containers and cooled to 4°C to reduce microbiological decomposition of solid matter. No preservative is needed.

Holding time is defined as the elapsed time period from sample collection to analysis. A 7-day holding time is specified by the method. Chain of Custodies (COCs) and raw data are reviewed to determine if holding times were met for all samples. Positive results and nondetects will be qualified as estimated,

(J) and (UJ), respectively, if holding times were exceeded. Gross holding time violations (>2X holding time) will warrant rejection, (R), of nondetects.

8.10.4 Quality Control

Method 160.1 does not require specific quality control analyses (i.e., blanks, duplicates, etc.). However, if these analyses were performed by the laboratory, the following criteria will be used to evaluate the associated sample data.

8.10.4.1 Verification

If a verification standard is analyzed, the percent recovery (%R) of the standard should be within a quality control range of 90-110%. Associated sample data will be qualified as estimated, (J) and (UJ), if the verification %R is <90%. Positive sample results will be qualified as estimated, (J), if the verification %R is >110%; nondetects are not impacted.

8.10.4.2 Blanks

Laboratory method and field quality control blanks, if analyzed, should be evaluated for contamination. Field quality control blanks (field, rinsate, equipment, etc.) can be identified by reviewing the COCs. Positive sample results for TDS < the maximum amount detected in the blanks will be qualified as undetected, (U).

8.10.4.3 Duplicates

Qualification of sample data based on duplicate precision is left to the professional judgment of the validator. Generally, a quality control limit of ±20% is used to evaluate the relative percent difference (RPD) between the sample and duplicate results. An aqueous quality control limit of ±30% and a solid quality control limit of ±50% is used to evaluate the RPD between field duplicate results; qualification based on field duplicate imprecision for general chemistry parameters is applied to the field duplicate pair only.

8.10.4.4 Sample Quantitation

The validator should verify that sample results were calculated accurately. The following equation is used to calculate TDS:

$$TDS\ (mg/L)\ x\ \frac{wt_{dish+residue} - wt_{dish}}{vol_{sample\ aliquot\ used}}\ x\ \frac{1{,}000\ mL}{1\ L}$$

where: wt = weight (mg)
vol = volume (ml)

8.10.5 Deliverables Guidance

In addition to any work-request requirements (e.g., data validation memorandum), all laboratory data package quality control summary forms, laboratory summaries of sample results and laboratory method blanks, and COCs must be provided to the Data Validation Quality Assurance Officer (DV/QAO) for quality assurance review.

The validator should ensure that the format of the data validation deliverable is complete and correct and that the validation narrative is free of transcription and typographical errors before submitting all requested items for DV/QAO review.

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1.0 PURPOSE

The purpose of this document is to specify a consistent procedure for the quality assurance review of electronic and hard copy data bases. This SOP outlines the requirements for establishment of a Data Base Record File, Quality Assurance review procedures, and documentation of the Quality Assurance Review Process.

2.0 SCOPE

The methods described in this Standard Operating Procedure (SOP) shall be used consistently for all projects managed by personnel located in the Northeast Region of Brown & Root Environmental (Pittsburgh, PA; Wayne, PA; Wilmington, MA; and Holt, MI), for any large contracts managed by the Northeast Region (e.g., NORTHDIV CLEAN, SOUTHDIV CLEAN, ARCS I, ARCS III, etc.), and by other offices of Brown & Root Environmental at the discretion of the Project Manager. Smaller projects (as determined by Project Manager) are outside the scope of this SOP.

3.0 GLOSSARY

Chain-of-Custody Form - A Chain-of-Custody Form is a printed form that accompanies a sample or a group of samples from the time of sample collection to the laboratory. The Chain-of-Custody Form is retained with the samples during transfer of samples from one custodian to another. The Chain-of-Custody Form is a controlled document that becomes part of the permanent project file. Chain-of-Custody and field documentation requirements are addressed in SOP SA-6.1.

Electronic Data Base - A database provided on a 5.25" or 3.5" diskette or a laser disk. Such electronic data bases will generally be prepared using public domain software such as DBase, RBase, Oracle, Visual FoxPro, Microsoft Access, Paradox, etc.

Hardcopy Database - A printed copy of a data base prepared using the software discussed under the definition of an electronic data base.

Sample Tracking Summary - A printed record of sample information including the date the samples were collected, the number of samples collected, the sample matrix, the laboratory to which the samples were shipped, the associated analytical requirements for the samples, the date the analytical data were received from the laboratory, and the date that validation of the sample data was completed.

4.0 RESPONSIBILITIES

Database Records Custodian - It shall be the responsibility of the Database Records Custodian to update and file the Sample Tracking Summaries for all active projects on a weekly basis. It shall be the responsibility of the Database Records Custodian to ensure that the most recent copies of the Sample Tracking Summaries are placed in the Database Records file. It shall be the responsibility of the Database Records Custodian to ensure that a copy of all validation deliverables is provided to the Project Manager (for placement in the project file). It shall be the responsibility of the Database Records Custodian to ensure that photocopies of all validation deliverables and historical data and reports (as applicable) are placed in the Database Records file.

Data Validation Coordinator - It shall be the responsibility of the Data Validation Coordinator (or designee) to ensure that the Sample Tracking Summaries are maintained by the Database Records Custodian. It shall be the responsibility of the Data Validation Coordinator (or designee) to ensure that

photocopies of all data validation deliverables are placed in the applicable Database Records file by the Database Records Custodian.

Earth Sciences Department Manager - It shall be the responsibility of the Earth Sciences Department Manager (or equivalent) to ensure that all field personnel are familiar with the requirements of this Standard Operating Procedure (specifically Section 5.5).

Field Operations Leader - It shall be the responsibility of the Field Operations Leader of each project to ensure that all field technicians or sampling personnel are thoroughly familiar with this SOP, specifically regarding provision of the Chain-of-Custody Forms to the Database Records Custodian. Other responsibilities of the Field Operations Leader are described in Sections 5.4 and 5.5.

Information Management Systems Manager - It shall be the responsibility of the Information Management Systems Manager to ensure that copies of original electronic deliverables (diskettes) are placed in both the project files and the Database Records File. It shall be the responsibility of the Information Management Systems Manager (or designee) to verify the completeness of the database (presence of all samples) in both electronic and hardcopy form in the Database Records File. It shall be the responsibility of the Information Management Systems Manager (IMSM) to ensure that Quality Assurance Reviews are completed and are attested to by Quality Assurance Reviewers. It shall be the responsibility of the Information Management Systems Manager to ensure that records of the Quality Assurance review process are placed in the Database Records File. It shall be the responsibility of the Information Management Systems Manager to ensure that both electronic and hardcopy forms of the final data base are placed in both the project and the Database Record File. It shall be the responsibility of the Information Management Systems Manager to ensure that data validation qualifiers are entered in the data base.

Furthermore, it shall be the responsibility of the IMSM to participate in project planning at the request of the Project Manager, specifically with respect to the generation of level of effort and schedule estimates. To support the project planning effort, the IMSM shall provide a copy of the database checklist included as Attachment A to the project manager. It shall be the responsibility of the IMSM to generate level of effort and budget estimates at the time database support is requested if a budget does not exist at the time of the request. The database checklist shall be provided to the Project Manager at the time of any such requests. It shall be the responsibility of the IMSM to notify the Project Manager of any anticipated level of effort overruns or schedule noncompliances as soon as such problems arise along with full justification for any deviations from the budget estimates (provided they were generated by the IMSM). It shall be the responsibility of the IMSM to document an changes to the scope of work dictated by the Project Manager, along with an estimate of the impact of the change on the level of effort and the schedule.

Program/Department Managers - It shall be the responsibility of the Department and/or Program Managers (or designees) to inform their respective department's Project Managers of the existence and requirements of this SOP.

Project Manager - It shall be the responsibility of each Project Manager to determine the applicability of this SOP based on: (1) program-specific requirements, and (2) project size and objectives. It shall be the responsibility of the Project Manager (or designee) to ensure that the Field Operations Leader is familiar with the requirements regarding Chain-of-Custody Form provision to the Data Base Records Custodian. It shall be the responsibility of the Project Manager (or designee) to determine which, if any, historical data are relevant and to ensure that such data (including all relevant information such as originating entity, sample locations, sampling dates, etc.) are provided to the Database Records Custodian for inclusion in the Database Records File. It shall be the responsibility of the Project Manager

to obtain project planning input regarding the level of effort and schedule from the Information Management System Manager. It shall be the responsibility of the Project Manager to complete the database checklist (Attachment A) to support the level of effort and schedule estimate and to facilitate database preparation and subroutine execution.

Risk Assessment Department Manager - It shall be the responsibility of the Risk Assessment Department Manager to monitor compliance with this Standard Operating Procedure, to modify this SOP as necessary, and to take corrective action if necessary. Monitoring of the process shall be completed on a quarterly basis.

Quality Assurance Reviewers - It shall be the responsibility of the Quality Assurance Reviewers to verify the completeness of the sample results via review of the Chain-of-Custody Forms and Sample Tracking Summaries. It shall be the responsibility of the Quality Assurance Reviewers to ensure the correctness of the data base via direct comparison of the hardcopy printout of the data base and the hardcopy summaries of the original analytical data (e.g., Form Is provided in data validation deliverables). Correctness includes the presence of all relevant sample information (all sample information fields), agreement of the laboratory and database analytical results, and the presence of data validation qualifiers.

Quality Manager - It shall be the responsibility of the Quality Manager to monitor compliance with this Standard Operating Procedure via routine audits.

5.0 PROCEDURES

5.1 Introduction

Verification of the accuracy and completeness of an electronic data base can only be accomplished via comparison of a hardcopy of the database with hardcopy of all relevant sample information. The primary purposes of this SOP are to ensure that 1) all necessary hardcopy information is readily available to Quality Assurance Reviewers; 2) ensure that the Quality Assurance review is completed in a consistent and comprehensive manner, and; 3) ensure that documentation of the Quality Assurance review process is maintained in the project file.

5.2 File Establishment

A Database Record file shall be established for a specific project at the discretion of the Project Manager. Initiation of the filing procedure will commence upon receipt of the first set of Chain-of-Custody documents from a Field Operations Leader or sampling technician. The Database Record Custodian shall establish a project-specific file for placement in the Database Record File and will ensure that no information is removed from the file without the use of an "outcard." Each file in the Database Record File shall consist of standard components placed in the file as the project progresses. Each file shall be clearly labeled with the project number, which shall be placed on the front of the file drawer and on each and every hanging file folder relevant to the project. The following constitute the minimum components of a completed file:

- File Index
- Electronic Deliverables
- Sample Tracking Forms
- Chain-of-Custody Forms
- Data Validation Letters
- Historical Data (if applicable)

- Final Electronic Data Base
- Final Hardcopy Data Base
- Quality Assurance Records

Each file in the Database Record File must have an index summarizing the contents of the file. It shall be the responsibility of the Database Record Custodian to maintain the file index such that it is always current. The file index should specifically list the content of each of the subsections of the file and must also summarize the Sample Delivery Group numbers and samples and associated analyses associated with each Sample Delivery Group. Additional file requirements as well as database quality assurance procedures are summarized in the remainder of this section.

It should be noted that the majority of this "duplicate" file (i.e., the data validation deliverables) are already maintained by the Chemistry/Toxicology/Risk Assessment Department. Therefore, inclusion of the additional information outlined in this SOP is inconsequential from a cost perspective.

5.3 Electronic Deliverables

The format of electronic deliverables shall be specified in the laboratory procurement specification and shall be provided by the laboratory. The integrity of all original electronic data deliverables shall be maintained. This shall be accomplished via the generation of copies of each electronic deliverable provided by the laboratory. The original electronic deliverable shall be provided to the project manager for inclusion in the project file. A copy of the original electronic deliverable shall be placed in the Database Record File. The second copy shall be maintained by the Information Management Systems Manager (or designee) to be used as a working copy. The original and Database Record File copy of the electronic deliverable shall be converted to read only files by the Information Management Systems Manager or designee.

5.4 Sample Tracking Forms

Updated versions of the sample tracking form for each relevant project shall be maintained by the Database Record Custodian. The Sample Tracking Forms shall be updated any time additional Chain-of-Custody Forms are received from a Field Operations Leader or sampling technician, or at any time that data are received from a laboratory, or at any time that validation of a given data package (sample delivery group) is completed. The Data Validation Coordinator shall inform the Database Record Custodian of the receipt of any data packages from the laboratory and of completion of validation of a given data package to facilitate updating of the Sample Tracking Form. The Database Record Custodian shall place a revised copy of the Sample Tracking Form in the Database Record File anytime it has been updated. Copies of the updated Sample Tracking Form shall also be provided to the project manager to apprise the project manager of sample package receipt, completion of validation, etc.

5.5 Chain-of-Custody Forms

The Chain-of-Custody Forms for all sampling efforts will be used as the basis for (1) updating the Sample Tracking Form, and (2) confirming that all required samples and associated analyses have been completed. It shall be the responsibility of the Field Operations Leader (or sample technician) to provide a photocopy of all Chain-of-Custody Forms to the Database Record Custodian immediately upon completion of a sampling effort. The Database Record Custodian shall then place the copies of the Chain-of-Custody Form(s) in the Database Record File. Upon receipt of a sample data package from an analytical laboratory, the Data Validation Coordinator shall provide a copy of the laboratory Chain-of-Custody Form to the Database Record Custodian. The Database Record Custodian shall use this copy to update the Sample Tracking Summary and shall place the copy of the laboratory-provided Chain-of-

Custody Form in the Database Record File. The photocopy of the laboratory-provided Chain-of Custody Form shall be stapled to the previously filed field copy. Upon receipt of all analytical data, two copies of the Chain-of-Custody will therefore be in the file. Review of the Chain-of-Custody Forms will therefore be a simple mechanism to determine if all data have been received. Chain-of-Custody is addressed in SOP SA-6.1.

5.6 Data Validation Letters

All data validation deliverables (or raw data summaries if validation is not conducted) shall be provided for inclusion in both the Database Record File and the project file. If USEPA regional- or client-specific requirements are such that Form Is (or similar analytical results) need not be provided with the validation deliverable, copies of such results must be appended to the deliverable. It is preferable, although not essential that the validation qualifiers be hand-written directly on the data summary forms. The data validation deliverables (and attendant analytical summaries) will provide the basis for direct comparison of the database printout and the raw data and qualifiers.

5.7 Historical Data

At the direction of the Project Manager, historical data may also be included in a project-specific analytical data base. In the event that historical data are germane to the project, hardcopy of the historical data must be included in the Database Record File. Historical data may be maintained in the form of final reports or as raw data. The information contained in the historical data file must be sufficient to identify its origin, its collection date, the sample location, the matrix, and any and all other pertinent information. All available analytical data, Chain-of-Custody Forms, boring logs, well construction logs, sample location maps, shall be photocopied by the Project Manager (or designee) and placed in one or more 3-ring binders. All information shall be organized chronologically by matrix. It shall be the responsibility of the Project Manager (or designee) to ensure that all inconsistencies between analytical data, Chain-of-Custody Forms, boring logs, sample log sheets, and field logbooks are identified and corrected. The Project Manager (or designee) shall decide which nomenclature is appropriate and edit, initial and date all relevant forms. Data entry may only be performed on information that has undergone the aforementioned editing process, thereby having a direct correlation between hardcopy information and what will become the electronic database.

Sample spreadsheets shall be generated for all samples previously collected at the site (see Attachment B). The sample spreadsheets shall have specific references to all source documents. If many historical reports exist, the Project Manager shall maintain an organized library with outcards for tracking purposes.

5.8 Final Electronic Data Base

The final electronic database shall be filed in both the project and Database Record Files on diskettes, tapes, laser disks, etc. The final files shall be toggled as read only files. It shall be the responsibility of the Information Management Systems Manager to ensure that the final electronic files are provided to both the project and Database Record Files. The final electronic database shall be clearly labeled with the Site Name, Project Number, and Project Title, and shall indicate that the diskette, tape, or CD ROM is the final database including the completion date. An example is as follows:

MCAS Cherry Point
Project Number
RCRA Facility Investigation
Operable Unit 3
Final Electronic Database
Completed 06/15/96

5.9 Final Hardcopy Data Base

The final hardcopy data base shall be filed in both the project and Database Record Files as legible, reproducible printouts. The final database printouts shall be clearly identified as such on the cover page(s). It shall be the responsibility of the Information Management Systems Manager to ensure that the final hardcopy of the database are provided to both the project and Database Record Files.

The final hardcopy database shall be clearly labeled with the Site Name, Project Number, and Project Title, and shall indicate that the hardcopy is the final database including the completion date. An example is as follows:

MCAS Cherry Point
Project Number
RCRA Facility Investigation
Operable Unit 3
Final Hardcopy Database
Completed 06/15/96

The final hardcopy database must also clearly display an attestation that Quality Assurance review has been completed. Specifically, the signature of the Information Management Systems Manager (or designee must appear on the final hardcopy. The date of the final review and an attestation that the final review was completed must be provided. The attestation shall take the following form:

"Final Database Quality Assurance Review Completed By: _____ on __/__/__."

In addition, the final hardcopy database should reference the electronic database via reference to the medium used for storage (e.g, diskettes 1 through 3), and the final file names for all components of the database.

5.10 Quality Assurance Procedures

The Information Management System Manager (or designee) shall assign one or more individuals (Quality Assurance Reviewers) to complete Quality Assurance Review of the data base, either in its entirety or on an Sample Delivery Group-specific basis. Such review shall focus on the "accuracy" of the analytical results (do the numerical values agree with the results as provided by the laboratory), have the data validation qualifiers (if applicable) been entered and are they correct (i.e., do they agree with the qualifiers contained in the data validation letters), are all requested analytical results present in the Sample Delivery Group(s) or the database, are all required data base fields provided (e.g., northing, easting, sample depth, sampling date, matrix, site name, operable unit, total versus dissolved metals, sampling round, descriptive information such as "upstream", "downstream", "composite", and any other relevant information deemed appropriate by the Project Manager), are units provided and are they the correct units, are any fractions that were not analyzed in specific samples identified as such, does the data base indicate that validation has been completed, are all validation qualifiers defined in footnotes, are the results for duplicate samples and the average values for duplicates provided if required on a project-

specific basis, is the hardcopy database legible and suitable for photocopying if necessary, are quantitation or method detection limits provided for nondetected analytes, are the sample results segregated by matrix, are the Quality Control sample results provided. Additional requirements may be specified by the Project Manager during database task commencement. Upon completion of such Quality Assurance review, the Quality Assurance Reviewer shall attest that the review has been completed via the following statements:

"Intermediate Database QA Review Completed By: _____ on __/__/__."

"Data correct as provided in the attached summary." or

"Data incorrect as provided in the attached summary. Submitted for correction."

Copies of such intermediate database reviews shall be placed in the Database Record File. Upon completion of the intermediate database review, the database shall be returned for correction (if necessary) by the ISMS (or designee), and shall undergo an additional Quality Assurance review to ensure that all necessary modifications have been made. Upon satisfactory completion of the revision process, the final attestation discussed in Section 5.9 must be printed on the final data base.

5.11 Quality Assurance Records

Quality Assurance records for the Database Record File include the intermediate and final attestation copies discussed in the preceding two sections.

6.0 RECORDS

Records regarding database preparation and quality assurance review include all those identified in the previous section. Upon completion of the database task, records from the file will be forwarded to the Project Manager for inclusion in the project file, or will be placed in bankers boxes (or equivalent) for storage. The final records for storage shall include the following minimum information on placards placed on both the top and end of the storage box:

Database Record File
PROJECT NUMBER: ____
SITE NAME: _____
DATE FILED: __/__/__
SUMMARY OF CONTENTS ENCLOSED
BOX _ OF _

Project- or program-specific record keeping requirements shall take precedence over the record keeping requirements of this SOP.

ATTACHMENT A

DATABASE PLANNING CHECKLIST

PROJECT NAME _____ **PROJECT NUMBER** _____

PROJECT MANAGER _____ **PLANNING DATE** _____

1. Provide a general description of the project (regulatory authority, media to be samples, approximate number of samples by media, analyses by media, data evaluation tasks required):

_____
_____
_____
_____
_____

2. Provide a general description of the sample nomenclature that will be used for samples collected by Brown & Root Environmental:

_____
_____
_____
_____

3. Will historical data be entered in the database? Yes No

4. Will historical data be used to define the nature and extent of contamination? Yes No

5. Will historical data be used for risk assessment purposes? Yes No

6. How much historical data exists (i.e., number of samples by matrix, analysis by matrix)?

_____
_____
_____
_____

7. In what format will the historical data be provided? Hardcopy Electronic

8. If historical data are in electronic form, what software was used and what is the format?

_____
_____
_____
_____

9. If historical data are in hardcopy form, will Form I's, summary tables, or reports be provided? Copies of historical data will be necessary to generate a budget estimate.

_____
_____
_____
_____

10. Will Quality Assurance review of historical data be necessary? Yes No

ATTACHMENT A (Continued)
DATABASE PLANNING CHECKLIST

11. If Quality Assurance review of historical data is necessary, describe the scope of the Quality Assurance review:

_____
_____
_____
_____

12. Will a GIS database be necessary for the project? Yes No

    If so, Design Engineering should be consulted for a budget estimate.

13. What nomenclature has been (will be) used to identify field duplicate samples?

_____
_____
_____
_____

14. Will field duplicate results be averaged and presented as one result in the data base? Will they be presented as distinct results, or will both the average and the distinct results be presented?

_____
_____
_____
_____

15. How will the average value for duplicate samples be determined on a matrix-specific basis?

_____
_____
_____
_____

16. Are any unvalidated data to be included in the database? Yes No
17. Will unvalidated data be used for defining the nature and extent of contamination? Yes No
18. Will unvalidated data be used for risk assessment purposes? Yes No
19. Are any field screening data to be included in the database? Yes No
20. Will field screening data be used for defining the nature and extent of contamination? Yes No
21. Will field screening data be used for risk assessment purposes? Yes No
22. Will statistical correlation of laboratory and field screening data be necessary? Yes No
23. If a correlation exists between field screening and laboratory data, will the results of regression analysis be used to define nature and extent? Yes No
24. If a correlation exists between field screening and laboratory data, will the results of regression analysis be used to support the risk assessment? Yes No
25. Will field parameters be included in the database (e.g., pH, conductance, temperature)? Yes No
26. Will statistical correlations be necessary for TCLP versus RAS/SAS data? Yes No

ATTACHMENT A (Continued)
DATABASE PLANNING CHECKLIST

27. Will statistical correlations be necessary for filtered versus unfiltered samples? Yes No

28. Will any other statistical correlations be necessary? Yes No

29. Are there wells that have been screened in different aquifers? Yes No

30. Will data for various aquifers be segregated by depth? Yes No

31. Can the sample nomenclature system be used to identify wells in different aquifers? Yes No

32. Will samples from other matrices (soil, sediment, or surface water) be segregated by depth? Yes No

33. Can the sample nomenclature system be used to identify depth-specificity? Yes No

34. Have any removal actions be performed at the site? Yes No

    If removal actions have been performed, plan and cross-sectional views reflecting the extent of the removal action must be provided.

35. Will any composite sample results be included in the database? Yes No

36. If composite samples are included how will they be used for the nature and extent of contamination?

    _____
    _____
    _____

37. If composite samples are included how will they be used for the risk assessment?

    _____
    _____
    _____

38. Will the site be segregated into Areas of Concern, Solid Waste Management Units, etc? Yes No

39. Is the sample nomenclature adequate for such segregation? Yes No

    If the sample nomenclature is inadequate for assigning samples to an AOC or SWMU, the Project Manager or designee must provide a base map of tabular summary clearly delineating the relationship between each sample and each AOC/SWMU.

40. Were any temporal samples collected (e.g., quarterly sampling of wells)? Yes No

41. If temporal samples were collected, how will they be used to define the nature and extent of contamination?

    _____
    _____
    _____

42. If temporal samples were collected, how will they be used to support the risk assessment?

    _____
    _____
    _____

43. Are State, Federal, or Regional criteria to be included in data summary tables? Yes No

ATTACHMENT A (Continued)
DATABASE PLANNING CHECKLIST

44. Identify the criteria that must be presented in the summary tables.

_____
_____
_____

45. Will State, Federal, or Regional criteria be used to select COPCs? Yes No

46. Identify the criteria to be used as COPC selection tools.

_____
_____
_____

47. Are filtered and unfiltered surface water samples differentiated? Yes No

48. If such samples are differentiated, how?

_____
_____
_____

49. Which of these samples will be used for the human health risk assessment?

Surface Water	Filtered	Unfiltered
Groundwater	Filtered	Unfiltered

50. Which of these samples will be used for the ecological assessment?

Surface Water	Filtered	Unfiltered
Groundwater	Filtered	Unfiltered

51. Will background data be included in the database? Yes No

52. How are background samples identified?

_____
_____
_____

53. Will background results be used to support selection of COPCs? Yes No

54. What statistical analyses will be required for the background data?

_____
_____
_____

55. Will background data be segregated by depth? Yes No

56. What background matrices must be segregated by depth?

_____
_____
_____

ATTACHMENT A (Continued)
DATABASE PLANNING CHECKLIST

57. What format will be used for data presentation (e.g., appendices and summary tables, comprehensive text tables, tag maps, isoconcentration contours, etc.)?

_____

_____

_____

ATTACHMENT B
HISTORICAL DATA FOR _____ GROUNDWATER

Investigations	Investigative Well Identification	Installation Company & Date	Laboratory Parameters				
			09/82	11/82	01/83	02/83	04/83
Groundwater Monitoring Program (USACEWES, 1981).	WES-05-01-81	WES 09/14/81	C, D, E	B	F	A	
	WES-05-02-81	WES 09/15/81	C, D, E	B	F	A	
Hydrogeological Investigation of Waste Disposal Sites at the NSWC Crane, Indiana (Dunbar, 1982).	WE-05-03-81	WES 09/16/81	C, D, E	B	F	A	
	WES-05-04-81(*)	WES 10/01/81	C, D, E	B	F	A	
	05-04A (**)	WES 1986					
Definition of Contaminated Groundwater Plumes at Selected Waste Disposal Sites; Draft (Dunbar, 1984).	WES-05-05-81	WES 10/02/81	C, D, E	B	F	A	
	WES-05-06-81	WES 10/10/81	C, D, E	B	F	A	
	WES-05-07-81	WES 10/20/81	C, D, E		F	A	
	WES-05-08-81	WES 11/04/81	C, D, E	B	F	A	
U.S. Dept. of the Navy IRP RFI Phase III Groundwater Investigations for NSWC Crane, Indiana Old Burn Pit; U.S. Army Corps of Engineers; WES (June 1991).	WES-05-09-82	WES 10/27/82		B			
	WES-05-10-82	WES 10/27/82		B			
	WES-05-11-82	WES 10/29/82		B			
	WES-05-12-82	WES 10/30/82		B			
	WES-05-13-82	WES 11/01/82		B			
	WES-05-14-83	WES 01/10/83			B		
	WES-05-15-83	WES 01/11/83			B		G
	WES-05-16-83	WES 01/11/83			B		
	WES-05-17-83	WES 02/02/82			B		G
	WES-05-18-83	WES 02/03/83			B		G
	WES-05-19-83	WES 02/03/83			B		G

(*) Original contaminated well yielding highest concentrations of contaminants.
(**) Replacement well.
A Metals, chloride, specific conductance, TOC, phenols, sulfate, TOX, pH.
B VOCs.
C Metals, fluoride, nitrate-nitrate, pest., chlorinated herbicides, GRA/GRB, chloride, phenols, sulfate, pH specific conductance, TOC, TOX.
D GRA.
E GRB.
F Metals.

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1.0 PURPOSE

The purpose of this document is to establish standard procedures and technical guidance on borehole and sample logging.

2.0 SCOPE

These procedures provide descriptions of the standard techniques for borehole and sample logging. These techniques shall be used for each boring logged to provide consistent descriptions of subsurface lithology. While experience is the only method to develop confidence and accuracy in the description of soil and rock, the field geologist/engineer can do a good job of classification by careful, thoughtful observation and by being consistent throughout the classification procedure.

3.0 GLOSSARY

None.

4.0 RESPONSIBILITIES

Site Geologist. Responsible for supervising all boring activities and assuring that each borehole is completely logged. If more than one rig is being used on site, the Site Geologist must make sure that each field geologist is properly trained in logging procedures. A brief review or training session may be necessary prior to the start up of the field program and/or upon completion of the first boring.

5.0 PROCEDURES

The classification of soil and rocks is one of the most important jobs of the field geologist/engineer. To maintain a consistent flow of information, it is imperative that the field geologist/engineer understand and accurately use the field classification system described in this SOP. This identification is based on visual examination and manual tests.

5.1 Materials Needed

When logging soil and rock samples, the geologist or engineer may be equipped with the following:

- Rock hammer
- Knife
- Camera
- Dilute hydrochloric acid (HCl)
- Ruler (marked in tenths and hundredths of feet)
- Hand Lens

5.2 Classification of Soils

All data shall be written directly on the boring log (Figure 1) or in a field notebook if more space is needed. Details on filling out the boring log are discussed in Section 5.5.

5.2.1 USCS Classification

Soils are to be classified according to the Unified Soil Classification System (USCS). This method of classification is detailed in Figure 1 (Continued).

FIGURE 1

BORING LOG (EXAMPLE)

BORING LOG

Page ___ of ___

PROJECT NAME: _____ BORING NUMBER: _____
PROJECT NUMBER: _____ DATE: _____
DRILLING COMPANY: _____ GEOLOGIST: _____
DRILLING RIG: _____ DRILLER: _____

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	MATERIAL DESCRIPTION: Color	MATERIAL DESCRIPTION: Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	PID/FID Reading (ppm): Sampler BZ	PID/FID Reading (ppm): Borehole**	PID/FID Reading (ppm): Driller BZ**

* When rock coring, enter rock brokeness.

** Include monitor reading in 5 foot intervals @ borehole. Increase reading frequency if elevated response read.

Drilling Area Background (ppm): [ ]

Remarks: _____

Converted to Well: Yes _____ No _____ Well I.D. #: _____

FIGURE 1 (CONTINUED)

SOIL TERMS

UNIFIED SOIL CLASSIFICATION (USCS)

COARSE-GRAINED SOILS — More Than Half of Material is LARGER Than No. 200 Sieve Size

FIELD IDENTIFICATION PROCEDURES (Excluding Particles Larger Than 3 Inches and Basing Fractions on Estimated Weights)			GROUP SYMBOL	TYPICAL NAMES
GRAVELS (50%(+)>1/4"Ø	CLEAN GRAVELS (Low % Fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.	GW	Well graded gravels, gravel-sand mixtures, little or no fines.
		Predominantly one size or a range of sizes with some intermediate sizes missing.	GP	Poorly graded gravels, gravel-sand mixtures, little or no fines.
	GRAVELS W/FINES (High % Fines)	Non-plastic fines (for identification procedures, see ML)	GM	Silty gravels, poorly graded gravel-sand-silt mixtures.
		Plastic fines (for identification procedures, see CL)	GC	Clayey gravels, poorly graded gravel sand-clay mixtures.
SANDS 50%(+)<1/4"Ø	CLEAN SANDS (Low % Fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.	SW	Well graded sand, gravelly sands, little or no fines.
		Predominantly one size or a range of sizes with some intermediate sizes missing.	SP	Poorly graded sands, gravelly sands, little or no fines.
	SANDS W/FINES (High % Fines)	Non-plastic fines (for identification procedures, see MCL)	SM	Silty sands, poorly graded sand-silt mixtures.
		Plastic fines (for identification procedures, see CL)	SC	Clayey sands, poorly graded sand-clay mixtures.

FINE-GRAINED SOILS — More Than Half of Material is SMALLER Than No. 200 Sieve Size

FIELD IDENTIFICATION PROCEDURES (Excluding Particles Larger Than 3 Inches and Basing Fractions on Estimated Weights)	Identification Procedures on Fraction Smaller than No. 40 Sieve Size				GROUP SYMBOL	TYPICAL NAMES
		DAY STRENGTH (Crushing Characteristics)	DILATANCY (Reaction to Shaking)	TOUGHNESS (Consistency Near Plastic Limit)		
SILTS AND CLAYS Liquid Limit <50		None to Slight	Quick to Slow	None	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity.
		Medium to High	None to Very Slow	Medium	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		Slight to Medium	Slow	Slight	OL	Organic silts and organic silt-clays of low plasticity.
SILTS AND CLAYS Liquid Limit >50		Slight to Medium	Slow to None	Slight to Medium	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		High to Very High	None	High	CH	Inorganic clays of high plasticity, fat clays.
		Medium to High	None to Very Slow	Slight to Medium	OH	Organic clays of medium to high plasticity.
HIGHLY ORGANIC SOILS	Readily identified by color, odor, spongy feel and frequently by fibrous texture.				Pt	Peat and other organic soils

Boundary classifications: Soils possessing characteristics of two groups are designated by combining group symbols. For example, GW-GC, well graded gravel-sand mixture with clay binder.
All sieve sizes on this chart are U.S. Standard.

DENSITY OF GRANULAR SOILS

DESIGNATION	STANDARD PENETRATION RESISTANCE-BLOWS/FOOT
Very Loose	0-4
Loose	5-10
Medium Loose	11-30
Dense	31-50
Very Dense	Over 50

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	UNC COMPRESSIVE STRENGTH (TONS/SQ. FT.)	STANDARD PENETRATION RESISTANCE-BLOWS/FOOT	FIELD IDENTIFICATION METHODS
Very Soft	Less than 0.25	0 to 2	Easily penetrated several inches by fist
Soft	0.25 to 0.50	2 to 4	Easily penetrated several inches by thumb.
Medium Stiff	0.50 to 1.0	4 to 8	Can be penetrated several inches by thumb.
Stiff	1.0 to 2.0	8 to 15	Readily indented by thumb.
Very Stiff	2.0 to 4.0	15 to 30	Readily indented by thumbnail.
Hard	More than 4.0	Over 30	Indented with difficulty by thumbnail.

ROCK TERMS

ROCK HARDNESS (FROM CORE SAMPLES)			ROCK BROKENNESS		
Descriptive Terms	Screwdriver or Knife Effects	Hammer Effects	Descriptive Terms	Abbreviation	Spacing
Soft	Easily Gouged	Crushes when pressed with hammer	Very Broken	(V. Br.)	0-2"
Medium Soft	Can be Gouged	Breaks (one blow); crumbly edges	Broken	(Br.)	2"-1'
Medium Hard	Can be scratched	Breaks (one blow); sharp edges	Blocky	(Bl.)	1'-3"
Hard	Cannot be scratched	Breaks conchoidally (several blows); sharp edges	Massive	(M.)	3'-10'

LEGEND:

SOIL SAMPLES - TYPES	ROCK SAMPLES - TYPES	WATER LEVELS
S-2" Split-Barrel Sample	X-NX (Conventional) Core (-2-1/8" O.D.)	12/18 ▽ 12.6' Initial Level w/Date & Depth
ST-3" O.D. Undisturbed Sample	Q-NQ (Wireline) Core (-1-7/8" O.D.)	12/18 ▽ 12.6' Stabilized Level w/Date & Depth
O - Other Samples, Specify in Remarks	Z - Other Core Sizes, Specify in Remarks	

This method of classification identifies soil types on the basis of grain size and cohesiveness.

Fine-grained soils, or fines, are smaller than the No. 200 sieve and are of two types: silt (M) and clay (C). Some classification systems define size ranges for these soil particles, but for field classification purposes, they are identified by their respective behaviors. Organic material (O) is a common component of soil but has no size range; it is recognized by its composition. The careful study of the USCS will aid in developing the competence and consistency necessary for the classification of soils.

Coarse-grained soils shall be divided into rock fragments, sand, or gravel. The terms sand and gravel not only refer to the size of the soil particles but also to their depositional history. To insure accuracy in description, the term rock fragments shall be used to indicate angular granular materials resulting from the breakup of rock. The sharp edges typically observed indicate little or no transport from their source area, and therefore the term provides additional information in reconstructing the depositional environment of the soils encountered. When the term "rock fragments" is used it shall be followed by a size designation such as "(1/4 inchΦ-1/2 inchΦ)" or "coarse-sand size" either immediately after the entry or in the remarks column. The USCS classification would not be affected by this variation in terms.

5.2.2 Color

Soil colors shall be described utilizing a single color descriptor preceded, when necessary, by a modifier to denote variations in shade or color mixtures. A soil could therefore be referred to as "gray" or "light gray" or "blue-gray." Since color can be utilized in correlating units between sampling locations, it is important for color descriptions to be consistent from one boring to another.

Colors must be described while the sample is still moist. Soil samples shall be broken or split vertically to describe colors. Samplers tend to smear the sample surface creating color variations between the sample interior and exterior.

The term "mottled" shall be used to indicate soils irregularly marked with spots of different colors. Mottling in soils usually indicates poor aeration and lack of good drainage.

Soil Color Charts shall not be used unless specified by the project manager.

5.2.3 Relative Density and Consistency

To classify the relative density and/or consistency of a soil, the geologist is to first identify the soil type. Granular soils contain predominantly sands and gravels. They are noncohesive (particles do not adhere well when compressed). Finer-grained soils (silts and clays) are cohesive (particles will adhere together when compressed).

The density of noncohesive, granular soils is classified according to standard penetration resistances obtained from split-barrel sampling performed according to the methods detailed in Standard Operating Procedures GH-1.3 and SA-1.3. Those designations are:

Designation	Standard Penetration Resistance (Blows per Foot)
Very loose	0 to 4
Loose	5 to 10
Medium dense	11 to 30
Dense	31 to 50
Very dense	Over 50

Standard penetration resistance is the number of blows required to drive a split-barrel sampler with a 2-inch outside diameter 12 inches into the material using a 140-pound hammer falling freely through 30 inches. The sampler is driven through an 18-inch sample interval, and the number of blows is recorded for each 6-inch increment. The density designation of granular soils is obtained by adding the number of blows required to penetrate the last 12 inches of each sample interval. It is important to note that if gravel or rock fragments are broken by the sampler or if rock fragments are lodged in the tip, the resulting blow count will be erroneously high, reflecting a higher density than actually exists. This shall be noted on the log and referenced to the sample number. Granular soils are given the USCS classifications GW, GP, GM, SW, SP, SM, GC, or SC (see Figure 1).

The consistency of cohesive soils is determined by performing field tests and identifying the consistency as shown in Figure 2.

Cohesive soils are given the USCS classifications ML, MH, CL, CH, OL, or OH (see Figure 1).

The consistency of cohesive soils is determined either by blow counts, a pocket penetrometer (values listed in the table as Unconfined Compressive Strength), or by hand by determining the resistance to penetration by the thumb. The pocket penetrometer and thumb determination methods are conducted on a selected sample of the soil, preferably the lowest 0.5 foot of the sample in the split-barrel sampler. The sample shall be broken in half and the thumb or penetrometer pushed into the end of the sample to determine the consistency. Do not determine consistency by attempting to penetrate a rock fragment. If the sample is decomposed rock, it is classified as a soft decomposed rock rather than a hard soil. Consistency shall not be determined solely by blow counts. One of the other methods shall be used in conjunction with it. The designations used to describe the consistency of cohesive soils are shown in Figure 2.

FIGURE 2

CONSISTENCY FOR COHESIVE SOILS

Consistency	Standard Penetration Resistance (Blows per Foot)	Unconfined Compressive Strength (Tons/Sq. Foot by pocket penetration)	Field Identification
Very soft	0 to 2	Less than 0.25	Easily penetrated several inches by fist
Soft	2 to 4	0.25 to 0.50	Easily penetrated several inches by thumb
Medium stiff	4 to 8	0.50 to 1.0	Can be penetrated several inches by thumb with moderate effort
Stiff	8 to 15	1.0 to 2.0	Readily indented by thumb but penetrated only with great effort
Very stiff	15 to 30	2.0 to 4.0	Readily indented by thumbnail
Hard	Over 30	More than 4.0	Indented with difficulty by thumbnail

5.2.4 Weight Percentages

In nature, soils are comprised of particles of varying size and shape, and are combinations of the various grain types. The following terms are useful in the description of soil:

Terms of Identifying Proportion of the Component	Defining Range of Percentages by Weight
Trace	0 - 10 percent
Some	11 - 30 percent
Adjective form of the soil type (e.g., "sandy")	31 - 50 percent

Examples:

- Silty fine sand: 50 to 69 percent fine sand, 31 to 50 percent silt.
- Medium to coarse sand, some silt: 70 to 80 percent medium to coarse sand, 11 to 30 percent silt.
- Fine sandy silt, trace clay: 50 to 68 percent silt, 31 to 49 percent fine sand, 1 to 10 percent clay.
- Clayey silt, some coarse sand: 70 to 89 percent clayey silt, 11 to 30 percent coarse sand.

5.2.5 Moisture

Moisture content is estimated in the field according to four categories: dry, moist, wet, and saturated. In dry soil, there appears to be little or no water. Saturated samples obviously have all the water they can hold. Moist and wet classifications are somewhat subjective and often are determined by the individual's judgment. A suggested parameter for this would be calling a soil wet if rolling it in the hand or on a porous surface liberates water, i.e., dirties or muddies the surface. Whatever method is adopted for describing moisture, it is important that the method used by an individual remains consistent throughout an entire drilling job.

Laboratory tests for water content shall be performed if the natural water content is important.

5.2.6 Stratification

Stratification can only be determined after the sample barrel is opened. The stratification or bedding thickness for soil and rock is depending on grain size and composition. The classification to be used for stratification description is shown in Figure 3.

5.2.7 Texture/Fabric/Bedding

The texture/fabric/bedding of the soil shall be described. Texture is described as the relative angularity of the particles: rounded, subrounded, subangular, and angular. Fabric shall be noted as to whether the particles are flat or bulky and whether there is a particular relation between particles (i.e., all the flat particles are parallel or there is some cementation). The bedding or structure shall also be noted (e.g., stratified, lensed, nonstratified, heterogeneous varved).

FIGURE 3

BEDDING THICKNESS CLASSIFICATION

Thickness (metric)	Thickness (Approximate English Equivalent)	Classification
> 1.0 meter	> 3.3'	Massive
30 cm - 1 meter	1.0' - 3.3'	Thick Bedded
10 cm - 30 cm	4" - 1.0'	Medium Bedded
3 cm - 10 cm	1" - 4"	Thin Bedded
1 cm - 3 cm	2/5" - 1"	Very Thin Bedded
3 mm - 1 cm	1/8" - 2/5"	Laminated
1 mm - 3 mm	1/32" - 1/8"	Thinly Laminated
< 1 mm	<1/32"	Micro Laminated

(Weir, 1973 and Ingram, 1954)

5.2.8 Summary of Soil Classification

In summary, soils shall be classified in a similar manner by each geologist/engineer at a project site. The hierarchy of classification is as follows:

- Density and/or consistency
- Color
- Plasticity (Optional)
- Soil types
- Moisture content
- Stratification
- Texture, fabric, bedding
- Other distinguishing features

5.3 Classification of Rocks

Rocks are grouped into three main divisions: sedimentary, igneous and metamorphic. Sedimentary rocks are by far the predominant type exposed at the earth's surface. The following basic names are applied to the types of rocks found in sedimentary sequences:

- Sandstone - Made up predominantly of granular materials ranging between 1/16 to 2 mm in diameter.

- Siltstone - Made up of granular materials less than 1/16 to 1/256 mm in diameter. Fractures irregularly. Medium thick to thick bedded.

- Claystone - Very fine-grained rock made up of clay and silt-size materials. Fractures irregularly. Very smooth to touch. Generally has irregularly spaced pitting on surface of drilled cores.

- Shale - A fissile very fine-grained rock. Fractures along bedding planes.

- Limestone - Rock made up predominantly of calcite ($CaCO_3$). Effervesces strongly upon the application of dilute hydrochloric acid.

- Coal - Rock consisting mainly of organic remains.

- Others - Numerous other sedimentary rock types are present in lesser amounts in the stratigraphic record. The local abundance of any of these rock types is dependent upon the depositional history of the area. Conglomerate, halite, gypsum, dolomite, anhydrite, lignite, etc. are some of the rock types found in lesser amounts.

In classifying a sedimentary rock the following hierarchy shall be noted:

- Rock type
- Color
- Bedding thickness
- Hardness
- Fracturing
- Weathering
- Other characteristics

5.3.1 Rock Type

As described above, there are numerous types of sedimentary rocks. In most cases, a rock will be a combination of several grain types, therefore, a modifier such as a sandy siltstone, or a silty sandstone can be used. The modifier indicates that a significant portion of the rock type is composed of the modifier. Other modifiers can include carbonaceous, calcareous, siliceous, etc.

Grain size is the basis for the classification of clastic sedimentary rocks. Figure 4 is the Udden-Wentworth classification that will be assigned to sedimentary rocks. The individual boundaries are slightly different than the USCS subdivision for soil classification. For field determination of grain sizes, a scale can be used for the coarse grained rocks. For example, the division between siltstone and claystone may not be measurable in the field. The boundary shall be determined by use of a hand lens. If the grains cannot be seen with the naked eye but are distinguishable with a hand lens, the rock is a siltstone. If the grains are not distinguishable with a hand lens, the rock is a claystone.

5.3.2 Color

The color of a rock can be determined in a similar manner as for soil samples. Rock core samples shall be classified while wet, when possible, and air cored samples shall be scraped clean of cuttings prior to color classifications.

Rock color charts shall not be used unless specified by the Project Manager.

5.3.3 Bedding Thickness

The bedding thickness designations applied to soil classification (see Figure 3) will also be used for rock classification.

5.3.4 Hardness

The hardness of a rock is a function of the compaction, cementation, and mineralogical composition of the rock. A relative scale for sedimentary rock hardness is as follows:

- Soft - Weathered, considerable erosion of core, easily gouged by screwdriver, scratched by fingernail. Soft rock crushes or deforms under pressure of a pressed hammer. This term is always used for the hardness of the saprolite (decomposed rock which occupies the zone between the lowest soil horizon and firm bedrock).

- Medium soft - Slight erosion of core, slightly gouged by screwdriver, or breaks with crumbly edges from single hammer blow.

- Medium hard - No core erosion, easily scratched by screwdriver, or breaks with sharp edges from single hammer blow.

- Hard - Requires several hammer blows to break and has sharp conchoidal breaks. Cannot be scratched with screwdriver.

Note the difference in usage here of the works "scratch" and "gouge." A scratch shall be considered a slight depression in the rock (do not mistake the scraping off of rock flour from drilling with a scratch in the rock itself), while a gouge is much deeper.

FIGURE 4

GRAIN SIZE CLASSIFICATION FOR ROCKS

Particle Name	Grain Size Diameter
Cobbles	> 64 mm
Pebbles	4 - 64 mm
Granules	2 - 4 mm
Very Coarse Sand	1 - 2 mm
Coarse Sand	0.5 - 1 mm
Medium Sand	0.25 - 0.5 mm
Fine Sand	0.125 - 0.25 mm
Very Fine Sand	0.0625 - 0.125 mm
Silt	0.0039 - 0.0625 mm

After Wentworth, 1922

5.3.5 Fracturing

The degree of fracturing or brokenness of a rock is described by measuring the fractures or joint spacing. After eliminating drilling breaks, the average spacing is calculated and the fracturing is described by the following terms:

- Very broken (V. BR.) - Less than 2-inch spacing between fractures
- Broken (BR.) - 2-inch to 1-foot spacing between fractures
- Blocky (BL.) - 1- to 3-foot spacing between fractures
- Massive (M.) - 3 to 10-foot spacing between fractures

The structural integrity of the rock can be approximated by calculating the Rock Quality Designation (RQD) of cores recovered. The RQD is determined by adding the total lengths of all pieces exceeding 4 inches and dividing by the total length of the coring run, to obtain a percentage.

Method of Calculating RQD
(After Deere, 1964)

$$RQD\ \% = r/l \times 100$$

r = Total length of all pieces of the lithologic unit being measured, which are greater than 4 inches length, and have resulted from natural breaks. Natural breaks include slickensides, joints, compaction slicks, bedding plane partings (not caused by drilling), friable zones, etc.

l = Total length of the coring run.

5.3.6 Weathering

The degree of weathering is a significant parameter that is important in determining weathering profiles and is also useful in engineering designs. The following terms can be applied to distinguish the degree of weathering:

- Fresh - Rock shows little or no weathering effect. Fractures or joints have little or no staining and rock has a bright appearance.

- Slight - Rock has some staining which may penetrate several centimeters into the rock. Clay filling of joints may occur. Feldspar grains may show some alteration.

- Moderate - Most of the rock, with exception of quartz grains, is stained. Rock is weakened due to weathering and can be easily broken with hammer.

- Severe - All rock including quartz grains is stained. Some of the rock is weathered to the extent of becoming a soil. Rock is very weak.

5.3.7 Other Characteristics

The following items shall be included in the rock description:

- Description of contact between two rock units. These can be sharp or gradational.
- Stratification (parallel, cross stratified).

- Description of any filled cavities or vugs.
- Cementation (calcareous, siliceous, hematitic).
- Description of any joints or open fractures.
- Observation of the presence of fossils.
- Notation of joints with depth, approximate angle to horizontal, any mineral filling or coating, and degree of weathering.

All information shown on the boring logs shall be neat to the point where it can be reproduced on a copy machine for report presentation. The data shall be kept current to provide control of the drilling program and to indicate various areas requiring special consideration and sampling.

5.3.8 Additional Terms Used in the Description of Rock

The following terms are used to further identify rocks:

- Seam - Thin (12 inches or less), probably continuous layer.

- Some - Indicates significant (15 to 40 percent) amounts of the accessory material. For example, rock composed of seams of sandstone (70 percent) and shale (30 percent) would be "sandstone -- some shale seams."

- Few - Indicates insignificant (0 to 15 percent) amounts of the accessory material. For example, rock composed of seam of sandstone (90 percent) and shale (10 percent) would be "sandstone -- few shale seams."

- Interbedded - Used to indicate thin or very thin alternating seams of material occurring in approximately equal amounts. For example, rock composed of thin alternating seams of sandstone (50 percent) and shale (50 percent) would be "interbedded sandstone and shale."

- Interlayered - Used to indicate thick alternating seams of material occurring in approximately equal amounts.

The preceding sections describe the classification of sedimentary rocks. The following are some basic names that are applied to igneous rocks:

- Basalt - A fine-grained extrusive rock composed primarily of calcic plagioclase and pyroxene.

- Rhyolite - A fine-grained volcanic rock containing abundant quartz and orthoclase. The fine-grained equivalent of a granite.

- Granite - A coarse-grained plutonic rock consisting essentially of alkali feldspar and quartz.

- Diorite - A coarse-grained plutonic rock consisting essentially of sodic plagioclase and hornblende.

- Gabbro - A coarse-grained plutonic rock consisting of calcic plagioclase and clinopyroxene. Loosely used for any coarse-grained dark igneous rock.

