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Remedial Investigation Report
for
IR Site 57
Former Drum Loading Area
Building 292

Indian Head Division
Naval Surface Warfare Center
Indian Head, Maryland

VOLUME I - TEXT

Engineering Field Activity Chesapeake
Naval Facilities Engineering Command
Contract Number N62472-90-D-1298
Contract Task Order 0245

July 2000

FINAL

TETRA TECH NUS, INC.

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REMEDIAL INVESTIGATON REPORT
FOR
IR SITE 57
FORMER DRUM LOADING AREA
BUILDING 292

INDIAN HEAD DIVISION
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Engineering Field Activity Chesapeake
Environmental Branch Code 18
Naval Facilities Engineering Command
Washington Navy Yard, Building 212
Washington, D.C. 20374-2121

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ACRONYMS AND DEFINITIONS

AET	Apparent Effects Thresholds
AOC	Area of Concern
ARCS	Assessment and Remediation of Contaminated Sediments Program
AVS/SEM	Acid Volatile Sulfide/Simultaneously Extracted Metals
AWQC	Ambient Water Quality Criteria
B&R Environmental	Brown & Root Environmental
bgs	Below Ground Surface
BI	Background Investigation
BTAG	Biological Technical Assistance Group
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEAN	Comprehensive Long-Term Environmental Action Navy (CLEAN)
CLP	Contract Laboratory Program
COC	Chemical of Concern
COPC	Chemical of Potential Concern
CRDL	Contract Required Detection Limit
CSF	Cancer Slope Factor
CTE	Central Tendancy Exposure
CTO	Contract Task Order
DOT	Department of Transportation
ECD	Electron Capture Detector
EE/CA	Engineering Evaluation/Cost Assessment
EPA	United States Environmental Protection Agency
ERA	Ecological Risk Assessment
ER-L	Effects Range, Low
ER-M	Effects Range, Medium
FID	Flame Ionization Detector
FOL	Field Operations Leader
FSP	Field Sampling Plan
GC	Gas Chromatography
GC/MS	Gas Chromatography/Mass Spectrometry
HEAST	Health Effects Assessment Summary Tables
HI	Hazard Index
HMX	Cyclotetramethylene tetranitramine; Octogen; Homocyclonite
HQ	Hazard Quotent
ICP	Inductively Coupled Plasma

ICR	Incremental Cancer Risk
ID	Inside Diameter
IDW	Investigation-Derived Wastes
IEUBK	Integrated Exposure Uptake Biokinetic Model
IHDIV-NSWC	Indian Head Division, Naval Surface Warfare Center
IR	Inhalation Rate
IRIS	Integrated Risk Management System
K_d	Distribution Coefficient
K_{oc}	Organic Carbon Partition Coefficient
K_{ow}	Octanol/Water Partition Coefficient
LOAEL	Lowest Observed Adverse Effect Level
MCL	Maximum Contaminant Level
MDE	Maryland Department of the Environment
MS	Mass Spectrometer
MSL	Mean Sea Level
NACIP	Naval Assessment and Control of Installation Pollutants
NAD	North American Datum
NGVD	North American Geodetic Vertical Datum
NOAA	National Oceanic and Atmospheric Administration
NOAEL	No Observed Adverse Effect Level
NPDES	National Pollution Discharge Elimination System
NSF	National Sanitation Foundation
NSWC	Naval Surface Warfare Center
NTU	Nephelometric Turbidity Units
ORNL	Oak Ridge National Laboratory
OSWER	Office of Solid Waste and Emergency Response
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated biphenyls
PCE	Perchloroethene (tetrachloroethene)
PCOCs	Preliminary contaminants of concern
PPM	Parts Per Million
PQL	Practical Quantitation Limit
PVC	Polyvinyl chloride
QAPP	Quality Assurance Project Plan
QC	Quality Control
RBC	Risk-Based Concentration
RDX	Hexahydro-1,3,5-trinitro-1,3,5-triazine
RfD	Reference Dose

RFI	RCRA Facility Investigation
RFI/VI	RCRA Facility Investigation/Verification Investigation
RI	Remedial Investigation
RME	Reasonable Maximum Exposure
SA	Skin Surface Area
SDG	Sample Delivery Group
SMDPs	Scientific/Management Decision Points
SOP	Standard Operating Procedures
SOW	Statement of Work
SSL	Soil Screening Level
SVE	Soil Vapor Extraction
SVOCs	Semivolatile Organic Compounds
SWMU	Solid Waste Management Unit
TAL	Target Analyte List
TCE	Trichloroethene
TCL	Target Compound List
TNT	2,4,6-Trinitrotoluene
TOC	Total Organic Carbon
TOX	Total Organic Halides
TPH	Total Petroleum Hydrocarbons
TRVs	Toxicity Reference Values
UCL	Upper Confidence Limit
USATHAMA	United States Army Toxic and Hazardous Material Agency
USDA	United States Department of Agriculture
USFWS	Untied States Fish and Wildlife Service
$UTL_{95\%}$	Upper 95 Percent Tolerance Limit
UXO	Unexploded Ordnance
Vdc	Volts Direct Current
VI	Verification Investigation
VOC	Volatile Organic Compound

EXECUTIVE SUMMARY

This remedial investigation (RI) report for the Indian Head Division Naval Surface Warfare Center (IHDIV-NSWC), Indian Head, Maryland, was prepared by Tetra Tech NUS, Inc. (formerly Brown & Root Environmental) in response to Contract Task Order (CTO) 0245, under the Comprehensive Long-Term Environmental Action Navy (CLEAN), Contract Number N62472-90-D-1298. The purpose of this RI report is to evaluate field data collected during October 1998 and January 1999, in order to determine the extent of contamination and the human health and ecological risks present at the site based on the compounds detected during the field investigation.

Field investigations leading to this report were outlined in a site-specific work plan (B&R Environmental, 1998b) that detailed the additional environmental samples and analytical methods needed to better define conditions at the site. In October 1998 and January 1999, Tetra Tech NUS performed the additional field sampling described in the site-specific work plan. The collected environmental data were entered into an analytical database prepared in support of this RI report.

Table ES-1 summarizes the numerical results of the human health risk assessment. The human health and ecological risk evaluations determined the following:

- The estimated excess lifetime cancer risk was within or less than the Environmental Protection Agency (EPA) target risk range of 10^{-4} to 10^{-6} for both the full-time employee and the construction worker. The range was exceeded for residential scenarios only.

- The hazard index was less than 1.0 for the full-time employee. The hazard index was greater than 1.0 for the construction worker and residential scenarios.

- Potential ecological risks do exist at the site, predominantly in connection with Mattawoman Creek sediments near site-related discharge points.

The hazard index for a construction worker exposed to surface/subsurface soil, groundwater, sediment, and surface water in the downgradient area exceeds 1.0 for the Reasonable Maximum Exposure (RME) scenario. Incidental ingestion of arsenic in surface/subsurface soil was the main contributor to the hazard index. The remediation of a small area of arsenic contaminated soil near the southern corner of Building 292 would reduce the construction worker hazard index to less than 1.0. The hazard index for the construction worker under the Central Tendency Exposure (CTE) scenario was less than 1.0.

The excess lifetime cancer risks for a lifelong resident exposed to surface/subsurface soil and groundwater in the upgradient area exceeded EPA's target risk range of 10^{-4} to 10^{-6} for the RME scenario. Potential exposure to 1,1-dichloroethene in groundwater was the main contributor to the cancer risk. The excess lifetime cancer risk for a lifelong resident under the CTE scenario was very nearly within EPA's target risk range.

The total cumulative hazard index for a hypothetical child resident exposed to surface/subsurface soil and groundwater in the upgradient area was 1.0, although the hazard index per target organs was less than 1.0, which indicates that there is minimal potential for adverse health effects under the conditions established in the risk assessment. The hazard index for the child resident under the CTE scenario was less than 1.0.

The excess lifetime cancer risk for a lifelong resident exposed to surface/subsurface soil, groundwater, surface water, and sediment in the downgradient area exceeded EPA's target risk range of 10^{-4} to 10^{-6} for the RME and CTE scenarios. Incidental ingestion of arsenic in soil, ingestion of trichloroethene in groundwater, and ingestion and inhalation of vinyl chloride in groundwater were the main contributors to the cancer risk.

The total cumulative hazard index for a hypothetical future child and adult resident exposed to surface/subsurface soil, groundwater, surface water, and sediment in the downgradient area exceeded the acceptable level of 1.0 for the RME and CTE scenarios. Incidental ingestion of arsenic in soil and ingestion of cis-1,2-dichloroethene, ethyl ether, and trichloroethene (TCE) in groundwater were the main contributors to the hazard index for the child resident. Ingestion of cis-1,2-dichloroethene and trichloroethene in groundwater were the main contributors to the hazard index for the adult resident.

The maximum detected concentration of lead in downgradient subsurface soil exceeded the Office of Solid Waste and Emergency Response (OSWER) residential screening level of 400 mg/kg. The Integrated Exposure Uptake Biokenetic (IEUBK) model was used to evaluate exposures to lead in soil by hypothetical residential children. The IEUBK model indicated that no adverse effects are anticipated for hypothetical future child residents exposed to lead in surface/subsurface soil at Site 57.

Incremental cancer risks for a lifelong resident exposed to groundwater from potable well PW-7 were within or less than EPA's target risk range of 10^{-4} to 10^{-6} based on the sample collected during the January 1999 field investigation. Hazard indices for child and adult residents exposed to groundwater from PW-7 were less than 1.0, indicating that there is minimal potential for adverse health effects under the conditions established in the risk assessment. Well PW-7 was resampled in October 1999. Chemical

analysis of the more recent sample resulted in a single detection (1,4-dichlorobenzene at 0.13 µg/L compared with EPA tap water criteria of 0.47 µg/L, and the Federal MCL of 75 µg/L).

Several chemicals were detected in the sewer near Site 57, the downgradient ditches and stream, and Mattawoman Creek, where the sewer and stream discharge. For the most part, concentrations of chemicals in surface water and sediment in these areas were relatively low and indicative of low potential risks. The exceptions are potential risks from copper in sewer and Mattawoman Creek sediments and sewer surface water and mercury in Mattawoman Creek and downgradient sediment. VOCs were elevated also in almost all media assessed in this Ecological Risk Assessment (ERA). Although VOCs are not generally associated with ecotoxicity, their elevated concentrations could be of concern. It is unclear whether activities at Building 292 have contributed copper and mercury to the environment, although it does not appear to be the case. The recent cleaning of the sewer suggests that sewer sediments are no longer a source of chemicals to downgradient areas, including Mattawoman Creek. However, due to the elevated concentrations of some chemicals in Mattawoman Creek near the stream and sewer discharge points, this area should be studied further as part of the Mattawoman Creek watershed study.

Based on the results of this RI, the following actions are recommended.

- A feasibility study should be initiated to evaluate potential alternatives for mitigating the potential risk to construction workers due to arsenic contamination in soil.

- Potential ecological risks identified in connection with Mattawoman Creek sediment samples collected during the field investigation should be addressed under the pending Mattawoman Creek ecological study.

- A feasibility study should be initiated to evaluate potential alternatives for mitigating high concentrations of TCE contamination in soil and groundwater near the southern corner of Building 292 with a view toward protecting groundwater quality.

TABLE ES-1

SUMMARY OF ESTIMATED CANCER RISKS AND NONCARCINOGENIC HAZARD INDICES[1]
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Area	Full Time Employee	Construction Worker	Child Resident	Adult Resident	Lifelong Resident
REASONABLE MAXIMUM EXPOSURE[2]					
Incremental Cancer Risk					
Upgradient	3.80E-06	1.70E-06	3.4E-04	6.60E-04	1.00E-03
Downgradient	5.20E-05	1.00E-05	1.40E-03	2.4E-03	3.8E-03
Storm Sewer	NA	1.60E-07	NA	NA	NA
PW-7	NA	NA	NA	NA	1.90E-06
Hazard Index[3]					
Upgradient	2.40E-02	1.70E-01	1.0E+00	8.50E-01	NA
Downgradient	2.50E-01	1.30E+00	1.60E+01	6.70E+00	NA
Storm Sewer	NA	5.10E-02	NA	NA	NA
PW-7	NA	NA	8.50E-02	3.80E-02	NA
CENTRAL TENDANCY EXPOSURE[4]					
Incremental Cancer Risk					
Upgradient	2.40E-07	7.50E-07	6.30E-05	8.70E-05	1.50E-04
Downgradient	3.10E-06	4.40E-06	2.50E-04	3.10E-04	5.60E-04
Storm Sewer	NA	4.50E-08	NA	NA	NA
PW-7	NA	NA	NA	NA	2.80E-07
Hazard Index[3]					
Upgradient	7.60E-03	7.10E-02	5.60E-01	3.40E-01	NA
Downgradient	8.10E-02	5.80E-01	9.20E+00	2.80E+00	NA
Storm Sewer	NA	8.00E-02	NA	NA	NA
PW-7	NA	NA	5.60E-02	1.80E-02	NA

1 More detailed, site-specific tables and text are located in Section 9 in this document.
2 Estimated cancer and noncancer risks assume a Reasonable Maximum Exposure (RME).
3 Hazard Indices (i.e., summation of the hazard quotients) are used only for comparison purposes and do not reflect actual additive noncarcinogenic effects.
4 Estimated cancer and noncancer risks assume a Central Tendancy Exposure (CTE).
NA = Not applicable for this receptor.

1.0 INTRODUCTION

1.1 PURPOSE OF REPORT

This remedial investigation (RI) report for Site 57, Former Drum Loading Area, at the Indian Head Division Naval Surface Warfare Center (IHDIV-NSWC), Indian Head, Maryland, was prepared by Tetra Tech NUS, Inc. (formerly Brown and Root Environmental) in response to Contract Task Order (CTO) 0245, under the Comprehensive Long-Term Environmental Action Navy (CLEAN), Contract Number N62472-90-D-1298. The purpose of this RI report is to evaluate field data collected during October 1998 and January 1999, in order to determine the extent of contamination and the human health and ecological risks present at the site based on the compounds detected during the field investigation.

1.2 NSWC BACKGROUND

The IHDIV-NSWC is located in northwestern Charles County, Maryland, approximately 25 miles southwest of Washington, DC. The IHDIV-NSWC is a military facility consisting of the main area on the Cornwallis Neck Peninsula and the Annex on Stump Neck. The main area is bounded by the Potomac River to the northwest, west, and south, Mattawoman Creek to the south and east, and the town of Indian Head to the northeast (Figure 1-1). Stump Neck Annex is located across Mattawoman Creek. The Stump Neck Annex is not contiguous with the main area, has a separate United States Environmental Protection Agency (EPA) identification number, and is operated by a tenant. The location of Site 57 is shown on Figure 1-2.

The primary mission of IHDIV-NSWC is as follows.

- 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 IHDIV-NSWC.

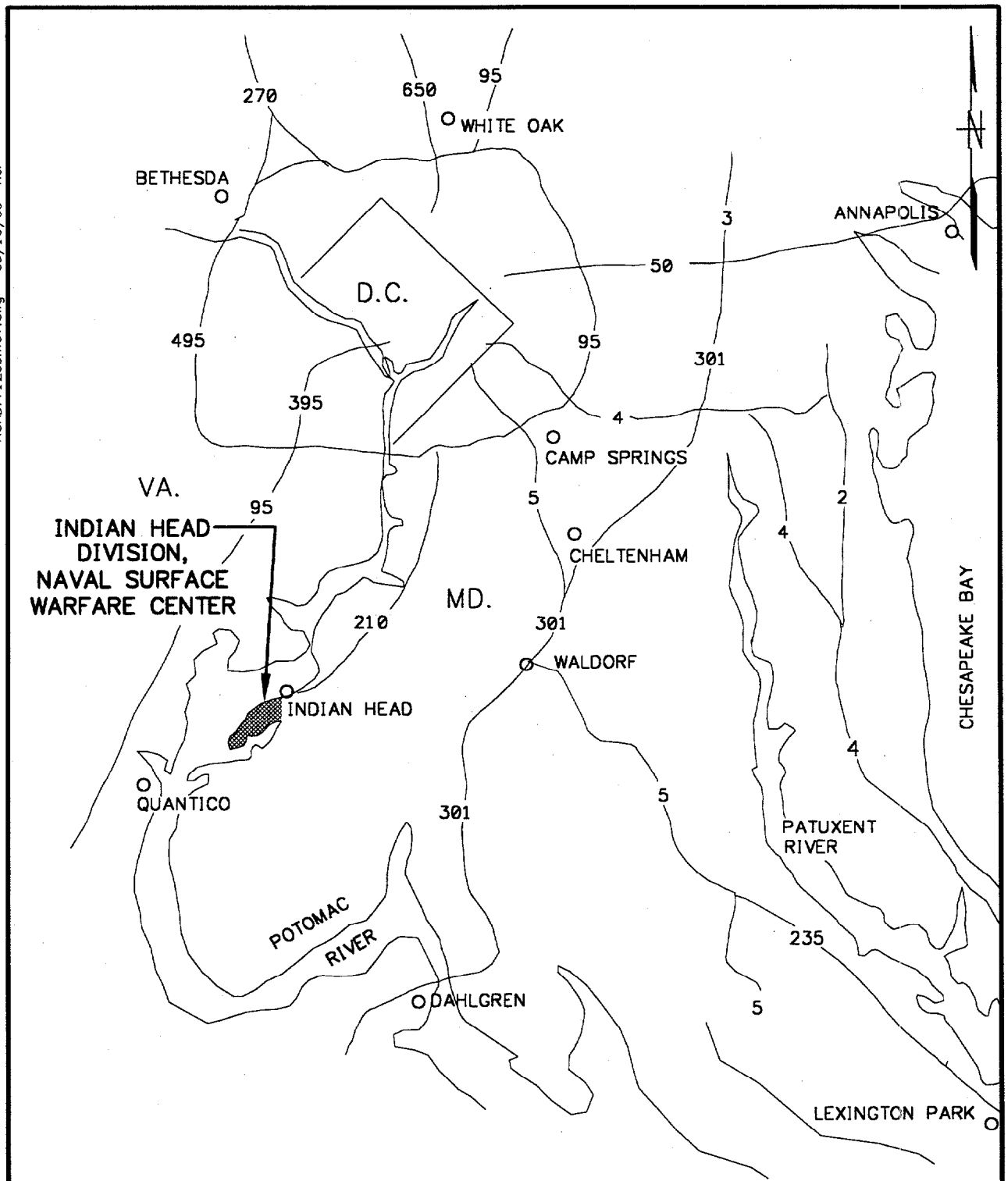
1.3 SITE 57 DESCRIPTION

Installation Restoration (IR) Site 57, Former Drum Loading Area, encompasses the area located southwest of Building 292 at the main operational facility of the IHDIV-NSWC, as shown in Figure 1-2. Previous operations at the building involved vapor degreasing of metal parts using trichloroethene (TCE). It is believed that these operations may have resulted in the contamination of the soil and groundwater near the building. Specifically, Building 292 operations reportedly included the following activities:

- Mid-1960 until 1989 - operated a 1,900-gallon TCE vapor degreaser unit.
- Mid-1970s until 1989 - large solvent dip tanks used for general cleaning.
- During the 1970s and 1980s, spent TCE was piped to drums outside Building 292 via a ball valve through the wall of the building. Drums were reportedly stored on a grass-covered area near the ball valve and near Manhole (MH)-1.
- The use of TCE at the facility was reportedly stopped in 1989.

1.4 DOCUMENT ORGANIZATION

This Remedial Investigation Report of Site 57 is organized as follows. Section 1.0 describes the purpose of the document, offers a brief background of the Indian Head facility and describes the site. Section 2.0 details the field methods utilized in conducting the field investigations for Site 57. Section 3.0 provides a broad description of the characteristics of the facility. The historical background of Site 57 with respect to past environmental investigations is presented in Section 4.0. Section 5.0 describes the field investigations undertaken to assemble the field data necessary to support the human health and ecological risk assessments in subsequent sections. The geologic and hydrogeologic aspects of the site as determined by the data gathered during the field investigation are discussed in Section 6.0. Section 7.0 describes the nature and extent of the contamination detected in environmental samples collected from the study area. Section 8.0 describes the fate and transport considerations for the contaminants detected in the collected samples. The human health risk assessment is presented in Section 9.0, and the ecological risk assessment is presented in Section 10.0. Section 11.0 summarizes the preceding sections of the document and offers recommendations regarding future actions.

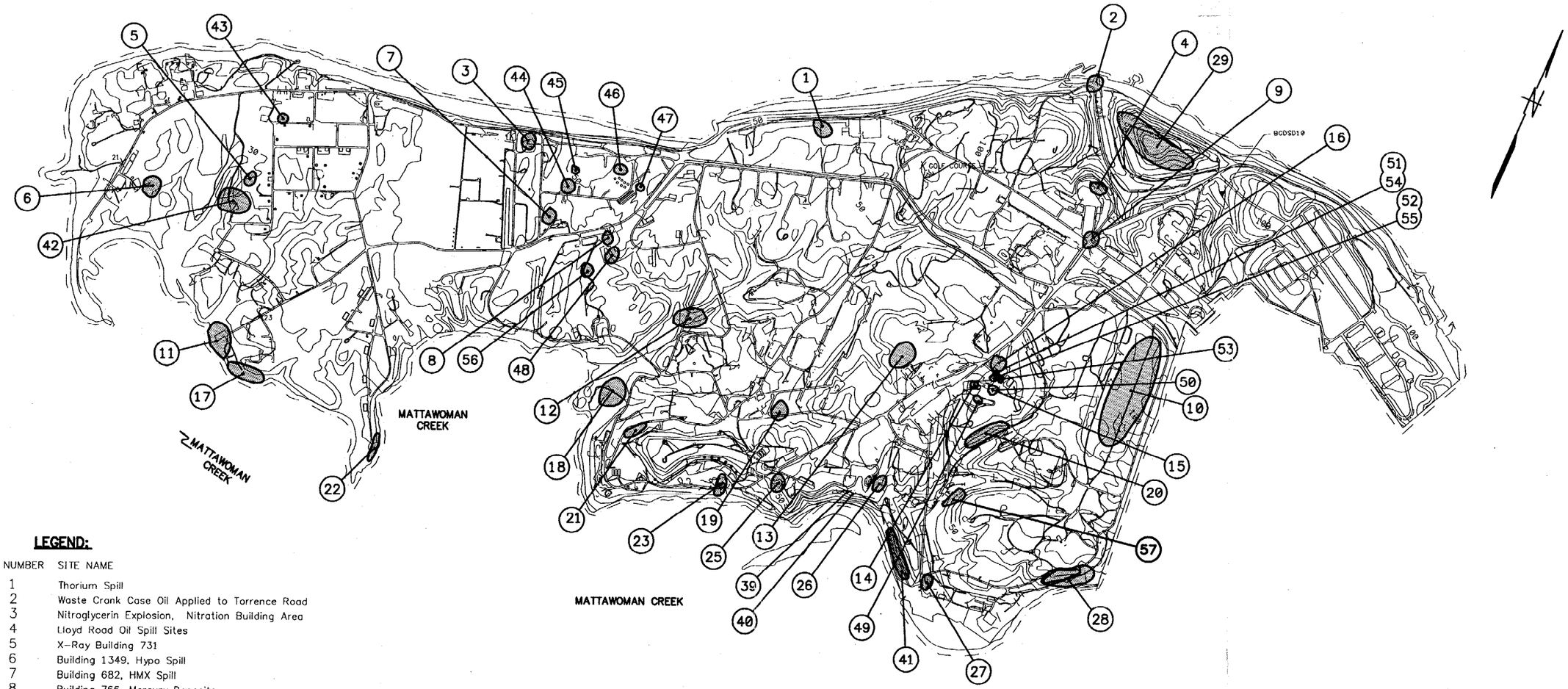


DRAWN BY TAD DATE 4/98	Tetra Tech NUS, Inc.	CONTRACT NO. 7129	OWNER NO. ———
CHECKED BY GJL DATE 2/1/00	VICINITY MAP IHDIV – NSWC, INDIAN HEAD, MARYLAND	APPROVED BY GJL	DATE 2/1/00
COST/SCHED-AREA		APPROVED BY	DATE
SCALE AS NOTED		DRAWING NO. FIGURE 1-1	REV. 0

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

ACAD: 7129bm07.dwg 05/19/99 HJP

ACAD: 7129cm33.dwg 05/19/99 HJP



LEGEND:

SITE 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	Caffee 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 (SEE FIGURE 3-2)
39	Organic Plant Outfall
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**

APPROXIMATE SITE LOCATION
INTERMITTENT STREAM
NAVAL RESERVE BOUNDARY
100 CONTOUR INTERVAL 10 FEET
FLOW DIRECTION

0 1600 3200
SCALE IN FEET

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY KW DATE 3/30/99
CHECKED BY GJL DATE 2/1/00
COST/SCHED-AREA
SCALE AS NOTED

Tetra Tech NUS, Inc.

SITE LOCATION MAP
INDIAN HEAD NSWC
INDIAN HEAD, MARYLAND

CONTRACT NO. 7129
OWNER NO.
APPROVED BY GJL DATE 2/1/00
APPROVED BY DATE
DRAWING NO. FIGURE 1-2
REV. 0

FORM CADD NO. SOUTH_BH.DGN - REV 0 - 02/11/97

00668C012

2.0 FIELD INVESTIGATION ACTIVITIES

2.1 FIELD INVESTIGATION

RI field activities were conducted during two events, at Site 57 – Former Drum Loading Area, in October 1998 and January 1999. All field activities were performed in accordance with the Master Plans (B&R Environmental, 1997a) for RIs at the facility and the project-specific RI work plan (B&R Environmental, 1998b), unless otherwise noted. A fixed-base laboratory (GP Environmental Laboratory) was used for all environmental sample analyses. Ackenheil Engineering laboratory provided the geotechnical analyses.

Event I of the RI included the following tasks:

- Mobilization/demobilization
- Surface and subsurface soil sampling at 11 soil boring locations
- Quality control sampling

Event II of the RI included the following tasks:

- Mobilization/demobilization.
- Surface water sampling at 15 locations.
- Sediment sampling at 8 locations.
- Surface and subsurface soil sampling at 6 locations.
- Installation of 13 permanent and 3 temporary monitoring wells.
- Groundwater sampling at 16 monitoring wells and one potable water supply well.
- One round of synoptic groundwater-level measurement.
- Aquifer testing.
- Site topographic survey and vertical and horizontal survey of all monitoring wells, soil borings, and surface water/sediment sample locations.
- Marshalling of investigation-derived waste (IDW).
- Quality control sampling.

2.1.1 Mobilization/Demobilization

TtNUS prepared technical specifications and procured subcontractors for the drilling, land surveying, and laboratory analyses prior to the mobilization activities for both Event I and Event II of the field work. All field team members reviewed the work plans prior to the field activities.

The field operations leader (FOL) coordinated the mobilization activities and secured the equipment required to conduct the field investigation. All field equipment was shipped from the TtNUS Pittsburgh, Pennsylvania warehouse, trucked from the TtNUS Philadelphia, Pennsylvania warehouse by TtNUS personnel, or shipped directly from the vendor(s) providing the equipment. After the field activities were completed, the FOL and crew demobilized by cleaning the field office (the abandoned rail car located near Building D-327) and shipping equipment back to the warehouses and vendors.

2.1.2 Surface Water and Sediment Sampling

Nineteen surface water samples (plus three duplicates) and eight sediment samples (plus one duplicate) were collected during the Event II investigation.

The surface water and sediment samples were collected at successive locations progressing in a down stream-to-upstream manner.

The surface water samples were collected using the direct-fill method of submerging the sample container into the water when sampling from the concrete channel, the stream running along the west side of Hersey Road south of Building 292, and Mattawoman Creek. Surface water samples collected from the storm sewer were collected using a stainless-steel beaker or peristaltic pump. The peristaltic pump was used only at two locations (S57SW001 and S57SW002), where the storm drain grates were not removable with the available equipment. When the peristaltic pump was used to collect surface water from the sewer system, the sample containers were filled in the same manner as groundwater sample containers, as described in Section 2.1.6. The discharge end of ¼-inch Teflon tubing was attached to a decontaminated steel pipe that was then lowered through the storm drain to the water.

Sediment samples were collected from a depth of 0 to 6 inches below the surface using a disposable plastic trowel. Whenever volatile organic compounds (VOCs) were to be collected, the VOC container was filled first, followed by the remaining containers necessary to complete the set of planned analyses.

Surface water and sediment sample log sheets were generated for each collected sample. The sheets provide a record of the applicable sampling conditions, including sample identification, water depth, date, time, and analyses requested from the fixed-base laboratory. The surface water sample log sheets also show sample data such as pH, conductivity, water temperature, dissolved oxygen, turbidity, and salinity. The sample log sheets are supplied in Appendix A.

2.1.3 Surface Soil Sampling

A total of 10 surface soil samples (plus one duplicate sample) were collected to characterize the surface soils at the site. During both events, the samples were collected from a depth of 0 to 6 inches below ground surface (bgs). A solid-core sampler was used to collect samples during Event I and a split-spoon sampler during Event II. Plastic disposable trowels or stainless-steel trowels were also used as necessary during both events. A soil sample log sheet was generated for each sample. The sample log sheets are supplied in Appendix A.

2.1.4 Subsurface Soil Sampling

Subsurface soil samples were collected from the unsaturated and saturated soil to provide lithologic and chemical characterization of site subsurface soils.

Twenty-three and 15 subsurface soil samples, respectively were collected during Event I and Event II. The samples were submitted to a fixed-base laboratory for chemical analysis and collected using direct-push large-core sampling tools during Event I and split-spoon samplers during Event II. When direct-push large-core sampling tools were used, lithologic samples were collected continuously at 4-foot intervals to the total depth of the hole. Split-spoon lithologic samples were collected continuously at 2-foot intervals during the hollow-stem auger drilling to the bottom of the boring. A complete log of each boring was maintained in accordance with Master Field Sampling Plan (FSP) (B&R Environmental, 1997a). The boring log sheets are supplied in Appendix C.

Four subsurface soil samples were collected and submitted during Event II for geotechnical analysis. The initial attempt at collecting the samples utilized Shelby tube tools; however, as the tubes were driven into the subsurface soil, the Shelby tube collapsed during each attempt due to the density of the material. Therefore, split-spoon samplers were used to collect the soil samples for geotechnical analysis.

2.1.5 Monitoring Well Construction

Thirteen permanent shallow groundwater monitoring wells and three temporary shallow groundwater monitoring wells were installed by a Maryland-licensed well driller (Hardin-Huber, Incorporated) during the Event II investigation. The permanent wells were installed using hollow-stem auger drilling techniques.

The wells were constructed with 2-inch inside-diameter (ID), National Sanitation Foundation (NSF) approved Schedule 40, flush-joint, polyvinyl chloride (PVC) riser pipe, and 2-inch ID factory-slotted (0.01-inch slot size) PVC well screen, 5 or 10 feet long. The top of the screened interval was positioned approximately 1 to 3 feet above the encountered water-bearing zone for the water-table wells. The lower surficial wells were installed

so that the bottom of the screen was placed at the top of the first aquitard encountered. The well materials were installed through the augers after advancement to the appropriate depth. A silica sand pack (Nos. 10 to 20 U.S. Standard Sieve size) was installed into the boring annulus around the well screen as the augers were withdrawn from the boring. The sand pack was installed from the bottom of the hole to a level of approximately 2 feet above the top of the well screen. A bentonite pellet seal, approximately 2 feet thick, was installed above the sand pack and hydrated with approximately 15 gallons of potable water. The remainder of the annulus of the boring (from the seal to the ground surface) was then backfilled with cement and bentonite grout, installed using a tremie pipe. The depths of the tops of all backfill materials were constantly monitored during the well installation process by means of a weighted, stainless-steel or fiberglass tape. A 6-inch-diameter protective steel casing equipped with a locking steel cap was installed around each well. A concrete apron with bollards in the corners measuring 8 feet by 4 feet by 0.5 feet was placed around the base of each well cluster, and a 4 by 4-foot pad with bollards was installed around the single wells. Keyed-alike locks were supplied for each well.

Three temporary wells were installed using direct-push techniques and were constructed with 1.5-inch ID, NSF-approved Schedule 40, flush-joint, PVC riser pipe and 1.5-inch ID factory-slotted (0.01-inch slot size) PVC well screen, 5 or 10 feet long. The wells were installed into a hole with a nominal 2-inch diameter made by a direct-push large-core sampling tool. The wells were constructed in the following manner. After the hole was advanced to approximately 7 to 8 feet below the water table, the screen (5 or 10 feet long) was attached to the riser pipe and lowered into the hole to the desired depth so that the water table was approximately 2 feet below the top of the screen. The saturated formation material generally collapsed around the screen. The remaining annular space around the screen was filled with No. 1 silica sand to at least 0.5 foot above the top of the screen. Above the sand, a bentonite seal at least 0.5 foot thick was installed and hydrated with approximately 2 gallons of potable water. Temporary wells were abandoned, as described in Section 2.1.6.2.

A monitoring well construction diagram and a state well completion form were completed for each well that was installed. Copies of the monitoring well construction forms are provided in Appendix D. State well completion forms are provided in Appendix G.

2.1.5.1 Well Development

The permanent monitoring wells were developed using a surge block and stainless-steel bailer to remove excess fines from around the well screen. The well was initially surged without removing water from the well by raising and lowering the surge block within the water column for approximately 5 to 10 minutes. This process was repeated several times. The water, with the fines, was then removed using the bailer. A 12-volt direct current (vdc) well pump was then used to pump continuously at a flow rate of approximately 0.5 to 2 gallons per minute. The water-quality parameters temperature, pH, specific conductance, and turbidity were measured during the pumping step of development. The wells were considered developed when these

readings became stable and the purge water became visibly clear. All information collected during well development was recorded on a development data sheet and is provided in Appendix E.

The temporary well points were developed at a low pumping rate using a peristaltic pump just prior to purging and sampling. The wells were pumped until the water was visibly clear, then the purging process was started for sampling the well.

2.1.5.2 Well Abandonment

The temporary wells were abandoned by removing the PVC riser and screen prior to backfilling with bentonite hole plug hydrated with approximately 10 gallons of potable water. Maryland well abandonment reports are included in Appendix G.

2.1.6 Groundwater Sampling

Groundwater samples were collected from the 13 permanent monitoring wells, the three temporary wells, and one potable water supply well. Groundwater samples were collected from the permanent and temporary monitoring wells in accordance with the low-flow sampling procedures detailed in the IHDIV-NSWC standard operating procedures (SOPs) (NSWC, 1996). The purging and sampling apparatus used for collecting groundwater samples consisted of a length of ¼-inch Teflon tubing connected to a peristaltic pump. Silicon tubing was threaded through the pump to connect with Teflon tubing, used for discharge. Measurements of depth to water, purge rate, pH, specific conductivity, temperature, salinity, and turbidity of the groundwater were performed at approximately 5-minute intervals during the purging process. Groundwater sample collection was not initiated until at least one saturated screen length well volume was removed and stabilization of the groundwater parameters was observed. Stabilization was defined as ±0.1 pH units, ±10% for specific conductance, ±0.1°C for temperature, and <10 nephelometric turbidity units (NTU) for turbidity.

After a well was purged, sample containers were filled directly from the discharge tube. The VOC containers were filled last in the following manner: the ¼ -inch tubing was pinched at the inlet side of the peristaltic pump, withdrawn from the well, and allowed to drain by gravity into the sample container.

A groundwater sample log sheet and a low-flow purge data sheet were generated for each sample collected. These sheets provide records of the purging and sampling conditions, including sample identification, well depth, static water level, amount of water purged, date, time, analyses requested from the fixed-base laboratory, pH, conductivity, water temperature, turbidity, drawdown, and flow rate.

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Groundwater samples were collected from the 13 permanent monitoring wells, the three temporary wells, and one potable water supply well. Groundwater samples were collected from the permanent and temporary monitoring wells in accordance with the low-flow sampling procedures detailed in the IHDIV-NSWC standard operating procedures (SOPs) (NSWC, 1996). The purging and sampling apparatus used for collecting groundwater samples consisted of a length of ¼-inch Teflon tubing connected to a peristaltic pump. Silicon tubing was threaded through the pump to connect with Teflon tubing, used for discharge. Measurements of depth to water, purge rate, pH, specific conductivity, temperature, salinity, and turbidity of the groundwater were performed at approximately 5-minute intervals during the purging process. Groundwater sample collection was not initiated until at least one saturated screen length well volume was removed and stabilization of the groundwater parameters was observed. Stabilization was defined as ±0.1 pH units, ±10% for specific conductance, ±0.1°C for temperature, and <10 nephelometric turbidity units (NTU) for turbidity.

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A groundwater sample log sheet and a low-flow purge data sheet were generated for each sample collected. These sheets provide records of the purging and sampling conditions, including sample identification, well depth, static water level, amount of water purged, date, time, analyses requested from the fixed-base laboratory, pH, conductivity, water temperature, turbidity, drawdown, and flow rate.

The potable water well was sampled at the discharge pipe (approximately 4- to 6-inch diameter) flowing continuously into the water treatment plant. The containers were filled directly from the discharge. The sample log sheets and low-flow purge data sheets are supplied in Appendix A.

2.1.7 Water-Level Measurements

One complete round of water-level measurements was collected from the 16 monitoring wells on January 24, 1999. The synoptic groundwater-level measurement was performed to determine the groundwater flow pattern at the site. Measurements were taken with an electronic water-level indicator (M-scope) using the top of the well riser pipe as the reference point for determining depths to water. Groundwater-level measurements were recorded on a groundwater-level measurement form to the nearest 0.01 foot. The groundwater level data are provided in Appendix F.

2.1.8 Aquifer Testing

Slug tests were completed at 11 of the 13 wells to estimate the horizontal hydraulic conductivity (k_h) of the aquifer in accordance with the procedures provided in Section 2.7.1 of the Master Field Sampling Plan (FSP).

Rising and falling head slug tests were performed at wells at which the water level was above the top of the screen; otherwise, only rising head tests were done. Before a falling head slug test was initiated, the static water level in the monitoring well was measured using an electronic water-level indicator. A slug was then abruptly introduced into the well, and the water level and the time were recorded. Water levels were recorded with a pressure transducer at logarithmic intervals of time via a programmed electronic data logger as the head returned to the original static water level. Each rising head slug test was performed similarly by removing the slug, and recording water level and elapsed time measurements as the head returned to the original static water level. The time and the rate of change required for the water level to return to the original static water level are functions of the transmissivity of the aquifer. The slug test data are provided in Appendix M.

The water level was monitored continuously in the temporary well S57TW003 for a duration of 75.25 hours (3.14 days) to determine if the groundwater level in the area of the well is affected by the tidal fluctuations of the Mattawoman Creek. The water level was monitored by placing a pressure transducer into the well sufficiently deep to ensure the transducer remained submerged for the duration of the study. The data logger was set to record water-level measurements at 15-minute intervals. The water level was measured from the top of the riser pipe with a water-level indicator at the beginning of the study to allow conversion of the change of water levels to elevations. The resulting data are provided in Appendix K.

2.1.9 Surveying

A topographic survey was conducted in the vicinity of Building 292. The monitoring wells (temporary and permanent), soil borings, and sediment and surface water sample locations were surveyed by the firm of Donaldson, Garrett & Associates, Inc. Existing base control points within IHDIV-NSWC were used as reference points. The horizontal locations of all sampling locations were surveyed to ±0.5 foot. Vertical elevations were referenced to the North American Geodetic Vertical Datum (NGVD) 1929, and horizontal positioning is referenced to 1983 North America Datum (NAD) and the Maryland State Plane Coordinate System. The top of PVC riser pipe and ground surface elevations were surveyed to ±0.01 foot for the monitoring well locations. Appendix O is a list of sampled locations along with the corresponding surveyed elevations and coordinates.

2.1.10 Investigation-Derived Waste Handling

Purge water, decontamination water, and development water generated during Events I and II were collected and containerized in Department of Transportation (DOT) approved 55-gallon drums at the site and marshalled in an area across the street from Building 159. All drums were sealed and labeled with drum contents, site number, boring/well number, date and the statement, "Investigative Derived Waste." Drill cuttings were placed in 55-gallon drums during Event I and in a 30-cubic-yard lined and covered rolloff box during Event II.

A plastic-lined decontamination pad was constructed in the drum marshaling area and used to collect the water from the steam cleaning of the drilling rig and equipment. The water was pumped out of the lined pad into 55-gallon drums.

One drum of soil investigation-derived waste (IDW) and three partially full drums of liquid IDW were generated during the Event I investigation. The liquid IDW was transferred from the drums into a 6,000-gallon Baker tank supplied by the contractor OHM. Subsequently, OHM did not need to use the tank, and they transferred the liquid IDW back into the 55-gallon drums, resulting in two drums containing liquid IDW. The Event I IDW was removed by an OHM subcontractor during the Event II investigation.

Thirty 55-gallon drums of liquid IDW and one 30-cubic yard rolloff box approximately one-third full of soil were generated during the Event II investigation. On June 29, 1999, the liquid IDW was pumped from the drums to a tanker truck and disposed by OHM.

2.1.11 Equipment Decontamination

Equipment was decontaminated in accordance with the procedures described in the Master Plans (B&R Environmental, 1997a). Decontamination fluids and residual solids were handled as described in Section 2.1.10.

2.1.12 Sample Custody and Handling

Sample custody was maintained and documented at all times. Sample chain-of-custody was maintained in accordance with the IHDIV-NSWC SOPs. The completed chain-of-custody records generated during the field investigation are provided in Appendix B. All sample-handling procedures were conducted as described in the Master Plans (B&R Environmental, 1997a). After the samples were collected, they were placed on ice in a cooler and relinquished to a laboratory carrier at the front gate for transport to the fixed-base analytical laboratory. Samples collected for geotechnical analysis were shipped to the lab via FedEx. The sample identification scheme provided in the project-specific RI work plan (B&R Environmental, 1998b) was used for sample tracking.

2.1.13 Quality Control Samples

In addition to regular calibration of field equipment and appropriate documentation, quality control (QC) samples were generated during environmental sampling activities. The QC samples included field duplicates, matrix spike/matrix spike duplicates (MS/MSD), equipment rinsates, field blanks, and trip blanks and were collected at a frequency described in the project-specific RI work plan (B&R Environmental, 1998b). The duplicate and the MS/MSD sample locations were documented on the environmental sample log sheet.

2.2 BACKGROUND INVESTIGATION

A basewide Background Investigation (BI) was conducted at IHDIV-NSWC between June 18, 1997 and September 17, 1997 (B&R Environmental, 1997c). The purpose of this BI was to establish a basewide background database for IHDIV-NSWC that would be used as a tool to evaluate analytical results for soil and groundwater samples collected during future IHDIV-NSWC investigations. In particular, the data contained in the BI would be used to determine whether environmental samples collected at IHDIV-NSWC contain contaminants at concentrations that exceed naturally occurring background concentrations.

As part of the BI field effort, five new monitoring wells were installed and sampled, 10 soil borings were installed and sampled, and 10 freshwater sediments were sampled. These samples were analyzed for pesticides/polychlorinated biphenyls (PCBs), metals, and some miscellaneous inorganic and geotechnical parameters. This BI data set was supplemented with data from existing wells and borings installed for a

previous Verification Investigation (VI), CTO 222 (B&R Environmental, 1996a), and the then-ongoing 1997 RCRA Facility Investigation/Verification Investigation (RFI/VI) for six sites at Stump Neck Annex. These supplemental samples (collected from five monitoring wells and four soil borings) were analyzed for semivolatile organic compounds (SVOCs), volatile organic compounds (VOCs), and energetics, in addition to metals and miscellaneous inorganics, as specified in the planning documents for their respective investigations. Because these additional organics data were available, they were added to the data set. A literature search was also conducted to determine whether any environmental data in the literature could be used to supplement data collected at IHDIV-NSWC. This search yielded minimal data for sediments and biota only. The literature data were used only for qualitative comparison with on-site data.

The following conclusions were developed from the analysis of the data generated during the BI:

There are sufficient numbers of samples to characterize background groundwater, freshwater sediment, surface soil, and subsurface soil. The goal of attaining a minimum of 10 samples for future statistical analysis was achieved for soils and freshwater sediments. This goal was not achieved for groundwater because of the influence of turbidity on some of the unfiltered groundwater samples. However, the sample count is viewed as sufficient to yield reliable statistical comparisons and summaries for each medium type sampled during the BI, including groundwater.

The collected data are of sufficient quality to be used for purposes of background comparisons in risk assessments, RIs, RFIs, and other environmental investigations conducted at IHDIV-NSWC. Five monitoring wells, 10 soil borings, and 10 freshwater sediment samples were installed and sampled expressly for the purpose of the BI. Every effort was taken to ensure that the samples were collected from pristine, undisturbed areas not influenced by Solid Waste Management Units (SWMUs) or Areas of Concern (AOCs). Existing samples, which were added to supplement the background data set, were carefully screened. All sample data in the background data set have been validated in accordance with EPA Region III guidelines.

Samples were evenly distributed across both the Indian Head and Stump Neck Annex peninsulas of the facility. Since there was no bias regarding sample distribution, the background database is valid for future comparisons to suspected SWMUs or AOCs anywhere on IHDIV-NSWC.

Organics detections were infrequent and insignificant for all medium types when analyses were available. Specifically, the inorganic profile of the background samples was not impacted by the presence of low-level organic constituents. At the request of the Navy, organics analyses for volatiles, semivolatiles, and energetics were not performed on samples collected specifically for the BI. However, samples collected for the CTO 222 VI in 1995 (B&R Environmental, 1996a) and the then-ongoing 1997 RFI/VI at the Stump

Neck Annex, which were added to the background data set, were analyzed for these parameters in accordance with the statements of work for these projects, and the data were included in the background database.

There was evidence that turbidity impacted the inorganic profile of some of the unfiltered background groundwater samples. Data sets for the unfiltered groundwater samples were evaluated with "turbid" samples included in the data set and with the turbid samples removed from the data set. Generally, results for the unfiltered samples with the "turbid" samples removed from the data set were significantly lower and similar to results reported for the filtered groundwater samples. The "turbid" samples may not be representative of local groundwater quality, and it was recommended that they not be considered for inclusion in the background data set.

The inorganic concentrations reported in the freshwater sediments, surface soils, and subsurface soils were within the range of background concentrations reported for surface soils in the eastern United States (Shacklette and Boerngen, 1984). With few exceptions, the concentrations reported were also within the range of values reported for surface soils of the state of Maryland (Dragun, 1991). There was a positive correlation between the total organic content of the sediment samples and the metals content in the sediments.

The inorganic profile for background surface and subsurface soils was not the same. Generally, metals concentrations were higher in subsurface soil samples than surface soil samples collected from the same locations.

There was no statistically significant difference in the data between soil samples collected at higher elevations ("uplands") and those collected at lower elevations ("lowlands") at IHDIV-NSWC.

2.3 DATA EVALUATION AND VALIDATION

2.3.1 Introduction

All fixed-base analytical laboratory data for samples collected during the October 1998 and January 1999 field investigations in support of the RI for IHDIV-NSWC under CTO 245 were analyzed by GP Laboratories and subjected to third-party data validation by TtNUS. Third-party data validation is an objective, systematic process during which analytical data are reviewed against a set of criteria to ascertain the validity of the reported results and to identify for the data user the possible limitations of the results.

The following sections summarize the various aspects of the data validation process.

2.3.2 General Data Validation Procedures

All fixed-base laboratory data for the RI were generated according to EPA Contract Laboratory Program (CLP) methodology. The data were validated in accordance with the EPA Region III Modifications to the National Functional Guidelines for Organic and Inorganic Data Review (EPA, 1994, and EPA, 1993) to the greatest extent practicable in view of method-specific quality assurance/quality control requirements and criteria outlined in the IHDIV-NSWC project specific RI work plan quality assurance project plan (QAPP) (B&R Environmental, 1997c) and the IHDIV-NSWC master plans (B&R Environmental, 1997a).

The validation process included consideration of the following: data completeness, holding time compliance, mass calibrations, field QC and laboratory-generated blanks, internal standards, surrogate spikes, blank spikes, matrix spikes, field duplicate precision, chemical interferences, quantitation, detection limits, and system performance. Evaluation of laboratory and field QC blank analyses aided in the elimination of false positive results, which were identified as laboratory and/or field artifacts. Non-compliances observed during the validation process resulted in qualification of analytical data. The qualifiers alert the data user to imprecise or estimated results and, in the worst case, unreliable and unusable data.

The results of the validation process were summarized in sample-delivery-group (SDG)-specific technical reports consisting of a memorandum, a section of qualified analytical results, and a supporting documentation section that provided the rationale for changes and/or qualification of the data. These memoranda provided a detailed explanation of the results of the data validation review. Copies of the data validation memoranda are included in Appendix I of the RI report. All other data validation documentation is currently retained on file by B&R Environmental.

2.3.3 Data Validation Qualifiers

As mentioned previously, the qualification of analytical data during the validation process (i.e., application of U, B, UJ, UL, J, L, K, and UR qualifiers) was conducted as required by EPA Region III data validation guidance (EPA, 1993, and EPA, 1994). The addition of the data qualifiers to analytical results signifies the occurrence of quality control non-compliances that have been noted during the course of data validation. The various third-party data qualifiers are defined as follows:

- **U** - Indicates that the chemical was not detected at the numerical detection limit (quantitation limit) noted. Nondetected results from the laboratory are reported in this manner.

- **B** - This qualifier is added to a positive result (reported by the laboratory) to indicate that the detected concentration is a false positive determined to be attributable to contamination introduced during field sampling or laboratory analysis.

- **UJ** - Indicates that the chemical was not detected. However, the detection limit (quantitation limit) is considered to be estimated based on problems encountered during laboratory analysis. The associated numerical detection limit is regarded as imprecise. No bias can assigned to this estimate.

- **UL** - Indicates that the chemical was not detected. However, the detection limit (quantitation limit) is considered to be a biased low estimate based on problems encountered during laboratory analysis. The associated numerical detection limit is regarded as imprecise.

- **J** - Indicates that the chemical was detected. However, the associated numerical result is an imprecise representation of the amount that is actually present in the sample. The laboratory-reported quantity is considered to be an estimate. No bias can be assigned to this estimate.

- **L** - Indicates that the chemical was detected. However, the associated numerical result is an imprecise representation of the amount that is actually present in the sample. The laboratory-reported quantity is considered to be a biased-low estimate.

- **K** - Indicates that the chemical was detected. However, the associated numerical result is an imprecise representation of the amount that is actually present in the sample. The laboratory-reported quantity is considered to be a biased-high estimate.

- **UR** - Indicates that the nondetected analytical result reported by the laboratory is considered to be unreliable and unusable and has been rejected. The chemical may or may not be present; thus there is the potential for reporting of false negative results. This qualifier is applied in cases of gross technical deficiencies (e.g., holding times missed by a factor of two times the specified time limit, severe calibration noncompliance, and extremely low quality control recoveries).

The preceding data qualifiers may be categorized as indicative of major problems or minor problems. Major problems are defined as issues that result in the rejection of data, qualified with UR data validation qualifiers. These data are considered invalid and are not used for risk assessment and decision making. Minor problems are defined as issues resulting in the estimation of data, qualified with the B, J, L, K, UL, and UJ data validation qualifiers. Estimated analytical results (regardless of bias or lack thereof) are considered to be suitable for risk assessment and decision-making purposes.

3.0 IHDIV-NSWC CHARACTERISTICS

3.1 CLIMATE

IHDIV-NSWC is located in the Atlantic Coastal Plain on the eastern bank of the Potomac River, midway between the rigorous climate of the north and the mild climate of the south. Since IHDIV-NSWC is located in the middle latitudes where the general atmospheric flow is from west to east across North America, it has a continental-type climate with four well-defined seasons. However, the proximity of the Potomac River and its tributaries has a considerable modifying effect on the climate, especially in moderating extreme temperatures.

Generally, the coldest period of the year is late January and early February, when the low temperatures average 21°F. The warmest period is late July, when the maximum temperatures average 89°F. The highest temperature on record in the county was 108°F, recorded at Newberg in July 1930, and the lowest was -12°F at La Plata in January 1913. Precipitation is evenly distributed through the year; either July or August is the wettest month, and February or October is the driest. The heaviest precipitation during the colder half of the year is generally the result of low pressure systems moving northeastward along the Atlantic coast; in summer, precipitation occurs as thunderstorms. The highest official one-day precipitation on record is 6.45 inches, which occurred at Waldorf in August 1955. Thunderstorms occur on an average of 35 days per year, mostly from May through August.

Prevailing surface winds are from the west-northwest to northwest except during the warm months of the year, when they become more southerly. The periods with most wind occur in late winter and early spring. The growing season is approximately 187 days long.

3.2 TOPOGRAPHY, SURFACE WATER, AND DRAINAGE

The NSWC Indian Head peninsula is located in the western portion of Charles County, which lies within the Atlantic Coastal Plain physiographic province, approximately 8 to 10 miles east of the Fall Line that marks the western extent of the physiographic province. Indian Head has gently rolling to undulating topography with elevations ranging from sea level to greater than 100 feet above mean sea level (msl). The higher elevations exist in the eastern portion of IHDIV-NSWC. Generally, the land surface slopes to the southwest and southeast. The western side of IHDIV-NSWC along the Potomac River is characterized by 20- to 100-foot bluffs, and the eastern side along Mattawoman Creek is more gently sloping. The Indian Head peninsula is shown on Figure 3-1.

The two principal waterways in the vicinity of NSWC Indian Head peninsula are the Potomac River and Mattawoman Creek. The Potomac River is a tidally influenced estuary and is slightly brackish. Mattawoman Creek is a tributary to the Potomac River and is also tidally influenced. Tidal marshes exist along Mattawoman Creek.

Wastewater from NSWC Indian Head is discharged directly to the Potomac River or Mattawoman and from outfalls to tributaries of the Potomac River or Mattawoman Creek. The wastewaters consist of industrial, sanitary, and storm effluents or combinations thereof (Hart, 1983).

The land surface at Site 57 is relatively flat and slopes slightly to the south-southwest. Surface runoff at the site appears to flow over land toward a concrete drainage ditch to the south. A half-pipe corrugated steel pipe drainage ditch runs along the east side of Building 292 and Site 57, draining into a underground pipe that feeds into the open concrete drainage ditch to the south.

3.3 GEOLOGY

The geologic units underlying the IHDIV-NSWC peninsula, in stratigraphically ascending order, are the Lower Cretaceous Potomac Group, the Tertiary age Aquia Formation and Park Hall Formation, and several Quaternary fluvial and estuarine deposits.