The following are some basic names that are applied to metamorphic rocks:

- Slate - A very fine-grained foliated rock possessing a well developed slaty cleavage. Contains predominantly chlorite, mica, quartz, and sericite.
- Phyllite - A fine-grained foliated rock that splits into thin flaky sheets with a silky sheen on cleavage surface.
- Schist - A medium to coarse-grained foliated rock with subparallel arrangement of the micaceous minerals which dominate its composition.
- Gneiss - A coarse-grained foliated rock with bands rich in granular and platy minerals.
- Quartzite - A fine- to coarse-grained nonfoliated rock breaking across grains, consisting essentially of quartz sand with silica cement.

5.4 Abbreviations

Abbreviations may be used in the description of a rock or soil. However, they shall be kept at a minimum. Following are some of the abbreviations that may be used:

C	-	Coarse	Lt	-	Light	Yl	-	Yellow
Med	-	Medium	BR	-	Broken	Or	-	Orange
F	-	Fine	BL	-	Blocky	SS	-	Sandstone
V	-	Very	M	-	Massive	Sh	-	Shale
Sl	-	Slight	Br	-	Brown	LS	-	Limestone
Occ	-	Occasional	Bl	-	Black	Fgr	-	Fine-grained
Tr	-	Trace						

5.5 Boring Logs and Documentation

This section describes in more detail the procedures to be used in completing boring logs in the field. Information obtained from the preceding sections shall be used to complete the logs. A sample boring log has been provided as Figure 5.

The field geologist/engineer shall use this example as a guide in completing each boring log. Each boring log shall be fully described by the geologist/engineer as the boring is being drilled. Every sheet contains space for 25 feet of log. Information regarding classification details is provided either on the back of the boring log or on a separate sheet, for field use.

FIGURE 5
COMPLETED BORING LOG (EXAMPLE)

BORING LOG

Page 1 of 1

PROJECT NAME: NSB- SITE
PROJECT NUMBER: 9594
DRILLING COMPANY: SOILTEST CO.
DRILLING RIG: CME-55

BORING NUMBER: SB/MW 1
DATE: 3/8/96
GEOLOGIST: SJ CONTI
DRILLER: R. ROCK

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**
S-1	0.0	7/6	1.5/2.0		M DENSE	BRN	SILTY SAND - SOME	SM	MOIST SL. ORG.	5	0	0	0
@ 0800	2.0	9/10				TO BLK	ROCK FR. - TR BRICKS		ODOR				
							(FILL)		FILL TO 4'±				
	4.0			4.0									
S-2 @		5/7	2.0/2.0		M DENSE	BRN	SILTY SAND - TR FINE	SM	MOIST - W ODOR	10	0	-	-
0810	6.0	9/8					GRAVEL		NAT. MATL.				
	•			7'± ▽					TOOK SAMPLE SB01-0406 FOR ANALYSIS				
	8.0			8.0									
S-3 @		6/8	1.9/2.0		DENSE	TAN BRN	FINE TO COARSE SAND	SW	WET	0	0	0	0
0820	10.0	17/16					TR. F. GRAVEL		HIT WATER ≈ 7'±				
	12.0			12.0									
S-4 @		7/6	1.6/2.0		STIFF	GRAY	SILTY CLAY	CL	MOIST → WET	0	.5	-	-
0830	14.0	5/8											
	15.0			15.0					AUGER REF @ 15'				
				11 BSIHE 16	M HARD	BRN	SILTSTONE	VBR	WEATHERED				
									LO & JNTS @ 15.5				
9/5	①		4.0/5.0						WATER STAINS @ 16.5, 17.1, 17.5	0	0	0	0
				19'					LOSING SOME				
	20.0				HARD	GRAY	SANDSTONE - SOME	BR	DRILL H2O @ 17'±				
							SILTSTONE		SET TEMP 6" CAS TO 15.5				
4.9/5.0	②		5.0/5.0						SET 2" Φ PVC SCREEN 16-25	0	0	0	0
									SAND 14-25				
	25.0			25					PELLETS 12-14				

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated response read.

• 1-20Z
1-80Z

Drilling Area Background (ppm): 0

Remarks: CME-55 R16, 4¼" ID HSA - 9" OD ±
2" SPLIT SPOONS - 140 LB HAMMER - 30" DROP
NX CORE IN BEDROCK RUN ① = 25 min, RUN ② = 15 min

Converted to Well: Yes ✓ No ____ Well I.D. #: MW-1

5.5.1 Soil Classification

- Identify site name, boring number, job number, etc. Elevations and water level data to be entered when surveyed data is available.

- Enter sample number (from SPT) under appropriate column. Enter depth sample was taken from (1 block = 1 foot). Fractional footages, i.e., change of lithology at 13.7 feet, shall be lined off at the proportional location between the 13- and 14-foot marks. Enter blow counts (Standard Penetration Resistance) diagonally (as shown). Standard penetration resistance is covered in Section 5.2.3.

- Determine sample recovery/sample length as shown. Measure the total length of sample recovered from the split-spoon sampler, including material in the drive shoe. Do not include cuttings or wash material that may be in the upper portion of the sample tube.

- Indicate any change in lithology by drawing a line at the appropriate depth. For example, if clayey silt was encountered from 0 to 5.5 feet and shale from 5.5 to 6.0 feet, a line shall be drawn at this increment. This information is helpful in the construction of cross-sections. As an alternative, symbols may be used to identify each change in lithology.

- The density of granular soils is obtained by adding the number of blows for the last two increments. Refer to Density of Granular Soils Chart on back of log sheet. For consistency of cohesive soils refer also to the back of log sheet - Consistency of Cohesive Soils. Enter this information under the appropriate column. Refer to Section 5.2.3.

- Enter color of the material in the appropriate column.

- Describe material using the USCS. Limit this column for sample description only. The predominate material is described last. If the primary soil is silt but has fines (clay) - use clayey silt. Limit soil descriptors to the following:

  - Trace: 0 - 10 percent
  - Some: 11 - 30 percent
  - And/Or: 31 - 50 percent

- Also indicate under Material Classification if the material is fill or natural soils. Indicate roots, organic material, etc.

- Enter USCS symbol - use chart on back of boring log as a guide. If the soils fall into one of two basic groups, a borderline symbol may be used with the two symbols separated by a slash. For example ML/CL or SM/SP.

- The following information shall be entered under the "Remarks" column and shall include, but is not limited by, the following:

  - Moisture - estimate moisture content using the following terms - dry, moist, wet and saturated. These terms are determined by the individual. Whatever method is used to determine moisture, be consistent throughout the log.

- Angularity - describe angularity of coarse grained particles using the terms angular, subangular, subrounded, or rounded. Refer to ASTM D 2488 or Earth Manual for criteria for these terms.
- Particle shape - flat, elongated, or flat and elongated.
- Maximum particle size or dimension.
- Water level observations.
- Reaction with HCl - none, weak, or strong.

- Additional comments:
  - Indicate presence of mica, caving of hole, when water was encountered, difficulty in drilling, loss or gain of water.
  - Indicate odor and Photoionization Detector (PID) or Flame Ionization Detector (FID) reading if applicable.
  - Indicate any change in lithology by drawing a line through the lithology change column and indicate the depth. This will help when cross-sections are subsequently constructed.
  - At the bottom of the page indicate type of rig, drilling method, hammer size and drop, and any other useful information (i.e., borehole size, casing set, changes in drilling method).
  - Vertical lines shall be drawn (as shown in Figure 5) in columns 6 to 8 from the bottom of each sample to the top of the next sample to indicate consistency of material from sample to sample, if the material is consistent. Horizontal lines shall be drawn if there is a change in lithology, then vertical lines drawn to that point.
  - Indicate screened interval of well, as needed, in the lithology column. Show top and bottom of screen. Other details of well construction are provided on the well construction forms.

5.5.2 Rock Classification

- Indicate depth at which coring began by drawing a line at the appropriate depth. Indicate core run depths by drawing coring run lines (as shown) under the first and fourth columns on the log sheet. Indicate RQD, core run number, RQD percent, and core recovery under the appropriate columns.
- Indicate lithology change by drawing a line at the appropriate depth as explained in Section 5.5.1.
- Rock hardness is entered under designated column using terms as described on the back of the log or as explained earlier in this section.

- Enter color as determined while the core sample is wet; if the sample is cored by air, the core shall be scraped clean prior to describing color.

- Enter rock type based on sedimentary, igneous or metamorphic. For sedimentary rocks use terms as described in Section 5.3. Again, be consistent in classification. Use modifiers and additional terms as needed. For igneous and metamorphic rock types use terms as described in Sections 5.3.8.

- Enter brokenness of rock or degree of fracturing under the appropriate column using symbols VBR, BR, BL, or M as explained in Section 5.3.5 and as noted on the back of the Boring Log.

- The following information shall be entered under the remarks column. Items shall include but are not limited to the following:

  - Indicate depths of joints, fractures and breaks and also approximate to horizontal angle (such as high, low), i.e., 70° angle from horizontal, high angle.

  - Indicate calcareous zones, description of any cavities or vugs.

  - Indicate any loss or gain of drill water.

  - Indicate drop of drill tools or change in color of drill water.

- Remarks at the bottom of Boring Log shall include:

  - Type and size of core obtained.

  - Depth casing was set.

  - Type of rig used.

- As a final check the boring log shall include the following:

  - Vertical lines shall be drawn as explained for soil classification to indicate consistency of bedrock material.

  - If applicable, indicate screened interval in the lithology column. Show top and bottom of screen. Other details of well construction are provided on the well construction forms.

5.5.3 Classification of Soil and Rock from Drill Cuttings

The previous sections describe procedures for classifying soil and rock samples when cores are obtained. However, some drilling methods (air/mud rotary) may require classification and borehole logging based on identifying drill cuttings removed from the borehole. Such cuttings provide only general information on subsurface lithology. Some procedures that shall be followed when logging cuttings are:

- Obtain cutting samples at approximately 5-foot intervals, sieve the cuttings (if mud rotary drilling) to obtain a cleaner sample, place the sample into a small sample bottle or "zip lock"

bag for future reference, and label the jar or bag (i.e. hole number, depth, date, etc.). Cuttings shall be closely examined to determine general lithology.

- Note any change in color of drilling fluid or cuttings, to estimate changes in lithology.
- Note drop or chattering of drilling tools or a change in the rate of drilling, to determine fracture locations or lithologic changes.
- Observe loss or gain of drilling fluids or air (if air rotary methods are used), to identify potential fracture zones.
- Record this and any other useful information onto the boring log as provided in Figure 1.

This logging provides a general description of subsurface lithology and adequate information can be obtained through careful observation of the drilling process. It is recommended that split-barrel and rock core sampling methods be used at selected boring locations during the field investigation to provide detailed information to supplement the less detailed data generated through borings drilled using air/mud rotary methods.

5.6 Review

Upon completion of the borings logs, copies shall be made and reviewed. Items to be reviewed include:

- Checking for consistency of all logs.
- Checking for conformance to the guideline.
- Checking to see that all information is entered in their respective columns and spaces.

6.0 REFERENCES

Unified Soil Classification System (USCS).

ASTM D2488, 1985.

Earth Manual, U.S. Department of the Interior, 1974.

7.0 RECORDS

Originals of the boring logs shall be retained in the project files.

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ATTACHMENTS

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1.0 PURPOSE

This procedure provides general guidance and information pertaining to proper monitoring well design, installation, and development.

2.0 SCOPE

This procedure is applicable to the construction of permanent monitoring wells. The methods described herein may be modified by project-specific requirements for monitoring well construction. In addition, many regulatory agencies have specific regulations pertaining to monitoring well construction and permitting. These requirements must be determined during the project planning phases of the investigation, and any required permits must be obtained before field work begins. Innovative monitoring well installation techniques, which typically are not used, will be discussed only generally in this procedure.

3.0 GLOSSARY

Monitoring Well - A well which is properly screened (if screening is necessary, e.g., open borehole), cased, and sealed which is capable of providing a groundwater level and groundwater sample representative of the zone being monitored.

Piezometer - A pipe or tube inserted into the water bearing zone, typically open to water flow at the bottom and to the atmosphere at the top, and used to measure water level elevations. Piezometers may range in size from 1/2-inch-diameter plastic tubes to well points or monitoring wells.

Potentiometric Surface - The surface representative of the level to which water will rise in a well cased to the screened aquifer.

Well Point (Drive Point) - A screened or perforated tube (Typically 1-1/4 or 2 inches in diameter) with a solid, conical, hardened point at one end, which is attached to a riser pipe and driven into the ground with a sledge hammer, drop weight, or mechanical vibrator. Well points may be used for groundwater injection and recovery, as piezometers (i.e., to measure water levels) or to provide groundwater samples for water quality data.

4.0 RESPONSIBILITIES

Driller - The driller provides adequate and operable equipment, sufficient quantities of materials, and an experienced and efficient labor force capable of performing all phases of proper monitoring well installation and construction. The driller may also be responsible for obtaining, in advance, any required permits for monitoring well installation and construction.

Rig Geologist - The rig geologist supervises and documents well installation and construction performed by the driller, and insures that well construction is adequate to provide representative groundwater data from the monitored interval. Geotechnical engineers, field technicians, or other suitable trained personnel may also serve in this capacity.

5.0 PROCEDURES

5.1 Equipment/Items Needed

Below is a list of items that may be needed when installing a monitoring well:

- Health and safety equipment as required by the Site Safety Officer.
- Well drilling and installation equipment with associated materials (typically supplied by the driller).
- Hydrogeologic equipment (weighted engineer's tape, water level indicator, retractable engineers rule, electronic calculator, clipboard, mirror and flashlight - for observing downhole activities, paint and ink marker for marking monitoring wells, sample jars, well installation forms, and a field notebook).
- Drive point installations tools (sledge hammer, drop hammer, or mechanical vibrator; tripod, pipe wrenches, drive points, riser pipe, and end caps).

5.2 Well Design

The objectives for each monitoring well and its intended use must be clearly defined before the monitoring system is designed. Within the monitoring system, different monitoring wells may serve different purposes and, therefore, require different types of construction. During all phases of the well design, attention must be given to clearly documenting the basis for design decisions, the details of well construction, and the materials to be used. The objectives for installing the monitoring wells may include:

- Determining groundwater flow directions and velocities.
- Sampling or monitoring for trace contaminants.
- Determining aquifer characteristics (e.g., hydraulic conductivity).

Siting of monitoring wells shall be performed after a preliminary estimation of the groundwater flow direction. In most cases, groundwater flow and potential well locations can be determined through the review of geologic data and the site terrain. In addition, data from production wells or other monitoring wells in the area may be used to determine the groundwater flow direction. If these methods cannot be used, piezometers, which are relatively inexpensive to install, may have to be installed in a preliminary investigative phase to determine groundwater flow direction.

5.2.1 Well Depth, Diameter, and Monitored Interval

The well depth, diameter, and monitored interval must be tailored to the specific monitoring needs of each investigation. Specification of these items generally depends on the purpose of the monitoring system and the characteristics of the hydrogeologic system being monitored. Wells of different depth, diameter, and monitored interval can be employed in the same groundwater monitoring system. For instance, varying the monitored interval in several wells, at the same location (cluster wells) can help to determine the vertical gradient and the levels at which contaminants are present. Conversely, a fully penetrating well is usually not used to quantify or vertically locate a contaminant plume, since groundwater samples collected in wells that are screened over the full thickness of the water-bearing zone will be representative of average conditions across the entire monitored interval. However, fully penetrating wells can be used to establish the existence of contamination in the water-bearing zone. The

well diameter desired depends upon the hydraulic characteristics of the water-bearing zone, sampling requirements, drilling method and cost.

The decision concerning the monitored interval and well depth is based on the following (and possibly other) information:

- The vertical location of the contaminant source in relation to the water-bearing zone.
- The depth, thickness and uniformity of the water-bearing zone.
- The anticipated depth, thickness, and characteristics (e.g., density relative to water) of the contaminant plume.
- Fluctuation in groundwater levels (due to pumping, tidal influences, or natural recharge/discharge events).
- The presence and location of contaminants encountered during drilling.
- Whether the purpose of the installation is for determining existence or non-existence of contamination or if a particular stratigraphic zone is being investigated.
- The analysis of borehole geophysical logs.

In most situations where groundwater flow lines are horizontal, depending on the purpose of the well and the site conditions, monitored intervals are 20 feet or less. Shorter screen lengths (1 to 2 feet) are usually required where flow lines are not horizontal, (i.e., if the wells are to be used for accurate measurement of the potentiometric head at a specific point).

Many factors influence the diameter of a monitoring well. The diameter of the monitoring well depends on the application. In determining well diameter, the following needs must be considered:

- Adequate water volume for sampling.
- Drilling methodology.
- Type of sampling device to be used.
- Costs.

Standard monitoring well diameters are 2, 4, 6, or 8 inches. However, drive points are typically 1-1/4 or 2 inches in diameter. For monitoring programs which require screened monitoring wells, either a 2-inch or 4-inch-diameter well is preferred. Typically, well diameters greater than 4 inches are used in monitoring programs in which open-hole monitoring wells are required. In the smaller diameter wells, the volume of stagnant water in the well is minimized, and well construction costs are reduced, however, the type of sampling devices that can be used are limited. In specifying well diameter, sampling requirements must be considered (up to a total of 4 gallons of water may be required for a single sample to account for full organic and inorganic analyses, and split samples). The volume of water in the monitoring well available for sampling is dependent on the well diameter as follows:

Casing Inside Diameter (Inch)	Standing Water Depth to Obtain 1 Gallon Water (Feet)	Total Depth of Standing Water for 4 Gallons (Feet)
2	6.13	25
4	1.53	6
6	0.68	3

However, if a specific well recharges quickly after purging, then well diameter may not be an important factor regarding sample volume requirements.

Pumping tests for determining aquifer characteristics may require larger diameter wells; however, in small-diameter wells in-situ permeability tests can be performed during drilling or after well installation is completed.

5.2.2 Riser Pipe and Screen Materials

Well materials are specified by diameter, type of material, and thickness of pipe. Well screens require an additional specification of slot size. Thickness of pipe is referred to as "schedule" for polyvinyl chloride (PVC) casing and is usually Schedule 40 (thinner wall) or 80 (thicker wall). Steel pipe thickness is often referred to as "Strength" and Standard Strength is usually adequate for monitoring well purposes. With larger diameter pipe, the wall thickness must be greater to maintain adequate strength. The required thickness is also dependent on the method of installation; risers for drive points require greater strength than wells installed inside drilled borings.

The selection of well screen and riser materials depends on the method of drilling, the type of subsurface materials the well penetrates, the type of contamination expected, and natural water quality and depth. Cost and the level of accuracy required are also important. The materials generally available are Teflon, stainless steel, PVC galvanized steel, and carbon steel. Each has advantages and limitations (see Attachment A of this guideline for an extensive presentation on this topic). The two most commonly used materials are PVC and stainless steel for wells in which screens are installed. Properties of these two materials are compared in Attachment B. Stainless steel is preferred where trace metals or organic sampling is required; however, costs are high. Teflon materials are extremely expensive, but are relatively inert and provide the least opportunity for water contamination due to well materials. PVC has many advantages, including low cost, excellent availability, light weight, and ease of manipulation; however, there are also some questions about organic chemical sorption and leaching that are currently being researched (see Barcelona et al., 1983). Concern about the use of PVC can be minimized if PVC wells are used strictly for geohydrologic measurements and not for chemical sampling. The crushing strength of PVC may limit the depth of installation, but Schedule 80 materials normally used for wells greater than 50 feet deep may overcome some of the problems associated with depth. However, the smaller inside diameter of Schedule 80 pipe may be an important factor when considering the size of bailers or pumps required for sampling or testing. Due to this problem, the minimum well pipe size recommended for Schedule 80 wells is 4-inch I.D.

Screens and risers may have to be decontaminated before use because oil-based preservatives and oil used during thread cutting and screen manufacturing may contaminate samples. Metal pipe, may corrode and release metal ions or chemically react with organic constituents, but this is considered by some to be less of a problem than the problem associated with PVC material. Galvanized steel is not

recommended where samples may be collected for metal analyses, as zinc and cadmium levels in groundwater samples may become elevated from leaching of the zinc coating.

Threaded, flush-joint casing is most often preferred for monitoring well applications. PVC, Teflon, and steel can all be obtained with threaded joints at slightly more costs. Welded-joint steel casing is also acceptable. Glued PVC may release organic contaminants into the well, and therefore, should not be used if the well is to be sampled for organic constituents.

When the water-bearing zone is in consolidated bedrock, such as limestone or fractured granite, a well screen is often not necessary (the well is simply an open hole in bedrock). Unconsolidated materials, such as sands, clay, and silts require a screen. A screen slot size of 0.010 or 0.020 inch is generally used when a screen is necessary and the screened interval is artificially packed with a fine sand. The slot size controls the quantity of water entering the well and prevents entry of natural materials or sand pack. The screen shall pass no more than 10 percent of the pack material, or in-situ aquifer material. The rig geologist shall specify the combination of screen slot size and sand pack which will be compatible with the water-bearing zone, to maximize groundwater inflow and minimize head losses and movement of fines into the wells. For example, as a standard procedure, a Morie No. 1 or No. 10 to No. 20 U.S. Standard Sieve size filter pack is typically appropriate for a 0.020-inch slot screen; however, a No. 20 to No. 40 U.S. Standard Sieve size filter pack is typically appropriate for a 0.010-inch slot screen.

5.2.3 Annular Materials

Materials placed in the annular space between the borehole and riser pipe and screen include a sand pack when necessary, a bentonite seal, and cement-bentonite grout. The sand pack is usually a fine- to medium-grained poorly graded, silica sand and should relate to the grain size of the aquifer sediments. The quantity of sand placed in the annular space is dependent upon the length of the screened interval, but should always extend at least 1 foot above the top of the screen. At least 1 to 3 feet of bentonite pellets or equivalent shall be placed above the sand pack. Cement-bentonite grout (or equivalent) is then placed to extent from the top of the bentonite pellets to the ground surface.

On occasion, and with the concurrence of the involved regulatory agencies, monitoring wells may be packed naturally (i.e., no artificial sand pack installed), and the natural formation material is allowed to collapse around the well screen after the well is installed. This method has been used where the formation material itself is a relatively uniform grain size, or when artificial sand packing is not possible due to borehole collapse.

Bentonite expands by absorbing water and provides a seal between the screened interval and the overlying portion of the annular space and formation. Cement-bentonite grout is placed on top of the bentonite pellets extending to the surface. The grout effectively seals the well and eliminates the possibility for surface infiltration reaching the screened interval. Grouting also replaces material removed during drilling and prevents hole collapse and subsidence around the well. A tremie pipe should be used to introduce grout from the bottom of the hole upward, to prevent bridging, and to provide a better seal. However, in shallow boreholes that don't collapse, it may be more practical to pour the grout from the surface without a tremie pipe.

Grout is a general term which has several different connotations. For all practical purposes within the monitoring well installation industry, grout refers to the solidified material which is installed and occupies the annular space above the bentonite pellet seal. Grout, most of the time, is made up of two assemblages of material, (e.g., cement-bentonite). A cement-bentonite grout normally is a mixture of cement, bentonite, and water at a ratio of one 90-pound bag of Portland Type I cement, plus

3 to 5 pounds of granular or flake-type bentonite, and 6 gallons of water. A neat cement consists of one ninety-pound bag of Portland Type I cement and 6 gallons of water.

In certain cases, the borehole may be drilled to a depth greater than the anticipated well installation depth. For these cases, the well shall be backfilled to the desired depth with bentonite pellets or equivalent. A short (1- to 2-foot) section of capped riser pipe sump is sometimes installed immediately below the screen, as a silt reservoir, when significant post-development silting is anticipated. This will ensure that the entire screen surface remains unobstructed.

5.2.4 Protective Casing

When the well is completed and grouted to the surface, a protective steel casing is often placed over the top of the well. This casing generally has a hinged cap and can be locked to prevent vandalism. A vent hole shall be provided in the cap to allow venting of gases and maintain atmospheric pressure as water levels rise or fall in the well. The protective casing has a larger diameter than the well and is set into the wet cement grout over the well upon completion. In addition, one hole is drilled just above the cement collar through the protective casing which acts as a weep hole for the flow of water which may enter the annulus during well development, purging, or sampling.

A protective casing which is level with the ground surface is used in roadway or parking lot applications where the top of a monitoring well must be below the pavement. The top of the riser pipe is placed 4 to 5 inches below the pavement, and a locking protective casing is cemented in place to 3 inches below the pavement. A large diameter protective sleeve is set into the wet cement around the well with the top set level with the pavement. A manhole-type lid placed over the protective sleeve. The cement should be slightly mounded to direct pooled water away from the well head.

5.3 Monitoring Well Installation

Pertinent data regarding monitoring well installation shall be recorded on log sheets as depicted and discussed in SOP SA-6.3. Attachments to this referenced SOP illustrate terms and physical construction of various types of monitoring wells.

5.3.1 Monitoring Wells in Unconsolidated Sediments

After the borehole is drilled to the desired depth, well installation can begin. The procedure for well installation will partially be dictated by the stability of the formation in which the well is being placed. If the borehole collapses immediately after the drilling tools are withdrawn, then a temporary casing must be installed and well installation will proceed through the center of the temporary casing, and continue as the temporary casing is withdrawn from the borehole. In the case of hollow-stem auger drilling, the augers will act to stabilize the borehole during well installation.

Before the screen and riser pipe are lowered into the borehole, all pipe and screen sections should be measured with an engineer's rule to ensure proper placement. When measuring sections, the threads on one end of the pipe or screen must be excluded while measuring, since the pipe and screen sections are screwed flush together.

After the screen and riser pipe are lowered through the temporary casing, the sand pack can be installed. A weighted tape measure must be used during the installation procedure to carefully monitor installation progress. The sand is poured into the annulus between the riser pipe and temporary casing, as the casing is withdrawn. Sand should always be kept within the temporary casing during withdrawal in order to ensure an adequate sand pack. However, if too much sand is within the temporary casing (greater

than 1 foot above the bottom of the casing) bridging between the temporary casing and riser pipe may occur.

After the sand pack is installed to the desired depth (at least 1 foot above the top of the screen), then the bentonite pellet seal (or equivalent), can be installed in the same manner as the sand pack. At least 1 to 3 feet of bentonite pellets should be installed above the sand pack.

The cement-bentonite grout is then mixed and either poured or tremied into the annulus as the temporary casing or augers are withdrawn. Finally, the protective casing can be installed as detailed in Section 5.2.4.

In stable formations where borehole collapse does not occur, the well can be installed as discussed above, and the use of a temporary casing is not needed. However, centralizers may have to be installed, one above and one below the screen, to assure enough annular space for sand pack placement.

5.3.2 Confining Layer Monitoring Wells

When drilling and installing a well in a confined aquifer, proper well installation techniques must be applied to avoid cross contamination between the unconfined and confined aquifer. Under most conditions, this can be accomplished by installing double-cased wells. This is accomplished by drilling a large-diameter boring through the upper aquifer, 1 to 3 feet into the underlying confining layer, and setting and pressure grouting or tremie grouting the outer casing into the confining layer. The grout material must fill the space between the native material and the outer casing. A smaller diameter boring is then continued through the confining layer for installation of the monitoring well as detailed for overburden monitoring wells (with the exception of not using a temporary casing during installation). Sufficient time (determined by the rig geologist), must be allowed for setting of the grout prior to drilling through the confined layer.

5.3.3 Bedrock Monitoring Wells

When installing bedrock monitoring wells, a large diameter boring is drilled through the overburden and approximately 5 feet into the bedrock. A casing (typically steel) is installed and either pressure grouted or tremie grouted in place. After the grout has cured, a smaller diameter boring is continued through the bedrock to the desired depth. If the boring does not collapse, the well can be left open, and a screen is not necessary. If the boring collapses, then a screen is required and can be installed as detailed for overburden monitoring wells. However, if a screen is to be used, then the casing which is installed through the overburden and into the bedrock does not require grouting and can be installed temporary until final well installation is completed.

5.3.4 Drive Points

Drive points can be installed with either a sledge hammer, drop hammer, or a mechanical vibrator. The screen is threaded and tightened onto the riser pipe with pipe wrenches. The drive point is simply pounded into the subsurface to the desired depth. If a heavy drop hammer is used, then a tripod and pulley setup is required to lift the hammer. Drive points typically cannot be driven to depths exceeding 10 feet.

5.3.5 Innovative Monitoring Well Installation Techniques

Certain innovative sampling devices have proven advantageous. These devices are essentially screened samplers installed in a borehole with only one or two small-diameter tubes extending to the surface.

Manufacturers of these types of samplers claim that four samplers can be installed in a 3-inch-diameter borehole. This reduces drilling costs, decreases the volume of stagnant water, and provides a sampling system that minimizes cross-contamination from sampling equipment. These samplers also perform well when the water table is within 25 feet of the surface (the typical range of suction pumps). Two manufacturers of these samplers are Timco Manufacturing Company, Inc., of Prairie du Sac, Wisconsin, and BARCAD Systems, Inc., of Concord, Massachusetts. Each manufacturer offers various construction materials.

Two additional types of multilevel sampling systems have been developed. Both employ individual screened openings through a small-diameter casing. One of these systems (marketed by Westbay Instruments Ltd. of Vancouver, British Columbia, Canada) uses a screened port and a sampling probe to obtain samples and head measurements or perform permeability tests. This system allows sampling ports at intervals as close as 5 feet, if desired, in boreholes from 3 to 4.8 inches in diameter.

The second system, developed at the University of Waterloo at Waterloo, Ontario, Canada, requires field assembly of the individual sampling ports and tubes that actuate a simple piston pump and force the samples to the surface. Where the depth to ground water is less than 25 feet, the piston pumps are not required. The assembly is made of easily obtained materials; however, the cost of labor to assemble these monitoring systems may not be cost-effective.

5.4 Well Development Methods

The purpose of well development is to stabilize and increase the permeability of the gravel pack around the well screen, and to restore the permeability of the formation which may have been reduced by drilling operations. Wells are typically developed until all fine material and drilling water is removed from the well. Sequential measurements of pH, conductivity and temperature taken during development may yield information (stabilized values) that sufficient development is reached. The selection of the well development method shall be made by the rig geologist and is based on the drilling methods, well construction and installation details, and the characteristics of the formation that the well is screened in. The primary methods of well development are summarized below. A more detailed discussion may be found in Driscoll (1986).

5.4.1 Overpumping and Backwashing

Wells may be developed by alternatively drawing the water level down at a high rate (by pumping or bailing) and then reversing the flow direction (backwashing) so that water is passing from the well into the formation. This back and forth movement of water through the well screen and gravel pack serves to remove fines from the formation immediately adjacent to the well, while preventing bridging (wedging) of sand grains. Backwashing can be accomplished by several methods, including pouring water into the well and then bailing, starting and stopping a pump intermittently to change water levels, or forcing water into the well under pressure through a water-tight fitting ("rawhiding"). Care should be taken when backwashing not to apply too much pressure, which could damage or destroy the well screen.

5.4.2 Surging with a Surge Plunger

A surge plunger (also called a surge block) is approximately the same diameter as the well casing and is used to agitate the water, causing it to move in and out of the screens. This movement of water pulls fine materials into the well, where they may be removed by any of several methods, and prevents bridging of sand particles in the gravel pack. There are two basic types of surge plungers; solid and valved surge plungers. In formations with low yields, a valved surge plunger may be preferred, as solid

plungers tend to force water out of the well at a greater rate than it will flow back in. Valved plungers are designed to produce a greater inflow than outflow of water during surging.

5.4.3 Compressed Air

Compressed air can be used to develop a well by either of two methods: backwashing or surging. Backwashing is done by forcing water out through the screens, using increasing air pressure inside a sealed well, then releasing the pressurized air to allow the water to flow back into the well. Care should be taken when using this method so that the water level does not drop below the top of the screen, thus reducing well yield. Surging, or the "open well" method, consists of alternately releasing large volumes of air suddenly into an open well below the water level to produce a strong surge by virtue of the resistance of water head, friction, and inertia. Pumping of the well is subsequently done using the air lift method.

5.4.4 High Velocity Jetting

In the high velocity jetting method, water is forced at high velocities from a plunger-type device and through the well screen to loosen fine particles from the sand pack and surrounding formation. The jetting tool is slowly rotated and raised and lowered along the length of the well screen to develop the entire screened area. Jetting using a hose lowered into the well may also be effective. The fines washed into the screen during this process can then be bailed or pumped from the well.

6.0 REFERENCES

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7.0 RECORDS

A critical part of monitoring well installation is recording of significant details and events in the site logbook or field notebook. The geologist must record the exact depths of significant hydrogeological features screen placement, gravel pack placement, and bentonite placement.

A Monitoring Well Sheet (see Attachments to SOP SA-6.3) shall be completed thus ensuring the uniform recording of data for each installation and rapid identification of missing information. Well depth, length, materials of construction, length and openings of screen, length and type of riser, and depth and type of all backfill materials shall be recorded. Additional information shall include location, installation date, problems encountered, water levels before and after well installation, cross-reference to the geologic boring log, and methods used during the installation and development process. Documentation is very important to prevent problems involving questionable sample validity. Somewhat different information

will need to be recorded.depending on whether the well is completed in overburden, in a confined layer, in bedrock with a cased well, or as an open hole in bedrock.

The quantities of sand, bentonite, and grout placed in the well are also important. The geologist shall calculate the annular space volume and have a general idea of the quantity of material needed to fill the annular space. Volumes of backfill significantly higher than the calculated volume may indicate a problem such as a large cavity, while a smaller backfill volume may indicate a cave-in. Any problems with rig operation or down-time shall be recorded and may affect the driller's final fee.

ATTACHMENT A

RELATIVE COMPATIBILITY OF RIGID WELL CASING MATERIAL (PERCENT)

Potentially-Deteriorating Substance	Type of Casing Material						
	PVC 1	Galvanized Steel	Carbon Steel	Lo-carbon Steel	Stainless Steel 304	Stainless Steel 316	Teflon*
Buffered Weak Acid	100	56	51	59	97	100	100
Weak Acid	98	59	43	47	96	100	100
Mineral Acid/ High Solids Content	100	48	57	60	80	82	100
Aqueous/Organic Mixtures	64	69	73	73	98	100	100
Percent Overall Rating	91	58	56	59	93	96	100

Preliminary Ranking of Rigid Materials:

1 Teflon®
2 Stainless Steel 316
3. Stainless Steel 304
4 PVC 1
5 Lo-Carbon Steel
6 Galvanized Steel
7 Carbon Steel

* Trademark of DuPont

RELATIVE COMPATIBILITY OF SEMI-RIGID OR ELASTOMERIC MATERIALS (PERCENT)

Potentially-Deteriorating Substance	Type of Casing Material								
	PVC Flexible	PP	PE Conv.	PE Linear	PMM	Viton®*	Silicone	Neoprene	Teflon®*
Buffered Weak Acid	97	97	100	97	90	92	87	85	100
Weak Acid	92	90	94	96	78	78	75	75	100
Mineral Acid/ High Solids Content	100	100	100	100	95	100	78	82	100
Aqueous/Organic Mixtures	62	71	40	60	49	78	49	44	100
Percent Overall Rating	88	90	84	88	78	87	72	72	100

Preliminary Ranking of Semi-Rigid or Elastomeric Materials:

1 Teflon®
2 Polypropylene (PP)
3. PVC Flexible/PE Linear
4 Viton®
5 PE Conventional
6 Plexiglas/Lucite (PMM)
7 Silicone/Neoprene

* Trademark of DuPont

Source: Barcelona et al., 1983

ATTACHMENT B

COMPARISON OF STAINLESS STEEL AND PVC FOR MONITORING WELL CONSTRUCTION

Characteristic	Stainless Steel	PVC
Strength	Use in deep wells to prevent compression and closing of screen/riser.	Use when shear and compressive strength are not critical.
Weight	Relatively heavier.	Light-weight; floats in water.
Cost	Relatively expensive.	Relatively inexpensive.
Corrosivity	Deteriorates more rapidly in corrosive water.	Non-corrosive -- may deteriorate in presence of ketones, aromatics, alkyl sulfides, or some chlorinated hydrocarbons.
Ease of Use	Difficult to adjust size or length in the field.	Easy to handle and work with in the field.
Preparation for Use	Should be steam cleaned organics will be subsequently sampled.	Never use glue fittings -- pipes should be threaded or pressure fitted. Should be steam cleaned when used for monitoring wells.
Interaction with Contaminants*	May sorb organic or inorganic substances when oxidized.	May sorb or release organic substances.

* See also Attachment A.

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1.0 PURPOSE

The purpose of this procedure is to provide general reference information regarding the sampling of groundwater wells.

2.0 SCOPE

This procedure provides information on proper sampling equipment, onsite water quality testing, and techniques for groundwater sampling. Review of the information contained herein will facilitate planning of the field sampling effort by describing standard sampling techniques. The techniques described shall be followed whenever applicable, noting that site-specific conditions or project-specific plans may require modifications to methodology.

3.0 GLOSSARY

Conductance - The conductance of a conductor 1 centimeter long and 1 square centimeter in cross-sectional area. For groundwater measurements, a volume of water contained in a 1 cm x 1 cm sample container (the water acts as the conductor). Conductivity and specific conductance are used synonymously.

Electrolytic Cell - An electrochemical cell in which electrical energy is supplied from an external source. This cell functions in much the same way as a galvanic cell, only the current flows in the opposite direction due to the external source of applied voltage. Electrolytic cells are used in dissolved oxygen measurement.

Galvanic Cell - A electrochemical cell in which chemical energy is spontaneously converted to electrical energy. The electrical energy produced is supplied to an external circuit. Galvanic cells are used in dissolved oxygen measurement.

Ohm - Standard unit of electrical resistance (R). Used in specific conductance measurement. A siemen (or umho) is the standard unit of electrical conductance, the inverse of the ohm.

Oxidation-Reduction Potential (ORP) - A measure of the activity ratio of oxidizing and reducing species as determined by the electromotive force developed by a noble metal electrode, immersed in water, as referenced against a standard hydrogen electrode.

pH - The negative logarithm (base 10) of the hydrogen ion activity. The hydrogen ion activity is related to the hydrogen ion concentration, and, in a relatively weak solution, the two are nearly equal. Thus, for all practical purposes, pH is a measure of the hydrogen ion concentration.

pH Paper - Indicator paper that turns different colors depending on the pH of the solution to which it is exposed. Comparison with color standards supplied by the manufacturer will then give an indication of the solution's pH.

Resistance - A measure of the solution's ability to oppose the passage of electrical current. For metals and solutions, resistance is defined by Ohm's Law, $E = IR$, where E is the potential difference, I is the current, and R is the resistance. Used in measurement of specific conductance.

4.0 RESPONSIBILITIES

Project Hydrogeologist - Responsible for selecting and detailing the specific groundwater sampling techniques, onsite water quality testing (type, frequency, and location), and equipment to be used, and providing detailed input in this regard to the project plan documents. The project hydrogeologist is also responsible for properly briefing and overseeing the performance of the site sampling personnel.

Project Geologist - is primarily responsible for the proper acquisition of the groundwater samples. He/she is also responsible for the actual analyses of onsite water quality samples, as well as instrument calibration, care, and maintenance. When appropriate, such responsibilities may be performed by other qualified personnel (e.g., field technicians).

5.0 PROCEDURES

5.1 General

To be useful and accurate, a groundwater sample must be representative of the particular zone of the water being sampled. The physical, chemical, and bacteriological integrity of the sample must be maintained from the time of sampling to the time of analysis in order to keep any changes in water quality parameters to a minimum.

Methods for withdrawing samples from completed wells include the use of pumps, compressed air, bailers, and various types of samplers. The primary considerations in obtaining a representative sample of the groundwater are to avoid collection of stagnant (standing) water in the well and to avoid physical or chemical alteration of the water due to sampling techniques. In a non-pumping well, there will be little or no vertical mixing of water in the well pipe or casing, and stratification will occur. The well water in the screened section will mix with the groundwater due to normal flow patterns, but the well water above the screened section will remain isolated and become stagnant. To safeguard against collecting non-representative stagnant water in a sample, the following approach shall be followed prior to sample acquisition:

1. All monitoring wells shall be purged prior to obtaining a sample. Evacuation of three to five volumes is recommended prior to sampling. In a high-yielding groundwater formation and where there is no stagnant water in the well above the screened section, extensive evacuation prior to sample withdrawal is not as critical.

2. For wells that can be purged dry, the well shall be evacuated and allowed to recover prior to sample acquisition. If the recovery rate is fairly rapid, evacuation of more than one volume of water is required.

3. For high-yielding monitoring wells which cannot be evacuated to dryness, there is no absolute safeguard against contaminating the sample with stagnant water. One of the following techniques shall be used to minimize this possibility:

   - A submersible pump or the intake line of a surface pump or bailer shall be placed just below the water surface when removing the stagnant water and lowered as the water level drops. Three to five volumes of water shall be removed to provide reasonable assurance that all stagnant water has been evacuated. Once this is accomplished, a bailer or other approved device may be used to collect the sample for analysis.

- The intake line of the sampling pump (or the submersible pump itself) shall be placed near the bottom of the screened section, and approximately one casing volume of water shall be pumped from the well at a low purge rate, equal to the well's recovery rate (low flow sampling).

Stratification of contaminants may exist in the aquifer. Concentration gradients as a result of mixing and dispersion processes, layers of variable permeability, and the presence of separate-phase product (i.e, floating hydrocarbons) may cause stratification. Excessive pumping or improper sampling methods can dilute or increase the contaminant concentrations in the recovered sample compared to what is representative of the integrated water column as it naturally occurs at that point, thus the result is the collection of a non-representative sample.

5.2 Sampling, Monitoring, and Evacuation Equipment

Sample containers shall conform with the guidelines expressed in SOP SA-6.1.

The following equipment shall be on hand when sampling ground water wells (reference SOPs SA-6.1 and SA-7.1):

- Sample packaging and shipping equipment - Coolers for sample shipping and cooling, chemical preservatives, appropriate sampling containers and filler, ice, labels and chain-of-custody documents.

- Field tools and instrumentation - Thermometer, pH paper/meter, camera and film (if appropriate), appropriate keys (for locked wells), engineer's rule, water level indicator, specific conductivity meter, and turbidity meter (as applicable).

- Pumps

  - Shallow-well pumps: Centrifugal, pitcher, suction, or peristaltic pumps with droplines, air-lift apparatus (compressor and tubing) where applicable.

  - Deep-well pumps: Submersible pump and electrical power-generating unit, or air-lift apparatus where applicable.

- Other sampling equipment - Bailers and inert line with tripod-pulley assembly (if necessary). Bailers or submersible centrifugal pumps shall be used to obtain samples for volatile organics from shallow and deep groundwater wells.

- Pails - Plastic, graduated.

- Decontamination solutions - Deionized water, laboratory detergents, 10% nitric acid solution (as required), and analytical-grade solvents (e.g., methanol, acetone, hexane), as required.

Ideally, sample withdrawal equipment shall be completely inert, economical, easily cleaned, cleaned prior to use, reusable, able to operate at remote sites in the absence of power sources, and capable of delivering variable rates for well flushing and sample collection.

5.3 Calculations of Well Volume

To insure that the proper volume of water has been removed from the well prior to sampling it is first necessary to know the volume of standing water in the well pipe. This volume can be easily calculated by the following method. Calculations shall be entered in the site logbook or field notebook or on a sample log sheet form (see SOP SA-6.3):

- Obtain all available information on well construction (location, casing, screens, etc.).
- Determine well or casing diameter.
- Measure and record static water level (depth below ground level or top of casing reference point).
- Determine depth of well by sounding using a clean, decontaminated, weighted tape measure.
- Calculate number of linear feet of static water (total depth or length of well pipe minus the depth to static water level).
- Calculate one static well volume in gallons $V = (0.163)(T)(r^2)$

  where:
  - V = Static volume of well in gallons.
  - T = Thickness of water table in the well measured in feet (i.e., linear feet of static water).
  - r = Inside radius of well casing in inches.
  - 0.163 = A constant conversion factor which compensates for the conversion of the casing radius from inches to feet, the conversion of cubic feet to gallons, and pi.
- Per evacuation volumes discussed above, determine the minimum amount to be evacuated before sampling.

5.4 Evacuation of Static Water (Purging)

5.4.1 General

The amount of purging a well shall receive prior to sample collection will depend on the intent of the monitoring program and the hydrogeologic conditions. Programs to determine overall quality of water resources may require long pumping periods to obtain a sample that is representative of a large volume of that aquifer. The pumped volume may be specified prior to sampling so that the sample can be a composite of a known volume of the aquifer. Alternately the well can be pumped until the parameters such as temperature, electrical conductance, pH, and turbidity (as applicable), have stabilized. Onsite measurements of these parameters shall be recorded in the site logbook, field notebook, or on standardized data sheets.

5.4.2 Evacuation Devices

The following discussion is limited to those devices commonly used at hazardous waste sites. Attachment A provides guidance on the proper evacuation device to use for given sampling situations. Note that all of these techniques involve equipment which is portable and readily available.

Bailers

Bailers are the simplest evacuation devices used and have many advantages. They generally consist of a length of pipe with a sealed bottom (bucket-type bailer) or, as is more useful and favored, with a ball check-valve at the bottom. An inert line is used to lower the bailer and retrieve the sample.

Advantages of bailers include:

- Few limitations on size and materials used for bailers.
- No external power source needed.
- Bailers are inexpensive, and can be dedicated and hung in a well to reduce the chances of cross-contamination.
- There is minimal outgassing of volatile organics while the sample is in the bailer.
- Bailers are relatively easy to decontaminate.

Limitations on the use of bailers include the following:

- It is time consuming to remove stagnant water using a bailer.
- Transfer of sample may cause aeration.
- Use of bailers is physically demanding, especially in warm temperatures at protection levels above Level D.

Suction Pumps

There are many different types of inexpensive suction pumps including centrifugal, diaphragm, peristaltic, and pitcher pumps. Centrifugal and diaphragm pumps can be used for well evacuation at a fast pumping rate and for sampling at a low pumping rate. The peristaltic pump is a low volume pump that uses rollers to squeeze a flexible tubing, thereby creating suction. This tubing can be dedicated to a well to prevent cross contamination. The pitcher pump is a common farm hand-pump.

These pumps are all portable, inexpensive and readily available. However, because they are based on suction, their use is restricted to areas with water levels within 20 to 25 feet of the ground surface. A significant limitation is that the vacuum created by these pumps can cause significant loss of dissolved gases and volatile organics.

Air-Lift Samplers

This group of pump samplers uses gas pressure either in the annulus of the well or in a venturi to force the water up a sampling tube. These pumps are also relatively inexpensive. Air (or gas)-lift samplers are more suitable for well development than for sampling because the samples may be aerated, leading to pH changes and subsequent trace metal precipitation, or loss of volatile organics.

Submersible Pumps

Submersible pumps take in water and push the sample up a sample tube to the surface. The power sources for these samplers may be compressed gas or electricity. The operation principles vary and the displacement of the sample can be by an inflatable bladder, sliding piston, gas bubble, or impeller. Pumps are available for 2-inch-diameter wells and larger. These pumps can lift water from considerable depths (several hundred feet).

Limitations of this class of pumps include:

- They may have low delivery rates.
- Many models of these pumps are expensive.
- Compressed gas or electric power is needed.
- Sediment in water may cause clogging of the valves or eroding the impellers with some of these pumps.
- Decontamination of internal components can be difficult and time-consuming.

5.5 Onsite Water Quality Testing

This section describes the procedures and equipment required to measure the following parameters of an aqueous sample in the field:

- pH
- Specific Conductance
- Temperature
- Dissolved Oxygen (DO) Concentration
- Oxidation Reduction Potential
- Certain Dissolved Constituents Using Specific Ion Elements
- Turbidity

This section is applicable for use in an onsite groundwater quality monitoring program to be conducted at a hazardous or nonhazardous site. The procedures and equipment described are applicable to groundwater samples and are not, in general, subject to solution interferences from color, turbidity, and colloidal material or suspended matter.

This section provides general information for measuring the parameters listed above with instruments and techniques in common use. Since instruments from different manufacturers may vary, review of the manufacturer's literature pertaining to the use of a specific instrument is required before use.

5.5.1 Measurement of pH

5.5.1.1 General

Measurement of pH is one of the most important and frequently used tests in water chemistry. Practically every phase of water supply and wastewater treatment such as acid-base neutralization, water softening, and corrosion control is pH dependent. Likewise, the pH of leachate can be correlated with other chemical analyses to determine the probable source of contamination. It is therefore important that reasonably accurate pH measurements be taken.

Two methods are given for pH measurement: the pH meter and pH indicator paper. The indicator paper is used when only a rough estimate of the pH is required, and the pH meter when a more accurate measurement is needed. The response of a pH meter can be affected to a slight degree by high levels of colloidal or suspended solids, but the effect is usually small and generally of little significance. Consequently, specific methods to overcome this interference are not described. The response of pH paper is unaffected by solution interferences from color, turbidity, colloidal or suspended materials unless extremely high levels capable of coating or masking the paper are encountered. In such cases, use of a pH meter is recommended.

5.5.1.2 Principles of Equipment Operation

Use of pH papers for pH measurement relies on a chemical reaction caused by the acidity or basicity of the solution created by the addition of the water sample reacting with the indicator compound on the paper. Various types of pH papers are available, including litmus (for general acidity or basicity determination) and specific pH range hydrion paper.

Use of a pH meter relies on the same principle as other ion-specific electrodes. Measurement relies on establishment of a potential difference across a glass or other type of membrane in response to (in this instance, hydrogen) ion concentration across that membrane. The membrane is conductive to ionic species and, in combination with a standard or reference electrode, a potential difference proportional to the ion concentration is generated and measured.

5.5.1.3 Equipment

The following equipment is needed for taking pH measurements:

- Stand-alone 150 portable pH meter, or combination meter (e.g., Horiba U-10), or combination meter equipped with an in-line sample chamber.
- Combination electrode with polymer body to fit the above meter (alternately a pH electrode and a reference electrode can be used if the pH meter is equipped with suitable electrode inputs).
- Buffer solutions, as specified by the manufacturer.
- pH indicator paper, to cover the pH range 2 through 12.
- Manufacturer's operation manual.

5.5.1.4 Measurement Techniques for Field Determination of pH

pH Meter

The following procedure is used for measuring pH with a pH meter (meter standardization is according to manufacturer's instructions):

- Inspect the instrument and batteries prior to initiation of the field effort.
- Check the integrity of the buffer solutions used for field calibration. Buffer solutions need to be changed often as a result of degradation upon exposure to the atmosphere.

- Immerse the tip of the electrodes in water overnight. If this is not possible due to field conditions, immerse the electrode tip in water for at least an hour before use. The electrode tip may be immersed in a rubber or plastic sack containing buffer solution for field transport or storage. This is not applicable for all electrodes as some must be stored dry.

- If applicable, make sure all electrolyte solutions within the electrode(s) are at their proper levels and that no air bubbles are present within the electrode(s).

- Calibrate on a daily use basis following manufacturer's instructions. Record calibration data on an equipment calibration log sheet.

- Immerse the electrode(s) in the unknown solution, slowly stirring the probe until the pH stabilizes. Stabilization may take several seconds to minutes. If the pH continues to drift, the sample temperature may not be stable, a physical reaction (e.g., degassing) may be taking place in the sample, or the meter or electrode may be malfunctioning. This must be clearly noted in the logbook.

- Read and record the pH of the solution. pH shall be recorded to the nearest 0.1 pH unit. Also record the sample temperature.

- Rinse the electrode(s) with deionized water.

- Store the electrode(s) in an appropriate manner when not in use.

Any visual observation of conditions which may interfere with pH measurement, such as oily materials, or turbidity, shall be noted.

pH Paper

Use of pH paper is very simple and requires no sample preparation, standardization, etc. pH paper is available in several ranges, including wide-range (indicating approximately pH 1 to 12), mid-range (approximately pH 0 to 6, 6 to 9, 8 to 14) and narrow-range (many available, with ranges as narrow as 1.5 pH units). The appropriate range of pH paper shall be selected. If the pH is unknown the investigation shall start with wide-range paper and proceed with successively narrower range paper until the sample pH is adequately determined.

5.5.2 Measurement of Specific Conductance

5.5.2.1 General

Conductance provides a measure of dissolved ionic species in water and can be used to identify the direction and extent of migration of contaminants in groundwater or surface water. It can also be used as a measure of subsurface biodegradation or to indicate alternate sources of groundwater contamination.

Conductivity is a numerical expression of the ability of a water sample to carry an electric current. This value depends on the total concentration of the ionized substances dissolved in the water and the temperature at which the measurement is made. The mobility of each of the various dissolved ions, their valences, and their actual and relative concentrations affect conductivity.

It is important to obtain a specific conductance measurement soon after taking a sample, since temperature changes, precipitation reactions, and absorption of carbon dioxide from the air all affect the specific conductance.

5.5.2.2 Principles of Equipment Operation

An aqueous system containing ions will conduct an electric current. In a direct-current field, the positive ions migrate toward the negative electrode, while the negatively charged ions migrate toward the positive electrode. Most inorganic acids, bases and salts (such as hydrochloric acid, sodium carbonate, or sodium chloride, respectively) are relatively good conductors. Conversely, organic compounds such as sucrose or benzene, which do not disassociate in aqueous solution, conduct a current very poorly, if at all.

A conductance cell and a Wheatstone Bridge (for the measurement of potential difference) may be used for measurement of electrical resistance. The ratio of current applied to voltage across the cell may also be used as a measure of conductance. The core element of the apparatus is the conductivity cell containing the solution of interest. Depending on ionic strength of the aqueous solution to be tested, a potential difference is developed across the cell which can be converted directly or indirectly (depending on instrument type) to a measurement of specific conductance.

5.5.2.3 Equipment

The following equipment is needed for taking specific conductance (SC) measurements:

- Stand alone portable conductivity meter, or combination meter (e.g., Horiba U-10), or combination meter equipped with an in-line sample chamber.
- Calibration solution, as specified by the manufacturer.
- Manufacturer's operation manual.

A variety of conductivity meters are available which may also be used to monitor salinity and temperatures. Probe types and cable lengths vary, so equipment must be obtained to meet the specific requirement of the sampling program.

5.5.2.4 Measurement Techniques for Specific Conductance

The steps involved in taking specific conductance measurements are listed below (standardization is according to manufacturer's instructions):

- Check batteries and calibrate instrument before going into the field.

- Calibrate on a daily use basis, according to the manufacturer's instructions and record all pertinent information on an equipment calibration log sheet. Potassium chloride solutions with a SC closest to the values expected in the field shall be used for calibration. Attachment B provides guidance in this regard.

- Rinse the cell with one or more portions of the sample to be tested or with deionized water.

- Immerse the electrode in the sample and measure the conductivity. Adjust the temperature setting to the sample temperature (if applicable).
- Read and record the results in a field logbook or sample log sheet.
- Rinse the electrode with deionized water.

If the specific conductance measurements become erratic, recalibrate the instrument and see the manufacturer's instructions for details.

5.5.3 Measurement of Temperature

5.5.3.1 General

In combination with other parameters, temperature can be a useful indicator of the likelihood of biological action in a water sample. It can also be used to trace the flow direction of contaminated groundwater. Temperature measurements shall be taken in-situ, or as quickly as possible in the field. Collected water samples may rapidly equilibrate with the temperature of their surroundings.

5.5.3.2 Equipment

Temperature measurements may be taken with alcohol-toluene, mercury filled or dial-type thermometers. In addition, various meters such as specific conductance or dissolved oxygen meters, which have temperature measurement capabilities, may also be used. Using such instrumentation along with suitable probes and cables, in-situ measurements of temperature at great depths can be performed.

5.5.3.3 Measurement Techniques for Water Temperature

If a thermometer is used to determine the temperature for a water sample:

- Immerse the thermometer in the sample until temperature equilibrium is obtained (1-3 minutes). To avoid the possibility of cross-contamination, the thermometer shall not be inserted into samples which will undergo subsequent chemical analysis.
- Record values in a field logbook or sample log sheet.

If a temperature meter or probe is used, the instrument shall be calibrated according to manufacturer's recommendations.

5.5.4 Measurement of Dissolved Oxygen Concentration

5.5.4.1 General

Dissolved oxygen (DO) levels in natural water and wastewater depend on the physical, chemical and biochemical activities in the water body. Conversely, the growth of many aquatic organisms as well as the rate of corrosivity, are dependent on the dissolved oxygen concentration. Thus, analysis for dissolved oxygen is a key test in water pollution and waste treatment process control. If at all possible, DO measurements shall be taken in-situ, since concentration may show a large change in a short time if the sample is not adequately preserved.

The monitoring method discussed herein is limited to the use of dissolved oxygen meters only. Chemical methods of analysis (i.e., Winkler methods) are available, but require more equipment and greater sample manipulation. Furthermore, DO meters, using a membrane electrode, are suitable for highly polluted waters, because the probe is completely submersible, and is not susceptible to interference caused by color, turbidity, colloidal material or suspended matter.

5.5.4.2 Principles of Equipment Operation

Dissolved oxygen probes are normally electrochemical cells that have two solid metal electrodes of different nobility immersed in an electrolyte. The electrolyte is retained by an oxygen-permeable membrane. The metal of highest nobility (the cathode) is positioned at the membrane. When a suitable potential exists between the two metals, reduction of oxygen to hydroxide ion (OH) occurs at the cathode surface. An electrical current is developed that is directly proportional to the rate of arrival of oxygen molecules at the cathode.

Since the current produced in the probe is directly proportional to the rate of arrival of oxygen at the cathode, it is important that a fresh supply of sample always be in contact with the membrane. Otherwise, the oxygen in the aqueous layer along the membrane is quickly depleted and false low readings are obtained. It is therefore necessary to stir the sample (or the probe) constantly to maintain fresh solution near the membrane interface. Stirring, however, shall not be so vigorous that additional oxygen is introduced through the air-water interface at the sample surface. To avoid this possibility, some probes are equipped with stirrers to agitate the solution near the probe, while leaving the surface of the solution undisturbed.

Dissolved oxygen probes are relatively unaffected by interferences. Interferences that can occur are reactions with oxidizing gases (such as chlorine) or with gases such as hydrogen sulfide, which are not easily depolarized from the indicating electrode. If a gaseous interference is suspected, it shall be noted in the field log book and checked if possible. Temperature variations can also cause interference because probes exhibit temperature sensitivity. Automatic temperature compensation is normally provided by the manufacturer.

5.5.4.3 Equipment

The following equipment is needed to measure dissolved oxygen concentration:

- Stand alone portable dissolved oxygen meter, or combination meter (e.g., Horiba U-10), or combination meter equipped with an in-line sample chamber.
- Sufficient cable to allow the probe to contact the sample.
- Manufacturer's operation manual.

5.5.4.4 Measurement Techniques for Dissolved Oxygen Determination

Probes differ as to specifics of use. Follow the manufacturer's instructions to obtain an accurate reading. The following general steps shall be used to measure the dissolved oxygen concentration:

- The equipment shall be calibrated and have its batteries checked in the warehouse before going to the field.

- The probe shall be conditioned in a water sample for as long a period as practical before use in the field. Long periods of dry storage followed by short periods of use in the field may result in inaccurate readings.

- The instrument shall be calibrated in the field according to manufacturer's recommendations or in a freshly air-saturated water sample of known temperature. Dissolved oxygen values for air-saturated water can be determined by consulting a table listing oxygen solubilities as a function of temperature and salinity (see Attachment C).

- Record all pertinent information on an equipment calibration sheet.

- Rinse the probe with deionized water.

- Immerse the probe in the sample. Be sure to provide for sufficient flow past the membrane by stirring the sample. Probes without stirrers placed in wells can be moved up and down.

- Record the dissolved oxygen content and temperature of the sample in a field logbook or sample log sheet.

- Rinse the probe with deionized water.

- Recalibrate the probe when the membrane is replaced, or as needed. Follow the manufacturer's instructions.

Note that in-situ placement of the probe is preferable, since sample handling is not involved. This however, may not always be practical. Be sure to record whether the liquid was analyzed in-situ, or if a sample was taken.

Special care shall be taken during sample collection to avoid turbulence which can lead to increased oxygen solubilization and positive test interferences.

5.5.5 Measurement of Oxidation-Reduction Potential

5.5.5.1 General

The oxidation-reduction potential (ORP) provides a measure of the tendency of organic or inorganic compounds to exist in an oxidized state. The ORP parameter therefore provides evidence of the likelihood of anaerobic degradation of biodegradable organics or the ratio of activities of oxidized to reduced species in the sample.

5.5.5.2 Principles of Equipment Operation

When an inert metal electrode, such as platinum, is immersed in a solution, a potential is developed at that electrode depending on the ions present in the solution. If a reference electrode is placed in the same solution, an ORP electrode pair is established. This electrode pair allows the potential difference between the two electrodes to be measured and is dependent on the concentration of the ions in solution. By this measurement, the ability to oxidize or reduce species in solution may be determined. Supplemental measurements, such as dissolved oxygen, may be correlated with ORP to provide a knowledge of the quality of the solution, water, or wastewater.

5.5.5.3 Equipment

The following equipment is needed for measuring the oxidation-reduction potential of a solution:

- Portable pH meter or equivalent, with a millivolt scale.
- Platinum electrode to fit above pH meter.
- Reference electrode such as a calomel, silver-silver chloride, or equivalent.
- Reference solution as specified by the manufacturer.
- Manufacturer's operation manual.

5.5.5.4 Measurement Techniques for Oxidation-Reduction Potential

The following procedure is used for measuring oxidation-reduction potential:

- The equipment shall be calibrated and have its batteries checked before going to the field.

- Check that the platinum probe is clean and that the platinum bond or tip is unoxidized. If dirty, polish with emery paper or, if necessary, clean the electrode using aqua regia, nitric acid, or chromic acid, in accordance with manufacturer's instructions.

- Thoroughly rinse the electrode with deionized water.

- Verify the sensitivity of the electrodes by noting the change in millivolt reading when the pH of the test solution is altered. The ORP will increase when the pH of the test solution decreases and the ORP will decrease if the test solution pH is increased. Place the sample in a clean container and agitate the sample. Insert the electrodes and note the ORP drops sharply when the caustic is added (i.e., pH is raised) thus indicating the electrodes are sensitive and operating properly. If the ORP increases sharply when the caustic is added, the polarity is reversed and must be corrected in accordance with the manufacturer's instructions. If the ORP does not respond as above when the caustic is added, the electrodes shall be cleaned and the above procedure repeated.

- After the assembly has been checked for sensitivity, wash the electrodes with three changes of water or by means of a flowing stream of deionized water from a wash bottle. Place the sample in a clean container and insert the electrodes. Set temperature compensator throughout the measurement period. Read the millivolt potential of the solution, allowing sufficient time for the system to stabilize and reach temperature equilibrium. Measure successive portions of the sample until readings on two successive portions differ by no more than 10 mV. A system that is very slow to stabilize properly will not yield a meaningful ORP. Record all results in a field logbook or sample logsheet, including ORP (to nearest 10 mV), sample temperature and pH at the time of measurement.

5.5.6 Measurement of Turbidity

5.5.6.1 General

Turbidity in water is caused by suspended matter, such as clay, silt, finely divided organic and inorganic matter, soluble colored organic compounds, and microscopic organisms, including plankton. Turbidity is an expression of the optical property that causes light to be scattered and absorbed rather than transmitted in a straight line through the sample.

It is important to obtain a turbidity reading immediately after taking a sample, since irreversible changes in turbidity may occur if the sample is stored too long.

5.5.6.2 Principles of Equipment Operation

Turbidity is measured by the Nephelometric Method. This method is based on a comparison of the intensity of light scattered by the sample under defined conditions with the intensity of light scattered by a standard reference suspension under the same conditions. The higher the scattered light intensity, the higher the turbidity.

Formazin polymer is used as the reference turbidity standard suspension because of its ease of preparation combined with a higher reproducibility of its light-scattering properties than clay or turbid natural water. The turbidity of a specified concentration of formazin suspension is defined as 40 nephelometric units. This same suspension has an approximate turbidity of 40 Jackson units when measured on the candle turbidmeter. Therefore, nephelometric turbidity units (NTU) based on the formazin preparation will approximate units derived from the candle turbidimeter but will not be identical to them.

5.5.6.3 Equipment

The following equipment is needed for turbidity measurement:

- Stand alone portable turbidity meter, or combination meter (e.g., Horiba U-10), or combination meter equipped with an in-line sample chamber.
- Calibration solution, as specified by the manufacturer.
- Manufacturer's operation manual.

5.5.6.4 Measurements Techniques for Specific Conductance

The steps involved in taking turbidity measurements are listed below (standardization is according to manufacturer's instructions):

- Check batteries and calibrate instrument before going into the field.
- Check the expiration date (etc.) of the solutions used for field calibration.
- Calibrate on a daily use basis, according to the manufacturer's instructions and record all pertinent information on an equipment calibration log sheet.
- Rinse the cell with one or more portions of the sample to be tested or with deionized water.
- Immerse the probe in the sample and measure the turbidity. The reading must be taken immediately as suspended solids will settle over time resulting in a lower, inaccurate turbidity reading.

- Read and record the results in a field logbook or sample log sheet. Include a physical description of the sample, including color, qualitative estimate of turbidity, etc.

- Rinse the electrode with deionized water.

5.6 Sampling

5.6.1 Sampling Plan

The sampling approach consisting of the following, shall be developed as part of the project plan documents which are approved prior to beginning work in the field:

- Background and objectives of sampling.

- Brief description of area and waste characterization.

- Identification of sampling locations, with map or sketch, and applicable well construction data (well size, depth, screened interval, reference elevation).

- Intended number, sequence volumes, and types of samples. If the relative degrees of contamination between wells is unknown or insignificant, a sampling sequence which facilitates sampling logistics may be followed. Where some wells are known or strongly suspected of being highly contaminated, these shall be sampled last to reduce the risk of cross-contamination between wells as a result of the sampling procedures.

- Sample preservation requirements.

- Work schedule.

- List of team members.

- List of observers and contacts.

- Other information, such as the necessity for a warrant or permission of entry, requirement for split samples, access problems, location of keys, etc.

5.6.2 Sampling Methods

The collection of a groundwater sample consists of the following steps:

1. The site Health & Safety Officer (or designee) will first open the well cap and use volatile organic detection equipment (PID or FID) on the escaping gases at the well head to determine the need for respiratory protection.

2. When proper respiratory protection has been donned, sound the well for total depth and water level (using clean equipment) and record these data on a groundwarer sampling log sheet (see SOP SA-6.3); then calculate the fluid volume in the well pipe (as previously described in this SOP).

3. Calculate well volume to be removed as stated in Section 5.3.

4. Select the appropriate purging equipment (see Attachment A). If an electric submersible pump with packer is chosen, go to Step 10.

5. Lower the purging equipment or intake into the well to a short distance below the water level and begin water removal. Collect the purged water and dispose of it in an acceptable manner (as applicable). Lower the purging device, as required, to maintain submergence.

6. Measure the rate of discharge frequently. A graduated bucket and stopwatch are most commonly used; other techniques include use of pipe trajectory methods, weir boxes or flow meters.

7. Observe the peristaltic pump intake for degassing "bubbles." If bubbles are abundant and the intake is fully submerged, this pump is not suitable for collecting samples for volatile organics. Never collect volatile organics samples using a vacuum pump.

8. Purge a minimum of three to five casing volumes before sampling. In low-permeability strata (i.e., if the well is pumped to dryness), one volume will suffice. Purged water shall be collected in a designated container and disposed in an acceptable manner.

9. If sampling using a pump, lower the pump intake to midscreen (or the middle of the open section in uncased wells) and collect the sample. If sampling with a bailer, lower the bailer to the sampling level before filling.

10. (For pump and packer assembly only). Lower the assembly into the well so that the packer is positioned just above the screen or open section. Inflate the packer. Purge a volume equal to at least twice the screened interval (or unscreened open section volume below the packer) before sampling. Packers shall always be tested in a casing section above ground to determine proper inflation pressures for good sealing.

11. In the event that recovery time of the well is very slow (e.g., 24 hours or greater), sample collection can be delayed until the following day. If the well has been purged early in the morning, sufficient water may be standing in the well by the day's end to permit sample collection. If the well is incapable of producing a sufficient volume of sample at any time, take the largest quantity available and record this occurrence in the site logbook.

12. Fill sample containers (preserve and label as described in SOP SA-6.1).

13. Replace the well cap and lock as appropriate. Make sure the well is readily identifiable as the source of the samples.

14. Process sample containers as described in SOP SA-6.1.

15. Decontaminate equipment as described in SOP SA-7.1.

5.7 Low Flow Purging and Sampling

5.7.1 Scope & Application

Low flow purging and sampling techniques are sometimes required for groundwater sampling activities. The purpose of low flow purging and sampling is to collect groundwater samples that contain

"representative" amounts of mobile organic and inorganic constituents in the vicinity of the selected open well interval, at near natural flow conditions. The minimum stress procedure emphasizes negligible water level drawdown and low pumping rates in order to collect samples with minimal alterations in water chemistry. This procedure is designed primarily to be used in wells with a casing diameter of 2 inches or more and a saturated screen, or open interval, length of ten feet or less. Samples obtained are suitable for analyses of common types of groundwater contaminants (volatile and semi-volatile organic compounds, pesticides, PCBs, metals and other inorganic ions [cyanide, chloride, sulfate, etc.]). This procedure is not designed to collect non-aqueous phase liquids samples from wells containing light or dense non-aqueous phase liquids (LNAPLs or DNAPLs), using the low flow pumps.

The procedure is flexible for various well construction types and groundwater yields. The goal of the procedure is to obtain a turbidity level of less than 5 NTU and to achieve a water level drawdown of less than 0.3 feet during purging and sampling. If these goals cannot be achieved, sample collection can take place provided the remaining criteria in this procedure are met.

5.7.2 Equipment

The following equipment is required (as applicable) for low flow purging and sampling:

- Adjustable rate, submersible pump (e.g., centrifugal or bladder pump constructed of stainless steel or Teflon). Peristaltic pumps may be used only for inorganic sample collection.
- Disposable clear plastic bottom filling bailers may be used to check for and obtain samples of LNAPLs or DNAPLs.
- Tubing - Teflon, Teflon lined polyethylene, polyethylene, PVC, tygon steel tubing can be used to collect samples for analysis, depending on the analyses to be performed and regulatory requirements.
- Water level measuring device, 0.01 foot accuracy, (electronic devices are preferred for tracking water level drawdown during all pumping operations).
- Flow measurement supplies.
- Interface probe, if needed.
- Power source (generator, nitrogen tank, etc.). If a gasoline generator is used, it must be located downwind and at a safe distance from the well so that the exhaust fumes do not contaminate the samples.
- Indicator parameter monitoring instruments - pH, turbidity, specific conductance, and temperature. Use of a flow-through cell is recommended. Optional Indicators - eH and dissolved oxygen, flow-through cell is required. Standards to perform field calibration of instruments.
- Decontamination supplies.
- Logbook(s), and other forms (e.g., well purging forms).
- Sample Bottles.

- Sample preservation supplies (as required by the analytical methods).
- Sample tags or labels.
- Well construction data, location map, field data from last sampling event.
- Field Sampling Plan.
- PID or FID instrument for measuring VOCs (volatile organic compounds).

5.7.3 Purging and Sampling Procedure

Use a submersible pump to purge and sample monitoring wells which have a 2.0 inch or greater well casing diameter.

Measure and record the water level immediately prior to placing the pump in the well.

Lower pump, safety cable, tubing and electrical lines slowly into the well so that the pump intake is located at the center of the saturated screen length of the well. If possible keep the pump intake at least two feet above the bottom of the well, to minimize mobilization of sediment that may be present in the bottom of the well. Collection of turbid free water samples may be difficult if there is three feet or less of standing water in the well.

When starting the pump, slowly increase the pump speed until a discharge occurs. Check water level. Adjust pump speed to maintain little or no water level drawdown. The target drawdown should be less than 0.3 feet and it should stabilize. If the target of less than 0.3 feet cannot be achieved or maintained, the sampling is acceptable if remaining criteria in the procedure are met. Subsequent sampling rounds will probably have intake settings and extraction rates that are comparable to those used in the initial sampling rounds.

Monitor water level and pumping rate every three to five minutes (or as appropriate) during purging. Record pumping rate adjustments and depths to water. Pumping rates should, as needed, be reduced to the minimum capabilities of the pump (e.g., 0.1-0.2 l/min) to ensure stabilization of indicator parameters. Adjustments are best made in the first fifteen minutes of pumping in order to help minimize purging time. During initial pump start-up, drawdown may exceed the 0.3 feet target and then recover as pump flow adjustments are made (minimum purge volume calculations should utilize stabilized drawdown values, not the initial drawdown). If the recharge rate of the well is less than minimum capability of the pump do not allow the water level to fall to the intake level (if the static water level is above the screen, avoid lowering the water level into the screen). Shut off the pump if either of the above is about to occur and allow the water level to recover. Repeat the process until field indicator parameters stabilize and the minimum purge volume is removed. The minimum purge volume with negligible drawdown (0.3 feet or less) is two saturated screen length volumes. In situations where the drawdown is greater than 0.3 feet and has stabilized, the minimum purge volume is two times the saturated screen volume plus the stabilized drawdown volume. After the minimum purge volume is attained (and field parameters have stabilized) begin sampling. For low yields wells, commence sampling as soon as the well has recovered sufficiently to collect the appropriate volume for all anticipated samples.

During well purging, monitor field indicator parameters (turbidity, temperature, specific conductance, pH, etc.) every three to five minutes (or as appropriate). Purging is complete and sampling may begin when

all field indicator parameters have stabilized (variations in values are within ten percent of each other, pH +/- 0.2 units, for three consecutive readings taken at three to five minute intervals). If the parameters have stabilized, but turbidity remains above 5 NTU goal, decrease pump flow rate, and continue measurement of parameters every three to five minutes. If pumping rate cannot be decreased any further and stabilized turbidity values remain above 5 NTU goal record this information. Measurements of field parameters should be obtained (as per Section 5.5) and recorded.

VOC samples are preferably collected first and directly into pre-preserved sample containers. Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

If the water column in the pump tubing collapses (water does not completely fill the tubing) before exiting the tubing, use one of the following procedures to collect VOC samples: (1) Collect the non-VOCs samples first, then increase the flow rate incrementally until the water column completely fills the tubing, collect the sample and record the new flow rate; (2) reduce the diameter of the existing tubing until the water column fills the tubing either by adding a connector (Teflon or stainless steel), or clamp which should reduce the flow rate by constricting the end of the tubing; (3) insert a narrow diameter Teflon tube into the pump's tubing so that the end of the tubing is in the water column and the other end of the tubing protrudes beyond the pump's tubing, collect sample from the narrow diameter tubing.

Prepare samples for shipping as per SOP SA-6.1.

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ATTACHMENT A

PURGING EQUIPMENT SELECTION

Diameter Casing		Bailer	Peristaltic Pump	Vacuum Pump	Air-lift	Diaphragm "Trash" Pump	Submersible Diaphragm Pump	Submersible Electric Pump	Submersible Electric Pump w/Packer
1.25-Inch	Water level <25 feet		X	X	X	X			
	Water Level >25 feet				X				
2-Inch	Water level <25 feet	X	X	X	X	X	X		
	Water Level >25 feet	X			X		X		
4-Inch	Water level <25 feet	X	X	X	X	X	X	X	X
	Water Level >25 feet	X			X		X	X	X
6-Inch	Water level <25 feet				X	X		X	X
	Water Level >25 feet				X			X	X
8-Inch	Water level <25 feet				X	X		X	X
	Water Level >25 feet				X			X	X

ATTACHMENT A
PURGING EQUIPMENT SELECTION
PAGE 2

Manufacturer	Model Name/Number	Principle of Operation	Maximum Outside Diameter/ Length (Inches)	Construction Materials (w/Lines and Tubing)	Lift Range (ft)	Delivery Rates or Volumes	1982 Price (Dollars)	Comments
BarCad Systems, Inc.	BarCad Sampler	Dedicated; gas drive (positive displacement)	1.5/16	PE, brass, nylon, aluminum oxide	0-150 with std. tubing	1 liter for each 10-15 feet of submergence	$220-350	Requires compressed gas; custom sizes and materials available; acts as piezometer.
Cole-Parmer Inst. Co.	Master Flex 7570 Portable Sampling Pump	Portable; peristaltic (suction)	<1.0/NA	(not submersible) Tygon®, silicone Viton®	0-30	670 mL/min with 7015-20 pump head	$500-600	AC/DC; variable speed control available; other models may have different flow rates.
ECO Pump Corp.	SAMPLifier	Portable; venturi	<1.5 or <2.0/NA	PP, PE, PVC, SS, Teflon®, Tefzel®	0-100	0-500 mL/min depending on lift	$400-700	AC, DC, or gasoline-driven motors available; must be primed.
Geltek Corp.	Bailer 219-4	Portable; grab (positive displacement)	1.66/38	Teflon®	No limit	1,075 mL	$120-135	Other sizes available.
GeoEngineering, Inc.	GEO-MONITOR	Dedicated; gas drive (positive displacement)	1.5/16	PE, PP, PVC, Viton®	Probably 0-150	Approximately 1 liter for each 10 feet of submergence	$185	Acts as piezometer; requires compressed gas.
Industrial and Environmental Analysts, Inc. (IEA)	Aquarius	Portable; bladder (positive displacement)	1.75/43	SS, Teflon®, Viton®	0-250	0-2,800 mL/min	$1,500-3,000	Requires compressed gas; other models available; AC, DC, manual operation possible.
IEA	Syringe Sampler	Portable; grab (positive displacement)	1.75/43	SS, Teflon®	No limit	850 mL sample volum e	$1,100	Requires vacuum and/or pressure from hand pump.
Instrument Specialties Co. (ISCO)	Model 2600 Well Sampler	Portable; bladder (positive displacement)	1.75/50	PC, silicone, Teflon®, PP, PE, Detrin®, acetal	0-150	0-7,500 mL/min	$990	Requires compressed gas (40 psi minimum).
Keck Geophysical Instruments, Inc.	SP-81 Submersible Sampling Pump	Portable; helical rotor (positive displacement)	1.75/25	SS, Teflon®, PP, EPDM, Viton®	0-160	0-4,500 mL/min	$3,500	DC operated.
Leonard Mold and Die Works, Inc.	GeoFilter Small Diameter Well Pump (#0500)	Portable; bladder (positive displacement)	1.75/38	SS, Teflon®, PC, Neoprene®	0-400	0-3,500 mL/min	$1,400-1,500	Requires compressed gas (55 psi minimum); pneumatic or AC/DC control module.
Oil Recovery Systems, Inc.	Surface Sampler	Portable; grab (positive displacement)	1.75/12	acrylic, Detrin®	No limit	Approximately 250 mL	$125-160	Other materials and models available; for measuring thickness of "floating" contaminants.
Q.E.D. Environmental Systems, Inc.	Well Wizard® Monitoring System (P-100)	Dedicated; bladder (positive displacement)	1.66/36	PVC	0-230	0-2,000 mL/min	$300-400	Requires compressed gas; piezometric level indicator; other materials available.

ATTACHMENT A
PURGING EQUIPMENT SELECTION
PAGE 3

Manufacturer	Model Name/Number	Principle of Operation	Maximum Outside Diameter/ Length (Inches)	Construction Materials (w/Lines and Tubing)	Lift Range (ft)	Delivery Rates or Volumes	1982 Price (Dollars)	Comments
Randolph Austin Co.	Model 500 Vari-Flow Pump	Portable; peristaltic (suction)	<0.5/NA	(Not submersible) Rubber, Tygon®, or Neoprene®	0-30	See comments	$1,200-1,300	Flow rate dependent on motor and tubing selected; AC operated; other models available.
Robert Bennett Co.	Model 180	Portable; piston (positive displacement)	1.8/22	SS, Teflon®, Delrin® PP, Viton®, acrylic, PE	0-500	0-1,800 mL/min	$2,600-2,700	Requires compressed gas; water level indicator and flow meter; custom models available.
Slope Indicator Co. (SINCO)	Model 514124 Pneumatic Water Sampler	Portable; gas drive (positive displacement)	1.9/18	PVC, nylon	0-1,100	250 mL/ flushing cycle	$250-350	Requires compressed gas; SS available; piezometer model available; dedicated model available.
Solinst Canada Ltd.	5W Water Sampler	Portable; grab (positive displacement)	1.9/27	PVC, brass, nylon, Neoprene®	0-330	500 mL	$1,300-1,800	Requires compressed gas; custom models available.
TIMCO Mfg. Co., Inc.	Std. Bailer	Portable; grab (positive displacement)	1.66/Custom	PVC, PP	No limit	250 mL/ft of bailer	$20-60	Other sizes, materials, models available; optional bottom-emptying device available; no solvents used.
TIMCO	Air or Gas Lift Sampler	Portable; gas drive (positive displacement)	1.66/30	PVC, Tygon®, Teflon®	0-150	350 mL/ flushing cycle	$100-200	Requires compressed gas; other sizes, materials, models available; no solvents used.
Tole Devices Co.	Sampling Pump	Portable; bladder (positive displacement)	1.38/48	SS, silicone, Delrin®, Tygon®	0-125	0-4,000 mL/min	$800-1,000	Compressed gas required; DC control module; custom built.

Construction Material Abbreviations:

- PE Polyethylene
- PP Polypropylene
- PVC Polyvinyl chloride
- SS Stainless steel
- PC Polycarbonate
- EPDM Ethylene-propylene diene (synthetic rubber)

Other Abbreviations:

- NA Not applicable
- AC Alternating current
- DC Direct current

NOTE: Other manufacturers market pumping devices which could be used for groundwater sampling, though not expressly designed for this purpose. The list is not meant to be all-inclusive and listing does not constitute endorsement for use. Information in the table is from sales literature and/or personal communication. No skimmer, scavenger-type, or high-capacity pumps are included.

Source: Barcelona et al., 1983.

ATTACHMENT B

SPECIFIC CONDUCTANCE OF 1 MOLAR KCl AT VARIOUS TEMPERATURES[1]

Temperature (°C)	Specific Conductance (umhos/cm)
15	1,147
16	1,173
17	1,199
18	1,225
19	1,251
20	1,278
21	1,305
22	1,332
23	1,359
24	1,368
25	1,413
26	1,441
27	1,468
28	1,496
29	1,524
30	1,552

[1] Data derived from the International Critical Tables 1-3-8.

ATTACHMENT C

VARIATION OF DISSOLVED OXYGEN CONCENTRATION IN WATER AS A FUNCTION OF TEMPERATURE AND SALINITY

Temperature (°C)	Dissolved Oxygen (mg/L)					
	Chloride Concentration in Water					Difference/ 100 mg Chloride
	0	5,000	10,000	15,000	20,000	
0	14.6	13.8	13.0	12.1	11.3	0.017
1	14.2	13.4	12.6	11.8	11.0	0.016
2	13.8	13.1	12.3	11.5	10.8	0.015
3	13.5	12.7	12.0	11.2	10.5	0.015
4	13.1	12.4	11.7	11.0	10.3	0.014
5	12.8	12.1	11.4	10.7	10.0	0.014
6	12.5	11.8	11.1	10.5	9.8	0.014
7	12.2	11.5	10.9	10.2	9.6	0.013
8	11.9	11.2	10.6	10.0	9.4	0.013
9	11.6	11.0	10.4	9.8	9.2	0.012
10	11.3	10.7	10.1	9.6	9.0	0.012
11	11.1	10.5	9.9	9.4	8.8	0.011
12	10.8	10.3	9.7	9.2	8.6	0.011
13	10.6	10.1	9.5	9.0	8.5	0.011
14	10.4	9.9	9.3	8.8	8.3	0.010
15	10.2	9.7	9.1	8.6	8.1	0.010
16	10.0	9.5	9.0	8.5	8.0	0.010
17	9.7	9.3	8.8	8.3	7.8	0.010
18	9.5	9.1	8.6	8.2	7.7	0.009
19	9.4	8.9	8.5	8.0	7.6	0.009
20	9.2	8.7	8.3	7.9	7.4	0.009
21	9.0	8.6	8.1	7.7	7.3	0.009
22	8.8	8.4	8.0	7.6	7.1	0.008
23	8.7	8.3	7.9	7.4	7.0	0.008
24	8.5	8.1	7.7	7.3	6.9	0.008
25	8.4	8.0	7.6	7.2	6.7	0.008

ATTACHMENT C
VARIATION OF DISSOLVED OXYGEN CONCENTRATION IN WATER AS A FUNCTION OF TEMPERATURE AND SALINITY
PAGE TWO

Temperature (°C)	Dissolved Oxygen (mg/L)					
	Chloride Concentration in Water					Difference/ 100 mg Chloride
	0	5,000	10,000	15,000	20,000	
26	8.2	7.8	7.4	7.0	6.6	0.008
27	8.1	7.7	7.3	6.9	6.5	0.008
28	7.9	7.5	7.1	6.8	6.4	0.008
29	7.8	7.4	7.0	6.6	6.3	0.008
30	7.6	7.3	6.9	6.5	6.1	0.008
31	7.5					
32	7.4					
33	7.3					
34	7.2					
35	7.1					
36	7.0					
37	6.9					
38	6.8					
39	6.7					
40	6.6					
41	6.5					
42	6.4					
43	6.3					
44	6.2					
45	6.1					
46	6.0					
47	5.9					
48	5.8					
49	5.7					
50	5.6					

Note: In a chloride solution, conductivity can be roughly related to chloride concentration (and therefore, used to correct measured D.O. concentration) using Attachment B.

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1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide information on sample preservation, packaging, and shipping procedures to be used in handling environmental samples submitted for chemical constituent, biological, or geotechnical analysis. Sample chain-of-custody procedures and other aspects of field documentation are addressed in SOP SA-6.3. Sample identification is addressed in SOP CT-04.

2.0 SCOPE

This procedure:

- Describes the appropriate containers to be used for samples depending on the analyses to be performed, and the steps necessary to preserve the samples when shipped off site for chemical analysis.
- Provides instruction for sample packaging and shipping in accordance with current U.S. Department of Transportation (DOT) regulations.

3.0 GLOSSARY

Hazardous Material - A substance or material which has been determined by the Secretary of Transportation to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and which has been so designated. Under 49 CFR, the term includes hazardous substances, hazardous wastes, marine pollutants, and elevated temperature materials, as well as materials designated as hazardous under the provisions of §172.101 and §172.102 and materials that meet the defining criteria for hazard classes and divisions in Part 173.

Hazardous Waste - Any substance listed in 40 CFR, Subpart D (~~y~~261.30 et seq.), or otherwise characterized as ignitable, corrosive, reactive, or toxic (as defined by Toxicity Characteristic Leaching Procedure, TCLP, analysis) as specified under 40 CFR, Subpart C (~~y~~261.20 et seq.), that would be subject to manifest requirements specified in 40 CFR 262. Such substances are defined and regulated by EPA.

Marking - A descriptive name, identification number, instructions, cautions, weight, specification or UN marks, or combination thereof required on outer packaging of hazardous materials.

n.o.i - Not otherwise indicated (may be used interchangeably with n.o.s.).

n.o.s. - Not otherwise specified.

ORM - Other regulated material (see DOT 49 CFR 173.144).

Packaging - A receptacle and any other components or materials necessary for compliance with the minimum packaging requirements of 49 CFR 174, including containers (other than freight containers or overpacks), portable tanks, cargo tanks, tank cars, and multi-unit tank-car tanks to perform a containment function in conformance with the minimum packaging requirements of 49 CFR 173.24(a) & (b).

Placard - Color-coded, pictorial sign which depicts the hazard class symbol and name and which is placed on the side of a vehicle transporting certain hazardous materials.

Common Preservatives:

- Hydrochloric Acid - HCl
- Sulfuric Acid - H_2SO_4
- Nitric Acid - HNO_3
- Sodium Hydroxide - NaOH

Other Preservatives

- Zinc Acetate
- Sodium Thiosulfate - $Na_2S_2O_3$

Normality (N) - Concentration of a solution expressed as equivalent per liter, an equivalent being the amount of a substance containing 1 gram-atom of replaceable hydrogen or its equivalent. Thus, a one-molar solution of HCl, containing 1 gram-atom of H, is "one normal," whereas a one-molar solution of H_2SO_4, containing 2 gram-atoms of H, is "two normal."

Reportable Quantity (RQ) - For the purposes of this SOP, means the quantity specified in column 3 of the Appendix to DOT 49 CFR §172.101 for any material identified in column 1 of the appendix. A spill greater than the amount specified must be reported to the National Response Center.

Sample - A sample is physical evidence collected from a facility or the environment, which is representative of conditions at the location and time of collection.

4.0 RESPONSIBILITIES

Field Operations Leader - Directly responsible for the bottling, preservation, labeling, packaging, shipping, and custody of samples up to and including release to the shipper.

Field Samplers - Responsible for initiating the Chain-of-Custody Record (per SOP SA-6.3), implementing the packaging and shipping requirements, and maintaining custody of samples until they are relinquished to another custodian or to the common carrier.

5.0 PROCEDURES

Sample identification, labeling, documentation, and chain-of-custody are addressed by SOP SA-6.3.

5.1 Sample Containers

Different types of chemicals react differently with sample containers made of various materials. For example, trace metals adsorb more strongly to glass than to plastic, whereas many organic chemicals may dissolve various types of plastic containers. Attachments A and B show proper containers (as well as other information) per 40 CFR 136. In general, the sample container shall allow approximately 5-10 percent air space ("ullage") to allow for expansion/vaporization if the sample warms during transport. However, for collection of volatile organic compounds, head space shall be omitted. The analytical laboratory will generally provide certified-clean containers for samples to be analyzed for chemical constituents. Shelby tubes or other sample containers are generally provided by the driller for samples requiring geotechnical analysis. Sufficient lead time shall be allowed for a delivery of bottle orders. Therefore, it is critical to use the correct container to maintain the integrity of the sample prior to analysis.

Once opened, the container must be used at once for storage of a particular sample. Unused but opened containers are to be considered contaminated and must be discarded; because of the potential for introduction of contamination, they cannot be reclosed and saved for later use. Likewise, any unused containers which appear contaminated upon receipt, or which are found to have loose caps or a missing Teflon liner (if required for the container), shall be discarded.

5.2 Sample Preservation

Many water and soil samples are unstable and therefore require preservation to prevent changes in either the concentration or the physical condition of the constituent(s) requiring analysis. Although complete and irreversible preservation of samples is not possible, preservation does retard the chemical and biological changes that inevitably take place after the sample is collected. Preservation techniques are usually limited to pH control, chemical addition(s), and refrigeration/ freezing (certain biological samples only).

5.2.1 Overview

The preservation techniques to be used for various analytes are listed in Attachments A and B. Reagents required for sample preservation will either be added to the sample containers by the laboratory prior to their shipment to the field or be added in the field (in a clean environment). Only high purity reagents shall be used for preservation. In general, aqueous samples of low-concentration organics (or soil samples of low- or medium-concentration organics) are cooled to 4°C. Medium-concentration aqueous samples and high-hazard organics samples are typically not preserved. Low-concentration aqueous samples for metals are acidified with HNO_3, whereas medium-concentration and high-hazard aqueous metal samples are not preserved. Low- or medium-concentration soil samples for metals are cooled to 4°C, whereas high-hazard samples are not preserved.

The following subsections describe the procedures for preparing and adding chemical preservatives. Attachments A and B indicate the specific analytes which require these preservatives.

5.2.2 Preparation and Addition of Reagents

Addition of the following acids or bases may be specified for sample preservation; these reagents shall be analytical reagent (AR) grade or purer and shall be diluted to the required concentration with deionized water before field sampling commences. To avoid uncontrolled reactions, be sure to Add Acid to water (not vice versa). A dilutions guide is provided below.

Acid/Base	Dilution	Concentration	Estimated Amount Required for Preservation
Hydrochloric Acid (HCl)	1 part concentrated HCl: 1 part double-distilled, deionized water	6N	5-10 mL
Sulfuric Acid (H_2SO_4)	1 part concentrated H_2SO_4: 1 part double-distilled, deionized water	18N	2 - 5 mL
Nitric Acid (HNO_3)	Undiluted concentrated HNO_3	16N	2 - 5 mL
Sodium Hydroxide (NaOH)	400 grams solid NaOH dissolved in 870 mL double-distilled, deionized water; yields 1 liter of solution	10N	2 mL

The amounts required for preservation shown in the above table assumes proper preparation of the preservative and addition of the preservative to one liter of aqueous sample (assuming that the sample is initially at pH 7, is poorly buffered, and does not contain particulate matter; as these conditions vary, more preservative may be required). Consequently, the final sample pH must be checked using narrow-range pH paper, as described in the generalized procedure detailed below:

- Pour off 5-10 mL of sample into a dedicated, clean container. Use some of this sample to check the initial sample pH using wide range (0-14) pH paper. Never dip the pH paper into the sample; always apply a drop of sample to the pH paper using a clean stirring rod or pipette.

- Add about one-half of the estimated preservative required to the original sample bottle. Cap and invert gently several times to mix. Check pH (as described above) using medium range pH paper (pH 0-6 or pH 7.5-14, as applicable).

- Cap sample bottle and seal securely.

Additional considerations are discussed below:

- To test if ascorbic acid must be used to remove oxidizing agents present in the sample before it can be properly preserved, place a drop of sample on KI-starch paper. A blue color indicates the need for ascorbic acid addition.

  If required, add a few crystals of ascorbic acid to the sample and retest with the KI-starch paper. Repeat until a drop of sample produces no color on the KI-starch paper. Then add an additional 0.6 grams of ascorbic acid per each liter of sample volume.

  Continue with proper base preservation of the sample as described, generally, above.

- Samples for sulfide analysis must be treated by the addition of 4 drops (0.2 mL) of 2N zinc acetate solution per 100 ml of sample.

  The 2N zinc acetate solution is made by dissolving 220 grams of zinc acetate in 870 mL of double-distilled, deionized water to make 1 liter of solution.

  The sample pH is then raised to 9 using the NaOH preservative.

- To test of sodium thiosulfate must be added to remove residual chlorine from a sample, test the sample for residual chlorine using a field test kit especially made for this purpose.

  If residual chlorine is present, add 0.08 grams of sodium thiosulfate per liter of sample to remove the residual chlorine.

  Continue with proper acidification of the sample as described, generally, above.

For biological samples, 10% buffered formalin or isopropanol may also be required for preservation. Questions regarding preservation requirements should be resolved through communication with the laboratory <u>before</u> sampling begins.

5.3 Field Filtration

At times, field-filtration may be required to provide for the analysis of dissolved chemical constituents. Field-filtration must be performed prior to the preservation of samples as described above. General procedures for field filtration are described below:

- The sample shall be filtered through a non-metallic, 0.45-micron membrane filter, immediately after collection. The filtration system shall consist of dedicated filter canister, dedicated silicon tubing, and a peristaltic pump with pressure or vacuum pumping squeeze action (since the sample is filtered by mechanical peristalsis, the sample travels only through the tubing).

- To perform filtration, thread the silicon tubing through the peristaltic pump head. Attach the filter canister to the discharge end of the silicon tubing (note flow direction arrow); attach the aqueous sample container to the intake end of the silicon tubing. Turn the peristaltic pump on and perform filtration.

- Continue by preserving the filtrate (contained in the filter canister), as applicable and generally described above.

5.4 Sample Packaging and Shipping

Samples collected for shipment from a site shall be classified as either environmental or hazardous material samples. Samples from drums containing materials other than Investigative Derived Waste (IDW) and samples obtained from waste piles or bulk storage tanks are generally shipped as hazardous materials. A distinction must be made between the two types of samples in order to:

- Determine appropriate procedures for transportation of samples (if there is any doubt, a sample shall be considered hazardous and shipped accordingly.)

- Protect the health and safety of transport and laboratory personnel receiving the samples (special precautions are used by the shipper and at laboratories when hazardous materials are received.)

Detailed procedures for packaging environmental and hazardous material samples are outlined in the remainder of this section.

5.4.1 Environmental Samples

Environmental samples are packaged as follows:

- Place sample container, properly identified and with lid securely fastened in a plastic bag (e.g. Ziploc baggie), and seal the bag.

- Place sample in a cooler constructed of sturdy material which has been lined with a large, plastic (e.g. "garbage" bag).

- Pack with enough noncombustible, absorbent, cushioning materials such as vermiculite (shoulders of bottles must be iced if required) to minimize the possibility of the container breaking.

- If cooling is required (see Attachments A and B), double-bag ice in Ziploc baggies and place around container shoulders, and on top of absorbent packing material (minimum of 8 pounds of ice for a medium-size cooler).

- Seal (i.e., tape or tie top in knot) large liner bag.

- The original (top, signed copy) and extra carbonless copies of the COC form shall be placed inside a large Ziploc-type bag and taped inside the lid of the shipping cooler. If multiple coolers are sent but are included on one COC form, the COC form should be sent with the first cooler. The COC form should then state how many coolers are included with that shipment.

- Close and seal outside of cooler as described in SOP SA-6.3. Signed custody seals must be used.

Coolers must be marked as containing "Environmental Samples." The appropriate side of the container must be marked "This End Up" and arrows placed appropriately. No DOT marking or labeling is required; there are no DOT restrictions on mode of transportation.

5.4.2 Determination of Shipping Classification for Hazardous Material Samples

Samples not determined to be environmental samples, or samples known or expected to contain hazardous materials, must be considered hazardous material samples and transported according to the requirements listed below.

5.4.2.1 Known Substances

If the substance in the sample is known or can be identified, package, mark, label, and ship according to the specific instructions for that material (if it is listed) in the DOT Hazardous Materials Table, 49 CFR 172.101. (DOT Guide for shippers can be found in Attachment D of this document.)

To determine the proper shipping name, use the following steps to help locate the shipping name on the Hazardous Materials Table, DOT 49 CFR 172.101.

1. Look first for the chemical or technical name of the material, for example, ethyl alcohol. Note that many chemicals have more than one technical name, for example, perchloroethylene (not listed in 172.101) is listed as tetrachloroethylene (listed 172.101). It may be useful to consult a chemist for all possible technical names a material can have. If your material is not listed by its technical name, then . . .

2. Look for the chemical family name. For example, pentyl alcohol is not listed but the chemical family name is: alcohol, n.o.s. (not otherwise specified). If the chemical family name is not listed, then . . .

3. Look for a generic name based on end use. For example, Paint, n.o.s or Fireworks, n.o.s. If a generic name based on end use is not listed, then . . .

4. Look for a generic family name based on end use, for example, drugs, n.o.s. or cosmetics, n.o.s. Finally, if your material is not listed by a generic family name but you suspect or know the material is hazardous because it meets the definition of one or more hazardous classes, then . . .

5. You will have to use the general hazard class for a proper shipping name. For example, Flammable Liquid, n.o.s, or Oxidizer, n.o.s.

5.4.2.2 Unknown Substances

For samples of hazardous substances of unknown content, select the appropriate transportation category according to the DOT hazardous materials classification of a material having more than one hazard. This procedure is outlined in DOT Regulation 49 CFR 173.2a. (This can be found in Attachment C of this SOP.)

The correct shipping classification for an unknown sample is selected through a process of elimination, as outlined in DOT Regulation 49 CFR 172.101(c)(11). By using the provisions in this paragraph, the proper shipping name and description will be determined. A step-by-step guide is provided by the Department of Transportation (DOT) and can be found in Attachment D of this SOP.

5.4.3 Packaging and Shipping of Samples Classified as Flammable Liquid (or Solid)

5.4.3.1 Packaging

Applying the word "flammable" to a sample does not imply that it is in fact flammable. The word prescribes the class of packaging according to DOT regulations.

1. Containerize sample as required (see Attachments A and B). To prevent leakage, fill container no more than 90 percent full. Seal lid with teflon tape or wire.

2. Complete sample label and attach securely to sample container.

3. Seal container and place in 2-mil-thick (or thicker) polyethylene bag (e.g., Ziploc baggie), one sample per bag. Position sample identification label so that it can be read through bag. Seal bag.

4. For soil jars, place sealed bag inside metal can (available from laboratory or laboratory supplier) and cushion it with enough noncombustible, absorbent material (for example, vermiculite or diatomaceous earth) between the bottom and sides of the can and bag to prevent breakage and absorb leakage. Pack one bag per can. Use clips, tape, or other positive means to hold can lid securely, tightly and permanently. Mark can as indicated in Paragraph 1 of Section 5.3.4.2, below. Single 1-gallon bottles do not need to be placed in metal cans.

5. Place one or more metal cans (or a single 1-gallon bottle) into a strong outside container, such as a metal picnic cooler or a DOT-approved fiberboard box. Surround cans (or bottle) with noncombustible, absorbent cushioning materials for stability during transport. The absorbent material should be able to absorb the entire contents of the container. Mark container as indicated in Paragraph 2 below.

5.4.3.2 Marking/Labeling

1. Use abbreviations only where specified. Place the following information, either hand-printed or in label form, on the metal can (or 1-gallon bottle):

   - Laboratory name and address.

- Proper shipping name from the hazardous materials table (DOT Regulation CFR 49 172.101). Example: "Flammable Liquid, n.o.s. UN1993" or "Flammable Solid, n.o.s. UN1325." This will include packing group (see Section 5.3.4.2, No. 2.)