The Potomac Group (Lower Cretaceous) consists of three geologic units (in descending stratigraphic order): the Patapsco Formation, the Arundel Formation, and the Patuxent Formation. The lithology of the Potomac Group consists of interbedded clay, silt, sand, and gravel deposited in fluviodeltaic environments (Hiortdahl, 1990) and ranges in thickness from 650 to 750 feet (Vroblesky, 1991; Harsh, 1990). The Patapsco Formation generally consists of clays with interbedded sand units. The Arundel Formation generally consists of a variegated clay. The Patuxent Formation consists of clays with interbedded sand units.

The Aquia Formation (Upper Paleocene) consists of marine deposits of olive black to olive gray, micaceous, glauconitic quartz sand interbedded with sand, silt, and clay. The formation is approximately 0 to 80 feet thick in the NSWC Indian Head peninsula area.

The Park Hall Formation (upper Pliocene) consists of non-marine, fluvial and estuarine deposits of sand and clay interbedded with sand with gravel. It is overlain unconformably by Quaternary deposits. The thickness of this formation in the area ranges from 0 to approximately 60 feet.

The Tertiary geologic formations are missing in many locations in the NSWC Indian Head peninsula area. Where this occurs, the overlying Quarternary deposits come in contact with the underlying Cretaceous

formations. The Quarternary fluvial and estuarine deposits in the NSWC Indian Head peninsula area consist of Pleistocene paleochannel deposits and Holocene alluvial deposits (Hiortdahl, 1990). These deposits consist of gravel, sand, silt, clay, and peat mixtures with irregular bedding. The aggregate thickness may range from 0 to approximately 40 feet.

3.4 REGIONAL HYDROGEOLOGY

The Patapsco and Patuxent Formations of the Potomac Group are the main groundwater aquifers used for supply purposes in the Indian Head peninsula area. The aquifers are separated by the Arundel Formation confining unit. Figure 3-2 presents a generalized cross-sectional view of the Indian Head peninsula regional area.

The three principal water-bearing zones within the Patapsco Formation are the Lower, Middle, and Upper Sands. They are under confined conditions. The Lower Sand outcrops in Virginia; the Middle Sand outcrops below the Potomac River and in Virginia; and the Upper Sand outcrops beneath the Potomac River.

The water-bearing zones of the Patuxent Formation consist of laterally discontinuous sand lenses. The Patuxent Formation outcrops in Virginia, where it is recharged by surface water.

3.5 LOCAL HYDROGEOLOGY

Shallow, unconfined to semiconfined groundwater at the Indian Head peninsula occurs from near surface to approximately 45 feet bgs, with water-table elevations ranging from sea level to approximately 65 feet above msl. Typically, the shallow groundwater occurs in perched water-bearing zones and is recharged from infiltration (Hart, 1983; Slaughter and Otton, 1968). In some lowland areas, surface water intrusion may be an additional source of recharge of the shallow aquifer along the edge of water bodies and during periods of high tide. It is assumed that shallow groundwater flow follows topography and discharges into local water bodies.

The lower and middle sands of the Patapsco Formation and the Patuxent Formation of the Potomac Group are the principal aquifers for domestic use at the IHDIV-NSWC. The upper sands of the Patapsco Formation are poor producers of groundwater in the area and are not considered to be an important aquifer. The upper sands are considered to be a confining layer above the underlying middle and lower sand aquifers in the area and below the shallow, small-scale, surficial water-bearing zones. The middle sand aquifer is believed to be hydraulically connected to the Potomac River, where the river has eroded into the aquifer. Potomac River water may be partially recharging the aquifer in this area because of the heavy pumping of supply wells at Indian Head (Hiortdahl, 1990).

Potable water wells at IHDIV-NSWC are screened in one or more sand zones to an average depth of 200 to 300 feet. These potable water wells serve an approximate population of 3,350 people, including civilian and enlisted Navy employees and contractor employees. None of these wells supply reserves or residences beyond the facility boundaries.

3.6 POPULATION AND LAND USE

IHDIV-NSWC is located in the northwestern section of Charles County, Maryland, approximately 25 miles south of Washington, DC. IHDIV-NSWC 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. 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.

The population of IHDIV-NSWC is approximately 3,300 (E/A&H, 1994). It includes 2,000 employees, 1,000 contracted employees, 100 Strauss Avenue residents, and 200 Bachelor Enlisted Quarters residents. The population of the town of Indian Head is approximately 3,806. Based on the 1998 U.S. Census Bureau estimates, the total population of Charles County is 117,963. The town of Indian Head is primarily residential, with a business corridor located along Maryland Route 210. Tourism comprises a significant portion of the local commerce, because Indian Head is located near some of the best fishing locations on Mattawoman Creek.

3.7 ECOLOGY

The information in this section was extracted from the Initial Assessment Study (IAS) report (Hart, 1983), except where noted.

3.7.1 Flora

Approximately 35 percent of IHDIV-NSWC is wooded. The forests consist of hardwoods, including oak and hickory, and loblolly and Virginia pines. The upland areas are characterized by older growth of pine and oaks, and the lower elevations are composed of sycamore, ash, elm, and sweet gum.

About 53 percent of IHDIV-NSWC is open field and shrub vegetation. Loblolly pine, sweet gum, red cedar, and black locust are typical of these communities.

Along the shoreline and beaches of the Potomac River, black persimmon, false indigo, poison ivy, sea myrtle, grape, and Virginia creeper are present along with phlox, gama grass, panic grass, Bermuda grass, or finger grass. Marsh areas predominate along the shores of Mattawoman Creek. They are characterized by jewelweed, alger, marsh cattail, weedgrass, sedge, three square bulrush, wild rice, saltmarsh cordgrass, smartweek, and marsh mallow.

3.7.2 Wildlife

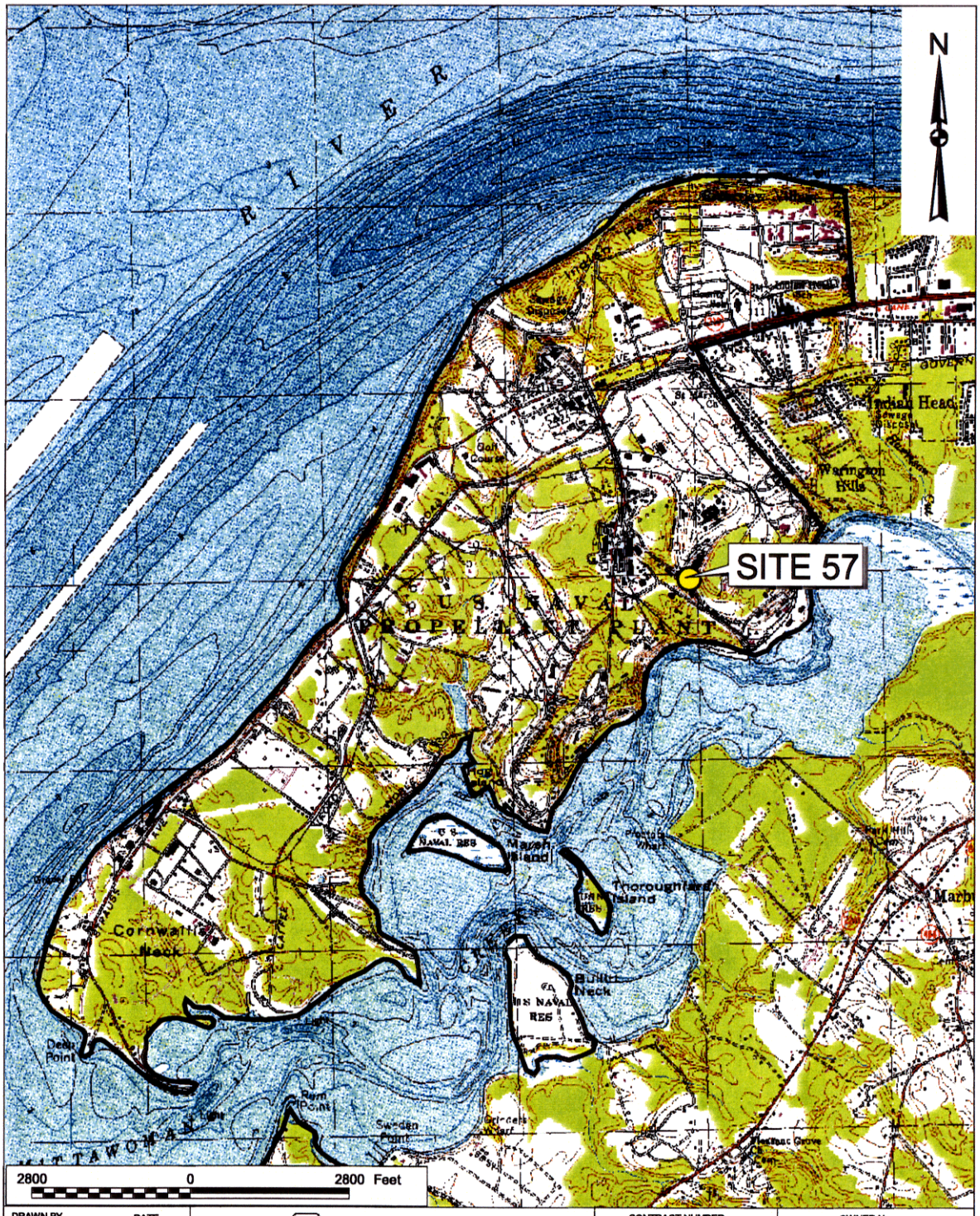
The ecosystem at IHDIV-NSWC supports a variety of animal life, including an abundant white-tailed deer population. Other common mammals include possum, bats, squirrels, mice, raccoon, woodchuck, rabbits, skunks, and other burrowing rodents, such as voles and shrews. The birds found within Charles County include grebes, herons, ducks, geese, hawks, kestrels, osprey, eagles, owls, gulls, and perching birds, such as robins, warblers, and jays. Common reptiles and amphibians of Charles County include lizards, snakes, turtles, salamanders, frogs, and toads.

3.7.3 Aquatic Life

The area of the Potomac River adjacent to IHDIV-NSWC is part of the spawning and nursery area for striped bass, white perch, herrings, and shad. Bay anchovies and three species of silversides also spawn and nurse within this area. The area is the upstream limit of the nursery area for estuarine-dependent species, including the Atlantic menhaden and Atlantic croaker. Mattawoman Creek is a spawning area for blueback herring, white and yellow perch, and gizzard shad.

3.7.4 Threatened and Endangered Species

Several rare, threatened, and endangered species of plants and animals occur on or near IHDIV-NSWC. A rare, threatened, and endangered species and natural protection area (sensitive or rare habitat) survey was performed at IHDIV-NSWC by the Maryland Natural Heritage Program in 1992. A comprehensive list of the species observed by Maryland Department of Natural Resources (MDNR) is provided in their survey report (MDNR, 1992).



DRAWN BY T. BECKMAN	DATE 6/13/99	Tetra Tech NUS, Inc.	CONTRACT NUMBER — / OWNER No. —
CHECKED BY G. LATULIPPE	DATE 6/15/99	INDIAN HEAD PENINSULA INDIAN HEAD DIVISION NSWC INDIAN HEAD, MARYLAND	APPROVED BY G. LATULIPPE / DATE 6/15/99
COST/SCHEDULE-AREA			APPROVED BY — / DATE —
SCALE AS NOTED			DRAWING No. FIGURE 3-1 / REV 0

P:\GIS\NSWC_INDIAN_HEAD\RI_FIGURES.APR 6/13/99 FIG 3-1 LAYOUT

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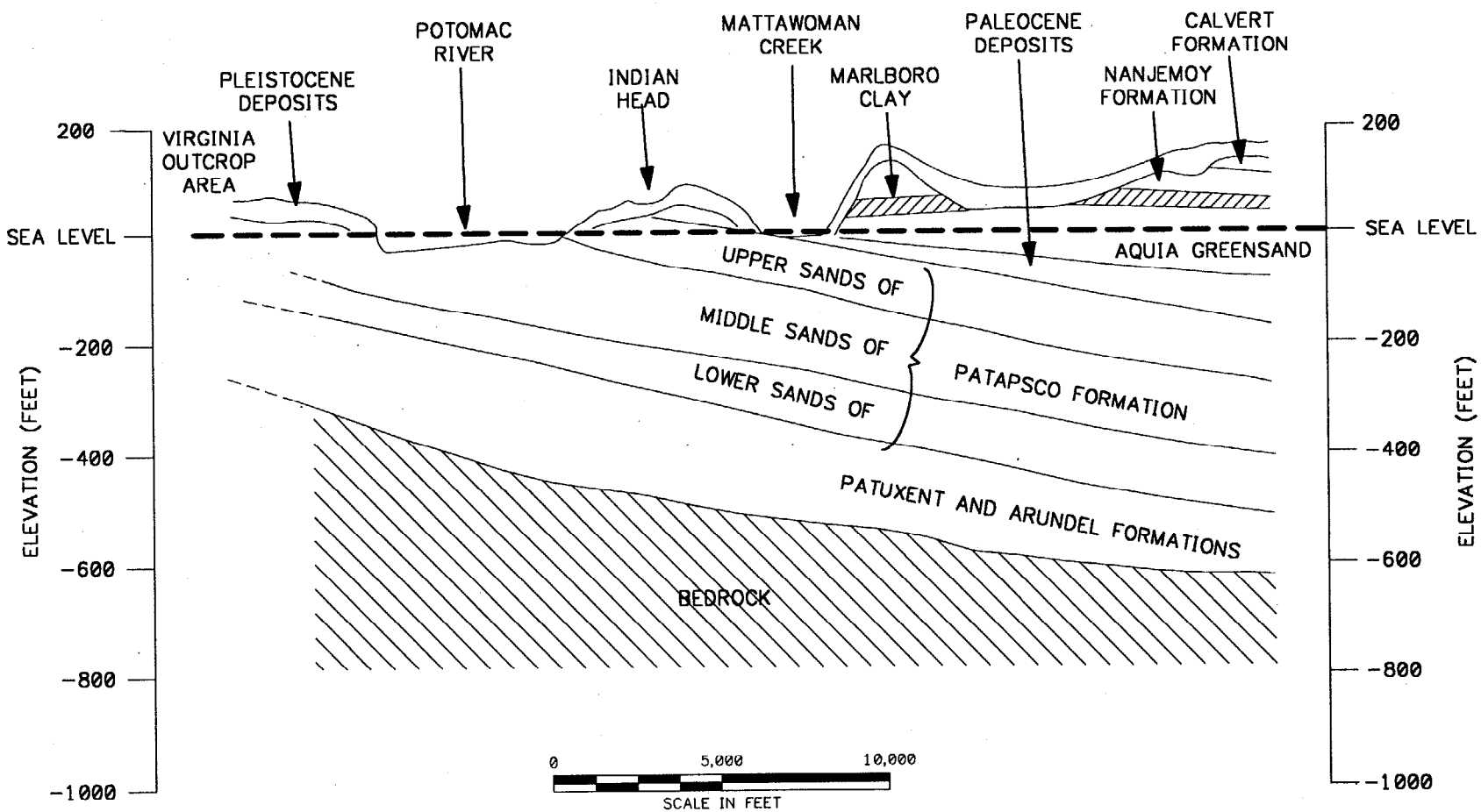


DRAWN BY HJP DATE 6/14/99	Tetra Tech NUS, Inc.	CONTRACT NO. 7129	OWNER NO. ———
CHECKED BY GJL DATE 2/1/00	GENERALIZED CROSS-SECTION OF THE REGION IHDIV-NSWC, INDIAN HEAD, MARYLAND	APPROVED BY GJL	DATE 2/1/00
COST/SCHED-AREA		APPROVED BY	DATE
SCALE AS NOTED		DRAWING NO. FIGURE 3-2	REV. 0

FORM CADD NO. TtNUS_AH.DWG - REV 0 - 1/22/98

4.0 SITE 57 BACKGROUND

4.1 SITE 57 HISTORY

Site 57 has been the subject of several investigations of potential environmental contamination. The following describes the chronology of past events connected with Site 57:

- February and May 1994 - TCE was detected in a water sample from the storm sewer at IW80.

- July 1994 - Water samples from storm sewer locations located upgradient and downgradient of Building 292 were analyzed for TCE. The downgradient samples were found to contain TCE.

- September 1995 - soil-gas, soil, groundwater, and storm water samples were collected from Site 57 to verify the presence of TCE. The presence of TCE was verified (B&R Environmental, 1997b).

- October 1996 - A draft Engineering Evaluation/Cost Assessment (EE/CA) document was prepared to determine the most effective approach to address TCE contamination in soil. The document recommended application of the soil vapor extraction (SVE) technology.

- September 1997 - A SVE pilot study was conducted at Site 57 to verify the suitability of the site for application of SVE technology. The pilot study demonstrated that the site is not suitable for SVE (B&R Environmental, 1997b).

- February 1998 - A final EE/CA (B&R Environmental, 1998a) was prepared to evaluate approaches for mitigating the presence of TCE in the discharge through the 24-inch storm sewer as identified in samples collected during previous field work. The final EE/CA recommended rehabilitation of the storm sewer.

- March 1998 - The draft final Site 57 RI work plan (B&R Environmental, 1998b) was prepared to describe the field investigation of Site 57.

- October 1998 - The first sampling event for the Site 57 RI was performed.

- October 1998 - The Site 57 storm sewer was relined between manholes MH-427 and MH-487.

- January 1999 - The second sampling event for the Site 57 RI was performed.

- September 1999 - Round 2 sampling of the Site 57 storm sewer was performed.

4.2 HISTORICAL ENVIRONMENTAL DATA

4.2.1 Investigations by IHDIV-NSWC Personnel

TCE was first detected in connection with Site 57 in February 1994, at 53 micrograms per liter (µg/L, equivalent to parts per billion, ppb) at the industrial wastewater/stormwater outfall designated IW-80 (see Figures 4-1 and 4-2). This location is approximately 1,300 feet south of Building 292 and serves the drainage basin that includes Building 292. This initial sampling was conducted because of an odor reported at IW-80. A sample collected from the same outfall in May 1994 detected 60.2 µg/L TCE. The Navy notified the Maryland Department of the Environment (MDE) of the TCE discharge and submitted a revised National Pollutant Discharge Elimination System (NPDES) permit application on November 4, 1994, to MDE, requesting approval of a 100 µg/L TCE discharge limit. The application was subsequently approved.

Since May 1994, the Navy has conducted several rounds of storm sewer sampling for TCE in an attempt to locate the source of this chemical. The results of the sampling efforts are summarized below:

- July 12, 1994 - Sample results did not detect TCE or any other volatile organic priority pollutants at three sampling points upstream from Building 292 (Sampling Points 1, 2, and 3 on Figure 4-2).

- July 27, 1994 - Sample results did not detect TCE upstream of Building 292 but did detect TCE at MH-1 (62 µg/L) immediately downstream from the building and more than 1,300 feet downstream from the building at IW-80 (47 µg/L) (Sampling Points 4 and 5, Figure 4-2). No other volatile organic priority pollutant was detected.

On November 2, 1994, Halliburton NUS Corporation (now Tetra Tech NUS, Inc.) conducted an extensive site visit of the Building 292 area. The results of the physical observation and detailed description of the site are provided in the Abbreviated Field Sampling Plan (B&R Environmental, 1995b).

4.2.2 Subsurface Investigation

This section discusses the analytical results from the samples collected during the subsurface field investigation conducted on September 26, 1995 and as presented in the subsequent report entitled Data Report (B&R Environmental, 1996a).

4.2.2.1 Soil-Gas Analytical Results

Soil-gas sampling locations and the field TCE analytical results are shown on Figure 4-3. The soil gas data confirm the presence of TCE in the vadose zone, with the point of apparent highest concentration located approximately 30 feet southwest of the southern corner of Building 292 (SG-07 on Figure 4-3).

The soil-gas sampling points exhibiting the highest TCE concentrations were SG-02 at 3,200 µg/L, SG-07 at 9,600 µg/L, and SG-10 at 2,500 µg/L. The first non-detect soil-gas sample along the north-south axis, as reported in the field, was SG-06.

4.2.2.2 Soil Data

Nine subsurface soil samples were collected at four different sampling locations. The soil samples were collected close to the soil-gas sampling points so as to be essentially the same locations. Table 4-1 displays the soil data but limits the presentation to detected soil contaminants. This table also presents EPA Region III Risk-Based Concentrations (RBCs). Figure 4-4 illustrates the location of the samples containing the detected concentrations.

Concerning regulatory compliance, emphasis was placed on the EPA Soil Screening Level (SSL) for TCE concentrations in soil that may result in sufficient contaminant migration to groundwater. From the soil data analytical results, the EPA SSL of 60 µg/kg TCE concentration was exceeded by a single deep soil sample, SO-10-10/12 (150 µg/kg), which was collected at SG-07, the location exhibiting the greatest TCE concentration in soil gas (9,600 µg/L) and the second highest in surface soil (9,300 µg/kg). The 60 µg/kg TCE concentration was exceeded by all the shallow soil samples collected.

One shallow sample, SO-07-2/4, at location SG-02, exhibited a TCE concentration in excess of the RBCs for the industrial soil ingestion value as shown in Table 4-1. None of the other soil samples exceeded RBC values, including SO-09-2/4, which is located approximately 25 feet downgradient from SO-07-2/4.

Data from the deeper soil samples (10 to 12 feet below ground surface) indicate that TCE contamination in deeper soil may be very localized. The TCE concentration in the deep soil sample collected at location SG-07 (SO-10-10/12) exceeded the SSL for protection of groundwater, but the same criterion was not exceeded by the deep soil samples from locations SG-02 (SG-08-10/12) and SG-10 (SO-13-10/12), which are approximately 25 feet west and 20 feet south, respectively, from SG-07. This indicates that deep soil with TCE concentrations exceeding the SSLs for protection of groundwater may be limited to a radius of approximately 25 feet from location SG-07. Shallow soil samples SO-09-2/4 and SO-07-2/4 collected from locations SG-07 and SG-02, respectively, also exceeded the TCE SSL for transfer from soil to air.

The fact that the shallow soil TCE concentrations were consistently higher than the groundwater protection SSL and the deep soil TCE concentrations were not as high seems to indicate that the potential migration of TCE to the deeper soil occurs at a very slow rate. The analytical evidence indicated that TCE contamination has not migrated to the deeper soil (again, with the exception of SG-07) at a rapid rate.

4.2.2.3 Groundwater Data

Data were collected at Site 57 for both groundwater and storm water media. The full set of data was presented and evaluated in the Data Report (B&R Environmental, 1996a). Table 4-2 summarizes analytical results for detected contaminants. The table also presents the EPA Region III RBCs for tap water, along with the EPA Ambient Water Quality Criteria (AWQC), the federal MCLs and Maximum Contaminant Level Goals (MCLGs) under the National Primary Drinking Water Standard, and the state of Maryland MCLs. Figure 4-5 illustrates the locations that were the sources of the samples containing the detected concentrations. The groundwater sample collection points were intentionally placed close to the soil-gas sampling points so as to be essentially the same locations.

Two groundwater samples were collected from Site 57 during the soil gas investigation. One (GW-11-11) was collected at location SG-07 (the location exhibiting the greatest TCE concentration in soil gas (9,600 µg/L) and the second highest was in soil (9,300 µg/L). GW-14-13 was collected from the second location, SG-05, located approximately 50 feet north of the point of lowest TCE concentration in soil gas (SG-06). As described in the Data Report (B&R Environmental, 1996a), attempts to collect a groundwater sample from SG-06 were unsuccessful.

Of the contaminants detected in GW-11-11 (see Table 4-2), only 1,1-DCA did not exceed regulatory criteria. At 260 µg/L in GW-11-11, 1,1,1-TCA did not exceed EPA Region III RBC or the AWQC, but it did exceed the federal MCL and MCLG and the State MCL, all of which were set at 200 µg/L. Other contaminants detected in GW-11-11 all exceed the regulatory criteria, especially TCE, with a concentration of 370,000 µg/L.

The only contaminant detected in GW-14-13 was 3 µg/L of TCE. None of the other contaminants detected in GW-11-11 were found in GW-14-13. The 3 µg/L TCE concentration exceeded EPA's RBC, the AWQC, and the National Primary Drinking Water Standard MCLG but not the federal or the state MCLs.

4.2.2.4 Storm Water Data

Table 4-2 also shows analytical results for the two storm water samples collected from manhole MH-1. One sample (SW-01-04) was collected from the upper pipe in this manhole and the other (SW-02-09) was collected from the lower pipe. Sample SW-01-04 contained 7 µg/L of 1,2-DCE (total) and 39 µg/L of TCE. The latter concentration exceeded all the regulatory criteria shown in Table 4-2. The TCE level detected in SW-02-09 was 2 µg/L, which exceeded the EPA Region III RBC for tap water and the federal MCLG.

4.2.3 Soil Vapor Extraction Pilot Study

A pilot-scale SVE investigation (B&R Environmental, 1997b) was conducted at Site 57 to evaluate the effectiveness and implementability of SVE for reducing TCE concentrations in the unsaturated soils (vadose zone) and determine the following performance criteria:

- Could TCE-contaminated air contained in the unsaturated soils be collected through a vertical well screen installed in the vadose zone?

- Could an air circulation pattern be established in the vadose zone, by induced vacuum, that would promote additional volatilization of TCE currently sorbed to the unsaturated soil?

- Measured from the air extraction well, what is the horizontal limit of vacuum within the vadose zone for four different vacuum levels? And does this limit increase with increasing vacuum levels?

The pilot-scale SVE system consisted of one extraction well screened at a depth of 6 to 10 feet below the ground surface. Twelve drive port monitoring wells were used to evaluate the effect of the various air flow rates. The results of the study were presented in the Findings Report Pilot-Scale Soil Vapor Extraction Study (B&R Environmental, 1997b).

The pilot-scale SVE system was installed and operated over a 2-day period. Four different vacuum levels were produced within the air extraction well by the vacuum system. These vacuum levels and the corresponding air flow rates were monitored at several locations within the pilot-scale system. Air samples were collected at several locations in the pilot-scale system and analyzed on site for concentrations of 1,1-DCE, 1,2-DCE, TCE, and TCA, and the results were presented in the Findings Report (B&R Environmental, 1997b).

Four different vacuum levels (15 inches of water, 30 inches of water, 45 inches of water, and 60 inches of water) were produced within the air extraction well during the 2 days of testing. At all four vacuum settings, the vacuum induced within the unsaturated soil was detected only at drive point probe A4, which

was located 4.25 feet horizontally from the air extraction well and approximately 2 feet above the top of the air extraction well screen (4 feet bgs). No detectable vacuum was measured at probe F4, which was located at relatively the same horizontal (6.5 feet) and vertical (2 feet) distances from the air extraction well screen but at a 90-degree offset to the extraction well-probe A4 axis. Vacuum levels were not detected in any of the other probes at any of the four vacuum settings. The horizontal limit of the vacuum detected within the unsaturated soil did not increase as greater vacuum levels were applied to the air extraction well.

The lack of vacuum transfer through the subsurface soil at all four vacuum settings may have been caused by the presence of a moist clay lens between 6 feet bgs and 8 feet bgs or the saturated conditions of the subsurface soil surrounding the air extraction well screen between 8 feet and 10 feet bgs.

As an additional test of subsurface conditions prior to the end of pilot testing, the field team raised the bottoms of drive point monitoring probes A8 and F8 from 8 feet bgs to 6 feet bgs after operating the SVE system at vacuum of 60 inches water for 45 minutes. Once again, with the bottom of these two probes at the new, shallower soil depth, no vacuum levels were detected at A8 and F8.

Based on the vacuum and air flow monitoring results and analytical results for air samples collected from various locations in the pilot-scale SVE system, the following conclusions can be made:

- TCE-contaminated air contained in the unsaturated soils was collected through the vertical well screen of the air extraction well. However, a moist clay lens located between 6 feet bgs and 8 feet bgs and an unexpectedly high water table located between 8 feet bgs and the base of the well screen inhibited air flow through the subsurface soils and consequently inhibited collection of volatilized contaminants.

- Because of the moist clay layer and the unexpectedly high water table, only a minimal air circulation pattern could be established in the subsurface soils that would allow additional volatilization of TCE currently sorbed to the contaminated soils. Contaminated soils contained in the moist clay layer and the saturated soil underlying the clay later received minimal air treatment.

- Vacuum level increases in the air extraction well from 15 inches of water to 60 inches of water did not produce proportional increases in the horizontal or vertical extensions into the subsurface soil of the applied vacuum. This inhibited horizontal and vertical extension of the well vacuum into the subsurface soil may be attributed to the moist clay layer and the unexpectedly high water table.

Therefore, it was concluded that the subsurface conditions at Site 57, as experienced during this pilot study, are not well suited to the application of the SVE technology.

4.2.4 Engineering Evaluation/Cost Assessment (EE/CA)

The EE/CA was prepared to develop, evaluate, and select a non-time-critical removal action for the impacted soil and groundwater, because the Navy, as the lead agency, determined that a Removal Action under CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act) was appropriate for the contaminated soil and groundwater present at Site 57.

The removal action evaluation was developed to address the specific media impacted. The alternatives developed for soil and the alternatives developed for groundwater are presented in the following paragraphs.

Soil

EPA has established presumptive remedy guidance (OSWER Directive No. 9355.0-47FS) for streamlining site investigations and remediating sites. Presumptive remedies are remediation technologies identified by EPA as having a history of success when applied to certain situations characterized by common combinations of environmental media and contaminants. The presumptive remedies for VOCs in soil in order of preference are SVE, thermal desorption, and incineration. The OSWER directive indicates that primary consideration should be given to SVE. If site conditions are not conducive to SVE (i.e., low-permeability soils), then thermal desorption should be evaluated, followed by consideration of incineration. In accordance with presumptive remedy guidance, the following removal action alternatives were developed to address impacted soil:

- Alternative 1: No-Action
- Alternative 2: In-Situ Soil Vapor Extraction
- Alternative 3A: Excavate Soil Exceeding EPA Soil Screening Levels; On-Site Thermal Desorption; Backfilling; Restoration
- Alternative 3B: Excavate Soil "Hot Spots"; On-Site Thermal Desorption; Backfilling, Restoration
- Alternative 4A: Excavate Soil Exceeding U.S. EPA Region III Soil Screening Levels; Off-Site Incineration; Backfilling; Restoration
- Alternative 4B: Excavate Soil "Hot Spots"; Off-Site Incineration; Backfilling, Restoration

An analysis of these removal alternatives was conducted. Alternative 2 was determined to be not technically feasible as a result of the pilot-scale SVE study conducted in April 1997 at Site 57 (B&R Environmental, 1997b) that concluded that the subsurface soil conditions at Site 57 are not well suited to the application of the SVE technology. Alternatives 3 and 4 are technically feasible. The present-worth cost associated with these alternatives are as follows: Alternative 1 - no cost, Alternative 2 - no cost

analysis performed because the alternative is not implementable, Alternative 3A - $2,970,000, Alternative 3B - $997,000, Alternative 4A - $20,600,000, and Alternative 4B - $1,910,000.

Groundwater

The selection of removal action alternatives for groundwater differed from the approach taken for soil. Initially, a preliminary screening of groundwater technologies was conducted to eliminate process options not suited for use at Site 57. The remedial technologies and process options that passed the preliminary screening were evaluated in detail based on the criteria of effectiveness, implementability, and cost. Based on this approach, the following removal action alternatives for groundwater were developed:

- Alternative 1: No-Action.
- Alternative 2: Storm Sewer System Rehabilitation.
- Alternative 3: In-Situ Air Sparging with Off-Gas Treatment.
- Alternative 4: Groundwater Extraction/Treatment (air stripping with off gas treatment or enhanced oxidation)/Discharge.

As with soils, a comparative analysis was conducted to evaluate these alternatives in order to select a recommended removal action alternative. The present-worth costs associated with these alternatives are as follows: Alternative 1 - no cost, Alternative 2 - $668,297, Alternative 3 - $1,895,773, Alternative 4 - $1,128,031 for the air stripping/off gas treatment option or $1,491,235 for the enhanced oxidation option.

Based on the identification and comparative analysis of removal action alternatives for soil and groundwater, the recommendations made in the EE/CA for a removal action were identified as follows:

- At this time (EE/CA preparation), conduct no further action for site soil until the nature and extent of soil contamination are more clearly defined during the RI (this document).

- Perform a storm sewer system rehabilitation to mitigate the infiltration of contaminated groundwater into the storm sewer and eliminate VOC discharge at IW-80. Conduct no further action for site groundwater until the nature and extent of groundwater contamination are more clearly defined during the RI.

4.3 DEGRADATION OF TCE

TCE degrades in the environment to form cis-1,2-dichloroethene (1,2-DCE), trans-1,2-DCE, 1,1-dichloroethene (1,1-DCE), and 1,2-dichloroethane (1,2-DCA). These compounds can subsequently degrade to form vinyl chloride and chloroethane. The presence of vinyl chloride in contaminated soil and

groundwater is usually indicative of a TCE discharge that occurred many years ago. Technical-grade TCE contains 3.5 percent, by weight, 1,1,1-trichloroethane (1,1,1-TCA), as well as chloroform, carbon tetrachloride, and other priority pollutants.

1,1,1-TCA degrades in the environment to form 1,1-DCE, 1,1-dichloroethane (1,1-DCA), vinyl chloride, and/or chloroethane. The presence of the last two compounds in contaminated soil and groundwater is usually indicative of an older 1,1,1-TCA discharge. Impurities in commercial-grade 1,1,1-TCA are normally below a concentration of 250 milligrams per liter (mg/L), by weight.

TABLE 4-1

SOIL ANALYTICAL RESULTS AND REGULATORY CRITERIA AND GUIDANCE[1]
FIELD INVESTIGATION CONDUCTED SEPTEMBER 26, 1995
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

	SOIL ANALYTICAL RESULTS									REGULATORY CRITERIA AND GUIDANCE			
Sample Number	SO-01-2/4	SO-05-10/12	SO-06-2/4	SO-07-2/4	SO-08-10/12	SO-09-2/4	SO-10-10/12	SO-12-2/4	SO-13-10/12	U.S. EPA Region III[2]		EPA[3]	
Corresponding Soil-Gas Sample	(SG-06)	(SG-06)	(SG-06)	(SG-02)	(SG-02)	(SG-07)	(SG-07)	(SG-10)	(SG-10)	Risk Based		Soil Screening Levels (SSL) -	
										Concentrations (RBCs)		Transfers from Soil to:	
										Soil Ingestion			
Depth Below Grade (Feet)	(2 to 4)	(10 to 12)	(2 to 4)	(2 to 4)	(10 to 12)	(2 to 4)	(10 to 12)	(2 to 4)	(10 to 12)	Residential	Industrial	Air	Groundwater[4]
Units	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
ACETONE	160 J	99 J	150 J	85 J	82 J	B	ND	B	B	7,800,000	200,000,000	100,000,000	16,000
1,2-DICHLOROETHENE (TOTAL)	18	ND	14	37,000	ND	36	15	10 J	ND	700,000	18,000,000	1200000[5]	400[5]
1,1,1-TRICHLOROETHANE	ND	ND	ND	ND	ND	10	4 J	5 J	ND	1,600,000	41,000,000	1,200,000	2,000
TRICHLOROETHENE	140[6]	3 J	220	840,000	4 J	9,300 J	150	120	ND	58,000	520,000	5,000	60

NOTES:

J = Estimated value.

B = Positive result is considered to be an artifact of blank contamination, and should not be considered present.

ND = Not Detected

1 Source document: B&R Environmental, 1996A.

2 EPA, 1997c.

3 EPA, 1996c.

4 Groundwater SSL is based on a dilution attenuation factor of 20.

5 Values are for cis-1,2-dichloroethene.

6 Shaded Soil Analytical Results exceed one or more regulatory criteria and guidance values.

TABLE 4-2

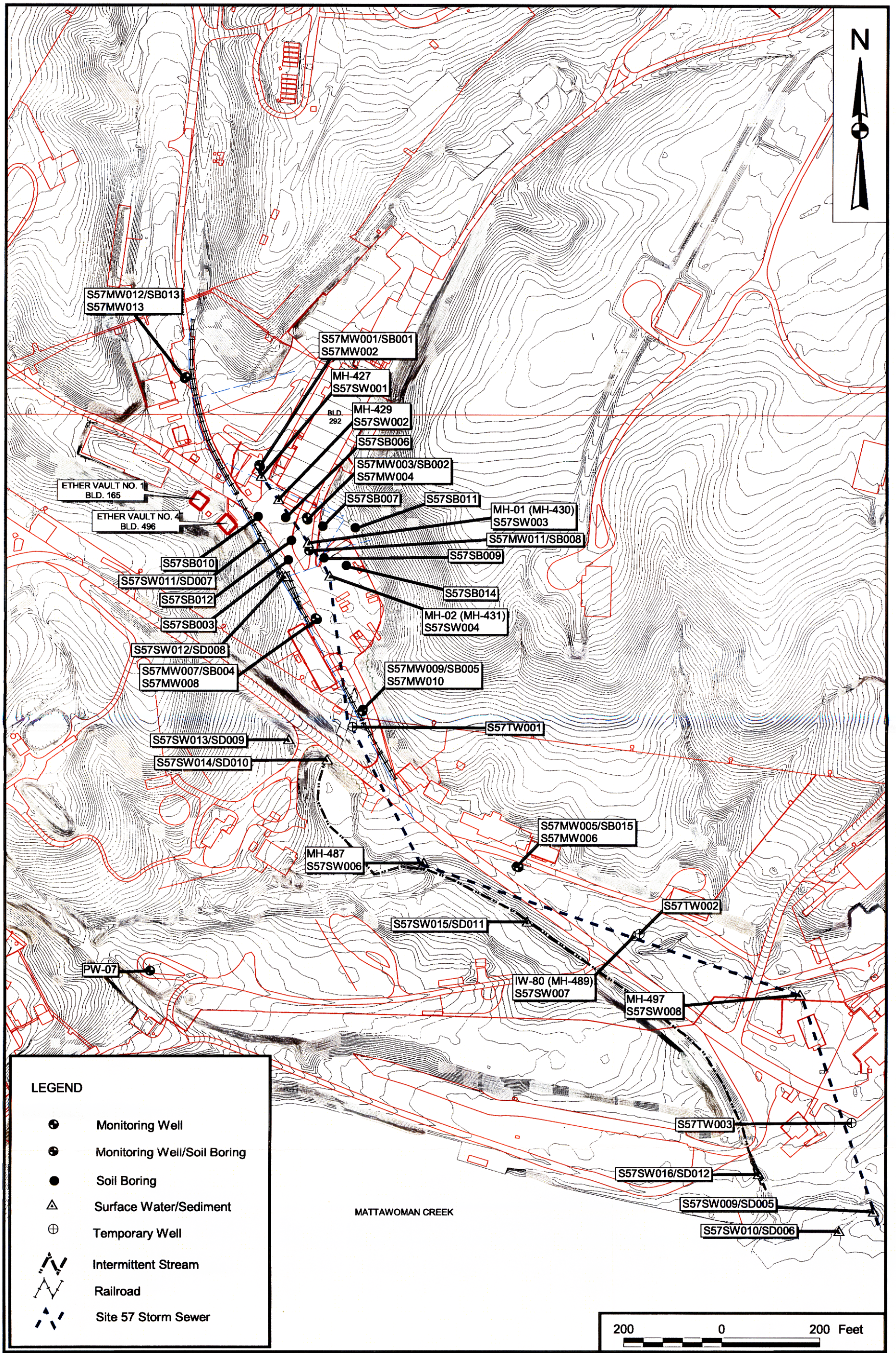
WATER ANALYTICAL RESULTS AND REGULATORY CRITERIA AND GUIDANCE[1)]
FIELD INVESTIGATION CONDUCTED SEPTEMBER 26, 1995
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

GROUNDWATER AND STORM WATER ANALYTICAL RESULTS					REGULATORY CRITERIA AND GUIDANCE						
Sample Number	GW-11-11	GW-14-13	SW-01-04	SW-02-09	U.S. EPA Region III (3)	EPA - Ambient	National Primary Drinking Water Standard				State of Maryland
Corresponding Soil-Gas Sample	SG-07	SG-05	MH #1	MH #1	Risk Based	Water Quality	Maximum		Maximum		Maximum
					Concentrations (RBCs)	Criteria (4)	Contaminant		Contaminant Level		Contaminant
Depth Below Grade (Feet)	11	13	N/A (2)	N/A	Tap Water	(AWQC)	Level (MCL) (5)		Goal (MCLG) (6)		Level (MCL) (7)
Units	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	Status	ug/L	Status	ug/L
VINYL CHLORIDE	2000[13)]	ND (8)	ND	ND	0.019	2	2	F (9)	0	F	2
CHLOROETHANE	6	ND	ND	ND	3.6			L (10)		L	
1,1-DICHLOROETHENE	140	ND	ND	ND	0.044	0.057	7	F	7	F	7
1,1-DICHLOROETHANE	65	ND	ND	ND	810						
1,2-DICHLOROETHENE (TOTAL)	52,000	ND	7	ND	55		70 (12)	F	70 (12)	F	70 (12)
1,2-DICHLOROETHANE	5	ND	ND	ND	0.12	0.38	5	F	0	F	5
1,1,1-TRICHLOROETHANE	260	ND	B (11)	ND	540		200	F	200	F	200
TRICHLOROETHENE	370,000	3	39	2	1.6	2.7	5	F	0	F	5
1,1,2-TRICHLOROETHANE	108	ND	ND	ND	0.19	0.6	5	F	3	F	5
TETRACHLOROETHENE	61	ND	ND	ND	1.1	0.8	5	F	0	F	5

NOTES:

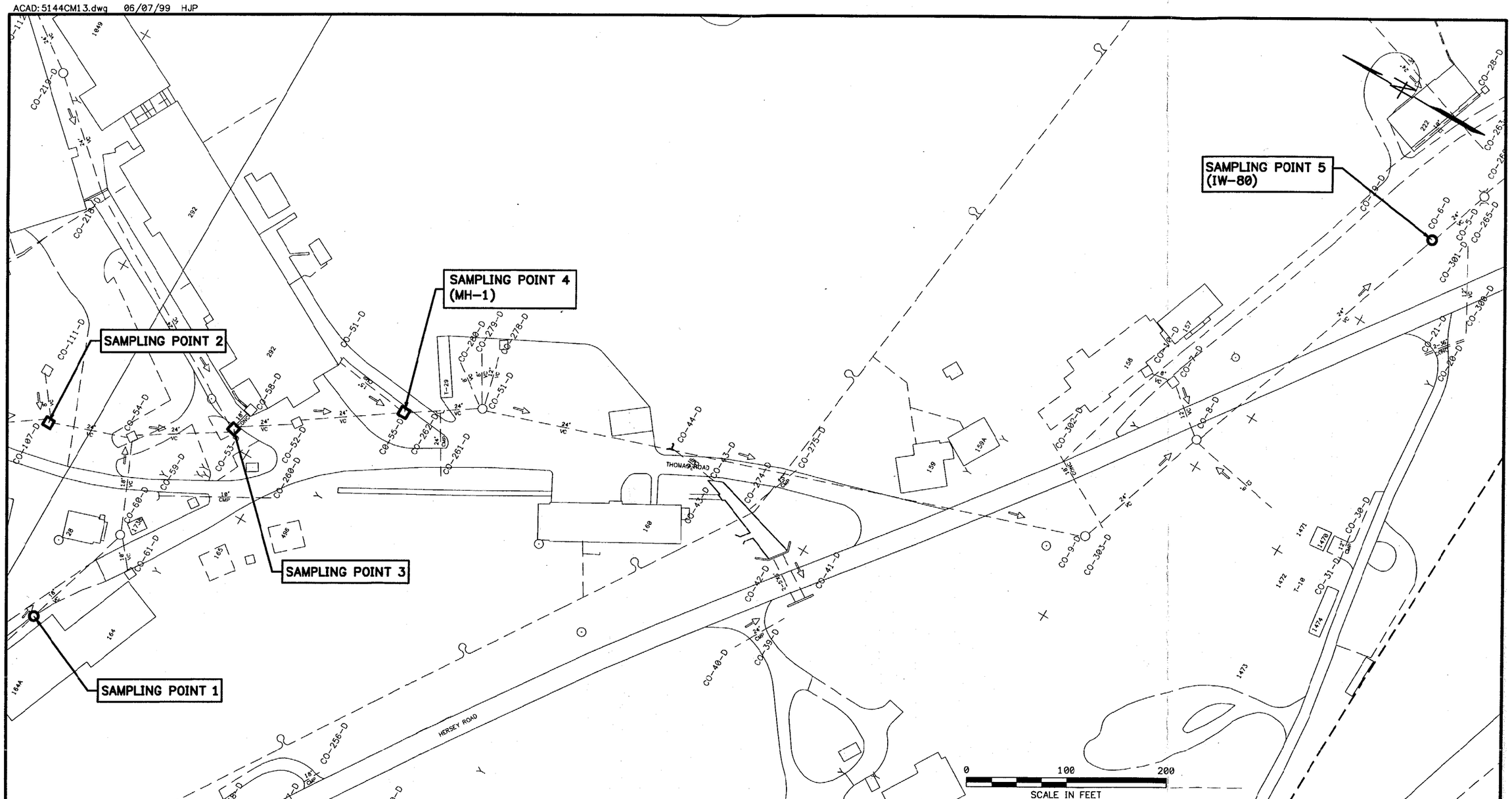
1 Source document: B&R Environmental, 1996a.
2 N/A = Not Applicable. Sample collected in a manhole.
3 EPA, 1997c.
4 40 CFR 131.36
5 40 CFR 141.61
6 40 CFR 141.50
7 Code of Maryland Regulation 26.04.01.07
8 ND = Not Detected
9 F = Final promulgated standard
10 L = Listed for regulation
11 B = Positive result is considered to be an artifact of blank contamination, and should not be considered present.
12 Value shown is applicable to the CIS isomer only.
13 Shaded Groundwater and Storm Water Analytical Results exceed one or more regulatory criteria and guidance values.

P:\GIS\NSWC_INDIAN_HEAD\7129_SITE57.APR\SITE CONDITIONS MAP JCB 2/4/00



DRAWN BY J. BELLONE — DATE 2/1/00	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7129	OWNER NUMBER —
CHECKED BY G. Latulippe — DATE 2/2/00	SITE CONDITIONS MAP SITE 57 - FORMER DRUM LOADING AREA NSWC INDIAN HEAD INDIAN HEAD, MARYLAND	APPROVED BY G. LATULIPPE	DATE 2/2/00
COST/SCHEDULE-AREA		APPROVED BY —	DATE —
SCALE AS NOTED		DRAWING NO. FIGURE 4-1	REV 0

ACAD: 5144CM13.dwg 06/07/99 HJP



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP DATE 6/7/99
CHECKED BY GJL DATE 2/1/00
COST/SCHED-AREA
SCALE AS NOTED

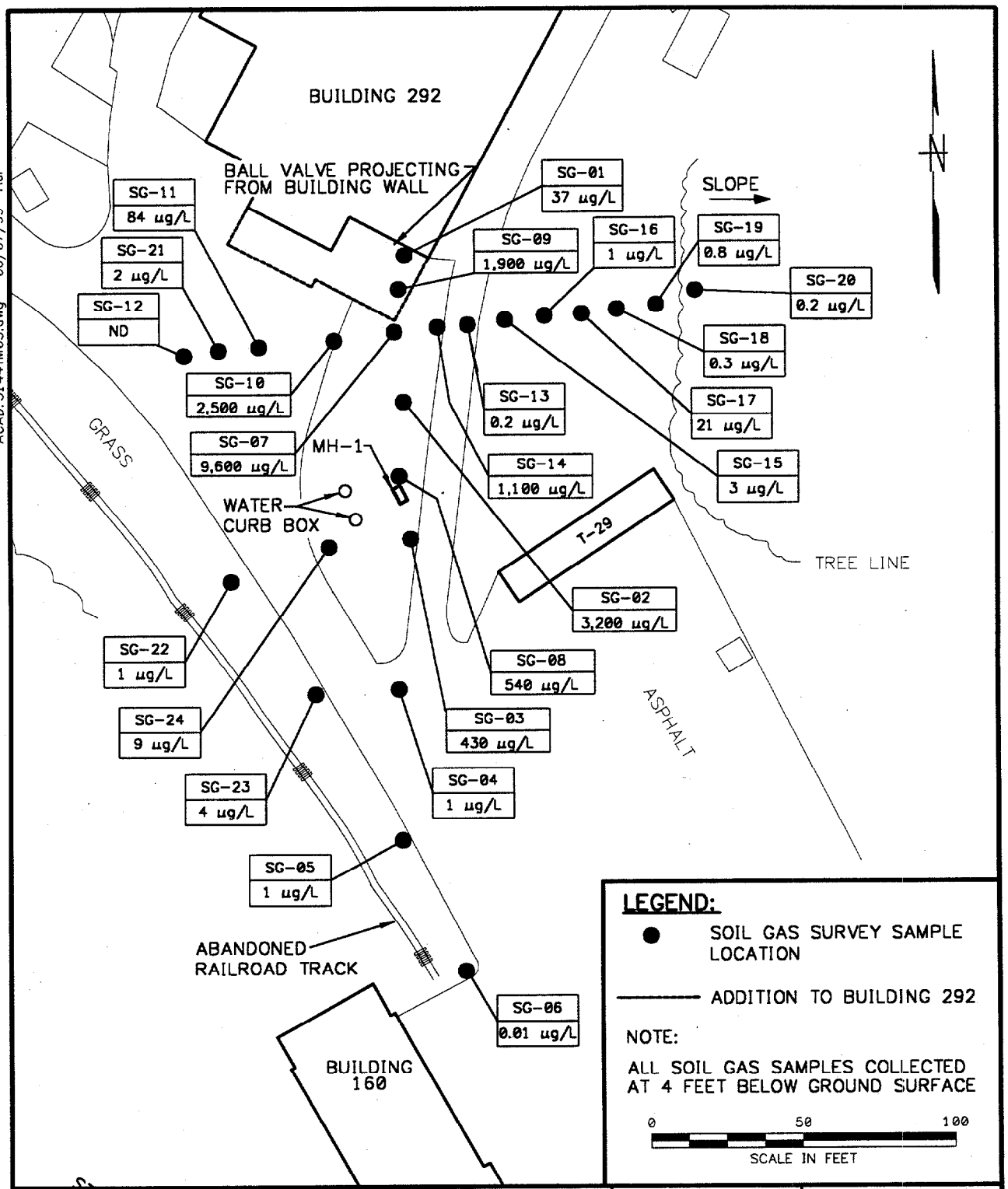
Tetra Tech NUS, Inc.