Not otherwise specified (n.o.s) is not used if the flammable liquid (or solid) is identified. If identified, the name of the specific material is listed before the category (for example, Acetone, Flammable Liquid), followed by its appropriate UN number found in the DOT Hazardous Materials table (49 CFR 172.101).

2. Determine packing group. The packing group is part of the proper shipping name and must be included on the shipping papers in the description section.

   I. Most Hazardous
   II. Medium Hazard
   III. Least Hazardous

   The packing group will be listed in the hazardous materials table, column 5.

3. Place all information on outside shipping container as on can (or bottle), specifically:

   - Proper shipping name
   - UN or NA number
   - Proper label(s)
   - Addressee and sender

   Place the following labels on the outside shipping container: "Cargo Aircraft Only" and DOT label such as: "Flammable Liquid" (or "Flammable Solid"). "Dangerous When Wet" label shall be used if the Flammable Solid has not been exposed to a wet environment. "Laboratory Samples" and "THIS SIDE UP" or "THIS END UP" shall also be marked on the top of the outside container, and upward-pointing arrows shall be placed on all four sides of the container.

5.4.3.3 Shipping Papers

1. Use abbreviations only where specified. Complete the carrier-provided bill of lading and sign certification statement. Provide the following information in the order listed (one form may be used for more than one exterior container):

   - Proper shipping name. (Example: "Flammable Liquid, n.o.s. UN1993" or "Flammable Solid, n.o.s. UN1325 Packing Group I, II, III").
   - "Limited Quantity" (or "Ltd. Qty."). (See No. 3, below.)
   - "Cargo Aircraft Only."
   - Net weight (wt) or net volume (vol), just before or just after "Flammable Liquid, n.o.s." or "Flammable Solid, n.o.s.," by item, if more than one metal can is inside an exterior container.
   - "Laboratory Samples" (if applicable).

2. Include Chain-of-Custody Record, properly executed in outside container; use custody seals.

3. "Limited Quantity" means the maximum amount of a hazardous material for which there is a specific labeling or packaging exception (DOT CFR 49 171.8). This may mean that packages are exempted from labeling requirements. To determine if your sample meets the Limited Quantity Exception, refer to DOT Regulation CFR 49 Subpart C 173.50 through 173.156. First, determine the proper classification and shipping name for the material; then refer to the exception requirements for that particular class of material beginning with 173.50.

   Example: "Flammable Liquid n.o.s. UN1993 Packing Group 1." The outer package can weigh no more than 66 pounds gross weight. The inner package or container can weigh no more than 0.1 gallon net capacity for each container.

   To determine whether the material can be shipped as a "Limited Quantity," you must check the specific requirement for that class of material.

5.4.3.4 Transportation

1. The majority of unknown hazardous substance samples will be classified as flammable liquids. The samples will be transported by rented or common carrier truck, railroad, or express overnight package services. Do not transport samples on any passenger-carrying air transport system, even if the system has cargo-only aircraft. DOT regulations permit regular airline cargo-only aircraft, but difficulties with most suggest avoiding them. Instead, ship by airline carriers that carry only cargo. If unsure of what mode of transportation to use, consult the FOL or Project Manager.[1]

2. For transport by government-owned vehicle, including aircraft, DOT regulations do not apply. However, procedures described above, with the exception of execution of the bill of lading with certification, shall still be followed.

3. Use the hazardous materials shipping check list (Attachment E) as a guidance to ensure that all sample-handling requirements are satisfied.

4. In some cases, various materials may react if they break during shipment. To determine if you are shipping such materials, refer to the DOT compatibility chart in Attachment F.

5.5 Shipment of Lithium Batteries

Monitoring well data are analyzed using either the Hermit SE 1000 or the Hermit SE 2000 environmental data logger. These instruments are powered by lithium batteries. The Department of Transportation has determined that lithium batteries are a hazardous material and are to be shipped using the following information:

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[1] Note: If you are unsure as how to ship the sample (hazardous or environmental sample), contact the FOL or Project Manager so that a decision can be made as to the proper shipping practices. The DOT penalties for improper shipment of a hazardous material are stringent and may include a prison term for intentional violations.

- Product Designation
  - Hermit SE 1000
  - Hermit SE 2000

- DOT Proper Shipping Name
  - Lithium batteries, contained in equipment, UN3091

- Classification or Division
  - Class 9

Shipment of equipment containing lithium batteries must be accompanied by shipping papers completed as indicated in Attachment G. The instrument will be shipped by Federal Express as a Hazardous Material. Place the instrument in the same container in which it was received. This container or case is a DOT-approved shipping container. For Federal Express procedures to ship hazardous materials, call 1-800-238-5355, extension 922-1666. In most cases, the return shipping papers and DOT labels will be shipped to you from the company warehouse or the vendor. An example of the types of labels used for shipment and the wording are shown in Attachment G. These labels will be attached to the outside container with the following wording:

- Lithium Batteries Contained in Equipment
  - UN-3091
  - Shipped Under CA-9206009

6.0 REFERENCES

American Public Health Association, 1981. Standard Methods for the Examination of Water and Wastewater, 15th Edition. APHA, Washington, D.C.

U.S. Department of Transportation, 1993. Hazardous Materials Regulations, 49 CFR 171-177.

U.S. EPA, 1984. "Guidelines Establishing Test Procedures for the Analysis of Pollutants under Clean Water Act." Federal Register, Volume 49 (209), October 26, 1984, p. 43234.

U.S. EPA, 1979. Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020, U.S. EPA-EMSL, Cincinnati, Ohio.

ATTACHMENT A

GENERAL SAMPLE CONTAINER AND PRESERVATION REQUIREMENTS

Sample Type and Concentration		Container[1]	Sample Size	Preservation[2]	Holding Time[2]
WATER					
Organics (GC&GC/MS)	VOC Low	Borosilicate glass	2 x 40 mL	Cool to 4°C HCl to ≤ 2	14 days[3]
	Extractables (Low SVOCs and pesticide/PCBs)	Amber glass	2x2 L or 4x1 L	Cool to 4°C	7 days to extraction; 40 days after extraction
	Extractables (Medium SVOCs and pesticide/PCBs)	Amber glass	2x2 L or 4x1 L	None	7 days to extraction; 40 days after extraction
Inorganics	Metals Low	High-density polyethylene	1 L	HNO_3 to pH ≤2	6 months (Hg-28 days)
	Medium	Wide-mouth glass	16 oz.	None	6 months
	Cyanide Low	High-density polyethylene	1 L	NaOH to pH>12	14 days
	Cyanide Medium	Wide-mouth glass	16 oz.	None	14 days
Organic/ Inorganic	High Hazard	Wide-mouth glass	8 oz.	None	14 days
SOIL					
Organics (GC&GC/MS)	VOC	Wide-mouth glass with teflon liner	2 x 4 oz.	Cool to 4°C	14 days
	Extractables (Low SVOCs and pesticides/PCBs)	Wide-mouth glass	8 oz.	Cool to 4°C	14 days to extraction; 40 days after extraction
	Extractables (Medium SVOCs and pesticides/PCBs)	Wide-mouth glass	8 oz.	Cool to 4°C	14 days to extraction; 40 days after extraction
Inorganics	Low/Medium	Wide-mouth glass	8 oz.	Cool to 4°C	6 months (Hg - 28 days) Cyanide (14 days)
Organic/ Inorganic	High Hazard	Wide-mouth glass	8 oz.	None	NA
Dioxin/Furan	All	Wide-mouth glass	4 oz.	None	7 days until extraction; 40 days after extraction
TCLP	All	Wide-mouth glass	8 oz.	None	7 days until preparation; analysis as per fraction
AIR					
Volatile Organics	Low/Medium	Charcoal tube – 7 cm long, 6 mm OD, 4 mm ID	100 L air	Cool to 4°C	5 days recommended

(1) All glass containers should have Teflon cap liners or septa.
(2) See Attachment E. Preservation and maximum holding time allowances per 40 CFR 136.

ATTACHMENT B

ADDITIONAL REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES

Parameter Number/Name	Container(1)	Preservation(2)(3)	Maximum Holding Time(4)
INORGANIC TESTS:			
Acidity	P, G	Cool, 4°C	14 days
Alkalinity	P, G	Cool, 4°C	14 days
Ammonia - Nitrogen	P, G	Cool, 4°C; H_2SO_4 to pH 2	28 days
Biochemical Oxygen Demand (BOD)	P, G	Cool, 4°C	48 hours
Bromide	P, G	None required	28 days
Chemical Oxygen Demand (COD)	P, G	Cool, 4°C; H_2SO_4 to pH 2	28 days
Chloride	P, G	None required	28 days
Chlorine, Total Residual	P, G	None required	Analyze immediately
Color	P, G	Cool, 4°C	48 hours
Cyanide, Total and Amenable to Chlorination	P, G	Cool, 4°C; NaOH to pH 12; 0.6 g ascorbic acid(5)	14 days(6)
Fluoride	P	None required	28 days
Hardness	P, G	HNO_3 to pH 2; H_2SO_4 to pH 2	6 months
Total Kjeldahl and Organic Nitrogen	P, G	Cool, 4°C; H_2SO_4 to pH 2	28 days
Nitrate - Nitrogen	P, G	None required	48 hours
Nitrate-Nitrite - Nitrogen	P, G	Cool, 4°C; H_2SO_4 to pH 2	28 days
Nitrite - Nitrogen	P, G	Cool, 4°C	48 hours
Oil & Grease	G	Cool, 4°C; H_2SO_4 to pH 2	28 days
Total Organic Carbon (TOC)	P, G	Cool, 4°C; HCl or H_2SO_4 to pH 2	28 days
Orthophosphate	P, G	Filter immediately; Cool, 4°C	48 hours
Oxygen, Dissolved-Probe	G Bottle & top	None required	Analyze immediately
Oxygen, Dissolved-Winkler	G Bottle & top	Fix on site and store in dark	8 hours
Phenols	G	Cool, 4°C; H_2SO_4 to pH 2	28 days
Phosphorus, Total	P, G	Cool, 4°C; H_2SO_4 to pH 2	28 days
Residue, Total	P, G	Cool, 4°C	7 days
Residue, Filterable (TDS)	P, G	Cool, 4°C	7 days
Residue, Nonfilterable (TSS)	P, G	Cool, 4°C	7 days
Residue, Settleable	P, G	Cool, 4°C	48 hours
Residue, Volatile (Ash Content)	P, G	Cool, 4°C	7 days
Silica	P	Cool, 4°C	28 days
Specific Conductance	P, G	Cool, 4°C	28 days
Sulfate	P, G	Cool, 4°C	28 days

ATTACHMENT B
ADDITIONAL REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES
PAGE TWO

Parameter Number/Name	Container(1)	Preservation(2)(3)	Maximum Holding Time(4)
INORGANIC TESTS (Cont'd):			
Sulfide	P, G	Cool, 4°C; add zinc acetate plus sodium hydroxide to pH 9	7 days
Sulfite	P, G	None required	Analyze immediately
Turbidity	P, G	Cool, 4°C	48 hours
METALS:(7)			
Chromium VI (Hexachrome)	P, G	Cool, 4°C	24 hours
Mercury (Hg)	P, G	HNO_3 to pH 2	28 days
Metals, except Chromium VI and Mercury	P, G	HNO_3 to pH 2	6 months
ORGANIC TESTS:(8)			
Purgeable Halocarbons	G, Teflon-lined septum	Cool, 4°C; 0.008% $Na_2S_2O_3$(5)	14 days
Purgeable Aromatic Hydrocarbons	G, Teflon-lined septum	Cool, 4°C; 0.008% $Na_2S_2O_3$(5) HCl to pH 2 (9)	14 days
Acrolein and Acrylonitrile	G, Teflon-lined septum	Cool, 4°C; 0.008% $Na_2S_2O_3$(5) adjust pH to 4-5 (10)	14 days
Phenols(11)	G, Teflon-lined cap	Cool, 4°C; 0.008% $Na_2S_2O_3$(5)	7 days until extraction; 40 days after extraction
Benzidines(11), (12)	G, Teflon-lined cap	Cool, 4°C; 0.008% $Na_2S_2O_3$(5)	7 days until extraction(13)
Phthalate esters(11)	G, Teflon-lined cap	Cool, 4°C	7 days until extraction; 40 days after extraction
Nitrosamines(11), (14)	G, Teflon-lined cap	Cool, 4°C; store in dark; 0.008% $Na_2S_2O_3$(5)	7 days until extraction; 40 days after extraction
PCBs(11)	G, Teflon-lined cap	Cool, 4°C	7 days until extraction; 40 days after extraction
Nitroaromatics & Isophorone(11)	G, Teflon-lined cap	Cool, 4°C; 0.008% $Na_2S_2O_3$(5); store in dark	7 days until extraction; 40 days after extraction
Polynuclear Aromatic Hydrocarbons (PAHs)(11),(14)	G, Teflon-lined cap	Cool, 4°C; 0.008% $Na_2S_2O_3$(5); store in dark	7 days until extraction; 40 days after extraction
Haloethers(11)	G, Teflon-lined cap	Cool, 4°C; 0.008% $Na_2S_2O_3$(5)	7 days until extraction; 40 days after extraction
Dioxin/Furan (TCDD/TCDF)(11)	G, Teflon-lined cap	Cool, 4°C; 0.008% $Na_2S_2O_3$(5)	7 days until extraction; 40 days after extraction

ATTACHMENT B
ADDITIONAL REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES
PAGE THREE

Parameter Number/Name	Container(1)	Preservation(2)(3)	Maximum Holding Time(4)
RADIOLOGICAL TESTS:			
1-5 Alpha, beta and radium	P, G	HNO_3 to pH 2	6 months

(1) Polyethylene (P): generally 500 ml or Glass (G): generally 1L.
(2) Sample preservation should be performed immediately upon sample collection. For composite chemical samples each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining at 4°C until compositing and sample splitting is completed.
(3) When any sample is to be shipped by common carrier or sent through the United States Mail, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172).
(4) Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid. Samples may be held for longer periods only if the permittee, or monitoring laboratory, has data on file to show that the specific types of samples under study are stable for the longer periods, and has received a variance from the Regional Administrator.
(5) Should only be used in the presence of residual chlorine.
(6) Maximum holding time is 24 hours when sulfide is present. Optionally, all samples may be tested with lead acetate paper before pH adjustments are made to determine if sulfide is present. If sulfide is present, it can be removed by the addition of cadmium nitrate powder until a negative spot test is obtained. The sample is filtered and then NaOH is added to pH 12.
(7) Samples should be filtered immediately on site before adding preservative for dissolved metals.
(8) Guidance applies to samples to be analyzed by GC, LC, or GC/MS for specific compounds.
(9) Sample receiving no pH adjustment must be analyzed within 7 days of sampling.
(10) The pH adjustment is not required if acrolein will not be measured. Samples for acrolein receiving no pH adjustment must be analyzed within 3 days of sampling.
(11) When the extractable analytes of concern fall within a single chemical category, the specified preservative and maximum holding times should be observed for optimum safeguard of sample integrity. When the analytes of concern fall within two or more chemical categories, the sample may be preserved by cooling to 4°C, reducing residual chlorine with 0.008% sodium thiosulfate, storing in the dark, and adjusting the pH to 6-9; samples preserved in this manner may be held for 7 days before extraction and for 40 days after extraction. Exceptions to this optional preservation and holding time procedure are noted in footnote 5 (re: the requirement for thiosulfate reduction of residual chlorine) and footnotes 12, 13 (re: the analysis of benzidine).
(12) If 1,2-diphenylthydrazine is likely to be present, adjust the pH of the sample to 4.0 ± 0.2 to prevent rearrangement to benzidine.
(13) Extracts may be stored up to 7 days before analysis if storage is conducted under an inert (oxidant-free) atmosphere.
(14) For the analysis of diphenylnitrosamine, add 0.008% $Na_2S_2O_3$ and adjust pH to 7-10 with NaOH within 24 hours of sampling.
(15) The pH adjustment may be performed upon receipt at the laboratory and may be omitted if the samples are extracted within 72 hours of collection. For the analysis of aldrin, add 0.008% $Na_2S_2O_3$.

ATTACHMENT C

DOT HAZARDOUS MATERIAL CLASSIFICATION
(49 CFR 173.2a)

1. Radioactive material (except a limited quantity)
2. Division 2.3, Poisonous Gases
3. Division 2.1, Flammable Gas
4. Division 2.2, Nonflammable gas
5. Division 6.1, Poisonous Liquids, Packing Group 1 (poison by inhalation only)
6. Division 4.2, Pyrophoric Material
7. Division 4.1, Self-Reactive Material
8. Class 3, Flammable Liquids*
9. Class 8, Corrosive Material
10. Division 4.1, Flammable Solid*
11. Division 4.2, Spontaneously Combustible Materials*
12. Division 4.3, Dangerous When Wet Materials*
13. Division 5.1, Oxidizers*
14. Division 6.1, Poisonous Liquids or Solids (other than Packing Group 1)*
15. Combustible liquid
16. Class 9, Miscellaneous Hazardous Materials

* If a material has or meets the criteria for more than one hazard class, use the precedence of hazardous table on the following page for Classes 3 and 8 and Divisions 4.1, 4.2, 4.3, 5.1, and 6.1. The following table ranks those materials that meet the definition of Classes 3 and 8 and Divisions 4.1, 4.2, 4.3, 5.1, and 6.1.

ATTACHMENT C (Continued)

PRECEDENCE OF HAZARD TABLE

(Hazard Class and Packing Group)

Class	Packing Group	4.2	4.3	5.1 I[a]	5.1 II[a]	5.1 III[a]	6.1 I (Dermal)	6.1 I (Oral)	6.1 II	6.1 III	8 I (Liquid)	8 I (Solid)	8 II (Liquid)	8 II (Solid)	8 III (Liquid)	8 III (Solid)
3	I						3	3	3	3	3	[c]	3	[c]	3	[c]
3	II						3	3	3	3	8	[c]	3	[c]	3	[c]
3	III						6.1	6.1	6.1	3[d]	8	[c]	8	[c]	3	[c]
4.1	II[b]	4.2	4.3	5.1	4.1	4.1	6.1	6.1	4.1	4.1	[c]	8	[c]	4.1	[c]	4.1
4.1	III[b]	4.2	4.3	5.1	4.1	4.1	6.1	6.1	6.1	4.1	[c]	8	[c]	8	[c]	4.1
4.2	II		4.3	5.1	4.2	4.2	6.1	6.1	4.2	4.2	[c]	8	[c]	4.2	[c]	4.2
4.2	III		4.3	5.1	4.2	4.2	6.1	6.1	6.1	4.2	[c]	8	[c]	8	[c]	4.2
4.3	I			5.1	4.3	4.3	6.1	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
4.3	II			5.1	4.3	4.3	6.1	4.3	4.3	4.3	8	8	8	4.3	4.3	4.3
4.3	III			5.1	4.3	4.3	6.1	6.1	6.1	4.3	8	8	8	8	4.3	4.3
5.1	I[a]						5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1
5.1	II[a]						6.1	5.1	5.1	5.1	8	8	8	5.1	5.1	5.1
5.1	III[a]						6.1	6.1	6.1	5.1	8	8	8	8	5.1	5.1
6.1	I, Dermal										8	6.1	6.1	6.1	6.1	6.1
6.1	I, Oral										8	6.1	6.1	6.1	6.1	6.1
6.1	II, Inhalation										8	6.1	6.1	6.1	6.1	6.1
6.1	II, Dermal										8	6.1	8	6.1	6.1	6.1
6.1	II, Oral										8	8	8	6.1	6.1	6.1
6.1	III										8	8	8	8	8	8

(a) There are at present no established criteria for determining Packing Groups for liquids in Division 5.1. At present, the degree of hazard is to be assessed by analogy with listed substances, allocating the substances to Packing Group I, Great; Group II, Medium; or Group III, Minor Danger.
(b) Substances of Division 4.1 other than self-reactive substances.
(c) Denotes an impossible combination.
(d) For pesticides only, where a material has the hazards of Class 3, Packing Group III, and Division 6.1, Packing Group III, the primary hazard is Division 6.1, Packing Group III.

ATTACHMENT D

GUIDE FOR HAZARDOUS MATERIALS SHIPPERS

USE OF GUIDE - This guide is presented as an aid to shippers of hazardous materials. It does not contain or refer to all of the DOT requirements for shipping hazardous materials. For specific details, refer to all of the DOT requirements for shipping hazardous materials, as provided in the Code of Federal Regulations (CFR), Title 49, Transportation, Parts 100-199.

The following is offered as a step-by-step procedure to aid in compliance with the applicable DOT regulations.

STEP 1 - DETERMINE THE PROPER SHIPPING NAME. The shipper must determine the proper shipping name of the materials as listed in the Hazardous Materials Table, 49 CFR 172.101, Column (2).

STEP 2 - DETERMINE THE HAZARD CLASS OR CLASSES.

a. Refer to the Table, 49 CFR 172.101, Column (3), and locate the hazard class of the material.
b. If more than one class is shown for the proper shipping name, determine the proper class by definition.
c. If the materials have more than one hazard, classify the material based on the order of hazards in 49 CFR 173.2.

STEP 3 - SELECT THE PROPER IDENTIFICATION NUMBERS.

a. Refer to the Table, 49 CFR 172.101, Column (3a), and select the Identification Number (ID) that corresponds to the proper shipping name and hazard class.
b. Enter the ID number(s) on the shipping papers and display them, as required, on packagings, placards and/or orange panels.

STEP 4 - DETERMINE THE MODE(S) OF TRANSPORT TO ULTIMATE DESTINATION.

a. As a shipper, you must assure yourself that the shipment complies with various modal requirements.
b. The modal requirements may affect the following: (1) Packaging; (2) Quantity per Package; (3) Marking; (4) Labeling; (5) Shipping Papers; and (6) Certification.

STEP 5 - SELECT THE PROPER LABEL(S) AND APPLY AS REQUIRED.

a. Refer to the Table, 49 CFR 172.101, Column (4) for required labels.
b. For details on labeling refer to (1) Additional Labels, 49 CFR 172.402; (2) Placement of Labels, 49 CFR 172.406; (3) Packagings (Mixed or Consolidated), 49 CFR 172.404(a) and (h); (4) Packages Containing Samples, 49 CFR 172.402(h); (5) Radioactive Materials, 49 CFR 172.403; and (6) Authorized Label Modifications, 49 CFR 172.405.

STEP 6 - DETERMINE AND SELECT THE PROPER PACKAGES.

a. Refer to the Table, 49 CFR 172.101, Column (5a) for exceptions and Column (5b) for specification packagings. Consider the following when selecting an authorized package: Quantity per Package; Cushioning Material, if required; Proper Closure and Reinforcement; Proper Pressure; Outage; etc., as required.
b. If packaged by a prior shipper, make sure the packaging is correct and in proper condition for transportation.

ATTACHMENT D (Continued)
GUIDE FOR HAZARDOUS MATERIALS SHIPPERS

STEP 7 - MARK THE PACKAGING (INCLUDING OVERPACKS).

a. Apply the required markings (49 CFR 172.300); Proper shipping name and ID number, when required (49 CFR 172.301); Name and address of Consignee or Consignor (49 CFR 172.306).
b. For details and other required markings, see 49 CFR 172.300 through 172.338.

STEP 8 - PREPARE THE SHIPPING PAPERS.

a. The basic requirements for preparing shipping papers include Proper Shipping Name; Hazard Class; ID Number; Total Quantity; Shipper's Certification; and Emergency Response Telephone Number.
b. Make all entries on the shipping papers using the information required and in proper sequence (49 CFR 172.202).

STEP 9 - CERTIFICATION.

a. Each shipper must certify by printing (manually or mechanically) on the shipping papers that the materials being offered for shipment are properly classified, described, packaged, marked and labeled, and in proper condition for transportation according to the applicable DOT Regulations (49 CFR 172.202).

STEP 10 - LOADING, BLOCKING, AND BRACING. When hazardous materials are loaded into the transport vehicle or freight container, each package must be loaded, blocked, and braced in accordance with the requirements for mode of transport.

a. If the shipper loads the freight container or transport vehicle, the shipper is responsible for the proper loading, blocking, and bracing of the materials.
b. If the carrier does the loading, the carrier is responsible.

STEP 11 - DETERMINE THE PROPER PLACARD(S). Each person who offers hazardous materials for transportation must determine that the placarding requirements have been met.

a. For Highway, unless the vehicle is already correctly placarded, the shipper must provide the required placard(s) and required ID number(s) (49 CFR 172.506).
b. For Rail, if loaded by the shipper, the shipper must placard the rail car if placards are required (49 CFR 172.508).
c. For Air and Water shipments, the shipper has the responsibility to apply the proper placards.

STEP 12 - HAZARDOUS WASTE/HAZARDOUS SUBSTANCE.

a. If the material is classed as a hazardous waste or hazardous substance, most of the above steps will be applicable.
b. Pertinent Environmental Protection Agency regulations are found in the Code of Federal Regulations, Title 40, Part 262.

As a final check and before offering the shipment for transportation, visually inspect your shipment. The shipper should ensure that emergency response information is on the vehicle for transportation of hazardous materials.

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Revised March 1995.

ATTACHMENT E

HAZARDOUS MATERIALS SHIPPING CHECK LIST

PACKAGING

1. Check DOT 173.24 for appropriate type of package for hazardous substance.
2. Check for container integrity, especially the closure.
3. Check for sufficient absorbent material in package.
4. Check for sample tags and log sheets for each sample and for chain-of-custody record.

SHIPPING PAPERS

1. Check that entries contain only approved DOT abbreviations.
2. Check that entries are in English.
3. Check that hazardous material entries are specially marked to differentiate them from any nonhazardous materials being sent using same shipping paper.
4. Be careful that all hazardous classes are shown for multiclass materials.
5. Check total amounts by weight, quantity, or other measures used.
6. Check that any limited-quantity exemptions are so designated on the shipping paper.
7. Check that certification is signed by shipper.
8. Make certain driver signs for shipment.

RCRA MANIFEST

1. Check that approved state/federal manifests are prepared.
2. Check that transporter has the following: valid EPA identification number, valid driver's license, valid vehicle registration, insurance protection, and proper DOT labels for materials being shipped.
3. Check that destination address is correct.
4. Check that driver knows where shipment is going.
5. Check that the driver is aware of emergency procedures for spills and accidents.
6. Make certain driver signs for shipment.
7. Make certain one copy of executed manifest and shipping document is retained by shipper.

ATTACHMENT F

DOT SEGREGATION AND SEPARATION CHART

Class or Division	Notes	1.1-1.2	1.3	1.4	1.5	1.6	2.1	2.2	2.3 gas Zone A*	2.3 gas Zone B*	3	4.1	4.2	4.3	5.1	5.2	6.1 liquids PG-I Zone A*	7	8 liquids only
Explosives . . . . . 1.1 and 1.2	A	*	*	*	*	*	X	X	X	X	X	X	X	X	X	X	X	X	X
Explosives 1.3		*	*	*	*	*	X		X	X	X		X	X	X	X	X		X
Explosives 1.4		*	*	*	*	*	O		O	O	O		O				O		O
Very insensitive explosives 1.5	A	*	*	*	*	*	X	X	X	X	X	X	X	X	X	X	X	X	X
Extremely insensitive explosives 1.6		*	*	*	*	*													
Flammable gases 2.1		X	X	O	X				X	O							O	O	
Non-toxic, non-flammable gases 2.2		X			X														
Poisonous gas - Zone A** 2.3		X	X	O	X		X				X	X	X	X	X	X			X
Poisonous gas - Zone B** 2.3		X	X	O	X		O				O	O	O	O	O	O			O
Flammable liquids 3		X	X	O	X				X	O					O		X		
Flammable solids 4.1		X			X				X	O							X		O
Spontaneously combustible materials 4.2		X	X	O	X				X	O							X		X
Dangerous-when-wet materials 4.3		X	X		X				X	O							X		O
Oxidizers 5.1	A	X	X		X				X	O	O						X		O
Organic peroxides 5.2		X	X		X				X	O							X		O
Poisonous liquids PG I - Zone A** . . 6.1		X	X	O	X		O				X	X	X	X	X	X			X
Radioactive materials 7		X			X		O												
Corrosive liquids 8		X	X	O	X				X	O		O	X	O	O	O	X		

No entry means that the materials are compatible (have no restrictions).

X These materials may not be loaded, transported, or stored together in the same vehicle or facility.
O The materials may not be loaded, transported, or stored together in the same vehicle or facility unless they are separated for 4 feet on all sides.
* Check the explosives compatibility chart in 49 CFR 179.848(f).
A Ammonium nitrate fertilizers may be stored with Division 1.1 materials.
** Denotes inhalation hazardous for poisons; consult field team leader or project manager if you encounter a material in this class before shipment.

ATTACHMENT G
LITHIUM BATTERY SHIPPING PAPERS

3224637861

TRANSPORT DETAILS

This shipment is within the limitations prescribed for: *(delete non applicable)*

[illegible] | CARGO AIRCRAFT ONLY

Airport of Departure:

Airport of Destination: 19CYS

Two completed and signed copies of this Declaration must be handed to the operator.

WARNING

Failure to comply in all respects with the applicable Dangerous Goods Regulations may be in breach of the applicable law, subject to legal penalties. This Declaration must not, in any circumstances, be completed and/or signed by a consolidator, a forwarder or an IATA cargo agent.

Shipment type: *(delete non-applicable)* NON-RADIOACTIVE | ~~RADIOACTIVE~~

NATURE AND QUANTITY OF DANGEROUS GOODS

Dangerous Goods Identification						
Proper Shipping Name	Class or Division	UN or ID No.	Subsidiary Risk	Quantity and type of packing	Packing Inst.	Authorization
LITHIUM BATTERIES CONTAINED IN EQUIPMENT	9	UN3091		1 PLASTIC BOX X 55 GRAMS	912 II	PER CA-9206009

Additional Handling Information

1 HERMIT SERIES DATALOGGER X 55 GRAMS (11 GRAMS/CELL)

I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in the proper condition for transport by air according to the applicable International and National Government Regulations.

Name/Title of Signatory

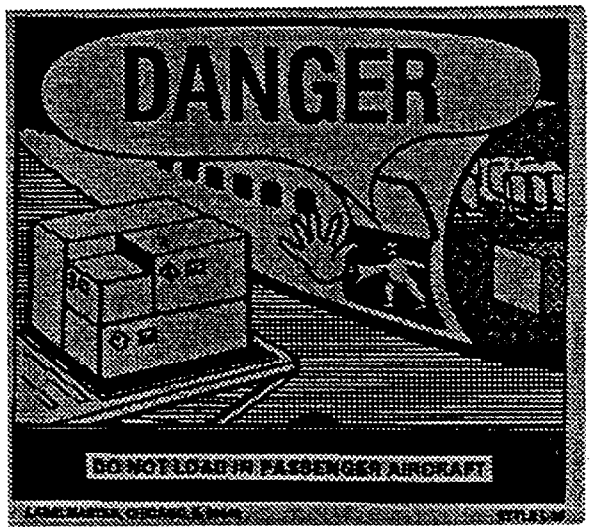
Place and Date

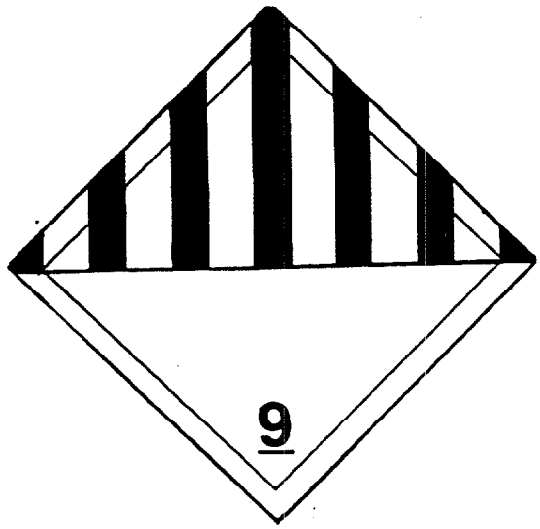
Signature *(see warning above)*

Emergency Telephone Number (Required for US Origin or Destination Shipments)
800-535-5053

IF ACCEPTABLE FOR PASSENGER AIRCRAFT, THIS SHIPMENT CONTAINS RADIOACTIVE MATERIAL INTENDED FOR USE IN, OR INCIDENT TO, RESEARCH, MEDICAL DIAGNOSIS, OR TREATMENT.

ATTACHMENT G (CONTINUED)
LITHIUM BATTERY SHIPPING PAPERS





LITHIUM BATTERIES CONTAINED IN EQUIPMENT.
UN-3091.
SHIPPED UNDER CA-9206009

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D EXAMPLE EQUIPMENT CALIBRATION LOG 29
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F FIELD TRIP SUMMARY REPORT 31

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to identify and designate the field data record forms, logs and reports generally initiated and maintained for documenting Brown & Root Environmental field activities.

2.0 SCOPE

Documents presented within this procedure (or equivalents) shall be used for all Brown & Root Environmental field activities, as applicable. Other or additional documents may be required by specific client contracts.

3.0 GLOSSARY

None

4.0 RESPONSIBILITIES

Project Manager - The Project Manager is responsible for obtaining hardbound, controlled-distribution logbooks (from the appropriate source), as needed. In addition, the Project Manager is responsible for placing all forms used in site activities (i.e., records, field reports, and upon the completion of field work, the site logbook) in the project's central file.

Field Operations Leader (FOL) - The Field Operations Leader is responsible for ensuring that the site logbook, notebooks, and all appropriate forms and field reports illustrated in this guideline (and any additional forms required by the contract) are correctly used, accurately filled out, and completed in the required time-frame.

5.0 PROCEDURES

5.1 Site Logbook

5.1.1 General

The site logbook is a hard-bound, paginated controlled-distribution record book in which all major onsite activities are documented. At a minimum, the following activities/events shall be recorded (daily) in the site logbook:

- All field personnel present
- Arrival/departure of site visitors
- Arrival/departure of equipment
- Start or completion of borehole/trench/monitoring well installation or sampling activities
- Daily onsite activities performed each day
- Sample pickup information
- Health and Safety issues (level of protection observed, etc.)
- Weather conditions

A site logbook shall be maintained for each project. The site logbook shall be initiated at the start of the first onsite activity (e.g., site visit or initial reconnaissance survey). Entries are to be made for every day that onsite activities take place which involve Brown & Root Environmental or subcontractor personnel. Upon completion of the fieldwork, the site logbook must become part of the project's central file.

The following information must be recorded on the cover of each site logbook:

- Project name
- Brown & Root Environmental project number
- Sequential book number
- Start date
- End date

Information recorded daily in the site logbook need not be duplicated in other field notebooks (see Section 5.2), but must summarize the contents of these other notebooks and refer to specific page locations in these notebooks for detailed information (where applicable). An example of a typical site logbook entry is shown in Attachment A.

If measurements are made at any location, the measurements and equipment used must either be recorded in the site logbook or reference must be made to the site notebook in which the measurements are recorded (see Attachment A).

All logbook, notebook, and log sheet entries shall be made in indelible ink (black pen is preferred). No erasures are permitted. If an incorrect entry is made, the data shall be crossed out with a single strike mark, and initialed and dated. At the completion of entries by any individual, the logbook pages used must be signed and dated. The site logbook must also be signed by the Field Operations Leader at the end of each day.

5.1.2 Photographs

When movies, slides, or photographs are taken of a site or any monitoring location, they must be numbered sequentially to correspond to logbook entries. The name of the photographer, date, time, site location, site description, and weather conditions must be entered in the logbook as the photographs are taken. A series entry may be used for rapid-sequence photographs. The photographer is not required to record the aperture settings and shutter speeds for photographs taken within the normal automatic exposure range. However, special lenses, films, filters, and other image-enhancement techniques must be noted in the logbook. If possible, such techniques shall be avoided, since they can adversely affect the admissibility of photographs as evidence. Chain-of-custody procedures depend upon the subject matter, type of film, and the processing it requires. Film used for aerial photography, confidential information, or criminal investigation require chain-of-custody procedures. Adequate logbook notation and receipts must be compiled to account for routine film processing. Once processed, the slides of photographic prints shall be consecutively numbered and labeled according to the logbook descriptions. The site photographs and associated negatives must be docketed into the project's central file.

5.2 Site Notebooks

Key field team personnel may maintain a separate dedicated notebook to document the pertinent field activities conducted directly under their supervision. For example, on large projects with multiple investigative sites and varying operating conditions, the Health and Safety Officer may elect to maintain a separate site notebook. Where several drill rigs are in operation simultaneously, each site geologist assigned to oversee a rig must maintain a site notebook.

5.3 Sample Forms

A summary of the forms illustrated in this procedure is shown as the listing of Attachments in the Table of Contents for this SOP. Forms may be altered or revised for project-specific needs contingent upon client approval. Care must be taken to ensure that all essential information can be documented. Guidelines for completing these forms can be found in the related sampling SOP.

5.3.1 Sample Collection, Labeling, Shipment and Request for Analysis

5.3.1.1 Sample Log Sheet

Sample Log Sheets are used to record specified types of data while sampling. Attachments B-1 to B-4 are examples of Sample Log Sheets. The data recorded on these sheets are useful in describing the waste source and sample as well as pointing out any problems encountered during sampling. A log sheet must be completed for each sample obtained, including field quality control (QC) samples.

5.3.1.2 Sample Label

A typical sample label is illustrated in Attachment B-5. Adhesive labels must be completed and applied to every sample container. Sample labels can usually be obtained from the appropriate Program source or are supplied from the laboratory subcontractor.

5.3.1.3 Chain-of-Custody Record Form

The Chain-of-Custody (COC) Record is a multi-part form that is initiated as samples are acquired and accompanies a sample (or group of samples) as they are transferred from person to person. This form must be used for any samples collected for chemical or geotechnical analysis whether the analyses are performed on site or off site. One part of the completed COC form is retained by the field crew while the other two or three portions are sent to the laboratory. The original (top, signed copy) and extra carbonless copies of the COC form shall be placed inside a large Ziploc-type bag and taped inside the lid of the shipping cooler. If multiple coolers are sent but are included on one COC form, the COC form should be sent with the first cooler. The COC form should then state how many coolers are included with that shipment. An example of a Chain-of-Custody Record form is provided as Attachment B-6. A supply of these forms are purchased and stocked by the field department of the various Brown & Root Environmental offices. Alternately, COC forms supplied by the laboratory may be used. Once the samples are received at the laboratory, the sample cooler and contents are checked and any problems are noted on the enclosed COC form (any discrepancies between the sample labels and COC form and any other problems that are noted are resolved through communication between the laboratory point-of-contact and the Brown & Root Environmental Project Manager). The COC form is signed and one of the remaining two parts are retained by the laboratory while the last part becomes part of the samples' corresponding analytical data package. Internal laboratory chain-of-custody procedures are documented in the Laboratory Quality Assurance Plan (LQAP).

5.3.1.4 Chain-of-Custody Seal

Attachment B-7 is an example of a custody seal. The Custody seal is also an adhesive-backed label. It is part of a chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field and sealed in coolers for transit to the laboratory. The COC seals are signed and dated by the samplers and affixed across the opening edges of each cooler containing environmental samples. COC seals may be available from the laboratory; these seals may also be purchased from a supplier.

5.3.2 Geohydrological and Geotechnical Forms

5.3.2.1 Groundwater Level Measurement Sheet

A groundwater level measurement sheet, shown in Attachment C-1 must be filled out for each round of water level measurements made at a site.

5.3.2.2 Data Sheet for Pumping Test

During the performance of a pumping test (or an in-situ hydraulic conductivity test), a large amount of data must be recorded, often within a short time period. The pumping test data sheet (Attachment C-2) facilitates this task by standardizing the data collection format, and allowing the time interval for collection to be laid out in advance.

5.3.2.3 Packer Test Report Form

A packer test report form shown in Attachment C-3 must be completed for each well upon which a packer test is conducted following well installation.

5.3.2.4 Summary Log of Boring

During the progress of each boring, a log of the materials encountered, operation and driving of casing, and location of samples must be kept. The Summary Log of Boring (Attachment C-4) is used for this purpose and must be completed for each soil boring performed. In addition, if volatile organics are monitored on cores, samples or cuttings from the borehole (using HNU or OVA detectors), these results must be entered on the boring log (under the "Remarks" column) at the appropriate depth. The "Remarks" column can also be used to subsequently enter the laboratory sample number and the concentration of a few key analytical results. This feature allows direct comparison of contaminant concentrations with soil characteristics.

5.3.2.5 Monitoring Well Construction Details Form

A Monitoring Well Construction Details Form must be completed for every monitoring well piezometer or temporary well point installed. This form contains specific information on length and type of well riser pipe and screen, backfill, filter pack, annular seal and grout characteristics, and surface seal characteristics. This information is important in evaluating the performance of the monitoring well, particularly in areas where water levels show temporal variation, or where there are multiple (immiscible) phases of contaminants. Depending on the type of monitoring well (in overburden or bedrock), different forms are used (see Attachments C-5 through C-9). Similar forms are used for flush-mount well completions. The Monitoring Well Construction Details Form is not a controlled document.

5.3.2.6 Test Pit Log

When a test pit or trench is constructed for investigative or sampling purposes, a Test Pit Log (Attachment C-10) must be filled out by the responsible field geologist or sampling technician.

5.3.3 Equipment Calibration and Maintenance Form

The calibration or standardization of monitoring, measuring or test equipment is necessary to assure the proper operation and response of the equipment, to document the accuracy, precision or sensitivity of the measurement, and determine if correction should be applied to the readings. Some items of

equipment require frequent calibration, others infrequent. Some are calibrated by the manufacturer, others by the user.

Each instrument requiring calibration has its own Equipment Calibration Log (Attachment D) which documents that the manufacturer's instructions were followed for calibration of the equipment, including frequency and type of standard or calibration device. An Equipment Calibration Log must be maintained for each electronic measuring device used in the field; entries must be made for each day the equipment is used.

5.4 Field Reports

The primary means of recording onsite activities is the site logbook. Other field notebooks may also be maintained. These logbooks and notebooks (and supporting forms) contain detailed information required for data interpretation or documentation, but are not easily useful for tracking and reporting of progress. Furthermore, the field logbook/notebooks remain onsite for extended periods of time and are thus not accessible for timely review by project management.

5.4.1 Weekly Status Reports

To facilitate timely review by project management, Xeroxed copies of logbook/notebook entries may be made for internal use. To provide timely oversight of onsite contractors, Daily Activities Reports are completed and submitted as described below.

It should be noted that in addition to the summaries described herein, other summary reports may also be contractually required.

5.4.2 Daily Activities Report

5.4.2.1 Description

The Daily Activities Report (DAR) documents the activities and progress for each day's field work. This report must be filled out on a daily basis whenever there are drilling, test pitting, well construction, or other related activities occurring which involve subcontractor personnel. These sheets summarize the work performed and form the basis of payment to subcontractors (Attachment E is an example of a Daily Activities Report).

5.4.2.2 Responsibilities

It is the responsibility of the rig geologist to complete the DAR and obtain the driller's signature acknowledging that the times and quantities of material entered are correct.

5.4.2.3 Submittal and Approval

At the end of the shift, the rig geologist must submit the Daily Activities Report to the Field Operations Leader (FOL) for review and filing. The Daily Activities Report is not a formal report and thus requires no further approval. The DAR reports are retained by the FOL for use in preparing the site logbook and in preparing weekly status reports for submission to the Project Manager.

6.0 ATTACHMENTS

Attachment A	TYPICAL SITE LOGBOOK ENTRY
Attachment B-1	EXAMPLE GROUNDWATER SAMPLE LOG SHEET
Attachment B-2	EXAMPLE SURFACE WATER SAMPLE LOG SHEET
Attachment B-3	EXAMPLE SOIL/SEDIMENT SAMPLE LOG SHEET
Attachment B-4	CONTAINER SAMPLE LOG SHEET FORM
Attachment B-5	SAMPLE LABEL
Attachment B-6	CHAIN-OF-CUSTODY RECORD FORM
Attachment B-7	CHAIN-OF-CUSTODY SEAL
Attachment C-1	EXAMPLE GROUNDWATER LEVEL MEASUREMENT SHEET
Attachment C-2	EXAMPLE PUMPING TEST DATA SHEET
Attachment C-3	PACKER TEST REPORT FORM
Attachment C-4	EXAMPLE BORING LOG
Attachment C-5	EXAMPLE OVERBURDEN MONITORING WELL SHEET
Attachment C-5A	EXAMPLE OVERBURDEN MONITORING WELL SHEET (FLUSHMOUNT)
Attachment C-6	EXAMPLE CONFINING LAYER MONITORING WELL SHEET
Attachment C-7	EXAMPLE BEDROCK MONITORING WELL SHEET - OPEN HOLE WELL
Attachment C-8	EXAMPLE BEDROCK MONITORING WELL SHEET - WELL INSTALLED IN BEDROCK
Attachment C-8A	EXAMPLE BEDROCK MONITORING WELL SHEET - WELL INSTALLED IN BEDROCK (FLUSHMOUNT)
Attachment C-9	EXAMPLE TEST PIT LOG
Attachment D	EXAMPLE EQUIPMENT CALIBRATION LOG
Attachment E	EXAMPLE DAILY ACTIVITIES RECORD
Attachment F	FIELD TRIP SUMMARY REPORT

ATTACHMENT A
TYPICAL SITE LOGBOOK ENTRY

START TIME: _____ DATE: _____

SITE LEADER: _____

PERSONNEL:

BROWN & ROOT ENV.	DRILLER	EPA
_____	_____	_____
_____	_____	_____
_____	_____	_____

WEATHER: Clear, 68°F, 2-5 mph wind from SE

ACTIVITIES:

1. Steam jenney and fire hoses were set up.
2. Drilling activities at well ____ resumes. Rig geologist was _____. See Geologist's Notebook, No. 1, page 29-30, for details of drilling activity. Sample No. 123-21-S4 collected: see sample logbook, page 42. Drilling activities completed at 11:50 and a 4-inch stainless steel well installed. See Geologist's Notebook, No. 1, page 31, and well construction details for well _____.
3. Drilling rig No. 2 steam-cleaned at decontamination pit. Then set up at location of well _____.
4. Well _____ drilled. Rig geologist was _____. See Geologist's Notebook, No. 2, page ____ for details of drilling activities. Sample numbers 123-22-S1, 123-22-S2, and 123-22-S3 collected; see sample logbook, pages 43, 44, and 45.
5. Well _____ was developed. Seven 55-gallon drums were filled in the flushing stage. The well was then pumped using the pitcher pump for 1 hour. At the end of the hour, water pumped from well was "sand free."
6. EPA remedial project manger arrives on site at 14:25 hours.
7. Large dump truck arrives at 14:45 and is steam-cleaned. Backhoe and dump truck set up over test pit _____.
8. Test pit _____ dug with cuttings placed in dump truck. Rig geologist was _____. See Geologist's Notebook, No. 1, page 32, for details of test pit activities. Test pit subsequently filled. No samples taken for chemical analysis. Due to shallow groundwater table, filling in of test pit ___ resulted in a very soft and wet area. A mound was developed and the area roped off.
9. Express carrier picked up samples (see Sample Logbook, pages 42 through 45) at 17:50 hours. Site activities terminated at 18:22 hours. All personnel off site, gate locked.

_____
Field Operations Leader

ATTACHMENT B-1
EXAMPLE GROUNDWATER SAMPLE LOG SHEET

GROUNDWATER
SAMPLE LOG SHEET

Page ____ of ____

Project Site Name: _____

Project No.: _____

☐ Domestic Well Data
☐ Monitoring Well Data
☐ Other Well Type: _____
☐ QA Sample Type: _____

Sample ID No.: _____

Sample Location: _____

Sampled By: _____

C.O.C. No.: _____

Sampling Data

Date: / Time: / Method:	pH	S.C.	Temp. (°C)	Turbidity	Color	TBD	TBD	TBD

Purge Data

Date: / Method:	Volume	pH	S.C.	Temp.(°C)	Turbidity	Color	TBD	TBD
	Initial							
Monitor Reading (ppm):	1							
Well Casing Dia. & Material Type:	2							
	3							
Total Well Depth (TD):	4							
Static Water Level (WL):	5							
TD-WL (ft.) =								
One Casing Volume: (gal/L)								
Start Purge (hrs.):								
End Purge (hrs.):								
Total Purge Time (min):								
Total Amount Purged (gal/L):								

Analysis	Preservative	Container Requirements	Collected (✓)

Observations/Notes:

Circle if Applicable:		Signature(s):
MS/MSD	Duplicate ID No:	

TBD: To Be Determined

ATTACHMENT B-2
EXAMPLE SURFACE WATER SAMPLING LOG SHEET

SURFACE WATER
SAMPLING LOG SHEET

Page ____ of ____

Project Site Name: _____ Sample ID No.: _____

Project No.: _____ Sample Location: _____

☐ Spring ☐ Pond
☐ Stream ☐ Lake
☐ Other _____

Sampled By: _____

☐ QA Sample Type: _____ C.O.C. No.: _____

Sample Date		
Date and Time	Method	Depth

pH	S.C.	Temp. (°C)	Turbidity	Color	TBD	TBD	TBD

Analysis	Preservative	Container Requirements	Collected (✓)

Observations/Notes:

Circle if Applicable:		Signature(s):
MS/MSD	Duplicate ID No.:	

TBD: To Be Determined

ATTACHMENT B-3
EXAMPLE SOIL/SEDIMENT SINGLE SAMPLE LOG SHEET

SOIL/SEDIMENT
SINGLE SAMPLE LOG SHEET

Page ___ of ___

Project Site Name: _____

Project No.: _____

- ☐ Surface Soil
- ☐ Subsurface Soil
- ☐ Sediment
- ☐ Other _____
- ☐ QA Sample Type: _____

Sample ID No.: _____

Sample Location: _____

Sampled By: _____

C.O.C. No.: _____

Sample Method:	Composite Sample Data		
	Sample	Time	Color/Description
Depth Sampled:			
Sample Date and Time:			
Type of Sample			
☐ Grab			
☐ Composite			
☐ Grab-Composite	Grab Sample Data		
☐ High Concentration	Color	Description: (Sand, Clay, Dry, Moist, Wet, etc.)	
☐ Low Concentration			

Analysis	Container Type/Preservative	Collected (✓)	Map:

Observations/Notes:

Circle if Applicable:		Signature(s):
MS/MSD	Duplicate ID No:	

ATTACHMENT B-4
CONTAINER SAMPLE LOG SHEET FORM

Brown & Root Environmental

Page ___ of _

☐ Container Data

Case #: _____

By: _____

Project Site Name: _____ Project Site No. _____

Brown & Root Env. Source No. _____ Source Location: _____

Container Source	Container Description
☐ Drum ☐ Bung Top ☐ Lever Lock ☐ Bolted Ring ☐ Other _____ _____ ☐ Bag/Sack ☐ Tank ☐ Other _____ _____	Color: _____ Condition: _____ Markings: _____ Vol. of Contents: _____ Other: _____

Disposition of Sample	Sample Description			
☐ Container Sampled ☐ Container opened but not sampled. Reason: _____ _____ ☐ Container not opened. Reason: _____ _____		Layer 1	Layer 2	Layer 3
	Phase	☐Sol. ☐Liq.	☐Sol. ☐Liq.	☐Sol. ☐Liq.
	Color	_____	_____	_____
	Viscosity	☐L ☐M ☐H	☐L ☐M ☐H	☐L ☐M ☐H
	% of Total Volume	_____	_____	_____
	Other	_____	_____	_____

Monitor Reading:	Type of Sample ☐ Grab ☐ Composite ☐ Grab-composite
Sample Method:	☐ Low Concentration ☐ High Concentration
Sample Date & Time:	
Sampled by:	
Signature(s):	
Analysis:	

Sample Identification	Organic	Inorganic
Date Shipped		
Time Shipped		
Lab		
Volume		

ATTACHMENT B-5

SAMPLE LABEL

Brown & Root Environmental PROJECT: _____

STATION LOCATION: _____

DATE: ____/____/____ TIME: _____ hrs.

MEDIA: WATER ☐ SOIL ☐ SEDIMENT ☐ _____ ☐

CONCENTRATION: LOW ☐ MEDIUM ☐ HIGH ☐

TYPE: GRAB ☐ COMPOSITE ☐

ANALYSIS	PRESERVATION
VOA ☐ BNAs ☐	Cool to 4°C ☐
PCBs ☐ PESTICIDES ☐	HNO_3 to pH < 2 ☐
METALS: TOTAL ☐ DISSOLVED ☐	NaOH to pH > 12 ☐
CYANIDE ☐	_____ ☐
_____ ☐	

Sampled by: _____

Remarks:

ATTACHMENT B-6

CHAIN-OF-CUSTODY RECORD FORM
(Original is 8.5 x 11")

PROJECT NO.	PROJECT NAME	NO. OF CONTAINERS	REMARKS
SAMPLERS: *(Signature)*			

STA NO.	DATE	TIME			STATION LOCATION							

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)	Date/Time	Remarks:	

ATTACHMENT B-7

CHAIN-OF-CUSTODY SEAL

CUSTODY SEAL	**CUSTODY SEAL**
Date	**Date**
Signature	**Signature**

ATTACHMENT C-1
EXAMPLE GROUNDWATER LEVEL MEASUREMENT SHEET

GROUNDWATER LEVEL MEASUREMENT SHEET

Page ___ of ___

PROJECT NAME: _____ LOCATION: _____
PROJECT NUMBER: _____ MEASURING DEVICE: _____
PERSONNEL: _____ ADJUSTMENT FACTOR: _____
DATE: _____ REMARKS: _____
WEATHER CONDITIONS: _____

Well or Piezometer Number	Time	Elevation of Reference Point (Feet)*	Water Level Indicator Reading (Feet)*	Groundwater Elevation (Feet)*	Comments

*Measurements to nearest 0.01 foot.

Signature(s): _____

ATTACHMENT C-2
EXAMPLE PUMPING TEST DATA SHEET

PUMPING TEST DATA SHEET

Page ___ of ___

PROJECT NAME: _____
PROJECT NUMBER: _____
PUMPING TEST: [ ]
TEST NUMBER: _____
METHOD OF MEASUREMENT: _____
DATE(s): _____
STATIC H_2O LEVEL (ft) (SO) _____

PUMPING WELL NUMBER: _____
MEASURED WELL NUMBER: _____
STEP DRAW DOWN TEST [ ]
MONITORING POINT: _____
DEPTH CORRECTION (ft) _____
PUMP SETTING (Ft. below monitoring point): _____
DISTANCE FROM PUMPING WELL (ft) (r): _____

PUMPING TEST PERFORMED BY: _____
REMARKS: _____

MILITARY TIME	ELAPSED TIME SINCE PUMP START OR STOP (Min.)	WATER LEVEL (Ft.)	CORRECTION (Ft.)	DRAW DOWN OR RECOVERY (Ft.)	FLOW METER READING (Gals.)	PUMPING RATE (GPM)	REMARKS

SIGNATURE(s): _____

ATTACHMENT C-3

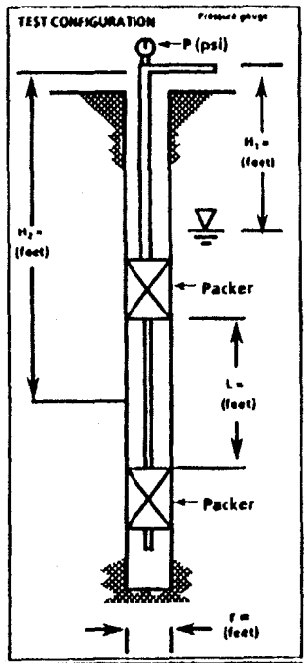
PACKER TEST REPORT FORM

PROJECT: _____ PROJECT NO.: _____ TEST NO: _____ PAGE ____ OF ____

BORING NO.: _____ CASING DEPTH: _____ CONTRACTOR: _____ STATIC WATER LEVEL _____

TEST INTERVAL: _____ BY: _____ CHECKED: _____ PACKER PRESSURE _____

Flow Test					Calculated Results							
Pressure, P (psi)	Elapsed Time (min)	Flow Reading	Δ Flow, ΔQ (ft^3)	Δ Flow, ΔQ (gal)	Flow Rate Q (gal/min)	H_1* (ft)	Hp(ft) = 2.31 (psi)	H_2* (ft)	H = Hp + (H1 or H2)	Cp	K (ft/yr) = Cp Q/H	K (cm/sec) = 9.67 x 10^{-7} K (ft/yr)



Length of Test Section in feet, L	Cp Drilling bit size EX (1.5")	AX (1.875")	BX (2.3/8")	NX (3")
1	31,000	28,500	25,000	21,500
2	19,400	18,100	16,000	15,500
5	9,000	8,300	8,000	6,700
8	6,000	5,500	5,100	5,000
10	5,700	5,400	5,000	4,900
15	4,100	3,900	3,700	3,600
20	3,200	3,100	3,000	2,800

CP = (1/(2 π L)) ln(L/r) (70,315 5)
7.48 Gallons = 1 Ft^3
1 psi = 2.31 ft head

* H_1 is used when the test length is below the water table.
H_2 is used when the test length is above the water table.

Remarks: _____

ATTACHMENT C-4
EXAMPLE BORING LOG

BORING LOG Page___ of___

PROJECT NAME: _____ BORING NUMBER: _____
PROJECT NUMBER: _____ DATE : _____
DRILLING COMPANY: _____ GEOLOGIST: _____
WATER LEVEL DATA: _____

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			* USCS	Remarks	PID or FID Reading (ppm)
					Soil Density/ Consistency or Rock Hardness	Color	Material Classification			

*When rock coring enter rock brokeness.

CONVERTED TO WELL : ___ Yes ___ No; WELL I.D.#: _____
REMARKS: _____

Signature(s): _____

LEGEND

SOIL TERMS

UNIFIED SOIL CLASSIFICATION (USCS)

COARSE-GRAINED SOILS — More Than Half of Material is LARGER Than No. 200 Sieve Size				
FIELD IDENTIFICATION PROCEDURES (Excluding Particles Larger Than 3 Inches and Basing Fractions on Estimated Weights)			GROUP SYMBOL	TYPICAL NAMES
GRAVELS (50%(+)>1/4"Ø)	CLEAN GRAVELS (Low % Fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.	GW	Well graded gravels, gravel-sand mixtures, little or no fines.
		Predominantly one size or a range of sizes with some intermediate sizes missing.	GP	Poorly graded gravels, gravel sand mixtures, little or no fines.
	GRAVELS W/FINES (High % Fines)	Non-plastic fines (for identification procedures, see ML)	GM	Silty gravels, poorly graded gravel-sand-silt mixtures.
		Plastic fines (for identification procedures, see CL)	GC	Clayey gravels, poorly graded gravel sand-clay mixtures.
SANDS 50%(+)<1/4"Ø)	CLEAN SANDS (Low % Fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.	SW	Well graded sand, gravelly sands, little or no fines.
		Predominantly one size or a range of sizes with some intermediate sizes missing.	SP	Poorly graded sands, gravelly sands, little or no fines.
	SANDS W/FINES (High % Fines)	Non-plastic fines (for identification procedures, see MCL)	SM	Silty sands, poorly graded sand silt mixtures.
		Plastic fines (for identification procedures, see CL)	SC	Clayey sands, poorly graded sand-clay mixtures.

FINE-GRAINED SOILS — More Than Half of Material is SMALLER Than No. 200 Sieve Size						
FIELD IDENTIFICATION PROCEDURES (Excluding Particles Larger Than 3 Inches and Basing Fractions on Estimated Weights)					GROUP SYMBOL	TYPICAL NAMES
	Identification Procedures on Fraction Smaller than No. 40 Sieve Size					
		DRY STRENGTH (Crushing Characteristics)	DILATANCY (Reaction to Shaking)	TOUGHNESS (Consistency Near Plastic Limit)		
SILTS AND CLAYS Liquid Limit <50		None to Slight	Quick to Slow	None	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity.
		Medium to High	None to Very Slow	Medium	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		Slight to Medium	Slow	Slight	OL	Organic silts and organic silt-clays of low plasticity.
SILTS AND CLAYS Liquid Limit >50		Slight to Medium	Slow to None	Slight to Medium	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		High to Very High	None	High	CH	Inorganic clays of high plasticity, fat clays.
		Medium to High	None to Very Slow	Slight to Medium	OH	Organic clays of medium to high plasticity.
HIGHLY ORGANIC SOILS		Readily identified by color, odor, spongy feel and frequently by fibrous texture.			Pt	Peat and other organic soils

Boundary classifications: Soils possessing characteristics of two groups are designated by combining group symbols. For example, GW-GC, well graded gravel-sand mixture with clay binder.
All sieve sizes on this chart are U.S. Standard.

DENSITY OF GRANULAR SOILS

DESIGNATION	STANDARD PENETRATION RESISTANCE-BLOWS/FOOT
Very Loose	0-4
Loose	5-10
Medium Loose	11-30
Dense	31-50
Very Dense	Over 50

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	UNC COMPRESSIVE STRENGTH (TONS/SQ. FT.)	STANDARD PENETRATION RESISTANCE-BLOWS/FOOT	FIELD IDENTIFICATION METHODS
Very Soft	Less than 0.25	0 to 2	Easily pentrated several inches by fist
Soft	0.25 to 0.50	2 to 4	Easily penetrated several inches by thumb.
Medium Stiff	0.50 to 1.0	4 to 8	Can be penetrated several inches by thumb.
Stiff	1.0 to 2.0	8 to 15	Readily indented by thumb.
Very Stiff	2.0 to 4.0	15 to 30	Readily indented by thumbnail.
Hard	More than 4.0	Over 30	Indented with difficulty by thumbnail.

ROCK TERMS

ROCK HARDNESS (FROM CORE SAMPLES)

Descriptive Terms	Screwdriver or Knife Effects	Hammer Effects
Soft	Easily Gouged	Crushes when pressed with hammer
Medium Soft	Can be Gouged	Breaks (one blow); crumbly edges
Medium Hard	Can be scratched	Breaks (one blow); sharp edges
Hard	Cannot be scratched	Breaks conchoidally (several blows); sharp edges

ROCK BROKENESS

Descriptive Terms	Abbreviation	Spacing
Very Broken	(V. Br.)	0-2"
Broken	(Br.)	2"-1'
Blocky	(Bl.)	1'-3"
Massive	(M.)	3'-10'

LEGEND:

SOIL SAMPLES - TYPES

S-2" Split-Barrel Sample

ST-3" O.D. Undisturbed Sample

O - Other Samples, Specify in Remarks

ROCK SAMPLES - TYPES

X-NX (Conventional) Core (-2-1/8" O.D.)

Q-NQ (Wireline) Core (-1-7/8" O.D.)

Z - Other Core Sizes, Specify in Remarks

WATER LEVELS

12/18 ▼ 12.6' Initial Level w/Date & Depth

12/18 ▼ 12.6' Stabilized Level w/Date & Depth

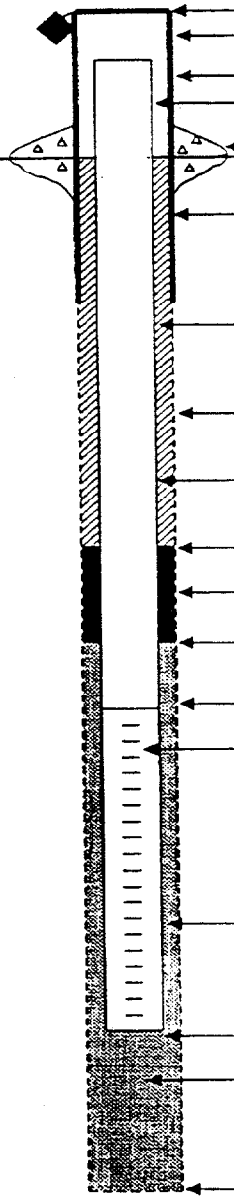
ATTACHMENT C-5
EXAMPLE OVERBURDEN MONITORING WELL SHEET

BORING NO.: _____

OVERBURDEN
MONITORING WELL SHEET

PROJECT _____ LOCATION _____
PROJECT NO. _____ BORING _____
ELEVATION _____ DATE _____
FIELD GEOLOGIST _____

DRILLER _____
DRILLING METHOD _____
DEVELOPMENT METHOD _____



ELEVATION OF TOP OF SURFACE CASING : _____
ELEVATION OF TOP OF RISER PIPE: _____

STICK - UP TOP OF SURFACE CASING: _____
STICK - UP RISER PIPE : _____

TYPE OF SURFACE SEAL: _____

I.D. OF SURFACE CASING: _____
TYPE OF SURFACE CASING: _____

RISER PIPE I.D. _____
TYPE OF RISER PIPE: _____

BOREHOLE DIAMETER: _____

TYPE OF BACKFILL: _____

ELEVATION / DEPTH TOP OF SEAL: _____ / _____

TYPE OF SEAL: _____

DEPTH TOP OF SAND PACK: _____

ELEVATION / DEPTH TOP OF SCREEN: _____ / _____

TYPE OF SCREEN: _____

SLOT SIZE x LENGTH: _____

I.D. OF SCREEN: _____

TYPE OF SAND PACK: _____

ELEVATION / DEPTH BOTTOM OF SCREEN: _____ / _____

ELEVATION / DEPTH BOTTOM OF SAND PACK: _____ / _____
TYPE OF BACKFILL BELOW OBSERVATION WELL: _____

ELEVATION / DEPTH OF HOLE: _____ / _____

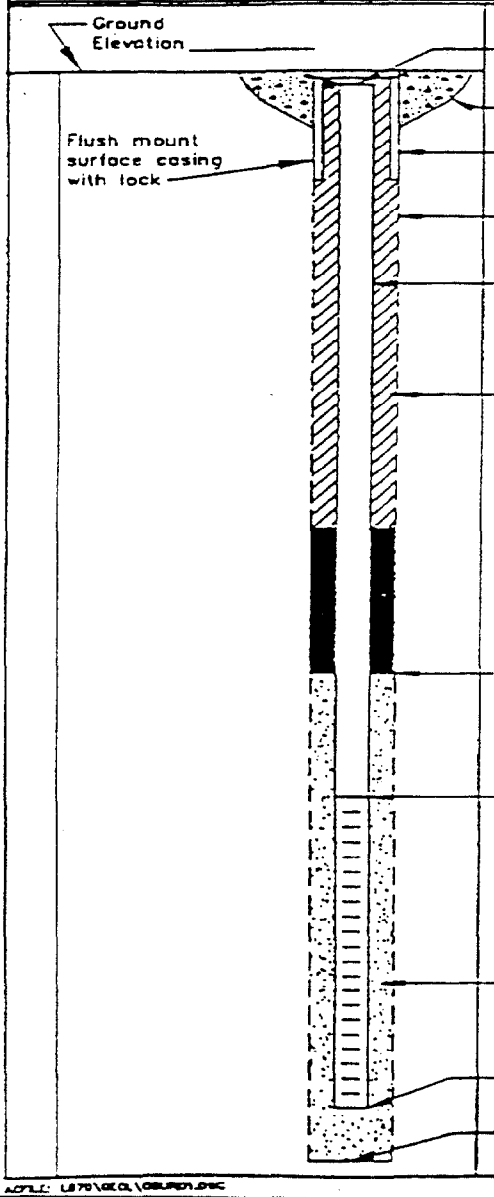
ATTACHMENT C-5A
EXAMPLE OVERBURDEN MONITORING WELL SHEET (FLUSHMOUNT)

BORING NO.: _____

MONITORING WELL SHEET

PROJECT _____ LOCATION _____
PROJECT NO. _____ BORING _____
ELEVATION _____ DATE _____
FIELD GEOLOGIST _____

DRILLER _____
DRILLING METHOD _____
DEVELOPMENT METHOD _____



ELEVATION TOP OF RISER: _____

TYPE OF SURFACE SEAL: _____

TYPE OF PROTECTIVE CASING: _____

I.D. OF PROTECTIVE CASING: _____

DIAMETER OF HOLE: _____

TYPE OF RISER PIPE: _____

RISER PIPE I.D.: _____

TYPE OF BACKFILL/SEAL: _____

_____

DEPTH/ELEVATION TOP OF SAND: _____ / _____

DEPTH/ELEVATION TOP OF SCREEN: _____ / _____

TYPE OF SCREEN: _____

SLOT SIZE x LENGTH: _____

TYPE OF SAND PACK: _____

DIAMETER OF HOLE IN BEDROCK: _____

DEPTH/ELEVATION BOTTOM OF SCREEN: _____ / _____

DEPTH/ELEVATION BOTTOM OF SAND: _____ / _____

DEPTH/ELEVATION BOTTOM OF HOLE: _____ / _____

BACKFILL MATERIAL BELOW SAND: _____

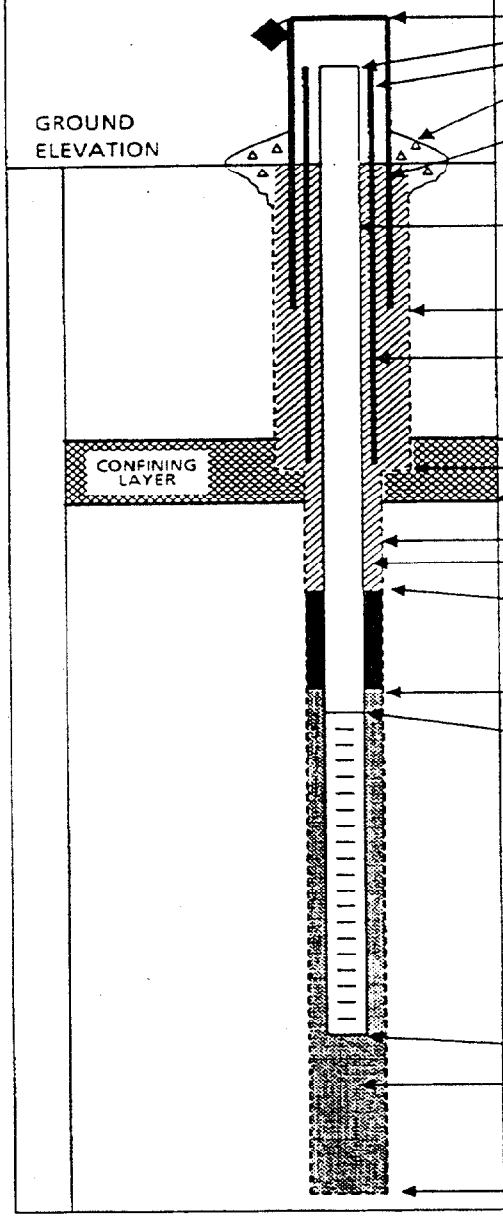
ATTACHMENT C-6
EXAMPLE CONFINING LAYER MONITORING WELL SHEET

BORING NO.: _____

CONFINING LAYER
MONITORING WELL SHEET

PROJECT _____ LOCATION _____
PROJECT NO. _____ BORING _____
ELEVATION _____ DATE _____
FIELD GEOLOGIST _____

DRILLER _____
DRILLING METHOD _____
DEVELOPMENT METHOD _____



ELEVATION OF TOP OF SURFACE CASING : _____
ELEVATION OF TOP OF RISER PIPE: _____
ELEVATION TOP OF PERM. CASING: _____
TYPE OF SURFACE SEAL: _____

I.D. OF SURFACE CASING: _____
TYPE OF SURFACE CASING: _____

RISER PIPE I.D. _____
TYPE OF RISER PIPE: _____

BOREHOLE DIAMETER: _____

PERM. CASING I.D. _____
TYPE OF CASING & BACKFILL: _____

ELEVATION / DEPTH TOP CONFINING LAYER: _____
ELEVATION / DEPTH BOTTOM OF CASING: _____
ELEVATION / DEPTH BOT. CONFINING LAYER: _____

BOREHOLE DIA. BELOW CASING: _____
TYPE OF BACKFILL: _____

ELEVATION / DEPTH TOP OF SEAL: _____
TYPE OF SEAL: _____

DEPTH TOP OF SAND PACK: _____

ELEVATION/DEPTH TOP OF SCREEN: _____
TYPE OF SCREEN: _____

TYPE OF SAND PACK: _____

ELEVATION / DEPTH BOTTOM OF SCREEN: _____

ELEVATION / DEPTH BOTTOM OF SAND PACK: _____
TYPE OF BACKFILL BELOW OBSERVATION WELL: _____

ELEVATION / DEPTH OF HOLE: _____

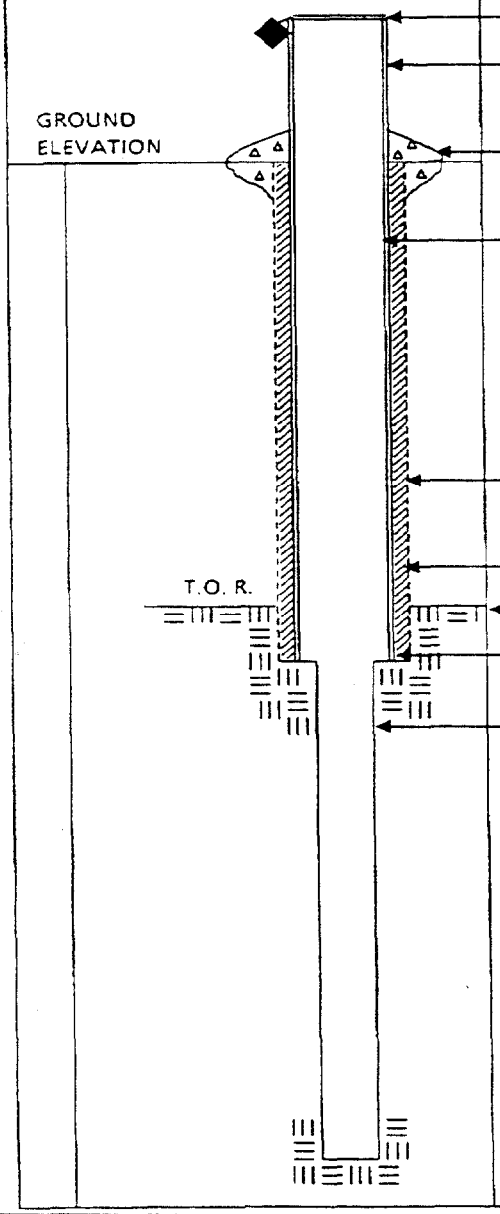
ATTACHMENT C-7
EXAMPLE BEDROCK MONITORING WELL SHEET - OPEN HOLE WELL

BORING NO.: _____

BEDROCK
MONITORING WELL SHEET
OPEN HOLE WELL

PROJECT _____ LOCATION _____
PROJECT NO. _____ BORING _____
ELEVATION _____ DATE _____
FIELD GEOLOGIST _____

DRILLER _____
DRILLING METHOD _____
DEVELOPMENT METHOD _____



ELEVATION OF TOP OF CASING: _____

STICK UP OF CASING ABOVE GROUND SURFACE: _____

TYPE OF SURFACE SEAL: _____

I.D. OF CASING: _____
TYPE OF CASING: _____

TEMP. / PERM.: _____

DIAMETER OF HOLE: _____

TYPE OF CASING SEAL: _____

DEPTH TO TOP OF ROCK: _____

DEPTH TO BOTTOM CASING: _____

DIAMETER OF HOLE IN BEDROCK: _____

DESCRIBE IF CORE / REAMED WITH BIT:

_____
_____
_____

DESCRIBE JOINTS IN BEDROCK AND DEPTH:

_____
_____
_____

ELEVATION / DEPTH OF HOLE: _____ / _____

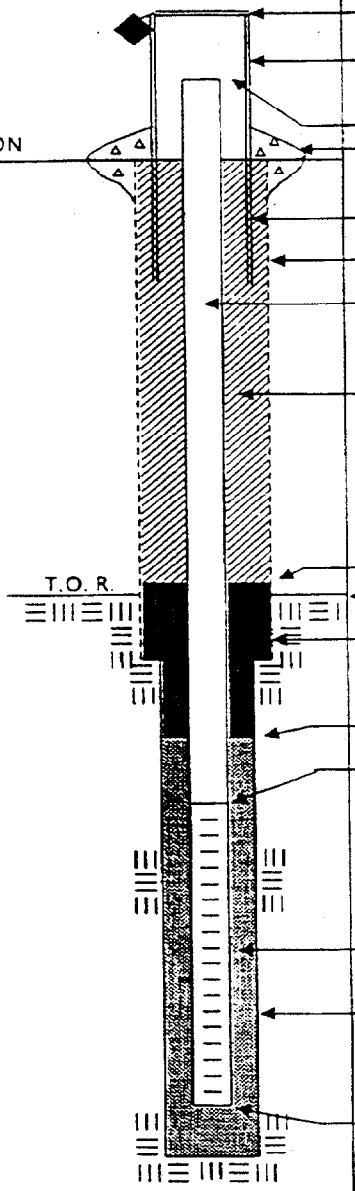
ATTACHMENT C-8
EXAMPLE BEDROCK MONITORING WELL SHEET - WELL INSTALLED IN BEDROCK

BORING NO.: _____

BEDROCK
MONITORING WELL SHEET
WELL INSTALLED IN BEDROCK

PROJECT _____ LOCATION _____
PROJECT NO. _____ BORING _____
ELEVATION _____ DATE _____
FIELD GEOLOGIST _____

DRILLER _____
DRILLING METHOD _____
DEVELOPMENT METHOD _____



ELEVATION OF TOP OF SURFACE CASING: _____

STICK UP OF CASING ABOVE GROUND SURFACE: _____

ELEVATION TOP OF RISER: _____

TYPE OF SURFACE SEAL: _____

I.D. OF SURFACE CASING: _____

DIAMETER OF HOLE: _____

RISER PIPE I.D.: _____

TYPE OF RISER PIPE: _____

TYPE OF BACKFILL: _____

ELEVATION / DEPTH TOP OF SEAL: ____/____

ELEVATION / DEPTH TOP OF BEDROCK: ____/____

TYPE OF SEAL: _____

ELEVATION / DEPTH TOP OF SAND: ____/____

ELEVATION / DEPTH TOP OF SCREEN: ____/____

TYPE OF SCREEN: _____

SLOT SIZE x LENGTH: _____

I.D. SCREEN: _____

TYPE OF SAND PACK: _____

DIAMETER OF HOLE IN BEDROCK:

CORE / REAM: _____

ELEVATION / DEPTH BOTTOM SCREEN: ____/____

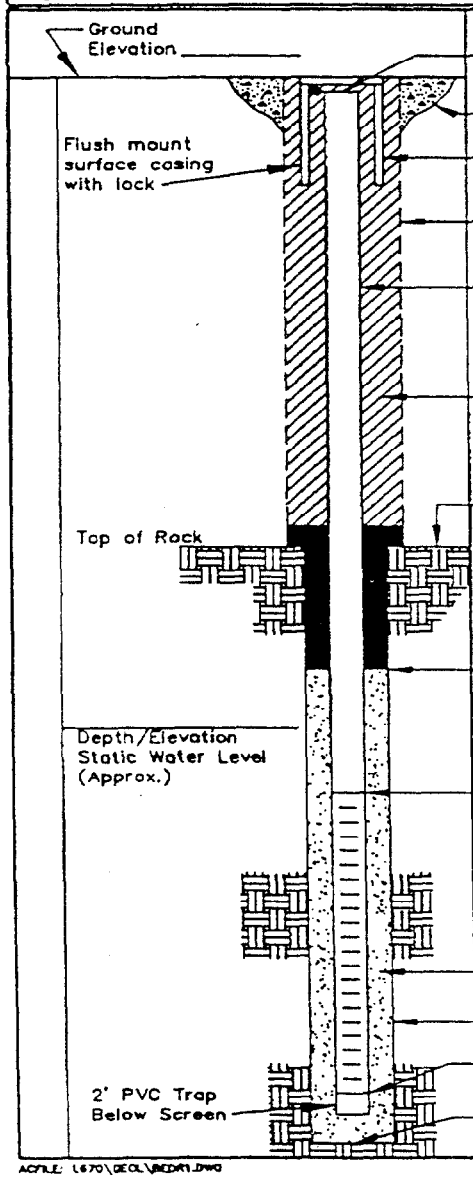
ELEVATION / DEPTH BOTTOM OF HOLE: ____/____

ATTACHMENT C-8A
EXAMPLE BEDROCK MONITORING WELL SHEET
WELL INSTALLED IN BEDROCK (FLUSHMOUNT)

BORING NO.: _____

BEDROCK
MONITORING WELL SHEET
WELL INSTALLED IN BEDROCK

PROJECT: _____	LOCATION: _____	DRILLER: _____
PROJECT NO.: _____	BORING: _____	DRILLING METHOD: _____
ELEVATION: _____	DATE: _____	DEVELOPMENT METHOD: _____
FIELD GEOLOGIST: _____		



ELEVATION TOP OF RISER: _____

TYPE OF SURFACE SEAL: _____

TYPE OF PROTECTIVE CASING: _____

I.D. OF PROTECTIVE CASING: _____

DIAMETER OF HOLE: _____

TYPE OF RISER PIPE: _____

RISER PIPE I.D.: _____

TYPE OF BACKFILL/SEAL: _____

_____

DEPTH/ELEVATION TOP OF BEDROCK: _____/_____

DEPTH/ELEVATION TOP OF SAND: _____/_____

DEPTH/ELEVATION TOP OF SCREEN: _____/_____

TYPE OF SCREEN: _____

SLOT SIZE x LENGTH: _____

TYPE OF SAND PACK: _____

DIAMETER OF HOLE IN BEDROCK: _____

DEPTH/ELEVATION BOTTOM OF SCREEN: _____/_____

DEPTH/ELEVATION BOTTOM OF SAND: _____/_____

DEPTH/ELEVATION BOTTOM OF HOLE: _____/_____

BACKFILL MATERIAL BELOW SAND: _____

ACFILE: L670\DECL\BEDR1.DWG

ATTACHMENT C-9
EXAMPLE TEST PIT LOG

TEST PIT LOG

Brown & Root Environmental

PROJECT: _____ TEST PIT NO.:
PROJECT NO _____ DATE: _____
LOCATION: _____
FIELD GEOLOGIST: _____

DEPTH (ft.)	LITHOLOGY CHANGE (Depth ft.)	MATERIAL DESCRIPTION (Soil Density / Consistency, Color)	USCS	REMARKS

Test Pit Cross Section and / or Plan View

REMARKS _____

PHOTO LOG _____ TEST PIT _____

PAGE ____ OF ____

ATTACHMENT D
EXAMPLE EQUIPMENT CALIBRATION LOG

Brown & Root Environmental

EQUIPMENT CALIBRATION LOG

INSTRUMENT NAME / MODEL : _____

JOB NAME : _____

MANUFACTURER : _____

JOB NUMBER : _____

CALIBRATION DATE	INITIAL SETTINGS	STANDARDS USED	PROCEDURE	ADJUSTMENTS MADE	FINAL SETTINGS	SIGNATURE	COMMENTS

ATTACHMENT E
EXAMPLE DAILY ACTIVITIES RECORD

Brown & Root Environmental

DAILY ACTIVITIES RECORD

PROJECT _____ LOCATION _____
CLIENT _____ ARRIVAL TIME _____ JOB NO. _____
DATE _____ DEPARTURE TIME _____
CONTRACTOR _____ DRILLER _____
BORING NO. _____ HNUS REPRESENTATIVE _____

ITEM	QUANTITY ESTIMATE	QUANTITY TODAY	PREVIOUS TOTAL QUANTITY	CUMULATIVE QUANTITY TO DATE

COMMENTS: _____

APPROVED BY:

_____ HNUS FIELD REPRESENTATIVE

_____ DRILLER OR REPRESENTATIVE

ATTACHMENT F
FIELD TRIP SUMMARY REPORT
PAGE 1 OF 2

SUNDAY

Date: _____ Personnel: _____
Weather: _____ Onsite: _____

Site Activities: _____

MONDAY

Date: _____ Personnel: _____
Weather: _____ Onsite: _____

Site Activities: _____

TUESDAY

Date: _____ Personnel: _____
Weather: _____ Onsite: _____

Site Activities: _____

WEDNESDAY

Date: _____ Personnel: _____
Weather: _____ Onsite: _____

Site Activities: _____

ATTACHMENT F
PAGE 2 OF 2
FIELD TRIP SUMMARY REPORT

THURSDAY

Date: _____ Personnel: _____

Weather: _____ Onsite: _____

Site Activities: _____

_____

_____

_____

FRIDAY

Date: _____ Personnel: _____

Weather: _____ Onsite: _____

Site Activities: _____

_____

_____

_____

SATURDAY

Date: _____ Personnel: _____

Weather: _____ Onsite: _____

Site Activities: _____

_____

_____

_____

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1.0 PURPOSE

The purpose of this procedure is to provide guidelines regarding the appropriate procedures to be followed when decontaminating drilling equipment, monitoring well materials, chemical sampling equipment and field analytical equipment.

2.0 SCOPE

This procedure addresses drilling equipment and monitoring well materials decontamination, as well as chemical sampling and field analytical equipment decontamination. This procedure also provides general reference information on the control of contaminated materials.

3.0 GLOSSARY

Acid - For decontamination of equipment when sampling for trace levels of inorganics, a 10% solution of nitric acid in deionized water should be used. Due to the leaching ability of nitric acid, it should not be used on stainless steel.

Alconox/Liquinox - A brand of phosphate-free laboratory-grade detergent.

Deionized Water - Deionized (analyte free) water is tap water that has been treated by passing through a standard deionizing resin column. Deionized water should contain no detectable heavy metals or other inorganic compounds at or above the analytical detection limits for the project.

Potable Water - Tap water used from any municipal water treatment system. Use of an untreated potable water supply is not an acceptable substitute for tap water.

Solvent - The solvent of choice is pesticide-grade Isopropanol. Use of other solvents (methanol, acetone, pesticide-grade hexane, or petroleum ether) may be required for particular projects or for a particular purpose (e.g. for the removal of concentrated waste) and must be justified in the project planning documents. As an example, it may be necessary to use hexane when analyzing for trace levels of pesticides, PCBs, or fuels. In addition, because many of these solvents are not miscible in water, the equipment should be air dried prior to use. Solvents should not be used on PVC equipment or well construction materials.

4.0 RESPONSIBILITIES

Project Manager - Responsible for ensuring that all field activities are conducted in accordance with approved project plan(s) requirements.

Field Operations Leader (FOL) - Responsible for the onsite verification that all field activities are performed in compliance with approved Standards Operating Procedures or as otherwise dictated by the approved project plan(s).

5.0 PROCEDURES

To ensure that analytical chemical results reflect actual contaminant concentrations present at sampling locations, the various drilling equipment and chemical sampling and analytical equipment used to acquire the environment sample must be properly decontaminated. Decontamination minimizes the potential for cross-contamination between sampling locations, and the transfer of contamination off site.

5.1 Drilling Equipment

Prior to the initiation of a drilling program, all drilling equipment involved in field sampling activities shall be decontaminated by steam cleaning at a predetermined area. The steam cleaning procedure shall be performed using a high-pressure spray of heated potable water producing a pressurized stream of steam. This steam shall be sprayed directly onto all surfaces of the various equipment which might contact environmental samples. The decontamination procedure shall be performed until all equipment is free of all visible potential contamination (dirt, grease, oil, noticeable odors, etc.) In addition, this decontamination procedure shall be performed at the completion of each sampling and/or drilling location, including soil borings, installation of monitoring wells, test pits, etc. Such equipment shall include drilling rigs, backhoes, downhole tools, augers, well casings, and screens. Where the drilling rig is set to perform multiple borings at a single area of concern, the steam-cleaning of the drilling rig itself may be waived with proper approval. Downhole equipment, however, must always be steam-cleaned between borings. Where PVC well casings are to be installed, decontamination is not required if the manufacturer provides these casings in factory-sealed, protective, plastic sleeves (so long as the protective packaging is not compromised until immediately before use).

The steam cleaning area shall be designed to contain decontamination wastes and waste waters and can be a lined excavated pit or a bermed concrete or asphalt pad. For the latter, a floor drain must be provided which is connected to a holding facility. A shallow above-ground tank may be used or a pumping system with discharge to a waste tank may be installed.

In certain cases such an elaborate decontamination pad is not possible. In such cases, a plastic lined gravel bed pad with a collection system may serve as an adequate decontamination area. Alternately, a lined sloped pad with a collection pump installed at the lower end may be permissible. The location of the steam cleaning area shall be onsite in order to minimize potential impacts at certain sites.

Guidance to be used when decontaminating drilling equipment shall include:

- As a general rule, any part of the drilling rig which extends over the borehole, shall be steam cleaned.
- All drilling rods, augers, and any other equipment which will be introduced to the hole shall be steam cleaned.
- The drilling rig, all rods and augers, and any other potentially contaminated equipment shall be decontaminated between each well location to prevent cross contamination of potential hazardous substances.

Prior to leaving at the end of each work day and/or at the completion of the drilling program, drilling rigs and transport vehicles used onsite for personnel or equipment transfer shall be steam cleaned, as practicable. A drilling rig left at the drilling location does not need to be steam cleaned until it is finished drilling at that location.

5.2 Sampling Equipment

5.2.1 Bailers and Bailing Line

The potential for cross-contamination between sampling points through the use of a common bailer or its attached line is high unless strict procedures for decontamination are followed. For this reason, it is preferable to dedicate an individual bailer and its line to each sample point, although this does not

eliminate the need for decontamination of dedicated bailers. For non-dedicated sampling equipment, the following conditions and/or decontamination procedures must be followed.

Before the initial sampling and after each successive sampling point, the bailer must be decontaminated. The following steps are to be performed when sampling for organic contaminants. Note: contract-specific requirements may permit alternative procedures.

- Potable water rinse
- Alconox or Liquinox detergent wash
- Scrubbing of the line and bailer with a scrub brush (may be required if the sample point is heavily contaminated with heavy or extremely viscous compounds)
- Potable water rinse
- Rinse with 10 percent nitric acid solution*
- Deionized water rinse
- Pesticide-grade isopropanol (unless otherwise required)
- Pesticide-grade hexane rinse**
- Copious distilled/Deionized water rinse
- Air dry

If sampling for volatile organic compounds (VOCs) only, the nitric acid, isopropanol, and hexane rinses may be omitted. Only reagent grade or purer solvents are to be used for decontamination. When solvents are used, the bailer must be thoroughly dry before using to acquire the next sample.

In general, specially purchased pre-cleaned disposable sampling equipment is not decontaminated (nor is an equipment rinsate blank collected) so long as the supplier has provided certification of cleanliness. If decontamination is performed on several bailers at once (i.e., in batches), bailers not immediately used may be completely wrapped in aluminum foil (shiny-side toward equipment) and stored for future use. When batch decontamination is performed, one equipment rinsate is generally collected from one of the bailers belonging to the batch before it is used for sampling.

It is recommended that clean, dedicated braided nylon or polypropylene line be employed with each bailer use.

5.2.2 Sampling Pumps

Most sampling pumps are low volume (less than 2 gpm) pumps. These include peristaltic, diaphragm, air-lift, pitcher and bladder pumps, to name a few. If these pumps are used for sampling from more than one sampling point, they must be decontaminated prior to initial use and after each use.

The procedures to be used for decontamination of sampling pumps compare to those used for a bailer except that the 10 percent nitric acid solution is omitted. Each of the liquid factions is to be pumped through the system. The amount of pumping is dependent upon the size of the pump and the length of the intake and discharge hoses. Certain types of pumps are unacceptable for sampling purposes. For peristaltic pumps, the tubing is replaced rather than cleaned.

---

* Due to the leaching ability of nitric acid on stainless steel, this step is to be omitted if a stainless steel sampling device is being used and metals analysis is required with detection limits less than approximately 50 ppb.

** If sampling for pesticides, PCBs, or fuels.

An additional problem is introduced when the pump relies on absorption of water via an inlet or outlet hose. For organic sampling, this hose should be Teflon. Other types of hoses leach organics (especially phthalate esters) into the water being sampled or adsorb organics from the sampled water. For all other sampling, the hose should be Viton, polyethylene, or polyvinyl chloride (listed in order of preference). Whenever possible, dedicated hoses should be used. It is preferable that these types of pumps not be used for sampling, only for purging.

5.2.3 Filtering Equipment

On occasion, the sampling plan may require acquisition of filtered groundwater samples. Field-filtering is addressed in SOP SA-6.1 and should be conducted as soon after sample acquisition as possible. To this end, three basic filtration systems are most commonly used: the in-line disposable Teflon filter, the inert gas over-pressure filtration system, and the vacuum filtration system.

For the in-line filter, decontamination is not required since the filter cartridge is disposable, however, the cartridge must be disposed of in an approved receptacle and the intake and discharge lines must still be decontaminated or replaced before each use.

For the over-pressure and the vacuum filtration systems, the portions of the apparatus which come in contact with the sample must be decontaminated as outlined in the paragraphs describing the decontamination of bailers. (Note: Varieties of both of these systems come equipped from the manufacturer with Teflon-lined surfaces for those that would come into contact with the sample. These filtration systems are preferred when decontamination procedures must be employed.)

5.2.4 Other Sampling Equipment

Field tools such as trowels and mixing bowls are to be decontaminated in the same manner as described above.

5.3 Field Analytical Equipment

5.3.1 Water Level Indicators

Water level indicators that come into contact with groundwater must be decontaminated using the following steps:

- Rinse with potable water
- Rinse with deionized water
- Pesticide-grade isopropanol (unless otherwise directed by manufacturer)
- Rinse with deionized water

Water level indicators that do not come in contact with the groundwater but may encounter incidental contact during installation or retrieval need only undergo the first and last steps stated above.

5.3.2 Probes

Probes (e.g., pH or specific-ion electrodes, geophysical probes, or thermometers) which would come in direct contact with the sample, will be decontaminated using the procedures specified above unless manufacturer's instructions indicate otherwise (e.g., dissolved oxygen probes). Probes that contact a volume of groundwater not used for laboratory analyses can be rinsed with deionized water. For probes which make no direct contact, (e.g., OVA equipment) the probe is self-cleaning when exposure to

uncontaminated air is allowed and the housing can be wiped clean with paper-towels or cloth wetted with alcohol.

5.4 Waste Handling

For the purposes of these procedures, contaminated materials are defined as any byproducts of field activities that are suspected or known to be contaminated with hazardous substances. These byproducts include such materials as decontamination solutions, disposable equipment, drilling muds, well-development fluids, and spill-contaminated materials and Personal Protection Equipment (PPE).

The procedures for obtaining permits for investigations of sites containing hazardous substances are not clearly defined at present. In the absence of a clear directive to the contrary by the EPA and the states, it must be assumed that hazardous wastes generated during field activities will require compliance with Federal agency requirements for generation, storage, transportation, or disposal. In addition, there may be state regulations that govern the disposal action. This procedure exclusively describes the technical methods used to control contaminated materials.

The plan documents for site activities must include a description of control procedures for contaminated materials. This planning strategy must assess the type of contamination, estimate the amounts that would be produced, describe containment equipment and procedures, and delineate storage or disposal methods. As a general policy, it is wise to select investigation methods that minimize the generation of contaminated spoils. Handling and disposing of potentially hazardous materials can be dangerous and expensive. Until sample analysis is complete, it is assumed that all produced materials are suspected of contamination from hazardous chemicals and require containment.

5.5 Sources of Contaminated Materials and Containment Methods

5.5.1 Decontamination Solutions

All waste decontamination solutions and rinses must be assumed to contain the hazardous chemicals associated with the site unless there are analytical or other data to the contrary. The waste solution volumes could vary from a few gallons to several hundred gallons in cases where large equipment required cleaning.

Containerized waste rinse solutions are best stored in 55-gallon drums (or equivalent containers) that can be sealed until ultimate disposal at an approved facility. Larger equipment such as backhoes and tractors must be decontaminated in an area provided with an impermeable liner and a liquid collection system. A decontamination area for large equipment could consist of a bermed concrete pad with a floor drain leading to a buried holding tank.

5.5.2 Disposable Equipment

Disposable equipment that could become contaminated during use typically includes PPE, rubber gloves, boots, broken sample containers, and cleaning-wipes. These items are small and can easily be contained in 55-gallon drums with lids. These containers should be closed at the end of each work day and upon project completion to provide secure containment until disposed.

5.5.3 Drilling Muds and Well-Development Fluids

Drilling muds and well-development fluids are materials that may be used in groundwater monitoring well installations. Their proper use could result in the surface accumulation of contaminated liquids and muds

that require containment. The volumes of drilling muds and well-development fluids used depend on well diameter and depth, groundwater characteristics, and geologic formations. There are no simple mathematical formulas available for accurately predicting these volumes. It is best to rely on the experience of reputable well drillers familiar with local conditions and the well installation techniques selected. These individuals should be able to estimate the sizes (or number) of containment structures required. Since guesswork is involved, it is recommended that an slight excess of the estimated amount of containers required will be available.

Drilling muds are mixed and stored in what is commonly referred to as a mud pit. This mud pit consists of a suction section from which drilling mud is withdrawn and pumped through hoses, down the drill pipe to the bit, and back up the hole to the settling section of the mud pit. In the settling section, the mud's velocity is reduced by a screen and several flow-restriction devices, thereby allowing the well cuttings to settle out of the mud/fluid.

The mud pit may be either portable above-ground tanks commonly made of steel (which is preferred) or stationary in-ground pits as depicted in Attachment A. The above-ground tanks have a major advantage over the in-ground pits because the above-ground tanks isolate the natural soils from the contaminated fluids within the drilling system. These tanks are also portable and can usually be cleaned easily.

As the well is drilled, the cuttings that accumulate in the settling section must be removed. This is best done by shoveling them into drums or other similar containers. When the drilling is complete, the contents of the above-ground tank are likewise shoveled or pumped into drums, and the tank is cleaned and made available for its next use.

If in-ground pits are used, they should not extend into the natural water table. They should also be lined with a bentonite-cement mixture followed by a layer of flexible impermeable material such as plastic sheeting. Of course, to maintain its impermeable seal, the lining material used would have to be nonreactive with the wastes. An advantage of the in-ground pits is that well cuttings do not necessarily have to be removed periodically during drilling because the pit can be made deep enough to contain them. Depending on site conditions, the in-ground pit may have to be totally excavated and refilled with uncontaminated natural soils when the drilling operation is complete.

When the above-ground tank or the in-ground pit is used, a reserve tank or pit should be located at the site as a backup system for leaks, spills, and overflows. In either case, surface drainage should be such that any excess fluid could be controlled within the immediate area of the drill site.

The containment procedure for well-development fluids is similar to that for drilling muds. The volume and weight of contaminated fluid will be determined by the method used for development. When a new well is pumped or bailed to produce clear water, substantially less volume and weight of fluid result than when backwashing or high-velocity jetting is used.

5.5.4 Spill-Contaminated Materials

A spill is always possible when containers of liquids are opened or moved. Contaminated sorbents and soils resulting from spills must be contained. Small quantities of spill-contaminated materials are usually best contained in drums, while larger quantities can be placed in lined pits or in other impermeable structures. In some cases, onsite containment may not be feasible and immediate transport to an approved disposal site will be required.

5.6 Disposal of Contaminated Materials

Actual disposal techniques for contaminated materials are the same as those for any hazardous substance, that is, incineration, landfilling, treatment, and so on. The problem centers around the assignment of responsibility for disposal. The responsibility must be determined and agreed upon by all involved parties before the field work starts. If the site owner or manager was involved in activities that precipitated the investigation, it seems reasonable to encourage his acceptance of the disposal obligation. In instances where a responsible party cannot be identified, this responsibility may fall on the public agency or private organization investigating the site.

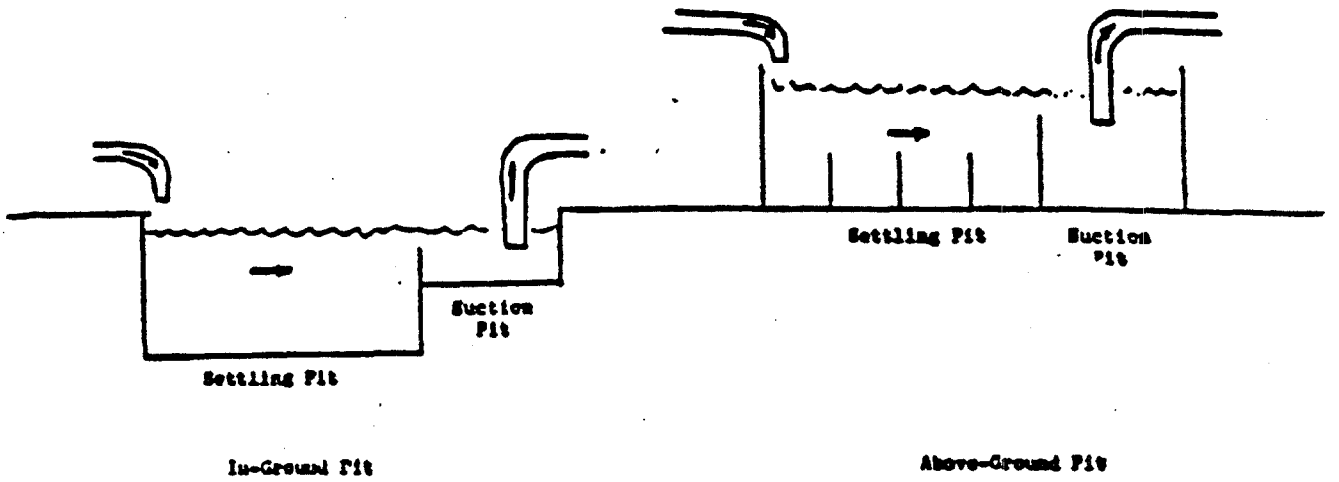
Another consideration in selecting disposal methods for contaminated materials is whether the disposal can be incorporated into subsequent site cleanup activities. For example, if construction of a suitable onsite disposal structure is expected, contaminated materials generated during the investigation should be stored at the site for disposal with other site materials. In this case, the initial containment structures should be evaluated for use as long-term storage structures. Also, other site conditions such as drainage control, security, and soil type must be considered so that proper storage is provided. If onsite storage is expected, then the containment structures should be specifically designed for that purpose.