HISTORICAL INVESTIGATION SAMPLING POINTS
SITE 57-FORMER DRUM LOADING AREA
IHDIV-NSWC
INDIAN HEAD, MARYLAND

CONTRACT NO. 5144
OWNER NO. ———
APPROVED BY GJL DATE 2/1/00
APPROVED BY DATE
DRAWING NO. FIGURE 4-2
REV. 0

FORM CADD NO. T+NUS_BH.DGN - REV 0 - 1/20/98

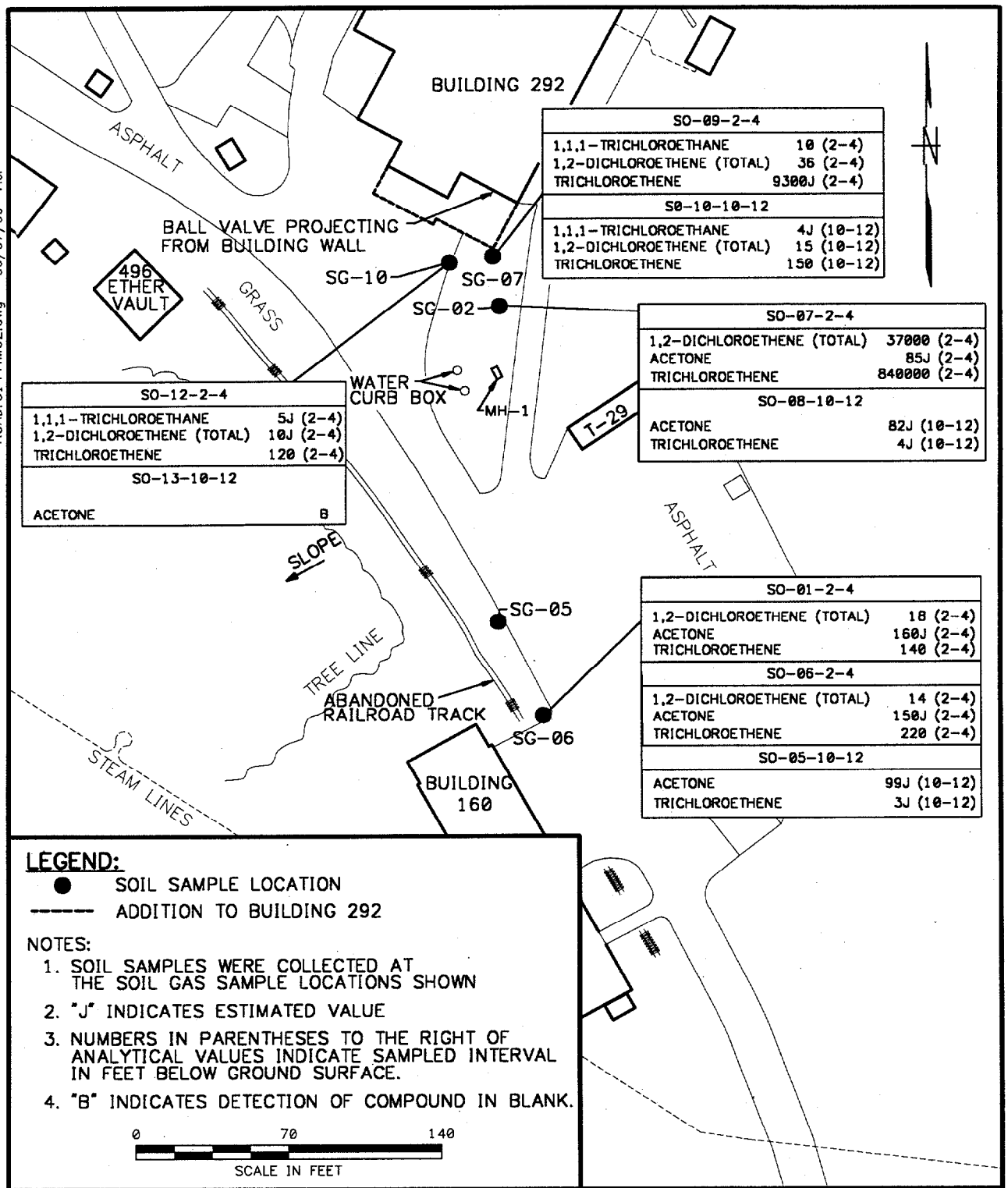
00668C042



ACAD: 5144TM03.dwg 06/07/99 HJP

DRAWN BY HJP DATE 6/7/99	Tetra Tech NUS, Inc.	CONTRACT NO. 5144	OWNER NO. ———
CHECKED BY GJL DATE 2/1/00	TCE SOIL GAS RESULTS SITE 57–FORMER DRUM LOADING AREA IHDIV–NSWC INDIAN HEAD, MARYLAND	APPROVED BY GJL	DATE 2/1/00
COST/SCHED–AREA		APPROVED BY	DATE
SCALE AS NOTED		DRAWING NO. FIGURE 4–3	REV. 0

FORM CADD NO. TtNUS_AV.DWG - REV 0 - 1/22/98

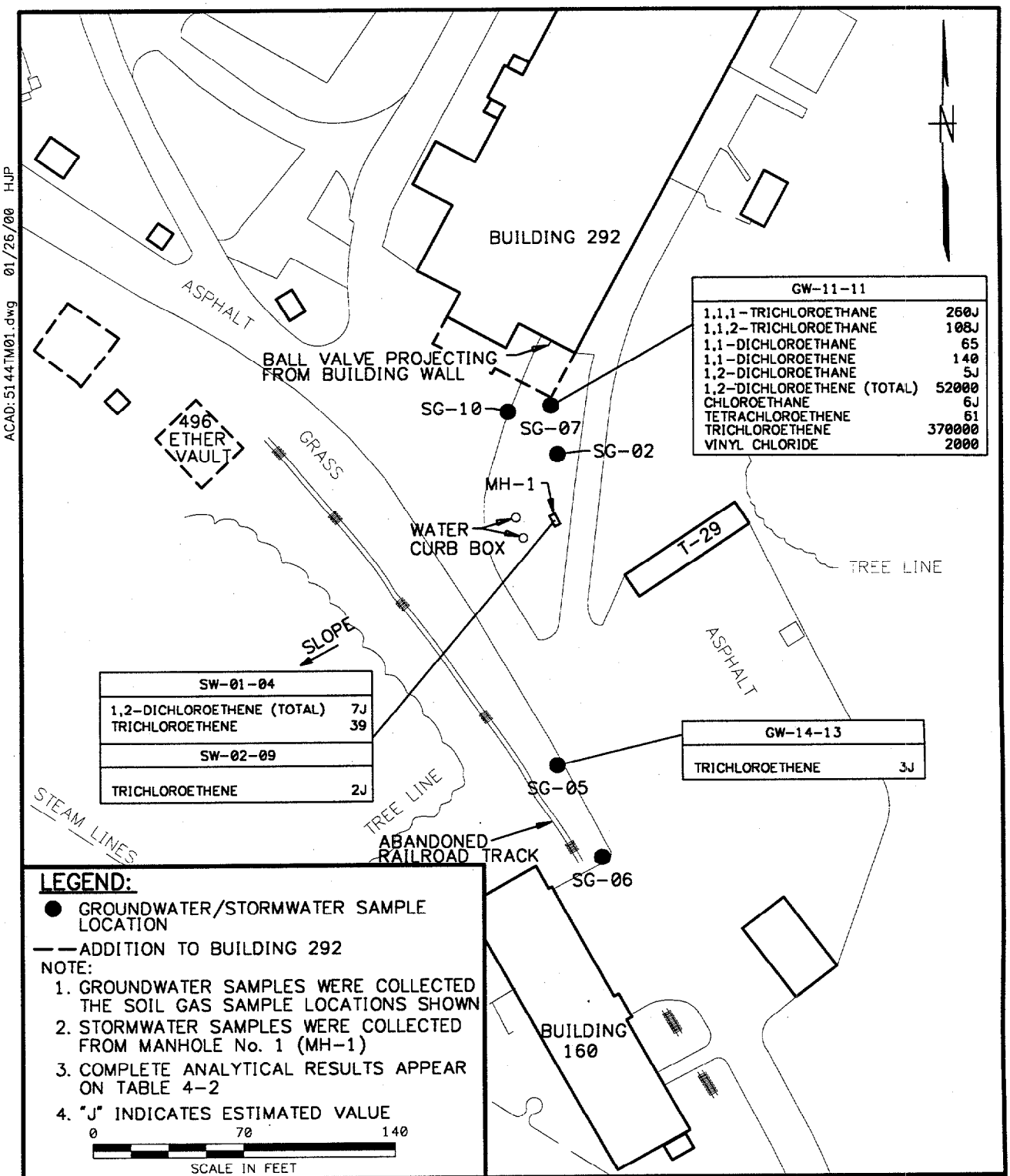


ACAD: 5144TM02.dwg 06/07/99 HJP

DRAWN BY HJP DATE 6/7/99	Tetra Tech NUS, Inc.	CONTRACT NO. 5144	OWNER NO. ———
CHECKED BY GJL DATE 2/1/00	DETECTED SOIL CONTAMINANTS (ug/kg) SITE 57-FORMER DRUM LOADING AREA IHDIV-NSWC INDIAN HEAD, MARYLAND	APPROVED BY GJL DATE 2/1/00	
COST/SCHED-AREA		APPROVED BY DATE	
SCALE AS NOTED		DRAWING NO. FIGURE 4-4	REV. 0

FORM CADD NO. TtNUS_AV.DWG - REV 0 - 1/22/98

ACAD:5144TM01.dwg 01/26/00 HJP



GW-11-11	
1,1,1-TRICHLOROETHANE	260J
1,1,2-TRICHLOROETHANE	108J
1,1-DICHLOROETHANE	65
1,1-DICHLOROETHENE	140
1,2-DICHLOROETHANE	5J
1,2-DICHLOROETHENE (TOTAL)	52000
CHLOROETHANE	6J
TETRACHLOROETHENE	61
TRICHLOROETHENE	370000
VINYL CHLORIDE	2000

SW-01-04	
1,2-DICHLOROETHENE (TOTAL)	7J
TRICHLOROETHENE	39
SW-02-09	
TRICHLOROETHENE	2J

GW-14-13	
TRICHLOROETHENE	3J

LEGEND:

● GROUNDWATER/STORMWATER SAMPLE LOCATION

— — ADDITION TO BUILDING 292

NOTE:

1. GROUNDWATER SAMPLES WERE COLLECTED THE SOIL GAS SAMPLE LOCATIONS SHOWN
2. STORMWATER SAMPLES WERE COLLECTED FROM MANHOLE No. 1 (MH-1)
3. COMPLETE ANALYTICAL RESULTS APPEAR ON TABLE 4-2
4. "J" INDICATES ESTIMATED VALUE

0 70 140

SCALE IN FEET

DRAWN BY HJP DATE 6/7/99	Tetra Tech NUS, Inc.	CONTRACT NO. 5144	OWNER NO. ————
CHECKED BY GJL DATE 2/1/00	DETECTED GROUNDWATER AND STORMWATER CONTAMINANTS (ug/L) SITE 57, FORMER DRUM LOADING AREA IHDIV-NSWC INDIAN HEAD, MARYLAND	APPROVED BY GJL	DATE 2/1/00
COST/SCHED-AREA		APPROVED BY	DATE
SCALE AS NOTED		DRAWING NO. FIGURE 4-5	REV. 0

FORM CADD NO. TtNUS_AV.DWG - REV 0 - 1/22/98

5.0 REMEDIAL INVESTIGATION FIELD ACTIVITIES

This section discusses the field activities performed at Site 57. The activities consisted of aquifer testing and sampling of surface soil, groundwater, sediment, and surface water for fixed-base laboratory analyses. The driller for all the field work was Hardin Huber, Incorporated. Figure 4-1 shows the current conditions of the site and sampling locations. Discussion of sampling methods is provided in Section 2.0. The sampling locations were established in the project-specific RI work plan (B&R Environmental, 1998b). Table 5-1 provides a summary of the Event I and Event II sampling program. Table 5-2 provides a more detailed summary of the sampling and analytical program and sampling depths. Sample log sheets are provided in Appendix A. Overall, the Event I and II field activities included the collection of 17 groundwater samples, 10 surface soil samples, 38 subsurface soil samples, eight sediment samples, and 20 surface water samples for fixed-base laboratory analyses.

5.1 EVENT I FIELD ACTIVITIES

The Event I field activities were carried out in October 1998.

5.1.1 Soil Investigation

A total of five surface soil samples and 22 subsurface soil samples were collected at Site 57 for chemical analysis to further define the extent of soil contamination.

Surface soil sample S57SS002 was collected at the southern end of Building 292 from a gravel surface adjacent to the building. Samples S57SS007, S57SS008, and S57SS011 were collected from a grassy area just to the east, across a service road and a surface drainage ditch. Sample S57SS001 was collected from a non-paved area in the southwestern corner of Building 292, adjacent to an asphalt service road. The proposed surface soil samples at S57SS003 and S57SS009 were not collected because the boring locations were moved to asphalt areas to avoid underground utilities.

Twenty-two subsurface soil samples were collected at Site 57 from 11 soil borings: S57SB001, S57SB002, S57SB003, S57SB006, S57SB007, S57SB008, S57SB009, S57SB010, S57SB011, S57SB012, and S57SB014. Two samples were collected from each boring, one from the unsaturated zone and one just above the saturated zone.

All surface and subsurface soil samples were submitted to the laboratory for TCL VOCs and ethyl ether analyses. The surface soil and subsurface soil samples collected from locations S57SB007 and S57SB008 were submitted to the laboratory for the additional analyses, which included TCL SVOCs, TAL

metals, TCL, pesticides/PCBs, and explosives. The subsurface soil samples collected from S57SB002 were submitted to the laboratory for TOC in addition to TCL VOCs and ethyl ether analyses. Table 5-2 provides a summary of the October 1998 (Event I) sampling analytical program.

5.2 EVENT II FIELD ACTIVITIES

The Event II field activities were carried out in January 1999.

5.2.1 Soil Investigation

A total of five surface soil samples and 15 subsurface soil samples were collected at Site 57 for chemical analysis to further define the extent of soil contamination and to provide geotechnical characterization of the site soils.

5.2.1.1 Surface soil investigation

Surface soil samples S57SS004, S57SS005, and S57SS015 were collected in downgradient areas. S57SS004 was collected just below a rip-rap surface adjacent to an asphalt road. S57SS005 was collected in a grassy area south of Building 160. S57SS015 was collected from a barren surface that appeared to be recently reworked as a result of the demolition of Building 158. Sample S57SS009 was collected in a grassy area southeast across a service road and surface drainage ditch from Building 292. Sample S57SS013 was collected in a grassy area to the east of Building 163 and adjacent to an asphalt service road.

All surface soil samples were submitted to the laboratory for TCL VOCs and ethyl ether analyses. Surface soil samples S57SS005 and S57SS013 were submitted to the laboratory for additional analyses, including TCL SVOCs, TAL metals, TCL, pesticides/PCBs, and explosives.

Table 5-2 provides a summary of the January 1999 sampling analytical program and sampling depths.

5.2.1.2 Subsurface soil investigation

Fifteen subsurface soil samples were collected at Site 57 from five soil borings: S57SB002, S57SB004, S57SB005, S57SB013, and S57SB015. At S57SB013, two samples were collected: one sample from the unsaturated zone and one from the water table. Three samples were collected from boring S57SB002, three from above the water table, two at the monitoring well screen interval, and one at the aquitard below the screened interval. Ten samples were collected from the downgradient borings S57SB005, S57SB013, and S57SB015. At S57SB005, five samples were collected: two from the unsaturated zone, one from immediately above the water table, one from the well screen interval, and one from the aquitard just below

the screen. At S57SB015, two samples were collected: one from the well screen interval and, because the water table was at approximately 4 feet below the ground surface, only one sample was collected above the water table in the unsaturated zone.

The four subsurface soil samples from the screen interval were submitted to the laboratory for TCL VOCs and ethyl ether, and TOC analyses. However, at S57SB005, the screen interval sample was also submitted to the laboratory for TCL SVOCs, TAL metals, TCL pesticides/PCBs, and explosives.

The seven subsurface soil samples collected from near the water table and from the unsaturated zone were submitted to the laboratory for TCL VOCs and ethyl ether analysis. However, at S57SB005 and S57SB013, the water table and unsaturated zone samples were also submitted to the laboratory for TCL SVOCs, TAL metals, TCL pesticides/PCBs, and explosives.

Four subsurface soil samples, two from the unsaturated zone and two from the aquitard were collected at S57SB002 and S57SB005 and submitted to a fixed-based laboratory for geotechnical analysis (moisture content, TOC, bulk density, grain size distribution, and specific gravity) to provide input parameters for aquifer modeling.

Table 5-2 provides a summary of the January 1999 (Event II) sampling analytical program and sampling depths.

5.2.2 Groundwater Investigation

Thirteen permanent and three temporary monitoring wells were sampled. The existing potable water supply well PW07 was sampled to update and better define the nature and concentration of contamination. The sample collected from the supply well PW07 was identified as S57PW0070101. Monitoring well locations are shown on Figure 4-1. All samples collected from the permanent monitoring wells were analyzed for TCL VOCs and ethyl ether. However, at monitoring wells S57MW003, S57MW004, S57MW009, S57MW010, S57MW012, and S57MW013, the samples were submitted to the laboratory for TCL SVOCs, TAL metals (total and dissolved), cyanide, TCL pesticides/PCBs, ammonium perchlorate, hardness, TOC, total dissolved solids, pH, and explosives, in addition to the TCL VOCs and ethyl ether analyses.

The samples collected from the three temporary monitoring wells were submitted to the laboratory for TCL VOCs and ethyl ether analyses.

The existing potable water supply well PW07 sample was submitted to the laboratory for TCL VOCs and ethyl ether analyses and ammonium perchlorate.

Table 5-2 provides a summary of the January 1999 (Event II) sampling analytical program.

5.2.3 Surface Water and Sediment Investigation

Eight surface water and sediment pair samples were collected from the Mattawoman Creek, the unnamed stream, and the concrete channel running between Thomas Road and Building 160. The samples were collected to determine the nature and extent of contamination in the sediment and surface water adjacent to and downstream of Site 57.

Three of the eight surface water and sediment sample pairs were collected from Mattawoman Creek. Sample pair S57SW009/SD005 was collected at the 36-inch concrete pipe outfall from the storm sewer system. Sample pair S57SW010/SD006 was collected 80 feet downstream from the storm sewer outfall at approximately 40 feet from the shoreline. The third sample pair, S57SW016/SD012, was collected at the mouth of the unnamed stream, which runs along Hersey Road.

Three of the eight surface water and sediment sample pairs were collected from the unnamed stream. Sample pair S57SW015/SD011 was collected at approximately 800 feet upstream from the Mattawoman Creek. Sample pair S57SW014/SD010 was collected at the concrete channel outlet into the stream beneath Hersey Road. Sample pair S57SW013/SD009 was collected from a swale approximately 80 feet upstream from the concrete channel outlet into the stream just south of Hersey Road.

Two of the eight surface water and sediment sample pairs were collected from the concrete channel south of Building 292 and across Thomas Road. Sample pair S57SW012/SD008 was collected just downstream of an outlet fed from drainage along the eastern side of Building 292. Sample pair S57SW011/SD007 was collected just downstream of the northern extent of the concrete channel.

All the surface water samples were submitted to the laboratory for TCL VOCs and ethyl ether analyses. However, surface water samples S57SW0090101, S57SW0140101, and S57SW0160101 were submitted to the laboratory for additional analyses: TCL SVOCs, TAL metals (total and dissolved), cyanide, TCL pesticides/PCBs, explosives, hardness, TOC, ecological parameters, turbidity, TDS, TSS, chloride, fluoride, nitrate/nitrite, sulfate, salinity, and dissolved oxygen. Sample S57SW00130101 was submitted to the laboratory for ecological parameters, hardness, and TOC analyses, in addition to the TCL VOCs and ethyl ether analysis.

Table 5-2 provides a summary of the January 1999 (Event II) sampling analytical program.

5.2.4 Storm Sewer

A total of 12 surface water samples were collected from within the storm sewer system at seven manhole locations. The water flows relatively steadily through the sewer system and at a relatively high volume, even during dry periods, as observed during the field effort. Sand size or smaller sediment was not present within the manhole locations, probably due to the flushing action caused by the steady flow of water. Large pea-size gravel was present at locations S57SW001 and S57SW002. This sewer line is used to discharge non-contact cooling water from the power plant, according to the base personnel. A fire hydrant (Potomac River water) continuously discharges water into manhole MH-497 in order to cool the water prior to discharge to the Mattawoman Creek. The fire hydrant was turned off approximately 1 hour before the surface water samples were collected from MH-497 and Mattawoman Creek. Three samples were collected at location S57SW008 (MH-497), from the main outlet and inlet and a 6-inch pipe coming from the southeast and approximately 2.5 feet below the manhole rim. There was also a 12-inch pipe with no flow entering from the southeast into MH-497. Two samples were collected at location S57SW007 (MH-489, IW-80) from the main inlet and outlet. Two samples were collected at location S57SW006 (MH-487) from the main inlet and outlet. One sample was collected at location S57SW004 (MH-431) from the main outlet. At MH-431, there were five other pipes (three 6-inch and two 12-inch pipe) that had no water flow. The main inlet at S57SW004 (MH-431) could not be sampled due to the turbulence of the water. Two samples were collected at location S57SW003 (MH-430), one from the main outlet and one at a 6-inch pipe inlet coming from the northeast direction. One sample was collected from the main outlet of S57SW002 (MH-429) and one from the main outlet at S57SW001 (MH-427).

All surface water samples from the sewer system were submitted to the laboratory for TCL VOCs and ethyl ether analyses. However, surface water samples S57SW0020101, S57SW0030101, S57SW0040101 and S57SW0070101, collected from the main outlets, were submitted to the laboratory for the additional analyses: TCL SVOCs, TAL metals (total and dissolved), cyanide, TCL pesticides/PCBs, and explosives. Hardness and TOC analyses were also included for the sample S57SW0020101.

Table 5-2 provides a summary of the January 1999 (Event II) sampling analytical program.

TABLE 5-1

SUMMARY OF INVESTIGATION ACTIVITIES
SITE 57 - FORMER DRUM LOADING AREA
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Site Name	Soil Sampling						Groundwater Sampling				Surface Water Samples		Sediment Samples		Comments / Other Work
	Surface Soil Samples		Number of Soil Borings[1]		Subsurface Soil Samples		Number of New Wells		Number of GW samples						
	Phase I	Phase II	Phase I	Phase II	Phase I	Phase II	Phase I	Phase II	Phase I	Phase II	Phase I	Phase II	Phase I	Phase II	
Up gradient of Site Area	---	1	1	1	---	2	---	4	---	4	---	---	---	---	Boring logs for site geology.
Site Area (including Hot Spot area)	5	1	10	---	23	3	---	5	---	5	---	---	---	---	Boring logs for site geology. Geotechnical Parameters
Down gradient of Site Area	---	3	---	3	---	10	---	4	---	4	---	---	---	---	Boring logs for site geology. Geotechnical Parameters
Storm Sewer Trench and Bedding	---	---	---	---	---	---	---	3 Temps	---	3 from Temps	---	---	---	---	Includes all temporary wells.
Storm Sewer System	---	---	---	---	---	---	---	---	---	---	---	14	---	2	Storm sewer system layout survey.
Concrete Drain Channel	---	---	---	---	---	---	---	---	---	---	---	6	---	6	Channel layout survey
Potable Wells	---	---	---	---	---	---	---	---	---	1	---	---	---	---	Background samples/check
Total Samples[2]	5	5	11	4	23	15	---	16	---	17	---	20	---	8	

1 Some soil borings and monitoring wells are actually the same boring (see Figure 4-1).
2 Totals do not include QA/QC samples. QA/QC samples include.
Field Duplicates: One field duplicate per 10 investigative samples or one per matrix per day, whichever is greater.
Trip Blanks: One trip blank per shipping container containing samples to be evaluated for VOCs.
Field Blanks: One field blank per potable and DI water source used for decontaminaiton.
Equipment Rinsate / Field Blanks: One rinsate blank per type of sampling equipment used per day with a minimum frequency of 10 percent.
MS/MSD: One MS/MSD sample per 20 investigative samples of each sample matrix will be submitted to the laboratory. No extra volume is required for soil samples; however, aqueous samples require triple the volume for VOCs and double the volume for extractable organics.

TABLE 5-2

ENVIRONMENTAL SAMPLING AND ANALYSIS SUMMARY
SITE 57 - FORMER DRUM LOADING AREA
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Sample Location		Sample Designation	Sample Depth (feet below ground surface)	Sample Analysis					
PHASE I	PHASE II			TCL VOCs (and ethyl ether)	TCL SVOCs	TAL Metals (Total)	TCL Pest/ PCBs	Explosives (with nitrocellulose, nitroguanidine, and nitroglycerine)	Additional Analysis
SURFACE SOIL									
S57SB001	S57MW001	S57SS0010101	0 - 0.5	●					
S57SB003	S57MW003	S57SS0020101	0 - 0.5	●					MS/MSD, VOC
	S57SB004 / S57MW007	S57SS0040101	0 - 0.5	●					
	S57SB005 / S57MW009	S57SS0050101	0 - 0.5	●	●	●	●	●	
S57SB008	S57MW011	S57SS0080101	0 - 0.5	●	●	●	●	●	
	S57SB009	S57SS0090101	0 - 0.5	●					
S57SB011	S57SB011	S57SS0110101	0 - 0.5	●					
	S57SB013 / S57MW012	S57SS0130101	0 - 0.5	●	●	●	●	●	
	S57SB015 / S57MW005	S57SS0150101	0 - 0.5	●					
S57SB007		S57SS0070101	0 - 0.5	●	●	●	●	●	
S57SS0080 101		S57DUP003	0 - 0.5	●	●	●	●	●	
	S57SS0090101	S57SSDUP001	0 - 0.5	●					

TABLE 5-2

ENVIRONMENTAL SAMPLING AND ANALYSIS SUMMARY
SITE 57 - FORMER DRUM LOADING AREA
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Sample Location		Sample Designation	Sample Depth (feet below ground surface)	Sample Analysis					
PHASE I	PHASE II			TCL VOCs (and ethyl ether)	TCL SVOCs	TAL Metals (Total)	TCL Pest/ PCBs	Explosives (with nitrocellulose, nitroguanidine, and nitroglycerine)	Additional Analysis
SUBSURFACE SOIL									
S57SB001	S57MW001	S57SB0010101	Middle Vadose Zone: 2 – 4 ft.	●					
S57SB001	S57MW001	S57SB0010201	Groundwater/ Vadose Zone Interface: 4 – 6 ft.	●					
S57SB002	S57MW003	S57SB0020101	Middle of Vadose Zone: 4 – 6 ft.	●					MS/MSD TOC
S57SB002	S57MW003	S57SB0020201	Groundwater/ Vadose Zone Interface: 8 – 10 ft.	●					TOC
	S57SB002 / S57MW003	S57SB0020301	Saturated Zone 14-16 ft.	●					TOC
	S57SB002 / S57MW003	S57SB0020601	Well Screen Interval: 18 – 20 ft.	●					TOC
	S57SB002 / S57MW003	S57SB0020401	Unsaturated Zone: 6 – 8 ft.						Analyzed for moisture content, TOC, bullk density, grainsize and specific gravity
	S57SB002 / S57MW003	S57SB0020501	At shallow confining unit: 24 – 25 ft.						Analyzed for moisture content, TOC, bullk density, grainsize and specific gravity
S57SB003		S57SB0030101	Middle of Vadose Zone: 3 – 4 ft.	●					

TABLE 5-2

ENVIRONMENTAL SAMPLING AND ANALYSIS SUMMARY
SITE 57 - FORMER DRUM LOADING AREA
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Sample Location		Sample Designation	Sample Depth (feet below ground surface)	Sample Analysis					
PHASE I	PHASE II			TCL VOCs (and ethyl ether)	TCL SVOCs	TAL Metals (Total)	TCL Pest/ PCBs	Explosives (with nitrocellulose, nitroguanidine, and nitroglycerine)	Additional Analysis
S57SB003		S57SB0030201	Groundwater/ Vadose Zone Interface: 4 – 6 ft.	●					
	S57SB004 / S57MW007	S57SB0040201	Middle of Vadose Zone: 4 – 5 ft.	●					
	S57SB004 / S57MW007	S57SB0040101	Groundwater/ Vadose Zone Interface: 6 – 8 ft.	●					
	S57SB004 / S57MW007	S57SB0040301	Well Screen Interval: 14 – 16 ft.	●					TOC
	S57SB005 / S57MW009	S57SB0050101	Middle of Vadose Zone: 2 – 4 ft.	●	●	●	●	●	TOC
	S57SB005 / S57MW009	S57SB0050201	Groundwater/ Vadose Zone Interface: 4 – 6 ft.	●	●	●	●	●	TOC
	S57SB005 / S57MW009	S57SB0050301	Well Screen Interval: 16 – 18 ft.	●	●	●	●	●	TOC
	S57SB005 / S57MW009	S57SB0050401	Unsaturated Zone: 3 – 5 ft.						Analyzed for moisture content, bulk density, grainsize and specific gravity

TABLE 5-2

ENVIRONMENTAL SAMPLING AND ANALYSIS SUMMARY
SITE 57 - FORMER DRUM LOADING AREA
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Sample Location		Sample Designation	Sample Depth (feet below ground surface)	Sample Analysis					
PHASE I	PHASE II			TCL VOCs (and ethyl ether)	TCL SVOCs	TAL Metals (Total)	TCL Pest/ PCBs	Explosives (with nitrocellulose, nitroguanidine, and nitroglycerine)	Additional Analysis
	S57SB005 / S57MW009	S57SB0050501	At deeper confining unit: 18 – 20 ft.						Analyzed for moisture content, bullk density, grainsize and specific gravity
S57SB006		S57SB0060101	Middle of Vadose Zone: 3 – 4 ft.	●					
S57SB006		S57SB0060201	Groundwater/ Vadose Zone Interface: 10 – 11 ft.	●					
S57SB008	S57MW011	S57SB0080101	Middle of Vadose Zone: 4 – 6 ft.	●	●	●	●	●	
S57SB008	S57MW011	S57SB0080201	Groundwater/ Vadose Zone Interface: 10 – 11 ft.	●	●	●	●	●	
S57SB007		S57SB0070101	Middle of Vadose Zone: 4 – 5 ft.	●	●	●	●	●	
S57SB007		S57SB0070201	Groundwater/ Vadose Zone Interface: 6 – 8 ft.	●	●	●	●	●	
S57SB009		S57SB0090101	Middle of Vadose Zone: 3 – 4 ft.	●					
S57SB009		S57SB0090201	Groundwater/ Vadose Zone Interface: 7 – 8 ft.	●					
S57SB010		S57SB0100101	Middle of Vadose Zone: 3 – 4 ft.	●					

TABLE 5-2

ENVIRONMENTAL SAMPLING AND ANALYSIS SUMMARY
SITE 57 - FORMER DRUM LOADING AREA
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Sample Location		Sample Designation	Sample Depth (feet below ground surface)	Sample Analysis					
PHASE I	PHASE II			TCL VOCs (and ethyl ether)	TCL SVOCs	TAL Metals (Total)	TCL Pest/ PCBs	Explosives (with nitrocellulose, nitroguanidine, and nitroglycerine)	Additional Analysis
S57SB010		S57SB0100201	Groundwater/ Vadose Zone Interface: 7 – 8 ft.	●					
S57SB011		S57SB0110101	Middle of Vadose Zone: 6 – 8 ft.	●					
S57SB011		S57SB0110201	Groundwater/ Vadose Zone Interface: 14 – 15 ft.	●					
S57SB012		S57SB0120101	Middle of Vadose Zone: 3 – 4 ft.	●					
S57SB012		S57SB0120201	Groundwater/ Vadose Zone Interface: 7 – 8 ft.	●					
	S57SB013 / S57MW012	S57SB0130101	Middle of Vadose Zone: 3 – 4 ft.	●	●	●	●	●	
	S57SB013 / S57MW012	S57SB0130201	Groundwater/ Vadose Zone Interface: 6 – 8 ft.	●	●	●	●	●	
S57SB014		S57SB0140101	Middle of Vadose Zone: 3 – 5 ft.	●					
S57SB014		S57SB0140201	Groundwater/ Vadose Zone Interface: 7 – 8 ft.	●					
	S57SB015 / S57MW005	S57SB0150101	Middle of Vadose Zone: 2 – 4 ft.	●					
	S57SB015 / S57MW005	S57SB0150201	Well Screen Interval: 10 – 12 ft.	●					TOC MS/MSD

TABLE 5-2

ENVIRONMENTAL SAMPLING AND ANALYSIS SUMMARY
SITE 57 - FORMER DRUM LOADING AREA
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Sample Location		Sample Designation	Sample Depth (feet below ground surface)	Sample Analysis					
PHASE I	PHASE II			TCL VOCs (and ethyl ether)	TCL SVOCs	TAL Metals (Total)	TCL Pest/ PCBs	Explosives (with nitrocellulose, nitroguanidine, and nitroglycerine)	Additional Analysis
	S57SB0050201/ S57SB0040301	S57SBDUP0101	Middle of Vadose Zone: 4 – 6 ft. / 14 – 16 ft.	●	●	●	●	●	TOC
	S57SB0020601	S57SBDUP002	Middle of Vadose Zone: 18 – 20 ft.	●	●	●	●	●	TOC
S57SB0030 101		S57DUP001	3 – 4 ft.	●					
S57SB0030 201		S57DUP002	4 – 6 ft.	●					

TABLE 5-2

ENVIRONMENTAL SAMPLING AND ANALYSIS SUMMARY
SITE 57 - FORMER DRUM LOADING AREA
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Sample Location PHASE II ONLY	Sample Designation	Sample Depth (Screened Interval)	Sample Analysis										
			TCL VOCs (with ethyl ether)	TCL SVOCs	Ammo-nium Per-chlorate	TAL Metals (Total) and Cyanide	TAL Metals (Filtered) and Cyanide	TCL Pest/ PCBs	Explosives (with nitro-cellulose, nitro-quanidine, and nitro-glycerine)	TOC, pH, Hard-ness (as $CaCO_3$)	Total Dis-solved Solids	Field Slug Test and Water Level	Additional Analysis
GROUNDWATER													
S57MW001	S57MW0010101	Surficial Aquifer Deep 26 ft.	▲								●	●	
S57MW002	S57MW0020101	Surficial Aquifer Shallow: 13.5 ft	▲								●	●	
S57MW003	S57MW0030101	Surficial Aquifer Deep 22.5 ft.	▲	▲	●	●	●	▲	●	●	●	●	
S57MW004	S57MW0040101	Surficial Aquifer Shallow 16.5 ft.	▲	▲	●	●	●	▲	●	●	●	●	
S57MW005	S57MW0050101	Surficial Aquifer Deep 20 ft.	▲								●	●	
S57MW006	S57MW0060101	Surficial Aquifer Shallow 12.5 ft.	▲								●	●	
S57MW007	S57MW0070101	Surficial Aquifer Deep 27 ft.	▲								●	●	
S57MW008	S57MW0080101	Surficial Aquifer Shallow 15.5 ft.	▲								●	●	
S57MW009	S57MW0090101	Surficial Aquifer Deep 20 ft.	▲	▲	●	●	●	▲	●	●	●	●	

TABLE 5-2

ENVIRONMENTAL SAMPLING AND ANALYSIS SUMMARY
SITE 57 - FORMER DRUM LOADING AREA
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Sample Location PHASE II ONLY	Sample Designation	Sample Depth (Screened Interval)	Sample Analysis										
			TCL VOCs (with ethyl ether)	TCL SVOCs	Ammo-nium Per-chlorate	TAL Metals (Total) and Cyanide	TAL Metals (Filtered) and Cyanide	TCL Pest/ PCBs	Explosives (with nitro-cellulose, nitro-quanidine, and nitro-glycerine)	TOC, pH, Hard-ness (as $CaCO_3$)	Total Dis-solved Solids	Field Slug Test and Water Level	Additional Analysis
S57MW010	S57MW0100101	Surficial Aquifer Shallow 14.5 ft.	▲	▲	●	●	●	▲	●	●	●	●	MS/MSD
S57MW011	S57MW0110101	Surficial Aquifer Shallow 20 ft.	▲								●	●	
S57MW012	S57MW0120101	Surficial Aquifer Deep 44 ft.	▲	▲	●	●	●	▲	●	●	●	●	
S57MW013	S57MW0130101	Surficial Aquifer Shallow 16.5 ft.	▲	▲	●	●	●	▲	●	●	●	●	
S57MW01201 01	S57MWDUP001	Surficial Aquifer Deep	▲	▲	●	●	●	▲	●	●	●	●	
S57MW01101 01	S57MWDUP002		▲								●		
POTABLE WELL GROUNDWATER													
PW-07	S57PW0070101	Screened Interval	▲		●								

TABLE 5-2

ENVIRONMENTAL SAMPLING AND ANALYSIS SUMMARY
SITE 57 - FORMER DRUM LOADING AREA
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Sample Location PHASE II ONLY	Sample Designation	Sample Depth[1]	Sample Analysis								
			TCL VOCs (with ethyl ether)	TCL SVOCs	TAL Metals (Total) and Cyanide	TAL Metals (Filtered) and Cyanide	TCL Pest/ PCBs	Explosives (including nitrocellulose, nitroguanidine, and nitroglycerine	TOC, pH, Hardness (as $CaCO_3$)	Ecological Parameters[2]	Additional Analysis
STORM SEWER WATER											
MH-427	S57SW0010101	Invert of main flow	▲								
MH-429	S57SW0020101	Invert of inlet	▲	▲	●	●	▲	●	●		MS/MSD
MH-01 (MH-430)	S57SW0030101	Invert of main flow	▲	▲	●	●	▲	●			
	S57SW0030201	Invert of inlet	▲								
MH-02 (MH-431)	S57SW0040301	Invert of main flow	▲	▲	●	●	▲	●			
MH-487	S57SW0060101	Invert of main flow	▲								
	S57SW0060201	Invert of main flow	▲								
IW-80 (MH-489)	S57SW0070101	Invert of outlet	▲	▲	●	●	▲	●			
	S57SW0070201	Invert of inlet	▲								
MH-497	S57SW0080101	Invert of outlet	▲								
	S57SW0080201	Invert of inlet	▲								
	S57SW0080301	Invert of inlet	▲								
36" Pipe outfall at Mattawoman Creek	S57SW0090101	Invert of pipe at outfall	▲	▲	●	●	▲	●	●	●	

TABLE 5-2

ENVIRONMENTAL SAMPLING AND ANALYSIS SUMMARY
SITE 57 - FORMER DRUM LOADING AREA
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Sample Location PHASE II ONLY	Sample Designation	Sample Depth[1]	Sample Analysis								
			TCL VOCs (with ethyl ether)	TCL SVOCs	TAL Metals (Total) and Cyanide	TAL Metals (Filtered) and Cyanide	TCL Pest/ PCBs	Explosives (including nitrocellulose, nitroguanidine, and nitroglycerine	TOC, pH, Hardness (as $CaCO_3$)	Ecological Parameters[2]	Additional Analysis
Down stream of outfall.	S57SW0100101	Mattawoman Creek down stream of outfall	▲								
CONCRETE DRAIN CHANNEL WATER											
Site Area	S57SW0110101	Outlet of 10" CMP	▲								
Site Area	S57SW0120101	Outlet of 24" CMP	▲								
Upgradient	S57SW0130101	West and Upgradient from channel outlet in swale	▲						●	●	
Downgradient	S57SW0140101	At channel outlet in swale	▲	▲	●	●	▲	●	●	●	
In Creek South of Building 157	S57SW0150101	In creek	▲							●	
At Discharge of Concrete Channel to Mattawoman Creek	S57SW0160101	Outlet of Concrete Channel	▲	▲	●	●	▲	●	●	●	
S57SW0160101	S57SWDUP0101		▲	▲	●	●	▲	●	●	●	MS/MSD
S57SW0060101	S57SWDUP0201		▲								
S57SW0030101	S57SWDUP0301		▲								

TABLE 5-2

ENVIRONMENTAL SAMPLING AND ANALYSIS SUMMARY
SITE 57 - FORMER DRUM LOADING AREA
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Sample Location PHASE II ONLY	Sample Designation	Sample Depth[1]	Sample Analysis							
			TCL VOCs (with ethyl ether)	TCL SVOCs	TAL Metals (Total) and Cyanide	TAL Metals (Filtered) and Cyanide	TCL Pest/ PCBs	Explosives (including nitrocellulose, nitroguanidine, and nitroglycerine)	TOC and SEM/AVS Metals	Additional Analysis
STORM SEWER SEDIMENTS										
36" Pipe outfall at Mattawoman Creek	S57SD0050101	Outfall at Mattawoman Creek	●	●	●	●	●	●	●	
Down stream of outfall.	S57SD0060101	Mattawoman Creek	●						●	
CONCRETE DRAIN CHANNEL SEDIMENTS										
Upgradient	S57SD0070101	Outlet of 10" CMP	●							
Site Area	S57SD0080101	Outlet of 24" CMP	●							
Downgradient	S57SD0090101	West and upgradient from channel outlet in swale	●						●	
Downgradient	S57SD0100101	At channel outlet in swale	●	●	●	●	●	●	●	
In Creek South of Building 157	S57SD0110101	In creek	●							
At Discharge of Concrete Channel to Mattawoman Creek	S57SD0120101	Outlet of Concrete Channel	●	●	●	●	●	●	●	MS/MSD
S57SD0120101	S57SDDUP0101	Outlet of Concrete Channel	●	●	●	●	●	●	●	

TABLE 5-2

ENVIRONMENTAL SAMPLING AND ANALYSIS SUMMARY
SITE 57 - FORMER DRUM LOADING AREA
INDIAN HEAD DIVISION NSWC, INDIAN HEAD, MD

Sample Location PHASE II ONLY	Sample Designation	Sample Depth	Sample Analysis					
			TCL VOCs (with ethyl ether)	TCL SVOCs	TAL Metals (Total) and Cyanide	TAL Metals (Filtered) and Cyanide	TCL Pest/PCBs	Additional Analysis
STORM SEWER PIPE TRENCH AND BEDDING WATER								
S57TW001	S57TW0010101	Depth of pipe bedding 12 ft.	●					
S57TW002	S57TW0020101	Depth of pipe bedding 8 ft.	●					
S57TW003	S57TW0030101	Depth of pipe bedding 9.5 ft.	●					

1 Sample collected at invert depth of pipe.
2 Ecological Parameters: Turbidity, TDS, TSS, chloride, fluoride, nitrate/nitrite, sulfate, salinity, and dissolved oxygen.

● Analysis using mid-concentration detection limits per project-specific QAPP.

▲ Analysis using low-concentration detection limits per project-specific QAPP.

6.0 SITE CHARACTERISTICS

6.1 GEOLOGY

Generally, the subsurface materials consist of fill material and alluvium. The fill material consists primarily of reworked natural material of gravel, sand, silt, and clay. At some locations, the fill material contains minor amounts of asphalt, concrete brick, terra cotta, and slag fragments. In areas of construction, the natural soil and alluvium are cut by, or supplemented with, the fill material.

The alluvium is interpreted as being derived from erosion of the adjacent highlands. It generally consists of a yellow-brown and gray, poorly sorted sand with minor amounts of gravel, silt, and clay overlying a olive-brown, well-sorted, very fine-grained sand, silt, and clay. The contact between these two units is approximately at sea level. A lens of greenish-gray, very fine-grained, well-sorted sand and silt with a trace of clay is found within the yellow-brown and gray sand unit. Its upper surface is at approximately 10 feet above sea level. The thickness of this lens is unknown, and it is found beneath the southern portion of Building 292.

6.1.1 Descriptions Cross Sections

Figure 6-1 shows the location of cross sections A-A' and B-B' in plan view. The cross sections have been developed to further describe the subsurface materials underlying study area and are shown on Figures 6-2 and 6-3. The lithologic units illustrated are relatively flat lying. Both cross sections have a vertical exaggeration of 4x, thus slightly exaggerating the relief of the otherwise flat-lying units.

6.1.1.1 Cross Section A1-A1′

Cross section A-A′ (Figure 6-2) is a northwest to southeast transect looking northeastward that depicts the subsurface materials along the northern portion of the study area, including Site 57 – Former Drum Loading Area and Building 292. Fill material is encountered throughout the extent of this section. The fill is identified by traces of brick, terra cotta, and slag fragments in a gravel, sand, and clay matrix. At S57MW013, fill material is identified by a layer of asphalt at seven feet bgs. At well clusters S57MW001/002, S57MW007/008 and S57MW009/010, fill material is encountered at the ground surface to approximately 7, 8, and 12 feet bgs, respectively. The recovery rate at these locations during split spoon sampling was very poor and the material encountered was very loose. At S57MW003/004 and S57MW011, the fill material is 8 and 11 feet thick, respectively.

A variegated yellow brown and light gray well-graded (poorly sorted) sand with varying amounts of gravel, silt, and clay is encountered below the fill material throughout the cross section. At location

S57MW012/013, the sand unit is approximately 36 feet thick, and thins to approximately 8 feet in the south at S57MW009/010. At boring locations S57MW001 and S57MW003, a lens of moderately sorted, greenish-gray very fine-grained sand and silt with trace clay is encountered below the sand unit at 23 and 22 feet bgs, respectively. Based on field observations, it is interpreted as an aquitard beneath Building 292. The thickness of this aquitard is unknown. The lateral extent is marked to the north by S57MW012 and to the south by S57MW007. At locations S57MW012, S57MW007, and S57MW009, a brown olive gray clay and silt are encountered at 43, 27, and 19 feet bgs, respectively. This clay unit extends the length of the cross section, with the clay content increasing toward the north. Based on field observations, it is interpreted as an aquitard.

6.1.1.2 Cross Section B-B′

Cross section B-B′ (Figure 6-3) is a southern continuation of cross section A-A′. It is a northwest to southeast transect looking northeastward that depicts the subsurface materials along the southern portion of the study area in the vicinity of the former Building 158 and extending to IW-80. Fill material is encountered at locations S57MW009/010 and S57TW02 from the ground surface to 11 and 9 feet bgs, respectively. The fill material at S57TW02 is interpreted to be the storm sewer bedding. The yellow-brown and gray sand unit is encountered below the fill material and at the surface when the fill is absent. The sand unit contains more gravel near the ground surface where it is exposed at the ground surface between S57MW010 and S57MW005/SB015. The lower clay and silt aquitard encountered at S57MW007 on cross section A–A', as described Section 6.2.1, is encountered at locations S57MW009 and S57MW005 at approximately 19 feet bgs.

6.1.2 Soil Classification

Four soil samples were collected for grain size distribution analysis as part of the Event II investigation at S57MW003/SB002 and S57MW009/SB005. The results were reported using the Unified Soil Classification System. The grain size distribution report indicates that the soil sampled from the unsaturated zone consists of a wide variety of particle sizes from gravel to clay. The samples from both aquitards consisted of sand, silt, and clay. The sand portion of the aquitard consists mostly of fine sand-size particles. The effective grain sizes of the aquitards are 0.0015 mm and 0.0072 diameter (silt size particles) at S57MW009/SB005 and S57MW003/SB002, respectively. Grain size distribution analysis laboratory reports are provided in Appendix N.

6.2 LOCAL HYDROGEOLOGY

This section presents information concerning the occurrence and movement (flow direction and rate) of upper and lower groundwater in the surficial aquifer in the alluvium sediments beneath the study area.

The data acquired during the aquifer slug tests and the subsequent evaluation results as well as the tidal study data are presented in Appendix M.

6.2.1 Groundwater Occurrence

The surficial aquifer in the yellow-brown sand unit and fill beneath the study area displays the characteristics of an unconfined system. Typically, after monitoring well completion, the static water level equilibrates in the well screen at the level at which saturated material was encountered while drilling. The depth to the first occurrence of groundwater during drilling was obscured in some areas due to soft and loose fill material. Depth to the static water level in completed wells ranged from 1.8 to 7.4 feet bgs at the study area. A silt and clay aquitard beneath the surficial aquifer impedes the downward movement of the groundwater in the surficial aquifer to deeper aquifers.

6.2.2 Groundwater Flow Direction

The direction of groundwater flow for the study area within the surficial aquifer was determined from a potentiometric surface map (Figure 6-1) that was developed from static water level data collected during the field effort. A summary of the water-level measurements is provided on Table 6-1.

Based on the potentiometric surface contour elevations, the groundwater in the upper and lower portions of the surficial aquifer beneath study area is flowing south toward the intermittent stream, herein referred to as the unnamed stream, and Mattawoman Creek. There is a slight downward flow component to the groundwater in the northern portion of the study area and a slight upward flow component in the southern portion of the study area, based on water levels measured at well clusters S57MW012/013 and S57MW005/006, respectively. A silt and clay aquitard beneath the surficial aquifer impedes the downward movement of the groundwater in the surficial aquifer to deeper aquifers. The upper surficial groundwater may be discharging to both the unnamed stream and Mattawoman Creek, and the lower groundwater in the surficial aquifer is most likely discharging to Mattawoman Creek, and to a lesser extent, possibly to the unnamed stream. The surficial aquifer is recharged by downward infiltration of precipitation through the vadose zone and by groundwater flowing from the adjacent upland areas located to the north, east, and west.

6.2.3 Hydraulic Conductivity/Aquifer Tests

Slug tests were conducted in study area wells to estimate the bulk horizontal hydraulic conductivity of the surficial aquifer. Rising and falling head slug tests were performed at wells where the water level was above the top of the screen; otherwise, only a rising head test was done. At S57MW009, a slug test was not completed because the well riser pipe was slightly bent, preventing the insertion of the solid slug into

the water. The slug test data at S57MW003 were inconclusive for the same reasons. The falling head test result at S57MW007 was also inconclusive.

Hydraulic conductivity values (K) were calculated using the Hvorslev method. The geometric mean is the best measure of central tendency. Therefore, the most representative hydraulic conductivity for the site is best presented as the geometric mean of the arithmetic average of the hydraulic conductivities estimated from the falling and rising head slug test results. Table 6-2 presents a summary of hydraulic conductivities that were estimated from the slug test results and the mean hydraulic conductivity for the site. The calculations and field data are presented in Appendix M.

The geometric mean hydraulic conductivity was calculated from both the deep and shallow wells because they exhibited similar lithologies. The geometric mean hydraulic conductivity values calculated for the study area were 0.17 feet per day for the shallow monitoring wells and 9.9 feet per day for the deep monitoring wells. The resulting geometric mean value for the study area is 2.2 feet per day. The geometric mean value of the hydraulic conductivity will be used to estimate the groundwater seepage velocity of the groundwater across the study area.

6.2.4 Groundwater Movement

The general direction of groundwater movement is southward toward Mattawoman Creek. The hydraulic gradient across the site is estimated by graphic interpretation of the potentiometric surface contour map as shown on Figure 6-1. The hydraulic gradient is estimated to be 0.03 feet/foot.

Given the geometric mean value of hydraulic conductivity and the estimated hydraulic gradient, an average groundwater seepage velocity may be calculated for Site 57.

The seepage velocity V_s is calculated using the following equation:

$$V_s = K \times i \, (1/n)$$

Where:

V_s	=	estimated groundwater seepage velocity (feet/day)
K	=	horizontal hydraulic conductivity (feet/day)
i	=	hydraulic gradient (feet/feet)
n	=	effective porosity

Estimated Site Conditions:

0.00076539 cm/sec
7×10^{-4} cm/sec

K = 2.2 feet/day (geometric mean)

n = 0.25 (effective porosity for sand from Fetter, 1980.)

i = 0.0309 feet/feet

The resulting seepage velocity of the groundwater beneath Site 57 is estimated to be 0.27 feet/day.

6.2.5 Tidal Study

The results of the tidal study show that there is a tidal influence on the groundwater at well S57TW003. Figure 6-4 is a plot illustrating the change in water-level elevation at S57TW003 versus time. Distinct cycles with wavelengths of approximately 16 hours and peak to peak amplitudes of approximately 0.5 feet, changing between 1.5 to 2.0 feet above mean sea level are seen for the first 33 hours of the study. At this point, a heavy precipitation event caused a rapid rise in water level in the well and masked the tidal effects. The groundwater flow pattern at Site 57 is unlikely to be affected by the tidal fluctuations seen at the S57TW003 area. The tidal study data are provided in Appendix L.

TABLE 6-1

MONITORING WELL GROUNDWATER LEVEL SUMMARY
SITE 57 - FORMER DRUM LOADING AREA
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Well Identification	Depth to Water (feet btoc[1])	Top of Casing Elevation	Water Level Elevation (feet msl[2])
S57MW001	7.31	37.09	29.78
S57MW002	7.27	37.58	30.31
S57MW003	8.56	35.82	27.26
S57MW004	8.69	35.72	27.03
S57MW005	4.18	18.54	14.36
S57MW006	4.38	18.57	14.19
S57MW007	8.69	30.58	21.89
S57MW008	7.81	30.26	22.45
S57MW009	8.15	25.75	17.60
S57MW010	8.23	25.82	17.59
S57MW011	9.27	33.49	24.22
S57MW012	5.38	43.82	38.44
S57MW013	5.26	43.98	38.72
S57TW001	8.51	24.78	16.27
S57TW002	4.77	11.94	7.17
S57TW003	4.49	7.12	2.63

1. btoc = Below Top of Casing
2. msl = Mean Sea Level

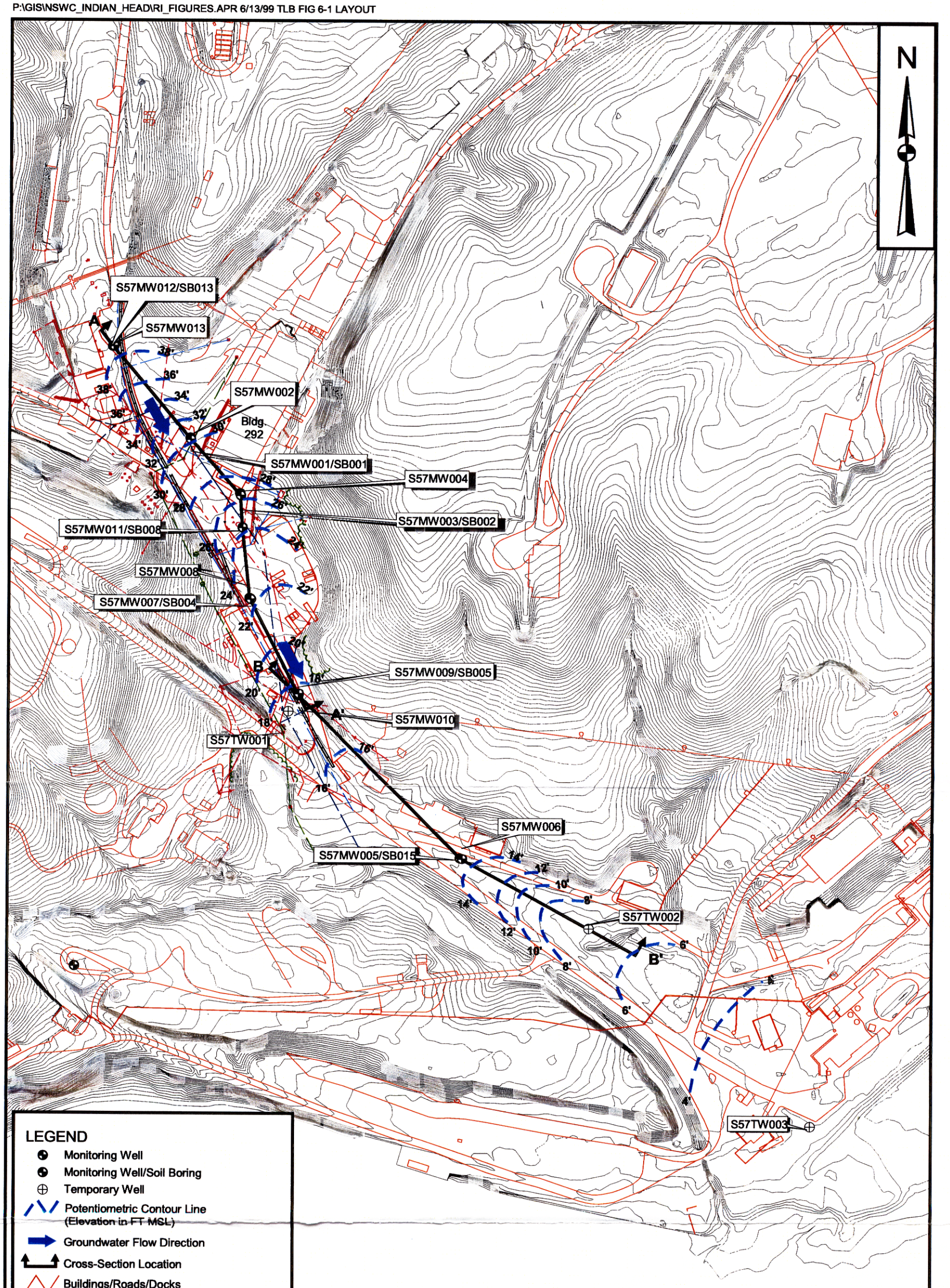
TABLE 6-2

SLUG TEST HYDRAULIC CONDUCTIVITY RESULTS
SITE 57 – FORMER DRUM LOADING AREA
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Monitored Interval	Well	Falling Head (feet/day)	Rising Head (feet/day)	Average[1] (feet/day)
Shallow	S57MW002	-	1.4	1.4
	S57MW004	-	5.2	5.2
	S57MW006	-	9.9	9.9
	S57MW008	-	7.2	7.2
	S57MW010	-	3.0	3.0
	S57MW011	0.76	0.52	0.64
	S57MW013	0.76	0.46	0.61
			Geometric Mean	2.5
Deep	S57MW001	1.44	0.98	1.2
	S57MW005	3.4	4.6	8.0
	S57MW007	-	0.17	0.17
	S57MW012	4.5	10.6	7.6
			Geometric Mean	1.9
SITE 57 GEOMETRIC MEAN HYDRAULIC CONDUCTIVITY				**2.2**

1 - Arithmetic average of falling and rising head test.