6.0 REFERENCES

Brown & Root Environmental: Standard Operating Procedure No. 4.33, Control of Contaminated Material.

ATTACHMENT A

TWO TYPES OF MUD PITS USED IN WELL DRILLING



APPENDIX D

QUALITY ASSURANCE PROJECT PLAN

Quality Assurance Project Plan
for the
Background Investigation
at
Indian Head and Stump Neck Annex
Naval Surface Warfare Center
Indian Head, Maryland

Engineering Field Activity Chesapeake
Naval Facilities Engineering Command

Contract Number N62472-90-D-1298
Contract Task Order 0287

October 1997

069713/P

QUALITY ASSURANCE PROJECT PLAN FOR THE BACKGROUND INVESTIGATION AT INDIAN HEAD AND STUMP NECK ANNEX 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:
Brown & Root Environmental
600 Clark Avenue, Suite 3
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ACRONYMS/ABBREVIATIONS

B&R Environmental	Brown & Root Environmental
BI	Background Investigation
CLEAN	Comprehensive Long-Term Environmental Action, Navy
CLP	Contract Laboratory Program
COC	Chain of Custody
CVAA	Cold Vapor Atomic Absorption
EC	Electron Capture
EQL	Estimated Quantitation Limits
FID	Flame Ionization Detector
FOL	Field Operations Leader
FTMR	Field Task Modification Request
GC	Gas Chromatograph
GFAA	Graphite Furnace Atomic Absorption
HPLC	High Performance Liquid Chromatography
ICP	Inductively Coupled Plasma
LCS	Laboratory Control Sample
MDE	Maryland Department of the Environment
MS	Mass Spectrophotometer
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NFESC	Naval Facilities Engineering Service Center
NIST	National Institute of Science and Technology
NSWC	Naval Surface Warfare Center
PARCC	Precision, Accuracy, Representativeness, Comparability, Completeness
PCB	Polychlorinated Biphenyl
PID	Photoionization Detector
PQL	Practical Quantitation Limits
QA	Quality Assurance
QAM	Quality Assurance Manager
QAPP	Quality Assurance Project Plan
QC	Quality Control
RPD	Relative Percent Difference
SOP	Standard Operating Procedure
TAL	Target Analyte List
TCL	Target Compound List
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
TOX	Total Organic Halogen
TSS	Total Suspended Solids
UCL	Upper Ninety-Five Percent Confidence Limit
U.S. EPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound
%R	Percent Recovery

1.0 PROJECT DESCRIPTION

1.1 INTRODUCTION

This Quality Assurance Project Plan (QAPP) has been prepared by Brown & Root Environmental (B&R Environmental) on behalf of the United States Navy Engineering Field Activity Chesapeake Naval Facilities Engineering Command and the Indian Head Naval Surface Warfare Center (the Station or NSWC) in support of a comprehensive statistical background study. The background study will apply to both the Indian Head Naval Surface Warfare Center and the Stump Neck Annex, Indian Head. This QAPP has been prepared under Comprehensive Long-Term Environmental Action Navy Contract N62472-90-D-1298, Contract Task Order 0287. This QAPP and other associated documents, including the Work Plan and the Health and Safety Plan, constitute the project planning documents for the site Background Investigation (BI).

This QAPP presents the organization, objectives, planned activities, and specific Quality Assurance/Quality Control (QA/QC) procedures associated with the Work Plan for the site BI. Specific protocols for sampling, sample handling and storage, chain-of-custody, and laboratory and field analyses are described. All QA/QC procedures are structured in accordance with applicable technical standards, the Naval Facilities Engineering Service Center (NFESC) guidance document "Navy Installation Restoration Laboratory Quality Assurance Guide" (February 1996), and United States Environmental Protection Agency (U.S. EPA) Region III and Maryland Department of the Environment (MDE) requirements, regulations, guidance, and technical standards.

This QAPP has been prepared in accordance with the general requirements outlined in "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans," dated December 29, 1980 (QAMS-005/80).

1.2 FACILITY DESCRIPTION

A facility description, including the location and general description, physiography, climate, soils, geology, and hydrogeology, is provided in Section 1.0 of the Work Plan.

1.3 PROJECT TARGET PARAMETERS AND INTENDED DATA USES

This section discusses field and laboratory analytical information to be generated during the course of the BI. 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 the completion of soil borings, collection of surface and sediment samples, installation and development of monitoring wells, and groundwater sampling and analysis. Field measurements will include only those completed using simple field instrumentation.

Field measurements of total volatile organics will be completed using a Photoionization Detector (PID) or Flame Ionization Detector (FID). These measurements will be used to breathing zone conditions of site workers.

Field parameters including pH, specific conductance, turbidity, dissolved oxygen, salinity, and temperature will be completed for all aqueous phase samples. These measurements will typically be used to support monitoring well development and purging of stagnant water from well casings. Specific conductance, salinity, and pH will also be used as general indicators of water quality.

1.3.2 Laboratory Parameters

The analytical methods to be used for analysis of the background samples have been selected based on existing information regarding the use of the facility. Laboratory parameters will include Target Compound List (TCL) pesticides/polychlorinated biphenyls, Target Analyte List (TAL) metals, and several general chemistry parameters. Tables 1-1 through 1-3 provide a summary of all target laboratory analytes and associated Estimated Quantitation Limits (EQLs). Analytical methods and quantitation limits are further discussed in Section 7.0.

1.4 SAMPLE NETWORK DESIGN AND RATIONALE

The sample network design and rationale is discussed in Section 2.0 of the Work Plan.

1.5 PROJECT SCHEDULE

The project schedule is provided in Section 5.2 of the Work Plan.

TABLE 1-1

BACKGROUND STUDY WORK PLAN
ESTIMATED QUANTITATION LIMITS - TCL PESTICIDES/PCBs
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

Pesticides/PCBs	EQL[1]	
	Aqueous Samples (µg/L)	Solid Samples[2] (µg/kg)
Aldrin	0.050	1.7
alpha-BHC	0.050	1.7
alpha-Chlordane	0.050	1.7
beta-BHC	0.050	1.7
4,4'-DDE	0.10	3.3
4,4'-DDD	0.10	3.3
4,4'-DDT	0.10	3.3
delta-BHC	0.050	1.7
Dieldrin	0.10	3.3
Endosulfan I	0.050	1.7
Endosulfan II	0.10	3.3
Endosulfan sulfate	0.10	3.3
Endrin	0.10	3.3
Endrin aldehyde	0.10	3.3
Endrin ketone	0.10	3.3
gamma-BHC (Lindane)	0.050	1.7
gamma-Chlordane	0.050	1.7
Heptachlor	0.050	1.7
Heptachlor epoxide	0.050	1.7
Methoxychlor	0.50	17
Toxaphene	5.0	170
Aroclor-1016	1.0	33
Aroclor-1221	2.0	67
Aroclor-1232	1.0	33
Aroclor-1242	1.0	33
Aroclor-1248	1.0	33
Aroclor-1254	1.0	33
Aroclor-1260	1.0	33

1 EQL - Estimated Quantitation Limit. Limits may vary based on laboratory and sample matrix.
2 EQLs listed for soil/sediment are based on wet weight. Data will be reported on a dry weight basis; therefore, EQLs will be higher based on the percent dry weight of each sample.

TABLE 1-2

BACKGROUND STUDY WORK PLAN
ESTIMATED QUANTITATION LIMITS - TAL METALS PLUS TIN
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

TAL Metals plus Tin	EQL[1]	
	Aqueous (µg/L)	Solid[2] mg/kg
Aluminum	45	9
Antimony	32	6.4
Arsenic	1	0.2
Barium	2	0.4
Beryllium	0.3	0.06
Cadmium	4	0.8
Calcium	10	2
Chromium	7	1.4
Cobalt	7	1.4
Copper	6	1.2
Iron	7	1.4
Lead	1	0.2
Magnesium	30	6
Manganese	2	0.4
Mercury	0.2	0.1
Nickel	15	3
Potassium	96[3]	19.2[3]
Selenium	2	0.4
Silver	7	1.4
Sodium	29	5.8
Thallium	1	0.2
Tin	10	2
Vanadium	8	1.6
Zinc	2	0.4

1 EQL - Estimated Quantitation Limit. Limits may vary based on laboratory and sample matrix.
2 EQLs listed for soil/sediment are based on wet weight. Data will be reported on a dry weight basis; therefore, EQLs will be higher, based on the percent dry weight of each sample.
3 Highly dependent on operating conditions and plasma position.

TABLE 1-3

BACKGROUND STUDY WORK PLAN
ESTIMATED QUANTITATION LIMITS - GENERAL CHEMISTRY PARAMETERS
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

Parameter	EQL[1]	
	Aqueous Samples (mg/L)	Solid Samples[2] (mg/kg)
Total Organic Carbon (TOC)	1	50
Total Organic Halogens (TOX)	0.05	1
Total Dissolved Solids (TDS)	10	NA
Total Suspended Solids (TSS)	4	NA
Sulfate	1	NA
Chloride	1	NA
Nitrate	0.2	NA
Nitrite	0.1	NA
Phosphate	1	NA
Fluoride	1	NA
Grain Size (% finer)	NA	#200 sieve

1 EQL Estimated Quantitation Limit. Limits may vary based on laboratory and sample matrix.

2 EQLs listed for soil/sediment are based on wet weight. Data will be reported on a dry weight basis; therefore, EQLs will be higher, based on the percent dry weight of each sample.

NA Not Applicable

2.0 PROJECT ORGANIZATION

The project organization for the BI is discussed in Section 5.1 of the Work Plan. A project organization chart is also provided therein.

3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

The overall Quality Assurance (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 are legally defensible in a court of law. Specific procedures for sampling, chain-of-custody, instrument calibration, laboratory analysis, reporting of data, internal quality control, audits, preventive maintenance of field and laboratory equipment, and corrective action are described in other sections of this 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.

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.

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 (QC) 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 RPD values and Precision Control Limits specified in the analytical method or by the laboratory's QA/QC Program.

Precision for pesticide/PCB analyses will be measured via the RPDs for matrix spike/matrix spike duplicate (MS/MSD) samples. Precision for metals and general chemistry analysis will be measured via RPDs for laboratory duplicates. Internal laboratory control limits, which are statistically derived and typically set at three times the standard deviation of a series of RPDs, will be used for evaluation of precision. These limits will be provided in each analytical data package.

3.2 ACCURACY

3.2.1 Definition

Accuracy is the degree of agreement between are observed value and an accepted reference value. The equation for determining accuracy is provided in Section 12.1.

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 calibration as discussed in Section 6.0.

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. 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). Laboratory control sample analyses measure the accuracy of laboratory operations. Surrogate and matrix spike analyses measure the accuracy of laboratory operations as affected by the sample 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 chromatographic organic analyses. Laboratory accuracy is assessed via comparison of calculated percent recovery (%R) values with Accuracy Control Limits specified in the analytical method or by the contracted laboratory's QA/QC Program.

Accuracy for pesticide/PCB analyses will be measured via the percent recoveries for surrogate spikes and MS/MSDs. Accuracy for metals and general chemistry analyses (as applicable) will be measured via percent recoveries for matrix spikes and laboratory control samples. Internal laboratory control limits for

accuracy, which are typically set at three times the standard deviation of a series of %R values, will be used for evaluation of accuracy 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 laboratory data for the BI will be validated in accordance with the applicable analytical method requirements. To the greatest extent practicable, validation of these data will conform to the National Functional Guidelines for Organic Data Review (February 1994) and Inorganic Data Review (February 1994), as amended for use within EPA Region III. (Data validation is further discussed in Section 9.2.2 of this QAPP.) 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. Field data completeness for this project is expected to be at least 95 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. Laboratory completeness for this project 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 Work Plan is followed and that proper sampling techniques 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 analyzing 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 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 Work Plan is followed and that proper sampling techniques are used. It is also dependent on recording field measurements using the correct units. Field measurement units are further discussed in Section 9.1.1 of this QAPP.

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. Laboratory measurement units are further discussed in Section 9.1.2 of this QAPP.

3.6 LEVEL OF QUALITY CONTROL EFFORT

Trip blank, equipment blank, field blank, method blank, field and laboratory duplicate, laboratory control, 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 temperature, dissolved oxygen, pH, specific conductance, salinity, 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., groundwater), or a single sample homogenized and split into two portions. 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 field samples.

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 non-dedicated sampling equipment used (i.e., bailer, split-spoon sampler, hand tools, etc.) per day that sampling is conducted. However, only the rinsate blanks obtained every other day will be analyzed. Those not analyzed will be retained by the laboratory until completion of field activities. It will be the responsibility of the Field Operations Leader (FOL) to communicate to the laboratory whether a rinsate blank is, or is not, to be analyzed. 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.

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, sediment).

4.0 SAMPLING PROCEDURES

Field sampling procedures for Indian Head and Stump Neck Annex NSWC BI activities are discussed in detail in Section 3 of the Work Plan. Specific sampling information contained in the Work Plan is as follows:

- Field operations summary - Section 3.1.1
- Mobilization/Demobilization - Section 3.1.2
- Soil Boring/Monitoring Well Soil Samples - Section 3.1.3
- Monitoring Well Construction and Sampling - Section 3.1.4
- Surveying - Section 3.1.5
- Decontamination of Equipment - Section 3.1.6
- Handling of Investigation Derived Waste - Section 3.1.7
- Field Equipment Calibration and Maintenance - Section 3.1.8
- Sample Analysis Summary - Section 3.2.1
- Sample Handling - Section 3.2.2
- Quality Control Samples - Section 3.2.3
- Sample Custody - Section 3.2.4
- Sampling Forms - Section 3.2.5

5.0 CUSTODY PROCEDURES

Custody is one of several factors which is necessary for the admissibility of environmental data as evidence in a court of law. Custody procedures help to satisfy the two major requirements for admissibility: relevance and authenticity. Sample custody is addressed in three parts: field sample collection, laboratory analysis, and final evidence files. Final evidence files, including all originals of laboratory reports and purge files, are maintained under document control in a secure area. A sample or evidence file is under custody if:

- the item is in the actual physical possession of an authorized person, or;
- the item is in view of the person after being in his or her possession, or;
- the item was placed in a secure area to prevent tampering; or
- the item is in a designated and identified secure area with access restricted to authorized personnel only.

The chain-of-custody (COC) report is a multi-part, standardized form used to summarize and document pertinent sample information, such as sample identification and type, matrix, date and time of collection, preservation, and requested analyses. Furthermore, through the sequential signatures of various sample custodians (e.g., sampler, airbill number, laboratory sample custodian), the COC report documents sample custody and tracking. Custody procedures apply to all environmental and associated field quality control samples obtained as part of the data collection system.

5.1 FIELD CUSTODY PROCEDURES

The FOL (or designee) is responsible for the care and custody of the samples collected until they are relinquished to the analyzing laboratory or entrusted to a commercial overnight courier. COC reports are completed for each sample shipment. The reports are filled out in a legible manner, using waterproof ink, and are signed (and dated) by the sampler. Pertinent notes, such as whether the sample was field filtered, or whether the sample is suspected to be high in contaminant concentration, are also indicated on the COC report. Information similar to that contained in the COC report is also provided on the sample label, which is securely attached to the sample bottle. COC report forms and sample labels are generally supplied by the laboratory subcontractor. In accordance with NFESC guidelines protocols, samples for chemical constituent analysis must be sent (for next-day receipt) to the laboratory within 24-hours of collection.

Full details regarding sample chain-of-custody (including use of custody seals and sample shipment protocols) are contained in B&R Environmental SOP SA-6.1. B&R Environmental SOP SA-6.3 discusses maintenance of site logbooks, site notebooks, and other field records. All sample records are to be docketed into the B&R Environmental project central file.

5.2 LABORATORY CUSTODY PROCEDURES

When samples are received by the laboratory subcontractor, the laboratory's sample custodian examines each cooler's custody seals to verify that they are intact and that the integrity of the environmental samples has been maintained. The custodian then opens the cooler and measures its internal temperature. The temperature reading is noted on the accompanying COC report. The sample custodian then signs the COC report and examines the contents of the cooler. Sample container breakage or discrepancies between the COC report and sample label documentation are recorded. The pH of chemically preserved samples is checked using Hydrion paper and recorded. All problems or discrepancies noted during this process are to be promptly reported to the B&R Environmental Project Manager. Interlaboratory COC procedures and specific procedures for sample handling, storage, dispersement for analysis, and remnant disposal will be followed as specific as the subcontract laboratory's SOPs and/or QA Plan.

5.3 FINAL EVIDENCE FILES

The B&R Environmental central file will be the repository for all documents which constitute evidence relevant to sampling and analysis activities as described in this QAPP. B&R Environmental is the custodian of the evidence file and maintains the contents of these files, including all relevant records, reports, logs, field notebooks, photographs, subcontractor reports and data reviews in a secure, limited access location and under custody of the facility manager. The control file will include at a minimum:

- field logbooks
- field data and data deliverables
- photographs
- drawings
- soil boring logs
- laboratory data deliverables
- data validation reports
- data assessment reports

- progress reports, QA reports, interim project reports, etc.
- all custody documentation (tags, forms, airbills, etc.)

Upon completion of the contract, all pertinent files will be relinquished to the custody of the United States Navy.

6.0 CALIBRATION PROCEDURES AND FREQUENCY

All instrumentation used to perform chemical measurements must be properly calibrated prior to use in order to obtain valid and usable results. The requirement to properly calibrate instruments prior to use applies equally to field instruments as it does to fixed laboratory instruments. Field instrument calibration is discussed in Section 6.1. Laboratory instrument calibration is discussed in Section 6.2.

6.1 FIELD INSTRUMENT CALIBRATION

Field instrument calibration is discussed in Section 3.1.8 of the Work Plan.

6.2 LABORATORY INSTRUMENT CALIBRATION

Calibration procedures for a specific laboratory instrument will consist of initial calibration (generally 3 to 5 points), initial calibration verification (inorganic methods only), and continuing calibration verification. In all cases, the initial calibration will be verified using an independently prepared calibration verification solution.

All standards used to calibrate analytical instruments must be obtained from National Institute of Standards and Technology (NIST) or through a reliable commercial supplier with a proven record for quality standards. All commercially supplied standards must be traceable to NIST reference standards, where possible, and appropriate documentation will be obtained from the supplier. In cases where documentation is not available, the laboratory will analyze the standard and compare the results to an EPA-supplied known or previous NIST-traceable standard.

The calibration procedures and frequencies used by the subcontract laboratory will comply with the applicable analytical method. Brief descriptions of calibration procedures for major instrument types follow.

6.2.1 Pesticide/PCB Analyses

For Pesticide/PCB analyses, the GC system will be calibrated in accordance with SW-846 Method 8081. A 5-point initial calibration is required before any samples are analyzed. A mid-level continuing calibration is required at the beginning of each 12-hour shift. A continuing calibration is also required after every 20 samples (after every 10 samples is recommended). A standard containing only 4,4'-DDT and endrin must also be analyzed before samples are analyzed, and at the beginning of each 12-hour shift to check for endrin and 4,4'-DDT breakdown.

6.2.2 Metals Analyses

6.2.2.1 Inductively Coupled Argon Plasma (ICP) Analyses

Inductively coupled plasma spectrometry (ICP) systems will be calibrated in accordance with SW-846 Method 6010A. Initial calibration is required each day before any samples are analyzed. The method specifies that the instrument be calibrated according to the instrument manufacturer's recommended procedures, but should consist of a blank and three standards. The standard must be within the demonstrated linear range of the instrument. The linear range is verified quarterly. Following initial calibration, an initial calibration verification sample (obtained from a different source than the solutions used for calibration), an initial calibration blank, and interference check samples are analyzed. A continuing calibration verification sample and a continuing calibration blank are run every 10 samples. A continuing calibration verification sample, a continuing calibration blank, and interference check samples are also run after analysis of the last sample. All calibration standards contain acids at the same concentrations as the sample digestates.

6.2.2.2 Atomic Absorption Analyses

Graphite furnace and cold vapor atomic absorption (GFAA and CVAA, respectively) analyses will be calibrated in accordance with the applicable SW-846 7000-series methods. Initial calibration is required each day before any samples are analyzed and consists of a calibration blank and at least three calibration standards (at least four standards for mercury) covering the range of concentrations of interest. The correlation coefficient of the regression of concentration versus response should be 0.995 or greater. Immediately following initial calibration, an initial calibration verification sample (obtained from a different source than the solutions used for calibration) and an initial calibration blank are analyzed. A continuing calibration verification sample and a continuing calibration blank are run every two hours or every ten samples, whichever occurs first. A continuing calibration verification sample and a continuing calibration blank are also run after analyses of the last sample.

If any of the continuing calibration samples fail to yield a response within 10% of the true value, initial calibration will be repeated, and all field samples analyzed since the last in-control calibration standard will be reanalyzed.

7.0 ANALYTICAL AND MEASUREMENT PROCEDURES

Samples will be subjected to field and laboratory parameter measurement as necessary based on the sample location under investigation. The analytical program for environmental samples collected at each anticipated location is provided in Section 3.2.1 of the Work Plan.

Chemical/physical parameters to be measured using field instrumentation include volatile organics as methane equivalents (breathing zone air and soil vapors), temperature, specific conductance, pH, dissolved oxygen, salinity, and turbidity (groundwater samples). Measurement of field parameters and calibration of field instruments are discussed in Section 3.1 of the Work Plan.

All groundwater, soil, and sediment samples collected for fixed-laboratory analysis during the NSWC White Oak investigation will be analyzed by a NFESC-approved laboratory. Table 7-1 provides a summary of the laboratory analytical methods for the NSWC White Oak investigation. A complete list of the target compounds/analytes and EQLs is provided in Section 1.3.2 of this QAPP. The EQLs represent estimated Practical Quantitation Limits (PQLs). All environmental data will be reported to the analyte's PQL. An analyte's PQL is an expression of the method detection limit with consideration given to required adjustments to ensure that the precision and accuracy requirements of the method are attainable. Analyte PQLs may vary based on the laboratory.

All solid sample results will be reported on a dry-weight basis. Quantitation limits will also be adjusted, as necessary, based on dilutions and sample volume.

TABLE 7-1

BACKGROUND STUDY WORK PLAN
ANALYTICAL METHODS SUMMARY
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND
PAGE 1 OF 2

Parameter - Aqueous Matrices	Preparation Method	Analytical Method
TCL Organochlorine Pesticides/PCBs	SW-846 3510/3520	SW-846 8081
TAL Metals + Tin (total and dissolved)	SW-846 3010/3020	SW-846 6010A/ 7000 Series
Sulfate	NA	EPA 300.0[5]
Chloride	NA	EPA 300.0
Nitrate	NA	EPA 300.0
Nitrite	NA	EPA 300.0
Total Phosphate	NA	EPA 300.0
Fluoride	NA	EPA 300.0
Total Dissolved Solids (TDS)	NA	EPA 160.1[4]
Total Suspended Solids (TSS)	NA	EPA 160.2[4]
Total Organic Carbon (TOC)	NA	EPA 415.1[4]
Total Organic Halides (TOX)	NA	SW-846 9020B

TABLE 7-1

BACKGROUND STUDY WORK PLAN
ANALYTICAL METHODS SUMMARY
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND
PAGE 2 OF 2

Parameter - Solid Matrices	Preparation Method	Analytical Method
TCL Organochlorine Pesticides/PCBs	SW-846 3540/3550	SW-846 8081
TAL Metals + Tin	SW-846 3050	SW-846 6010A/ 7000 Series
Total Organic Carbon (TOC)	NA	Lloyd Kahn[6]
Total Organic Halides (TOX)	NA	SW-846 9020B
Grain Size	NA	ASTM D422[7]

1 NA - Not Applicable.
2 U.S. EPA, 1986. Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods. SW-846, 3rd ed., as amended by Final Updates I, II, IIA, and IIB.
3 Laboratory SOPs are based on USATHAMA methods. No further information is available at this time.
4 U.S. EPA, 1983. Methods for Chemical Analysis of Water and Wastes.
5 U.S. EPA, 1993. Methods for the Determination of Inorganic Substances in Environmental Samples.
6 U.S. EPA, Region II, Environmental Services Division, Monitoring Management Branch. Lloyd Kahn, Determination of Total Organic Carbon in Sediment.
7 American Society for Testing and Materials (ASTM), 1995. Annual Book of ASTM Standards. Volume 04.08, Soil and Rock; Building Stones.

8.0 INTERNAL QUALITY CONTROL CHECKS

Field-related Quality Control checks were discussed in Section 3.0 of this Master Quality Assurance Project Plan and in Section 3.2.3 of the 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, and turbidity will include calibrating the instruments as described in Section 3.1.8 of the Work Plan. 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 QC samples will be in accordance with the procedures provided in the Work Plan at the frequencies discussed in Section 3.6 of this QAPP.

8.2 LABORATORY QUALITY CONTROL CHECKS

The subcontract laboratory will have a QC program that ensures the reliability and validity of the analyses performed at the laboratory. All analytical procedures are typically documented in writing by the laboratory as SOPs. All quality control measures will comply with the applicable analytical methods. Several internal laboratory QC 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. Method blanks must not contain levels of target analytes above the reported detection limits. If method blank contamination is found to exist above allowable limits, corrective actions indicated in 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 matrix spike (as applicable) and **laboratory duplicate** analysis is likewise performed for every 20 environmental sample analyses of like matrix. 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. The field

crew provides extra volumes of sample matrices designated for laboratory quality control analyses, as required. As discussed in Section 3.0 of this QAAP, control limits for matrix spike and laboratory duplicate analyses are established statistically by the laboratory in accordance with method-specific procedures and general protocols outlined in the laboratory SOPs.

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 most analytical methods, based on method-specific requirements. Aqueous LCS results must fall within the control limits specified statistically established by the laboratory. Solid LCS results must fall within the control limits established by the supplier of the LCS standard. Aqueous and solid LCS shall be analyzed utilizing the same sample preparations, analytical methods and QA/QC procedures as employed for the samples.

Additional internal laboratory QC checks include mass tuning for GC/MS analysis and second column confirmation for Gas Chromatograph/Electron Capture (GC/EC) analysis.

9.0 DATA REDUCTION, VALIDATION, AND REPORTING

This section describes the procedures to be used for data reduction, validation, and reporting for the NSWC Indian Head and Stump Neck Annex BI activities. All data generated during the course of the activities will be maintained in hardcopy form by B&R Environmental in the contractor's central files.

In addition to the central files, all electronic data will be maintained in the database records files. Standard Operating Procedure CT-03, included in Appendix C of the Work Plan, governs Database Management and Quality Assurance. Upon completion of the contract, all files will be relinquished to the United States Navy.

9.1 DATA REDUCTION

Data reduction will be completed for both field measurements and laboratory-generated analytical data. Field data reduction will be relatively limited versus the degree of laboratory data reduction required for the project. Reduction of both field data and laboratory data are discussed in the remainder of this section.

9.1.1 Field Data Reduction

Field data may be generated as a result of real time measurement of organic vapor concentrations via a PID or FID (for health and safety monitoring) and through onsite water quality testing for general indicator parameters including hydronium ion concentration (pH), specific conductance, turbidity, dissolved oxygen, salinity, and temperature.

Field measurements of organic vapor concentrations (parts per million on a volume/volume basis relative to methane or benzene) will be recorded in the site logbook but will not be used once the field effort is completed. Hence, no further reduction of field PID/FID data will be completed. General water quality indicator parameters will be recorded in the site logbook and on sample logsheets immediately after the measurements are taken and later encoded in a database for presentation in the BI Report. If an error is made in the logbook, the error will be legibly crossed out (single-line strikeout), initialed and dated by the field member, and corrected in a space adjacent to the original (erroneous) entry. No calculations will be necessary to reduce these data for inclusion in the BI Report. Field data will be entered in the electronic data base manually and the entries will be verified by an independent reviewer to make sure that no "transcription" errors occurred. General groundwater quality data will be recorded and reported in the following units:

- Hydronium ion concentration (standard pH units)
- Temperature (degrees Celsius)
- Specific Conductance (micromhos)
- Turbidity (Nephelometric turbidity units)
- Dissolved oxygen (mg/L)
- Salinity (%)

Standard pH units as specified above is the negative logarithm (base 10) of the hydronium ion concentration in moles/liter.

9.1.2 Laboratory Data Reduction

Laboratory data reduction will be completed in accordance with the applicable analytical methods. Laboratory analytical data will be reported using standard concentration units to ensure comparability with regulatory standards/guidelines and previous analytical results. Reporting units for solid and aqueous matrices for the various classes of chemicals under consideration are as follows.

Aqueous samples:

- Pesticides/PCBs - µg/L
- Metals - µg/L
- All general chemistry parameters - mg/L

Solid samples:

- Pesticides/PCBs - µg/kg
- Metals - mg/kg
- Grain size - % finer (#200 sieve)
- All remaining general chemistry parameters - mg/Kg

All laboratory analytical results will be presented in summary tables in the BI Report. These results will be presented as received by the laboratory with the possible exception of the elimination of false positives as a result of data validation (see Section 9.2).

Descriptive statistics may also be performed for use in describing the nature and extent of contamination and for risk assessment. These statistics, as described in the following paragraphs, include the

determination of average concentrations for duplicate samples and the determination of upper 95% confidence limits.

Determination of average concentrations for duplicate samples will be necessary because duplicate samples will be collected as a QC measure. Arithmetic means will be determined for duplicate samples for reporting purposes in summary tables in the BI Report. The original duplicate sample results will be presented in an appendix to the BI Report as discussed in Section 9.3. Averages for duplicates will be determined using distinct equations which are contingent upon the analytical results for the duplicate samples. The equations to be used are as follows:

Positive result for both the original and duplicate sample:

Average = (Original Result + Duplicate Result)/2

Nondetect for both the original and duplicate sample:

Average = (Original Quantitation Limit/2 + Duplicate Quantitation Limit/2)/2

Nondetect for one sample and positive result for the other (when the quantitation limit/2 for the nondetect is < positive result for the other sample):

Average = (Quantitation Limit/2 + Positive Result)/2

Nondetect for one sample and positive result for the other (when the quantitation limit/2 for the nondetect > positive result for the other sample):

Average = Positive Result

Note that the preceding treatment of average results includes the handling of nondetects quantitatively as values equal to one-half the quantitation limit. This is a typical procedure for the handling of nondetects.

In the event that manipulation of the analytical data for evaluation of nature and extent of contamination or for risk assessment purposes is necessary, calculations to determine representative concentrations for the exposure assessment will be performed. Such procedures will only be necessary in the event that the results for various sampling locations are pooled to generate representative concentrations for an exposure unit. In the event that pooling of data is completed, representative concentrations will be determined using the following equations:

Normally distributed data

$$UCL = X_m + t(s / \sqrt{n})$$

Where: UCL = the upper 95% confidence limit
X_m = the arithmetic mean concentration
t = the Student's t statistic
s = the sample standard deviation
n = the number of samples

Log-normally distributed data

$$UCL = \exp(X_m + 0.5s^2 + sH / \sqrt{n-1})$$

Where: UCL = the upper 95% confidence limit
X_m = the arithmetic mean concentration
s = the sample standard deviation
H = H statistic
n = the number of samples
exp = the exponential function (e)

Note that distributional assumption testing will be completed prior to use of the preceding equations. Either the Shapiro-Wilk W-Test or the Komolgorov-Smirnov test will be used to test for normality or log-normality.

Field QC sample results will be included in the data base for the NSWC Indian Head and Stump Neck Annex BI activities. Specifically, the analytical results for trip blanks, equipment blanks, and field blanks will be provided. The results for field QC samples will be considered during the course of data validation (in concert with laboratory method blanks) to eliminate false positive results according to the 5- and 10-times rules specified in the U.S. EPA Region III and National Functional Guidelines for Organic and Inorganic Data Review. The results for laboratory QC samples such as method blanks will not be included in the data base. In addition, only the original (unspiked) sample results for MS/MSD samples will be provided in the data base.

9.2 DATA VALIDATION

Validation of field measurements and laboratory analytical data are discussed in this section. Validation of field data will be limited to real time "reality" checks whereas laboratory analytical data will be validated in accordance with current U.S. EPA guidance. Validation of field measurements is discussed in Section 9.2.1. Validation of laboratory analytical data is discussed in Section 9.2.2.

9.2.1 Field Measurement Data Validation

Field measurements will not be subjected to a formal data validation process. However, field technicians will ensure that the equipment used for field measurement is performing accurately via compliance with the calibration procedures discussed in Section 3.1.8 of the Work Plan. As described in Section 9.1.1, all field data entered into the electronic database will be independently reviewed for transcription errors.

9.2.2 Laboratory Data Validation

One hundred percent of the laboratory data will be validated. Validation of analytical data will be completed by the B&R Environmental Chemistry Department located in B&R Environmental's Pittsburgh office. Final review and approval of validation deliverables will be completed by the Department's Data Validation Coordinator.

All laboratory analytical data will be validated versus the applicable analytical methods. Validation of these data will conform to the National Functional Guidelines for Organic (2/94) and Inorganic (2/94) Data Review and the Region III modifications to National Functional Guidelines for Organic (9/94) and Inorganic (4/93) Data Review to the greatest extent practicable. The validation process is described in further detail in SOP CT-01, included in Appendix C of the Work Plan. Data validation will be completed to ensure that the data are of evidentiary quality. Particular emphasis will be placed on holding time compliance, equipment calibration, spike recoveries, and blank results, although all required elements of the validation process will be considered.

9.3 DATA REPORTING

This section discusses data reporting requirements for field and laboratory analytical data. Section 9.3.1 discusses field measurement data handling and reporting. Section 9.3.2 discusses laboratory data handling and reporting.

9.3.1 Field Measurement Data Reporting

Field data will be reported in the units discussed in Section 9.1.1. The BI Report will include a comprehensive data base including all field measurements (specifically pH, specific conductance, temperature, dissolved oxygen, salinity, and turbidity). Field measurements will be transferred from the site logbook or sample logsheets to the electronic data base manually and will be reviewed for accuracy by an independent reviewer. Transcription of field measurements to the electronic data base will be completed shortly after completion of the field investigation and prior to receipt of laboratory analytical data.

All records regarding field measurements (i.e., field logbooks, sampling logbooks, and sample logsheets) will be placed in the central files upon completion of the field effort. Entry of these results in the data base will require removal of these results from the files. Outcards will be used to document the removal of any such documentation from the files (date, person, subject matter). Field measurement data will be reported in an appendix of the BI Report at a minimum and may also be reported in summary fashion if they are indicative of the presence of contamination (e.g., high specific conductance readings).

9.3.2 Laboratory Data Reporting

Data reported by the laboratory for all analytical fractions will be in accordance with Contract Laboratory Program (CLP) reporting format (to the extent practicable). All pertinent quality control data including raw data and summary forms for blanks, standards analysis, calibration information, etc., will be provided all analyses. Case narratives will be provided for each Sample Delivery Group.

Environmental and field QC sample results (duplicates, equipment blanks, field blanks) will be included in BI Report as an appendix. The data base will include pertinent sampling information such as sample number, sampling date, general location, depth, and survey coordinates (if applicable). Sample-specific detection limits will be reported for nondetected analytes. Units will be clearly summarized in the data base and will conform to those identified in Section 9.1.2. The analytical data may also be reported in summary fashion within the body of BI Report in tabular and/or graphic fashion.

Data will be handled electronically pursuant to the electronic deliverable requirements outlined in specifications to the analytical laboratory. The analytical laboratory is required to provide data in both hardcopy and electronic form. The original electronic diskettes and the original hardcopy analytical data are maintained in the central files as received. All other pertinent information, including field logbooks, sampling notebooks, chain-of-custody forms, etc. are also maintained in the central files. SOP CT-03, included in Appendix C of the Work Plan, discusses database management and QA.

Validation will be completed using the hard copy data. Upon completion of validation of a Sample Delivery Group and review by the Data Validation Coordinator, the validation qualifiers will be entered in the electronic data base and will be subjected to independent review for accuracy. During this review process, the electronic data base printout will also be contrasted with the hard copy data (Form Is) to ensure that the hard copy data and electronic data are consistent. A summary of the validation results (actions taken and completeness, precision, and accuracy) will be provided in the BI Report.

10.0 PERFORMANCE AND SYSTEM AUDITS

Performance and system audits will be performed periodically to ensure that work is being implemented in accordance with the approved Project Plans and in an overall satisfactory manner. Such audits will be performed by various personnel and will include evaluation of field, laboratory, data validation, and data reporting processes. Examples of pertinent audits are as follows:

- The FOL will supervise and check daily that any field measurements are made accurately, equipment is thoroughly decontaminated, samples are collected and handled properly, and fieldwork is documented accurately and neatly.

- Performance and system audits for the laboratory will be performed regularly by a U.S. Navy Contractor, in accordance with the requirements of the Navy, and in accordance with Laboratory Quality Assurance Plan.

- Data validators will review (on a timely basis) the chemical analytical data packages submitted by the laboratory. The data validators will check that the data were obtained through use of the approved methodology, that the appropriate level of QC effort and reporting was conducted, and whether or not the results are in conformance with QC criteria. On the basis of these factors, the data validator will generate a report describing data limitations, which will be reviewed internally by the Data Validation Coordinator prior to submittal to the Project Manager.

- A formal audit of the field sampling procedures may be conducted by the B&R Environmental Quality Assurance Manager (QAM) or designee in addition to the auditing that is an inherent part of the daily project activities. The purpose of this audit is to ensure that sample collection, handling, and shipping protocols, as well as equipment decontamination and field documentation procedures, are being performed in accordance with the approved Project Plans and SOPs.

- The Project Manager will maintain contact with the FOL and Data Validation Coordinator to ensure that management of the acquired data proceeds in an organized and expeditious manner. Similarly, the Project Manager will interface with the Risk Assessment and Modeling Coordinators, as applicable.

11.0 PREVENTIVE MAINTENANCE PROCEDURES

Measuring equipment used in environmental monitoring or analysis for the NSWC Indian Head and Stump Neck Annex BI activities shall be maintained in accordance with the manufacturer's operation and maintenance manuals. Equipment and instruments shall be calibrated in accordance with the procedures, and at the frequency, discussed in Section 6.0 (Calibration Procedures and Frequency). Preventive maintenance for field and laboratory equipment are discussed in the remainder of this section.

11.1 FIELD EQUIPMENT PREVENTIVE MAINTENANCE

B&R Environmental has established a program for the maintenance of field equipment to ensure the availability of equipment in good working order when and where it is needed. This program consists of the following elements:

- The B&R Environmental equipment manager keeps an inventory of the equipment in terms of items (model and serial number), quantity, and condition. Each item of equipment is signed out when in use, and its operating condition and cleanliness checked upon return.

- The equipment manager conducts routine checks on the status of equipment and is responsible for the stocking of spare parts and equipment readiness. The equipment manager also maintains the equipment manual library.

- The FOL is responsible for working with the equipment manager to make sure that the equipment is tested, cleaned, charged, and calibrated in accordance with the manufacturer's instructions and B&R Environmental SOPs before being taken to the job site and during field activities.

- During calibration, an appropriate maintenance check is performed on each piece of equipment. Any problems encountered while operating the instrument will be recorded in the field log book including a description of the symptoms and corrective actions taken.

- If problem equipment is detected or should require service, the equipment should be logged, tagged, and segregated from equipment in proper working order. Use of the instrument will not be resumed until the problem is resolved.

11.2 LABORATORY INSTRUMENT PREVENTIVE MAINTENANCE

Proper maintenance of laboratory instruments and equipment is essential to ensuring their readiness when needed. Dependent on manufacturer's recommendations, maintenance intervals are established for each instrument. All instruments must be labeled with a model number and serial number, and a maintenance logbook must be maintained for each instrument. Personnel must be alert to the maintenance status of the equipment they are using at all times.

11.2.1 Major Instruments

Table 11-1 provides a summary of preventive maintenance procedures typically performed by environmental laboratories for key analytical instruments.

Maintenance of key instruments may also be covered under service contracts with external firms. Such contracts provide for periodic routine maintenance to help guard against unexpected instrument downtime. These contracts also typically provide for quick response for unscheduled service calls when malfunctions are observed by the operator.

The use of manufacturer recommended grades or better of supporting supplies and reagents is also a form of preventive maintenance. For example, gases used in the various gas chromatographs and metals instruments are of sufficient grade to minimize fouling of the instrument. The routine use of septa, chromatographic columns, ferrules, AA furnace tubes, and other supporting supplies from reputable manufacturers will assist in averting unnecessary periods of instrument downtime.

11.2.2 Refrigerators/Ovens

The temperatures of refrigerators used for sample storage and drying ovens will be monitored a minimum of once daily. The acceptable range for refrigerator temperatures is 4°C ±2°C. Required temperatures of ovens will vary based on the analytical methods for which the ovens are used. The temperatures will be recorded on temperature logs. The logs will contain the following information at a minimum:

- Date
- Temperature
- Initials of person performing the check

TABLE 11-1

BACKGROUND STUDY WORK PLAN
PREVENTIVE MAINTENANCE FOR KEY ANALYTICAL INSTRUMENTS
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

Instrument	Preventive Maintenance	Maintenance Frequency
GC	Replace solvent washes and clean syringe. Clip column, clean injection port, replace liner, and bake oven.	Daily. As required.
ICP	Change sample introduction tubing, clean nebulizer, clean spray chamber, clean torch, manual profile, and automatic profile optics.	As required.
GFAA	Clean contact cylinders, replace/clean tube, check lamp alignment.	As required.
CVAA	Change sample introduction tubing, change drying cell, re-zero detector.	As required.

Maintenance of the log will be the responsibility of the sample custodian or designee. However, assignment of responsibilities for temperature monitoring to specific personnel does not preclude the participation of other laboratory personnel. If unusual temperature fluctuations are noted, it is the responsibility of the observer to immediately notify the person in charge of the discrepancy before the condition of the samples is compromised.

Unstable or fluctuating temperatures may be indicative of malfunctions in the cooling or heating system. On the other hand, the instability may be due to frequent opening of the door. Regardless of the cause, such an observation must be investigated, and modifications must be made to access procedures or repairs to equipment must be made to prevent jeopardizing the integrity of the samples.

12.0 SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

Compliance with the QC objectives outlined in Section 3.0 will be monitored via two separate mechanisms. Precision and accuracy will be assessed through data validation as described in Section 9.2. Compliance with the completeness objectives for field and laboratory data/measurement will be calculated by hand (field measurements) and electronically via a database subroutine (laboratory data). Information necessary to complete the precision and accuracy calculations will be provided in electronic and hardcopy form by the subcontract laboratory. Equations to be used for the precision, accuracy, and completeness assessment are outlined in the remainder of this section.

12.1 ACCURACY ASSESSMENT

To assure the accuracy of the analytical procedures, a minimum of 1 of every 20 samples is spiked with a known amount of the analyte or analytes to be evaluated. The spiked sample is then analyzed. The increase in concentration of the analyte observed in the spiked sample, because of the addition of a known quantity of the analyte, compared to the reported value of the same analyte in the unspiked sample determines the percent recovery. Daily control charts are plotted for each commonly analyzed compound and kept on matrix-specific and analyte-specific bases. The percent recovery for a spiked sample is calculated according to the following formula:

$$\%R = \frac{\text{Amount in Spiked Sample} - \text{Amount in Sample}}{\text{Known Amount Added}} \times 100\%$$

12.2 PRECISION ASSESSMENT

Duplicate samples (for inorganic analyses) and matrix spike duplicate samples (for organic analyses) are prepared and analyzed at a minimum frequency of 1 per every 20 environmental samples. Duplicate samples are prepared by dividing an environmental sample into equal aliquots.

Matrix spike duplicate samples are prepared by dividing an environmental sample into equal aliquots and then spiking each of the aliquots with a known amount of analyte. The duplicate samples are then included in the analytical sample set. The splitting of the sample allows the analyst to determine the precision of the preparation and analytical techniques associated with the duplicate samples. The RPD between the sample (or spike) and duplicate (or duplicate spike) is calculated and plotted. The RPD is calculated according to the following formula:

$$RPD = \frac{\text{Amount in Sample} - \text{Amount in Duplicate}}{0.5\ (\text{Amount in Sample} + \text{Amount in Duplicate})} \times 100\%$$

12.3 COMPLETENESS ASSESSMENT

Completeness is the ratio of the number of valid sample results to the total number of samples analyzed with a specific matrix and/or analysis. Following the completion of the analytical testing, the percent completeness will be calculated by the following equation:

$$\text{Completeness} = \frac{(\text{number of valid measurements})}{(\text{number of measurements planned})} \times 100\%$$

The results of the data validation process and the completeness assessment will be summarized in the BI Report.

13.0 CORRECTIVE ACTION

It is required that any and all personnel noting conditions adverse to quality report these conditions immediately to the Project Manager and Quality Assurance Manager. These parties, in turn, are charged with performing root-cause analyses and implementing appropriate corrective action in a timely manner. It is ultimately the responsibility of the Quality Assurance Manager to document all findings and corrective actions taken and to monitor the effectiveness of the corrective measures performed.

13.1 FIELD CORRECTIVE ACTION

Field nonconformances or conditions adverse to quality must be identified and corrected as quickly as possible so that work integrity or quality of product is not compromised. The need for corrective action may arise based on deviations from Project Plans and procedures, adverse field conditions, or other unforeseen circumstances. Corrective action needs may become apparent during the performance of daily work tasks or as a consequence of internal or external field audits.

Corrective action may include resampling and may involve amending previously approved field procedures. If warranted by the severity of the problem (e.g., if a change in the approved Project Plan documents or SOPs is required), the Navy will be notified in writing via a Field Task Modification Request (FTMR), and Navy (in conjunction with U.S. EPA Region III) approvals will be obtained. The FOL is responsible for initiating FTMRs; an FTMR will be initiated for all deviations from the Project Plan documents, as applicable. An example of an FTMR is provided as Figure 13-1. Copies of all FTMRs will be maintained with the onsite project planning documents and will be placed in the final evidence file.

Minor modifications to field activities such as a slight offset of a boring location will be initiated at the discretion of the FOL, subject to onsite approval by NSWC Indian Head and Stump Neck Annex personnel. Approval for major modifications (e.g., elimination of a sampling point) must be obtained via an FTMR.

FIGURE 13-1

FIELD TASK MODIFICATION REQUEST FORM

Client Identification Project Number TMR Number

To_____Location_____Date_____

Description:

Reason for Change:

Recommended Disposition:

Field Operations Leader (Signature, if applicable) Date

Disposition:

Project Manager (Signature, if required) Date

Distribution:
Program Manager
Quality Assurance Manager
Project Manager
Field Operations Leader

Others as required_____

13.2 LABORATORY CORRECTIVE ACTION

In general, laboratory corrective actions are warranted whenever an out-of-control event or potential out-of-control event is noted. The specific corrective action taken depends on the specific analysis and the nature of the event. Generally, the following occurrences alert laboratory personnel that corrective action may be necessary:

- QC data are outside established warning or control limits;
- method blank analyses yield concentrations of target analytes above acceptable levels;
- undesirable trends are detected in spike recoveries or in duplicate RPDs;
- there is an unexplained change in compound detection capability;
- inquiries concerning data quality are received;
- deficiencies are detected by laboratory QA staff audits or from performance evaluation sample test results.

Corrective actions are documented for out-of-control situations on a corrective action form. Using the corrective action form, any employee may notify the QA/QC Officer of a problem. The QA/QC Officer initiates the corrective action by relating the problem to the appropriate Laboratory Manager and/or Internal Coordinator, who then investigates or assigns responsibility for investigating the problem and its cause. Once determined, an appropriate corrective action is approved by the QA/QC Officer. Its implementation is verified and documented on the corrective action form and is further documented through audits.

13.3 CORRECTIVE ACTION DURING DATA VALIDATION AND DATA ASSESSMENT

The need for corrective action may become apparent during data validation, interpretation, or presentation activities, or problems may be identified as a result of oversight findings. The performance of rework, instituting a change in work procedures, or providing additional/refresher training are possible corrective actions relevant to data evaluation activities. The Project Manager will be responsible for approving the implementation of corrective action.

14.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

Quality Assurance reports to management will be provided in three primary formats during the course of the NSWC Indian Head and Stump Neck Annex BI activities. Data validation letter reports will be prepared on a Sample Delivery Group-specific basis and will summarize Quality Assurance issues for the subcontract laboratory data. In addition, written weekly reports summarizing accomplishments and QA/QC issues during the field investigation will be provided by the FOL. Finally, monthly progress reports are prepared by the Project Manager.

14.1 CONTENTS OF PROJECT QUALITY ASSURANCE REPORTS

The contents of the specific QA reports are as follows. The data validation reports address all major and minor laboratory noncompliances, as well as, noted sample matrix effects. In the event that major problems occur with the analytical laboratory, (e.g., holding time exceedances or calibration noncompliances, etc.) the Data Validation Coordinator notifies the Project Manager, the Technical Program Manager, and the Laboratory Services Coordinator. Such notifications (if necessary) are typically provided via internal memoranda and are placed in the project file. Such reports contain a summary of the noncompliance, a synopsis of the impact on individual projects, and recommendations regarding corrective action and compensational adjustments. Corrective actions are initiated at the program level.

The FOL will provide the Project Manager with weekly reports regarding accomplishments, deviations from the Field Sampling Plan, upcoming activities, and a QA summary during the course of the field investigation. In addition, monthly project review meetings are held for all active Navy CLEAN projects. Issues discussed at the project review meeting include all aspects of budget and schedule compliance, and QA/QC problems. The Project Manager provides a monthly progress report to the Navy which addresses the project budget, schedule, accomplishments, planned activities, and QA/QC issues and intended corrective action.

14.2 INDIVIDUALS RECEIVING/REVIEWING QUALITY ASSURANCE REPORTS

Data validation Quality Assurance Reports are provided to the Project Manager for inclusion in the project files. In the event that major problems are observed for a given laboratory, the Program Manager, Deputy Program Manager, Quality Assurance Manager, Project Manager, and Laboratory Services Coordinator are provided copies of the QA report. Weekly field progress reports are provided to the Project Manager.

Monthly progress reports are provided to the Navy CLEAN Program Manager and the Navy CLEAN Contracting Officers Technical Representative.

APPENDIX E

BACKGROUND DATA FROM
VERIFICATION INVESTIGATION REPORT
FEBRUARY 1996

TABLE 5-1

CONTAMINANT OCCURRENCE AND DISTRIBUTION
IMPROVISED EXPLOSIVE DEVICES (IED) SITE - SOIL SAMPLES
VERIFICATION INVESTIGATION REPORT
THE NAVAL SCHOOL, EXPLOSIVE ORDNANCE DISPOSAL
STUMP NECK ANNEX, INDIAN HEAD DIVISION
INDIAN HEAD, MARYLAND

Parameter	S26-SB01-01[1]	S26-SB01-02[2]	S26-MW01-01[1]	S26-MW01-02[3]	S26-SB02-001[1,4]	S26-SB02-002[2]	S26-SB03-001[1]	S26-SB03-002[5]	S26-SB04-001[1,4]	S26-SB04-002[5]	S26-MW02-001[1]	S26-MW02-002[6]	S26-MW03-001[1]	S26-MW03-002[7]
	Detonation Demonstration Area-Source		Detonation Demonstration Area - Downgradient		Area in Front of Bleachers		French Drain from Building 2118		Incendiary Demonstration Area - Source		Incendiary Demonstration Area - Downgradient		Upgradient IED Site	
VOLATILE ORGANICS (μg/kg)														
Carbon disulfide	1.4[U]	1.3[U]	1.2[J]	1.4[U]	1.4[U]	1.4[U]	1.3[U]	1.4[U]	1.4[U]/1.3[U]	1.4[U]	1.4[U]	1.4[U]	1.3[U]	1.4[U]
Chloroform	0.43[U]	0.42[U]	5.0[J]	3.0[J]	0.45[U]	0.45[U]	0.41[U]	0.45[U]	4.1/3.9	3.4	0.45[U]	0.45[U]	0.42[U]	0.44[U]
Methylene chloride	171[J]	172[J]	122[B]	73.5[B]	15.7[J]	3.8[J]	13.8[B]	20.6[B]	174[B]/165[B]	208[B]	13.4[B]	18.0[B]	14.3[B]	8.3[B]
Toluene	33.7[J]	27.0[J]	2.1[J]	0.33[U]	0.33[U]	0.33[U]	0.30[U]	0.33[U]	1.3[B]/1.2[B]	0.33[U]	0.33[U]	0.33[U]	1.9[B]	0.32[U]
SEMIVOLATILE ORGANICS (μg/kg)														
Bis(2-ethylhexyl)phthlate	74.8[U]	72.3[U]	74.2[U]	77.4[U]	78.7[U]	78.1[U]	72.3[U]	78.7[U]	74.2[U]/72.9[U]	78.1[U]	46.8[J]	78.7[U]	72.9[U]	76.8[U]
PCBs														
NOT DETECTED														
ENERGETICS														
NOT DETECTED														
INORGANICS (mg/kg)														
Aluminum	6640	2450	10600	7520	12500	11100	9970[J]	3730[J]	5540[J]/5180[J]	10400[J]	10200[J]	8330[J]	12700[J]	8250[J]

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TABLE 5-1 (Continued)
CONTAMINANT OCCURRENCE AND DISTRIBUTION
IMPROVISED EXPLOSIVE DEVICES (IED) SITE - SOIL SAMPLES
VERIFICATION INVESTIGATION REPORT
THE NAVAL SCHOOL, EXPLOSIVE ORDNANCE DISPOSAL
STUMP NECK ANNEX, INDIAN HEAD DIVISION
INDIAN HEAD, MARYLAND

Parameter	S26-SB01-01[1]	S26-SB01-02[2]	S26-MW01-01[1]	S26-MW01-02[3]	S26-SB02-001[1,4]	S26-SB02-002[2]	S26-SB03-001[1]	S26-SB03-002[5]	S26-SB04-001[1,4]	S26-SB04-002[5]	S26-MW02-001[1]	S26-MW02-002[6]	S26-MW03-001[1]	S26-MW03-002[7]
	Detonation Demonstration Area-Source		Detonation Demonstration Area - Downgradient		Area in Front of Bleachers		French Drain from Building 2118		Incendiary Demonstration Area - Source		Incendiary Demonstration Area - Downgradient		Upgradient IED Site	
Antimony	0.20[UL]	0.19[UL]	0.20[UL]	0.20[UL]	0.21[UL]	0.45[L]	0.19[UL]	0.21[UL]	0.20[UL]/0.19[UL]	0.21[UL]	0.20[UL]	0.21[UL]	0.19[UL]	0.21[UL]
Arsenic	4.3	1.3[K]	4.5	2.5[K]	3.1[L]	2.2[L]	4.7[L]	3.5[L]	4.3/4.0	1.3	5.3[L]	15.9[L]	3.3[L]	1.9[J]
Barium	30.3	14.7	52.0	37.3	42.9	75.5	61.5	15.3	46.2/48.8	31.4	63.9	40.6	84.8	39.8
Beryllium	0.34	0.23	0.4[L]	0.33[L]	0.46	0.70	0.49[L]	0.13	0.44/0.42	0.30	0.51[L]	0.55[L]	0.61[L]	0.43[L]
Cadmium	0.58[UL]	0.56[UL]	0.57[U]	0.60[U]	0.61[UL]	0.60[UL]	0.56[U]	0.61[U]	0.57[UL]/0.57[UL]	0.60[UL]	1.2	0.61[U]	0.57[U]	0.59[U]
Calcium	9350	219[K]	53.1[K]	56.2[K]	316[K]	245[K]	438	44.9	1110[J]/1010[J]	90.3[B]	382	84.0	409	50.7
Chromium	11.8[J]	12.2[J]	14.4	10.2	15.7	13.9	16.1	6.1	14.6/9.7	18.0	47.2	33.9	20.8	13.4
Cobalt	9.2	5.1	5.7	4.5	3.3	8.6	11.6	1.7[U]	13.4/14.3	2.2	20.5	3.5	15.0	8.4
Copper	56.6	5.5[L]	7.7[L]	4.8[L]	7.5	8.4	5.5[L]	3.3	4.5[L]/4.3[L]	8.7	12.7[L]	8.6[L]	4.4[L]	5.2[L]
Iron	15500[J]	7850[J]	17800[J]	15800[J]	33100	11200	17800[J]	5840[J]	12300/9900	13700	83900[J]	13400[J]	25300[J]	20300[J]
Lead	9.3[L]	4.6[L]	9.8[L]	6.6[L]	11.0[J]	10.5[J]	95.7[J]	5.5[J]	10.0/10.2	7.4	33.8[J]	10.3[J]	9.9[J]	5.4[J]
Magnesium	1210	380[K]	1600	926	807[K]	1920	1040[J]	336[J]	477[J]/461[J]	881[J]	665[J]	1210[J]	1090[J]	746[J]
Manganese	100[J]	76.1[J]	83.4	45.8	30.7	70.9	265[J]	14.0[J]	1240[J]/985[J]	20.3	1130[J]	27.7[J]	882[J]	98.8[J]
Mercury	0.16[L]	0.05[UL]	0.05[UL]	0.06[UL]	0.09[L]	0.06[UL]	0.10	0.06[U]	0.05[U]/0.06[B]	0.06[B]	0.20	0.09	0.07	0.06[U]
Nickel	55.0	4.5[K]	4.4[K]	4.9[K]	7.6[J]	16.6	8.5	2.8	15.6/14.1	5.9[J]	49.7	10.6	10.5	8.0
Potassium	535	451	636	578	658	1130	1050	442	369/363	1020	696	845	783	385

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TABLE 5-1 (Continued)
CONTAMINANT OCCURRENCE AND DISTRIBUTION
IMPROVISED EXPLOSIVE DEVICES (IED) SITE - SOIL SAMPLES
VERIFICATION INVESTIGATION REPORT
THE NAVAL SCHOOL, EXPLOSIVE ORDNANCE DISPOSAL
STUMP NECK ANNEX, INDIAN HEAD DIVISION
INDIAN HEAD, MARYLAND

Parameter	S26-SB01-01[1]	S26-SB01-02[2]	S26-MW01-01[1]	S26-MW01-02[3]	S26-SB02-001[1,4]	S26-SB02-002[2]	S26-SB03-001[1]	S26-SB03-002[5]	S26-SB04-001[1,4]	S26-SB04-002[5]	S26-MW02-001[1]	S26-MW02-002[6]	S26-MW03-001[1]	S26-MW03-002[7]
	Detonation Demonstration Area-Source		Detonation Demonstration Area - Downgradient		Area in Front of Bleachers		French Drain from Building 2118		Incendiary Demonstration Area - Source		Incendiary Demonstration Area - Downgradient		Upgradient IED Site	
Selenium	0.17[U]	0.17[U]	0.20	0.18[U]	0.30[B]	0.18[U]	0.19[B]	0.18[U]	0.17[U]/0.21[L]	0.19	0.43[B]	0.49[B]	0.17[U]	0.18[U]
Silver	0.23	0.11[U]	0.11[U]	0.12[U]	0.12[U]	0.12[U]	0.11[U]	0.12[U]	3.0/2.2	0.12[U]	0.12[U]	0.12[U]	0.11[U]	0.12[U]
Sodium	84.3[B]	103[B]	116[B]	155[B]	41.5	182	44.3	28.1	20.7[U]/20.4[U]	34.8	21.7[U]	34.8	20.3[U]	21.4[U]
Tin	4.7[UL]	4.5[UL]	3.9[UL]	4.0[UL]	4.9[W]	4.8[W]	4.5[W]	4.9[W]	4.6[W]/4.5[W]	4.8[W]	15.3[J]	4.9[W]	4.5[W]	4.8[W]
Vanadium	15.8	11.5	22.5	14.6	26.9	17.4	26.7	12.4[B]	15.6/15.7	19.6	23.7	18.1	38.7	23.9
Zinc	28.0	9.7	23.9	18.9	28.6	47.3	66.2[J]	8.0[J]	19.3/19.7	16.3	137[J]	36.2[J]	30.8[J]	24.2[J]
Total Cyanide	1.2[U]	1.1[U]	1.1[U]	1.2[U]	1.2[U]	1.3	1.1[U]	1.2[U]	1.2[U]/1.1[U]	1.2[U]	1.2[U]	1.2[U]	1.1[U]	1.2[U]
INDICATOR PARAMTERS														
Ammonia (mg/kg)	16.2[L]	10.6[UL]	10.0[UL]	9.6[UL]	22.0[L]	16.4[L]	70.6	25.7	53.3/51.7	11.4	141	32.8	49.9	9.5
Nitrate+Nitrite (mg/kg)	0.743[U]	0.527[U]	0.66[U]	0.68[U]	0.75[W]	0.87[W]	3.0	2.6[U]	2.3[L]/1.9[L]	2.6[L]	5.3	2.0[U]	1.5[U]	2.6[U]
Percent Solids (%)	86	89	87.3	83.7	82.1/80.8	82.7	89.5	81.8	87.1/88.4	82.9	82.0	82.0	88.5	84.1
Total Organic Carbon (mg/kg)	848	658	554	373	3170	929	2380	495	3850/3320	849	6970	1940	5020	1290
Total Petroleum Hydrocarbons (mg/kg)	30.9	28.1[U]	28.6[U]	29.9[U]	34.4/30.9[U]	30.2[U]	27.9[UL]	30.6[UL]	48.5/28.3[U]	30.2[U]	30.1[UL]	30.5[UL]	33.7[L]	39.1[L]

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TABLE 5-1 (Continued)
CONTAMINANT OCCURRENCE AND DISTRIBUTION
IMPROVISED EXPLOSIVE DEVICES (IED) SITE - SOIL SAMPLES
VERIFICATION INVESTIGATION REPORT
THE NAVAL SCHOOL, EXPLOSIVE ORDNANCE DISPOSAL
STUMP NECK ANNEX, INDIAN HEAD DIVISION
INDIAN HEAD, MARYLAND

NOTE: **All positive detections have been bolded.**

1 Sample depth is 0 to 2 feet.
2 Sample depth is just above groundwater (6 to 10 feet).
3 Sample depth is just above groundwater (4 to 6 feet).
4 Duplicate samples taken from this location.
5 Sample depth is just above groundwater (8 to 10 feet).
6 Sample depth is just above groundwater (10 to 12 feet).
7 Sample depth is just above groundwater (6 to 9 feet).

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.

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TABLE 5-2

CONTAMINANT OCCURRENCE AND DISTRIBUTION
IMPROVISED EXPLOSIVE DEVICES (IED) SITE - GROUNDWATER SAMPLES
VERIFICATION INVESTIGATION REPORT
THE NAVAL SCHOOL, EXPLOSIVE ORDNANCE DISPOSAL
STUMP NECK ANNEX, INDIAN HEAD DIVISION
INDIAN HEAD, MARYLAND

Parameter[1]		26MW01[2]	26MW02	26MW03
		Detonation Demonstration Area - Downgradient	Incendiary Demonstration Area - Downgradient	Upgradient IED Site
VOLATILE ORGANICS (μg/L)				
Chloroform		0.18^{U}	0.18^{UJ}	**3.1**
SEMIVOLATILE ORGANICS				
NOT DETECTED				
PCBs				
NOT DETECTED				
ENERGETICS				
NOT DETECTED				
INORGANICS (μg/L)				
Aluminum	U	**1790^{J}**	**5660^{J}**	**11100^{J}**
	F	110^{UL}	110^{UL}	110^{UL}
Arsenic	U	**2.1^{L}**	1.9^{UL}	1.9^{UL}
	F	1.9^{U}	**2.0**	1.9^{U}
Barium	U	**89.6**	**89.7**	**140**
	F	**68.8**	**23.6**	14.0^{U}
Calcium	U	**4830^{K}**	**5180^{K}**	**3580^{K}**
	F	**5200^{K}**	**5010^{K}**	**1980^{K}**
Chromium	U	10.0^{UL}	10.0^{UL}	**14.8^{L}**
	F	10.0^{UL}	10.0^{UL}	10^{UL}
Cobalt	U	**17.6**	**17.8**	**15.6**
	F	**22.0**	**16.2**	14.0^{U}
Copper	U	15.0^{U}	**15.4**	**16.3**
	F	15.0^{U}	15.0^{U}	15.0^{U}
Iron	U	**6120**	**14200**	**22100**
	F	47.0^{U}	**305**	47.0^{U}
Magnesium	U	**4000^{K}**	**3810^{K}**	**2920^{K}**
	F	**4270^{K}**	**3440^{K}**	**892^{K}**
Manganese	U	**297**	**1090**	**328**
	F	**340**	**1160**	**106**
Potassium	U	**2010**	**2240**	**3640**
	F	**2020**	**1800**	**1040**

TABLE 5-2 (Continued)
CONTAMINANT OCCURRENCE AND DISTRIBUTION
IMPROVISED EXPLOSIVE DEVICES (IED) SITE - GROUNDWATER SAMPLES
VERIFICATION INVESTIGATION REPORT
THE NAVAL SCHOOL, EXPLOSIVE ORDNANCE DISPOSAL
STUMP NECK ANNEX, INDIAN HEAD DIVISION
INDIAN HEAD, MARYLAND

Parameter[1]		26MW01[2]	26MW02	26MW03
		Detonation Demonstration Area - Downgradient	Incendiary Demonstration Area - Downgradient	Upgradient IED Site
Sodium	U	**46200**	**10800**	**9120**
	F	**48400**	**11600**	**10900**
Vanadium	U	22.0^{U}	**28.4**	**37.4**
	F	22.0^{U}	22.0^{U}	22.0^{U}
Zinc	U	37.0^{B}	74.6^{B}	70.1^{B}
	F	**28.8**	**36.7**	8.0^{U}
INDICATOR PARAMETERS				
Ammonia (mg/L)		**0.22**	**0.21**	**0.60**
Nitrate + Nitrite (mg/L)		**0.09^{L}**	**1.7^{L}**	**0.73^{L}**
Sulfate (mg/L)		**6.9^{L}**	**6.9^{L}**	**1.6^{L}**
Total Kjedahl Nitrogen (mg/L)		**0.24^{L}**	**0.22^{L}**	**0.60^{L}**
Total Organic Carbon (mg/L)		**3.7**	1.0^{U}	**4.3**
Total Organic Halides (μg/L)		**22.0^{L}**	10.0^{UR}	**11.8^{L}**
Total Petroleum Hydrocarbons (mg/L)		0.53^{U}/0.55^{U}	0.57^{U}	0.52^{U}
Total Phosphorus (mg/L)		**0.08**	**0.03**	**0.21**

NOTE: All positive detections have been bolded.

1 U - Unfiltered sample
F - Filtered sample
2 Duplicate samples taken at this site (total petroleum hydrocarbons only).

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.
UR Nondetected result considered to be unreliable.

TABLE 5-3

IED SOIL - QUALITATIVE RISK ASSESSMENT
VERIFICATION INVESTIGATION
THE NAVAL SCHOOL, EXPLOSIVE ORDNANCE DISPOSAL
STUMP NECK ANNEX, INDIAN HEAD DIVISION
INDIAN HEAD, MARYLAND

Chemical (a)	Frequency of Detection (b)	Range of Detection (mg/kg)	Location of Maximum	Risk-Based Action Levels (mg/kg) (c)				Background Concentration (S26-MW03-001/002) (mg/kg)	Maryland Background Concentration (d) (mg/kg)
				Soil Ingestion		Soil Screening Levels			
				Industrial	Residential	Air	Groundwater		
Volatile Organics									
Carbon disulfide	1/15	0.0012	S26-MW01-01	200000	7800	11	14	ND	NA
Chloroform	5/15	0.003 - 0.005	S26-MW01-01	940	100	0.2	0.3	ND	NA
Methylene chloride	4/15	0.0038 - 0.172	S26-SB01-02	760	85	7	**0.01**	ND	NA
Toluene	3/15	.0021 - 0.033	S26-SB01-01	410000	16000	520	5	ND	NA
Semivolatile Organics									
Bis(2-ethylhexyl)phthalate	1/15	0.0468	26-MW02-00	410	46	210	11	ND	NA
Inorganics									
Aluminum	15/15	2450 - 12700	26-MW03-00	1000000	78000	NA	NA	12700/8250	<20000
Antimony	1/15	0.45	S26-SB02-002	820	31	NA	NA	ND	<1
Arsenic	15/15	1.3 - 15.9	26-MW02-00	**3.8**	**0.43**	380	**15**	3.3/1.9	2-6
Barium	15/15	14.7 - 84.8	26-MW03-00	140000	5500	350000	**32**	84.8/39.8	300
Beryllium	15/15	0.13 - 0.70	S26-SB02-002	1.3	**0.15**	690	180	0.61/0.43	<1
Cadmium	1/15	1.2	26-MW02-00	1000	39	920	6	ND	ND
Calcium	14/15	44.9 - 9350	S26-SB01-01	NA	NA	NA	NA	409/50.7	<2300
Chromium	15/15	6.1 - 47.2	26-MW02-00	1000000 (III) 10000 (VI)	78000 (III) 390 (VI)	140 (VI)	**19 (VI)**	20.8/13.4	<20
Cobalt	14/15	2.2 - 20.5	26-MW02-00	120000	4700	NA	NA	15.0/8.4	<3
Copper	15/15	3.3 - 56.6	S26-SB01-01	82000	3100	NA	NA	4.4/5.2	<10
Iron	15/15	5840 - 83900	26-MW02-00	610000	**23000**	NA	NA	25300/20300	<10000
Lead	15/15	4.6 - 95.7	S26-SB03-001	NA	NA	NA	NA	9.9/5.4	15
Magnesium	15/15	336 - 1920	S26-SB02-002	NA	NA	NA	NA	1090/746	1500

TABLE 5-3 (Continued)
IED SOIL - QUALITATIVE RISK ASSESSMENT
VERIFICATION INVESTIGATION
THE NAVAL SCHOOL, EXPLOSIVE ORDNANCE DISPOSAL
STUMP NECK ANNEX, INDIAN HEAD DIVISION
INDIAN HEAD, MARYLAND

Chemical (a)	Frequency of Detection (b)	Range of Detection (mg/kg)	Location of Maximum	Risk-Based Action Levels (mg/kg) (c)				Background Concentration (S26-MW03-001/002) (mg/kg)	Maryland Background Concentration (d) (mg/kg)
				Soil Ingestion		Soil Screening Levels			
				Industrial	Residential	Air	Groundwater		
Inorganics (Continued)									
Manganese	15/15	14 - 1240	S26-SB04-001	10000	**390**	NA	NA	882/98.8	<150
Mercury	6/15	0.07 - 0.20	26-MW02-00	610	23	7	3	0.07/ND	0.051-0.13
Nickel	15/15	2.8 - 55.0	S26-SB01-01	41000	1600	6900	21	10.5/8.0	<5
Potassium	15/15	363 - 1130	S26-SB02-002	NA	NA	NA	NA	783/385	<11000
Selenium	3/15	0.19 - 0.21	26-SB04-001d	10000	390	NA	3	ND	0.3
Silver	3/15	0.23 - 3.0	S26-SB04-001	10000	390	NA	NA	ND	ND
Sodium	6/15	28.1 - 182	S26-SB02-002	NA	NA	NA	NA	ND	5000
Tin	1/15	15.3	26-MW02-00	1000000	47000	NA	NA	ND	1
Vanadium	14/15	11.5 - 38.7	26-MW03-00	14000	550	NA	NA	38.7/23.9	<20
Zinc	15/15	8.0 - 137	26-MW02-00	610000	23000	NA	42000	30.8/24.2	<28
Total Cyanide	1/15	1.3	S26-SB02-002	41000	1600	NA	NA	ND	NA
Indicator Parameters									
Ammonia	12/15	9.5 - 141	26-MW02-00	NA	NA	NA	NA	49.9/9.5	NA
Nitrate/Nitrite	5/15	1.9 - 5.3	26-MW02-00	1E6/2E5	13000/7800	NA	NA	ND	NA
Total Organic Carbon	15/15	373 - 6970	26-MW02-00	NA	NA	NA	NA	5020/1290	NA
Total Petroleum Hydrocarb	5/16	30.9 - 48.5	S26-SB04-001	NA	NA	NA	NA	33.7/39.1	NA

TABLE 5-3 (Continued)
IED SOIL - QUALITATIVE RISK ASSESSMENT
VERIFICATION INVESTIGATION
THE NAVAL SCHOOL, EXPLOSIVE ORDNANCE DISPOSAL
STUMP NECK ANNEX, INDIAN HEAD DIVISION
INDIAN HEAD, MARYLAND

NA - Not Available.

ND - Not Detected.

(a) Chemical name displayed in bold font exceeds action level.

(b) Samples S26-SB01-01, S26-SB01-02, S26-SB02-001, S26-SB02-001dup (TPH only), S26-SB02-002, S26-SB03-001, S26-SB03-002, S26-SB04-001, S26-SB04-001dup, S26-SB04-002, S26-MW01-01, S26-MW01-02, S26-MW02-001, S26-MW02-002, S26-MW03-001, and S26-MW03-002 were utilized in this statistical evaluation.

(c) Source: Risk-Based Concentration Table, July - December 1995, USEPA, October 20, 1995.

(d) Source: Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States, USGS Professional Paper 1270, 1984.

TABLE 5-4

IED GROUNDWATER - QUALITATIVE RISK ASSESSMENT
VERIFICATION INVESTIGATION
THE NAVAL SCHOOL, EXPLOSIVE ORDNANCE DISPOSAL
STUMP NECK ANNEX, INDIAN HEAD DIVISION
INDIAN HEAD, MARYLAND

Chemical (a)	Frequency of Detection (b)	Range of Detection (ug/L)	Location of Maximum	Risk-Based Action Level for Tap Water (c) (ug/L)	Federal Maximum Contaminant Level (MCL) (d) (ug/L)	Maryland State Drinking Water Standard (d) (ug/L)	USEPA Health Advisories (d) (ug/L)	Background Concentration (26MW03) (ug/L)
Volatile Organics								
Chloroform	1/3	3.1	26MW03	0.15	100/80 (THM)	100 (THM)	100	3.1
Inorganics								
Aluminum unfiltered	3/3	5660 - 111000	26MW03	37000	50 TO 200	NA	NA	11100
Arsenic unfiltered	1/3	2.1	26MW01	0.038	50	50	NA	ND
(filtered)	(1/3)	(2.0)	(26MW02)					(ND)
Barium unfiltered	3/3	89.6 - 140	26MW03	2600	2000	2000	2000	140
(filtered)	(2/3)	(23.6 - 68.8)	(26MW01)					(MD)
Calcium unfiltered	3/3	3580 - 5180	26MW02	NA	NA	NA	NA	3580
(filtered)	(3/3)	(1980 - 5200)	(26MW01)					-1980
Chromium unfiltered	1/3	14.8	26MW03	37000 (III) 180 (VI)	100	100	100	14.8
Cobalt unfiltered	3/3	15.6 - 17.8	26MW02	2200	NA	NA	NA	15.6
(filtered)	(2/3)	(16.2 - 22.0)	(26MW01)					(ND)
Copper unfiltered	2/3	15.4 - 16.3	26MW03	1500	1300 (e)	NA	NA	16.3
Iron unfiltered	3/3	6120 - 22100	26MW03	11000	300	NA	NA	22100
(filtered)	(1/3)	(305)	(26MW02)					(ND)
Magnesium unfiltered	3/3	2920 - 4000	26MW01	NA	NA	NA	NA	2920
(filtered)	(3/3)	(892 - 4270)	(26MW01)					-892
Manganese unfiltered	3/3	297 - 1090	26MW02	180	50	NA	NA	328
(filtered)	(3/3)	(106 - 1160)	(26MW02)					(106)
Potassium unfiltered	3/3	2010 - 3640	26MW03	NA	NA	NA	NA	3640
(filtered)	(3/3)	(1040 - 2020)	(26MW01)					(1040)

TABLE 5-4 (Continued)
IED GROUNDWATER - QUALITATIVE RISK ASSESSMENT
VERIFICATION INVESTIGATION
THE NAVAL SCHOOL, EXPLOSIVE ORDNANCE DISPOSAL
STUMP NECK ANNEX, INDIAN HEAD DIVISION
INDIAN HEAD, MARYLAND

Chemical (a)	Frequency of Detection (b)	Range of Detection (ug/L)	Location of Maximum	Risk-Based Action Level for Tap Water (c) (ug/L)	Federal Maximum Contaminant Level (MCL) (d) (ug/L)	Maryland State Drinking Water Standard (d) (ug/L)	USEPA Health Advisories (d) (ug/L)	Background Concentration (26MW03) (ug/L)
Inorganics (Continued)								
Sodium unfiltered (filtered)	3/3 (3/3)	9120 - 46200 (10900 - 48400)	26MW01 (26MW01)	NA	NA	NA	NA	9120 (10900)
Vanadium unfiltered	2/3	28.4 - 37.4	26MW03	260	NA	NA	NA	37.4
Zinc (filtered)	(2/3)	(28.8 - 36.7)	(26MW02)	11000	5000	NA	NA	(ND)
Indicator Parameters								
Ammonia	3/3	210 - 600	26MW03	1000	NA	NA	30000	600
Nitrate + Nitrite	3/3	90 - 1700	26MW02	58000/3700	10000	10000	NA	730
Sulfate	3/3	1600 - 6900	26MW01/02	NA	500000	NA	NA	1600
TKN	3/3	220 - 600	26MW03	NA	NA	NA	NA	600
TOC	2/3	3700 - 4300	26MW03	NA	NA	NA	NA	4300
TOX	2/3	11.8 - 22.0	26MW01	NA	NA	NA	NA	11.8
Total Phosphorus	3/3	30 - 210	26MW03	NA	NA	NA	NA	210

NA - Not Available.

ND - Not Detected.

(a) Chemicals displayed in bold font exceed action levels.

(b) Samples 26MW01, 26MW02, and 26MW03 were utilized in this statistical evaluation.

(c) Source: Risk-Based Concentration Table, July - December 1995, USEPA, October 20, 1995.

(d) Taken from Table 2-3, Standards and Criteria for Chemicals of Concern.

(e) The actual MCLs for these compounds are treatment techniques, the values displayed are action levels.

TABLE 7-1

CONTAMINANT OCCURRENCE AND DISTRIBUTION
AREA 8 - SOIL SAMPLES
VERIFICATION INVESTIGATION REPORT
THE NAVAL SCHOOL, EXPLOSIVE ORDNANCE DISPOSAL
STUMP NECK ANNEX, INDIAN HEAD DIVISION
INDIAN HEAD, MARYLAND

Parameter	S25-SB01-001[1]	S25-SB01-002[2]	S25-SB02-001[1]	S25-SB02-002[3]	S25-SB03-001[1]	S25-SB03-002[3]	S25-MW01-01[1,4]	S25-MW01-02[4,6]	S25-MW02-001[1]	S25-MW02-002[6]	S25-MW03-001[1]	S25-MW03-002[7]
	Air-Shot Location 24B		Air-Shot Location 36/37B		Air-Shot Location 44/48B		Adjacent to Water-Shot Location 7A		Adjacent to Water-Shot Location 7B		Upgradient	
VOLATILE ORGANICS (µg/kg)												
Acetone	NA	4.4[UJ]	NA	4.0[U]	NA	17.0[B]	NA	5.5[J]/12.0[J]	NA	4.1[UJ]	NA	NA
Carbon disulfide	NA	1.3[UJ]	NA	1.4[B]	NA	1.2[U]	NA	2.6[J]/1.5[U]	NA	1.14[B]	NA	NA
Chloroform	NA	0.42[UJ]	NA	1.2	NA	0.4[UJ]	NA	3.2/2.8[J]	NA	0.4[UJ]	NA	NA
Methylene chloride	NA	5.0[J]	NA	32.8[B]	NA	18.8[B]	NA	89.1[B]/61.8[B]	NA	7.0[B]	NA	NA
Trichloroethene	NA	1.9[J]	NA	0.27[U]	NA	0.27[U]	NA	0.33[U]/0.33[U]	NA	0.28[UJ]	NA	NA
Xylene	NA	0.79[UJ]	NA	2.1	NA	0.73[U]	NA	0.86[U]/0.87[U]	NA	0.74[UJ]	NA	NA
SEMIVOLATILE ORGANICS												
NOT DETECTED												
ENERGETICS												
NOT DETECTED												
INORGANICS (mg/kg)												
Aluminum	2310	8340	5410	5710	3490	2290	2970/3100	1780	4900[J]	6020[J]	4010[J]	3070[J]
Antimony	0.51[L]	0.19[UL]	0.16[UR]	0.18[UR]	0.18[UR]	0.18[UR]	0.21[UL]/0.21[UL]	0.21[UL]	0.18[UL]	0.18[UL]	0.18[UL]	0.17[UL]
Arsenic	1.3[L]	2.4[L]	1.3[L]	2.5[L]	12.4[L]	10.2[L]	0.78[K]/1.7[K]	0.67[K]	1.5[L]	3.9[L]	2.2	3.7
Barium	24.2	55.0	20.3	20.7	20.6	13.4	24.1/23.0	18.7	45.6	18.6	29.8	9.1

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TABLE 7-1 (Continued)
CONTAMINANT OCCURRENCE AND DISTRIBUTION
AREA 8 - SOIL SAMPLES
VERIFICATION INVESTIGATION REPORT
THE NAVAL SCHOOL, EXPLOSIVE ORDNANCE DISPOSAL
STUMP NECK ANNEX, INDIAN HEAD DIVISION
INDIAN HEAD, MARYLAND

Parameter	S25-SB01-001[1]	S25-SB01-002[2]	S25-SB02-001[1]	S25-SB02-002[2]	S25-SB03-001[1]	S25-SB03-002[2]	S25-MW01-01[1,4]	S25-MW01-02[4,6]	S25-MW02-001[1]	S25-MW02-002[6]	S25-MW03-001[1]	S25-MW03-002[7]
	Air-Shot Location 24B		Air-Shot Location 36/37B		Air-Shot Location 44/48B		Adjacent to Water-Shot Location 7A		Adjacent to Water-Shot Location 7B		Upgradient	
Beryllium	0.24	0.84	0.24	0.30	0.40	0.39	0.11[U]/0.11[U]	0.32	0.32	0.24	0.20	0.14
Cadmium	0.53[UL]	0.57[UL]	0.53[UL]	0.52[UL]	0.56[L]	0.61[L]	0.62[U]/0.62[U]	0.62[U]	0.53[UL]	0.54[UL]	0.54[UL]	0.51[UL]
Calcium	59.9[K]	303[K]	46.4[B]	48.1[B]	41.3[B]	39.7[B]	74.9[K]/30.5[K]	233[K]	81.1[B]	43.2[B]	101[B]	113[B]
Chromium	17.2	18.4	16.8[J]	9.3[J]	8.7[J]	7.3[J]	5.1/6.6	4.5	8.3	10.6	10.5	8.5
Cobalt	4.1	21.2	2.6[L]	2.9[L]	5.4	3.7[L]	1.8/1.7[U]	3.5	5.2	3.9	3.5	3.3
Copper	4.4[L]	20.0	3.2[B]	3.5[B]	3.1[B]	1.6[B]	1.8[U]/2.1	5.1	3.5	4.4	2.5[L]	1.5[UL]
Iron	7280	34900	10800[J]	12400[J]	23400[J]	26900[J]	3410[J]/5280[J]	2300[J]	8920[J]	17800[J]	7930	10200
Lead	5.6[J]	8.2[J]	2.2[L]	1.9[L]	3.0[L]	2.0[L]	5.0[L]/4.8[L]	5.1[L]	7.7[J]	5.4[J]	10.0	3.1
Magnesium	148[K]	1540	365[K]	381[K]	102[K]	63.1[K]	176/178	217	292[J]	276[J]	236[J]	215[J]
Manganese	58.7	77.8	171[J]	49.8[J]	82.5[J]	56.6[J]	9.5/11.7	17.3	116[J]	78.1[J]	123[J]	50.1[J]
Nickel	9.8	25.4	5.8[B]	4.0[B]	1.9[B]	3.0[B]	2.1[U]/2.1[U]	2.1[U]	4.8[J]	4.2[J]	2.3[J]	3.3[J]
Potassium	153	761	292	330	232	153	158/160	335	273	387	221	250
Selenium	0.19[B]	0.17[U]	0.19[B]	0.15[U]	0.45[B]	0.31[B]	0.18[U]/0.19[U]	0.19[U]	0.39[B]	0.55[B]	0.17[L]	0.15[U]
Sodium	19.0[U]	26.2	19.3[U]	18.6[U]	19.4[U]	19.0[U]	77.4[B]/66.6[B]	54.3[B]	18.9[U]	19.3[U]	19.2[U]	18.4[U]
Vanadium	9.2[B]	34.3	13.7	14.4	11.0	7.8	6.6/9.8	5.5	13.3	19.4	9.8	9.8
Zinc	8.4	92.1	10.3	13.2	9.8	7.2	7.1/6.1[B]	5.0[B]	12.5[J]	15.8[J]	11.4	11.3
Total Cyanide	1.1[U]	1.1[U]	1.1[U]	1.0[U]	1.1[U]	1.1[U]	1.2[U]/1.3[U]	1.2[U]	1.5	1.1	1.1[U]	1.0[U]

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TABLE 7-1 (Continued)
CONTAMINANT OCCURRENCE AND DISTRIBUTION
AREA 8 - SOIL SAMPLES
VERIFICATION INVESTIGATION REPORT
THE NAVAL SCHOOL, EXPLOSIVE ORDNANCE DISPOSAL
STUMP NECK ANNEX, INDIAN HEAD DIVISION
INDIAN HEAD, MARYLAND

Parameter	S25-SB01-001[1]	S25-SB01-002[2]	S25-SB02-001[1]	S25-SB02-002[3]	S25-SB03-001[1]	S25-SB03-002[3]	S25-MW01-01[1,4]	S25-MW01-02[4,5]	S25-MW02-001[1]	S25-MW02-002[6]	S25-MW03-001[1]	S25-MW03-002[7]
	Air-Shot Location 24B		Air-Shot Location 36/37B		Air-Shot Location 44/48B		Adjacent to Water-Shot Location 7A		Adjacent to Water-Shot Location 7B		Upgradient	
INDICATOR PARAMETERS												
Ammonia (mg/kg)	**52.3**[L]	**14.9**[L]	**30.9**	**49.0**	**25.4**	**12.5**	10.8[UL]/12.0[UL]	11.6[UL]	**66.5**	**28.5**	**21.9**	**7.8**
Nitrate+Nitrite (mg/kg)	0.72[UJ]	0.68[UJ]	1.7[UL]	1.6[UL]	1.7[UL]	1.6[UL]	0.53[U]/0.98[U]	0.87[U]	2.3[UL]	2.0[UL]	**1.9**	1.8[U]
Percent Solids(%)	**94.6**	87.7	93.5	96.9	92.9	94.8	81.3/80.2	80.7/79.2	95.3	93.4	93.5	97.9
Total Organic Carbon (mg/kg)	**5250**	**713**	**2640**[L]	**1390**[L]	**1900**[L]	**1260**[L]	**1840/682**	**698**	**2650**	**1270**	**1620**	87.5[U]

NOTE: All positive detections have been bolded.

1 Sample depth is 0 to 2 feet.
2 Sample depth is just above groundwater (4 to 6 feet).
3 Sample depth is 2 to 4 feet.
4 Duplicate samples taken from this location.
5 Sample depth is just above groundwater (7 to 11 feet).
6 Sample depth is just above groundwater (6 to 8 feet).
7 Sample depth is just above groundwater (3 to 5 feet).

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.
UR Nondetect of analyte considered unreliable.

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TABLE 7-2

COMPARISON OF FIXED-BASED LAB AND FIELD SCREENING RESULTS
AREA 8 ENVIRONMENTAL MEDIA
VERIFICATION INVESTIGATION REPORT
THE NAVAL SCHOOL, EXPLOSIVE ORDNANCE DISPOSAL
STUMP NECK ANNEX, INDIAN HEAD DIVISION
INDIAN HEAD, MARYLAND

SEDIMENT SAMPLES (ppm)

Sample Location	25SW-SD01			25SW-SD02			25SW-SD03			25SW-SD04	
Parameter	Kit		Lab	Kit		Lab	Kit		Lab	Kit	Lab
	D-Tech	Omichron		D-Tech	Omichron		D-Tech	Omichron		D-Tech	
TNT	1.5	< 0.25	ND	1.5	< 0.25	ND	1.5	< 0.25	ND	1.5	ND
RDX	1.5		ND	1.5		ND	1.5		ND	< 0.5	ND

SURFACE WATER SAMPES (ppb)

Sample Location	25SW-SD01		25SW-SD02		25SW-SD03		25SW-SD04	
Parameter	Kit	Lab	Kit	Lab	Kit	Lab	Kit	Lab
	D-Tech		D-Tech		D-Tech		D-Tech	
TNT	< 5	1.91[a]	15	17.6[a]	15	ND	< 5	ND
RDX	< 5	ND	< 5	ND	15	ND	< 5	ND

SOIL BORING SAMPLES (ppm)

Sample Location	25MW01			25MW02			25SB01			25SB02			25SB03		
Parameter	Kit		Lab	Kit		Lab	Kit		Lab	Kit		Lab	Kit		Lab
	D-Tech	Omi.		D-Tech	Omi.		D-Tech	Omi.		D-Tech	Omi.		D-Tech	Omi.	
TNT	1.5	< 0.25	ND	< 0.5	< 0.25	ND	1.5	< 0.25	ND	1.5	< 0.25	ND	< 0.5	<0.25	ND
RDX	< 0.5		ND	1.5		ND	< 0.5		ND	< 0.5		ND	1.5		ND

[a] Test kit specific to TNT was used. Reported lab results were ND for TNT. Values shown in Table are for 4-amino-2,6-dinitrotoluene (which was the only SW-846 Method 8330 analyte detected in the laboratory analysis).

A comparison of test kit performance between two vendors (D-Tech and Omichron) was staged during the field event. D-Tech test kit results appear to correlate well for the water matrix, but lack analyte specificity. D-Tech test kit results appear to be biased high for the soil matrix. RDX was not analyzed for by the Omichron field test kit vendor.

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TABLE 7-3

CONTAMINANT OCCURRENCE AND DISTRIBUTION
AREA 8 - GROUNDWATER SAMPLES
VERIFICATION INVESTIGATION REPORT
THE NAVAL SCHOOL, EXPLOSIVE ORDNANCE DISPOSAL
STUMP NECK ANNEX, INDIAN HEAD DIVISION
INDIAN HEAD, MARYLAND

Parameter[1]		25MW01 Adjacent Water-Shot Location 7A	25MW02 Adjacent Water-Shot Location 7B	25MW03 Upgradient
VOLATILE ORGANICS (μg/L)				
Chloroform		**1.6**	**2.7**	**2.6^{J}**
SEMIVOLATILE ORGANICS (μg/L)				
Bis(2-ethylhexyl)phthalate		2.8^{U}	2.8^{UJ}	**3.3^{J}**
ENERGETICS				
NOT DETECTED				
INORGANICS (μg/L)				
Aluminum	U	**1300^{J}**	**13800^{J}**	**73400^{J}**
	F	110^{UL}	110^{U}	110^{UL}
Arsenic	U	1.9^{UL}	1.9^{UL}	**2.2^{L}**
	F	1.9^{U}	1.9^{U}	1.9^{U}
Barium	U	**67.8**	**101**	**688**
	F	**16.9**	**16**	**51.2**
Beryllium	U	0.9^{U}	**1.0**	**11.0**
	F	0.9^{U}	0.9^{U}	0.9^{U}
Cadmium	U	5.0^{UL}	5.0^{UL}	**6.4^{L}**
	F	5.0^{UL}	5.0^{UL}	5.0^{UL}
Calcium	U	**3570^{K}**	**3080^{K}**	**40300**
	F	**3910^{K}**	**2000^{K}**	**9650^{K}**
Chromium	U	10.0^{UL}	**40.4**	**191**
	F	10.0^{UL}	10.0^{UL}	10.0^{UL}
Cobalt	U	14.0^{U}	14.0^{U}	**169**
	F	14.0^{U}	14.0^{U}	14.0^{U}
Copper	U	15.0^{U}	**28.4**	**166^{L}**
	F	15.0^{U}	15.0^{U}	15.0^{U}
Iron	U	**3710**	**17900**	**252000**
	F	**938**	**758**	47.0^{U}
Lead	U	4.2^{B}	**11.9**	**51.0**
	F	0.6^{U}	0.6^{U}	0.6^{U}

TABLE 7-3 (Continued)
CONTAMINANT OCCURRENCE AND DISTRIBUTION
AREA 8 - GROUNDWATER SAMPLES
VERFICIATION INVESTIGATION REPORT
THE NAVAL SCHOOL, EXPLOSIVE ORDNANCE DISPOSAL
STUMP NECK ANNEX, INDIAN HEAD DIVISION
INDIAN HEAD, MARYLAND

Parameter[1]		25MW01	25MW02	25MW03
		Adjacent Water-Shot Location 7A	Adjacent Water-Shot Location 7B	Upgradient
Magnesium	U	**1170^{K}**	**1410^{K}**	**16800**
	F	**1250^{K}**	**538^{K}**	**3610^{K}**
Manganese	U	**120**	**176**	**2290**
	F	**148**	**113**	**288**
Nickel	U	17.7^{B}	27.7^{B}	**166^{K}**
	F	17.0^{U}	17.0^{U}	17.0^{U}
Potassium	U	**2940**	**2010**	**8430**
	F	**4090**	**1590**	**3440**
Sodium	U	**6810**	**14000**	**8840**
	F	**10500**	**14300**	**8790**
Vanadium	U	22.0^{U}	**54.6**	**281**
	F	22.0^{U}	22.0^{U}	22.0^{U}
Zinc	U	15.6^{B}	38.4^{B}	**483**
	F	8.0^{U}	8.0^{U}	8.0^{U}
INDICATOR PARAMETERS				
Ammonia (mg/L)		**0.31**	**0.42**	**0.41**
Sulfate (mg/L)		**1.6^{L}**	**14.8^{L}**	**8.0^{L}**
Total Kjedahl Nitrogen (mg/L)		**0.34^{L}**	**0.55^{L}**	**0.43^{L}**
Total Organic Halides (μg/L)		10.0^{UR}	**24.6^{L}**	**13.6^{L}**
Total Phosphorus (mg/L)		**0.17**	**0.41**	**1.5**

NOTE: All positive detections have been bolded.

1 U - Unfiltered sample
F - Filtered sample

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.
UR Nondetect of analyte considered unreliable.

TABLE 7-4

CONTAMINANT OCCURRENCE AND DISTRIBUTION
AREA 8 - SURFACE WATER SAMPLES
VERIFICATION INVESTIGATION REPORT
THE NAVAL SCHOOL, EXPLOSIVE ORDNANCE DISPOSAL
STUMP NECK ANNEX, INDIAN HEAD DIVISION
INDIAN HEAD, MARYLAND

Parameter[1]		S25-SW001[2]	S25-SW002	S25-SW003	S25-SW004
		Water-Shot Location 7B	Water-Shot Location 23B	Chicamuxen Creek near Water-Shot 7A	Chicamuxen Creek Upstream of Area 8
VOLATILE ORGANICS					
NOT DETECTED					
SEMIVOLATILE ORGANICS (μg/L)					
Bis(2-ethylhexyl)phthalate		13.6^{U}/**10.8**^{J}	2.8^{U}	2.8^{UL}	**1.1**^{J}
ENERGETICS (μg/L)					
4-Amino-2,6-dinitrotoluene		**1.9/1.9**	**17.6**	1.2^{U}	0.37^{U}
INORGANICS (μg/L)					
Aluminum	U	**19800**^{J}/**23000**^{J}	**1200**^{J}	**2090**^{J}	110^{UJ}
	F	**577**^{J}/**310**^{J}	**202**^{J}	110^{UJ}	110^{UJ}
Antimony	U	1.7^{U}/1.7^{U}	1.7^{U}	**2.3**^{L}	1.7^{U}
	F	1.7^{U}/1.7^{U}	1.7^{U}	1.7^{U}	1.7^{U}
Barium	U	**99/111**	**19.8**	**57.8**	**69.9**
	F	14.0^{U}/14.0^{U}	14.0^{U}	**38.3**	**85.3**
Beryllium	U	0.9^{U}/**1.1**	0.9^{U}	0.9^{U}	0.9^{U}
	F	0.9^{U}/0.9^{U}	0.9^{U}	0.9^{U}	0.9^{U}
Calcium	U	**2000**^{K}/**2070**^{K}	**2150**^{K}	**5980**^{K}	**39500**
	F	**1100**^{K}/**1070**^{K}	**2460**^{K}	**5870**^{K}	**48000**
Cobalt	U	**26.6/26.9**	14.0^{U}	14.0^{U}	14.0^{U}
	F	14.0^{U}/14.0^{U}	14.0^{U}	14.0^{U}	14.0^{U}
Copper	U	**55.5/55.8**	15.0^{UL}	**20.8**	15.0^{UL}
	F	**18.0**/15.0^{U}	15.0^{UL}	15.0^{U}	15.0^{UL}
Iron	U	**42000**^{K}/**52000**^{K}	**3010**^{K}	**8520**^{K}	**619**
	F	**564**^{K}/**987**^{K}	**395**^{K}	**2970**^{K}	47.0^{U}
Lead	U	**57.3**^{K}/**57.6**^{K}	**3.5**^{J}	**17.6**^{K}	**0.94**^{K}
	F	**0.72**^{K}/**4.2**^{K}	0.60^{UJ}	0.60^{U}	0.60^{U}

TABLE 7-4 (Continued)
CONTAMINANT OCCURRENCE AND DISTRIBUTION
AREA 8 - SURFACE WATER SAMPLES
VERIFICATION INVESTIGATION REPORT
THE NAVAL SCHOOL, EXPLOSIVE ORDNANCE DISPOSAL
STUMP NECK ANNEX, INDIAN HEAD DIVISION
INDIAN HEAD, MARYLAND

Parameter[1]		S25-SW001[2]	S25-SW002	S25-SW003	S25-SW004
		Water-Shot Location 7B	Water-Shot Location 23B	Chicamuxen Creek near Water-Shot 7A	Chicamuxen Creek Upstream of Area 8
Magnesium	U	**2040^{K}/2100^{K}**	**1130^{K}**	**4620^{K}**	**43900**
	F	**744^{K}/770^{K}**	**1170^{K}**	**4690^{K}**	**51100**
Manganese	U	**1200/1230**	**183**	**61.6**	**37.7**
	F	**612/640**	**199**	**62.9**	**24.7**
Mercury	U	**0.29/0.23**	0.10^{U}	**0.12**	0.10^{U}
	F	**0.16**/0.10^{U}	0.10^{U}	0.10^{U}	0.10^{U}
Nickel	U	**18.0^{J}**/17.0^{UJ}	17.0^{UJ}	17.0^{UJ}	17.0^{UJ}
	F	17.0^{UJ}/17.0^{UJ}	17.0^{UJ}	17.0^{UJ}	17.0^{UJ}
Potassium	U	**5500/6010**	**1560**	**2450**	**16200**
	F	**4530/4980**	**1590**	**2380**	**18300**
Sodium	U	**1040/1150**	**3520**	**32200**	**353000**
	F	**1250/1300**	**4160**	**36100**	**368000**
Total Cyanide		**470/442**	**56.0**	**8.0**	5.0^{U}

INDICATOR PARAMETERS (mg/L)

Ammonia (mg/L)	**9.3/9.3**	**0.60^{L}**	**0.26**	**0.67**
Nitrate+Nitrite (mg/L)	**0.05^{L}/0.07^{L}**	0.05^{U}	0.05^{UL}	0.05^{U}
Sulfate (mg/L)	25.0^{U}/25.0^{U}	1.0^{UL}	**6.8**	**98.7**
Total Kjeldahl Nitrogen (mg/L)	**10.4/11.1**	**1.5^{J}**	**2.6**	**0.74**
Total Organic Carbon (mg/L)	**29.5^{L}/30.1^{L}**	**4.0**	**16.0^{L}**	**2.3^{L}**
Total Organic Halides (μg/L)	**39.8^{L}/42.4^{L}**	10.0^{UR}	**29.3^{L}**	**42.2^{L}**
Total Phosphorus (mg/L)	**0.78/0.81**	**0.08**	**0.21**	**0.09**

NOTE: All positive detections have been bolded.

1 U - Unfiltered
F - Filtered
2 Duplicate samples taken from this location.

TABLE 7-4 (Continued)
CONTAMINANT OCCURRENCE AND DISTRIBUTION
AREA 8 - SURFACE WATER SAMPLES
VERIFICATION INVESTIGATION REPORT
THE NAVAL SCHOOL, EXPLOSIVE ORDNANCE DISPOSAL
STUMP NECK ANNEX, INDIAN HEAD DIVISION
INDIAN HEAD, MARYLAND

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.
UR	Nondetect of analyte considered unreliable.