P:\GIS\NSWC_INDIAN_HEAD\RI_FIGURES.APR 6/13/99 TLB FIG 6-1 LAYOUT



LEGEND

- Monitoring Well
- Monitoring Well/Soil Boring
- Temporary Well
- Potentiometric Contour Line (Elevation in FT MSL)
- Groundwater Flow Direction
- Cross-Section Location
- Buildings/Roads/Docks
- Power/Utility
- Railroad
- Sewer Pipeline
- Storm Water Piping
- Water Pipeline
- Vegetation

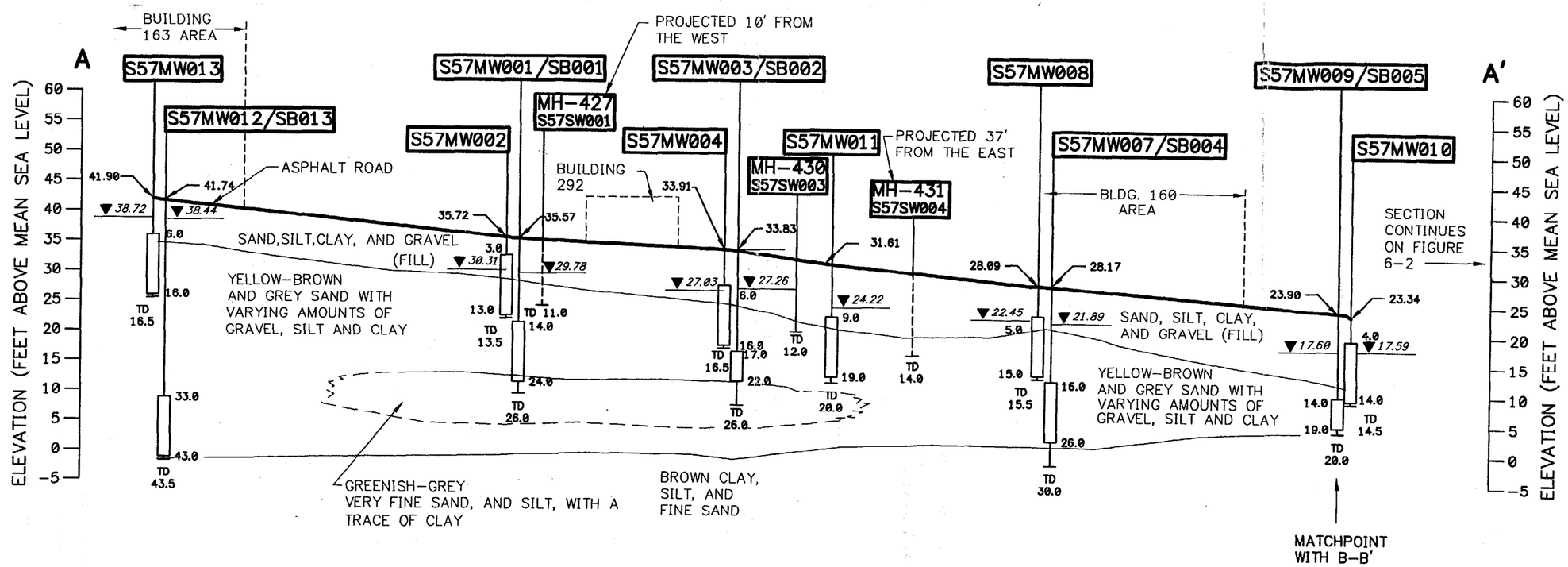
NOTE:
Potentiometric surface contours are based on water levels in shallow wells.

200 0 200 Feet

DRAWN BY T. BECKMAN — DATE 6/13/99	Tetra Tech NUS, Inc.	CONTRACT NUMBER —	OWNER NUMBER —
CHECKED BY G. LATULIPPE — DATE 6/15/99	CROSS-SECTIONS AND POTENTIOMETRIC SURFACE CONTOURS SITE 57 - FORMER DRUM LOADING AREA NSWC INDIAN HEAD INDIAN HEAD, MARYLAND	APPROVED BY G. LATULIPPE	DATE 6/15/99
COST/SCHEDULE-AREA		APPROVED BY —	DATE —
SCALE AS NOTED		DRAWING NO. FIGURE 6-1	REV 0

00668095Y

ACAD:7129gx07.dwg 06/15/99 DT



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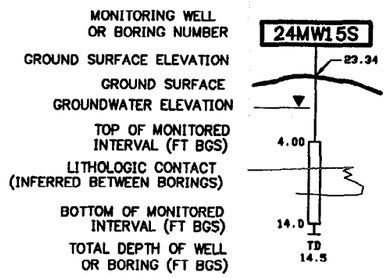

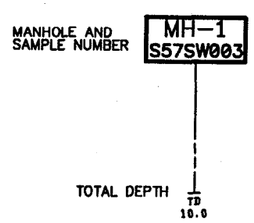

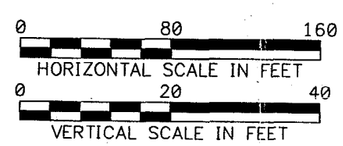

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

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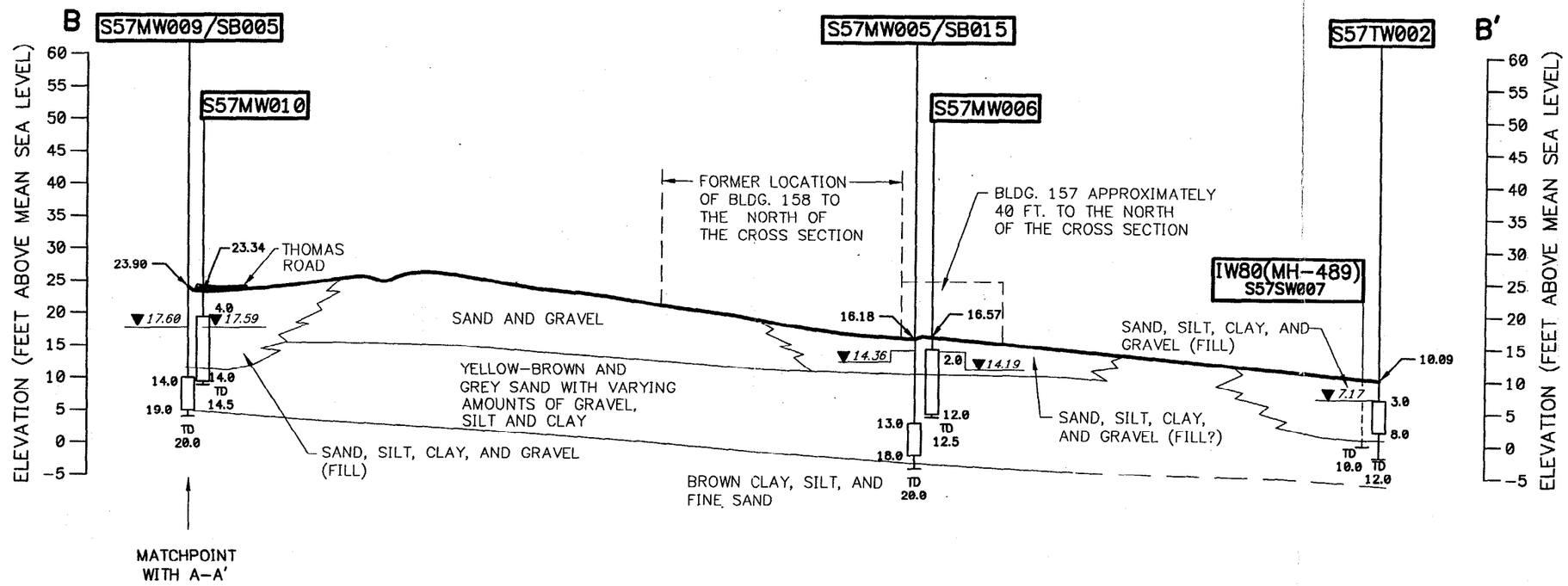
CHECKED BY GJL	DATE 2/1/00	GENERALIZED GEOLOGIC CROSS SECTION A-A' SITE 57 - FORMER DRUM LOADING AREA INDIAN HEAD DIVISION NSWC INDIAN HEAD, MARYLAND	APPROVED BY GJL / DATE 2/1/00
COST/SCHED-AREA			APPROVED BY / DATE
SCALE AS NOTED			DRAWING NO. FIGURE 6-2 / REV. 0

FORM CADD NO. TTNUS-BH.DWG - REV 0 - 9/9/98

00668CB62

ACAD: 7129gx08.dwg 06/15/99 DT



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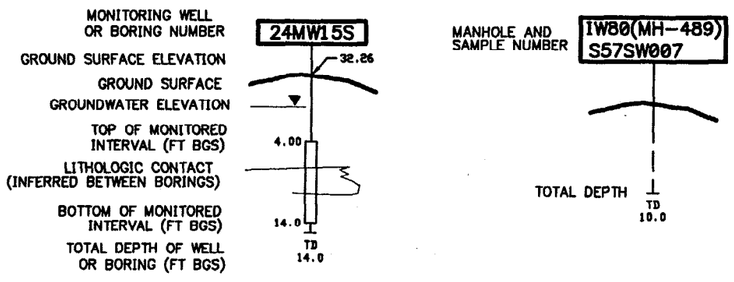
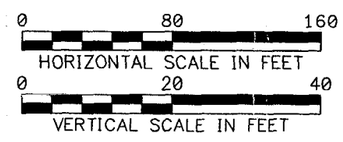




NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY KW DATE 3/11/99
CHECKED BY GJL DATE 2/1/00
COST/SCHED-AREA
SCALE AS NOTED

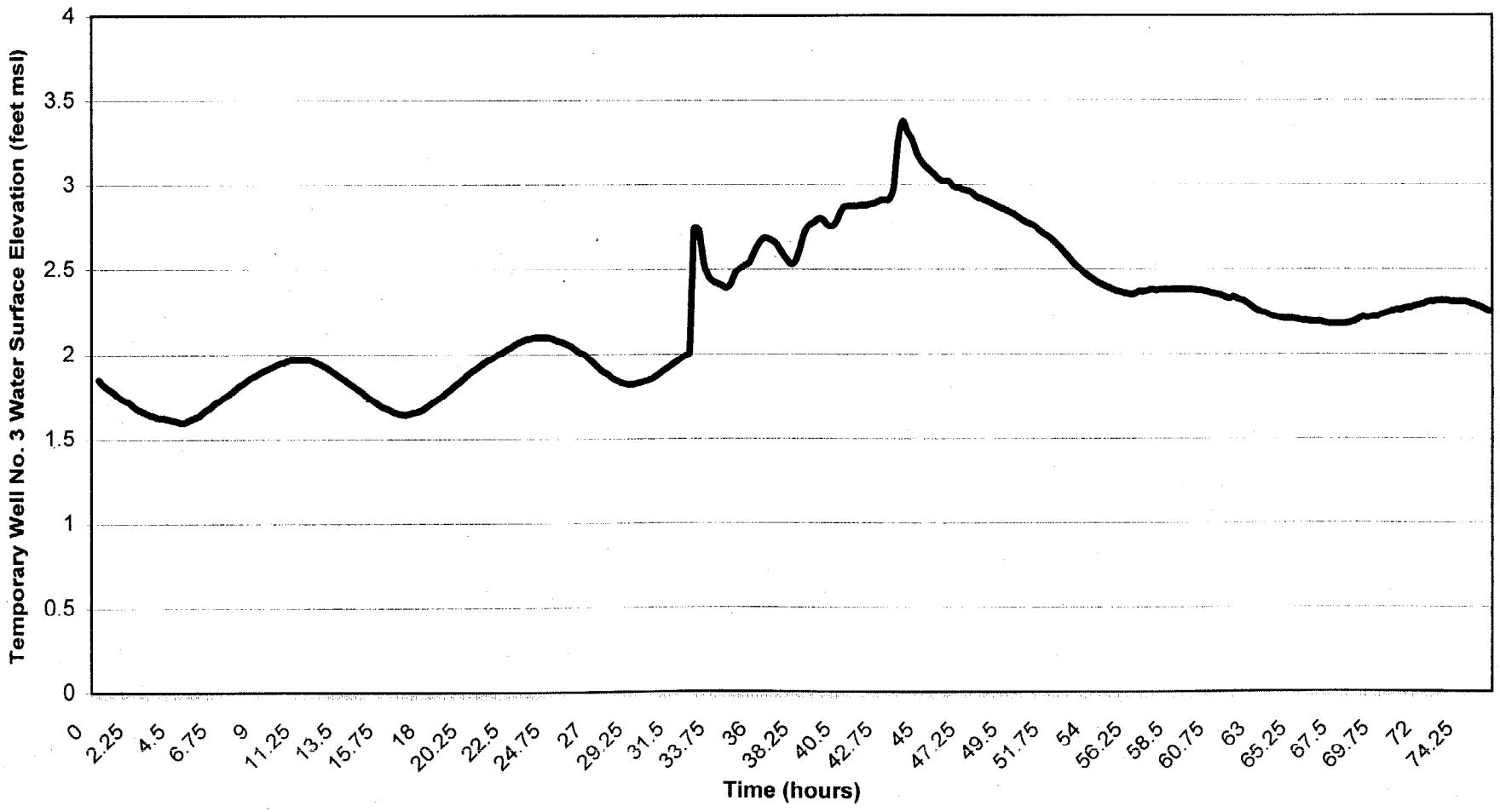
Tetra Tech NUS, Inc.

GENERALIZED GEOLOGIC CROSS SECTION B-B'
SITE 57 - FORMER DRUM LOADING AREA
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

CONTRACT NO. 7129
OWNER NO. 0550
APPROVED BY GJL DATE 2/1/00
APPROVED BY DATE
DRAWING NO. FIGURE 6-3
REV. 0

FORM CADD NO. TTNUS-BH.DWG - REV 0 - 9/9/98

FIGURE 6-4
TIDAL STUDY AT S57TW003
SITE 57 - FORMER DRUM LOADING AREA
INDIAN HEAD DIVISION NSWC, INDIAN HEAD, MD.



7.0 NATURE AND EXTENT OF CONTAMINATION

This section presents the results of the sampling and analysis of environmental samples collected by TtNUS at Site 57 during the Event I and Event II investigations, as described in Section 5. Table 5-2 provided a summary of the sampling and analytical program for the environmental samples. Analytical results are summarized in Tables 7-1 through 7-8 and presented in detail in Appendix H.

7.1 SURFACE SOIL CHARACTERIZATION

Analytical results for any parameter detected at least once in Site 57 surface soil samples are presented in Table 7-1. A single surface soil sample was collected upgradient of the site area. Nine surface soil samples were collected either from the site area or downgradient of the site area. For purposes of statistical evaluation and characterization, the surface soil samples collected from the site area or downgradient of the site area will hereafter be referenced collectively as downgradient surface soil samples. Table 7-9 provides descriptive statistics (i.e., minimum and maximum detected concentrations, location of maximum concentration, detection frequency, range of detection limits, and average of detected concentrations) for the upgradient surface soil sample. Table 7-10 provides similar information for downgradient surface soil samples. Based upon the chemical of potential concern (COPC) selection process described in Section 9.1, Figure 7-1 depicts the locations and concentrations of COPCs detected in Site 57 upgradient and downgradient surface soil samples.

7.1.1 Upgradient Surface Soil

Organics

As previously noted, a single upgradient surface soil sample was collected from Site 57 during the Event I and Event II investigations. This sample was collected from boring S57MW012/SB013, located west of Building 292 near the eastern side of Building 163. As shown on Tables 7-1 and 7-9, few organic compounds were detected in this sample. No VOCs, pesticides/PCBs, or explosives were detected. Four SVOCs were detected at relatively low concentrations. Benzo(b)fluoranthene, fluoranthene, and pyrene were detected at concentrations ranging from 50 µg/kg to 63 µg/kg. Bis(2-ethylhexyl)phthalate was detected at a concentration of 120 µg/kg. Although this result was not determined during data validation to be due to laboratory or field blank contamination, phthalates, which are common plasticizers, are common field and laboratory contaminants. Bis(2-ethylhexyl)phthalate was also detected in the facility-specific background surface soil samples at a maximum concentration of 640 µg/kg.

Inorganics

As shown on Table 7-9, twenty metals were detected in the upgradient surface soil sample. As shown by the following table, several metals were detected at concentrations exceeding the $UTLs_{95\%}$ calculated for the basewide background surface soil dataset. (In theory, if an infinite number of samples were collected, there is less than a 5% chance that a data point will exceed the 95 percent UTL).

Metal	Maximum Concentration (mg/kg)	$UTL_{95\%\ BACKGROUND}$ [1] (mg/kg)	Eastern United States Soils [2] (mg/kg)	Maryland Soils [3] (mg/kg)
Antimony	0.87	ND	<1 - 8.8	NA
Arsenic	9.6	4.25	<0.1 - 73	1.1 - 7.1
Calcium	1580	409	100 -280000	NA
Magnesium	9150	1382	50-50000	NA
Nickel	135	18.2	<5 - 700	ND - 30
Sodium	144	51.9	<500 - 50000	NA
Zinc	94.4	38.1	<5 - 2900	8 - 113

Note:

1 Brown & Root Environmental, December 1997 ($UTL_{95\%}$ = Upper 95% Tolerance Limit)
2 Shacklette and Boerngen, 1984
3 Dragun, 1991
NA Not available
ND Not detected

The detected concentrations of all inorganic parameters with concentrations exceeding background were within the concentration ranges reported in the literature for soils of the eastern United States. However, the detected concentrations of arsenic and nickel exceeded the concentration ranges reported for the state of Maryland.

Antimony was detected in the upgradient surface soil sample. This parameter was not detected in the background dataset for Indian Head. However, the concentration of antimony detected in the upgradient surface soil sample is within the concentration range reported for soils of the eastern United States.

The measured pH of the Site 57 upgradient surface soil sample was 8.36.

7.1.2 Downgradient Surface Soil

Volatile Organic Compounds

As shown on Table 7-10, three VOCs were detected in the nine downgradient surface soil samples. Toluene was detected in a single sample at a concentration of 1 µg/kg, and cis-1,2-dichloroethene was detected in two samples at concentrations of 2 µg/kg and 4 µg/kg. Trichloroethene (TCE) was detected in four samples at concentrations ranging from 10 µg/kg to 93 µg/kg. The maximum concentrations of TCE and cis-1,2-dichloroethene (a degradation product of TCE) were associated with the surface soil sample S57SS0070101 which was collected from boring S57SB007, located near the southeastern corner of Building 292 and the former drum loading area. As shown on Table 7-1, TCE was detected at concentrations of 63 µg/kg and 34 µg/kg, respectively, in the surface soil sample and field duplicate sample collected from boring S57MW011/SB008, located slightly southwest and downgradient of boring S57SB007. However, TCE was not detected in surface soil samples collected from the two borings (S57MW003/SB002 and S57SB011) located slightly northwest and east, respectively, (and cross-gradient) of boring S57SB007. Figure 7-2 illustrates the "hot spot" nature of the TCE surface soil contamination by showing a 50 µg/kg contour estimated based on the RI analytical data.

Semivolatile Organic Compounds

Eighteen SVOCs were detected in the three downgradient surface soil samples analyzed for SVOCs. As shown on Table 7-10, the list of detected SVOCs is comprised of bis(2-ethylhexyl)phthalate, carbazole, and 16 polynuclear aromatic hydrocarbons (PAHs). The maximum concentrations of all SVOCs were associated with the sample (S57SB0050101) collected from boring S57MW009/SB005, located approximately 400 feet southeast of Building 292 between the railroad tracks and Thomas Road. PAHs were detected in this sample at concentrations ranging from 37 µg/kg (2-methylnaphthalene) to 4200 µg/kg [benzo(b)fluoranthene]. Five PAHs were detected in sample S57SB0050101 only, and six additional PAHs were detected in this sample at concentrations greater than 10 times the respective concentrations detected in the other surface soil samples. Carbazole was detected in sample S57SB0050101 only at a concentration of 99 µg/kg. PAHs are by-products of combustion processes. PAHs and carbazole are also components of asphalt and creosote. Therefore, the presence of PAHs at this location may be related to the past and current use of gasoline fueled vehicles and asphalt associated with Thomas Road and/or the use of creosote as a preservative for the railroad ties.

Bis(2-ethylhexyl)phthalate was detected in two samples at concentrations of 41 µg/kg and 120 µg/kg. Phthalates, which are common plasticizers, are also common field and laboratory contaminants. However, the results for bis(2-ethylhexyl)phthalate were not qualified based upon blank contamination

during the data validation process. Bis(2-ethylhexyl)phthalate was also detected in the facility-specific background surface soil samples at a maximum concentration of 640 µg/kg.

Pesticides/PCBs

As shown on Table 7-10, 4,4'-DDD (12 µg/kg), 4,4'-DDE (61 µg/kg), 4,4'-DDT (150 µg/kg), and gamma-chlordane (5.3 µg/kg) were detected in the surface soil sample collected from boring S57MW009/SB005, located approximately 400 feet southeast of Building 292 between the railroad tracks and Thomas Road. Pesticides were not detected in any of the other Site 57 surface soil samples, and PCBs were not detected in any of the Site 57 surface soil samples. 4,4'-DDE and 4,4'-DDT were also detected in the basewide background surface soil samples at maximum concentrations of 10 µg/kg and 9.4 µg/kg, respectively.

Explosives

Nitrocellulose was detected at concentrations ranging from 116000 µg/kg to 299000 µg/kg in all three of the downgradient surface soil samples analyzed for explosives. The maximum concentration of nitrocellulose was associated with boring S57MW009/SB005, located approximately 400 feet southeast of Building 292 between the railroad tracks and Thomas Road. No other explosive compounds were detected in the downgradient surface soil samples.

Inorganics

Twenty metals were detected in the three downgradient surface soil samples analyzed for inorganic parameters. Several metals were detected at concentrations exceeding the $UTLs_{95\%}$ calculated for the basewide background surface soil dataset:

Metal	Maximum Concentration (mg/kg)	$UTL_{95\%\ BACKGROUND}$ [1] (mg/kg)	Eastern United States Soils [2] (mg/kg)	Maryland Soils [3] (mg/kg)
Arsenic	103	4.25	<0.1 - 73	1.1 - 7.1
Cadmium	0.8	0.26	NA	<0.01 - 5.6
Calcium	3270	409	100 - 280000	NA
Copper	20.3	18.7	<1 - 700	5 -70
Lead	487	149	<10 - 300	10 - 50
Mercury	0.1	0.087	0.01 - 3.4	0.04 - 0.14
Sodium	82	51.9	<500 - 50000	NA
Zinc	261	38.1	<5 - 2900	8 - 113

Note:
1 Brown & Root Environmental, December 1997 NA Not Available

2 Shacklette and Boerngen, 1984 ND Not detected
3 Dragun, 1991

Of the inorganic parameters with concentrations exceeding background, the maximum concentrations of cadmium, calcium, copper, mercury, and sodium were within the concentration ranges reported in the literature for soils of the eastern United States and/or the state of Maryland. The maximum concentration of zinc was within the concentration range reported for soils of the eastern United States, but exceeded the concentration range reported for the state of Maryland.

Notable detections include lead (487 mg/kg) in the surface soil sample collected from boring S57MW009/SB005 and arsenic (103 mg/kg) in the surface soil sample collected from boring S57SB007. The maximum concentrations of lead and arsenic in the other two downgradient surface soil samples were 89.2 mg/kg and 33.7 mg/kg, respectively.

In general, reported concentrations of metals in downgradient surface soil samples were similar (i.e., at the same order of magnitude) to reported concentrations of respective metals in the upgradient surface soil sample.

Analysis for total organic carbon (TOC) was performed for two surface soil samples and a field duplicate sample, with results for TOC ranging from 7,790 mg/kg to 50,600 mg/kg. The $UTL_{95\%}$ for TOC in the basewide background dataset for surface soil samples was 30,695 mg/kg. Results for pH in the three surface soil samples analyzed for this parameter ranged from 6.06 to 8.12.

7.2 SUBSURFACE SOIL CHARACTERIZATION

Analytical results for any parameter detected at least once in Site 57 subsurface soil samples are presented in Table 7-2. Two subsurface soil samples were collected from a single boring upgradient of the site area. Thirty-six subsurface soil samples were collected from 15 borings either from the site area or downgradient of the site area. For purposes of statistical evaluation and characterization, the subsurface soil samples collected from or downgradient of the site area will hereafter be referenced collectively as downgradient subsurface soil samples. Table 7-11 provides descriptive statistics (i.e., minimum and maximum detected concentrations, location of maximum concentration, detection frequency, range of detection limits, and average of detected concentrations) for the upgradient subsurface soil samples. Table 7-12 provides similar information for downgradient subsurface soil samples. Based upon the COPC selection process described in Section 9.1, Figure 7-3 depicts the locations and concentrations of COPCs detected in Site 57 upgradient and downgradient subsurface soil samples.

Note that analytical results for seven downgradient subsurface soil samples (S57SB0020301, S57SB0020601, S57SB0040301, S57SB0050301, S57SB0050501, S57SB0070201, and S57SB0150201) were excluded from Table 7-2 and Table 7-12. These six samples were collected from depth intervals below the water table. Because a risk assessment was to be performed using groundwater samples collected from the same locations, these six samples were excluded from the COPC selection process for downgradient subsurface soil samples. Analytical results for all samples, including the six subsurface soil samples collected below the groundwater table, are presented in the database tables included in Appendix H.

7.2.1 Upgradient Subsurface Soil

Organics

As shown on Tables 7-2 and 7-11, few organic compounds were detected in the two upgradient subsurface soil samples collected from boring S57MW012/SB013. Acetone (26 µg/kg) and di-n-butylphthalate (200 µg/kg) were detected in the sample collected from a depth interval of 3 to 4 feet bgs. Ethyl ether (54 µg/kg), bis(2-ethylhexyl)phthalate (89 µg/kg), and nitrocellulose (50400 µg/kg) were detected in the sample collected a depth interval of 6 to 8 feet bgs. Although the results reported for acetone, di-n-butylphthalate, and bis(2-ethylhexyl)phthalate were not determined during data validation to be due to laboratory or field blank contamination, all three of these compounds are common field and/or laboratory contaminants. Acetone was also detected in the site-specific background subsurface soil samples at a maximum concentration of 1800 µg/kg. No pesticides or PCBs were detected in either of the upgradient subsurface soil samples.

Inorganics

As shown on Table 7-11, 19 metals were detected in the upgradient subsurface soil samples. Of these 19 metals, the maximum concentration of only calcium (796 mg/kg) exceeded the $UTL_{95\%}$ calculated for the basewide background subsurface soil data set. However, the maximum concentration of calcium was within the concentration range (100 mg/kg to 280000 mg/kg) reported in the literature for soils of the eastern United States.

Results for pH in the two upgradient subsurface soil samples were 6.57 and 7.79.

7.2.2 Downgradient Subsurface Soil

Volatile Organic Compounds

Ten VOCs, including five chlorinated hydrocarbons, two ketones, two aromatics, and carbon disulfide, were detected in the 26 downgradient subsurface soil parameters analyzed for VOCs. As shown on Table 7-12, toluene, 1,1,1-trichloroethane, 2-butanone, trans-1,2-dichloroethene, and total xylenes were each detected in only one or two samples at concentrations ranging from 1 µg/kg to 29 µg/kg. Acetone, a common laboratory contaminant, was detected in seven samples at concentrations ranging from 14 µg/kg to 2200 µg/kg. Acetone was also detected in the basewide background subsurface soil samples at a maximum concentration of 1800 µg/kg. Carbon disulfide was detected in five of 26 subsurface soil samples at concentrations ranging from 1 µg/kg to 4 µg/kg.

Maximum concentrations of TCE (220000 µg/kg), cis-1,2-dichloroethene (77000 µg/kg), methylene chloride (21000 µg/kg), toluene (4 µg/kg), and total xylenes (8 µg/kg) were detected in the subsurface soil sample collected from a depth interval of 3 to 4 feet bgs from boring S57SB006. This boring location is near the southern end of Building 292. As shown on Table 7-2, only carbon disulfide (2 µg/kg) and TCE (4 µg/kg) were detected in the subsurface soil sample collected from boring S57SB006 at a depth interval of 10 to 11 feet bgs. Approximately 50 feet east of boring S57SB006 is boring S57MW003/SB002, near the southwestern corner of Building 292. In that boring, TCE (810 µg/kg) and cis-1,2-dichloroethene (33 µg/kg) were detected at a depth interval of 4 to 6 feet and again (TCE at 20,000 µg/kg and cis-1,2-dichloroethene at 1,300 µg/kg) at a depth interval of 14 to 16 feet. TCE was detected in ten additional samples at concentrations ranging from 1 µg/kg to 50 µg/kg. Most of the positive results for TCE were associated with borings located within 100 feet of the southeastern corner of Building 292. However, TCE was detected at a concentration of 3 µg/kg in the subsurface soil sample collected from the 4- to 6-foot interval of boring S57MW001/SB001, located west of Building 292. In addition, TCE was detected at concentrations of 1 µg/kg and 2 µg/kg in the two subsurface soil samples collected from boring S57MW007/SB004, located along the railroad tracks approximately 200 feet south of the Southeastern corner of Building 292. Figure 7-2 illustrates the "hot spot" nature of the TCE subsurface soil contamination by showing 50 µg/kg contours for soil at the 4 to 6 feet depth and the 14 to 16 feet depth. The contours were estimated based on the RI analytical data.

Semivolatile Organic Compounds

Five downgradient subsurface soil samples collected from three borings were analyzed for SVOCs. As shown on Table 7-12, 11 PAHs and bis(2-ethylhexyl)phthalate were detected. Maximum concentrations of SVOCs in downgradient subsurface soil samples were generally four to eight times less than respective concentrations detected in downgradient surface soil samples.

Pyrene (52 µg/kg) was detected in the subsurface soil collected at a depth interval of 4 to 6 feet bgs from boring S57MW011/SB008. No other SVOCs were detected in either of the two subsurface soil samples collected from boring S57MW011/SB008 or in the single subsurface soil sample collected from boring S57SB007. As shown on Table 7-2, 11 PAHs (at concentrations ranging from 43 µg/kg to 510 µg/kg) and bis(2-ethylhexyl)phthalate (92 µg/kg) were detected in the subsurface soil sample (2 to 4 feet bgs) collected from boring S57MW009/SB005. Eight PAHs, at concentrations ranging from 43 µg/kg to 140 µg/kg, were detected in the sample collected from a depth interval of 4 to 6 feet from this same boring. As previously noted, boring S57MW009/SB005 is located approximately 400 feet southeast of Building 292 between the railroad tracks and Thomas Road. The presence of PAHs at this location may be related to the past and current use of gasoline fueled vehicles and asphalt associated with Thomas Road and/or the use of creosote as a preservative for the railroad ties.

Pesticides/PCBs

4,4'-DDT and one of its derivatives, 4,4'-DDE, were detected at concentrations of 20 µg/kg and 17 µg/kg, respectively, in the subsurface soil sample (2 to 4 feet bgs) collected from boring S57MW009/SB005. These concentrations are also approximately 3.6 to 7.5 times less than respective concentrations of these parameters detected in the surface soil sample from this boring. No other pesticides or PCBs were detected in this sample or in any of the four other downgradient subsurface soil samples analyzed for pesticides/PCBs. 4,4'-DDT and 4,4'-DDE were also detected in the basewide background subsurface soil samples, with $UTLs_{95\%}$ of 3.05 µg/kg and 2.9 µg/kg, respectively.

Explosives

Nitrocellulose was detected at concentrations ranging from 66000 µg/kg to 205000 µg/kg in all five of the downgradient subsurface soil samples analyzed for explosives. No other explosive compounds were detected. A consistent pattern of nitrocellulose contamination in relation to depth is not evident. In boring S57MW009/SB005, concentrations decrease from the surface soil sample (299000 µg/kg) to the subsurface soil sample collected from the 2- to 4-foot interval (95100 µg/kg), and then increase to 123000 µg/kg in the field duplicate subsurface soil sample collected from the 4- to 6-foot interval. In boring S57SB007, concentrations decrease from 191000 µg/kg in the surface soil sample to 59200 µg/kg in the subsurface soil sample collected from the 4- to 5-foot interval. In boring S57MW011/SB008, concentrations decrease from the surface soil sample (116000 µg/kg) to the field duplicate of the sample from the 4- to 6-foot interval (66000 µg/kg), and then increase to 205000 µg/kg at a depth interval of 10 to 11 feet bgs.

Inorganics

Nineteen metals were detected in the downgradient subsurface soil samples. Several metals were detected at maximum concentrations exceeding the $UTLs_{95\%}$ calculated for the basewide background subsurface soil data set:

Metal	Maximum Concentration (mg/kg)	$UTL_{95\%\ BACKGROUND}$[1] (mg/kg)	Eastern United States Soils[2] (mg/kg)	Maryland Soils[3] (mg/kg)
Arsenic	50	24.4	<0.1 - 73	1.1 - 7.1
Beryllium	2.5	2.46	<1 - 7	ND - 3
Calcium	8840	196	100 - 280000	NA
Lead	100	37.5	<10 - 300	10 - 50
Mercury	0.25	0.13	0.01 - 3.4	0.04 - 0.14
Zinc	158	79.5	<5 - 2900	8 - 113

Note:
1 Brown & Root Environmental, December 1997
2 Shacklette and Boerngen, 1984
3 Dragun, 1991
NA Not available
ND Not detected

Of the metals with concentrations exceeding background, the maximum concentrations of beryllium and calcium were within the available concentration ranges reported in the literature for soils of the eastern United States and/or the state of Maryland. Maximum concentrations of arsenic, lead, mercury, and zinc were within the respective concentration ranges reported for soils of the eastern United States but exceeded the concentration ranges reported for the state of Maryland.

A comparison of Tables 7-12 and 7-10 indicates that maximum concentrations of most metals in downgradient subsurface soil samples are relatively similar (i.e., at the same order of magnitude) to the maximum concentrations of respective metals in downgradient surface soil samples.

Analysis for TOC was performed for five subsurface soil samples, with positive results for TOC in four samples ranging from 8120 mg/kg to 22000 mg/kg. The $UTL_{95\%}$ for TOC in the basewide background dataset for subsurface soil samples was 4243 mg/kg. Results for pH in the five subsurface soil samples analyzed for this parameter ranged from 5.4 to 8.34.

7.3 GROUNDWATER

Groundwater samples were collected from 13 monitoring wells, three temporary wells, and one potable well during the Event I and Event II investigations of Site 57. A shallow confining layer (approximately 10 feet bgs) is present in the surficial aquifer at Site 57. Therefore, samples representative of both the groundwater held by the shallow confining layer and the groundwater below the confining layer were collected.

As shown on Figure 7-4, the potable well, PW-07, is located downgradient of Site 57 (northwest of Site 41, Scrap Yard). A water sample was collected from this location to determine whether the potable well has been affected by site-related contamination. Note that analytical results for the water sample (S57PW0070101) collected from potable well PW-07 were excluded from the risk assessment and, accordingly, from all tables referenced in this section. Analytical results for this sample are discussed in Section 7.3.5. Analytical results for all samples, including the potable water sample, are presented in the database tables included in Appendix H.

As also shown on Figure 7-4, the three temporary wells were located along the storm sewer trench downgradient of the site. Groundwater samples were collected from these locations to determine if groundwater preferentially flowing through the bedding along the trench has been affected by contamination from the site.

Analytical results for any parameter detected at least once in Site 57 upper and lower surficial groundwater samples are presented in Tables 7-3 and 7-4, respectively. One upper surficial and one lower surficial groundwater sample were collected upgradient of the site area. Nine upper surficial and five lower surficial groundwater samples were collected either from the site area or downgradient of the site area. For purposes of statistical evaluation and characterization, groundwater samples collected from or downgradient of the site area will hereafter be referenced collectively as downgradient groundwater samples. Tables 7-13 and 7-14 provide descriptive statistics (i.e., minimum and maximum detected concentrations, location of maximum concentration, detection frequency, range of detection limits, and average of detected concentrations) for upper surficial and lower surficial upgradient groundwater samples, respectively. Tables 7-15 and 7-16 provide similar information for upper surficial and lower surficial downgradient groundwater samples, respectively. Based upon the COPC selection process described in Section 9.1, Figure 7-4 depicts the locations and concentrations of COPCs detected in all Site 57 groundwater samples.

7.3.1 Upper Surficial Upgradient Groundwater

Organics

Few organic compounds were detected in the upper surficial upgradient groundwater sample. As shown on Table 7-13, six VOCs, all chlorinated hydrocarbons, were detected. 1,1-Dichloroethene and 1,1,1-trichloroethane were detected at concentrations of 77.5 µg/L and 14.6 µg/L, respectively. 1,1-Dichloroethane, 1,2-dichloroethane, chloroform, and TCE were detected at relatively low concentrations, ranging from 0.8 µg/L to 2.7 µg/L. Chloroform, detected at a concentration of 1.3 µg/L in the shallow upgradient groundwater sample, was also detected in the basewide background groundwater samples at a maximum concentration of 2 µg/L.

No SVOCs, pesticides/PCBs, or explosives were detected in the upper surficial upgradient groundwater sample.

Inorganics

Eleven metals were detected in the unfiltered shallow upgradient groundwater sample. As shown on Table 7-13, none of the detected concentrations exceeded the respective $UTLs_{95\%}$ reported for the background dataset. Table 7-13 also shows that the same 11 metals were detected at similar concentrations [i.e., less than 20 percent relative percent difference (RPD)] in the filtered shallow upgradient groundwater sample.

The upper surficial upgradient groundwater sample was also analyzed for ammonium perchlorate, hardness as $CaCO_3$, pH, TDS, and TOC. TOC was not detected. Positive results for the remaining parameters are provided on Table 7-13.

7.3.2 Lower Surficial Upgradient Groundwater

Volatile Organic Compounds

Few organic compounds were detected in the lower surficial upgradient groundwater sample or its field duplicate sample. As shown on Table 7-14, six VOCs, including acetone, ethyl ether, and four chlorinated hydrocarbons, were detected. The chlorinated hydrocarbons (1,1-dichloroethane, 1,1-dichloroethene, cis-1,2-dichloroethene, and TCE) were detected at relatively low concentrations, ranging from 1.8 µg/L to 5.2 µg/L. Acetone and ethyl ether were detected at concentrations of 12 µg/L and 3.6 µg/L, respectively. Although the result for acetone was not determined during data validation to be reflective of blank contamination, it should be noted that acetone is a common laboratory contaminant.

Semivolatile Organic Compounds, Pesticides/PCBs, and Explosives

Bis(2-ethylhexyl)phthalate, a SVOC and a common field and laboratory contaminant, was detected in the lower surficial upgradient groundwater sample at a concentration of 2 µg/L. This compound was also detected in the basewide background groundwater samples at a maximum concentration of 1 µg/L. Nitrocellulose, an explosive compound, was detected at a concentration of 223 µg/L. No other SVOCs, pesticides/PCBs, or explosives were detected in the lower surficial upgradient groundwater sample or its field duplicate sample.

Inorganics

With one exception, the same eleven metals detected in the upper surficial upgradient groundwater samples were also detected in the unfiltered lower surficial upgradient groundwater sample. Beryllium, which was detected in the upper surficial upgradient groundwater samples, was not detected in the unfiltered lower surficial upgradient groundwater samples. Instead, cadmium was detected in the unfiltered lower surficial upgradient groundwater samples. As shown on Table 7-14, only the detected concentration of zinc in the lower surficial upgradient sample (64.1 µg/L) exceeds the $UTL_{95\%}$ reported for zinc in the background dataset (45.2 µg/L).

The same 11 metals detected in the unfiltered lower surficial upgradient groundwater sample were detected at similar concentrations (i.e., less than 20 percent RPD) in the filtered lower surficial upgradient groundwater sample. Beryllium (0.12 µg/L) and lead (1 µg/L) were also detected in the filtered lower surficial upgradient groundwater sample. Concentrations of cobalt and zinc in the filtered lower surficial upgradient groundwater sample exceeded the respective $UTLs_{95\%}$ reported for the background dataset.

The lower surficial upgradient groundwater sample was also analyzed for ammonium perchlorate, hardness as $CaCO_3$, pH, TDS, and TOC. Ammonium perchlorate was not detected. Positive results for the remaining parameters are provided on Tables 7-4 and 7-14.

7.3.3 Upper Surficial Downgradient Groundwater

Volatile Organic Compounds

Twelve VOCs, including nine chlorinated hydrocarbons, acetone, ethyl ether, and toluene, were detected in the nine upper surficial downgradient groundwater samples analyzed for VOCs. Acetone, a common laboratory contaminant, and toluene were each detected in only one sample at concentrations of 29.4 µg/L and 0.5 µg/L, respectively. Toluene was also detected at a maximum concentration of 7 µg/L in the basewide background groundwater samples.

As shown on Table 7-3 and Figure 7-4, ethyl ether was detected at concentrations of 3950 µg/L (S57MW0110101), 1089 µg/L (S57MW0080101), 296.6 µg/L (S57MW0040101), and 1 µg/L (S57MW0020101) in four of seven samples. All four of these samples are associated with permanent monitoring wells. Monitoring well S57MW011 is located approximately 150 feet southeast and downgradient of Building 496, a vault used for the storage of ether. Monitoring well S57MW008 is located along the drainage trench, approximately 275 feet southeast and downgradient of the ether vault. Monitoring well S57MW004 is located approximately 175 feet east and cross-gradient or slightly downgradient of the ether vault, near the southeastern corner of Building 292. Monitoring well S57MW002 is located approximately 80 feet northeast and slightly upgradient of the ether vault. Analytical results for the groundwater samples from the two remaining permanent monitoring wells, both located further downgradient of the site area, were rejected during data validation. Ethyl ether was not detected in the groundwater samples collected from the three temporary wells located downgradient of the site along the storm sewer trench.

Figure 7-5 illustrates contours for ethyl ether concentrations in surficial groundwater based on the RI analytical data. Contours are shown for both the upper and lower surficial groundwater. (The lower surficial downgradient groundwater is discussed in Section 7.3.4). As indicated by the contours, ethyl ether concentrations are higher in the upper surficial groundwater, but the lower surficial groundwater appears to cover a wider area. In both instances, the location of the highest contaminant concentrations is positioned 150 to 300 feet southeast of Ether Vault No. 1 and Ether Vault No. 4.

A definitive pattern of chlorinated hydrocarbon concentrations in the shallow groundwater samples could not be identified. As shown on Table 7-15, maximum concentrations of TCE (611.7 µg/L), cis-1,2-dichloroethene (528 µg/L), 1,1,1-trichloroethane (29.5 µg/L), tetrachloroethene (9.5 µg/L), and trans-1,2-dichloroethene (8.3 µg/L) were detected in the groundwater sample collected from monitoring well S57MW004, located near the southeastern corner of Building 292. However, these concentrations do not appear to consistently increase or decrease in samples collected from increasingly downgradient wells. For example, TCE was detected at a concentration of 213 µg/L in the shallow groundwater sample collected from well S57MW006, located near Building 158. Yet concentrations of TCE associated with shallow groundwater samples collected between monitoring wells S57MW004 and S57MW006 range from being not detected (S57MW007) to 157.8 µg/L (S57MW010). Figure 7-6 illustrates contours for TCE concentrations in surficial groundwater based on the RI analytical data. The contours show that, for the upper surficial groundwater, a localized (or hot spot) area of highest contamination occurs at the southern corner of Building 292. For the lower surficial groundwater (discussed in Section 7.3.4), contamination is also elevated at the southern corner of Building 292, but the location of highest concentration is located downgradient at S57MW009.

In addition, the maximum concentration of vinyl chloride (85 µg/L), a degradation product of TCE, was detected in the groundwater sample collected from temporary well S57TW003, located along the storm sewer trench, approximately 200 feet upgradient of the outfall at Mattawoman Creek. Two other degradation

products of TCE, cis-1,2-dichloroethene (260 µg/L) and trans-1,2-dichloroethene (2 µg/L), were also detected in this temporary well sample. Yet no VOCs were detected in the groundwater sample collected from temporary well S57TW002, located upgradient of well S57TW003.

Semivolatile Organic Compounds, Pesticides/PCBs, and Explosives

Bis(2-ethylhexyl)phthalate (2 µg/L) and di-n-butyl phthalate (5 µg/L) were each detected in one of the two upper surficial downgradient groundwater samples analyzed for SVOCs. As previously noted, phthalates are plasticizers and are common field and laboratory contaminants. Each of these phthalates was also detected in the basewide background groundwater samples at a maximum concentration of 1 µg/L.

Nitrocellulose was detected at a concentration of 148 µg/L in the upper surficial groundwater sample collected from monitoring well S57M010. The result for nitrocellulose associated with the groundwater sample from monitoring well S57MW004 was rejected during data validation. No other SVOCs, pesticides/PCBs, or explosives were detected in the two upper surficial downgradient groundwater samples analyzed for these parameters.

Inorganics

Twelve metals were detected in the two unfiltered upper surficial downgradient groundwater samples analyzed for metals. The maximum concentration of zinc exceeded the $UTL_{95\%}$ for zinc in the basewide background groundwater dataset. In addition, beryllium and lead, which were detected at maximum concentrations of 0.1 µg/L and 1.3 µg/L, respectively, were not detected in the basewide background groundwater samples. With the exception of iron (4330 µg/L) in the unfiltered upper surficial downgradient groundwater sample collected from well S57MW010, the concentrations of metals in unfiltered upper surficial downgradient groundwater samples were similar (i.e., at the same order of magnitude) as the respective concentrations of metals detected in unfiltered upper surficial upgradient groundwater samples.

With the exception of beryllium, the same list of metals was detected in the filtered upper surficial downgradient groundwater samples. In general, maximum concentrations of metals in filtered groundwater samples were very similar (i.e., within 20 percent RPD) to maximum concentrations of respective metals detected in unfiltered groundwater samples. As shown on Table 7-15, maximum concentrations of cobalt and zinc exceeded the respective $UTLs_{95\%}$ associated with the basewide background dataset. In addition, lead, which was detected in a single sample at a concentration of 1.3 µg/L, was not detected in the basewide background data samples.

As shown on Table 7-3, analyses for ammonium perchlorate, hardness as $CaCO_3$, pH, TDS, and TOC were performed for from one to all six of the upper surficial downgradient groundwater samples collected

from the permanent monitoring wells. Ammonium perchlorate was not detected in the single groundwater sample analyzed for this parameter. Analytical results for the remaining parameters are summarized on Table 7-15.

7.3.4 Lower Surficial Downgradient Groundwater

Volatile Organic Compounds

Nine VOCs, including eight chlorinated hydrocarbons and ethyl ether, were detected in the five lower surficial downgradient groundwater samples analyzed for VOCs. Ethyl ether was detected in all five samples at concentrations ranging from 2.8 µg/L to 1930.6 µg/L. A lower surficial groundwater sample was not collected at the location where the maximum concentration of ethyl ether was detected in the upper surficial groundwater samples. As shown on Figure 7-4, the maximum concentration of ethyl ether in the lower surficial downgradient groundwater samples was detected in the sample collected from well S57MW007, located approximately 150 feet southeast and downgradient of the previously described ether vault. This concentration is almost double the concentration (1089 µg/L) detected in the groundwater sample collected from the upper surficial well at this well cluster location. The concentration of ethyl ether detected in lower surficial groundwater at the southeastern corner of Building 292 (292.5 µg/L) was very similar to the concentration detected in the upper surficial groundwater at this location (296.6 µg/L). However, while ethyl ether was detected at a concentration of only 1 µg/L in the upper surficial groundwater sample collected from well S57MW002, located upgradient of the ether vault and west of Building 292, ethyl ether was detected at a concentration of 678.8 µg/L in the lower surficial groundwater sample collected from this same well cluster. Ethyl ether was detected at concentrations of 2.8 µg/L and 5 µg/L, respectively, in lower surficial groundwater samples collected from wells S57MW009 and S57MW005. These wells are located further downgradient from the site area than the previously discussed wells. Analytical results for upper surficial groundwater samples from these two well clusters are not available for comparison with lower surficial groundwater results because results for the upper surficial samples had been rejected during data validation.

Figure 7-5 illustrates contours for ethyl ether concentrations in surficial groundwater based on the RI analytical data. Contours are shown for both the upper and lower surficial groundwater. (The upper surficial downgradient is discussed in Section 7.3.3). As indicated by the contours, ethyl ether concentrations are higher in the upper surficial groundwater, but the lower surficial groundwater appears to cover a wider area. In both instances, the location of the highest contaminant concentration is positioned 150 to 300 feet southeast of Ether Vault No. 1 and Ether Vault No. 4.

A definitive pattern of chlorinated hydrocarbon concentrations is also not evident for the lower surficial downgradient groundwater samples. As shown on Table 7-16, the maximum concentrations of all chlorinated hydrocarbons except vinyl chloride were associated with the lower surficial groundwater sample

collected from well S57MW009. This well is located between the railroad tracks and Thomas Road, just south of the location where the paths of the railroad tracks and the concrete drainage ditch diverge. The only positive result for vinyl chloride (3.1 µg/L) was associated with the lower surficial groundwater sample collected from well S57MW003, located at the southeastern corner of Building 292. The lowest concentrations of chlorinated hydrocarbons in lower surficial downgradient groundwater samples were associated with well S57MW001, located approximately 200 feet northwest and upgradient of the southeastern corner of Building 292, and well S57MW007, located approximately 200 feet south and downgradient of the southeastern corner of Building 292.

A comparison of the TCE results associated with lower surficial and upper surficial groundwater samples from the same well clusters also does not conclude with a definitive pattern. The concentrations of TCE detected in the lower surficial groundwater samples associated with well clusters S57MW001/S57MW003 and S57MW003/S57MW004, located west and at the southeastern corner of Building 292, respectively, are approximately 36 and 2.5 times less than the concentrations and TCE detected in the respective lower surficial groundwater samples. Moving downgradient, the concentration of TCE detected in the lower surficial groundwater sample from well cluster S57MW007/S57MW008 is 2 µg/L. TCE was not detected in the respective upper surficial groundwater sample, although the reporting limit for the upper surficial sample (1 µg/L) was only slightly less than the concentration reported for the lower surficial groundwater sample. Continuing in a downgradient direction, the concentration of TCE detected in the lower surficial groundwater sample from well cluster S57MW009/S57MW010 is approximately 3.6 times greater than the concentration of TCE detected in the respective upper surficial groundwater sample. Finally, the concentrations of TCE detected in the upper surficial (213 µg/L) and lower surficial (249 µg/L) groundwater samples collected from well cluster S57MW005/S57MW006 are very similar (within 16 percent RPD).

Figure 7-6 illustrates contours for TCE concentrations in groundwater based on the RI analytical data. The figure shows contours for both the upper and lower surficial groundwater. For the upper surficial groundwater, a localized (or hot spot) area of highest contamination occurs at the southern corner of Building 292. For the lower surficial groundwater, contamination is also elevated at the southern corner of Building 292, but the location of highest concentration is located downgradient at S57MW009.

Semivolatile Organic Compounds, Pesticides/PCBs, and Explosives

Bis(2-ethylhexyl)phthalate (3 µg/L), a common field and laboratory contaminant, was detected in one of the two lower surficial downgradient groundwater samples analyzed for SVOCs. This compound was also detected in the basewide background groundwater samples at a maximum concentration of 1 µg/L.

Nitrocellulose was detected at a concentration of 148 µg/L in the lower surficial groundwater sample collected from monitoring well S57MW003. The result for nitrocellulose associated with the groundwater sample from monitoring well S57MW009 was rejected during data validation.

No other SVOCs, pesticides/PCBs, or explosives were detected in the two lower surficial downgradient groundwater samples analyzed for these parameters.

Inorganics

Eleven metals were detected in the two unfiltered lower surficial downgradient groundwater samples analyzed for metals. As shown on Table 7-16, none of the detected concentrations exceeded respective $UTLs_{95\%}$ associated with the basewide background groundwater dataset. The same list of metals was detected in the filtered lower surficial downgradient groundwater samples. With the exception of iron, maximum concentrations of metals in filtered groundwater samples were very similar (i.e., within 20 percent RPD) to maximum concentrations of respective metals detected in unfiltered groundwater samples. As shown on Table 7-16, maximum concentrations of cobalt and zinc in filtered lower surficial groundwater samples exceeded the respective $UTLs_{95\%}$ associated with the basewide background dataset.

As shown on Table 7-4, analyses for hardness as $CaCO_3$, pH, TDS, and TOC were performed for from two to all five of the lower surficial downgradient groundwater samples. TOC was not detected in either of the two groundwater samples analyzed for this parameter. Analytical results for the remaining parameters are summarized on Table 7-16.

7.3.5 Potable Water

As previously discussed, a water sample was collected from a potable well, PW-07, located downgradient of Site 57 (northwest of Site 41, Scrap Yard), to determine whether the well has been affected by site-related contamination. This sample was analyzed for VOCs and ammonium perchlorate. As shown in the database tables included in Appendix H, TCE was detected at a concentration of 7.2 µg/L in this sample. No other VOCs or ammonium perchlorate were detected in this sample.

For periodic monitoring of potable water quality, PW-07 had been sampled in 1990, 1992, 1995, and 1998. The samples were analyzed for VOCs, and TCE was not detected in any of the samples. In September 1992, PW-07 was sampled as part of a facility-wide site inspection. Tetrachloroethene (PCE) was detected in that sample at a concentration of 3.0 µg/L. PW-07 was resampled within days of the original analysis, and PCE was not detected. The site investigation report indicated that the pumping period of the well prior to the initial sampling might have affected the detection of PCE in the PW-07 water. Based on

the historical sampling and analytical results from PW-07, it is not clear that Site 57 is, in fact, affecting the water from the well. It should be noted that well PW-07 was removed from service for maintenance shortly after the RI field sampling.

An additional sample was collected from PW-07 in October 1999 and was analyzed for volatile organics to verify the results of the sample collected during the remedial investigation. No TCE was detected in either the new sample or its duplicate. The only detection occurred in the duplicate and was for 1,4-dichlorobenzene at 0.13 µg/L. As a frame of reference, the EPA Region III screening criteria for tap water is 0.47 µg/L, and the Federal MCL is 75 µg/L.

The potable water system is sampled periodically in accordance with the governing state and Federal regulations. When PW-07 is in operation and contributing water to the facility-wide potable water system, its water is sampled as part of the routine sampling of the potable system.

7.4 SURFACE WATER AND SEDIMENT FROM DRAINAGE CHANNEL/STREAM

Six surface water and six sediment samples were collected from the concrete drainage channel (along the southwestern side of the site) that flows to the intermittent stream that, in turn, flows downgradient from Site 57 to Mattawoman Creek. As shown on Figures 7-7 and 7-8, one of the surface water/sediment sampling locations (S57SW013/SD009) is in a swale located west and upgradient of the point where the drainage channel outlets into the intermittent stream. Although the surface water and sediment samples from this location were collected in connection with the surface water and sediment from the open channel, this location is more indicative of an upgradient location with respect to the site. The remaining surface water/sediment samples were collected either from the site area (i.e., in the concrete drainage channel) or downgradient of the site area along the natural drainage path previously referenced as the unnamed creek. For purposes of statistical evaluation and characterization, surface water and sediment samples collected from or downgradient of the site area will hereafter be referenced collectively as downgradient surface water and downgradient sediment samples.