TABLE 7-5

CONTAMINANT OCCURRENCE AND DISTRIBUTION
AREA 8 - SEDIMENT SAMPLES
VERIFICATION INVESTIGATION REPORT
THE NAVAL SCHOOL, EXPLOSIVE ORDNANCE DISPOSAL
STUMP NECK ANNEX, INDIAN HEAD DIVISION
INDIAN HEAD, MARYLAND

Parameter	S25-SD001[1]	S25-SD002	S25-SD003	S25-SD004
	Water-Shot Location 7B	Water-Shot Location 23B	Chicamuxen Creek Adjacent to Water-Shot 7B	Upstream Chicamuxen Creek
VOLATILE ORGANICS				
NOT DETECTED				
SEMIVOLATILE ORGANICS (μg/kg)				
Benzo(a)pyrene	18.6[UJ]/19.0[UJ]	18.3[UJ]	**170**	20.4[UJ]
Bis(2-ethylhexyl)phthalate	**73.8[J]**/82.0[UJ]	78.7[UJ]	80.7[UJ]	87.8[UJ]
Naphthalene	**80.7[J]/85.9[J]**	37.2[UJ]	38.1[UJ]	41.5[UJ]
Phenanthrene	**50.5[J]/56.8[J]**	45.5[UJ]	46.6[UJ]	50.7[UJ]
ENERGETICS				
NOT DETECTED				
INORGANICS (mg/kg)				
Aluminum	**6930[J]/4960[J]**	**8530**	**5070[J]**	**4230[J]**
Antimony	0.21[UL]/**0.39[L]**	0.21[UL]	0.21[UL]	0.23[UL]
Arsenic	**2.3[L]/5.5[L]**	**3.2[L]**	**1.8[L]**	**1.6**
Barium	**31.2/26.2**	**51.8**	**37.9**	**18.6**
Beryllium	**0.23/0.26**	**0.32**	**0.29**	**0.21**
Calcium	124[B]/121[B]	**269[K]**	106[B]	**432[J]**
Chromium	**10.3/9.0**	**13.2**	**6.9**	**26.8**
Cobalt	**4.3/4.2**	**7.0**	**3.4**	1.9[U]
Copper	**16.8/44.6**	**7.3**	**3.0**	2.0[UL]
Iron	**14200[J]/12000[J]**	**16000**	**4830[J]**	**8120**
Lead	**12.9[J]/15.2[J]**	**9.6[J]**	**7.9[J]**	**6.0**
Magnesium	**374[J]/288[J]**	**519[K]**	**294[J]**	**562[J]**

TABLE 7-5 (Continued)
CONTAMINANT OCCURRENCE AND DISTRIBUTION
AREA 8 - SEDIMENT SAMPLES
VERIFICATION INVESTIGATION REPORT
THE NAVAL SCHOOL, EXPLOSIVE ORDNANCE DISPOSAL
STUMP NECK ANNEX, INDIAN HEAD DIVISION
INDIAN HEAD, MARYLAND

Parameter	S25-SD001[1]	S25-SD002	S25-SD003	S25-SD004
	Water-Shot Location 7B	Water-Shot Location 23B	Chicamuxen Creek Adjacent to Water-Shot 7B	Upstream Chicamuxen Creek
Manganese	**129^{J}/104^{J}**	**132**	**17.9^{J}**	**33.5^{J}**
Mercury	**0.16/0.21**	**0.19^{L}**	0.06^{U}	0.06^{B}
Nickel	**5.1^{J}/3.4^{J}**	**4.9^{J}**	**5.2^{J}**	**4.3^{J}**
Potassium	**400/363**	**768**	**277**	**505**
Silver	0.12^{U}/**0.39**	0.12^{U}	0.12^{U}	0.13^{U}
Sodium	22.2^{U}/22.9^{U}	**29.0**	22.5^{U}	**171**
Vanadium	**20.6/15.2**	**21.2**	10.3^{B}	**10.8**
Zinc	**19.2^{J}/18^{J}**	**21.8**	**10.7^{J}**	**7.1**
Total Cyanide	**32.2**/1.3^{U}	**3.1**	**23.5**	1.4^{U}
INDICATOR PARAMETERS				
Ammonia (mg/kg)	**128/193**	**29.1^{L}**	**109**	**102**
Nitrate+Nitrite (mg/kg)	**2.4^{L}**/2.0^{UL}	0.92^{UJ}	2.7^{UL}	3.3^{U}
Percent Solids (%)	**80.9/78.6**	**81.7**	**80.1**	**73.7**
Total Organic Carbon (mg/kg)	**3580/3410**	**1350**	**4130**	**1920**

NOTE: All positive detections have been bolded.

1 Duplicate samples taken from this location.

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 7-6

AREA 8 SOIL - QUALITATIVE RISK ASSESSMENT
VERIFICATION INVESTIGATION
THE NAVAL SCHOOL, EXPLOSIVE ORDNANCE DISPOSAL
STUMP NECK ANNEX, INDIAN HEAD DIVISION
INDIAN HEAD, MARYLAND

Chemical (a)	Frequency of Detection (b)	Range of Detection (mg/kg)	Location of Maximum	Risk-Based Action Levels (mg/kg) (c)				Background Concentration (S25-MW03-001/002) (mg/kg)	Maryland Background Concentration (d) (mg/kg)
				Soil Ingestion		Soil Screening Levels			
				Industrial	Residential	Air	Groundwater		
Volatile Organics									
Acetone	2/6	0.0055 - 0.012	25-MW01-02d	200000	7800	62000	8	NA	NA
Carbon disulfide	1/6	0.0026	S25-MW01-02	200000	7800	11	14	NA	NA
Chloroform	3/6	.0012 - 0.003	S25-MW01-02	940	100	0.2	0.3	NA	NA
Methylene chloride	1/6	0.005	S25-SB01-002	760	85	7	0.01	NA	NA
Trichloroethene	1/6	0.0019	S25-SB01-002	520	58	3	0.02	NA	NA
Xylene	1/6	0.0021	S25-SB02-002	1000000	160000	320	74	NA	NA
Inorganics									
Aluminum	13/13	1780 - 8340	S25-SB01-002	1000000	78000	NA	NA	4010/3070	<20000
Antimony	1/13	0.51	S25-SB01-001	820	31	NA	NA	ND	<1
Arsenic	13/13	0.67 - 12.4	S25-SB03-001	**3.8**	**0.43**	380	15	2.2/3.7	2-6
Barium	13/13	9.1 - 55.0	S25-SB01-002	140000	5500	350000	**32**	29.8/9.1	300
Beryllium	11/13	0.14 - 0.84	S25-SB01-002	1.3	**0.15**	690	180	0.20/0.14	<1
Cadmium	2/13	0.56 - 0.61	S25-SB03-002	1000	39	920	6	ND	ND
Calcium	5/13	30.5 - 303	S25-SB01-002	NA	NA	NA	NA	ND	<2300
Chromium	13/13	4.5 - 18.4	S25-SB01-002	1000000 (III) 10000 (VI)	78000 (III) 390 (VI)	140 (VI)	19 (VI)	10.5/8.5	<20
Cobalt	12/13	1.8 - 21.2	S25-SB01-002	120000	4700	NA	NA	3.5/3.3	<3
Copper	7/13	2.1 - 20.0	S25-SB01-002	82000	3100	NA	NA	2.5/ND	<10
Iron	13/13	2300 - 34900	S25-SB01-002	NA	NA	NA	NA	7930/10200	<10000
Lead	13/13	1.9 - 10.0	25-MW03-00	NA	NA	NA	NA	10.0/3.1	15
Magnesium	13/13	63.1 - 1540	S25-SB01-002	NA	NA	NA	NA	236/215	1500

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TABLE 7-6 (Continued)
AREA 8 SOIL - QUALITATIVE RISK ASSESSMENT
VERIFICATION INVESTIGATION
THE NAVAL SCHOOL, EXPLOSIVE ORDNANCE DISPOSAL
STUMP NECK ANNEX, INDIAN HEAD DIVISION
INDIAN HEAD, MARYLAND

Chemical (a)	Frequency of Detection (b)	Range of Detection (mg/kg)	Location of Maximum	Risk-Based Action Levels (mg/kg) (c)				Background Concentration (S25-MW03-001/002) (mg/kg)	Maryland Background Concentration (d) (mg/kg)
				Soil Ingestion		Soil Screening Levels			
				Industrial	Residential	Air	Groundwater		
Inorganics (Continued)									
Manganese	13/13	9.5 - 171	S25-SB02-001	10000	390	NA	NA	123/50.1	<150
Nickel	6/13	2.3 - 25.4	S25-SB01-002	41000	1600	6900	**21**	2.3/3.3	<5
Potassium	13/13	153 - 761	S25-SB01-002	NA	NA	NA	NA	221/250	<11000
Selenium	1/13	0.17	25-MW03-00	10000	390	NA	3	0.17/ND	0.3
Sodium	1/13	26.2	S25-SB01-002	NA	NA	NA	NA	ND	5000
Vanadium	12/13	5.5 - 34.3	S25-SB01-002	14000	550	NA	NA	9.8/9.8	<20
Zinc	11/13	8.4 - 92.1	S25-SB01-002	610000	23000	NA	42000	11.4/11.3	<28
Total Cyanide	2/13	1.1 - 1.5	25-MW02-00	41000	1600	NA	NA	ND	NA
Indicator Parameters									
Ammonia	10/13	7.8 - 66.5	25-MW02-00	NA	NA	NA	NA	21.9/7.8	NA
Nitrate + Nitrite	1/13	1.9	25-MW03-00	1E6/2E5	13000/7800	NA	NA	1.9/ND	NA
Total Organic Carbon	12/13	682 - 5250	S25-SB01-001	NA	NA	NA	NA	1620/ND	NA

NA - Not Available.

ND - Not Detected.

(a) Chemical name displayed in bold font exceeds action level.

(b) Samples S25-SB01-002, S25-SB02-002, S25-SB03-002, S25-MW01-02, S25-MW01-02dup, and S25-MW02-002 were utilized for the statistical evaluation of volatile organic compounds, inorganics, and indicator parameters. Samples S25-SB01-001, S25-SB02-001, S25-SB03-001, S25-MW01-01, S25-MW01-01dup, S25-MW-02-001, S25-MW03-001, and S25-MW03-002 were utilized for the statistical evaluation of inorganic and indicator parameters.

(c) Source: Risk-Based Concentration Table, July - December, 1995, USEPA, October 20, 1995.

(d) Source: Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States, USGS Professional Paper 1270, 1984. Data for Maryland utilized.

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TABLE 7-7

AREA 8 GROUNDWATER - QUALITATIVE RISK ASSESSMENT
VERIFICATION INVESTIGATION
THE NAVAL SCHOOL, EXPLOSIVE ORDNANCE DISPOSAL
STUMP NECK ANNEX, INDIAN HEAD DIVISION
INDIAN HEAD, MARYLAND

Chemical (a)	Frequency of Detection (b)	Range of Detection (ug/L)	Location of Maximum	Risk-Based Action Level for Tap Water (c) (ug/L)	Federal Maximum Contaminant Level (MCL) (d) (ug/L)	Maryland State Drinking Water Standard (d) (ug/L)	USEPA Health Advisories (d) (ug/L)	Background Concentration (25MW03) (ug/L)
Volatile Organics								
Chloroform	3/3	1.6-2.7	25MW02	**0.15**	100/80 (THM)	100 (THM)	100	2.6
Semivolatile Organics								
Bis(2-ethylhexyl)phthalate	1/3	3.3	25MW03	4.8	6	6	NA	3.3
Inorganics								
Aluminum unfiltered	3/3	1300 - 73400	25MW03	**37000**	**50 TO 200**	NA	NA	73400
Arsenic unfiltered	1/3	2.2	25MW03	**0.038**	50	50	NA	2.2
Barium unfiltered (filtered)	3/3 (3/3)	67.8 - 688 (16.0 - 51.2)	25MW03 (25MW03)	2600	2000	2000	2000	688 (51.2)
Beryllium unfiltered	2/3	1.0 - 11.0	25MW03	**0.016**	**4**	**4**	4000	11
Cadmium unfiltered	1/3	6.4	25MW03	18	**5**	**5**	**5**	6.4
Calcium unfiltered (filtered)	3/3 (3/3)	3080 - 40300 (2000 - 9650)	25MW03 (25MW03)	NA	NA	NA	NA	40300 (9650)
Chromium unfiltered	2/3	40.4 - 191	25MW03	37000 (III) **180 (VI)**	**100**	**100**	**100**	191
Cobalt unfiltered	1/3	169	25MW03	2200	NA	NA	NA	169
Copper unfiltered	2/3	28.4 - 166	25MW03	1500	1300 (e)	NA	NA	166
Iron unfiltered (filtered)	3/3 (2/3)	3710 - 252000 (758 - 938)	25MW03 (25MW01)	**11000**	**300**	NA	NA	252000 (ND)
Lead unfiltered	2/3	11.9 - 51	25MW03	NA	**15(e)**	NA	NA	51
Magnesium unfiltered (filtered)	3/3 (3/3)	1170 - 16800 (538 - 3610)	25MW03 (25MW03)	NA	NA	NA	NA	16800 (3610)
Manganese unfiltered **(filtered)**	3/3 (3/3)	120 - 2290 (113 - 288)	25MW03 (25MW03)	**180**	**50**	NA	NA	2290 (288)

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TABLE 7-7 (Continued)
AREA 8 GROUNDWATER - QUALITATIVE RISK ASSESSMENT
VERIFICATION INVESTIGATION
THE NAVAL SCHOOL, EXPLOSIVE ORDNANCE DISPOSAL
STUMP NECK ANNEX, INDIAN HEAD DIVISION
INDIAN HEAD, MARYLAND

Chemical (a)	Frequency of Detection (b)	Range of Detection (ug/L)	Location of Maximum	Risk-Based Action Level for Tap Water (c) (ug/L)	Federal Maximum Contaminant Level (MCL) (d) (ug/L)	Maryland State Drinking Water Standard (d) (ug/L)	USEPA Health Advisories (d) (ug/L)	Background Concentration (25MW03) (ug/L)
Inorganics (Continued)								
Nickel unfiltered	1/3	166	25MW03	730	100	100	100	166
Potassium unfiltered	3/3	2010 - 8430	25MW03	NA	NA	NA	NA	8430
(filtered)	(3/3)	(1590 - 4090)	(25MW01)					(3440)
Sodium unfiltered	3/3	6810 - 14000	25MW02	NA	NA	NA	NA	8840
(filtered)	(3/3)	(8790 - 14300)	(25MW02)					(8790)
Vanadium unfiltered	2/3	54.6 - 281	25MW03	**260**	NA	NA	NA	281
Zinc unfiltered	1/3	483	25MW03	11000	5000	NA	2000	483
Indicator Parameters								
Ammonia	3/3	310 - 420	25MW02	1000	NA	NA	30000	410
Sulfate	3/3	1600 - 14800	25MW02	NA	500000	NA	NA	8000
TKN	3/3	340 - 550	25MW02	NA	NA	NA	NA	430
TOX	2/3	13.6 - 24.6	25MW02	NA	NA	NA	NA	13.6
Total Phosphorus	3/3	170 - 1500	25MW03	NA	NA	NA	NA	1500

NA - Not Available.

ND - Not Detected.

(a) *Chemicals displayed in bold font exceed action levels.*

(b) Samples 25MW01, 25MW02, and 25MW03 were utilized in this statistical evaluation.

(c) Source: Risk-Based Concentration Table, July - December, 1995, USEPA, October 20, 1995.

(d) Taken from Table 2-3, Standards and Criteria for Chemicals of Concern.

(e) The actual MCLs for these compounds are treatment techniques, the values displayed are action levels.

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TABLE 7-8

AREA 8 SURFACE WATER QUALITATIVE RISK ASSESSMENT
VERIFICATION INVESTIGATION
THE NAVAL SCHOOL, EXPLOSIVE ORDNANCE DISPOSAL
STUMP NECK ANNEX, INDIAN HEAD DIVISION
INDIAN HEAD, MARYLAND

Chemical (a)	Frequency of Detection (b)	Range of Detection (ug/L)	Location of Maximum	Risk-Based Action Level for Tap Water (c) (ug/L)	Federal Ambient (d) Water Quality Criteria (ug/L)		Maryland State (d) Surface Water Standards (ug/L)		Background Concentration (S25-SW004) (ug/L)
					Protection of Freshwater Aquatic Life	Consumption of Aquatic Life Only	Protection of Freshwater Aquatic Life	Consumption of Aquatic Life Only	
Semivolatile Organics									
Bis(2-ethylhexyl)phthalate	2/5	1.1 - 10.8	S25-SW001dup	4.8	3	12000	NA	NA	1.1
Energetics									
4-Amino-2,6-dinitrotoluene	3/5	1.9 - 17.6	S25-SW002	NA	NA	NA	NA	NA	ND
Inorganics									
Aluminum, unfiltered	4/5	1200 - 23000	S25-SW001dup	37000	NA	NA	NA	NA	ND
(filtered)	(3/5)	(202 - 577)	(S25-SW001)						(ND)
Antimony, unfiltered	1/5	2.3	S25-SW003	15	1600	4300	NA	NA	ND
Barium unfiltered	5/5	19.8 - 111	S25-SW001dup	2600	NA	NA	NA	NA	69.9
(filtered)	(2/5)	(38.3 - 85.3)	(S25-SW004)						(85.3)
Beryllium unfiltered	1/5	1.1	S25-SW001dup	0.018	5.3	0.13	NA	NA	ND
Calcium unfiltered	5/5	2000 - 39500	S25-SW004	NA	NA	NA	NA	NA	39500
(filtered)	(5/5)	(1070 - 48000)	(S25-SW004)						(48000)
Cobalt unfiltered	2/5	26.6 - 26.9	S25-SW001dup	2200	NA	NA	NA	NA	ND
Copper unfiltered	3/5	20.8 - 55.8	S25-SW001dup	1500	12	NA	12	NA	ND
(filtered)	(1/5)	(18)	(S25-SW001)						(ND)
Iron unfiltered	5/5	619 - 52000	S25-SW001dup	11000	1000	NA	NA	NA	619
(filtered)	(4/5)	(395 - 2970)	(S25-SW003)						(ND)
Lead unfiltered	5/5	0.94 - 57.6	S25-SW001dup	NA	3.2	NA	3.2	NA	0.94
(filtered)	(2/5)	(0.72 - 4.2)	(S25-SW001dup)						(ND)
Magnesium unfiltered	5/5	1130 - 43900	S25-SW004	NA	NA	NA	NA	NA	43900
(filtered)	(5/5)	(744 - 51100)	(S25-SW004)						(51100)
Manganese unfiltered	5/5	37.7 - 1230	S25-SW001dup	180	NA	NA	NA	NA	37.7
(filtered)	(5/5)	(24.7 - 640)	(S25-SW001dup)						(24.7)

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TABLE 7-8 (Continued)
AREA 8 SURFACE WATER QUALITATIVE RISK ASSESSMENT
VERIFICATION INVESTIGATION
THE NAVAL SCHOOL, EXPLOSIVE ORDNANCE DISPOSAL
STUMP NECK ANNEX, INDIAN HEAD DIVISION
INDIAN HEAD, MARYLAND

Chemical (a)	Frequency of Detection (b)	Range of Detection (ug/L)	Location of Maximum	Risk-Based Action Level for Tap Water (c) (ug/L)	Federal Ambient (d) Water Quality Criteria (ug/L)		Maryland State (d) Surface Water Standards (ug/L)		Background Concentration (S25-SW004) (ug/L)
					Protection of Freshwater Aquatic Life	Consumption of Aquatic Life Only	Protection of Freshwater Aquatic Life	Consumption of Aquatic Life Only	
Inorganics (Continued)									
Mercury unfiltered	3/5	0.12 - 0.29	S25-SW001	11	**0.012**	**0.15**	**0.012**	**0.146**	ND
(filtered)	(1/5)	(0.16)	(S25-SW001)						(ND)
Nickel unfiltered	1/5	18	S25-SW001	730	160	4600	160	100	ND
Potassium unfiltered	5/5	1560 - 16200	S25-SW004	NA	NA	NA	NA	NA	16200
(filtered)	(5/5)	(1590 - 18300)	(S25-SW004)						(18300)
Sodium unfiltered	5/5	1040 - 353000	S25-SW004	NA	NA	NA	NA	NA	353000
(filtered)	(5/5)	(1250 - 368000)	(S25-SW004)						(368000)
Total Cyanide	4/5	8.0 - 470	S25-SW001	730	**5.2**	NA	**5.2**	NA	ND
Indicator Parameters									
Ammonia	5/5	260 - 9300	S25-SW001	1000	**3.9**	NA	NA	NA	670
Nitrate/Nitrite	2/5	50 - 70	S25-SW001dup	58000/3700	NA	NA	NA	NA	ND
Sulfate	2/5	6800 - 98700	S25-SW004	NA	NA	NA	NA	NA	98700
TKN	5/5	740 - 11100	S25-SW001dup	NA	NA	NA	NA	NA	740
TOC	5/5	2300 - 30100	S25-SW001dup	NA	NA	NA	NA	NA	2300
TOX	4/5	29.3 - 42.4	S25-SW001dup	NA	NA	NA	NA	NA	42.2
Total Phosphorus	5/5	80 - 780	S25-SW001	NA	NA	NA	NA	NA	90

NA - Not Available.

ND - Not Detected

(a) Chemical names displayed in bold font exceed action levels.

(b) Samples S25-SW001, S25-SW001dup, S25-SW002, S25-SW003, and S25-SW004 were utilized in this statistical evaluation.

(c) Source: Risk-Based Concentration Table, July - December, 1995, USEPA, October 20, 1995.

(d) Taken from Table 2-3, Standards and Criteria for Chemicals of Concern.

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TABLE 7-9

AREA 8 SEDIMENT - QUALITATIVE RISK ASSESSMENT
VERIFICATION INVESTIGATION
THE NAVAL SCHOOL, EXPLOSIVE ORDNANCE DISPOSAL
STUMP NECK ANNEX, INDIAN HEAD DIVISION
INDIAN HEAD, MARYLAND

Chemical (a)	Frequency of Detection (b)	Range of Detection (mg/kg)	Location of Maximum	Risk-Based Action Level (mg/kg) for Soil Ingestion (c)		Background Concentration (S25-SD004) (mg/kg)
				Industrial	Residential	
Semivolatile Organics						
Benzo(a)pyrene	1/5	0.17	S25-SD003	0.78	**0.088**	ND
Bis(2-ethylhexyl)phthalate	1/5	0.0738	S25-SD001	410	46	ND
Naphthalene	2/5	0.0807 - 0.0859	S25-SD001dup	82000	3100	ND
Phenanthrene	2/5	0.0505 - 0.0568	S25-SD001dup	NA	NA	ND
Inorganics						
Aluminum	5/5	4230 - 8530	S25-SD002	1000000	78000	4230
Antimony	1/5	0.39	S25-SD001dup	820	31	ND
Arsenic	5/5	1.6 - 5.5	S25-SD001dup	**3.8**	**0.43**	1.6
Barium	5/5	18.6 - 51.8	S25-SD002	140000	5500	18.6
Beryllium	5/5	0.21 - 0.32	S25-SD002	1.3	**0.15**	0.21
Calcium	2/5	269 - 432	S25-SD004	NA	NA	432
Chromium	5/5	6.9 - 26.8	S25-SD004	1000000 (III) 10000 (VI)	78000 (III) 390 (VI)	26.8
Cobalt	4/5	3.4 - 7.0	S25-SD002	120000	4700	ND
Copper	4/5	3.0 - 44.6	S25-SD001dup	82000	3100	ND
Iron	5/5	4830 - 16000	S25-SD002	610000	23000	8120
Lead	5/5	6.0 - 15.2	S25-SD001dup	NA	NA	6
Magnesium	5/5	288 - 562	S25-SD004	NA	NA	562
Manganese	5/5	17.9 - 132	S25-SD002	10000	390	33.5
Mercury	3/5	0.16 - 0.21	S25-SD001dup	610	23	ND
Nickel	5/5	3.4 - 5.2	S25-SD003	41000	1600	4.3
Potassium	5/5	277 - 768	S25-SD002	NA	NA	505

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TABLE 7-9 (Continued)
AREA 8 SEDIMENT - QUALITATIVE RISK ASSESSMENT
VERIFICATION INVESTIGATION
THE NAVAL SCHOOL, EXPLOSIVE ORDNANCE DISPOSAL
STUMP NECK ANNEX, INDIAN HEAD DIVISION
INDIAN HEAD, MARYLAND

Chemical (a)	Frequency of Detection (b)	Range of Detection (mg/kg)	Location of Maximum	Risk-Based Action Level (mg/kg) for Soil Ingestion (c)		Background Concentration (S25-SD004) (mg/kg)
				Industrial	Residential	
Inorganics (Continued)						
Silver	1/5	0.39	S25-SD001dup	10000	390	ND
Sodium	2/5	29 - 171	S25-SD004	NA	NA	171
Vanadium	5/5	10.8 - 21.2	S25-SD002	14000	550	10.8
Zinc	5/5	7.1 - 21.8	S25-SD002	610000	23000	7.1
Total cyanide	3/5	3.1 - 32.2	S25-SD001	41000	1600	ND
Indicator Parameters						
Ammonia	5/5	29.1 - 193	S25-SD001dup	NA	NA	102
Nitrate + Nitrite	1/5	2.4	S25-SD001	1E6/2E5	13000/7800	ND
TOC	5/5	1350 - 4130	S25-SD003	NA	NA	1920

NA - Not Available.

ND - Not Detected.

(a) Chemical names displayed in bold font exceed action levels.

(b) Samples S25-SD001, S25-SD001dup, S25-SD002, S25-SD003, and S25-SD004 were utilized in this statistical evaluation

(c) Source: Risk-Based Concentration Table, July - December, 1995, USEPA, October 20, 1995.

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APPENDIX F

BACKGROUND DATA FROM
ENGINEERING EVALUATION COST ANALYSIS REPORT
JANUARY 1993

TABLE 1-5

BACKGROUND SEDIMENT/SOIL ANALYTICAL RESULTS
SITE 8 - NITROGLYCERIN PLANT OFFICE
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

Sample Number	Location Description	Mercury (mg/kg)
		0 to 6 inches
SS-200	300 Feet Upstream of Jackson Road	0.12 UJ(d)
SS-201	300 Feet Upstream of Jackson Road	0.14 UJ(d)
SS-202	300 Feet Upstream of Route 225 in Mattawoman Creek	0.18 U(1)
SS-203	500 Feet Upstream of NSWC property in Mattawoman Creek and downstream of Indian Head POTW	0.34(1)
SS-204	Upstream of Indian Head POTW in Mattawoman Creek	0.17U

(1) Sample taken from a depth of 0 to 4 inches.
U Value is a nondetect as reported by the laboratory.
UJ(d) Nondetect is estimated due to laboratory duplicate imprecision. Bias cannot be determined.

APPENDIX G

STATISTICAL APPROACH

CTO 287 NSWC INDIAN HEAD

STATISTICAL APPROACH

1 INTRODUCTION

This appendix presents the proposed methodology for statistical analysis of environmental and background data to be collected at the NSWC Indian Head Facility. Tables 1 through 4 are referenced statistical tables.

The statistical methods used to evaluate the groundwater, soil (subsurface and surface), and freshwater sediment data are suggested in order to:

1. Develop summary statistics (e.g., range, mean, standard deviation, 95% Upper Confidence Limits) which describe environmental contaminant concentrations at the facility.

2. Allow comparisons of background concentrations to those detected in site environmental samples (i.e., samples collected in areas potentially contaminated by SWMUs).

The statistical methods presented were based on:

1. Cochran, William G. and Snedecor, George W. Statistical Methods. The Iowa State University Press. 1980.

2. Gilbert, Richard O., Statistical Methods for Environmental Pollution Monitoring. Van Nostrand Reinhold Company. New York, New York. 1987.

3. U.S. EPA 530/SW-89-026. "Guidance Document on the Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities." 1989.

4. U.S. EPA 530/R-93-003. "Statistical Training Course for Ground-Water Monitoring Data Analysis." July, 1992.

2 BASIC APPROACH OF THE COMPARISON OF SITE DATA TO BACKGROUND

95% Upper Tolerance Limits will be calculated for each parameter in background. Any exceedances in the site data will be considered to be attributable to site activities. For parameters in which the 95% background UTL is exceeded, the site data will be compared to background using parametric or non-parametric t-tests, as appropriate.

$$UTL_{0.95} = \overline{X} + \kappa S_x$$

where UTL0.95 = 95% Upper Tolerance Limit

$$\overline{x} = \frac{\sum_{i=1}^{n} x_i}{n} = \text{Sample Mean}$$

$$\kappa = t_{n-1,1-\beta}\sqrt{1+\frac{1}{n}} = \text{One-sided tolerance factor}$$

$t_{n-1,1-\beta}$ = Student's t-score representing the (1-β)th upper percentile of the t-distribution with (n-1) degrees of freedom

$$S_x = \sqrt{\sum_{i=1}^{n}\frac{(x_i - \overline{x})^2}{(n-1)}} = \text{Standard Deviation}$$

2.1 Limit of Detection

In the chemical analysis of environmental samples, some analytes may be present at concentrations which are below the sample quantitation limit (SQL) of the analytical procedure. The results are generally reported as not detected (rather than zero), and the appropriate limit of detection is given. The amount of data that are below the detection limit plays an important role in selecting the method of addressing the limit of detection problem. The nondetects will be replaced with the SQL divided by two prior to statistical analysis. Clearly, if all the observations are nondetect results, no statistical analysis is warranted. In addition, field duplicate results will be averaged and counted as one sample for use in statistical analysis.

3 RECOMMENDED STATISTICAL METHODS

3.1.1 The Shapiro and Wilk "W-test"

The data must be analyzed to determine whether they were drawn from an underlying normal, lognormal or undetermined distribution. A number of statistical evaluations may be used to determine which, if either, of the distributions are exhibited by a given data set. As recommended by the EPA, the Shapiro and Wilk "W-test" (for sample sets ≤50) and the Shapiro-Francia "W-test" (for sample sets >50) will be used to determine whether the data are normally or lognormally distributed (EPA, 1992).

The null hypothesis (H_0) that is tested is that the population has a normal (or lognormal when the data is log-transformed) distribution.

The alternate hypothesis (H_A) is that the population does not have a normal (or lognormal when the data is log-transformed) distribution.

The equation for the W statistic is:

$$W = \left[\frac{b}{S_R \sqrt{n-1}} \right]^2$$

where

$$b = \sum_{i=1}^{k} a_i \left(x_{[n+1]} - x \right) = \sum_{i=1}^{k} b_i$$

and the coefficients a_1, $a_2, a_3, .., a_k$ are found in Table 1.

A "W" statistic (W_{calc}) is computed for a data set (or a log transformed data set) and compared to a test statistic (W_{test}). The test statistic is determined at the 5% significance level form Table 2. If $W_{calc} > W_{test}$, then the null hypothesis is not rejected (i.e. the data are assumed to be normally distributed [or lognormally distributed if log transformed data are tested]). If $W_{calc} < W_{test}$, then the null hypothesis is rejected and the alternative hypothesis is accepted (i.e., the data are not assumed to be normally distributed [or not log-normally distributed if log transformed data are tested]).

3.1.2 Homogeneity of Variance

Bartlett's test determines equality or homogeneity of a group of population variances. It should be noted that Bartlett's test often rejects equality of variances of populations that have long-tailed distributions or distributions with positive kurtosis (Snedecor and Cochran, 1980).

The equation for Bartlett's test statistic is:

$$\chi^2 = f \ln(S_p^2) - \sum_{i=1}^{k} f_i \ln(S_i^2)$$

where f is the total sample size (N) minus the number of groups (k) and S_p is the variance of the combined background and sample data (pooled variance).

A $\chi 2$ statistic is computed for a data set and compared to a critical value determined at the 5% significance level and (k-1) degrees of freedom from Table 3. If $\chi 2$ is greater than the critical value, the variances are not homogenous at the 5% significance level.

3.2 COMPARISON OF STUDY AREA DATA TO BACKGROUND DATA

For purposes of describing the nature and extent of contamination and performing the baseline risk assessment for the site, it is necessary to differentiate inorganic concentrations potentially attributable to activities at Indian Head from those present at background levels.

Site environmental data are compared to background data using parametric or non-parametric analyses, as appropriate. The statistical methods described in the following paragraphs are used to determine if parameter concentrations detected in site environmental media samples exhibit a statistically significant difference from those detected in background samples.

3.2.1 THE T-TEST FOR POPULATIONS WITH UNEQUAL SAMPLE SIZES

The t-test is widely used in the examination of data sets that are drawn from an underlying normal (or lognormal) distribution (See Shapiro-Wilk W-test) and that have homogeneous variances (see Bartlett's Test). The t-test for populations of unequal sizes (Snedecor and Cochran, 1980) was used to compare onsite inorganics to background. The t-test is used to determine whether or not the difference between average concentrations of a parameter detected in onsite samples and background concentrations is statistically significant. The t-test assumes that the variances of both populations are equal and that both data sets are drawn from the same underlying distribution.

The t-statistic is calculated using the formula

$$t_{calc} = \frac{|\overline{x_1} - \overline{x_2}|}{\sqrt{\frac{s^2 (n_1 + n_2)}{n_1 n_2}}}$$

where s^2 is the pooled variance calculated by

$$s^2 = \frac{\sum_{i=1}^{n_1} (x_{1i} - \overline{x_1})^2 + \sum_{i=1}^{n_2} (x_{2i} - \overline{x_2})^2}{n_1 + n_2 - 2}$$

If the calculated t-statistic is greater than the critical $t_{0.95}$ value with n_1+n_2-2 degrees of freedom (found in Table 4), there is significant evidence of contamination in the given study area at the 95 % significance level.

3.2.2 THE WILCOXON RANK-SUM TEST

When a single environmental data set is being compared to background data and a non-parametric test is needed (i.e., the population is not normally or lognormally distributed), the Wilcoxon Rank-Sum test (also known as the Mann-Whitney U test) should be employed (EPA, 1993). In general, the Wilcoxon Rank-Sum test should be employed whenever the proportion of nondetects is greater than 15% (but less than 90%). However, in order to provide valid results, the Wilcoxon Rank-Sum test should not be used unless the environmental and background data sets contain at least four samples. The following equations present a step-by-step procedure for conducting the Wilcoxon Rank-Sum test.

- Step 1. Combine the onsite data with the background data and rank the ordered values from 1 to N. Assume there are n onsite samples and m background samples so that N = m + n.

$$W = \sum_{i=1}^{n} E_i - \frac{1}{2} n(n + 1)$$

- Step 2. Compute the Wilcoxon statistic W:

  where E_i are the ranks of the onsite samples (Large values of the statistic W give evidence of contamination at the onsite sample locations).

- Step 3. Compute an approximate Z-score. To find the critical value of W, a normal approximation to its distribution is used. The expected value and standard deviation of W under the null hypothesis (i.e., no contamination exists) are given by the formulas

$$E(W) = \frac{1}{2}mn; \qquad SD(W) = \sqrt{\frac{1}{12}mn(N+1)}$$

An approximate Z-score for the Wilcoxon Rank-Sum test may be calculated by the following equations:

$$Z = \frac{W - E(W) - \frac{1}{2}}{SD(W)}$$

The factor of 1/2 in the numerator serves as a continuity correction since the discrete distribution of the statistic W is being approximated by the continuous normal distribution. If n,m > 10 and ties are present, an adjustment to the approximate Z-score must be made:

$$Z_{RS} = \frac{W - E(W) - \frac{1}{2}}{SD'(W)}$$

where: $$SD'(W) = \left(\frac{mn}{12} \left[N + 1 - \frac{\sum_{j=1}^{g} t_j(t_j^2 - 1)}{N(N-1)} \right] \right)^{\frac{1}{2}}$$

g = the number of tied groups and t_j is the number of tied data in the jth group.

- Step 4. For a one-tailed 0.05 significance level test for H_0 versus the H_A (i.e. the measurements from population 1 tend to exceed those from population

2), reject H_0 and accept H_A if $Z_{rs} > Z_{0.95} = 1.645$. For a one-tailed a significance level test for H_0 versus the H_A that the measurements from population 2 tend to exceed those from population 1, reject H_0 and accept H_A if $-Z_{rs} < -Z_{0.95} = -1.645$.

3.2.3 Representative Concentration for a Normal Distribution (Upper One-sided 95% Confidence Limit for the Arithmetic Mean)

The 100(1-α) Upper Confidence Limit ($UCL_{100(1-\alpha)}$) of the population mean ($\bar{x}$) is often used as a descriptive statistic for environmental data. When $\alpha = 0.05$, the 95 percent upper confidence limit (one-tailed test) may be calculated as follows:

$$UCL_{0.95} = \bar{x} + t_{0.95,n-1} \frac{S_x}{\sqrt{n}}$$

$$\bar{X} = \frac{1}{n}\sum_{i=1}^{n} x_i = arithmetic\ mean$$

$$S_x = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}} = the\ sample\ standard\ deviation$$

where: $t_{0.95,n-1} = Value\ from\ t\text{-}distribution\ (Table\ 4)$

It should be noted that the 95 percent confidence interval for a second sample of size n drawn from the same population will most likely not be the same as that for the first sample. In theory if an interval estimate is calculated for the means of a very large set of samples of size n, the true population mean will be within 95 percent of this limit.

3.2.4 Representative Concentration for a Lognormal Distribution (Upper One-sided 95% Confidence Limit for the Geometric Mean)

The following formula may be used to calculate the upper 95% confidence interval ($UCL_{95\%}$) for the geometric mean (x_g):

$$UCL_{0.95} = \exp\left[\bar{y} + 0.5(S_y)^2 + \frac{S_y(H_{0.95,n})}{\sqrt{n}}\right]$$

where: $\bar{y}1$ = arithmetic mean of the log-transformed data, y = ln(x)

S_y = standard deviation of y

$H_{0.95,n}$ = factor for sample size n

TABLE 1
COEFFICIENTS A_i FOR W TEST OF NORMALITY FOR N=2 to 50

i/n	2	3	4	5	6	7	8	9	10
1	0.7071	0.7071	0.6872	0.6646	0.6431	0.6233	0.6052	0.5888	0.5739
2			0.1677	0.2413	0.2806	0.3031	0.3164	0.3244	0.3291
3					0.0875	0.1401	0.1743	0.1976	0.2141
4							0.0561	0.0947	0.1224
5									0.0399

i/n	11	12	13	14	15	16	17	18	19	20
1	0.5601	0.5475	0.5359	0.5251	0.5150	0.5056	0.4968	0.4886	0.4808	0.4734
2	0.3315	0.3325	0.3325	0.3318	0.3306	0.3290	0.3273	0.3253	0.3232	0.3211
3	0.2260	0.2347	0.2412	0.2460	0.2495	0.2521	0.2540	0.2553	0.2561	0.2565
4	0.1429	0.1586	0.1707	0.1802	0.1878	0.1939	0.1988	0.2027	0.2059	0.2085
5	0.0695	0.0922	0.1099	0.1240	0.1353	0.1447	0.1524	0.1587	0.1641	0.1686
6		0.0303	0.0539	0.0727	0.0880	0.1005	0.1109	0.1197	0.1271	0.1334
7				0.0240	0.0433	0.0593	0.0725	0.0837	0.0932	0.1013
8						0.0196	0.0359	0.0496	0.0612	0.0711
9								0.0163	0.0303	0.0422
10										0.0140

i/n	21	22	23	24	25	26	27	28	29	30
1	0.4643	0.4590	0.4542	0.4493	0.4450	0.4407	0.4366	0.4328	0.4291	0.4254
2	0.3185	0.3156	0.3126	0.3098	0.3069	0.3043	0.3018	0.2992	0.2968	0.2944
3	0.2578	0.2571	0.2563	0.2554	0.2543	0.2533	0.2522	0.2510	0.2499	0.2487
4	0.2119	0.2131	0.2139	0.2145	0.2148	0.2151	0.2152	0.2151	0.2150	0.2148
5	0.1736	0.1764	0.1787	0.1807	0.1822	0.1836	0.1848	0.1857	0.1864	0.1870
6	0.1399	0.1443	0.1480	0.1512	0.1539	0.1563	0.1584	0.1601	0.1616	0.1630
7	0.1092	0.1150	0.1201	0.1245	0.1283	0.1316	0.1346	0.1372	0.1395	0.1415
8	0.0804	0.0878	0.0941	0.0997	0.1046	0.1089	0.1128	0.1162	0.1192	0.1219
9	0.0530	0.0618	0.0696	0.0764	0.0823	0.0876	0.0923	0.0965	0.1002	0.1036
10	0.0263	0.0368	0.0459	0.0539	0.0610	0.0672	0.0728	0.0778	0.0822	0.0862
11		0.0122	0.0228	0.0321	0.0403	0.0476	0.0540	0.0598	0.0650	0.0697
12				0.0107	0.0200	0.0284	0.0358	0.0424	0.0483	0.0537
13						0.0094	0.0178	0.0253	0.0320	0.0381
14								0.0084	0.0159	0.0227
15										0.0076

i/n	31	32	33	34	35	36	37	38	39	40
1	0.4220	0.4188	0.4156	0.4127	0.4096	0.4068	0.4040	0.4015	0.9689	0.3964
2	0.2921	0.2898	0.2876	0.2854	0.2834	0.2813	0.2794	0.2774	0.2755	0.2737
3	0.2475	0.2463	0.2451	0.2439	0.2427	0.2415	0.2403	0.2391	0.2380	0.2368
4	0.2145	0.2141	0.2137	0.2132	0.2127	0.2121	0.2116	0.2110	0.2104	0.2098
5	0.1874	0.1878	0.1880	0.1882	0.1883	0.1883	0.1883	0.1881	0.1880	0.1878
6	0.1641	0.1651	0.1660	0.1667	0.1673	0.1678	0.1683	0.1686	0.1689	0.1691
7	0.1433	0.1449	0.1463	0.1475	0.1487	0.1496	0.1503	0.1513	0.1520	0.1526
8	0.1243	0.1265	0.1284	0.1301	0.1317	0.1331	0.1344	0.1356	0.1366	0.1376
9	0.1066	0.1093	0.1118	0.1140	0.1160	0.1179	0.1196	0.1211	0.1225	0.1237
10	0.0899	0.0931	0.0961	0.0988	0.1013	0.1036	0.1056	0.1075	0.1092	0.1108
11	0.0739	0.0777	0.0821	0.0844	0.0873	0.0900	0.0924	0.0947	0.0967	0.0986
12	0.0585	0.0629	0.0669	0.0706	0.0739	0.0770	0.0798	0.0824	0.0848	0.0870
13	0.0435	0.0485	0.0530	0.0572	0.0610	0.0645	0.0677	0.0706	0.0733	0.0759
14	0.0289	0.0344	0.0395	0.0441	0.0484	0.0523	0.0559	0.0592	0.0622	0.0651
15	0.0144	0.0206	0.0262	0.0314	0.0361	0.0404	0.0444	0.0481	0.0515	0.0546
16		0.0068	0.0131	0.0187	0.0239	0.0287	0.0331	0.0372	0.0409	0.0444
17				0.0062	0.0119	0.0172	0.0220	0.0264	0.0305	0.0343
18						0.0057	0.0110	0.0158	0.0203	0.0244
19								0.0053	0.0101	0.0146
20										0.0049

i/n	41	42	43	44	45	46	47	48	49	50
1	0.3940	0.3917	0.3894	0.3872	0.3850	0.3830	0.3808	0.3789	0.3770	0.3751
2	0.2719	0.2701	0.2684	0.2667	0.2651	0.2635	0.2620	0.2604	0.2589	0.2574
3	0.2357	0.2345	0.2334	0.2323	0.2313	0.2302	0.2291	0.2281	0.2271	0.2260
4	0.2091	0.2085	0.2078	0.2072	0.2065	0.2058	0.2052	0.2045	0.2038	0.2032
5	0.1876	0.1874	0.1871	0.1868	0.1865	0.1862	0.1859	0.1855	0.1851	0.1847
6	0.1693	0.1694	0.1695	0.1695	0.1695	0.1695	0.1695	0.1693	0.1692	0.1691
7	0.1531	0.1535	0.1539	0.1542	0.1545	0.1548	0.1550	0.1551	0.1553	0.1554
8	0.1384	0.1392	0.1398	0.1405	0.1410	0.1415	0.1420	0.1423	0.1427	0.1430
9	0.1249	0.1259	0.1269	0.1278	0.1286	0.1293	0.1300	0.1306	0.1312	0.1317
10	0.1123	0.1136	0.1149	0.1160	0.1170	0.1180	0.1189	0.1197	0.1205	0.1212
11	0.1004	0.1020	0.1035	0.1049	0.1062	0.1073	0.1085	0.1095	0.1105	0.1113
12	0.0891	0.0909	0.0927	0.0943	0.0959	0.0972	0.0986	0.0998	0.1010	0.1020
13	0.0782	0.0804	0.0824	0.0842	0.0860	0.0876	0.0892	0.0906	0.0919	0.0932
14	0.0677	0.0701	0.0724	0.0745	0.0775	0.0785	0.0801	0.0817	0.0832	0.0846
15	0.0575	0.0602	0.0628	0.0651	0.0673	0.0694	0.0713	0.0731	0.0748	0.0764
16	0.0476	0.0506	0.0534	0.0560	0.0584	0.0607	0.0628	0.0648	0.0667	0.0685
17	0.0379	0.0411	0.0442	0.0471	0.0497	0.0522	0.0546	0.0568	0.0588	0.0608
18	0.0283	0.0318	0.0352	0.0383	0.0412	0.0439	0.0465	0.0489	0.0511	0.0532
19	0.0188	0.0227	0.0263	0.0296	0.0328	0.0357	0.0385	0.0411	0.0436	0.0459
20	0.0094	0.0136	0.0175	0.0211	0.0245	0.0277	0.0307	0.0335	0.0361	0.0386
21		0.0045	0.0087	0.0126	0.0163	0.0197	0.0229	0.0259	0.0288	0.0314
22				0.0042	0.0081	0.0188	0.0153	0.0185	0.0215	0.0244
23						0.0039	0.0076	0.0111	0.0143	0.0174
24								0.0037	0.0071	0.0104
25										0.0350

Table 2

PERCENTAGE POINTS OF THE W TEST FOR N=3 to 30

n	0.01	0.05
3	0.753	0.767
4	0.687	0.748
5	0.686	0.762
6	0.713	0.788
7	0.730	0.803
8	0.749	0.818
9	0.764	0.829
10	0.781	0.842
11	0.792	0.850
12	0.805	0.859
13	0.814	0.866
14	0.825	0.874
15	0.835	0.881
16	0.844	0.887
17	0.851	0.892
18	0.858	0.897
19	0.863	0.901
20	0.868	0.905
21	0.873	0.908
22	0.878	0.911
23	0.881	0.914
24	0.884	0.916
25	0.888	0.918
26	0.891	0.920
27	0.894	0.923
28	0.896	0.924
29	0.898	0.926
30	0.900	0.927

TABLE 3

PERCENTILES OF THE X^2 DISTRIBUTION WITH v DEGREES OF FREEDOM, $X^2_{v,0.95}$

v	X^2
1	3.841
2	5.991
3	7.815
4	9.488
5	11.07
6	12.59
7	14.07
8	15.51
9	16.92
10	18.31
11	19.68
12	21.03
13	22.36
14	23.68
15	25.00
16	26.30
17	27.59
18	28.87
19	30.14
20	31.41
21	32.67
22	33.92
23	35.17
24	36.42
25	37.65
26	38.89
27	40.11
28	41.34
29	42.56
30	43.77
40	55.76
50	67.50
60	79.08
70	90.53
80	101.9
90	113.1
100	124.3

TABLE 4
PERCENTILES OF STUDENT's t-DISTRIBUTION WITH n DEGREES OF FREEDOM

n\F	0.60	0.75	0.90	0.95	0.975	0.99	0.995	0.9995
1	0.325	1.000	3.078	6.314	12.706	31.821	63.656	636.578
2	0.289	0.816	1.886	2.920	4.303	6.965	9.925	31.600
3	0.277	0.765	1.638	2.353	3.182	4.541	5.841	12.924
4	0.271	0.741	1.533	2.132	2.776	3.747	4.604	8.610
5	0.267	0.727	1.476	2.015	2.571	3.365	4.032	6.869
6	0.265	0.718	1.440	1.943	2.447	3.143	3.707	5.959
7	0.263	0.711	1.415	1.895	2.365	2.998	3.499	5.408
8	0.262	0.706	1.397	1.860	2.306	2.896	3.355	5.041
9	0.261	0.703	1.383	1.833	2.262	2.821	3.250	4.781
10	0.260	0.700	1.372	1.812	2.228	2.764	3.169	4.587
11	0.260	0.697	1.363	1.796	2.201	2.718	3.106	4.437
12	0.259	0.695	1.356	1.782	2.179	2.681	3.055	4.318
13	0.259	0.694	1.350	1.771	2.160	2.650	3.012	4.221
14	0.258	0.692	1.345	1.761	2.145	2.624	2.977	4.140
15	0.258	0.691	1.341	1.753	2.131	2.602	2.947	4.073
16	0.258	0.690	1.337	1.746	2.120	2.583	2.921	4.015
17	0.257	0.689	1.333	1.740	2.110	2.567	2.898	3.965
18	0.257	0.688	1.330	1.734	2.101	2.552	2.878	3.922
19	0.257	0.688	1.328	1.729	2.093	2.539	2.861	3.883
20	0.257	0.687	1.325	1.725	2.086	2.528	2.845	3.850
21	0.257	0.686	1.323	1.721	2.080	2.518	2.831	3.819
22	0.256	0.686	1.321	1.717	2.074	2.508	2.819	3.792
23	0.256	0.685	1.319	1.714	2.069	2.500	2.807	3.768
24	0.256	0.685	1.318	1.711	2.064	2.492	2.797	3.745
25	0.256	0.684	1.316	1.708	2.060	2.485	2.787	3.725
26	0.256	0.684	1.315	1.706	2.056	2.479	2.779	3.707
27	0.256	0.684	1.314	1.703	2.052	2.473	2.771	3.689
28	0.256	0.683	1.313	1.701	2.048	2.467	2.763	3.674
29	0.256	0.683	1.311	1.699	2.045	2.462	2.756	3.660
30	0.256	0.683	1.310	1.697	2.042	2.457	2.750	3.646
40	0.255	0.681	1.303	1.684	2.021	2.423	2.704	3.551
60	0.254	0.679	1.296	1.671	2.000	2.390	2.660	3.460
120	0.254	0.677	1.289	1.658	1.980	2.358	2.617	3.373
1,000,000	0.253	0.674	1.282	1.645	1.960	2.326	2.576	3.290

$F = 1 - \alpha$