As also shown in Figures 7-7 and 7-8, a seventh set of surface water and sediment samples was collected from a location (S57SW010/SD006) in Mattawoman Creek, downgradient of the storm sewer outfall and upgradient of the drainage channel/stream outlet. This location is far enough downgradient of the site that the associated samples are more indicative of contamination in Mattawoman Creek than of contamination in the surface water of Site 57. The samples were collected to gain data for evaluating the possibility that Site 57 is contributing contamination to Mattawoman Creek. Therefore, the surface water and sediment samples from this location will be discussed in Section 7.4.5, but have been excluded from the risk assessment.

Analytical results for any parameter detected at least once in surface water and sediment samples collected from the drainage channel and unnamed creek, including the samples from the Mattawoman Creek location (S57SW101/SD006), are presented in Tables 7-5 and 7-6, respectively. Tables 7-17 and 7-18 provide descriptive statistics (i.e., minimum and maximum detected concentrations, location of maximum concentration, detection frequency, range of detection limits, and average of detected concentrations) for upgradient and downgradient surface water samples, respectively, collected from the drainage channel and the unnamed creek. Tables 7-19 and 7-20, respectively, provide similar information for upgradient and downgradient sediment samples collected from the drainage channel and the unnamed creek. Surface water and sediment samples from the Mattawoman Creek location (S57SW010/SD006) were not included in Tables 7-18 and 7-20 because, as previously noted, these samples were not included in the risk assessment. Based upon the COPC selection process described in Section 9.1, Figure 7-7 depicts the locations and concentrations of COPCs detected in all Site 57 surface water samples, and Figure 7-8 depicts the locations and concentrations of COPCs detected in all Site 57 sediment samples.

7.4.1 Upgradient Surface Water

As indicated on Table 5-2, the surface water sample collected upgradient of the drainage channel was analyzed for VOCs and 12 miscellaneous wet chemistry parameters. No VOCs were detected in this sample. Chloride, fluoride, salinity, and sulfate were also not detected in the upgradient surface water sample. Positive results for the remaining miscellaneous parameters are presented on Tables 7-5 and 7-17.

7.4.2 Downgradient Surface Water

Organics

As shown on Table 7-18, very few organic compounds were detected in the six downgradient surface water samples associated with the drainage channel and unnamed creek. Figure 7-7 depicts the surface water sample locations. Excluding the upgradient sample (S57SW0130101) and the Mattawoman Creek sample (S57SW0100101), positive results for the six downgradient surface water samples are presented from left to right in increasingly downgradient order on Table 7-5.

All six samples were analyzed for VOCs. No VOCs were detected in sample S57SW0110101, the sample collected from the most upgradient sampling location within the drainage channel. TCE (0.7 µg/L) and cis-1,2-dichloroethene (0.5 µg/L) were detected in surface water sample S57SW012. Acetone, a common laboratory contaminant, was detected in surface water sample S57SW0140101, collected in the swale at the drainage channel outlet into the unnamed creek. 1,2,4-Trichlorobenzene (0.7 µg/L) and TCE (1.4 µg/L) were detected in surface water sample S57SW0150101, collected from the unnamed creek

south of Building 157. No VOCs were detected in sample S57SW01601, collected at the outlet of the unnamed creek into Mattawoman Creek.

Sample S57SW0140101, collected at the drainage channel outlet into the unnamed creek, and sample S57SW01601, collected at the outlet of the unnamed creek into Mattawoman Creek, were analyzed for SVOCs, pesticides/PCBs, and explosives. Nitrocellulose was detected at a concentration of 221 µg/L in surface water sample S57SW0160101. No other SVOCs, pesticides/PCBs, or explosives were detected in the downgradient surface water samples.

Inorganics

Sixteen metals and cyanide were detected in the two unfiltered surface water samples analyzed for these parameters. As shown in on Table 7-18, maximum concentrations of cyanide and all but five of the metals were associated with the unfiltered surface water sample collected at the outfall of the unnamed creek into Mattawoman Creek. Eleven metals were detected in the associated filtered surface water samples. The maximum concentrations of all but three of the metals were associated with the filtered surface water sample collected at the outfall of the unnamed creek into Mattawoman Creek. Site-specific background data are not available for surface waters.

Analyses for hardness as $CaCO_3$ and TOC were performed for two of the downgradient surface water samples. Analyses for 10 additional miscellaneous parameters were performed for three of the downgradient surface water samples. Analytical results for these miscellaneous parameters are summarized on Table 7-18.

7.4.3 Upgradient Sediment

The sediment sample collected upgradient of the drainage channel was analyzed for VOCs, TOC, and acid volatile sulfide/simultaneously extracted metals (AVS/SEM). No VOCs were detected in this sample. TOC was detected at a concentration of 16900 mg/kg. This concentration exceeds the basewide background concentration for TOC in subsurface soils (4243 mg/kg) but is less than the basewide background concentrations for TOC in surface soils and freshwater sediments (30695 mg/kg and 395297 mg/kg, respectively). Positive AVS/SEM results are summarized in Table 7-19 and will be discussed in Section 10, the ecological risk assessment.

7.4.4 Downgradient Sediment

Organics

Acetone (31 µg/kg), a common laboratory contaminant, and carbon disulfide (3 µg/kg) were each detected in a single downgradient sediment sample. No other VOCs were detected in the five downgradient sediment samples associated with the drainage channel and the unnamed creek.

Sample S57SD0100101, collected at the drainage channel outlet into the unnamed creek, and sample S57SD0120101, collected at the outlet of the unnamed creek into Mattawoman Creek, were analyzed for SVOCs, pesticides/PCBs, and explosives. As shown on Table 7-20, two phthalates and 12 PAHs were detected in the sediment sample collected at the drainage channel outlet into the unnamed creek. The phthalates, which are common laboratory contaminants, were detected at concentrations of 46 µg/kg and 61 µg/kg. The PAHs were detected at concentrations ranging from 44 µg/kg (fluorene) to 380 µg/kg (fluoranthene). No SVOCs were detected in the sample collected at the outlet of the unnamed creek into Mattawoman Creek.

4,4'-DDT (0.96 µg/kg) and its derivatives, 4,4'-DDD (1.4 µg/kg) and 4,4'-DDE (0.34 µg/kg), were each detected in sediment sample S57SD0120101, collected at the outlet of the unnamed creek into Mattawoman Creek. No other pesticides/PCBs or explosives were detected in either of the two downgradient sediment samples analyzed for these parameters.

Inorganics

Nineteen metals and cyanide were detected in the two downgradient sediment samples analyzed for inorganic parameters. As shown on Table 7-20, maximum concentrations of all but two of the metals were associated with the sediment sample collected at the drainage channel outlet into the unnamed creek (S57SD0100101). Concentrations of chromium, magnesium, manganese, nickel, and zinc in this sample were approximately six to 18 times greater than concentrations of respective metals in the sediment sample collected at the outlet of the unnamed creek into Mattawoman Creek (S57SD0120101). Maximum concentrations of cyanide, potassium, and sodium were associated with downgradient sediment sample S57SD0120101.

The basewide background levels established based on freshwater sediment samples may not be completely applicable to the Site 57 sediment samples because the background study did not include background sampling locations from Mattawoman Creek, Chicamuxen Creek or surface water bodies influenced by these waterways. Therefore, detected concentrations of metals in the Site 57 sediment

samples were compared to basewide background soil concentrations in addition to background freshwater sediment concentrations:

Metal	Maximum Concentration (mg/kg)	Site-Specific Sediment[1] Background Concentration (mg/kg)	Site-Specific Soil[2] Background Concentration (mg/kg)
Aluminum	1480	52362	18329/34406
Arsenic	4.7	63	4.25/24.4
Barium	8	577	144/191
Beryllium	0.16	10.9	0.905/2.46
Cadmium	0.26	1.85	0.26/0.388
Calcium	696	88137	409/196
Chromium	10.7	79.2	24.2/101
Cobalt	5	118	39.7/133
Copper	6.9	297	18.7/56.5
Cyanide	0.61	ND	ND
Iron	7440	193218	43170/151453
Lead	18.8	476	149/37.5
Magnesium	1180	19043	1382/4307
Manganese	96.4	2561	2248/1270
Mercury	1.9	0.778	0.087/0.13
Nickel	10	382	18.2/22.1
Potassium	214	5061	1874/5998
Sodium	208	472	51.9/826
Vanadium	9	196	53.5/133
Zinc	126	1660	38.1/79.5

Note:
1 Site-specific background freshwater sediment data (B&R Environmental, December 1997).
2 Site-specific background surface/subsurface soil data (B&R Environmental, December 1997).
ND Not detected.

With the exception of mercury, all positive detections of metals were less than the respective $UTLs_{95\%}$ calculated for the background freshwater sediment dataset. Maximum concentrations of arsenic, calcium, mercury, sodium, and zinc exceeded basewide background surface and/or subsurface soil concentrations. Cyanide, which was detected in the downgradient sediment samples at a maximum concentration of 0.61 mg/kg, was not detected in the basewide background sediment or soil samples.

TOC was detected in both of the downgradient sediment samples at concentrations 10700 mg/kg (S57SD0120101) and 18800 mg/kg (S57SD0100101). The maximum concentration of TOC exceeds the basewide background concentration calculated for subsurface soils but is less than the basewide

background concentrations determined for surface soils and freshwater sediments. Analytical results for pH in sediment samples S57SD0100101 and S57SD0120101 were 7.51 and 7.85, respectively.

Sediment samples S57SD0100101 and S57SD0120101 were also analyzed for AVS/SEM. Positive AVS/SEM results are summarized on Table 7-20 and will be discussed in Section 10, the ecological risk assessment.

7.4.5 Mattawoman Creek Surface Water and Sediment

The surface water sample (S57SW0100101) collected from Mattawoman Creek downgradient of the storm sewer outlet was analyzed for VOCs only. As shown on Table 7-5, six VOCs were detected in this sample. 2-Butanone, a common laboratory contaminant, and carbon disulfide were detected at concentrations of 9.4 µg/L and 0.9 µg/L. Ethyl ether, a site-related contaminant, was detected at a concentration of 69.4 µg/L. TCE (16.5 µg/L), another site-related contaminant, and two of its degradation products, cis-1,2-dichloroethene (40.1 µg/L) and vinyl chloride (3.5 µg/L), were also detected in surface water sample S57SW0100101. These results indicate that contamination from Site 57 may be impacting the surface water of Mattawoman Creek.

The sediment sample (S57SD0060101) collected from Mattawoman Creek downgradient of the storm sewer outlet was analyzed for VOCs, TOC, and AVS/SEM. As shown on Table 7-6, three VOCs were detected in this sample. Acetone, a common laboratory contaminant, was detected at a concentration of 34 µg/kg. Ethyl ether, a site-related contaminant, was detected at a concentration of 7 µg/kg. A degradation product of TCE, cis-1,2-dichloroethene, was detected at a concentration of 4 µg/kg. Although the results for ethyl ether and cis-1,2-dichloroethene are relatively low, positive results for these site-related contaminants in the Mattawoman Creek sediment sample indicate that contamination from Site 57 may be impacting the sediment of Mattawoman Creek.

TOC was detected at a concentration of 36900 mg/kg in sediment sample S57SD0060101. Table 7-6 presents positive results for AVS/SEM for this sediment sample. AVS/SEM data will be discussed in Section 10, the ecological risk assessment.

7.5 STORM SEWER SURFACE WATER AND SEDIMENT

Twelve surface water samples were collected from seven manholes along the storm sewer that flows through Site 57 and downgradient to Mattawoman Creek. A thirteenth surface water sample and a sediment sample were collected at the storm sewer outfall at Mattawoman Creek. Analytical results for any parameter detected at least once in storm sewer surface water and sediment samples are presented in Tables 7-7 and 7-8, respectively. Tables 7-21 and 7-22 provide descriptive statistics (i.e., minimum and

maximum detected concentrations, location of maximum concentration, detection frequency, range of detection limits, and average of detected concentrations) for storm sewer surface water and sediment samples, respectively. Based upon the COPC selection process described in Section 9.1, Figure 7-7 depicts the locations and concentrations of COPCs detected in all Site 57 surface water samples, and Figure 7-8 depicts the locations and concentrations of COPCs detected in all Site 57 sediment samples.

7.5.1 Storm Sewer Surface Water

As previously noted, Site 57 storm sewer surface water samples were collected from seven manholes located along the storm sewer and at the outfall of the storm sewer to Mattawoman Creek. Table 7-7 indicates the location (i.e., manhole or outfall) from which each sample was collected, and presents the data by location from left to right in an increasingly downgradient order. Table 5-2 provides more specific information regarding where each of the surface water samples was collected from within the manhole or at the outfall (i.e., from the invert of the main flow, the invert of an inlet, or the invert of the outlet).

Volatile Organic Compounds

All 13 of the storm sewer surface water samples were analyzed for VOCs. Sixteen VOCs, including ethyl ether, nine chlorinated or brominated hydrocarbons, four aromatic compounds, and two ketones, were detected. Maximum concentrations of seven of the VOCs were associated with manhole MH-429, located along the southern side of Building 292.

Ethyl ether was detected in all 13 storm sewer surface water samples at concentrations ranging from 1.9 µg/L to 197 µg/L. The concentration of ethyl ether in the surface water sample collected from the most upgradient manhole (MH-427) was 145 µg/L. The maximum concentration of ethyl ether was associated with manhole MH-429, located along the southern side of Building 292. Figure 7-7 illustrates that, with a few exceptions, concentrations of ethyl ether in the storm sewer surface water samples gradually decrease from manhole MH-429 to increasingly downgradient locations. The concentration of ethyl ether in the surface water sample collected at the outfall to Mattawoman Creek was 70.2 µg/L.

TCE was detected in 12 of 13 storm sewer surface water samples at concentrations ranging from 0.4 µg/L to 21.3 µg/L. The maximum concentration of TCE (21.3 µg/L) was associated with manhole IW-80 (MH-489), located downgradient of the site area and west of Building 222. A definitive pattern of TCE concentrations is not evident. However, concentrations of TCE associated with the four storm sewer surface water sampling locations downgradient of the site area [MH-487, IW-80 (MH-489), MH-497, and S57SW009] were generally greater than concentrations of TCE associated with the four storm sewer surface water sampling locations within the site area. With the exception of sample S57SW0080301 (0.4 µg/L), concentrations of TCE associated with samples from the four downgradient locations ranged

from 11.5 µg/L to 21.3 µg/L. Concentrations of TCE associated with samples from the four sampling locations within the site area ranged from 5.9 µg/L to 10.1 µg/L.

One of the degradation products of TCE, cis-1,2-dichloroethene, was also detected in 12 of the 13 storm sewer surface water samples at concentrations ranging from 0.3 µg/L to 15 µg/L. A definitive pattern of cis-1,2-dichloroethene concentrations is not evident, although the maximum concentration of cis-1,2-dichloroethene was associated with manhole MH-429, located along the southern side of Building 292.

Acetone was detected at concentrations ranging from 255.3 µg/L to 741.1 µg/L in four storm sewer surface water samples collected from manholes MH-487, IW-80 (MH-489), and MH-497. 2-Butanone, bromoform, dibromochloromethane, ethylbenzene, styrene, vinyl chloride, and total xylenes were each detected in more than half of the 13 samples. However, with the exception of 2-butanone, a common laboratory contaminant detected at a maximum concentration of 21 µg/L, concentrations of these seven VOCs were relatively low, ranging from 0.1 µg/L (total xylenes) to 4 µg/L (ethylbenzene and styrene). The remaining five VOCs (1,1,1-trichloroethane, 1,1-dichloroethane, bromodichloromethane, toluene, and trans-1,2-dichloroethene) were each detected in from one to four of 13 storm sewer surface water samples at concentrations ranging from 0.1 µg/L to 0.2 µg/L.

Semivolatile Organic Compounds, Pesticides/PCBs, and Explosives

Five of the storm sewer surface water samples were analyzed for SVOCs, pesticides/PCBs, and explosives. Nitrocellulose was detected at concentrations of 144 µg/L, 1120 µg/L, and 1230 µg/L in surface water samples from manholes MH-429, MH-01 (MH-430), and MH-02 (MH-431), respectively. No other explosive compounds, SVOCs, or pesticides/PCBs were detected in the storm sewer surface water samples.

Inorganics

Five storm sewer surface water samples were analyzed for metals (total and dissolved) and cyanide. Fifteen metals and cyanide were detected in the unfiltered storm sewer surface water samples, although cyanide and vanadium were detected in only one and two samples, respectively. As shown on Table 7-21, each of the remaining metals was detected in four or five of the storm sewer surface water samples. The same list of metals plus selenium was detected in the filtered storm sewer surface water samples. Cyanide was not detected in any of the filtered samples. In general, concentrations of metals in filtered and unfiltered storm sewer surface water samples were similar (i.e., at the same order of magnitude). Basewide background data is not available for surface water samples.

Two of the storm sewer surface water samples were analyzed for hardness as $CaCO_3$ and TOC, and a single storm sewer surface water sample was analyzed for several additional miscellaneous parameters. Positive results for these miscellaneous parameters are provided on Table 7-7 and summarized on Table 7-21.

7.5.2 Storm Sewer Sediment

Volatile Organic Compounds

As shown on Table 7-22, eight VOCs were detected in the storm sewer sediment sample collected at the outfall of the storm sewer at Mattawoman Creek. All of these VOCs were also detected in the storm sewer surface water samples.

Vinyl chloride and cis-1,2-dichloroethene, both degradation products of TCE, were detected in the sediment sample at concentrations of 1000 µg/kg and 6300 µg/kg, respectively. TCE (18 µg/kg) and two more of its degradation products, trans-1,2-dichloroethene (14 µg/kg) and 1,1-dichloroethene (9 µg/kg), were also detected in this sample.

Ethyl ether, another site-related chemical, was detected in the storm sewer sediment sample at a concentration of 14 µg/kg. Acetone (28 µg/kg) and ethylbenzene (2 µg/kg) were also detected in this sample.

Semivolatile Organic Compounds, Pesticides/PCBs, and Explosives

As shown on Table 7-22, bis(2-ethylhexyl)phthalate, carbazole, dibenzofuran, n-nitrosodiphenylamine, and 16 PAHs were detected in the storm sewer sediment sample. Concentrations of the PAHs ranged from 50 µg/kg [dibenzo(a,h)anthracene] to 810 µg/kg (phenanthrene). None of these SVOCs were detected in the five storm sewer surface water samples analyzed for SVOCs. However, bis(2-ethylhexyl)phthalate, carbazole, and all of the detected PAHs except acenaphthene were detected in Site 57 downgradient surface and/or subsurface soil samples.

A single pesticide, gamma-Chlordane, was detected in the storm sewer sediment sample at a concentration of 2.1 µg/kg. This pesticide was not detected in any of the other Site 57 samples. No other pesticides/PCBs or explosive compounds were detected in the storm sewer sediment sample.

Inorganics

Twenty-one metals and cyanide were detected in the storm sewer sediment sample. In general, concentrations of inorganic parameters in the storm sewer sediment sample were similar (i.e., at the same

order of magnitude) to concentrations of respective parameters detected in Site 57 downgradient surface and subsurface soil samples.

The basewide background levels established based on freshwater sediment samples may not be completely applicable to the Site 57 sediment samples because the background study did not include background sampling locations from Mattawoman Creek, Chicamuxen Creek or surface water bodies influenced by these waterways. Therefore, detected concentrations of metals in the Site 57 storm sewer sediment samples were compared to basewide background soil concentrations in addition to background freshwater sediment concentrations:

Metal	Maximum Concentration (mg/kg)	Site-Specific Sediment[1] Background Concentration (mg/kg)	Site-Specific Soil[2] Background Concentration (mg/kg)
Aluminum	2260	52362	18329/34406
Antimony	3	ND	ND/3.6
Arsenic	8.4	63	4.25/24.4
Barium	23.2	577	144/191
Beryllium	0.27	10.9	0.905/2.46
Cadmium	0.76	1.85	0.26/0.388
Calcium	2870	88137	409/196
Chromium	12.6	79.2	24.2/101
Cobalt	7.7	118	39.7/133
Copper	103	297	18.7/56.5
Cyanide	0.76	ND	ND
Iron	20800	193218	43170/151453
Lead	182	476	149/37.5
Magnesium	2070	19043	1382/4307
Manganese	150	2561	2248/1270
Mercury	0.45	0.778	0.087/0.13
Nickel	24.9	382	18.2/22.1
Potassium	187	5061	1874/5998
Silver	0.15	0.92	ND/0.63
Sodium	118	472	51.9/826
Vanadium	118	196	53.5/133
Zinc	183	1660	38.1/79.5

Note:
1 Site-specific background freshwater sediment data (B&R Environmental, December 1997).
2 Site-specific background surface/subsurface soil data (B&R Environmental, December 1997).
ND Not detected.

With the exceptions of antimony and cyanide, which were not detected in the background freshwater sediment dataset, all positive detections of metals in the storm sewer sediment sample were less than the respective $UTLs_{95\%}$ calculated for the background freshwater sediment dataset. Maximum concentrations of arsenic, cadmium, calcium, copper, lead, magnesium, mercury, sodium, vanadium, and zinc exceeded basewide background surface and/or subsurface soil concentrations.

Analytical results for pH, TOC, and AVS/SEM in the storm sewer sediment sample are presented on Tables 7-8 and 7-22. Analytical results for AVS/SEM will be discussed in Section 10, the ecological risk assessment.

TABLE 7-1

SUMMARY OF POSITIVE SURFACE SOIL ANALYTICAL RESULTS
SITE 57 – FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	S57SS0130101	S57SS0010101	S57SS0020101	S57SS0040101	S57SS0050101	S57SS0070101	S57SS0080101	S57DUP003	S57SS0090101	S57SSDUP001	S57SS0110101	S57SS0150101
FIELD DUPLICATE OF:								S57SS0080101-D		S57SS0090101-D		
SAMPLE DATE:	01/09/99	10/07/98	10/08/98	01/10/99	01/12/99	10/07/98	10/08/98	10/08/98	01/22/99	01/22/99	10/07/98	01/11/99
RI EVENT:	II	I	I	II	II	I	I	I	II	II	I	II
LOCATION:	S57MW012/SB013	S57MW001/SB001	S57MW003/SB002	S57MW007/SB004	S57MW009/SB005	S57SB007	S57MW011/SB008	S57MW011/SB008	S57SB009	S57SB009	S57SB011	S57MW005/SB015
DEPTH (feet BGS):	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5
SUBSITE:	UPGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT
Volatile Organic Compounds												
cis-1,2-Dichloroethene	11 U UG/KG	11 UJ UG/KG	11 U UG/KG	2 J UG/KG	11 U UG/KG	4 J UG/KG	11 U UG/KG	11 U UG/KG	11 U UG/KG	11 U UG/KG	11 U UG/KG	12 U UG/KG
Toluene	11 U UG/KG	11 UJ UG/KG	11 U UG/KG	1 J UG/KG	11 U UG/KG	14 U UG/KG	11 U UG/KG	11 U UG/KG	11 U UG/KG	11 U UG/KG	11 U UG/KG	12 U UG/KG
Trichloroethene	11 U UG/KG	13 J UG/KG	11 U UG/KG	10 J UG/KG	11 U UG/KG	93 UG/KG	64 UG/KG	34 UG/KG	11 U UG/KG	11 U UG/KG	11 U UG/KG	12 U UG/KG
Semivolatile Organic Compounds												
2-Methylnaphthalene	380 U UG/KG				37 J UG/KG	480 U UG/KG	380 U UG/KG	370 U UG/KG				
Acenaphthylene	380 U UG/KG				140 J UG/KG	480 U UG/KG	380 U UG/KG	370 U UG/KG				
Anthracene	380 U UG/KG				240 J UG/KG	51 J UG/KG	380 U UG/KG	370 U UG/KG				
Benzo(a)anthracene	380 U UG/KG				2300 UG/KG	200 J UG/KG	150 J UG/KG	370 U UG/KG				
Benzo(a)pyrene	380 U UG/KG				1700 UG/KG	130 J UG/KG	150 J UG/KG	370 U UG/KG				
Benzo(b)fluoranthene	63 J UG/KG				4200 UG/KG	200 J UG/KG	280 J UG/KG	370 U UG/KG				
Benzo(g,h,i)perylene	380 U UG/KG				450 UG/KG	61 J UG/KG	52 J UG/KG	370 U UG/KG				
Benzo(k)fluoranthene	380 U UG/KG				1400 UG/KG	83 J UG/KG	98 J UG/KG	370 U UG/KG				
bis(2-Ethylhexyl)phthalate	120 J UG/KG				120 J UG/KG	480 U UG/KG	41 J UG/KG	370 U UG/KG				
Carbazole	380 U UG/KG				99 J UG/KG	480 U UG/KG	380 U UG/KG	370 U UG/KG				
Chrysene	380 U UG/KG				2200 UG/KG	200 J UG/KG	180 J UG/KG	370 U UG/KG				
Dibenzo(a,h)anthracene	380 U UG/KG				350 J UG/KG	480 U UG/KG	380 U UG/KG	370 U UG/KG				
Fluoranthene	55 J UG/KG				1800 UG/KG	310 J UG/KG	300 J UG/KG	370 U UG/KG				
Fluorene	380 U UG/KG				39 J UG/KG	480 U UG/KG	380 U UG/KG	370 U UG/KG				
Indeno(1,2,3-cd)pyrene	380 U UG/KG				970 UG/KG	79 J UG/KG	79 J UG/KG	370 U UG/KG				
Naphthalene	380 U UG/KG				38 J UG/KG	480 U UG/KG	380 U UG/KG	370 U UG/KG				
Phenanthrene	380 U UG/KG				490 UG/KG	310 J UG/KG	180 J UG/KG	370 U UG/KG				
Pyrene	50 J UG/KG				2500 UG/KG	480 UG/KG	310 J UG/KG	370 U UG/KG				
Pesticides/PCBs												
4,4'-DDD	3.8 U UG/KG				12 UG/KG	4.8 U UG/KG	3.8 U UG/KG	3.8 U UG/KG				
4,4'-DDE	3.8 U UG/KG				61 UG/KG	4.8 U UG/KG	3.8 U UG/KG	3.8 U UG/KG				
4,4'-DDT	3.8 U UG/KG				150 J UG/KG	4.8 U UG/KG	3.8 U UG/KG	3.8 U UG/KG				
gamma-Chlordane	1.9 U UG/KG				5.3 J UG/KG	2.4 U UG/KG	1.9 U UG/KG	1.9 U UG/KG				
Explosives												
Nitrocellulose	41000 UR UG/KG				299000 L UG/KG	191000 UG/KG	116000 UG/KG					
Inorganics												
Aluminum	6660 MG/KG				3640 J MG/KG	9170 MG/KG	6130 MG/KG					
Antimony	0.87 L MG/KG				0.88 B MG/KG	0.81 B MG/KG	0.74 B MG/KG					
Arsenic	9.6 MG/KG				33.7 MG/KG	103 MG/KG	29.3 MG/KG					
Barium	26.8 MG/KG				20.7 MG/KG	48.2 MG/KG	38.8 MG/KG					
Beryllium	0.27 MG/KG				0.29 MG/KG	0.77 MG/KG	0.88 MG/KG					
Cadmium	0.21 MG/KG				0.47 MG/KG	0.19 U MG/KG	0.80 MG/KG					
Calcium	1580 MG/KG				604 MG/KG	3270 MG/KG	2130 MG/KG					
Chromium	22.7 MG/KG				13.1 J MG/KG	14.3 MG/KG	12.0 MG/KG					
Cobalt	10.3 MG/KG				8.1 MG/KG	8.3 K MG/KG	6.9 K MG/KG					
Copper	15.0 MG/KG				10.4 MG/KG	14.7 MG/KG	20.3 MG/KG					

TABLE 7-1

SUMMARY OF POSITIVE SURFACE SOIL ANALYTICAL RESULTS
SITE 57 – FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	S57SS0130101	S57SS0010101	S57SS0020101	S57SS0040101	S57SS0050101	S57SS0070101	S57SS0080101	S57DUP003	S57SS0090101	S57SSDUP001	S57SS0110101	S57SS0150101
FIELD DUPLICATE OF:								S57SS0080101-D		S57SS0090101-D		
SAMPLE DATE:	01/09/99	10/07/98	10/08/98	01/10/99	01/12/99	10/07/98	10/08/98	10/08/98	01/22/99	01/22/99	10/07/98	01/11/99
RI EVENT:	II	I	I	II	II	I	I	I	II	II	I	II
LOCATION:	S57MW012/SB013	S57MW001/SB001	S57MW003/SB002	S57MW007/SB004	S57MW009/SB005	S57SB007	S57MW011/SB008	S57MW011/SB008	S57SB009	S57SB009	S57SB011	S57MW005/SB015
DEPTH (feet BGS):	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5
SUBSITE:	UPGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT
Iron	13000 MG/KG				12400 MG/KG	24800 MG/KG	20500 MG/KG					
Lead	120 MG/KG				487 J MG/KG	25.4 K MG/KG	89.2 K MG/KG					
Magnesium	9150 J MG/KG				301 MG/KG	796 MG/KG	682 MG/KG					
Manganese	124 L MG/KG				134 K MG/KG	101 J MG/KG	97.9 J MG/KG					
Mercury	0.08 MG/KG				0.09 MG/KG	0.03 MG/KG	0.10 MG/KG					
Nickel	135 J MG/KG				6.0 MG/KG	6.7 K MG/KG	8.4 K MG/KG					
Potassium	398 MG/KG				234 MG/KG	828 MG/KG	738 MG/KG					
Selenium	0.33 U MG/KG				0.56 L MG/KG	0.38 UL MG/KG	0.32 UL MG/KG					
Sodium	144 MG/KG				128 B MG/KG	45.7 MG/KG	82.0 MG/KG					
Vanadium	20.7 MG/KG				19.1 MG/KG	35.7 MG/KG	31.4 MG/KG					
Zinc	94.4 MG/KG				69.8 MG/KG	45.0 MG/KG	261 MG/KG					
Miscellaneous												
pH	8.36				6.06	8.12	7.84					
Total Organic Carbon			7790 L MG/KG						50600 J MG/KG	39600 J MG/KG		

TABLE 7-2

SUMMARY OF POSITIVE SUBSURFACE SOIL ANALYTICAL RESULTS
SITE 57 – FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

SAMPLE DATE:	S57SB0130101	S57SB0130201	S57SB0010101	S57SB0010201	S57SB0020101	S57SB0020201	S57SB0020301	S57SB0020401	S57SB0020501	S57SB0030101	S57DUP001	S57SB0030201
FIELD DUPLICATE OF:											S57SB0030101-D	
SAMPLE DATE:	01/09/99	01/12/99	10/07/98	10/07/98	10/08/98	10/08/98	10/08/98	01/07/99	01/07/99	10/07/98	10/07/98	10/07/98
RI EVENT:	II	II	I	I	I	I	I	II	II	I	I	I
LOCATION:	S57MW012/SB013	S57MW012/SB013	S57MW001/SB001	S57MW001/SB001	S57MW003/SB002	S57MW003/SB002	S57MW003/SB002	S57MW003/SB002	S57MW003/SB002	S57SB003	S57SB003	S57SB003
DEPTH (feet BGS):	3 - 4	6 - 8	2 - 4	4 - 6	4 - 6	8 - 10	14 - 16	6 - 8	24 - 25	3 - 4	3 - 4	4 - 6
SUBSITE:	UPGRADIENT	UPGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRAIDENT
Volatile Organic Compounds												
1,1,1-Trichloroethane	12 U UG/KG	12 U UG/KG	12 U UG/KG	13 U UG/KG	14 U UG/KG	12 U UG/KG	2 J UG/KG			12 U UG/KG	13 UJ UG/KG	12 U UG/KG
2-Butanone	12 U UG/KG	12 U UG/KG	12 UJ UG/KG	13 UJ UG/KG	14 UJ UG/KG	12 UJ UG/KG	11 UJ UG/KG			12 UJ UG/KG	13 UJ UG/KG	12 UJ UG/KG
Acetone	26 UG/KG	12 U UG/KG	16 J UG/KG	13 U UG/KG	14 U UG/KG	12 U UG/KG	11 UJ UG/KG			12 U UG/KG	13 UJ UG/KG	12 U UG/KG
Carbon Disulfide	12 U UG/KG	12 U UG/KG	1 J UG/KG	13 U UG/KG	14 U UG/KG	12 U UG/KG	11 UJ UG/KG			12 U UG/KG	13 UJ UG/KG	12 U UG/KG
cis-1,2-Dichloroethene	12 U UG/KG	12 U UG/KG	12 U UG/KG	3 J UG/KG	33 UG/KG	12 U UG/KG	1300 J UG/KG			12 U UG/KG	13 UJ UG/KG	12 U UG/KG
Ethyl Ether	12 U UG/KG	54 UG/KG	12 U UG/KG	13 UJ UG/KG	14 U UG/KG	12 U UG/KG	12 J UG/KG			12 UJ UG/KG	13 UJ UG/KG	12 UJ UG/KG
Methylene Chloride	7 B UG/KG	5 B UG/KG	18 B UG/KG	29 B UG/KG	32 B UG/KG	17 B UG/KG	8 B UG/KG			23 B UG/KG	23 B UG/KG	26 B UG/KG
Toluene	12 U UG/KG	12 U UG/KG	12 U UG/KG	13 U UG/KG	14 U UG/KG	12 U UG/KG	11 UJ UG/KG			12 U UG/KG	13 UJ UG/KG	12 U UG/KG
trans-1,2-Dichloroethene	12 U UG/KG	12 U UG/KG	12 U UG/KG	13 U UG/KG	14 U UG/KG	12 U UG/KG	3 J UG/KG			12 U UG/KG	13 UJ UG/KG	12 U UG/KG
Trichloroethene	12 U UG/KG	12 U UG/KG	12 U UG/KG	3 J UG/KG	810 J UG/KG	12 U UG/KG	20000 J UG/KG			12 U UG/KG	13 UJ UG/KG	12 U UG/KG
Xylenes, Total	12 U UG/KG	12 U UG/KG	12 U UG/KG	13 U UG/KG	14 U UG/KG	12 U UG/KG	11 UJ UG/KG			12 U UG/KG	13 UJ UG/KG	12 U UG/KG
Semivolatile Organic Compounds												
Benzo(a)anthracene	400 U UG/KG	410 U UG/KG										
Benzo(a)pyrene	400 U UG/KG	410 U UG/KG										
Benzo(b)fluoranthene	400 U UG/KG	410 U UG/KG										
Benzo(g,h,i)perylene	400 U UG/KG	410 U UG/KG										
Benzo(k)fluoranthene	400 U UG/KG	410 U UG/KG										
bis(2-Ethylhexyl)phthalate	400 U UG/KG	89 J UG/KG										
Chrysene	400 U UG/KG	410 U UG/KG										
Di-n-butyl phthalate	200 J UG/KG	410 U UG/KG										
Dibenzo(a,h)anthracene	400 U UG/KG	410 U UG/KG										
Fluoranthene	400 U UG/KG	410 U UG/KG										
Indeno(1,2,3-cd)pyrene	400 U UG/KG	410 U UG/KG										
Phenanthrene	400 U UG/KG	410 U UG/KG										
Pyrene	400 U UG/KG	410 U UG/KG										
Pesticides/PCBs												
4,4'-DDE	4.0 U UG/KG	4.1 U UG/KG										
4,4'-DDT	4.0 U UG/KG	4.1 U UG/KG										
Explosives												
Nitrocellulose	38900 UR UG/KG	50400 L UG/KG										
Inorganics												
Aluminum	7780 MG/KG	5410 J MG/KG										
Arsenic	2.9 MG/KG	2.6 L MG/KG										
Barium	24.5 MG/KG	34.2 MG/KG										
Beryllium	0.22 MG/KG	0.52 MG/KG										
Calcium	573 MG/KG	796 MG/KG										
Chromium	9.8 MG/KG	10.9 J MG/KG										
Cobalt	1.4 MG/KG	6.2 MG/KG										
Copper	7.5 MG/KG	6.2 MG/KG										
Iron	9360 MG/KG	10600 MG/KG										
Lead	8.4 MG/KG	8.2 J MG/KG										
Magnesium	549 J MG/KG	350 MG/KG										
Manganese	26.0 L MG/KG	42.3 K MG/KG										

TABLE 7-2

SUMMARY OF POSITIVE SUBSURFACE SOIL ANALYTICAL RESULTS
SITE 57 – FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

SAMPLE DATE:	S57SB0130101	S57SB0130201	S57SB0010101	S57SB0010201	S57SB0020101	S57SB0020201	S57SB0020301	S57SB0020401	S57SB0020501	S57SB0030101	S57DUP001	S57SB0030201
FIELD DUPLICATE OF:											S57SB0030101-D	
SAMPLE DATE:	01/09/99	01/12/99	10/07/98	10/07/98	10/08/98	10/08/98	10/08/98	01/07/99	01/07/99	10/07/98	10/07/98	10/07/98
RI EVENT:	II	II	I	I	I	I	I	II	II	I	I	I
LOCATION:	S57MW012/SB013	S57MW012/SB013	S57MW001/SB001	S57MW001/SB001	S57MW003/SB002	S57MW003/SB002	S57MW003/SB002	S57MW003/SB002	S57MW003/SB002	S57SB003	S57SB003	S57SB003
DEPTH (feet BGS):	3 - 4	6 - 8	2 - 4	4 - 6	4 - 6	8 - 10	14 - 16	6 - 8	24 - 25	3 - 4	3 - 4	4 - 6
SUBSITE:	UPGRADIENT	UPGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRAIDENT
Mercury	0.02 MG/KG	0.03 MG/KG										
Nickel	4.1 J MG/KG	3.0 MG/KG										
Potassium	743 MG/KG	370 MG/KG										
Selenium	0.82 K MG/KG	0.50 UL MG/KG										
Sodium	95.2 MG/KG	70.8 B MG/KG										
Vanadium	21.9 MG/KG	20.6 MG/KG										
Zinc	15.3 MG/KG	13.8 MG/KG										
Miscellaneous												
pH	7.79	6.57										
Total Organic Carbon					8120 L MG/KG	4440 UL MG/KG	2260 L MG/KG	10200 L MG/KG	4110 UR MG/KG			

TABLE 7-2

SUMMARY OF POSITIVE SUBSURFACE SOIL ANALYTICAL RESULTS
SITE 57 – FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

SAMPLE DATE:	S57DUP002	S57SB0040101	S57SB0040201	S57SB0050101	S57SB0050201	S57SBDUP0101(011299)	S57SB0050401	S57SB0060101	S57SB0060201	S57SB0070101	S57SB0080101	S57DUP003
FIELD DUPLICATE OF:	S57SB0030201-D					S57SB0050201-D						S57SB0080101-D
SAMPLE DATE:	10/07/98	01/10/99	01/10/99	01/12/99	01/12/99	01/12/99	01/12/99	10/08/98	10/08/98	10/07/98	10/08/98	10/08/98
RI EVENT:	I	II	II	II	II	II	II	I	I	I	I	I
LOCATION:	S57SB003	S57MW007/SB004	S57MW007/SB004	S57MW009/SB005	S57MW009/SB005	S57MW009/SB005	S57MW009/SB005	S57SB006	S57SB006	S57SB007	S57MW011/SB008	S57MW011/SB008
DEPTH (feet BGS):	4 - 6	6 - 8	4 - 5	2 - 4	4 - 6	4 - 6	3 - 5	3 - 4	10 - 11	4 - 5	4 - 6	4 - 6
SUBSITE:	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT
Volatile Organic Compounds												
1,1,1-Trichloroethane	12 U UG/KG	12 U UG/KG	12 U UG/KG	12 U UG/KG	12 U UG/KG			12 UJ UG/KG	11 U UG/KG	13 U UG/KG	12 U UG/KG	
2-Butanone	12 UJ UG/KG	12 U UG/KG	12 U UG/KG	12 U UG/KG	12 U UG/KG			12 UJ UG/KG	11 UJ UG/KG	13 UJ UG/KG	12 UJ UG/KG	
Acetone	12 U UG/KG	100 UG/KG	20 J UG/KG	12 U UG/KG	2200 J UG/KG			12 UJ UG/KG	11 U UG/KG	13 U UG/KG	12 U UG/KG	
Carbon Disulfide	12 U UG/KG	4 J UG/KG	1 J UG/KG	12 U UG/KG	12 U UG/KG			12 UJ UG/KG	2 J UG/KG	13 U UG/KG	12 U UG/KG	
cis-1,2-Dichloroethene	12 U UG/KG	12 U UG/KG	12 U UG/KG	12 U UG/KG	12 U UG/KG			77000 UG/KG	11 U UG/KG	11 J UG/KG	12 U UG/KG	
Ethyl Ether	12 UJ UG/KG	12 U UG/KG	12 U UG/KG	12 U UG/KG	12 U UG/KG			12 UJ UG/KG	11 U UG/KG	13 U UG/KG	12 UJ UG/KG	
Methylene Chloride	45 B UG/KG	8 B UG/KG	8 B UG/KG	6 B UG/KG	5 B UG/KG			21000 UG/KG	11 B UG/KG	13 B UG/KG	44 B UG/KG	
Toluene	12 U UG/KG	12 U UG/KG	12 U UG/KG	12 U UG/KG	12 U UG/KG			4 J UG/KG	11 U UG/KG	13 U UG/KG	12 U UG/KG	
trans-1,2-Dichloroethene	12 U UG/KG	12 U UG/KG	12 U UG/KG	12 U UG/KG	12 U UG/KG			4 J UG/KG	11 U UG/KG	13 U UG/KG	12 U UG/KG	
Trichloroethene	12 U UG/KG	2 J UG/KG	1 J UG/KG	12 U UG/KG	12 U UG/KG			220000 UG/KG	4 J UG/KG	50 UG/KG	48 UG/KG	
Xylenes, Total	12 U UG/KG	12 U UG/KG	12 U UG/KG	12 U UG/KG	12 U UG/KG			8 J UG/KG	11 U UG/KG	13 U UG/KG	12 U UG/KG	
Semivolatile Organic Compounds												
Benzo(a)anthracene				360 J UG/KG	400 U UG/KG	85 J UG/KG				420 U UG/KG	390 U UG/KG	
Benzo(a)pyrene				270 J UG/KG	400 U UG/KG	61 J UG/KG				420 U UG/KG	390 UJ UG/KG	
Benzo(b)fluoranthene				510 UG/KG	400 U UG/KG	85 J UG/KG				420 U UG/KG	390 UJ UG/KG	
Benzo(g,h,i)perylene				70 J UG/KG	400 U UG/KG	400 U UG/KG				420 U UG/KG	390 UJ UG/KG	
Benzo(k)fluoranthene				200 J UG/KG	400 U UG/KG	400 U UG/KG				420 U UG/KG	390 UJ UG/KG	
bis(2-Ethylhexyl)phthalate				92 J UG/KG	400 U UG/KG	400 U UG/KG				420 U UG/KG	390 U UG/KG	
Chrysene				350 J UG/KG	400 U UG/KG	76 J UG/KG				420 U UG/KG	390 U UG/KG	
Di-n-butyl phthalate				390 U UG/KG	400 U UG/KG	400 U UG/KG				420 U UG/KG	390 U UG/KG	
Dibenzo(a,h)anthracene				60 J UG/KG	400 U UG/KG	400 U UG/KG				420 U UG/KG	390 UJ UG/KG	
Fluoranthene				380 J UG/KG	400 U UG/KG	140 J UG/KG				420 U UG/KG	390 U UG/KG	
Indeno(1,2,3-cd)pyrene				160 J UG/KG	400 U UG/KG	43 J UG/KG				420 U UG/KG	390 UJ UG/KG	
Phenanthrene				110 J UG/KG	400 U UG/KG	110 J UG/KG				420 U UG/KG	390 U UG/KG	
Pyrene				380 J UG/KG	400 U UG/KG	140 J UG/KG				420 U UG/KG	52 J UG/KG	
Pesticides/PCBs												
4,4'-DDE				17 UG/KG	4.0 U UG/KG	4.0 U UG/KG				4.2 U UG/KG	3.9 U UG/KG	
4,4'-DDT				20 UG/KG	4.0 U UG/KG	4.0 U UG/KG				4.2 U UG/KG	3.9 U UG/KG	
Explosives												
Nitrocellulose				95100 L UG/KG	53900 L UG/KG	123000 L UG/KG				59200 UG/KG	37600 UG/KG	66000 UG/KG
Inorganics												
Aluminum				8060 J MG/KG	10200 J MG/KG	8260 J MG/KG				11500 MG/KG	4700 MG/KG	5300 MG/KG
Arsenic				21.3 MG/KG	17.4 MG/KG	50.0 MG/KG				36.2 MG/KG	9.7 MG/KG	16.2 MG/KG
Barium				24.7 MG/KG	27.9 MG/KG	39.8 MG/KG				58.2 MG/KG	25.5 MG/KG	32.3 MG/KG
Beryllium				0.32 MG/KG	0.45 MG/KG	0.33 MG/KG				2.5 MG/KG	0.62 MG/KG	0.63 MG/KG
Calcium				914 MG/KG	415 MG/KG	328 MG/KG				1650 MG/KG	8840 MG/KG	1300 MG/KG
Chromium				12.5 J MG/KG	14.1 J MG/KG	12.9 J MG/KG				21.0 MG/KG	7.3 MG/KG	9.1 MG/KG
Cobalt				3.1 MG/KG	3.2 MG/KG	2.7 MG/KG				34.6 K MG/KG	6.1 K MG/KG	7.7 K MG/KG
Copper				9.5 MG/KG	9.1 MG/KG	8.9 MG/KG				17.5 MG/KG	10.6 MG/KG	11.0 MG/KG
Iron				16000 MG/KG	17600 MG/KG	15600 MG/KG				46300 MG/KG	14000 MG/KG	17200 MG/KG
Lead				18.6 J MG/KG	100 J MG/KG	54.9 J MG/KG				8.6 K MG/KG	14.2 K MG/KG	43.6 K MG/KG
Magnesium				314 MG/KG	463 MG/KG	368 MG/KG				1440 MG/KG	401 MG/KG	505 MG/KG
Manganese				89.3 K MG/KG	59.8 K MG/KG	48.7 K MG/KG				253 J MG/KG	101 J MG/KG	108 J MG/KG

TABLE 7-2

SUMMARY OF POSITIVE SUBSURFACE SOIL ANALYTICAL RESULTS
SITE 57 – FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

SAMPLE DATE:	S57DUP002	S57SB0040101	S57SB0040201	S57SB0050101	S57SB0050201	S57SBDUP0101(011299)	S57SB0050401	S57SB0060101	S57SB0060201	S57SB0070101	S57SB0080101	S57DUP003
FIELD DUPLICATE OF:	S57SB0030201-D					S57SB0050201-D						S57SB0080101-D
SAMPLE DATE:	10/07/98	01/10/99	01/10/99	01/12/99	01/12/99	01/12/99	01/12/99	10/08/98	10/08/98	10/07/98	10/08/98	10/08/98
RI EVENT:	I	II	II	II	II	II	II	I	I	I	I	I
LOCATION:	S57SB003	S57MW007/SB004	S57MW007/SB004	S57MW009/SB005	S57MW009/SB005	S57MW009/SB005	S57MW009/SB005	S57SB006	S57SB006	S57SB007	S57MW011/SB008	S57MW011/SB008
DEPTH (feet BGS):	4 - 6	6 - 8	4 - 5	2 - 4	4 - 6	4 - 6	3 - 5	3 - 4	10 - 11	4 - 5	4 - 6	4 - 6
SUBSITE:	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT
Mercury				0.25 MG/KG	0.07 MG/KG	0.10 MG/KG				0.03 MG/KG	0.04 MG/KG	0.04 MG/KG
Nickel				4.4 MG/KG	3.9 MG/KG	3.8 MG/KG				13.0 K MG/KG	6.3 K MG/KG	5.7 K MG/KG
Potassium				334 MG/KG	504 MG/KG	470 MG/KG				1330 MG/KG	482 MG/KG	586 MG/KG
Selenium				0.59 L MG/KG	0.70 L MG/KG	0.69 L MG/KG				0.74 L MG/KG	0.26 UL MG/KG	0.29 UL MG/KG
Sodium				231 B MG/KG	133 B MG/KG	170 B MG/KG				55.1 MG/KG	56.8 MG/KG	51.1 MG/KG
Vanadium				22.1 MG/KG	30.4 MG/KG	27.1 MG/KG				60.8 MG/KG	16.2 MG/KG	21.8 MG/KG
Zinc				35.1 MG/KG	52.0 MG/KG	42.2 MG/KG				48.9 K MG/KG	53.8 MG/KG	158 MG/KG
Miscellaneous												
pH				7.10	5.35	5.40				6.85	8.31	7.47
Total Organic Carbon				22000 MG/KG	12600 MG/KG							

TABLE 7-2

SUMMARY OF POSITIVE SUBSURFACE SOIL ANALYTICAL RESULTS
SITE 57 – FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

SAMPLE DATE:	S57SB0080201	S57SB0090101	S57SB0090201	S57SB0100101	S57SB0100201	S57SB0110101	S57SB0110201	S57SB0120101	S57SB0120201	S57SB0140101	S57SB0140201	S57SB0150101
FIELD DUPLICATE OF:												
SAMPLE DATE:	10/08/98	10/07/98	10/07/98	10/07/98	10/07/98	10/07/98	10/07/98	10/07/98	10/07/98	10/07/98	10/07/98	01/11/99
RI EVENT:	I	I	I	I	I	I	I	I	I	I	I	II
LOCATION:	S57MW011/SB008	S57SB009	S57SB009	S57SB010	S57SB010	S57SB011	S57SB011	S57SB012	S57SB012	S57SB014	S57SB014	S57MW005/SB015
DEPTH (feet BGS):	10 - 11	7 - 8	7 - 8	3 - 4	7 - 8	6 - 8	14 - 15	3 - 4	7 - 8	3 - 5	7 - 8	2 - 4
SUBSITE:	DOWNGRADEITN	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADEINT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT
Volatile Organic Compounds												
1,1,1-Trichloroethane	12 U UG/KG	12 U UG/KG	12 U UG/KG	13 U UG/KG	13 U UG/KG	12 U UG/KG	13 U UG/KG	12 U UG/KG	4 J UG/KG	11 U UG/KG	12 U UG/KG	12 U UG/KG
2-Butanone	12 UJ UG/KG	12 UJ UG/KG	29 J UG/KG	13 UJ UG/KG	13 UJ UG/KG	12 UJ UG/KG	13 UJ UG/KG	12 UJ UG/KG	13 UJ UG/KG	11 UJ UG/KG	12 UJ UG/KG	12 U UG/KG
Acetone	41 J UG/KG	12 U UG/KG	86 J UG/KG	13 U UG/KG	13 U UG/KG	12 U UG/KG	13 U UG/KG	12 U UG/KG	13 UJ UG/KG	11 U UG/KG	14 J UG/KG	12 U UG/KG
Carbon Disulfide	12 U UG/KG	12 U UG/KG	2 J UG/KG	13 U UG/KG	13 U UG/KG	12 U UG/KG	13 U UG/KG	12 U UG/KG	13 UJ UG/KG	11 U UG/KG	12 U UG/KG	12 U UG/KG
cis-1,2-Dichloroethene	22 UG/KG	12 U UG/KG	12 U UG/KG	13 U UG/KG	13 U UG/KG	12 U UG/KG	7 J UG/KG	12 U UG/KG	13 UJ UG/KG	11 U UG/KG	12 U UG/KG	12 U UG/KG
Ethyl Ether	12 U UG/KG	12 UJ UG/KG	12 U UG/KG	13 UJ UG/KG	13 U UG/KG	12 U UG/KG	13 U UG/KG	12 UJ UG/KG	13 UJ UG/KG	11 U UG/KG	12 U UG/KG	12 U UG/KG
Methylene Chloride	21 B UG/KG	41 B UG/KG	10 B UG/KG	25 B UG/KG	16 B UG/KG	8 B UG/KG	13 B UG/KG	18 B UG/KG	110 J UG/KG	17 B UG/KG	11 B UG/KG	7 B UG/KG
Toluene	12 U UG/KG	12 U UG/KG	12 U UG/KG	13 U UG/KG	13 U UG/KG	12 U UG/KG	13 U UG/KG	12 U UG/KG	13 UJ UG/KG	11 U UG/KG	12 U UG/KG	12 U UG/KG
trans-1,2-Dichloroethene	20 UG/KG	12 U UG/KG	12 U UG/KG	13 U UG/KG	13 U UG/KG	12 U UG/KG	13 U UG/KG	12 U UG/KG	13 UJ UG/KG	11 U UG/KG	12 U UG/KG	12 U UG/KG
Trichloroethene	41 UG/KG	12 U UG/KG	12 U UG/KG	13 U UG/KG	13 U UG/KG	12 U UG/KG	31 UG/KG	35 UG/KG	8 J UG/KG	11 U UG/KG	12 U UG/KG	12 U UG/KG
Xylenes, Total	12 U UG/KG	12 U UG/KG	12 U UG/KG	13 U UG/KG	13 U UG/KG	12 U UG/KG	13 U UG/KG	12 U UG/KG	13 UJ UG/KG	11 U UG/KG	12 U UG/KG	12 U UG/KG
Semivolatile Organic Compounds												
Benzo(a)anthracene	410 U UG/KG											
Benzo(a)pyrene	410 U UG/KG											
Benzo(b)fluoranthene	410 U UG/KG											
Benzo(g,h,i)perylene	410 U UG/KG											
Benzo(k)fluoranthene	410 U UG/KG											
bis(2-Ethylhexyl)phthalate	410 U UG/KG											
Chrysene	410 U UG/KG											
Di-n-butyl phthalate	410 U UG/KG											
Dibenzo(a,h)anthracene	410 U UG/KG											
Fluoranthene	410 U UG/KG											
Indeno(1,2,3-cd)pyrene	410 U UG/KG											
Phenanthrene	410 U UG/KG											
Pyrene	410 U UG/KG											
Pesticides/PCBs												
4,4' DDE	4.1 U UG/KG											
4,4'-DDT	4.1 U UG/KG											
Explosives												
Nitrocellulose	205000 UG/KG											
Inorganics												
Aluminum	8650 MG/KG											
Arsenic	15.3 MG/KG											
Barium	46.1 MG/KG											
Beryllium	1.0 MG/KG											
Calcium	2510 MG/KG											
Chromium	14.0 MG/KG											
Cobalt	5.3 K MG/KG											
Copper	15.6 MG/KG											
Iron	28800 MG/KG											
Lead	47.4 K MG/KG											
Magnesium	902 MG/KG											
Manganese	60.9 J MG/KG											

TABLE 7-2

SUMMARY OF POSITIVE SUBSURFACE SOIL ANALYTICAL RESULTS
SITE 57 – FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

SAMPLE DATE:	S57SB0080201	S57SB0090101	S57SB0090201	S57SB0100101	S57SB0100201	S57SB0110101	S57SB0110201	S57SB0120101	S57SB0120201	S57SB0140101	S57SB0140201	S57SB0150101
FIELD DUPLICATE OF:												
SAMPLE DATE:	10/08/98	10/07/98	10/07/98	10/07/98	10/07/98	10/07/98	10/07/98	10/07/98	10/07/98	10/07/98	10/07/98	01/11/99
RI EVENT:	I	I	I	I	I	I	I	I	I	I	I	II
LOCATION:	S57MW011/SB008	S57SB009	S57SB009	S57SB010	S57SB010	S57SB011	S57SB011	S57SB012	S57SB012	S57SB014	S57SB014	S57MW005/SB015
DEPTH (feet BGS):	10 - 11	7 - 8	7 - 8	3 - 4	7 - 8	6 - 8	14 - 15	3 - 4	7 - 8	3 - 5	7 - 8	2 - 4
SUBSITE:	DOWNGRADEITN	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADEINT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT
Mercury	0.05 MG/KG											
Nickel	6.4 K MG/KG											
Potassium	1140 MG/KG											
Selenium	0.27 UL MG/KG											
Sodium	39.4 MG/KG											
Vanadium	42.6 MG/KG											
Zinc	36.0 K MG/KG											
Miscellaneous												
pH	8.34											
Total Organic Carbon												

TABLE 7-3

SUMMARY OF POSITIVE UPPER SURFICIAL GROUNDWATER ANALYTICAL RESULTS
SITE 57 – FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	S57MW0130101	S57MW0130101-F	S57MW0020101	S57MW0040101	S57MW0040101-F	S57MW0060101	S57MW0080101	S57MW0100101	S57MW0100101-F	S57MW0110101	S57MWDUP002	S57TW0010101	S57TW0020101	S57TW0030101
FIELD DUPLICATE OF:											S57MW0110101-D			
SAMPLE DATE:	01/25/99	01/25/99	01/25/99	01/25/99	01/25/99	01/27/99	01/26/99	01/26/99	01/26/99	01/27/99	01/27/99	01/22/99	01/21/99	01/21/99
RI PHASE:	II	II	II	II	II	II	II	II	II	II	II	II	II	II
LOCATION:	S57MW013	S57MW013	S57MW002	S57MW004	S57MW004	S57MW006	S57MW008	S57MW010	S57MW010	S57MW011/SB008	S57MW011/SB008	S57TW001	S57TW002	S57TW003
AQUIFER:	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW
FILTERING:	Unfiltered	Filtered	Unfiltered	Unfiltered	Filtered	Unfiltered	Unfiltered	Unfiltered	Filtered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered
SUBSITE:	UPGRADIENT	UPGRADIENT	DOWNGRADEINT	DOWNGRADEINT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT
Volatile Organic Compounds														
1,1,1-Trichloroethane	14.6 UG/L		2.5 UG/L	29.5 J UG/L		6 J UG/L	1 U UG/L	3.1 UG/L		1 U UG/L	1 U UG/L	1 J UG/L	10 U UG/L	10 U UG/L
1,1-Dichloroethane	0.8 J UG/L		4.4 UG/L	2 UG/L		2 J UG/L	1 U UG/L	3.1 UG/L		1 U UG/L	1 U UG/L	3 J UG/L	10 U UG/L	10 U UG/L
1,1-Dichloroethene	77.5 J UG/L		1 U UG/L	10.3 UG/L		11 J UG/L	1 U UG/L	6.6 UG/L		1 U UG/L	1 U UG/L	4 J UG/L	10 U UG/L	10 U UG/L
1,2-Dichloroethane	2.7 UG/L		1 U UG/L	1 U UG/L		1 U UG/L	1 U UG/L	1 U UG/L		1 U UG/L	1 U UG/L	10 U UG/L	10 U UG/L	10 U UG/L
Acetone	5 UR UG/L		5 UR UG/L	5 UR UG/L		5 UR UG/L	5 UR UG/L	29.4 J UG/L		5 UR UG/L	5 UR UG/L	10 U UG/L	10 U UG/L	10 U UG/L
Chloroform	1.3 UG/L		1 U UG/L	1 U UG/L		1 U UG/L	1 U UG/L	0.6 J UG/L		1 U UG/L	1 U UG/L	10 U UG/L	10 U UG/L	10 U UG/L
cis-1,2-Dichloroethene	1 U UG/L		5.1 UG/L	528 J UG/L		32 J UG/L	0.7 J UG/L	44.8 UG/L		5 UG/L	5 UG/L	75 UG/L	10 U UG/L	260 UG/L
Ethyl Ether	5 UR UG/L		1 J UG/L	296.6 J UG/L		5 UR UG/L	1089 J UG/L	5 UR UG/L		3950 L UG/L	3780 L UG/L	10 U UG/L	10 U UG/L	10 U UG/L
Tetrachloroethene	1 U UG/L		1 U UG/L	9.5 UG/L		1 U UG/L	1 U UG/L	1 U UG/L		1 U UG/L	1 U UG/L	10 U UG/L	10 U UG/L	10 U UG/L
Toluene	1 U UG/L		1 U UG/L	0.5 J UG/L		1 U UG/L	1 U UG/L	1 U UG/L		1 U UG/L	1 U UG/L	10 U UG/L	10 U UG/L	10 U UG/L
trans-1,2-Dichloroethene	1 U UG/L		1 U UG/L	8.3 UG/L		1 U UG/L	1 U UG/L	1 U UG/L		1 U UG/L	1 U UG/L	10 U UG/L	10 U UG/L	2 J UG/L
Trichloroethene	2.2 UG/L		86.7 J UG/L	611.7 J UG/L		213 J UG/L	1 U UG/L	157.8 UG/L		51 J UG/L	50 J UG/L	54 UG/L	10 U UG/L	10 U UG/L
Vinyl Chloride	1 U UG/L		2.9 UG/L	47.9 J UG/L		1 U UG/L	1 U UG/L	3.8 UG/L		1 U UG/L	1 U UG/L	13 UG/L	10 U UG/L	85 UG/L
Semivolatile Organic Compounds														
bis(2-Ethylhexyl)phthalate	5 U UG/L			2 J UG/L				6 U UG/L						
Di-n-butyl phthalate	5 U UG/L			6 U UG/L				5 J UG/L						
Explosives														
Nitrocellulose	150 UR UG/L			141 UR UG/L				148 L UG/L						
Inorganics														
Barium	72.7 UG/L			35.3 UG/L				57.4 UG/L						
Beryllium	0.39 UG/L			0.10 UG/L				0.10 U UG/L						
Calcium	2530 UG/L			2380 UG/L				15600 UG/L						
Cobalt	22.8 UG/L			30.7 UG/L				10.5 UG/L						
Iron	102 J UG/L			215 J UG/L				4330 UG/L						
Lead	1.0 U UG/L			1.3 UG/L				1.2 UG/L						
Magnesium	1500 UG/L			1380 UG/L				2360 UG/L						
Manganese	179 J UG/L			256 J UG/L				311 UG/L						
Nickel	7.0 UG/L			10.3 UG/L				5.7 UG/L						
Potassium	2490 UG/L			3110 UG/L				4760 UG/L						
Sodium	21900 J UG/L			14300 J UG/L				38200 UG/L						
Zinc	23.8 UG/L			28.5 UG/L				73.3 UG/L						
Inorganics - Filtered														
Barium, Filtered		73.5 UG/L			33.1 UG/L				55.0 UG/L					
Beryllium, Filtered		0.37 UG/L			0.10 U UG/L				0.10 U UG/L					
Calcium, Filtered		2640 UG/L			2310 UG/L				19700 UG/L					
Cobalt, Filtered		27.6 UG/L			30.2 UG/L				10.2 UG/L					
Iron, Filtered		131 UG/L			154 UG/L				3810 UG/L					
Lead, Filtered		1.0 U UG/L			1.0 U UG/L				1.3 UG/L					
Magnesium, Filtered		1510 UG/L			1310 UG/L				2390 UG/L					
Manganese, Filtered		205 UG/L			244 UG/L				301 UG/L					
Nickel, Filtered		8.0 UG/L			10.2 UG/L				6.9 UG/L					

TABLE 7-3

SUMMARY OF POSITIVE UPPER SURFICIAL GROUNDWATER ANALYTICAL RESULTS
SITE 57 – FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	S57MW0130101	S57MW0130101-F	S57MW0020101	S57MW0040101	S57MW0040101-F	S57MW0060101	S57MW0080101	S57MW0100101	S57MW0100101-F	S57MW0110101	S57MWDUP002	S57TW0010101	S57TW0020101	S57TW0030101
FIELD DUPLICATE OF:											S57MW0110101-D			
SAMPLE DATE:	01/25/99	01/25/99	01/25/99	01/25/99	01/25/99	01/27/99	01/26/99	01/26/99	01/26/99	01/27/99	01/27/99	01/22/99	01/21/99	01/21/99
RI PHASE:	II	II	II	II	II	II	II	II	II	II	II	II	II	II
LOCATION:	S57MW013	S57MW013	S57MW002	S57MW004	S57MW004	S57MW006	S57MW008	S57MW010	S57MW010	S57MW011/SB008	S57MW011/SB008	S57TW001	S57TW002	S57TW003
AQUIFER:	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW	SHALLOW
FILTERING:	Unfiltered	Filtered	Unfiltered	Unfiltered	Filtered	Unfiltered	Unfiltered	Unfiltered	Filtered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered
SUBSITE:	UPGRADIENT	UPGRADIENT	DOWNGRADEINT	DOWNGRADEINT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT
Potassium, Filtered		2570 UG/L			3000 UG/L				5690 UG/L					
Sodium, Filtered		22100 J UG/L			13900 J UG/L				41700 UG/L					
Zinc, Filtered		27.1 UG/L			44.1 UG/L				81.2 UG/L					
Miscellaneous														
Ammonium Perchlorate	8.78 UG/L							5 U UG/L						
Hardness As CaCO3	11.9 MG/L			13.9 MG/L				51.5 MG/L						
pH	4.96		6.23	5.62			5.78	6.39						
Total Dissolved Solids	68.0 MG/L		150 MG/L	44.0 MG/L		74 L MG/L	184 MG/L	152 MG/L		120 L MG/L	109 L MG/L			
Total Organic Carbon	1.0 U MG/L			1.0 U MG/L				3.6 MG/L						

TABLE 7-4

SUMMARY OF POSITIVE LOWER SURFICIAL GROUNDWATER ANALYTICAL RESULTS
SITE 57 – FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	S57MW0120101	S57MWDUP001	S57MW0120101-F	S57MWDUP001-F	S57MW0010101	S57MW0030101	S57MW0030101-F	S57MW0050101	S57MW0070101	S57MW0090101	S57MW0090101-F
FIELD DUPLICATE OF:		S57MW0120101-D		S57MW0120101-F-D							
SAMPLE DATE:	01/25/99	01/25/99	01/25/99	01/25/99	01/25/99	01/25/99	01/25/99	01/27/99	01/25/99	01/26/99	01/26/99
RI EVENT:	II	II	II	II	II	II	II	II	II	II	II
LOCATION:	S57MW012/SB013	S57MW012/SB013	S57MW012/SB013	S57MW012/SB013	S57MW001/SB001	S57MW003/SB002	S57MW003/SB002	S57MW005/SB015	S57MW007/SB004	S57MW009/SB005	S57MW009/SB005
AQUIFER:	DEEP	DEEP	DEEP	DEEP	DEEP	DEEP	DEEP	DEEP	DEEP	DEEP	DEEP
FILTERING:	Unfiltered	Unfiltered	Filtered	Filtered	Unfiltered	Unfiltered	Filtered	Unfiltered	Unfiltered	Unfiltered	Filtered
SUBSITE:	UPGRADIENT	UPGRADIENT	UPGRADIENT	UPGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT
Volatile Organic Compounds											
1,1,1-Trichloroethane	1 U UG/L	1 U UG/L			1 U UG/L	0.6 J UG/L		6 UG/L	1 U UG/L	13.7 UG/L	
1,1-Dichloroethane	5.2 UG/L	5.2 UG/L			1.8 UG/L	1 U UG/L		1 UG/L	1 U UG/L	5.2 UG/L	
1,1-Dichloroethene	1.8 UG/L	1.7 UG/L			1 U UG/L	2.9 UG/L		12 UG/L	1 U UG/L	29 J UG/L	
Acetone	12 J UG/L	5 UR UG/L			5 UR UG/L	5 U UG/L		5 UR UG/L	5 UR UG/L	5 UR UG/L	
Chloroform	1 U UG/L	1 U UG/L			1 U UG/L	1 U UG/L		1 U UG/L	1 U UG/L	1.3 UG/L	
cis-1,2-Dichloroethene	2.3 UG/L	2.2 UG/L			1 U UG/L	54.2 J UG/L		23 UG/L	0.5 J UG/L	79 UG/L	
Ethyl Ether	3.6 J UG/L	2 J UG/L			678.8 J UG/L	292.5 J UG/L		5 L UG/L	1930.6 J UG/L	2.8 J UG/L	
trans-1,2-Dichloroethene	1 U UG/L	1 U UG/L			1 U UG/L	0.6 J UG/L		1 U UG/L	1 U UG/L	0.6 J UG/L	
Trichloroethene	2.3 UG/L	2.2 UG/L			2.4 UG/L	247.4 J UG/L		249 UG/L	2.2 UG/L	566 UG/L	
Vinyl Chloride	1 U UG/L	1 U UG/L			1 U UG/L	3.1 UG/L		1 U UG/L	1 U UG/L	1 U UG/L	
Semivolatile Organic Compounds											
bis(2-Ethylhexyl)phthalate	2 J UG/L	2 J UG/L				6 U UG/L				3 J UG/L	
Di-n-butyl phthalate	6 U UG/L	5 U UG/L				7 UG/L				6 U UG/L	
Explosives											
Nitrocellulose	195 L UG/L	223 L UG/L				148 L UG/L				143 UR UG/L	
Inorganics											
Barium	58.9 UG/L	30.9 UG/L				38.1 UG/L				27.7 UG/L	
Beryllium	0.10 U UG/L	0.10 U UG/L				0.20 UG/L				0.25 UG/L	
Cadmium	0.38 UG/L	0.30 U UG/L				0.30 U UG/L				0.30 U UG/L	
Calcium	8090 UG/L	4240 UG/L				1910 UG/L				1920 UG/L	
Cobalt	17.5 UG/L	9.5 UG/L				31.9 UG/L				14.5 UG/L	
Iron	2220 J UG/L	1240 J UG/L				454 J UG/L				111 UG/L	
Magnesium	1880 UG/L	983 UG/L				1340 UG/L				1390 UG/L	
Manganese	271 J UG/L	140 J UG/L				257 J UG/L				41.6 UG/L	
Nickel	7.9 UG/L	4.2 UG/L				7.3 UG/L				5.2 UG/L	
Potassium	6940 UG/L	3910 UG/L				4170 UG/L				2860 UG/L	
Sodium	24100 J UG/L	12300 J UG/L				11600 J UG/L				9260 L UG/L	
Zinc	64.1 UG/L	40.0 UG/L				22.3 UG/L				26.2 UG/L	
Inorganics - Filtered											
Barium, Filtered			59.4 UG/L	59.4 UG/L			35.2 UG/L				27.0 UG/L
Beryllium, Filtered			0.10 U UG/L	0.12 UG/L			0.11 UG/L				0.26 UG/L
Cadmium, Filtered			0.30 U UG/L	0.37 UG/L			0.30 U UG/L				0.30 U UG/L
Calcium, Filtered			7810 UG/L	7540 UG/L			1870 UG/L				1980 UG/L
Cobalt, Filtered			20.7 UG/L	17.7 UG/L			31.9 UG/L				16.8 UG/L
Iron, Filtered			2180 UG/L	2260 UG/L			174 UG/L				28.0 B UG/L
Lead, Filtered			1.0 UG/L	1.0 U UG/L			1.0 U UG/L				1.0 U UG/L
Magnesium, Filtered			1920 UG/L	1890 UG/L			1250 UG/L				1400 UG/L

TABLE 7-4

SUMMARY OF POSITIVE LOWER SURFICIAL GROUNDWATER ANALYTICAL RESULTS
SITE 57 – FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	S57MW0120101	S57MWDUP001	S57MW0120101-F	S57MWDUP001-F	S57MW0010101	S57MW0030101	S57MW0030101-F	S57MW0050101	S57MW0070101	S57MW0090101	S57MW0090101-F
FIELD DUPLICATE OF:		S57MW0120101-D		S57MW0120101-F-D							
SAMPLE DATE:	01/25/99	01/25/99	01/25/99	01/25/99	01/25/99	01/25/99	01/25/99	01/27/99	01/25/99	01/26/99	01/26/99
RI EVENT:	II	II	II	II	II	II	II	II	II	II	II
LOCATION:	S57MW012/SB013	S57MW012/SB013	S57MW012/SB013	S57MW012/SB013	S57MW001/SB001	S57MW003/SB002	S57MW003/SB002	S57MW005/SB015	S57MW007/SB004	S57MW009/SB005	S57MW009/SB005
AQUIFER:	DEEP	DEEP	DEEP	DEEP	DEEP	DEEP	DEEP	DEEP	DEEP	DEEP	DEEP
FILTERING:	Unfiltered	Unfiltered	Filtered	Filtered	Unfiltered	Unfiltered	Filtered	Unfiltered	Unfiltered	Unfiltered	Filtered
SUBSITE:	UPGRADIENT	UPGRADIENT	UPGRADIENT	UPGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT
Manganese, Filtered			281 UG/L	275 UG/L			250 UG/L				48.5 UG/L
Nickel, Filtered			8.0 UG/L	7.5 UG/L			6.3 UG/L				5.4 UG/L
Potassium, Filtered			6950 UG/L	6810 UG/L			3980 UG/L				2900 UG/L
Sodium, Filtered			24600 J UG/L	24100 J UG/L			11300 J UG/L				9400 L UG/L
Zinc, Filtered			61.9 UG/L	54.8 UG/L			19.4 UG/L				23.1 UG/L
Miscellaneous											
Hardness As CaCO3	35.7 MG/L	31.7 MG/L				11.9 MG/L				9.91 MG/L	
pH	6.04	5.94			5.29	5.44			5.87	5.35	
Total Dissolved Solids	58.0 MG/L	90.0 MG/L			20.0 U MG/L	24.0 MG/L		80 L MG/L	170 MG/L	40 MG/L	
Total Organic Carbon	1.0 U MG/L	3.26 MG/L				1.0 U MG/L				1 U MG/L	

TABLE 7-5

SUMMARY OF POSITIVE SURFACE WATER ANALYTICAL RESULTS
SITE 57 – FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	S57SW0130101	S57SW0100101	S57SW0110101	S57SW0120101	S57SW0140101	S57SW0140101-F	S57SW0150101	S57SW0160101	S57SWDUP0101	S57SW0160101-F	S57SWDUP0101-F
FIELD DUPLICATE OF:									S57SW0160101-D		S57SW0160101-F-D
SAMPLE DATE:	01/25/99	01/20/99	01/09/99	01/09/99	01/07/99	01/07/99	01/07/99	01/20/99	01/20/99	01/20/99	01/20/99
RI EVENT:	II	II	II	II	II	II	II	II	II	II	II
LOCATION:	S57SW013/SD009	S57SW010/SD006	S57SW011/SD007	S57SW012/SD008	S57SW014/SD010	S57SW014/SD010	S57SW015/SD011	S57SW016/SD012	S57SW016/SD012	S57SW016/SD012	S57SW016/SD012
FILTERING:	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Filtered	Unfiltered	Unfiltered	Unfiltered	Filtered	Filtered
SUBSITE:	UPGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT
Volatile Organic Compounds											
1,2,4-Trichlorobenzene	1 U UG/L	1 U UG/L	1 U UG/L	1 U UG/L	1 U UG/L		0.7 J UG/L	1 U UG/L	1 U UG/L		
2-Butanone	5 UR UG/L	9.4 J UG/L	5 UR UG/L	5 UR UG/L	5 UR UG/L		5 UR UG/L	5 UR UG/L	5 UR UG/L		
Acetone	5 UR UG/L	5 UR UG/L	5 UR UG/L	5 UR UG/L	7 J UG/L		5 UR UG/L	5 UR UG/L	5 UR UG/L		
Carbon Disulfide	1 U UG/L	0.9 J UG/L	1 U UG/L	1 U UG/L	1 U UG/L		1 U UG/L	1 U UG/L	1 U UG/L		
cis-1,2-Dichloroethene	1 U UG/L	40.1 UG/L	1 U UG/L	0.5 J UG/L	1 U UG/L		1 U UG/L	1 U UG/L	1 U UG/L		
Ethyl Ether	5 UR UG/L	69.4 UG/L	5 UR UG/L	5 UR UG/L	5 UR UG/L		5 UR UG/L	5 UR UG/L	5 UR UG/L		
Trichloroethene	1 U UG/L	16.5 UG/L	1 U UG/L	0.7 J UG/L	1 U UG/L		1.4 UG/L	1 U UG/L	1 U UG/L		
Vinyl Chloride	1 U UG/L	3.5 UG/L	1 U UG/L	1 U UG/L	1 U UG/L		1 U UG/L	1 U UG/L	1 U UG/L		
Explosives											
Nitrocellulose					1440 UL UG/L			221 L UG/L	136 UR UG/L		
Inorganics											
Aluminum					319 UG/L			449 UG/L	447 UG/L		
Barium					17.3 UG/L			17.6 UG/L	19.7 UG/L		
Beryllium					0.20 U UG/L			0.26 UG/L	0.26 UG/L		
Calcium					9450 UG/L			28300 UG/L	30200 UG/L		
Chromium					1.0 UG/L			0.63 UG/L	0.60 U UG/L		
Cobalt					0.87 B UG/L			19.5 UG/L	21.1 UG/L		
Cyanide					6.5 UG/L			8.6 UG/L	10.6 UG/L		
Iron					785 UG/L			438 UG/L	461 UG/L		
Lead					7.9 UG/L			1.5 L UG/L	1.0 UL UG/L		
Magnesium					1580 UG/L			13900 UG/L	14900 UG/L		
Manganese					22.1 UG/L			340 UG/L	363 UG/L		
Nickel					3.1 UG/L			21.9 UG/L	23.4 UG/L		
Potassium					1290 UG/L			6470 UG/L	6710 UG/L		
Selenium					1.9 UJ UG/L			2.8 K UG/L	2.5 U UG/L		
Sodium					7660 K UG/L			151000 J UG/L	160000 J UG/L		
Vanadium					1.4 UG/L			1.4 B UG/L	2.1 B UG/L		
Zinc					119 UG/L			58.5 UG/L	63.1 UG/L		
Inorganics - Filtered											
Aluminum, Filtered						59.8 UG/L				69.7 B UG/L	78.6 B UG/L
Barium, Filtered						13.3 UG/L				16.4 UG/L	17.3 UG/L
Calcium, Filtered						8560 UG/L				28700 UG/L	30400 UG/L
Cobalt, Filtered						4.1 B UG/L				22.5 UG/L	21.0 UG/L
Iron, Filtered						205 UG/L				22.1 B UG/L	8.9 B UG/L
Magnesium, Filtered						1360 UG/L				14100 UG/L	15000 UG/L
Manganese, Filtered						41.9 UG/L				351 UG/L	364 UG/L
Nickel, Filtered						2.2 UG/L				22.2 UG/L	23.2 UG/L
Potassium, Filtered						1210 UG/L				6420 UG/L	6720 UG/L

TABLE 7-5

SUMMARY OF POSITIVE SURFACE WATER ANALYTICAL RESULTS
SITE 57 – FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	S57SW0130101	S57SW0100101	S57SW0110101	S57SW0120101	S57SW0140101	S57SW0140101-F	S57SW0150101	S57SW0160101	S57SWDUP0101	S57SW0160101-F	S57SWDUP0101-F
FIELD DUPLICATE OF:									S57SW0160101-D		S57SW0160101-F-D
SAMPLE DATE:	01/25/99	01/20/99	01/09/99	01/09/99	01/07/99	01/07/99	01/07/99	01/20/99	01/20/99	01/20/99	01/20/99
RI EVENT:	II	II	II	II	II	II	II	II	II	II	II
LOCATION:	S57SW013/SD009	S57SW010/SD006	S57SW011/SD007	S57SW012/SD008	S57SW014/SD010	S57SW014/SD010	S57SW015/SD011	S57SW016/SD012	S57SW016/SD012	S57SW016/SD012	S57SW016/SD012
FILTERING:	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Filtered	Unfiltered	Unfiltered	Unfiltered	Filtered	Filtered
SUBSITE:	UPGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT
Sodium, Filtered						7830 K UG/L				156000 J UG/L	164000 J UG/L
Zinc, Filtered						61.2 UG/L				43.3 UG/L	46.6 UG/L
Miscellaneous											
Chloride	150 U MG/L				10.2 MG/L		127 MG/L	220 L MG/L	170 L MG/L		
Dissolved Oxygen	10.6 MG/L				11 MG/L		10.6 MG/L	9.6 MG/L	9.4 MG/L		
Fluoride	0.10 U MG/L				0.174 K MG/L		2.17 K MG/L	0.27 MG/L	0.52 MG/L		
Hardness As CaCO3	17.8 MG/L				27.3 MG/L			143 MG/L	143 MG/L		
Nitrate/Nitrite	0.686 MG/L				0.121 MG/L		0.294 MG/L	2.85 L MG/L	0.952 L MG/L		
pH	5.54				7.0		7.16	7.59	7.5		
Sulfate	8.1 U MG/L				8.96 MG/L		454 J MG/L	270 L MG/L	210 L MG/L		
Total Dissolved Solids	178 MG/L				64 MG/L		921 MG/L	488 L MG/L	666 L MG/L		
Total Organic Carbon	3.28 MG/L				2.32 MG/L			1.92 MG/L	3.52 MG/L		
Total Suspended Solids	30.0 MG/L				7 MG/L		5 U MG/L	10.0 UL MG/L	5.0 UL MG/L		
Turbidity	25.7 NTU				3.99 NTU		6.03 NTU	5.09 L NTU	4.89 L NTU		

TABLE 7-6

SUMMARY OF POSITIVE SEDIMENT ANALYTICAL RESULTS
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	S57SD0090101	S57SD0060101	S57SD0070101	S57SD0080101	S57SD0100101	S57SD0110101	S57SD0120101	S57SDDUP0101
FIELD DUPLICATE OF:								S57SD0120101-D
SAMPLE DATE:	01/27/99	01/20/99	01/09/99	01/09/99	01/07/99	01/07/99	01/20/99	01/20/99
RI EVENT:	II	II	II	II	II	II	II	II
LOCATION:	S57SW013/SD009	S57SW010/SD006	S57SW011/SD007	S57SW012/SD008	S57SW014/SD010	S57SW015/SD011	S57SW016/SD012	S57SW016/SD012
DEPTH (feet BGS):	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5
SUBSITE:	UPGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT
Volatile Organic Compounds								
Acetone	12 U UG/KG	34 J UG/KG	12 U UG/KG	12 U UG/KG	13 UJ UG/KG	13 UJ UG/KG	31 UG/KG	23 J UG/KG
Carbon Disulfide	12 U UG/KG	16 UJ UG/KG	12 U UG/KG	3 J UG/KG	13 UJ UG/KG	13 UJ UG/KG	14 U UG/KG	13 UJ UG/KG
cis-1,2-Dichloroethene	12 U UG/KG	4 J UG/KG	12 U UG/KG	12 U UG/KG	13 UJ UG/KG	13 UJ UG/KG	14 U UG/KG	13 UJ UG/KG
Ethyl Ether	12 U UG/KG	7 J UG/KG	12 U UG/KG	12 U UG/KG	13 UJ UG/KG	13 UJ UG/KG	14 U UG/KG	13 UJ UG/KG
Semivolatile Organic Compounds								
Anthracene					59 J UG/KG		460 U UG/KG	440 U UG/KG
Benzo(a)anthracene					180 J UG/KG		460 U UG/KG	440 U UG/KG
Benzo(a)pyrene					120 J UG/KG		460 U UG/KG	440 U UG/KG
Benzo(b)fluoranthene					290 J UG/KG		460 U UG/KG	440 U UG/KG
Benzo(g,h,i)perylene					57 J UG/KG		460 U UG/KG	440 U UG/KG
Benzo(k)fluoranthene					77 J UG/KG		460 U UG/KG	440 U UG/KG
bis(2-Ethylhexyl)phthalate					46 J UG/KG		460 U UG/KG	440 U UG/KG
Chrysene					160 J UG/KG		460 U UG/KG	440 U UG/KG
Di-n-butyl phthalate					61 J UG/KG		460 U UG/KG	440 U UG/KG
Fluoranthene					380 J UG/KG		460 U UG/KG	440 U UG/KG
Fluorene					44 J UG/KG		460 U UG/KG	440 U UG/KG
Indeno(1,2,3-cd)pyrene					84 J UG/KG		460 U UG/KG	440 U UG/KG
Phenanthrene					280 J UG/KG		460 U UG/KG	440 U UG/KG
Pyrene					330 J UG/KG		460 U UG/KG	440 U UG/KG
Pesticides/PCBs								
4,4-DDD					4.2 U UG/KG		4.6 U UG/KG	1.4 J UG/KG
4,4'-DDE					4.2 U UG/KG		4.6 U UG/KG	0.34 J UG/KG
4,4'-DDT					4.2 U UG/KG		4.6 U UG/KG	0.96 J UG/KG
Inorganics								
Aluminum		3540 MG/KG			1480 MG/KG		586 MG/KG	599 MG/KG
Antimony		0.63 K MG/KG			0.70 U MG/KG		0.45 U MG/KG	0.46 U MG/KG
Arsenic		13.9 MG/KG			4.7 MG/KG		1.4 B MG/KG	1.5 B MG/KG
Barium		52.5 MG/KG			7.4 MG/KG		8.0 MG/KG	6.8 MG/KG
Beryllium		0.50 L MG/KG			0.16 MG/KG		0.15 MG/KG	0.16 MG/KG
Cadmium		0.69 K MG/KG			0.26 MG/KG		0.10 B MG/KG	0.08 B MG/KG
Calcium		2660 J MG/KG			696 MG/KG		113 B MG/KG	109 B MG/KG
Chromium		13.0 MG/KG			10.7 MG/KG		1.2 MG/KG	1.3 MG/KG
Cobalt		8.6 MG/KG			5.0 MG/KG		1.7 MG/KG	1.7 MG/KG
Copper		135 MG/KG			6.9 MG/KG		1.7 B MG/KG	2.0 B MG/KG
Cyanide		1.0 MG/KG			0.55 MG/KG		0.45 MG/KG	0.61 MG/KG
Iron		24200 MG/KG			7440 MG/KG		1360 MG/KG	1830 MG/KG
Lead		88.9 K MG/KG			18.8 J MG/KG		2.5 B MG/KG	2.8 B MG/KG
Magnesium		1720 MG/KG			1180 MG/KG		66.6 MG/KG	62.7 MG/KG
Manganese		239 MG/KG			96.4 J MG/KG		15.6 MG/KG	15.1 MG/KG
Mercury		0.89 MG/KG			1.9 L MG/KG		0.02 U MG/KG	0.02 U MG/KG

TABLE 7-6

SUMMARY OF POSITIVE SEDIMENT ANALYTICAL RESULTS
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	S57SD0090101	S57SD0060101	S57SD0070101	S57SD0080101	S57SD0100101	S57SD0110101	S57SD0120101	S57SDDUP0101
FIELD DUPLICATE OF:								S57SD0120101-D
SAMPLE DATE:	01/27/99	01/20/99	01/09/99	01/09/99	01/07/99	01/07/99	01/20/99	01/20/99
RI EVENT:	II	II	II	II	II	II	II	II
LOCATION:	S57SW013/SD009	S57SW010/SD006	S57SW011/SD007	S57SW012/SD008	S57SW014/SD010	S57SW015/SD011	S57SW016/SD012	S57SW016/SD012
DEPTH (feet BGS):	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5
SUBSITE:	UPGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT	DOWNGRADIENT
Nickel		19.8 MG/KG			10.0 MG/KG		0.70 MG/KG	0.94 MG/KG
Potassium		400 MG/KG			152 MG/KG		190 MG/KG	214 MG/KG
Silver		0.38 K MG/KG			0.13 U MG/KG		0.12 U MG/KG	0.12 U MG/KG
Sodium		298 L MG/KG			67.8 MG/KG		208 L MG/KG	189 L MG/KG
Vanadium		32.6 MG/KG			9.0 MG/KG		4.7 MG/KG	5.4 MG/KG
Zinc		633 MG/KG			126 MG/KG		7.6 MG/KG	9.1 MG/KG
AVS/Simultaneously Extracted Metals								
Acid Volatile Sulfide	80.1 K MG/KG	80.8 MG/KG			57.1 U MG/KG		53.4 U MG/KG	81.3 MG/KG
Cadmium (sem)	0.10 MG/KG	0.49 MG/KG			0.16 MG/KG		0.03 B MG/KG	0.02 B MG/KG
Copper (sem)	2.9 B MG/KG	77.7 MG/KG			2.1 MG/KG		0.78 B MG/KG	0.58 B MG/KG
Lead (sem)	21.7 MG/KG	80.2 J MG/KG			12.7 MG/KG		3.1 J MG/KG	1.1 J MG/KG
Mercury (sem)	0.031 U MG/KG	0.016 L MG/KG			0.0137 B MG/KG		0.012 L MG/KG	0.003 UL MG/KG
Nickel (sem)	0.74 MG/KG	5.8 MG/KG			1.7 MG/KG		0.54 MG/KG	0.31 MG/KG
Zinc (sem)	13.5 B MG/KG	129 MG/KG			48.0 MG/KG		4.8 MG/KG	3.8 MG/KG
Miscellaneous								
pH					7.51		7.44	7.85
Total Organic Carbon	16900 J MG/KG	36900 J MG/KG			18800 L MG/KG		10700 J MG/KG	8000 J MG/KG

TABLE 7-7

SUMMARY OF POSITIVE STORM SEWER SURFACE WATER ANALYTICAL RESULTS
SITE 57 – FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	S57SW0010101	S57SW0020101	S57SW0020101-F	S57SW0030101	S57SWDUP0301	S57SW0030101-F	S57SW0030201	S57SW0040101	S57SW0040101-F	S57SW0060101	S57SWDUP0201	S57SW0060201
FIELD DUPLICATE OF:					S57SW0030101-D						S57SW0060101-D	
SAMPLE DATE:	01/27/99	01/27/99	01/27/99	01/22/99	01/22/99	01/22/99	01/22/99	01/22/99	01/22/99	01/21/99	01/21/99	01/21/99
RI EVENT:	II	II	II	II	II	II	II	II	II	II	II	II
LOCATION:	MH-427	MH-429	MH-429	MH-01 (MH-430)	MH-01 (MH-430)	MH-01 (MH-430)	MH-01 (MH-430)	MH-02 (MH-431)	MH-02 (MH-431)	MH-487	MH-487	MH-487
FILTERING:	Unfiltered	Unfiltered	Filtered	Unfiltered	Unfiltered	Filtered	Unfiltered	Unfiltered	Filtered	Unfiltered	Unfiltered	Unfiltered
SUBSITE:	SEWER	SEWER	SEWER	SEWER	SEWER	SEWER	SEWER	SEWER	SEWER	SEWER	SEWER	SEWER
Volatile Organic Compounds												
1,1,1-Trichloroethane	1 U UG/L	1 U UG/L		1 U UG/L	1 U UG/L		1 U UG/L	1 U UG/L		0.1 J UG/L	0.1 J UG/L	1.0 U UG/L
1,1-Dichloroethene	1 U UG/L	1 U UG/L		1 U UG/L	1 U UG/L		1 U UG/L	1 U UG/L		0.2 J UG/L	0.2 J UG/L	1.0 U UG/L
2-Butanone	17 L UG/L	21 L UG/L		17.1 J UG/L	16.8 J UG/L		5 UR UG/L	18 J UG/L		17.8 L UG/L	17 L UG/L	14.9 L UG/L
Acetone	5 UR UG/L	5 UR UG/L		5 UR UG/L	5 UR UG/L		5 UR UG/L	5 UR UG/L		741.1 J UG/L	725.1 J UG/L	84.4 B UG/L
Bromodichloromethane	1 U UG/L	1 U UG/L		1 U UG/L	1 U UG/L		1 U UG/L	1 U UG/L		0.1 J UG/L	0.1 J UG/L	1.0 U UG/L
Bromoform	1 U UG/L	1 U UG/L		1 U UG/L	1 U UG/L		1 U UG/L	1 U UG/L		0.6 J UG/L	0.6 J UG/L	0.3 J UG/L
cis-1,2-Dichloroethene	1 U UG/L	15 J UG/L		4.3 UG/L	4.6 UG/L		7.1 UG/L	6.7 UG/L		8.8 UG/L	8.9 UG/L	4.7 UG/L
Dibromochloromethane	1 U UG/L	1 U UG/L		1 U UG/L	1 U UG/L		1 U UG/L	1 U UG/L		0.4 J UG/L	0.4 J UG/L	0.2 J UG/L
Ethyl Ether	145 J UG/L	197 L UG/L		147 J UG/L	147.3 J UG/L		18.5 J UG/L	140.8 J UG/L		98.7 J UG/L	96.4 J UG/L	47.3 J UG/L
Ethylbenzene	1 U UG/L	4 J UG/L		0.8 J UG/L	0.9 J UG/L		1 U UG/L	0.9 J UG/L		1.0 J UG/L	0.9 J UG/L	0.5 J UG/L
Styrene	1 U UG/L	4 J UG/L		1 U UG/L	1 U UG/L		1 U UG/L	0.6 J UG/L		1.5 UG/L	1.7 UG/L	1.1 UG/L
Toluene	1 U UG/L	1 U UG/L		1 U UG/L	1 U UG/L		1 U UG/L	1 U UG/L		1.0 U UG/L	0.1 J UG/L	0.1 J UG/L
trans-1,2-Dichloroethene	1 U UG/L	1 U UG/L		1 U UG/L	1 U UG/L		1 U UG/L	1 U UG/L		1.0 U UG/L	1.0 U UG/L	1.0 U UG/L
Trichloroethene	1 U UG/L	9 J UG/L		5.9 UG/L	6.5 UG/L		6.9 UG/L	10.1 UG/L		20.6 UG/L	20.6 UG/L	11.5 UG/L
Vinyl Chloride	1 U UG/L	2 J UG/L		1 U UG/L	1 U UG/L		1 U UG/L	1 U UG/L		0.5 J UG/L	0.5 J UG/L	0.2 J UG/L
Xylenes, Total	1 U UG/L	1 U UG/L		1 U UG/L	1 U UG/L		1 U UG/L	1 U UG/L		1.0 U UG/L	0.2 J UG/L	0.1 J UG/L
Explosives												
Nitrocellulose		144 L UG/L		1120 L UG/L				1230 L UG/L				
Inorganics												
Aluminum		148 B UG/L		715 J UG/L				924 J UG/L				
Barium		22.2 K UG/L		27.3 UG/L				28.7 UG/L				
Calcium		9820 K UG/L		12700 UG/L				13200 UG/L				
Chromium		0.60 U UG/L		1.4 UG/L				2.2 UG/L				
Cobalt		3.9 K UG/L		2.8 UG/L				2.6 UG/L				
Copper		14.8 B UG/L		21.8 UG/L				25.2 UG/L				
Cyanide		5 U UG/L		5.0 U UG/L				5.0 U UG/L				
Iron		925 K UG/L		1320 UG/L				1510 UG/L				
Lead		4.4 B UG/L		4.1 L UG/L				5.4 L UG/L				
Magnesium		2010 UG/L		2710 UG/L				2820 UG/L				
Manganese		85.3 K UG/L		71.9 UG/L				73.8 UG/L				
Nickel		2.8 K UG/L		3.2 UG/L				5.1 UG/L				
Potassium		2840 UG/L		2800 UG/L				2890 UG/L				
Sodium		50100 UG/L		49700 UG/L				50800 UG/L				
Vanadium		1.6 K UG/L		5.4 B UG/L				7.1 UG/L				
Zinc		84.2 K UG/L		83.4 UG/L				90.4 UG/L				
Inorganics - Filtered												
Aluminum, Filtered			17.4 UL UG/L			189 B UG/L			674 J UG/L			
Barium, Filtered			19.0 UG/L			25.1 UG/L			23.7 UG/L			
Calcium, Filtered			9070 K UG/L			13400 UG/L			12600 UG/L			
Chromium, Filtered			0.6 U UG/L			0.67 UG/L			0.89 UG/L			

TABLE 7-7

SUMMARY OF POSITIVE STORM SEWER SURFACE WATER ANALYTICAL RESULTS
SITE 57 – FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	S57SW0010101	S57SW0020101	S57SW0020101-F	S57SW0030101	S57SWDUP0301	S57SW0030101-F	S57SW0030201	S57SW0040101	S57SW0040101-F	S57SW0060101	S57SWDUP0201	S57SW0060201
FIELD DUPLICATE OF:					S57SW0030101-D						S57SW0060101-D	
SAMPLE DATE:	01/27/99	01/27/99	01/27/99	01/22/99	01/22/99	01/22/99	01/22/99	01/22/99	01/22/99	01/21/99	01/21/99	01/21/99
RI EVENT:	II	II	II	II	II	II	II	II	II	II	II	II
LOCATION:	MH-427	MH-429	MH-429	MH-01 (MH-430)	MH-01 (MH-430)	MH-01 (MH-430)	MH-01 (MH-430)	MH-02 (MH-431)	MH-02 (MH-431)	MH-487	MH-487	MH-487
FILTERING:	Unfiltered	Unfiltered	Filtered	Unfiltered	Unfiltered	Filtered	Unfiltered	Unfiltered	Filtered	Unfiltered	Unfiltered	Unfiltered
Cobalt, Filtered			5.5 K UG/L			6.0 UG/L			5.8 UG/L			
Copper, Filtered			8.6 B UG/L			12.5 UG/L			12.2 UG/L			
Iron, Filtered			609 K UG/L			601 UG/L			653 UG/L			
Lead, Filtered			2.6 B UG/L			3.1 L UG/L			2.7 L UG/L			
Magnesium, Filtered			1850 UG/L			2810 UG/L			2690 UG/L			
Manganese, Filtered			80.6 K UG/L			79.5 UG/L			73.6 UG/L			
Nickel, Filtered			1.6 UG/L			1.1 U UG/L			1.5 UG/L			
Potassium, Filtered			2690 UG/L			2920 UG/L			2750 UG/L			
Selenium, Filtered			2.5 U UG/L			3.1 K UG/L			2.5 U UG/L			
Sodium, Filtered			47900 UG/L			52300 UG/L			49000 UG/L			
Vanadium, Filtered			0.93 K UG/L			3.9 B UG/L			4.6 B UG/L			
Zinc, Filtered			72.0 K UG/L			60.7 UG/L			50.8 UG/L			
Miscellaneous												
Chloride												
Dissolved Oxygen												
Hardness As CaCO3		35.7 MG/L										
Nitrate/Nitrite												
pH												
Sulfate												
Total Dissolved Solids												
Total Organic Carbon		2.32 MG/L										
Turbidity												

TABLE 7-7

SUMMARY OF POSITIVE STORM SEWER SURFACE WATER ANALYTICAL RESULTS
SITE 57 – FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	S57SW0070101	S57SW0070101-F	S57SW0070201	S57SW0080101	S57SW0080201	S57SW0080301	S57SW0090101	S57SW0090101-F
FIELD DUPLICATE OF:								
SAMPLE DATE:	01/21/99	01/27/99	01/21/99	01/21/99	01/21/99	01/21/99	01/20/99	01/20/99
RI EVENT:	II	II	II	II	II	II	II	II
LOCATION:	IW-80 (MH-489)	IW-80 (MH-489)	IW-80 (MH-489)	MH-497	MH-497	MH-497	S57SW009/SD005	S57SW009/SD005
FILTERING:	Unfiltered	Filtered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Filtered
SUBSITE:	SEWER	SEWER	SEWER	SEWER	SEWER	SEWER	SEWER	SEWER
Volatile Organic Compound								
1,1,1-Trichloroethane	1.0 U UG/L		1.0 U UG/L	1.0 U UG/L	1.0 U UG/L	1.0 U UG/L	1 U UG/L	
1,1-Dichloroethene	0.1 J UG/L		0.1 J UG/L	1.0 U UG/L	1.0 U UG/L	1.0 U UG/L	1 U UG/L	
2-Butanone	17.3 L UG/L		17.0 L UG/L	13.3 L UG/L	16.7 L UG/L	5.0 UR UG/L	10.7 J UG/L	
Acetone	272.6 J UG/L		478.5 J UG/L	37.1 B UG/L	255.3 J UG/L	5.0 UR UG/L	5 UR UG/L	
Bromodichloromethane	1.0 U UG/L		1.0 U UG/L	1.0 U UG/L	1.0 U UG/L	1.0 U UG/L	1 U UG/L	
Bromoform	0.6 J UG/L		0.7 J UG/L	0.6 J UG/L	0.4 J UG/L	1.0 U UG/L	1 U UG/L	
cis-1,2-Dichloroethene	9.4 UG/L		11.3 UG/L	6.0 UG/L	6.0 UG/L	0.3 J UG/L	10.8 UG/L	
Dibromochloromethane	0.4 J UG/L		0.4 J UG/L	0.4 J UG/L	0.2 J UG/L	1.0 U UG/L	1 U UG/L	
Ethyl Ether	98.9 J UG/L		103.1 J UG/L	74.2 J UG/L	70.3 J UG/L	1.9 UG/L	70.2 UG/L	
Ethylbenzene	0.9 J UG/L		1.0 J UG/L	0.5 J UG/L	0.5 J UG/L	1.0 U UG/L	1 U UG/L	
Styrene	1.6 UG/L		0.6 J UG/L	0.3 J UG/L	0.2 J UG/L	1.0 U UG/L	0.8 J UG/L	
Toluene	0.1 J UG/L		0.1 J UG/L	1.0 U UG/L	1.0 U UG/L	1.0 U UG/L	1 U UG/L	
trans-1,2-Dichloroethene	0.1 J UG/L		0.1 J UG/L	1.0 U UG/L	0.1 J UG/L	1.0 U UG/L	1 U UG/L	
Trichloroethene	19.9 UG/L		21.3 UG/L	14.9 UG/L	14.7 UG/L	0.4 J UG/L	16.1 UG/L	
Vinyl Chloride	0.4 J UG/L		0.4 J UG/L	0.3 J UG/L	0.2 J UG/L	1.0 U UG/L	1.1 UG/L	
Xylenes, Total	0.6 J UG/L		0.5 J UG/L	0.3 J UG/L	0.2 J UG/L	1.0 U UG/L	1 U UG/L	
Explosives								
Nitrocellulose	136 UR UG/L						135 UR UG/L	
Inorganics								
Aluminum	277 UG/L						481 UG/L	
Barium	25.7 UG/L						34.0 UG/L	
Calcium	11400 UG/L						13800 UG/L	
Chromium	1.1 UG/L						0.73 UG/L	
Cobalt	3.7 UG/L						4.0 UG/L	
Copper	14.9 UG/L						17.1 UG/L	
Cyanide	5.0 U UG/L						8.6 UG/L	
Iron	929 UG/L						1570 UG/L	
Lead	3.2 L UG/L						4.2 L UG/L	
Magnesium	2890 UG/L						3680 UG/L	
Manganese	114 UG/L						119 UG/L	
Nickel	2.3 UG/L						3.7 UG/L	
Potassium	3200 UG/L						3160 UG/L	
Sodium	60900 UG/L						63700 J UG/L	
Vanadium	5.7 B UG/L						5.1 B UG/L	
Zinc	58.3 UG/L						78.5 UG/L	
Inorganics - Filtered								
Aluminum, Filtered		17.4 UL UG/L						69.9 B UG/L
Barium, Filtered		21.2 K UG/L						23.1 UG/L
Calcium, Filtered		9910 K UG/L						14100 UG/L
Chromium, Filtered		0.60 U UG/L						0.60 U UG/L

TABLE 7-7

SUMMARY OF POSITIVE STORM SEWER SURFACE WATER ANALYTICAL RESULTS
SITE 57 – FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	S57SW0070101	S57SW0070101-F	S57SW0070201	S57SW0080101	S57SW0080201	S57SW0080301	S57SW0090101	S57SW0090101-F
FIELD DUPLICATE OF:								
SAMPLE DATE:	01/21/99	01/27/99	01/21/99	01/21/99	01/21/99	01/21/99	01/20/99	01/20/99
RI EVENT:	II	II	II	II	II	II	II	II
LOCATION:	IW-80 (MH-489)	IW-80 (MH-489)	IW-80 (MH-489)	MH-497	MH-497	MH-497	S57SW009/SD005	S57SW009/SD005
FILTERING:	Unfiltered	Filtered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Filtered
Cobalt, Filtered		4.3 K UG/L						7.6 UG/L
Copper, Filtered		9.8 B UG/L						4.9 B UG/L
Iron, Filtered		595 K UG/L						267 UG/L
Lead, Filtered		1.9 B UG/L						1.3 L UG/L
Magnesium, Filtered		2080 UG/L						3750 UG/L
Manganese, Filtered		99.0 K UG/L						121 UG/L
Nickel, Filtered		2.5 K UG/L						2.6 UG/L
Potassium, Filtered		2730 UG/L						3100 UG/L
Selenium, Filtered		2.5 U UG/L						2.5 K UG/L
Sodium, Filtered		50500 UG/L						65700 J UG/L
Vanadium, Filtered		0.72 K UG/L						3.4 B UG/L
Zinc, Filtered		52.3 K UG/L						36.3 K UG/L
Miscellaneous								
Chloride							43.0 L MG/L	
Dissolved Oxygen							9.7 MG/L	
Hardness As CaCO3							59.5 MG/L	
Nitrate/Nitrite							0.452 L MG/L	
pH							7.35	
Sulfate							38.0 L MG/L	
Total Dissolved Solids							224 L MG/L	
Total Organic Carbon							2.08 MG/L	
Turbidity							7.71 L NTU	

TABLE 7-8

SUMMARY OF POSITIVE STORM SEWER SEDIMENT ANALYTICAL RESULTS
SITE 57 – FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	**S57SD0050101**
FIELD DUPLICATE OF:	
SAMPLE DATE:	**01/20/99**
RI EVENT:	**II**
LOCATION:	**S57SW009/SD005**
DEPTH (feet BGS):	**0 - 0.5**
SUBSITE:	**SEWER**
Volatile Organic Compounds	
1,1-Dichloroethene	9 J UG/KG
Acetone	28 J UG/KG
cis-1,2-Dichloroethene	6300 UG/KG
Ethyl Ether	14 J UG/KG
Ethylbenzene	2 J UG/KG
trans-1,2-Dichloroethene	14 J UG/KG
Trichloroethene	18 J UG/KG
Vinyl Chloride	1000 J UG/KG
Semivolatile Organic Compounds	
2-Methylnaphthalene	90 J UG/KG
Acenaphthene	84 J UG/KG
Anthracene	190 J UG/KG
Benzo(a)anthracene	420 J UG/KG
Benzo(a)pyrene	300 J UG/KG
Benzo(b)fluoranthene	500 UG/KG
Benzo(g,h,i)perylene	190 J UG/KG
Benzo(k)fluoranthene	140 J UG/KG
bis(2-Ethylhexyl)phthalate	180 J UG/KG
Carbazole	82 J UG/KG
Chrysene	340 J UG/KG
Dibenzo(a,h)anthracene	50 J UG/KG
Dibenzofuran	80 J UG/KG
Fluoranthene	750 UG/KG
Fluorene	130 J UG/KG
Indeno(1,2,3-cd)pyrene	160 J UG/KG
N-Nitrosodiphenylamine	50 J UG/KG
Naphthalene	180 J UG/KG
Phenanthrene	810 UG/KG
Pyrene	720 UG/KG
Pesticides/PCBs	
gamma-Chlordane	2.1 J UG/KG
Inorganics	
Aluminum	2260 MG/KG
Antimony	3.0 K MG/KG
Arsenic	8.4 MG/KG

TABLE 7-8

SUMMARY OF POSITIVE STORM SEWER SEDIMENT ANALYTICAL RESULTS
SITE 57 – FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	**S57SD0050101**
FIELD DUPLICATE OF:	
SAMPLE DATE:	**01/20/99**
RI EVENT:	**II**
LOCATION:	**S57SW009/SD005**
DEPTH (feet BGS):	**0 - 0.5**
SUBSITE:	**SEWER**
Barium	23.2 MG/KG
Beryllium	0.27 L MG/KG
Cadmium	0.76 K MG/KG
Calcium	2870 J MG/KG
Chromium	12.6 MG/KG
Cobalt	7.7 MG/KG
Copper	103 MG/KG
Cyanide	0.76 MG/KG
Iron	20800 MG/KG
Lead	182 K MG/KG
Magnesium	2070 MG/KG
Manganese	150 MG/KG
Mercury	0.45 MG/KG
Nickel	24.9 MG/KG
Potassium	187 MG/KG
Silver	0.15 K MG/KG
Sodium	118 L MG/KG
Vanadium	118 MG/KG
Zinc	183 MG/KG
AVS/Simultaneously Extracted Metals	
Acid Volatile Sulfide	64.4 MG/KG
Cadmium (sem)	0.25 MG/KG
Copper (sem)	62.9 MG/KG
Lead (sem)	140 J MG/KG
Mercury (sem)	0.006 L MG/KG
Nickel (sem)	3.9 MG/KG
Zinc (sem)	78.0 MG/KG
Miscellaneous	
pH	7.21
Total Organic Carbon	16000 J MG/KG

TABLE 7-9

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
DIRECT CONTACT WITH UPGRADIENT SURFACE SOIL
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Average Concentration	Concentration Used for Screening	Background (2) Value	Risk Based COPC Screening Level (3) Residential	Industrial	Basis	SSL Transfer from Soil to Air (4)	SSL Transfer to Groundwater DAF 20 (4)	COPC Flag	Rationale for (5) Contaminant Deletion or Selection
Semivolatile Organic Compounds																			
205-99-2	Benzo(b)fluoranthene	63	J	63	J	ug/kg	S57SS0130101	1/1	NA	63	63	NA	870	7800	C	NA	5000	No	BSL
117-81-7	Bis(2-Ethylhexyl)phthalate	120	J	120	J	ug/kg	S57SS0130101	1/1	NA	120	120	NA	46000	410000	C	31000000	3600000	No	BSL
206-44-0	Fluoranthene	55	J	55	J	ug/kg	S57SS0130101	1/1	NA	55	55	NA	310000	8200000	N	NA	4300000	No	BSL
129-00-0	Pyrene	50	J	50	J	ug/kg	S57SS0130101	1/1	NA	50	50	NA	230000	6100000	N	NA	4200000	No	BSL
Inorganics																			
7429-90-5	Aluminum	6660		6660		mg/kg	S57SS0130101	1/1	NA	6660	6660	18329	7800	200000	N	NA	NA	No	BSL, BKG
7440-36-0	Antimony	0.87	L	0.87	L	mg/kg	S57SS0130101	1/1	NA	0.87	0.87	ND	3.1	82	N	NA	5	No	BSL
7440-38-2	Arsenic	9.6		9.6		mg/kg	S57SS0130101	1/1	NA	9.6	9.6	4.25	0.43	3.8	C	750	29	Yes	ASL
7440-39-3	Barium	26.8		26.8		mg/kg	S57SS0130101	1/1	NA	26.8	26.8	144	550	14000	N	690000	1600	No	BSL, BKG
7440-41-7	Beryllium	0.27		0.27		mg/kg	S57SS0130101	1/1	NA	0.27	0.27	0.905	16	410	N	1300	63	No	BSL, BKG
7440-43-9	Cadmium	0.21		0.21		mg/kg	S57SS0130101	1/1	NA	0.21	0.21	0.26	3.9	10	N	1800	8	No	BSL, BKG
7440-70-2	Calcium	1580		1580		mg/kg	S57SS0130101	1/1	NA	1580	1580	409	1,000,000 (10)	1,000,000 (10)	N	NA	NA	No	BSL, NUT
7440-47-3	Chromium	22.7		22.7		mg/kg	S57SS0130101	1/1	NA	22.7	22.7	24.2	23 (6)	610 (6)	N	270 (6)	38	No	BSL, BKG
7440-48-4	Cobalt	10.3		10.3		mg/kg	S57SS0130101	1/1	NA	10.3	10.3	39.7	470	12000	N	NA	NA	No	BSL, BKG
7440-50-8	Copper	15		15		mg/kg	S57SS0130101	1/1	NA	15	15	18.7	310	8200	N	NA	NA	No	BSL, BKG
7439-89-6	Iron	13000		13000		mg/kg	S57SS0130101	1/1	NA	13000	13000	43170	2300	61000	N	NA	NA	No	BSL
7439-92-1	Lead	120		120		mg/kg	S57SS0130101	1/1	NA	120	120	149	400 (7)	1000 (8)	N	NA	NA	No	BSL, BKG
7439-95-4	Magnesium	9150	J	9150	J	mg/kg	S57SS0130101	1/1	NA	9150	9150	1382	460,468 (10)	460,468 (10)	N	NA	NA	No	BSL, NUT, BKG
7439-96-5	Manganese	124	L	124	L	mg/kg	S57SS0130101	1/1	NA	124	124	2246	160	4100	N	NA	NA	No	BSL, BKG
7439-97-6	Mercury	0.08		0.08		mg/kg	S57SS0130101	1/1	NA	0.08	0.08	0.087	2.3 (9)	61 (9)	N	10	2	No	BSL, BKG
7440-02-0	Nickel	135	J	135	J	mg/kg	S57SS0130101	1/1	NA	135	135	18.2	160	4100	N	13000	130	No	BSL
7440-09-7	Potassium	398		398		mg/kg	S57SS0130101	1/1	NA	398	398	1874	1,000,000 (10)	1,000,000 (10)		NA	NA	No	BSL, NUT, BKG
7440-23-5	Sodium	144		144		mg/kg	S57SS0130101	1/1	NA	144	144	51.9	1,000,000 (10)	1,000,000 (10)		NA	NA	No	BSL, NUT
7440-62-2	Vanadium	20.7		20.7		mg/kg	S57SS0130101	1/1	NA	20.7	20.7	53.5	55	1400	N	NA	6000	No	BSL, BKG
7440-66-6	Zinc	94.4		94.4		mg/kg	S57SS0130101	1/1	NA	94.4	94.4	38.1	2300	61000	N	NA	12000	No	BSL
Miscellaneous																			
	pH	8.36		8.36			S57SS0130101	1/1	NA	8.36	8.36	NA	NA	NA		NA	NA	NA	NTX

Notes:

Samples included in table include: S57SS0130101

1 Minimum/maximum detected concentration.

2 Background concentrations from Background Investigation Report for Indian Head and Stump Neck Annex, Brown & Root Environmental, December 1997. Only inorganic values were employed for COPC screening.

3 USEPA Region III Risk-Based Concentration Table, April 12, 1999. (Cancer benchmark value = 1E-06, HI = 0.1)

4 *USEPA Soil Screening Level Guidance: Technical Background Document, May 1996.*

5 Rationale Codes Selection Reason: Above Screening Levels (ASL)
Deletion Reason: Background Levels (BKG)
No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

6 Value is for hexavalent chromium.

7 Value is based on OSWER Soil Screening Level for residential land use (USEPA, July 1994).

8 EPA Region III.

9 Value is for mercuric chloride.

10 Essential nutrient screening level based or recommended dietary allowance (see Appendix K).

Definitions:
NA = Not Applicable
COPC = Chemical of Potential Concern
J = Estimated Value
C = Carcinogenic
N = Non-Carcinogenic
L = Biased Low

TABLE 7-10

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
DIRECT CONTACT WITH DOWNGRADIENT SURFACE SOIL
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Average Concentration	Concentration Used for Screening	Background (2) Value	Risk Based COPC Screening Level (3)			SSL Transfer from Soil to Air (4)	SSL Transfer to Groundwater DAF 20 (4)	COPC Flag	Rationale for (5) Contaminant Deletion or Selection
													Residential	Industrial	Basis				
Volatile Organic Compounds																			
156-59-2	cis-1,2-Dichloroethene	2	J	4	J	ug/kg	S57SS0070101	2/9	11 - 12	5	2	NA	78000	200000	N	1200000	400	No	BSL
108-88-3	Toluene	1	J	1	J	ug/kg	S57SS0040101	1/9	11 - 14	5.22	1	NA	1600000	41000000	N	650000	12000	No	BSL
79-01-6	Trichloroethene	10	J	93		ug/kg	S57SS0070101	4/9	11 - 12	23.1	10	NA	58000	520000	C	5000	60	Yes	ASL
Semivolatile Organic Compounds																			
91-57-6	2-Methylnaphthalene	37	J	37	J	ug/kg	S57SS0050101	1/3	370 - 480	154	37	NA	160000	4100000	N	NA	NA	No	BSL
208-96-8	Acenaphthylene	140	J	140	J	ug/kg	S57SS0050101	1/3	370 - 480	188	140	NA	160000 (6)	4100000 (6)	N	NA	NA	No	BSL
120-12-7	Anthracene	51	J	240	J	ug/kg	S57SS0050101	2/3	370	159	240	NA	2300000	61000000	N	NA	12000000	No	BSL
56-55-3	Benzo(a)anthracene	150		2300		ug/kg	S57SS0050101	3/3	NA	883	2300	NA	870	7800	C	NA	2000	Yes	ASL
50-32-8	Benzo(a)pyrene	130	J	1700		ug/kg	S57SS0050101	3/3	NA	660	1700	NA	87	780	C	NA	8000	Yes	ASL
205-99-2	Benzo(b)fluoranthene	200	J	4200		ug/kg	S57SS0050101	3/3	NA	1560	4200	NA	870	7800	C	NA	5000	Yes	ASL
191-24-2	Benzo(g,h,i)perylene	52		450		ug/kg	S57SS0050101	3/3	NA	188	450	NA	160000 (6)	4100000 (6)	N	NA	NA	No	BSL
207-08-9	Benzo(k)fluoranthene	83	J	1400		ug/kg	S57SS0050101	3/3	NA	527	1400	NA	8700	78000	N	NA	49000	No	BSL
117-81-7	Bis(2-Ethylhexyl)phthalate	41		120	J	ug/kg	S57SS0050101	2/3	480	134	120	NA	46000	410000	C	31000000	3600000	No	BSL
86-74-8	Carbazole	99	J	99	J	ug/kg	S57SS0050101	1/3	370 - 480	175	99	NA	32000	290000	C	NA	600	No	BSL
218-01-9	Chrysene	180		2200		ug/kg	S57SS0050101	3/3	NA	860	2200	NA	87000	780000	C	NA	160000	No	BSL
53-70-3	Dibenzo(a,h)anthracene	350	J	350	J	ug/kg	S57SS0050101	1/3	370 - 480	258	350	NA	87	780	C	NA	2000	Yes	ASL
206-44-0	Fluoranthene	300		1800		ug/kg	S57SS0050101.	3/3	NA	803	1800	NA	310000	8200000	N	NA	4300000	No	BSL
86-73-7	Fluorene	39	J	39	J	ug/kg	S57SS0050101	1/3	370 - 480	155	39	NA	310000	8200000	N	NA	560000	No	BSL
193-39-5	Indeno(1,2,3-cd)pyrene	79		970		ug/kg	S57SS0050101	3/3	NA	376	970	NA	870	7800	N	NA	14000	Yes	ASL
91-20-3	Naphthalene	38	J	38	J	ug/kg	S57SS0050101	1/3	370 - 480	154	38	NA	160000	41000000	C	NA	84000	No	BSL
85-01-8	Phenanthrene	180		490		ug/kg	S57SS0050101	3/3	NA	327	490	NA	160000 (6)	4100000 (6)	N	NA	NA	No	BSL
129-00-0	Pyrene	310		2500		ug/kg	S57SS0050101	3/3	NA	1097	2500	NA	230000	6100000	N	NA	4200000	No	BSL
Pesticides/PCBs																			
72-54-8	4,4'-DDD	12		12		ug/kg	S57SS0050101	1/3	3.8 - 4.8	5.43	12	NA	2700	24000	C	NA	16000	No	BSL
72-55-9	4,4'-DDE	61		61		ug/kg	S57SS0050101	1/3	3.8 - 4.8	21.8	61	NA	1900	17000	C	NA	54000	No	BSL
50-29-3	4,4'-DDT	150	J	150	J	ug/kg	S57SS0050101	1/3	3.8 - 4.8	51.4	150	NA	1900	17000	C	NA	32000	No	BSL
5103-74-2	Gamma-Chlordane	5.3	J	5.3	J	ug/kg	S57SS0050101	1/3	1.9 - 2.4	2.48	5.3	NA	1800	16000	C	NA	10000	No	BSL
Explosives																			
9004-70-0	Nitrocellulose	116000		299000	L	ug/kg	S57SS0050101	3/3	NA	202000	299000	NA	NA	NA		NA	NA	No	NTX
Inorganics																			
7429-90-5	Aluminum	3640	J	9170		mg/kg	S57SS0070101	3/3	NA	6313	9170	18329	7800	200000	N	NA	NA	No	BKG
7440-38-2	Arsenic	29.3		103		mg/kg	S57SS0070101	3/3	NA	55.3	103	4.25	0.43	3.8	C	750	29	Yes	ASL
7440-39-3	Barium	20.7		48.2		mg/kg	S57SS0070101	3/3	NA	35.9	48.2	144	550	14000	N	690000	1600	No	BSL, BKG
7440-41-7	Beryllium	0.29		0.88		mg/kg	S57SS0080101	3/3	NA	0.647	0.88	0.905	16	410	N	1300	63	No	BSL, BKG
7440-43-9	Cadmium	0.47		0.8		mg/kg	S57SS0080101	2/3	0.19	0.455	0.8	0.26	3.9	10	N	1600	8	No	BSL
7440-70-2	Calcium	604		3270		mg/kg	S57SS0070101	3/3	NA	2001	3270	409	1,000,000 (11)	1,000,000 (11)	N	NA	NA	No	BSL, NUT
7440-47-3	Chromium	12		14.3		mg/kg	S57SS0070101	3/3	NA	13.1	14.3	24.2	23 (7)	610 (7)	N	270 (6)	38	No	BSL, BKG
7440-48-4	Cobalt	6.9		8.3	K	mg/kg	S57SS0070101	3/3	NA	7.77	8.3	39.7	470	12000	N	NA	NA	No	BSL, BKG
7440-50-8	Copper	10.4		20.3		mg/kg	S57SS0080101	3/3	NA	15.1	20.3	18.7	310	8200	N	NA	NA	No	BSL, BKG
7439-89-6	Iron	12400		24800		mg/kg	S57SS0070101	3/3	NA	19233	24800	43170	2300	61000	N	NA	NA	No	BKG
7439-92-1	Lead	25.4	K	487	J	mg/kg	S57SS0050101	3/3	NA	201	487	149	400 (8)	1000 (9)	N	NA	NA	Yes	ASL
7439-95-4	Magnesium	301		796		mg/kg	S57SS0070101	3/3	NA	593	796	1382	460,468 (11)	460,468 (11)	N	NA	NA	No	BSL, NUT, BKG
7439-96-5	Manganese	97.9		134	K	mg/kg	S57SS0050101	3/3	NA	111	134	2248	160	4100	N	NA	NA	No	BSL, BKG
7439-97-6	Mercury	0.03		0.1		mg/kg	S57SS0080101	3/3	NA	0.073	0.1	0.087	2.3 (10)	61 (10)	N	10	2	No	BSL
7440-02-0	Nickel	6		8.4		mg/kg	S57SS0080101	3/3	NA	7.03	8.4	18.2	160	4100	N	13000	130	No	BSL, BKG

TABLE 7-10

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
DIRECT CONTACT WITH DOWNGRADIENT SURFACE SOIL
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND
PAGE 2 OF 2

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Average Concentration	Concentration Used for Screening	Background (2) Value	Risk Based COPC Screening Level (3)			SSL Transfer from Soil to Air (4)	SSL Transfer to Groundwater DAF 20 (4)	COPC Flag	Rationale for (5) Contaminant Deletion or Selection
													Residential	Industrial	Basis				
7440-09-7	Potassium	234		828		mg/kg	S57SS0070101	3/3	NA	600	828	1874	1,000,000 (11)	1,000,000 (11)		NA	NA	No	BSL, NUT, BKG
7782-49-2	Selenium	0.56	L	0.56	L	mg/kg	S57SS0050101	1/3	0.32 - 0.38	0.303	0.56	1.09	39	1000	N	NA	5	No	BSL, BKG
7440-23-5	Sodium	45.7		82		mg/kg	S57SS0080101	2/3	128	63.9	82	51.9	1,000,000 (11)	1,000,000 (11)		NA	NA	No	BSL, NUT
7440-62-2	Vanadium	19.1		35.7		mg/kg	S57SS0070101	3/3	NA	28.7	35.7	53.5	55	1400	N	NA	6000	No	BSL, BKG
7440-66-6	Zinc	45		261		mg/kg	S57SS0080101	3/3	NA	125	261	38.1	2300	61000	N	NA	12000	No	BSL
Miscellaneous																			
	pH	6.06		8.12			S57SS0070101	3/3	NA	7.34	8.12	NA	NA	NA		NA	NA	NA	NTX
	Total Organic Carbon	7790	L	50600		mg/kg	S57SS0090101	2/2	NA	29195	50600	NA	NA	NA		NA	NA	NA	NTX

Notes:

Samples included in table include: S57SS0010101, S57SS0020101, S57SS0040101, S57SS0050101, S57SS0070101, S57SS0080101-MAX, S57SS0090101-MAX, S57SS0110101, S57SS0150101.

1 Minimum/maximum detected concentration.

2 Background concentrations from Background Investigation Report for Indian Head and Stump Neck Annex, Brown & Root Environmental, December 1997.
Only inorganic values were employed for COPC screening.

3 USEPA Region III Risk-Based Concentration Table, April 12, 1999. (Cancer benchmark value = 1E-06, HI = 0.1)

4 USEPA Soil Screening Level Guidance: Technical Background Document, May 1996.

5 Rationale Codes Selection Reason: Above Screening Levels (ASL)
Deletion Reason: Background Levels (BKG)
No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

6 Value is for naphthalene.

7 Value is for hexavalent chromium.

8 Value is based on OSWER Soil Screening Level for residential land use (USEPA, July 1994).

9 EPA Region III.

10 Value is for mercuric chloride.

11 Essential nutrient screening level based onrecommendec dietary allowance (see Appendix K).

Definitions:

NA = Not Applicable
COPC = Chemical of Potential Concern
J = Estimated Value
C = Carcinogenic
N = Non-Carcinogenic
K = Biased High
L = Biased Low

TABLE 7-11

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
DIRECT CONTACT WITH UPGRADIENT SUBSURFACE SOIL
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Average Concentration	Concentration Used for Screening	Background (2) Value	Risk Based COPC Screening Level (3) Residential	Industrial	Basis	SSL Transfer from Soil to Air (4)	SSL Transfer to Groundwater DAF 20 (4)	COPC Flag	Rationale for (5) Contaminant Deletion or Selection
Volatile Organic Compounds																			
67-64-1	Acetone	26		26		ug/kg	S57SB0130101	1/2	12	16	26	NA	780000	20000000	N	100000000	16000	No	BSL
60-29-7	Ethyl Ether	54		54		ug/kg	S57SB0130201	1/2	12	30	54	NA	1600000	41000000	N	NA	NA	No	BSL
Semivolatile Organic Compounds																			
117-81-7	Bis(2-Ethylhexyl)phthalate	89	J	89	J	ug/kg	S57SB0130201	1/2	400	145	89	NA	46000	410000	C	31000000	3600000	No	BSL
84-74-2	Di-n-butyl phthalate	200	J	200	J	ug/kg	S57SB0130101	1/2	410	203	200	NA	780000	20000000	N	2300000	2300000	No	BSL
Explosives																			
9004-70-0	Nitrocellulose	50400	L	50400	L	ug/kg	S57SB0130201	1/1	NA	50400	50400	NA	NA	NA		NA	NA	No	NTX
Inorganics																			
7429-90-5	Aluminum	5410	J	7780		mg/kg	S57SB0130101	2/2	NA	6595	7780	34406	7800	200000	N	NA	NA	No	BSL, BKG
7440-38-2	Arsenic	2.6	L	2.9		mg/kg	S57SB0130101	2/2	NA	2.75	2.9	24.4	0.43	3.8	C	750	29	No	BKG
7440-39-3	Barium	24.5		34.2		mg/kg	S57SB0130201	2/2	NA	29.4	34.2	191	550	14000	N	690000	1600	No	BSL, BKG
7440-41-7	Beryllium	0.22		0.52		mg/kg	S57SB0130201	2/2	NA	0.37	0.52	2.46	16	410	N	1300	63	No	BSL, BKG
7440-70-2	Calcium	573		796		mg/kg	S57SB0130201	2/2	NA	685	796	196	1,000,000 (10)	1,000,000 (10)	N	NA	NA	No	BSL, NUT
7440-47-3	Chromium	9.8		10.9	J	mg/kg	S57SB0130201	2/2	NA	10.4	10.9	101	23 (6)	610 (6)	N	270 (6)	38	No	BSL, BKG
7440-48-4	Cobalt	1.4		6.2		mg/kg	S57SB0130201	2/2	NA	3.8	6.2	133	470	12000	N	NA	NA	No	BSL, BKG
7440-50-8	Copper	6.2		7.5		mg/kg	S57SB0130101	2/2	NA	6.85	7.5	56.5	310	8200	N	NA	NA	No	BSL, BKG
7439-89-6	Iron	9360		10600		mg/kg	S57SB0130201	2/2	NA	9980	10600	151453	2300	61000	N	NA	NA	No	BKG
7439-92-1	Lead	8.2	J	8.4		mg/kg	S57SB0130101	2/2	NA	8.3	8.4	37.5	400 (7)	1000 (8)	N	NA	NA	No	BSL, BKG
7439-95-4	Magnesium	350		549	J	mg/kg	S57SB0130101	2/2	NA	450	549	4307	460,468 (10)	460,468 (10)	N	NA	NA	No	BSL, NUT, BKG
7439-96-5	Manganese	26	L	42.3	K	mg/kg	S57SB0130201	2/2	NA	34.2	42.3	1270	160	4100	N	NA	NA	No	BSL, BKG
7439-97-6	Mercury	0.02		0.03		mg/kg	S57SB0130201	2/2	NA	0.025	0.03	0.13	2.3 (9)	61 (9)	N	10	2	No	BSL, BKG
7440-02-0	Nickel	3		4.1	J	mg/kg	S57SB0130101	2/2	NA	3.55	4.1	22.1	160	4100	N	13000	130	No	BSL, BKG
7440-09-7	Potassium	370		743		mg/kg	S57SB0130101	2/2	NA	557	743	5998	1,000,000 (10)	1,000,000 (10)		NA	NA	No	BSL, NUT, BKG
7782-49-2	Selenium	0.82	K	0.82	K	mg/kg	S57SB0130101	1/2	0.5	0.535	0.82	8.93	39	1000	N	NA	5	No	BSL, BKG
7440-23-5	Sodium	70.8		95.2		mg/kg	S57SB0130101	2/2	NA	83	95.2	826	1,000,000 (10)	1,000,000 (10)		NA	NA	No	BSL, NUT, BKG
7440-62-2	Vanadium	20.6		21.9		mg/kg	S57SB0130101	2/2	NA	21.3	21.9	133	55	1400	N	NA	6000	No	BSL, BKG
7440-66-6	Zinc	13.8		15.3		mg/kg	S57SB0130101	2/2	NA	14.6	15.3	79.5	2300	61000	N	NA	12000	No	BSL, BKG
Miscellaneous																			
	pH	6.57		7.79			S57SB0130101	2/2	NA	7.18	NA	NA	NA	NA		NA	NA	NA	NTX

Notes:
Samples included in table include: S57SB0130101, S57SB0130201
1 Minimum/maximum detected concentration.
2 Background concentrations from Background Investigation Report for Indian Head and Stump Neck Annex, Brown & Root Environmental, December 1997.
Only inorganic values were employed for COPC screening.
3 USEPA Region III Risk-Based Concentration Table, April 12, 1999. (Cancer benchmark value = 1E-06, HI = 0.1)
4 USEPA Soil Screening Level Guidance: Technical Background Document, May 1996.
5 Rationale Codes Selection Reason: Above Screening Levels (ASL)
Deletion Reason: Background Levels (BKG)
No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)
6 Value is for hexavalent chromium.
7 Value is based on OSWER Soil Screening Level for residential land use (USEPA, July 1994).
8 EPA Region III.
9 Value is for mercuric chloride.
10 Essential nutrient screening level based on recommended dietary allowance (see Appendix K).

Definitions:
NA = Not Applicable
COPC = Chemical of Potential Concern
J = Estimated Value
C = Carcinogenic
N = Non-Carcinogenic
K - Biased High
L = Biased Low

TABLE 7-12

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
DIRECT CONTACT WITH DOWNGRADIENT SUBSURFACE SOIL
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Average Concentration	Concentration Used for Screening	Background (2) Value	Risk Based COPC Screening Level (3) Residential	Industrial	Basis	SSL Transfer from Soil to Air (4)	SSL Transfer to Groundwater DAF 20 (4)	COPC Flag	Rationale for (5) Contaminant Deletion or Selection
Volatile Organic Compounds																			
71-55-6	1,1,1-Trichloroethane	4	J	4	J	ug/kg	S57SB0120201	1/26	11 - 14	6.02	4	NA	160000	4100000	N	120000	2000	No	BSL
78-93-3	2-Butanone	29	J	29	J	ug/kg	S57SB0090201	1/26	11 - 14	7.00	29	NA	4700000	120000000	N	NA	NA	No	BSL
67-64-1	Acetone	14	J	2200		ug/kg	S57SB0050201	7/26	11 - 14	99.8	2200	NA	780000	20000000	N	100000000	16000	No	BSL
75-15-0	Carbon Disulfide	1	J	4	J	ug/kg	S57SB0040101	5/26	11 - 14	5.37	4	NA	780000	20000000	N	720000	32000	No	BSL
156-59-2	cis-1,2-Dichloroethene	3	J	77000		ug/kg	S57SB0060101	6/26	11 - 13	2969	77000	NA	78000	2000000	N	1200000	400	Yes	BSL
75-09-2	Methylene Chloride	110	J	21000		ug/kg	S57SB0060101	2/26	5 - 44	820	21000	NA	85000	760000	C	13000	20	Yes	BSL
108-88-3	Toluene	4	J	4	J	ug/kg	S57SB0060101	1/26	11 - 14	6.04	4	NA	1600000	41000000	N	650000	12000	No	BSL
156-60-5	trans-1,2-Dichloroethene	4	J	20		ug/kg	S57SB0080201	2/26	11 - 14	6.58	20	NA	160000	4100000	N	3100000	700	No	BSL
79-01-6	Trichloroethene	1	J	220000		ug/kg	S57SB0060101	12/26	11 - 13	8505	220000	NA	58000	520000	C	5000	60	Yes	ASL
1330-20-7	Xylenes, Total	8	J	8	J	ug/kg	S57SB0060101	1/26	11 - 14	6.19	8	NA	16000000	410000000	N	410000	190000	No	BSL
Semivolatile Organic Compounds																			
56-55-3	Benzo(a)anthracene	85		360	J	ug/kg	S57SB0050101	2/5	390 - 420	211	360	NA	870	7800	C	NA	2000	No	BSL
50-32-8	Benzo(a)pyrene	61		270	J	ug/kg	S57SB0050101	2/5	390 - 420	188	270	NA	87	780	C	NA	8000	Yes	ASL
205-99-2	Benzo(b)fluoranthene	85		510		ug/kg	S57SB0050101	2/5	390 - 420	241	510	NA	870	7800	C	NA	5000	No	BSL
191-24-2	Benzo(g,h,i)perylene	70	J	70	J	ug/kg	S57SB0050101	1/5	390 - 420	176	70	NA	160000 (6)	4100000 (6)	N	NA	NA	No	BSL
207-08-9	Benzo(k)fluoranthene	200	J	200	J	ug/kg	S57SB0050101	1/5	390 - 420	202	200	NA	8700	78000	N	NA	49000	No	BSL
117-81-7	Bis(2-Ethylhexyl)phthalate	92	J	92	J	ug/kg	S57SB0050101	1/5	390 - 420	180	92	NA	46000	410000	C	31000000	3600000	No	BSL
218-01-9	Chrysene	76		350	J	ug/kg	S57SB0050101	2/5	390 - 420	207.2	350	NA	87000	780000	C	NA	160000	No	BSL
53-70-3	Dibenzo(a,h)anthracene	60	J	60	J	ug/kg	S57SB0050101	1/5	390 - 420	174	60	NA	87	780	C	NA	2000	No	BSL
206-44-0	Fluoranthene	140		380	J	ug/kg	S57SB0050101	2/5	390 - 420	226	380	NA	310000	8200000	N	NA	4300000	No	BSL
193-39-5	Indeno(1,2,3-cd)pyrene	43		160	J	ug/kg	S57SB0050101	2/5	390 - 420	163	160	NA	870	7800	N	NA	14000	No	BSL
85-01-8	Phenanthrene	110		110	J	ug/kg	S57SB0050101, S57SB0050201-MAX	2/5	390 - 420	166	110	NA	160000 (6)	4100000 (6)	N	NA	NA	No	BSL
129-00-0	Pyrene	52		380	J	ug/kg	S57SB0050101	3/5	410 - 420	197	380	NA	230000	6100000	N	NA	4200000	No	BSL
Pesticides/PCBs																			
72-55-9	4,4'-DDE	17		17		ug/kg	S57SB0050101	1/5	3.9 - 4.2	5.02	17	NA	1900	17000	C	NA	54000	No	BSL
50-29-3	4,4'-DDT	20		20		ug/kg	S57SB0050101	1/5	3.9 - 4.2	5.62	20	NA	1900	17000	C	NA	32000	No	BSL
Explosives																			
9004-70-0	Nitrocellulose	66000		205000		ug/kg	S57SB0050201-MAX	5/5	NA	109660	205000	NA	NA	NA		NA	NA	No	NTX
Inorganics																			
7429-90-5	Aluminum	5300		11500		mg/kg	S57SB0070101	5/5	NA	8742	13200	34406	7800	200000	N	NA	NA	No	BKG
7440-38-2	Arsenic	15.3		50		mg/kg	S57SB0050201-MAX	5/5	NA	27.8	50	24.4	0.43	3.8	C	750	29	Yes	ASL
7440-39-3	Barium	24.7		58.2		mg/kg	S57SB0070101	5/5	NA	40.2	58.2	191	550	14000	N	690000	1600	No	BSL, BKG
7440-41-7	Beryllium	0.32		2.5		mg/kg	S57SB0070101	5/5	NA	0.98	2.5	2.46	16	410	N	1300	63	No	BSL
7440-70-2	Calcium	415		8840		mg/kg	S57SB0080101-MAX	5/5	NA	2866	8840	196	1,000,000 (11)	1,000,000 (11)		NA	NA	No	BSL, NUT
7440-47-3	Chromium	9.1		21		mg/kg	S57SB0070101	5/5	NA	14.1	21	101	23 (7)	610 (7)	N	270 (7)	38	No	BSL, BKG
7440-48-4	Cobalt	3.1		34.6	K	mg/kg	S57SB0070101	5/5	NA	10.8	34.6	133	470	12000	N	NA	NA	No	BSL, BKG
7440-50-8	Copper	9.1		17.5		mg/kg	S57SB0070101	5/5	NA	12.5	17.5	56.5	310	8200	N	NA	NA	No	BSL, BKG
7439-89-6	Iron	16000		46300		mg/kg	S57SB0070101	5/5	NA	25180	46300	151453	2300	61000	N	NA	NA	No	BKG
7439-92-1	Lead	8.6	K	100		mg/kg	S57SB0050201-MAX	5/5	NA	43.6	100	37.5	400 (8)	1000 (9)	N	NA	NA	No	BSL, BKG
7439-95-4	Magnesium	314		1440		mg/kg	S57SB0070101	5/5	NA	725	1440	4307	460,468 (11)	460,468 (11)		NA	NA	No	BSL, NUT, BKG
7439-96-5	Manganese	59.8		253	J	mg/kg	S57SB0070101	5/5	NA	114	253	1270	160	4100	N	NA	NA	No	BKG
7439-97-6	Mercury	0.03		0.25		mg/kg	S57SB0050101	5/5	NA	0.094	0.25	0.13	2.3 (10)	61 (10)	N	10	2	No	BSL
7440-02-0	Nickel	3.9		13	K	mg/kg	S57SB0070101	5/5	NA	6.80	13	22.1	160	4100	N	13000	130	No	BSL, BKG
7440-09-7	Potassium	334		1330		mg/kg	S57SB0070101	5/5	NA	779	1330	5998	1,000,000 (11)	1,000,000 (11)		NA	NA	No	BSL, NUT, BKG
7782-49-2	Selenium	0.59	L	0.74	L	mg/kg	S57SB0070101	3/5	0.26 - 0.27	0.459	0.74	8.93	39	1000	N	NA	5	No	BSL, BKG
7440-23-5	Sodium	39.4		56.8		mg/kg	S57SB0080101-MAX	3/5	133 - 231	66.7	56.8	826	1,000,000 (11)	1,000,000 (11)		NA	NA	No	BSL, NUT
7440-62-2	Vanadium	21.8		60.8		mg/kg	S57SB0070101	5/5	NA	35.54	60.8	133	55	1400	N	NA	6000	No	BKG
7440-66-6	Zinc	35.1		158		mg/kg	S57SB0080101-MAX	5/5	NA	66.0	158	79.5	2300	61000	N	NA	12000	No	BSL
Miscellaneous																			
	pH	5.4		8.34			S57SB0080201	5/5	NA	7.2	8.34	NA	NA	NA		NA	NA	No	NTX

TABLE 7-12

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
DIRECT CONTACT WITH DOWNGRADIENT SUBSURFACE SOIL
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Average Concentration	Concentration Used for Screening	Background (2) Value	Risk Based COPC Screening Level (3)			SSL Transfer from Soil to Air (4)	SSL Transfer to Groundwater DAF 20 (4)	COPC Flag	Rationale for (5) Contaminant Deletion or Selection
													Residential	Industrial	Basis				
	Total Organic Carbon	8120	L	22000		mg/kg	S57SB0050101	4/5	4440	11028	22000	NA	NA	NA		NA	NA	No	NTX

Notes:
Samples included in table include: S57SB0010101, S57SB0010201, S57SB0020101, S57SB0020201, S57SB0020401, S57SB0020501, S57SB0030101-MAX, S57SB0030201-MAX, S57SB0040101, S57SB0040201, S57SB0050101, S57SB0050201-MAX, S57SB0050401, S57SB0060101, S57SB0060201, S57SB0070101, S57SB0080101-MAX, S57SB0080201, S57SB0090101, S57SB0090201, S57SB0100101, S57SB0100201, S57SB0110101, S57SB0110201, S57SB0120101, S57SB0120201, S57SB0140101, S57SB0140201, S57SB0150101.

1 Minimum/maximum detected concentration.
2 Background concentrations from Background Investigation Report for Indian Head and Stump Neck Annex, Brown & Root Environmental, December 1997. Only inorganic values were employed for COPC screening.
3 USEPA Region III Risk-Based Concentration Table, April 12, 1999. (Cancer benchmark value = 1E-06, HI = 0.1)
4 USEPA Soil Screening Level Guidance: Technical Background Document, May 1996.
5 Rationale Codes Selection Reason: Above Screening Levels (ASL)
Deletion Reason: Infrequent Detection (IFD)
Background Levels (BKG)
No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)
6 Value is for naphthalene.
7 Value is for hexavalent chromium.
8 Value is based on OSWER Soil Screening Level for residential land use (USEPA, July 1994).
9 EPA Region III.
10 Value is for mercuric chloride.
11 Essential nutrient screening level based on recommended dietary allowance (see Appendix K).

Definitions:
NA = Not Applicable
COPC = Chemical of Potential Concern
J = Estimated Value
C = Carcinogenic
N = Non-Carcinogenic
K = Biased High
L = Biased Low

TABLE 7-13

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
DIRECT CONTACT WITH UPPER UPGRADIENT GROUNDWATER
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Average Concentration	Concentration Used for Screening	Background (2) Value	Screening (3) Toxicity Value		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for (4) Contaminant Deletion or Selection
Volatile Organic Compounds																		
71-55-6	1,1,1-Trichloroethane	14.6		14.6		ug/L	S57MW0130101	1/1	NA	14.6	14.6	NA	54	N	200	MCL	No	BSL
75-34-3	1,1-Dichloroethane	0.8	J	0.8	J	ug/L	S57MW0130101	1/1	NA	0.8	0.8	NA	80	N	NA	NA	No	BSL
75-35-4	1,1-Dichloroethene	77.5	J	77.5	J	ug/L	S57MW0130101	1/1	NA	77.5	77.5	NA	0.044	C	7	MCL	Yes	ASL
107-06-2	1,2-Dichloroethane	2.7		2.7		ug/L	S57MW0130101	1/1	NA	2.7	2.7	NA	0.12	C	NA	NA	Yes	ASL
67-66-3	Chloroform	1.3		1.3		ug/L	S57MW0130101	1/1	NA	1.3	1.3	NA	0.15	C	80	MCL	Yes	ASL
79-01-6	Trichloroethene	2.2		2.2		ug/L	S57MW0130101	1/1	NA	2.2	2.2	NA	1.6	C	5	MCL	Yes	ASL
Inorganics - Unfiltered																		
7440-39-3	Barium	72.7		72.7		ug/L	S57MW0130101	1/1	NA	72.7	72.7	254	260	N	2000	MCL	No	BSL, BKG
7440-41-7	Beryllium	0.39		0.39		ug/L	S57MW0130101	1/1	NA	0.39	0.39	ND	7.3	N	4	MCL	No	BSL
7440-70-2	Calcium	2530		2530		ug/L	S57MW0130101	1/1	NA	2530	2530	599450	1,055,398 (5)		NA	NA	No	BSL, NUT, BKG
7440-48-4	Cobalt	22.8		22.8		ug/L	S57MW0130101	1/1	NA	22.8	22.8	39.6	220	N	NA	NA	No	BSL, BKG
7439-89-6	Iron	102	J	102	J	ug/L	S57MW0130101	1/1	NA	102	102	57199	1100	N	300	SMCL	No	BSL, BKG
7439-95-4	Magnesium	1500		1500		ug/L	S57MW0130101	1/1	NA	1500	1500	31254	118,807 (5)		NA	NA	No	BSL, NUT, BKG
7439-96-5	Manganese	179	J	179	J	ug/L	S57MW0130101	1/1	NA	179	179	28160	73	N	50	SMCL	No	BKG
7440-02-0	Nickel	7		7		ug/L	S57MW0130101	1/1	NA	7	7	39	73	N	100	MCL	No	BSL, BKG
7440-09-7	Potassium	2490		2490		ug/L	S57MW0130101	1/1	NA	2490	2490	83058	297,016 (5)		NA	NA	No	BSL, NUT, BKG
7440-23-5	Sodium	21900	J	21900	J	ug/L	S57MW0130101	1/1	NA	21900	21900	79585	396,022 (5)		NA	NA	No	BSL, NUT, BKG
7440-66-6	Zinc	23.8		23.8		ug/L	S57MW0130101	1/1	NA	23.8	23.8	45.2	1100	N	5000	SMCL	No	BSL, BKG
Inorganics - Filtered																		
7440-39-3	Barium	73.5		73.5		ug/L	S57MW0130101-F	1/1	NA	73.5	73.5	114	260	N	2000	MCL	No	BSL, BKG
7440-41-7	Beryllium	0.37		0.37		ug/L	S57MW0130101-F	1/1	NA	0.37	0.37	ND	7.3	N	4	MCL	No	BSL
7440-70-2	Calcium	2640		2640		ug/L	S57MW0130101-F	1/1	NA	2640	2640	102113	1,055,398 (5)		NA	NA	No	BSL, NUT, BKG
7440-48-4	Cobalt	27.6		27.6		ug/L	S57MW0130101-F	1/1	NA	27.6	27.6	13	220	N	NA	NA	No	BSL
7439-89-6	Iron	131		131		ug/L	S57MW0130101-F	1/1	NA	131	131	4171372	1100	N	300	SMCL	No	BSL, BKG
7439-95-4	Magnesium	1510		1510		ug/L	S57MW0130101-F	1/1	NA	1510	1510	13988	118,807 (5)		NA	NA	No	BSL, NUT, BKG
7439-96-5	Manganese	205		205		ug/L	S57MW0130101-F	1/1	NA	205	205	2257	73	N	50	SMCL	No	BKG
7440-02-0	Nickel	8		8		ug/L	S57MW0130101-F	1/1	NA	8	8	41.4	73	N	100	MCL	No	BSL, BKG
7440-09-7	Potassium	2570		2570		ug/L	S57MW0130101-F	1/1	NA	2570	2570	32631	297,016 (5)		NA	NA	No	BSL, NUT, BKG
7440-23-5	Sodium	22100	J	22100	J	ug/L	S57MW0130101-F	1/1	NA	22100	22100	135991	396,022 (5)		NA	NA	No	BSL, NUT, BKG
7440-66-6	Zinc	27.1		27.1		ug/L	S57MW0130101-F	1/1	NA	27.1	27.1	10.3	1100	N	5000	SMCL	No	BSL
Miscellaneous																		
7790-98-9	Ammonium Perchlorate	8.78		8.78		ug/L	S57MW0130101	1/1	NA	8.78	8.78	NA	NA		NA	NA	No	NTX
	Hardness As CaCO3	11.9		11.9		ug/L	S57MW0130101	1/1	NA	11.9	11.9	NA	NA		NA	NA	No	NTX
	pH	4.96		4.96			S57MW0130101	1/1	NA	4.96	4.96	NA	NA		NA	NA	No	NTX
	Total Dissolved Solids	68		68		ug/L	S57MW0130101	1/1	NA	68	68	NA	NA		NA	NA	No	NTX

Notes:

Samples included in table include: S57MW0130101, S57MW0130101-F

1 Minimum/maximum detected concentration.

2 Background concentrations from Background Investigation Report for Indian Head and Stump Neck Annex, Brown & Root Environmental, December 1997. Only inorganic values were employed for COPC screening.

3 USEPA Region III Risk-Based Concentration Table, April 12, 1999. (Cancer benchmark value = 1E-06, HI = 0.1)

4 Rationale Codes Selection Reason: Above Screening Levels (ASL)
Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

5 Essential nutrient screening level based on recommended dietary allowance (see Appendix K).

Definitions:
NA = Not Applicable
COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
MCL = Federal Maximum Contaminant Level
SMCL = Secondary Maximum Contaminant Level
J = Estimated Value
C = Carcinogenic
N = Non-Carcinogenic

TABLE 7-14

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
DIRECT CONTACT WITH LOWER UPGRADIENT GROUNDWATER
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Average Concentration	Concentration Used for Screening	Background (2) Value	Screening (3) Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for (4) Contaminant Deletion or Selection
Volatile Organic Compounds																	
75-34-3	1,1-Dichloroethane	5.2		5.2		ug/L	S57MW0120101-MAX	1/1	NA	5.2	5.2	NA	80 N	NA	NA	No	BSL
75-35-4	1,1-Dichloroethene	1.8		1.8		ug/L	S57MW0120101-MAX	1/1	NA	1.8	1.8	NA	0.044 C	7	MCL	Yes	ASL
67-64-1	Acetone	12		12		ug/L	S57MW0120101-MAX	1/1	NA	12	12	NA	370 N	NA	NA	No	BSL
156-59-2	cis-1,2-Dichloroethene	2.3		2.3		ug/L	S57MW0120101-MAX	1/1	NA	2.3	2.3	NA	6.1 N	70	MCL	No	BSL
60-29-7	Ethyl Ether	3.6		3.6		ug/L	S57MW0120101-MAX	1/1	NA	3.6	3.6	NA	120 N	NA	NA	No	BSL
79-01-6	Trichloroethene	2.3		2.3		ug/L	S57MW0120101-MAX	1/1	NA	2.3	2.3	NA	1.6 C	5	MCL	Yes	ASL
Semivolatile Organic Compounds																	
117-81-7	Bis(2-Ethylhexyl)phthalate	2		2		ug/L	S57MW0120101-MAX	1/1	NA	2	2	NA	4.8 C	6	MCL	No	BSL
Explosives																	
9004-70-0	Nitrocellulose	223		223		ug/L	S57MW0120101-MAX	1/1	NA	223	223	NA	NA	NA	NA	No	NTX
Inorganics - Unfiltered																	
7440-39-3	Barium	58.9		58.9		ug/L	S57MW0120101-MAX	1/1	NA	58.9	58.9	254	260 N	2000	MCL	No	BSL, BKG
7440-43-9	Cadmium	0.38		0.38		ug/L	S57MW0120101-MAX	1/1	NA	0.38	0.38	2.8	1.8 N	5	MCL	No	BSL,BKG
7440-70-2	Calcium	8090		8090		ug/L	S57MW0120101-MAX	1/1	NA	8090	8090	599450	1,055,398 (6)	NA	NA	No	BSL, NUT, BKG
7440-48-4	Cobalt	17.5		17.5		ug/L	S57MW0120101-MAX	1/1	NA	17.5	17.5	39.6	220 N	NA	NA	No	BSL, BKG
7439-89-6	Iron	2220		2220		ug/L	S57MW0120101-MAX	1/1	NA	2220	2220	57199	1100 N	300	SMCL	No	BKG
7439-95-4	Magnesium	1880		1880		ug/L	S57MW0120101-MAX	1/1	NA	1880	1880	31254	118,807 (6)	NA	NA	No	BSL, NUT, BKG
7439-96-5	Manganese	271		271		ug/L	S57MW0120101-MAX	1/1	NA	271	271	28160	73 N	50	SMCL	No	BKG
7440-02-0	Nickel	7.9		7.9		ug/L	S57MW0120101-MAX	1/1	NA	7.9	7.9	39	73 N	100	MCL	No	BSL, BKG
7440-09-7	Potassium	6940		6940		ug/L	S57MW0120101-MAX	1/1	NA	6940	6940	83058	297,016 (6)	NA	NA	No	BSL, NUT, BKG
7440-23-5	Sodium	24100		24100		ug/L	S57MW0120101-MAX	1/1	NA	24100	24100	79585	396,622 (6)	NA	NA	No	BSL, NUT, BKG
7440-66-6	Zinc	64.1		64.1		ug/L	S57MW0120101-MAX	1/1	NA	64.1	64.1	45.2	1100 N	5000	SMCL	No	BSL
Inorganics - Filtered																	
7440-39-3	Barium	59.4		59.4		ug/L	S57MW0120101-F-MAX	1/1	NA	59.4	59.4	114	260 N	2000	MCL	No	BSL, BKG
7440-41-7	Beryllium	0.12		0.12		ug/L	S57MW0120101-F-MAX	1/1	NA	0.12	0.12	ND	7.3 N	4	MCL	No	BSL
7440-43-9	Cadmium	0.37		0.37		ug/L	S57MW0120101-F-MAX	1/1	NA	0.37	0.37	2.9	1.8 N	5	MCL	No	BSL, BKG
7440-70-2	Calcium	7810		7810		ug/L	S57MW0120101-F-MAX	1/1	NA	7810	7810	102113	1,055,398 (6)	NA	NA	No	BSL, NUT, BKG
7440-48-4	Cobalt	20.7		20.7		ug/L	S57MW0120101-F-MAX	1/1	NA	20.7	20.7	13	220 N	NA	NA	No	BSL
7439-89-6	Iron	2260		2260		ug/L	S57MW0120101-F-MAX	1/1	NA	2260	2260	417372	1100 N	300	SMCL	No	BKG
7439-92-1	Lead	1		1		ug/L	S57MW0120101-F-MAX	1/1	NA	1	1	1.4	15 (5)	NA	NA	No	BSL, BKG
7439-95-4	Magnesium	1920		1920		ug/L	S57MW0120101-F-MAX	1/1	NA	1920	1920	13988	118,807 (6)	NA	NA	No	BSL, NUT, BKG
7439-96-5	Manganese	281		281		ug/L	S57MW0120101-F-MAX	1/1	NA	281	281	2257	73 N	50	SMCL	No	BKG
7440-02-0	Nickel	8		8		ug/L	S57MW0120101-F-MAX	1/1	NA	8	8	41.4	73 N	100	MCL	No	BSL, BKG
7440-09-7	Potassium	6950		6950		ug/L	S57MW0120101-F-MAX	1/1	NA	6950	6950	83058	297,016 (6)	NA	NA	No	BSL, NUT, BKG
7440-23-5	Sodium	24600		24600		ug/L	S57MW0120101-F-MAX	1/1	NA	24600	24600	79585	396,022 (6)	NA	NA	No	BSL, NUT, BKG
7440-66-6	Zinc	61.9		61.9		ug/L	S57MW0120101-F-MAX	1/1	NA	61.9	61.9	10.3	1100 N	5000	SMCL	No	BSL
Miscellaneous																	
	pH	6.04		6.04			S57MW0120101-MAX	1/1	NA	6.04	6.04	NA	NA	NA	NA	No	NTX
	Hardness As CaCO3	35.7		35.7		ug/L	S57MW0120101-MAX	1/1	NA	35.7	35.7	NA	NA	NA	NA	No	NTX
	Total Dissolved Solids	90		90		ug/L	S57MW0120101-MAX	1/1	NA	90	90	NA	NA	NA	NA	No	NTX
	Total Organic Carbon	3.26		3.26		ug/L	S57MW0120101-MAX	1/1	NA	3.26	3.26	NA	NA	NA	NA	No	NTX

TABLE 7-14

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
DIRECT CONTACT WITH LOWER UPGRADIENT GROUNDWATER
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Notes:

Samples included in table include: S57MW0120101-MAX, S57MW0120101-F-MAX

1 Minimum/maximum detected concentration.

2 Background concentrations from Background Investigation Report for Indian Head and Stump Neck Annex, Brown & Root Environmental, December 1997. Only inorganic values were employed for COPC screening.

3 USEPA Region III Risk-Based Concentration Table, April 12, 1999. (Cancer benchmark value = 1E-06, HI = 0.1)

4 Rationale Codes Selection Reason: Above Screening Levels (ASL)
Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

5 Action level.

6 Essential nutrient screening level based on recommended dietary allowance (see Appendix K).

Definitions:
NA = Not Applicable
COPC = Chemical of Potential Concern

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
MCL = Federal Maximum Contaminant Level
SMCL = Secondary Maximum Contaminant Level
J = Estimated Value
C = Carcinogenic
N = Non-Carcinogenic

TABLE 7-15

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
DIRECT CONTACT WITH UPPER DOWNGRADIENT GROUNDWATER
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND
PAGE 1 OF 2

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Average Concentration	Concentration Used for Screening	Background Value (2)	Screening Toxicity Value (3)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (4)
Volatile Organic Compounds																		
71-55-6	1,1,1-Trichloroethane	1	J	29.5	J	ug/L	S57MW0040101	5/9	1 - 10	5.9	29.5	NA	54	N	200	MCL	No	BSL
75-34-3	1,1-Dichloroethane	2		4.4		ug/L	S57MW0020101	5/9	1 - 10	2.83	4.4	NA	80	N	NA	NA	No	BSL
75-35-4	1,1-Dichloroethene	4	J	11	J	ug/L	S57MW0060101	4/9	1 - 10	4.82	11	NA	0.044	C	7	MCL	Yes	ASL
67-64-1	Acetone	29.4	J	29.4	J	ug/L	S57MW0100101	1/4	10	11.1	29.4	NA	370	N	NA	NA	No	BSL
67-66-3	Chloroform	0.6	J	0.6	J	ug/L	S57MW0100101	1/9	1 - 10	2.01	0.6	NA	0.15	C	80	MCL	Yes	ASL
156-59-2	cis-1,2-Dichloroethene	0.7	J	528	J	ug/L	S57MW0040101	8/9	10	106	528	NA	6.1	N	70	MCL	Yes	ASL
60-29-7	Ethyl Ether	1	J	3950		ug/L	S57MW0110101-MAX	4/7	10	765	3950	NA	120	N	NA	NA	Yes	ASL
127-18-4	Tetrachloroethene	9.5		9.5		ug/L	S57MW0040101	1/9	1 - 10	3	9.5	NA	1.1	C	5	MCL	Yes	ASL
108-88-3	Toluene	0.5	J	0.5	J	ug/L	S57MW0040101	1/9	1 - 10	2	0.5	NA	75	N	1	MCL	No	BSL
156-60-5	trans-1,2-Dichloroethene	2	J	8.3		ug/L	S57MW0040101	2/9	1 - 10	2.53	8.3	NA	12	N	100	MCL	No	BSL
79-01-6	Trichloroethene	51		611.7	J	ug/L	S57MW0040101	6/9	1 - 10	132	611.7	NA	1.6	C	5	MCL	Yes	ASL
75-01-4	Vinyl Chloride	2.9		85		ug/L	S57TW0030101	5/9	1 - 10	17.7	85	NA	0.019	C	2	MCL	Yes	ASL
Semivolatile Organic Compounds																		
117-81-7	Bis(2-Ethylhexyl)phthalate	2	J	2	J	ug/L	S57MW0040101	1/2	6	2.5	2	NA	4.8	C	6	MCL	No	BCL
84-74-2	Di-n-butyl phthalate	5	J	5	J	ug/L	S57MW0100101	1/2	6	4	5	NA	370	N	NA	NA	No	BSL
Explosives																		
9004-70-0	Nitrocellulose	148	L	148	L	ug/L	S57MW0100101	1/1	NA	148	148	NA	NA		NA	NA	No	NTX
Inorganics - Unfiltered																		
7440-39-3	Barium	35.3		57.4		ug/L	S57MW0100101	2/2	NA	46.4	57.4	254	260	N	2000	MCL	No	BSL, BKG
7440-41-7	Beryllium	0.1		0.1		ug/L	S57MW0040101	1/2	0.1	0.075	0.1	ND	7.3	N	4	MCL	No	BSL
7440-70-2	Calcium	2380		15600		ug/L	S57MW0100101	2/2	NA	8990	15600	599450	1,055,398 (6)		NA	NA	No	BSL, NUT, BKG
7440-48-4	Cobalt	10.5		30.7		ug/L	S57MW0040101	2/2	NA	20.6	30.7	39.6	220	N	NA	NA	No	BSL, BKG
7439-89-6	Iron	215	J	4330		ug/L	S57MW0100101	2/2	NA	2273	4330	57199	1100	N	300	SMCL	No	BKG
7439-92-1	Lead	1.2		1.3		ug/L	S57MW0040101	2/2	NA	1.25	1.3	ND	15 (5)		NA	NA	No	BSL
7439-95-4	Magnesium	1380		2360		ug/L	S57MW0100101	2/2	NA	1870	2360	31254	118,807 (6)		NA	NA	No	BSL, NUT, BKG
7439-96-5	Manganese	256	J	311		ug/L	S57MW0100101	2/2	NA	284	311	28160	73	N	50	SMCL	No	BKG
7440-02-0	Nickel	5.7		10.3		ug/L	S57MW0040101	2/2	NA	8	10.3	39	73	N	100	MCL	No	BSL, BKG
7440-09-7	Potassium	3110		4760		ug/L	S57MW0100101	2/2	NA	3935	4760	83058	297,016 (6)		NA	NA	No	BSL, NUT, BKG
7440-23-5	Sodium	14300	J	38200		ug/L	S57MW0100101	2/2	NA	26250	38200	79585	396,022 (6)		NA	NA	No	BSL, NUT, BKG
7440-66-6	Zinc	28.5		73.3		ug/L	S57MW0100101	2/2	NA	50.9	73.3	45.2	1100	N	5000	SMCL	No	BSL
Inorganics - Filtered																		
7440-39-3	Barium	33.1		55		ug/L	S57MW0100101-F	2/2	NA	44.1	55	114	260	N	2000	MCL	No	BSL, BKG
7440-70-2	Calcium	2310		19700		ug/L	S57MW0100101-F	2/2	NA	11005	19700	102113	1,055,398 (6)		NA	NA	No	BSL, NUT, BKG
7440-48-4	Cobalt	10.2		30.2		ug/L	S57MW0040101-F	2/2	NA	20.2	30.2	13	220	N	NA	NA	No	BSL, BKG
7439-89-6	Iron	154		3810		ug/L	S57MW0100101-F	2/2	NA	1982	3810	4171372	1100	N	300	SMCL	No	BKG
7439-92-1	Lead	1.3		1.3		ug/L	S57MW0100101-F	1/2	1	0.9	1.3	ND	15 (5)		NA	NA	No	BSL
7439-95-4	Magnesium	1310		2390		ug/L	S57MW0100101-F	2/2	NA	1850	2390	13988	118,807 (6)		NA	NA	No	BSL, NUT, BKG
7439-96-5	Manganese	244		301		ug/L	S57MW0100101-F	2/2	NA	273	301	2257	73	N	50	SMCL	No	BKG
7440-02-0	Nickel	6.9		10.2		ug/L	S57MW0040101-F	2/2	NA	8.55	10.2	41.4	73	N	100	MCL	No	BSL, BKG
7440-09-7	Potassium	3000		5690		ug/L	S57MW0100101-F	2/2	NA	4345	5690	32631	297,016 (6)		NA	NA	No	BSL, NUT, BKG
7440-23-5	Sodium	13900	J	41700		ug/L	S57MW0100101-F	2/2	NA	27800	41700	135991	396,022 (6)		NA	NA	No	BSL, NUT, BKG
7440-66-6	Zinc	44.1		81.2		ug/L	S57MW0100101-F	2/2	NA	62.65	81.2	10.3	1100	N	5000	SMCL	No	BSL
Miscellaneous																		
	Hardness As CaCO3	13.9		51.5		ug/L	S57MW0100101	2/2	NA	32.7	51.5	NA	NA		NA	NA	No	NTX

TABLE 7-15

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
DIRECT CONTACT WITH UPPER DOWNGRADIENT GROUNDWATER
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Average Concentration	Concentration Used for Screening	Background Value (2)	Screening Toxicity Value (3)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (4)
	pH	5.62		6.39			S57MW0100101	4/4	NA	6.01	6.39	NA	NA	NA	NA	No	NTX
	Total Dissolved Solids	44		184		ug/L	S57MW0080101	6/6	NA	121	184	NA	NA	NA	NA	No	NTX
	Total Organic Carbon	3.6		3.6		ug/L	S57MW0100101	1/2	1	2.05	3.6	NA	NA	NA	NA	No	NTX

Notes:

Samples included in table include: S57MW0020101, S57MW0040101, S57MW0040101-F, S57MW0060101, S57MW0080101, S57MW0100101, S57MW0110101-MAX, S57MW0100101-F, S57TW0010101, S57TW0020101, S57TW0030101

1 Minimum/maximum detected concentration.

2 Background concentrations from Background Investigation Report for Indian Head and Stump Neck Annex, Brown & Root Environmental, December 1997.
Only inorganic values were employed for COPC screening.

3 USEPA Region III Risk-Based Concentration Table, April 12, 1999. (Cancer benchmark value = 1E-06, HI = 0.1)

4 Rationale Codes Selection Reason: Above Screening Levels (ASL)
Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

5 Action Level.

6 Essential nutrient screening level based on recommended dietary allowance (see Appendix K).

Definitions:
NA = Not Applicable
COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
MCL = Federal Maximum Contaminant Level
SMCL = Secondary Maximum Contaminant Level
J = Estimated Value
C = Carcinogenic
N = Non-Carcinogenic
L = Biased Low

TABLE 7-16

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
DIRECT CONTACT WITH LOWER DOWNGRADIENT GROUNDWATER
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Average Concentration	Concentration Used for Screening	Background (2) Value	Screening (3) Toxicity Value		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for (4) Contaminant Deletion or Selection
Volatile Organic Compounds																		
71-55-6	1,1,1-Trichloroethane	0.6	J	13.7		ug/L	S57MW0090101	3/5	1	4.26	13.7	NA	54	N	200	MCL	No	BSL
75-34-3	1,1-Dichloroethane	1		5.2		ug/L	S57MW0090101	3/5	1	1.8	5.2	NA	80	N	NA	NA	No	BSL
75-35-4	1,1-Dichloroethene	2.9		29	J	ug/L	S57MW0090101	3/5	1	8.98	29	NA	0.044	C	7	MCL	Yes	ASL
67-66-3	Chloroform	1.3		1.3		ug/L	S57MW0090101	1/5	1	0.66	1.3	NA	0.15	C	80	MCL	Yes	ASL
156-59-2	cis-1,2-Dichloroethene	0.5	J	79		ug/L	S57MW0090101	4/5	1	31.4	79	NA	6.1	N	70	MCL	Yes	ASL
60-29-7	Ethyl Ether	2.8	J	1930.6	J	ug/L	S57MW0070101	5/5	NA	582	1930.6	NA	120	N	80	MCL	Yes	ASL
156-60-5	trans-1,2-Dichloroethene	0.6	J	0.6	J	ug/L	S57MW0030101 S57MW0090101	2/5	1	0.54	0.6	NA	12	N	100	MCL	No	BSL
79-01-6	Trichloroethene	2.2		566		ug/L	S57MW0090101	5/5	NA	213	566	NA	1.6	C	5	MCL	Yes	ASL
75-01-4	Vinyl Chloride	3.1		3.1		ug/L	S57MW0030101	1/5	1	1.02	3.1		0.019	C	2	MCL	Yes	ASL
Semivolatile Organic Compounds																		
117-81-7	Bis(2-Ethylhexyl)phthalate	3	J	3	J	ug/L	S57MW0090101	1/2	6	3	3	NA	4.8	C	6	MCL	No	BSL
Explosives																		
9004-70-0	Nitrocellulose	148	L	148	L	ug/L	S57MW0030101	1/1	NA	148	148	NA	NA		NA	NA	No	NTX
Inorganics - Unfiltered																		
7440-39-3	Barium	27.7		38.1		ug/L	S57MW0030101	2/2	NA	32.9	38.1	254	260	N	2000	MCL	No	BSL, BKG
7440-41-7	Beryllium	0.2		0.25		ug/L	S57MW0090101	2/2	NA	0.225	0.25	ND	7.3	N	4	MCL	No	BSL
7440-70-2	Calcium	1910		1920		ug/L	S57MW0090101	2/2	NA	1915	1920	599450	1,055,398 (5)		NA	NA	No	BSL, NUT, BKG
7440-48-4	Cobalt	14.5		31.9		ug/L	S57MW0030101	2/2	NA	23.2	31.9	39.6	220	N	NA	NA	No	BSL, BKG
7439-89-6	Iron	111		454	J	ug/L	S57MW0030101	2/2	NA	283	454	57199	1100	N	300	SMCL	No	BSL, BKG
7439-95-4	Magnesium	1340		1390		ug/L	S57MW0090101	2/2	NA	1365	1390	31254	118,807 (5)		NA	NA	No	BSL, NUT, BKG
7439-96-5	Manganese	41.6		257	J	ug/L	S57MW0030101	2/2	NA	149	257	28160	73	N	50	SMCL	No	BSL, BKG
7440-02-0	Nickel	5.2		7.3		ug/L	S57MW0030101	2/2	NA	6.25	7.3	39	73	N	100	MCL	No	BSL, BKG
7440-09-7	Potassium	2860		4170		ug/L	S57MW0030101	2/2	NA	3515	4170	83058	297,016 (5)		NA	NA	No	BSL, NUT, BKG
7440-23-5	Sodium	9260	L	11600	J	ug/L	S57MW0030101	2/2	NA	10430	11600	79565	396,022 (5)		NA	NA	No	BSL, NUT, BKG
7440-66-6	Zinc	22.3		26.2		ug/L	S57MW0090101	2/2	NA	24.3	26.2	45.2	1100	N	5000	SMCL	No	BSL, BKG
Inorganics - Filtered																		
7440-39-3	Barium	27		35.2		ug/L	S57MW0030101-F	2/2	NA	31.1	35.2	114	260	N	2000	MCL	No	BSL, BKG
7440-41-7	Beryllium	0.11		0.26		ug/L	S57MW0090101-F	2/2	NA	0.185	0.26	ND	7.3	N	4	MCL	No	BSL
7440-70-2	Calcium	1870		1980		ug/L	S57MW0090101-F	2/2	NA	1925	1980	102113	1,055,398 (5)		NA	NA	No	BSL, NUT, BKG
7440-48-4	Cobalt	16.8		31.9		ug/L	S57MW0030101-F	2/2	NA	24.4	31.9	13	220	N	NA	NA	No	BSL
7439-89-6	Iron	174		174		ug/L	S57MW0030101-F	1/2	28	94	174	417372	1100	N	300	SMCL	No	BSL, BKG
7439-95-4	Magnesium	1250		1400		ug/L	S57MW0090101-F	2/2	NA	1325	1400	13988	118,807 (5)		NA	NA	No	BSL, NUT, BKG
7439-96-5	Manganese	48.5		250		ug/L	S57MW0030101-F	2/2	NA	149	250	2257	73	N	50	SMCL	No	BSL, BKG
7440-02-0	Nickel	5.4		6.3		ug/L	S57MW0030101-F	2/2	NA	5.85	6.3	41.4	73	N	100	MCL	No	BSL, BKG
7440-09-7	Potassium	2900		3980		ug/L	S57MW0030101-F	2/2	NA	3440	3980	32631	297,016 (5)		NA	NA	No	BSL, NUT, BKG
7440-23-5	Sodium	9400	L	11300	J	ug/L	S57MW0030101-F	2/2	NA	10350	11300	135991	396,022 (5)		NA	NA	No	BSL, NUT, BKG
7440-66-6	Zinc	19.4		23.1		ug/L	S57MW0090101-F	2/2	NA	21.3	23.1	10.3	1100	N	5000	SMCL	No	BSL
Miscellaneous																		
	Hardness As CaCO3	9.91		11.9		ug/L	S57MW0030101	2/2	NA	10.9	11.9	NA	NA		NA	NA	No	NTX
	pH	5.29		5.87			S57MW0070101	4/4	NA	5.49	5.87	NA	NA		NA	NA	No	NTX
	Total Dissoved Solids	24		170		ug/L	S57MW0070101	4/5	20	64.8	170	NA	NA		NA	NA	No	NTX

Notes:
Samples included in table include: S57MW0010101, S57MW0030101, S57MW0030101-F, S57MW0050101, S57MW0070101, S57MW0090101, S57MW0090101-F

Definitions: NA = Not Applicable

TABLE 7-16

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
DIRECT CONTACT WITH LOWER DOWNGRADIENT GROUNDWATER
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

1 Minimum/maximum detected concentration.
2 Background concentrations from Background Investigation Report for Indian Head and Stump Neck Annex, Brown & Root Environmental, December 1997.
Only inorganic values were employed for COPC screening.
3 *USEPA Region III Risk-Based Concentration Table, April 12, 1999. (Cancer benchmark value = 1E-06, HI = 0.1)*
4 Rationale Codes Selection Reason: Above Screening Levels (ASL)
Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)
5 Essential nutrient screening level based on dietary allowance (see Appendix K).

COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
MCL = Federal Maximum Contaminant Level
SMCL = Secondary Maximum Contaminant Level
J = Estimated Value
C = Carcinogenic
N = Non-Carcinogenic
L = Biased Low

TABLE 7-17

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
DIRECT CONTACT WITH UPGRADIENT SURFACE WATER
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

CAS. Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Average Concentration	Concentration Used for Screening	Background Value	Screening (2) Toxicity Value	COPC Flag	Rationale for (3) Contaminant Deletion or Selection
Miscellaneous															
	Dissolved Oxygen	10600		10600		ug/L	S57SW0130101	1/1	NA	10600	10600	NA	NA	No	NTX
	Hardness As CaCO3	17800		17800		ug/L	S57SW0130101	1/1	NA	17800	17800	NA	NA	No	NTX
14797-55-8	Nitrate/nitrite	686		686		ug/L	S57SW0130101	1/1	NA	686	686	NA	NA	No	NTX
	pH	5.54		5.54			S57SW0130101	1/1	NA	5.54	5.54	NA	NA	No	NTX
	Total Dissolved Solids	178000		178000		ug/L	S57SW0130101	1/1	NA	178000	178000	NA	NA	No	NTX
	Total Organic Carbon	3280		3280		ug/L	S57SW0130101	1/1	NA	3280	3280	NA	NA	No	NTX
	Total Suspended Solids	30000		30000		ug/L	S57SW0130101	1/1	NA	30000	30000	NA	NA	No	NTX
	Turbidity	25.7		25.7		ug/L	S57SW0130101	1/1	NA	25.7	25.7	NA	NA	No	NTX

Notes.
Samples included in table include: S57SW0130101
1 Minimum/maximum detected concentration.
2 Criteria as published in FR 63:68354-68364 unless otherwise noted.
3 Rationale Codes Selection Reason: Above Screening Levels (ASL)
Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

Definitions: NA = Not Applicable
COPC = Chemical of Potential Concern

TABLE 7-18

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
DIRECT CONTACT WITH DOWNGRADIENT SURFACE WATER
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Average Concentration	Concentration Used for Screening	Background Value	Screening (2) Toxicity Value	COPC Flag	Rationale for (4) Contaminant Deletion or Selection
Volatile Organic Compounds															
120-82-1	1,2,4-Trichlorobenzene	0.7	J	0.7	J	ug/L	S57SW0150101	1/5	1	0.54	0.7	NA	260	No	BSL
67-64-1	Acetone	7	J	7	J	ug/L	S57SW0140101	1/1	NA	7	7	NA	61 (4) N	No	BSL
156-59-2	cis-1,2-Dichloroethene	0.5	J	0.5	J	ug/L	S57SW0120101	1/5	1	0.5	0.5	NA	6.1 (4) N	No	BSL
79-01-6	Trichloroethene	0.7	J	1.4		ug/L	S57SW0150101	2/5	1	0.72	1.4	NA	2.7	No	BSL
Explosives															
9004-70-0	Nitrocellulose	221		221		ug/L	S57SW0160101-MAX	1/2	1440	471	221	NA	NA	No	NTX
Inorganics - unfiltered															
7429-90-5	Aluminum	319		449		ug/L	S57SW0160101-MAX	2/2	NA	384	449	NA	3700 (4) N	No	BSL
7440-39-3	Barium	17.3		19.7		ug/L	S57SW0160101-MAX	2/2	NA	18.5	19.7	NA	1000	No	BSL
7440-41-7	Beryllium	0.26		0.26		ug/L	S57SW0160101-MAX	1/2	0.2	0.18	0.26	NA	7.3 (4) N	No	BSL
7440-70-2	Calcium	9450		30200		ug/L	S57SW0160101-MAX	2/2	NA	19825	30200	NA	1,055,398 (6)	No	BSL, NUT
7440-47-3	Chromium	0.63		1		ug/L	S57SW0140101	2/2	NA	0.815	1	NA	11 (4, 5) N	No	BSL
7440-48-4	Cobalt	21.1		21.1		ug/L	S57SW0160101-MAX	1/2	0.87	10.8	21.1	NA	220 (4) N	No	BSL
57-12-5	Cyanide	6.5		10.6		ug/L	S57SW0160101-MAX	2/2	NA	8.55	10.6	NA	73 (4) N	No	BSL
7439-89-6	Iron	461		785		ug/L	S57SW0140101	2/2	NA	623	785	NA	300	Yes	ASL
7439-92-1	Lead	1.5		7.9		ug/L	S57SW0140101	2/2	NA	4.7	7.9	NA	15 (7)	No	BSL
7439-95-4	Magnesium	1580		14900		ug/L	S57SW0160101-MAX	2/2	NA	8240	14900	NA	118,807 (6)	No	BSL, NUT
7439-96-5	Manganese	22.1		363		ug/L	S57SW0160101-MAX	2/2	NA	193	363	NA	50	Yes	ASL
7440-02-0	Nickel	3.1		23.4		ug/L	S57SW0160101-MAX	2/2	NA	13.3	23.4	NA	610	No	BSL
7440-09-7	Potassium	1290		6710		ug/L	S57SW0160101-MAX	2/2	NA	4000	6710	NA	297,016 (6)	No	BSL, NUT
7782-49-2	Selenium	2.8		2.8		ug/L	S57SW0160101-MAX	1/2	1.9	1.88	2.8	NA	170	No	BSL
7440-23-5	Sodium	7660	K	160000		ug/L	S57SW0160101-MAX	2/2	NA	83830	160000	NA	396,022 (6)	No	BSL,NUT
7440-62-2	Vanadium	1.4		1.4		ug/L	S57SW0140101	1/2	1.4	1.05	1.4	NA	26 (4) N	No	BSL
7440-66-6	Zinc	63.1		119		ug/L	S57SW0140101	2/2	NA	91.05	119	NA	9100	No	BSL
Inorganics - Filtered															
7429-90-5	Aluminum	59.8		59.8		ug/L	S57SW0140101-F	1/2	69.7	47.3	59.8	NA	3700 (4) N	No	BSL
7440-39-3	Barium	13.3		17.3		ug/L	S57SW0160101-F-MAX	2/2	NA	15.3	17.3	NA	1000	No	BSL
7440-70-2	Calcium	8560		30400		ug/L	S57SW0160101-F-MAX	2/2	NA	19480	30400	NA	1,055,398 (6)	No	BSL, NUT
7440-48-4	Cobalt	22.5		22.5		ug/L	S57SW0160101-F-MAX	1/2	4.1	12.3	22.5	NA	220 (4) N	No	BSL
7439-89-6	Iron	205		205		ug/L	S57SW0140101-F	1/2	8.9	105	205	NA	300	No	BSL
7439-95-4	Magnesium	1360		15000		ug/L	S57SW0160101-F-MAX	2/2	NA	8180	15000	NA	118,807 (6)	No	BSL, NUT
7439-96-5	Manganese	41.9		364		ug/L	S57SW0160101-F-MAX	2/2	NA	203	364	NA	50	Yes	ASL
7440-02-0	Nickel	2.2		23.2		ug/L	S57SW0160101-F-MAX	2/2	NA	12.7	23.2	NA	610	No	BSL
7440-09-7	Potassium	1210		6720		ug/L	S57SW0160101-F-MAX	2/2	NA	3965	6720	NA	297,016 (6)	No	BSL, NUT
7440-23-5	Sodium	7830	K	164000		ug/L	S57SW0160101-F-MAX	2/2	NA	85915	164000	NA	396,022 (6)	No	BSL, NUT
7440-66-6	Zinc	46.6		61.2		ug/L	S57SW0140101-F	2/2	NA	53.9	61.2	NA	9100	No	BSL
Miscellaneous															
16887-00-6	Chloride	10.2		220		ug/L	S57SW0160101-MAX	3/3	NA	119	220	NA	NA	No	NTX
	Dissolved Oxygen	9.6		11		ug/L	S57SW0140101	3/3	NA	10.4	11	NA	NA	No	NTX
	Fluoride	0.174	K	2.17	K	ug/L	S57SW0150101	3/3	NA	0.955	2.17	NA	NA	No	NTX

TABLE 7-18

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
DIRECT CONTACT WITH DOWNGRADIENT SURFACE WATER
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Average Concentration	Concentration Used for Screening	Background Value	Screening (2) Toxicity Value	COPC Flag	Rationale for (4) Contaminant Deletion or Selection
	Hardness As CaCO3	27.3		143		ug/L	S57SW0160101-MAX	2/2	NA	85.2	143	NA	NA	No	NTX
14797-55-8	Nitrate/nitrite	0.121		2.85		ug/L	S57SW0160101-MAX	3/3	NA	1.09	2.85	NA	NA	No	NTX
	pH	7		7.59			S57SW0160101-MAX	3/3	NA	7.25	7.59	NA	NA	No	NTX
14808-79-8	Sulfate	8.96		454	J	ug/L	S57SW0150101	3/3	NA	244	454	NA	NA	No	NTX
	Total Dissolved Solids	64		921		ug/L	S57SW0150101	3/3	NA	550	921	NA	NA	No	NTX
	Total Organic Carbon	2.32		3.52		ug/L	S57SW0160101-MAX	2/2	NA	2.92	3.52	NA	NA	No	NTX
	Total Suspended Solids	7		7		ug/L	S57SW0140101	1/3	5	4	7	NA	NA	No	NTX
	Turbidity	3.99		6.03		ug/L	S57SW0150101	3/3	NA	5.04	6.03	NA	NA	No	NTX

Notes:
Samples included in table include: S57SW0110101, S57SW0120101, S57SW0140101, S57SW0140101-F, S57SW0150101, S57SW0160101-MAX, S57SW0160101-F-MAX

1 Minimum/maximum detected concentration.
2 Criteria as published in FR 63:68354-68364 unless otherwise noted.
3 Rationale Codes Selection Reason: Above Screening Levels (ASL)
Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

Definitions:
NA = Not Applicable
COPC = Chemical of Potential Concern
J = Estimated Value
C = Carcinogenic
N = Non-Carcinogenic
K = Biased High

4 Water quality criteria not available EPA Region III RBC for tap water ingestion used (Cancer benchmark value = 1E-6, HI = 0.1).
5 Value is for hexavalent chromium..
6 Essential nutrient screening level based on dietary allowance (see Appendix K).
7 Action Level

TABLE 7-19
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
DIRECT CONTACT WITH UPGRADIENT SEDIMENT
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Average Concentration	Concentration Used for Screening	Background Value	Risk Based COPC Screening Level (2)			COPC Flag	Rationale for (3) Contaminant Deletion or Selection
													Residential	Industrial	Basis		
AVS/Simultaneously Extraced Metals																	
	Acid Volatile Sulfide	80.1	K	80.1	K	mg/kg	S57SD0090101	1/1	NA	80.1	80.1	NA	NA	NA		No	NTX
7440-43-9	Cadmium (sem)	0.1		0.1		mg/kg	S57SD0090101	1/1	NA	0.1	0.1	NA	NA	NA		No	NTX
7439-92-1	Lead (sem)	21.7		21.7		mg/kg	S57SD0090101	1/1	NA	21.7	21.7	NA	NA	NA		No	NTX
7440-02-0	Nickel (sem)	0.74		0.74		mg/kg	S57SD0090101	1/1	NA	0.74	0.74	NA	NA	NA		No	NTX
Miscellaneous																	
	Total Organic Carbon	16900	J	16900	J	mg/kg	S57SD0090101	1/1	NA	16900	16900	NA	NA	NA		No	NTX

Notes:
Samples included in table include: S57SD0090101
1 Minimum/maximum detected concentration.
2 USEPA Region III Risk-Based Concentration Table, October 1, 1998. (Cancer benchmark value = 1E-06, HI = 0.1)
3 Rationale Codes Selection Reason: Above Screening Levels (ASL)
Deletion Reason: Background Levels (BKG)
No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

Definitions:
NA = Not Applicable
COPC = Chemical of Potential Concern
AVS = Acid Volatile Sulfide
Sem = Simultaneously Extracted Metal
J = Estimated Value
C = Carcinogenic
N = Non-Carcinogenic
K = Biased High

TABLE 7-20

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
DIRECT CONTACT WITH DOWNGRADIENT SEDIMENT
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Average Concentration	Concentration Used for Screening	Background (2) Value	Risk Based COPC Screening Level (3)			COPC Flag	Rationale for (4) Contaminant Deletion or Selection
													Residential	Industrial	Basis		
Volatile Organic Compounds																	
67-64-1	Acetone	31		31		ug/kg	S57SD0120101-MAX	1/5	12 - 13	11.2	31	NA	780000	20000000	N	No	BSL
75-15-0	Carbon Disulfide	3	J	3	J	ug/kg	S57SD0080101	1/5	12 - 13	5.7	3	NA	780000	20000000	N	No	BSL
Semivolatile Organic Compounds																	
120-12-7	Anthracene	59	J	59	J	ug/kg	S57SD0100101	1/2	440	140	59	NA	2300000	61000000	N	No	BSL
56-55-3	Benzo(a)anthracene	180	J	180	J	ug/kg	S57SD0100101	1/2	440	200	180	NA	870	7800	C	No	BSL
50-32-8	Benzo(a)pyrene	120	J	120	J	ug/kg	S57SD0100101	1/2	440	170	120	NA	87	780	C	Yes	ASL
205-99-2	Benzo(b)fluoranthene	290	J	290	J	ug/kg	S57SD0100101	1/2	440	255	290	NA	870	7800	C	No	BSL
191-24-2	Benzo(g,h,i)perylene	57	J	57	J	ug/kg	S57SD0100101	1/2	440	139	57	NA	160000 (5)	4100000 (5)	N	No	BSL
207-08-9	Benzo(k)fluoranthene	77	J	77	J	ug/kg	S57SD0100101	1/2	440	149	77	NA	8700	78000	C	No	BSL
117-81-7	Bis(2-Ethylhexyl)phthalate	46	J	46	J	ug/kg	S57SD0100101	1/2	440	133	46	NA	46000	410000	C	No	BSL
218-01-9	Chrysene	160	J	160	J	ug/kg	S57SD0100101	1/2	440	190	160	NA	87000	780000	C	No	BSL
84-74-2	Di-n-butyl phthalate	61	J	61	J	ug/kg	S57SD0100101	1/2	440	141	61	NA	78000	20000000	N	No	BSL
206-44-0	Fluoranthene	380	J	380	J	ug/kg	S57SD0100101	1/2	440	300	380	NA	310000	8200000	N	No	BSL
86-73-7	Fluorene	44	J	44	J	ug/kg	S57SD0100101	1/2	440	132	44	NA	310000	8200000	N	No	BSL
193-39-5	Indeno(1,2,3-cd)pyrene	84	J	84	J	ug/kg	S57SD0100101	1/2	440	152	84	NA	870	7800	C	No	BSL
85-01-8	Phenanthrene	280	J	280	J	ug/kg	S57SD0100101	1/2	440	250	280	NA	160000 (5)	4100000 (5)	N	No	BSL
129-00-0	Pyrene	330	J	330	J	ug/kg	S57SD0100101	1/2	440	275	330	NA	230000	6100000	N	No	BSL
Pesticides/PCBs																	
72-54-8	4,4'-DDD	1.4		1.4		ug/kg	S57SD0120101-MAX	1/2	4.2	1.75	0.0014	NA	2700	24000	C	No	BSL
72-55-9	4,4'-DDE	0.34		0.34		ug/kg	S57SD0120101-MAX	1/2	4.2	1.22	0.00034	NA	1900	17000	C	No	BSL
50-29-3	4,4'-DDT	0.96		0.96		ug/kg	S57SD0120101-MAX	1/2	4.2	1.53	0.00096	NA	1900	17000	C	No	BSL
Inorganics																	
7429-90-5	Aluminum	599		1480		mg/kg	S57SD0100101	2/2	NA	1040	1480	18329	7800	200000	N	No	BSL, BKG
7440-38-2	Arsenic	4.7		4.7		mg/kg	S57SD0100101	1/2	1.4	2.7	4.7	4.25	0.43	3.8	C	Yes	ASL
7440-39-3	Barium	7.4		8		mg/kg	S57SD0120101-MAX S57SD0100101	2/2	NA	7.7	8	144	550	14000	N	No	BSL, BKG
7440-41-7	Beryllium	0.16		0.16		mg/kg	S57SD0100101	2/2	NA	0.16	0.16	0.905	16	410	N	No	BSL, BKG
7440-43-9	Cadmium	0.26		0.26		mg/kg	S57SD0100101	1/2	0.08	0.15	0.26	0.26	3.9	10	N	No	BSL, BKG
7440-70-2	Calcium	696		696		mg/kg	S57SD0100101	1/2	109	375	696	409	1,000,000 (6)	1,000,000 (6)		No	BSL, NUT, BKG
7440-47-3	Chromium	1.3		10.7		mg/kg	S57SD0100101	2/2	NA	6	10.7	24.2	23 (7)	610 (7)	N	No	BSL, BKG
7440-48-4	Cobalt	1.7		5		mg/kg	S57SD0100101	2/2	NA	3.35	5	39.7	470	12000	N	No	BSL, BKG
7440-50-8	Copper	6.9		6.9		mg/kg	S57SD0100101	1/2	1.7	3.875	6.9	18.7	310	8200	N	No	BSL, BKG
57-12-5	Cyanide	0.55		0.61		mg/kg	S57SD0120101-MAX	2/2	NA	0.58	0.61	ND	160	4100	N	No	BSL
7439-89-6	Iron	1830		7440		mg/kg	S57SD0100101	2/2	NA	4635	7440	43170	2300	61000	N	No	BKG
7439-92-1	Lead	18.8	J	18.8	J	mg/kg	S57SD0100101	1/2	2.5	10.025	18.8	149	400 (8)	1000 (9)		No	BSL, BKG
7439-95-4	Magnesium	66.6		1180		mg/kg	S57SD0100101	2/2	NA	623	1180	1382	460,468 (6)	460,468 (6)		No	BSL, NUT, BKG
7439-96-5	Manganese	15.6		96.4	J	mg/kg	S57SD0100101	2/2	NA	56	96.4	2248	160	4100	N	No	BSL, BKG
7439-97-6	Mercury	1.9	L	1.9	L	mg/kg	S57SD0100101	1/2	0.02	0.955	1.9	0.087	2.3 (10)	61 (10)	N	No	BSL
7440-02-0	Nickel	0.94		10		mg/kg	S57SD0100101	2/2	NA	5.47	10	18.2	160	4100	N	No	BSL, BKG
7440-09-7	Potassium	152		214		mg/kg	S57SD0120101-MAX	2/2	NA	183	214	1874	1,000,000 (6)	1,000,000 (6)		No	BSL, NUT, BKG
7440-23-5	Sodium	67.8		208		mg/kg	S57SD0120101-MAX	2/2	NA	138	208	51.9	1,000,000 (6)	1,000,000 (6)		No	BSL, NUT
7440-62-2	Vanadium	5.4		9		mg/kg	S57SD0100101	2/2	NA	7.2	9	53.5	55	1400	N	No	BSL, BKG

TABLE 7-20

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
DIRECT CONTACT WITH DOWNGRADIENT SEDIMENT
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Average Concentration	Concentration Used for Screening	Background (2) Value	Risk Based COPC Screening Level (3)			COPC Flag	Rationale for (4) Contaminant Deletion or Selection
													Residential	Industrial	Basis		
7440-66-6	Zinc	9.1		126		mg/kg	S57SD0100101	2/2	NA	67.6	126	38.1	2300	61000	N	No	BSL
AVS/Simultaneously Extracted Metals																	
	Acid Volatile Sulfide	81.3		81.3		mg/kg	S57SD0120101-MAX	1/2	57.1	54.9	81.3	NA	NA	NA		No	NTX
	Cadmium (Sem)	0.16		0.16		mg/kg	S57SD0100101	1/2	0.02	0.085	0.16	NA	NA	NA		No	NTX
	Copper (Sem)	2.1		2.1		mg/kg	S57SD0100101	1/2	0.58	1.20	2.1	NA	NA	NA		No	NTX
	Lead (Sem)	3.1		12.7		mg/kg	S57SD0100101	2/2	NA	7.9	12.7	NA	NA	NA		No	NTX
	Mercury (Sem)	0.012		0.012		mg/kg	S57SD0120101-MAX	1/2	0.0137	0.009	0.012	NA	NA	NA		No	NTX
	Nickel (Sem)	0.54		1.7		mg/kg	S57SD0100101	2/2	NA	1.12	1.7	NA	NA	NA		No	NTX
	Zinc (Sem)	4.8		48		mg/kg	S57SD0100101	2/2	NA	26.4	48	NA	NA	NA		No	NTX
Miscellaneous																	
	pH	7.51		7.85			S57SD0120101-MAX	2/2	NA	7.68	7.85	NA	NA	NA		No	NTX
	Total Organic Carbon	10700		18800	L	mg/kg	S57SD0100101	2/2	NA	14750	18800	NA	NA	NA		No	NTX

Notes:
Samples included in table include: S57SD0070101, S57SD0080101, S57SD0100101, S57SD0110101, S57SD0120101-MAX

1 Minimum/maximum detected concentration.
2 Surface soil background concentrations from Background Investigation Report for Indian Head and Stump Neck Annex, Brown & Root Environmental, December 1997. Only inorganic values were employed for COPC sreening.
3 USEPA Region III Risk-Based Concentration Table, April 12, 1999. (Cancer benchmark value = 1E-06, HI = 0.1)
4 Rationale Codes Selection Reason: Above Screening Levels (ASL)
Deletion Reason: Background Levels (BKG)
No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)
5 Value is for naphthalene.
6 Essential nutrient screening level based on dietary allowance (see Appendix K).
7 Value is for hexavalent chromium.
8 Value is based on OSWCR Soil Screening level for Residential Land Use (EPA, July1994).
9 EPA Region III.
10 *Value is for mercuric chloride.*

Definitions:
NA = Not Applicable
COPC = Chemical of Potential Concern
AVS = Acid Volatile Sulfide
Sem = Simultaneously Extracted Metals
J = Estimated Value

C = Carcinogenic
N = Non-Carcinogenic
L = Biased Low

TABLE 7-21

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
DIRECT CONTACT WITH STORM SEWER SURFACE WATER
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Average Concentration	Concentration Used for Screening	Background Value	Screening (2) Toxicity Value	COPC Flag	Rationale for (3) Contaminant Deletion or Selection
Volatile Organic Compounds															
71-55-6	1,1,1-Trichloroethane	0.1		0.1		ug/L	S57SW0060101-MAX	1/13	1	0.469	0.1	NA	54 (4) N	No	BSL
75-35-4	1,1-Dichloroethene	0.1	J	0.2		ug/L	S57SW0060101-MAX	3/13	1	0.415	0.2	NA	0.057	Yes	ASL
78-93-3	2-Butanone	10.7	J	21	L	ug/L	S57SW0020101	11/11	NA	16.4	21	NA	190 (4) N	No	BSL
67641	Acetone	255.3	J	741.1		ug/L	S57SW0060101-MAX	4/6	37.1 - 84.4	301	741.1	NA	61 (4) N	Yes	ASL
75-27-4	Bromodichloromethane	0.1		0.1		ug/L	S57SW0060101-MAX	1/13	1	0.469	0.1	NA	0.17 (4) N	No	BSL
75-25-2	Bromoform	0.3	J	0.7	J	ug/L	S57SW0070201	6/13	1	0.515	0.7	NA	4.3	No	BSL
156-59-2	cis-1,2-Dichloroethene	0.3	J	15	J	ug/L	S57SW0020101	12/13	1	7.02	15	NA	6.1 (4) N	Yes	ASL
124-48-1	Dibromochloromethane	0.2	J	0.4		ug/L	S57SW0060101-MAX S57SW0080101 S57SW0070201 S57SW0070101	6/13	1	0.423	0.4	NA	0.56	No	BSL
60-29-7	Ethyl Ether	1.9		197	L	ug/L	S57SW0020101	13/13	NA	93.3	197	NA	120 N	Yes	BSL
60-29-7	Ethylbenzene	0.5	J	4	J	ug/L	S57SW0020101	9/13	1	0.938	4	NA	3100	No	BSL
100-42-5	Styrene	0.2	J	4	J	ug/L	S57SW0020101	9/13	1	0.992	4	NA	160 (4) N	No	BSL
108-88-3	Toluene	0.1		0.1		ug/L	S57SW0060101-MAX S57SW0070201 S57SW0070101 S57SW0060201	4/13	1	0.377	0.1	NA	6800	No	BSL
156-60-5	trans-1,2-Dichloroethene	0.1	J	0.1	J	ug/L	S57SW0070101 S57SW0070201 S57SW0080201	3/13	1	0.408	0.1	NA	700	No	BSL
79-01-6	Trichloroethene	0.4	J	21.3		ug/L	S57SW0070201	12/13	1	11.7	21.3	NA	2.7	Yes	ASL
75-01-4	Vinyl Chloride	0.2	J	2	J	ug/L	S57SW0020101	8/13	1	0.585	2	NA	2	No	BSL
1330-20-7	Xylenes, Total	0.1	J	0.6	J	ug/L	S57SW0070101	6/13	1	0.415	0.6	NA	1200 (4) N	No	BSL
Explosives															
9004-70-0	Nitrocellulose	144	L	1230	L	ug/L	S57SW0040101	3/3	NA	831	1230	NA	NA	No	NTX
Inorganics - unfiltered															
7429-90-5	Aluminum	277		924	J	ug/L	S57SW0040101	4/5	148	494	924	NA	3700 (4) N	No	BSL
7440-39-3	Barium	22.2	K	34		ug/L	S57SW0090101	5/5	NA	27.6	34	NA	1000	No	BSL
7440-70-2	Calcium	9820	K	13800		ug/L	S57SW0090101	5/5	NA	12184	13800	NA	1,055,398 (7)	No	BSL, NUT
7440-47-3	Chromium	0.73		2.2		ug/L	S57SW0040101	4/5	0.6	1.15	2.2	NA	11 (4, 5) N	No	BSL
7440-48-4	Cobalt	2.6		4		ug/L	S57SW0090101	5/5	NA	3.4	4	NA	220 (4) N	No	BSL
7440-50-8	Copper	14.9		25.2		ug/L	S57SW0040101	4/5	14.8	17.3	25.2	NA	1300	No	BSL
57-12-5	Cyanide	8.6		8.6		ug/L	S57SW0090101	1/5	5	3.72	8.6	NA	73 (4) N	No	BSL
7439-89-6	Iron	925	K	1570		ug/L	S57SW0090101	5/5	NA	1251	1570	NA	300	Yes	ASL
7439-92-1	Lead	3.2	L	5.4	L	ug/L	S57SW0040101	4/5	4.4	3.82	5.4	NA	15 (6)	No	BSL
7439-95-4	Magnesium	2010		3680		ug/L	S57SW0090101	5/5	NA	2822	3680	NA	118,807 (7)	No	BSL, NUT
7439-96-5	Manganese	71.9		119		ug/L	S57SW0090101	5/5	NA	92.8	119	NA	50	Yes	ASL
7440-02-0	Nickel	2.3		5.1		ug/L	S57SW0040101	5/5	NA	3.42	5.1	NA	610	No	BSL
7440-09-7	Potassium	2800		3200		ug/L	S57SW0070101	5/5	NA	2978	3200	NA	297,016 (7)	No	BSL, NUT
7440-23-5	Sodium	49700		63700	J	ug/L	S57SW0090101	5/5	NA	55040	63700	NA	396,022 (7)	No	BSL, NUT
7440-62-2	Vanadium	1.6	K	7.1		ug/L	S57SW0040101	2/5	5.1 - 5.7	3.36	7.1	NA	26 (4) N	No	BSL
7440-66-6	Zinc	58.3		90.4		ug/L	S57SW0040101	5/5	NA	79.0	90.4	NA	9100	No	BSL
Inorganics - Filtered															
7429-90-5	Aluminum	674	J	674	J	ug/L	S57SW0040101-F	1/5	17.4 - 189	164	674	NA	3700 (4) N	No	BSL
7440-39-3	Barium	19		25.1		ug/L	S57SW0030101-F	5/5	NA	22.4	25.1	NA	1000	No	BSL

TABLE 7-21

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
DIRECT CONTACT WITH STORM SEWER SURFACE WATER
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Average Concentration	Concentration Used for Screening	Background Value	Screening (2) Toxicity Value	COPC Flag	Rationale for (3) Contaminant Deletion or Selection
7440-70-2	Calcium	9070	K	14100		ug/L	S57SW0090101-F	5/5	NA	11816	14100	NA	1,055,398 (7)	No	BSL, NUT
7440-47-3	Chromium	0.67		0.89		ug/L	S57SW0040101-F	2/5	0.6	0.492	0.89	NA	11 (4, 5) N	No	BSL
7440-48-4	Cobalt	4.3	K	7.6		ug/L	S57SW0090101-F	5/5	NA	5.84	7.6	NA	220 (4) N	No	BSL
7440-50-8	Copper	12.2		12.5		ug/L	S57SW0030101-F	2/5	4.9 - 9.8	7.27	12.5	NA	1300	No	BSL
7439-89-6	Iron	267		653		ug/L	S57SW0040101-F	5/5	NA	545	653	NA	300	Yes	BSL
7439-92-1	Lead	1.3	L	3.1	L	ug/L	S57SW0030101-F	3/5	1.9 - 2.6	1.87	3.1	NA	15 (5)	No	BSL
7439-95-4	Magnesium	1850		3750		ug/L	S57SW0090101-F	5/5	NA	2636	3750	NA	118,807 (7)	No	BSL, NUT
7439-96-5	Manganese	73.6		121		ug/L	S57SW0090101-F	5/5	NA	90.7	121	NA	50	Yes	ASL
7440-02-0	Nickel	1.5		2.6		ug/L	S57SW0090101-F	4/5	1.1	1.75	2.6	NA	610	No	BSL
7440-09-7	Potassium	2690		3100		ug/L	S57SW0090101-F	5/5	NA	2838	3100	NA	297,016 (7)	No	BSL, NUT
7782-49-2	Selenium	2.5	K	3.1	K	ug/L	S57SW0030101-F	2/5	2.5	1.87	3.1	NA	170	No	BSL
7440-23-5	Sodium	47900		65700	J	ug/L	S57SW0090101-F	5/5	NA	53080	65700	NA	396,022 (7)	No	BSL, NUT
7440-62-2	Vanadium	0.72	K	0.93	K	ug/L	S57SW0020101-F	2/5	3.4 - 4.6	1.52	0.93	NA	26 (4) N	No	BSL
7440-66-6	Zinc	36.3	K	72	K	ug/L	S57SW0020101-F	5/5	NA	54.4	72	NA	9100	No	BSL
Miscellaneous															
16887-00-6	Chloride	43000	L	43000	L	ug/L	S57SW0090101	1/1	NA	43000	43000	NA	NA	No	NTX
	Dissolved Oxygen	9700		9700		ug/L	S57SW0090101	1/1	NA	9700	9700	NA	NA	No	NTX
	Hardness As CaCO3	35700		59500		ug/L	S57SW0090101	2/2	NA	47600	59500	NA	NA	No	NTX
14797-55-8	Nitrate/nitrite	452	L	452	L	ug/L	S57SW0090101	1/1	NA	452	452	NA	NA	No	NTX
	pH	7.35		7.35			S57SW0090101	1/1	NA	7.35	7.35	NA	NA	No	NTX
14808-79-8	Sulfate	38000	L	38000	L	ug/L	S57SW0090101	1/1	NA	38000	38000	NA	NA	No	NTX
	Total Dissolved Solids	224000	L	224000	L	ug/L	S57SW0090101	1/1	NA	224000	224000	NA	NA	No	NTX
	Total Organic Carbon	2080		2320		ug/L	S57SW0020101	2/2	NA	2200	2320	NA	NA	No	NTX
	Turbidity	7.71	L	7.71	L	ug/L	S57SW0090101	1/1	NA	7.71	7.71	NA	NA	No	NTX

Notes:

Samples included in table include: S57SW0010101, S57SW0020101, S57SW0020101-F, S57SW0030101-F, S57SW0030101-MAX, S57SW0030201, S57SW0040101, S57SW0040101-F, S57SW0060101-MAX, S57SW0060201, S57SW0070101, S57SW0070101-F, S57SW0070201, S57SW0080101, S57SW0080201, S57SW0080301, S57SW0090101, S57SW0090101-F.

1 Minimum/maximum detected concentration.

2 Criteria as published in FR 63:68354-68364 unless otherwise noted.

3 Rationale Codes Selection Reason: Above Screening Levels (ASL)
Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

4 Water quality criteria not available EPA Region III RBC for tap water ingestion used (Cancer benchmark value = 1E-6, HI = 0.1).

5 Value is for hexavalent chromium..

6 Action level.

7 Essential nutrient screening level based on dietary allowance (see Appendix K).

Definitions:

NA = Not Applicable
COPC = Chemical of Potential Concern
J = Estimated Value
C = Carcinogenic
N = Non-Carcinogenic
K = Biased High
L = Biased Low

TABLE 7-22

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
DIRECT CONTACT WITH STORM SEWER SEDIMENT
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND
PAGE 1 OF 2

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Average Concentration	Concentration Used for Screening	Background (2) Value	Risk Based COPC Screening Level (3) Residential	Industrial	Basis	COPC Flag	Rationale for (4) Contaminant Deletion or Selection
Volatile Organic Compounds																	
75-35-4	1,1-Dichloroethene	9	J	9	J	ug/kg	S57SD0050101	1/1	NA	9	9	NA	1100	9500	C	No	BSL
67-64-1	Acetone	28	J	28	J	ug/kg	S57SD0050101	1/1	NA	28	28	NA	780000	20000000	N	No	BSL
156-59-2	cis-1,2-Dichloroethene	6300		6300		ug/kg	S57SD0050101	1/1	NA	6300	6300	NA	78000	200000	N	No	BSL
60-29-7	Ethyl Ether	14	J	14	J	ug/kg	S57SD0050101	1/1	NA	14	14	NA	1600000	41000000	N	No	BSL
100-41-4	Ethylbenzene	2	J	2	J	ug/kg	S57SD0050101	1/1	NA	2	2	NA	780000	20000000	N	No	BSL
156-60-5	trans-1,2-Dichloroethene	14	J	14	J	ug/kg	S57SD0050101	1/1	NA	14	14	NA	160000	4100000	N	No	BSL
79-01-6	Trichloroethene	18	J	18	J	ug/kg	S57SD0050101	1/1	NA	18	18	NA	58000	520000	C	No	BSL
75-01-4	Vinyl Chloride	1000	J	1000	J	ug/kg	S57SD0050101	1/1	NA	1000	1000	NA	340	3000	C	Yes	ASL
Semivolatile Organic Compounds																	
91-57-6	2-Methylnaphthalene	90	J	90	J	ug/kg	S57SD0050101	1/1	NA	90	90	NA	160000	4100000	N	No	BSL
83-32-9	Acenaphthene	84	J	84	J	ug/kg	S57SD0050101	1/1	NA	84	84	NA	470000	12000000	N	No	BSL
120-12-7	Anthracene	190	J	190	J	ug/kg	S57SD0050101	1/1	NA	190	190	NA	2300000	61000000	N	No	BSL
56-55-3	Benzo(a)anthracene	420	J	420	J	ug/kg	S57SD0050101	1/1	NA	420	420	NA	870	7800	C	No	BSL
50-32-8	Benzo(a)pyrene	300	J	300	J	ug/kg	S57SD0050101	1/1	NA	300	300	NA	87	780	C	Yes	ASL
205-99-2	Benzo(b)fluoranthene	500		500		ug/kg	S57SD0050101	1/1	NA	500	500	NA	870	7800	C	No	BSL
191-24-2	Benzo(g,h,i)perylene	190	J	190	J	ug/kg	S57SD0050101	1/1	NA	190	190	NA	160000 (5)	4100000 (5)	N	No	BSL
207-08-9	Benzo(k)fluoranthene	140	J	140	J	ug/kg	S57SD0050101	1/1	NA	140	140	NA	8700	78000	N	No	BSL
117-81-7	Bis(2-Ethylhexyl)phthalate	180	J	180	J	ug/kg	S57SD0050101	1/1	NA	180	180	NA	46000	410000	C	No	BSL
86-74-8	Carbazole	82	J	82	J	ug/kg	S57SD0050101	1/1	NA	82	82	NA	32000	290000	C	No	BSL
218-01-9	Chrysene	340	J	340	J	ug/kg	S57SD0050101	1/1	NA	340	340	NA	87000	780000	C	No	BSL
53-70-3	Dibenzo(a,h)anthracene	50	J	50	J	ug/kg	S57SD0050101	1/1	NA	50	50	NA	87	780	C	No	BSL
132-64-9	Dibenzofuran	80	J	80	J	ug/kg	S57SD0050101	1/1	NA	80	80	NA	31000	820000	N	No	BSL
206-44-0	Fluoranthene	750		750		ug/kg	S57SD0050101	1/1	NA	750	750	NA	310000	8200000	N	No	BSL
86-73-7	Fluorene	130	J	130	J	ug/kg	S57SD0050101	1/1	NA	130	130	NA	310000	8200000	N	No	BSL
193-39-5	Indeno(1,2,3-cd)pyrene	160	J	160	J	ug/kg	S57SD0050101	1/1	NA	160	160	NA	870	7800	N	No	BSL
86-30-6	N-Nitrosodiphenylamine	50	J	50	J	ug/kg	S57SD0050101	1/1	NA	50	50	NA	310000	8200000	N	No	BSL
91-20-3	Naphthalene	180	J	180	J	ug/kg	S57SD0050101	1/1	NA	180	180	NA	160000	41000000	C	No	BSL
85-01-8	Phenanthrene	810		810		ug/kg	S57SD0050101	1/1	NA	810	810	NA	160000 (5)	4100000 (5)	N	No	BSL
129-00-0	Pyrene	720		720		ug/kg	S57SD0050101	1/1	NA	720	720	NA	230000	6100000	N	No	BSL
Pesticides/PCBs																	
5103-74-2	Gamma-Chlordane	2.1	J	2.1	J	ug/kg	S57SD0050101	1/1	NA	2.1	2.1	NA	1800	16000	C	No	BSL
Inorganics																	
7429-90-5	Aluminum	2260		2260		mg/kg	S57SD0050101	1/1	NA	2260	2260	18329	7800	200000	N	No	BSL, BKG
7440-36-0	Antimony	3	K	3	K	mg/kg	S57SD0050101	1/1	NA	3	3	ND	3.1	82	N	No	BSL
7440-38-2	Arsenic	8.4		8.4		mg/kg	S57SD0050101	1/1	NA	8.4	8.4	4.25	0.43	3.8	C	Yes	ASL
7440-39-3	Barium	23.2		23.2		mg/kg	S57SD0050101	1/1	NA	23.2	23.2	144	550	14000	N	No	BSL, BKG
7440-41-7	Beryllium	0.27	L	0.27	L	mg/kg	S57SD0050101	1/1	NA	0.27	0.27	0.905	16	410	N	No	BSL, BKG
7440-43-9	Cadmium	0.76	K	0.76	K	mg/kg	S57SD0050101	1/1	NA	0.76	0.76	0.26	3.9	10	N	No	BSL
7440-70-2	Calcium	2870	J	2870	J	mg/kg	S57SD0050101	1/1	NA	2870	2870	409	1,000,000 (10)	1,000,000 (10)	N	No	BSL, NUT
7440-47-3	Chromium	12.6		12.6		mg/kg	S57SD0050101	1/1	NA	12.6	12.6	24.2	23 (6)	610 (6)	N	No	BSL, BKG
7440-48-4	Cobalt	7.7		7.7		mg/kg	S57SD0050101	1/1	NA	7.7	7.7	39.7	470	12000	N	No	BSL, BKG

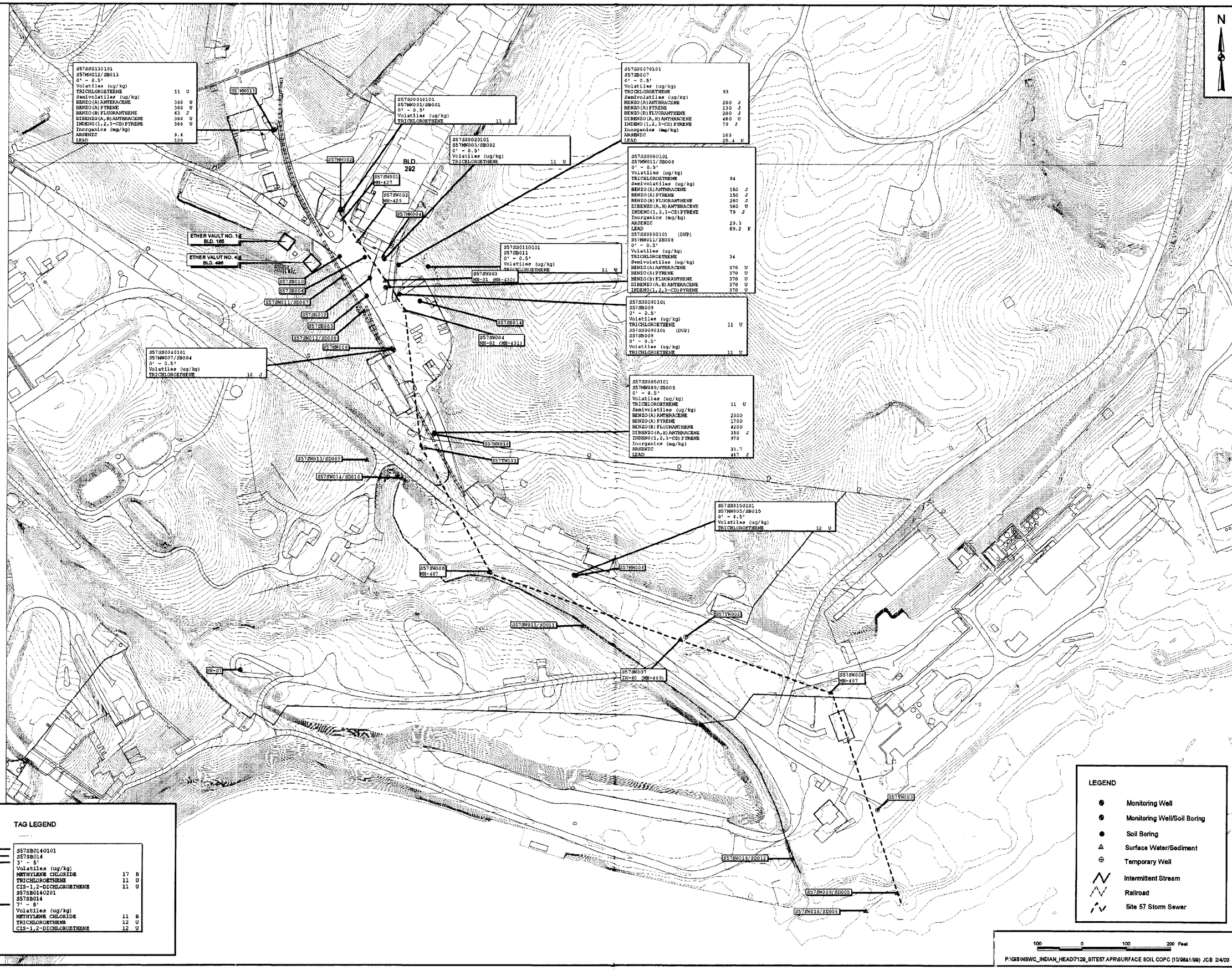
TABLE 7-22

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
DIRECT CONTACT WITH STORM SEWER SEDIMENT
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Average Concentration	Concentration Used for Screening	Background (2) Value	Risk Based COPC Screening Level (3)			COPC Flag	Rationale for (4) Contaminant Deletion or Selection
													Residential	Industrial	Basis		
7440-50-8	Copper	103		103		mg/kg	S57SD0050101	1/1	NA	103	103	18.7	310	8200	N	No	BSL
57-12-5	Cyanide	0.76		0.76		mg/kg	S57SD0050101	1/1	NA	0.76	0.76	ND	160	4100	N	No	BSL
7439-89-6	Iron	20800		20800		mg/kg	S57SD0050101	1/1	NA	20800	20800	43170	2300	61000	N	No	BKG
7439-92-1	Lead	182	K	182	K	mg/kg	S57SD0050101	1/1	NA	182	182	149	400 (7)	1000 (8)	N	No	BSL
7439-95-4	Magnesium	2070		2070		mg/kg	S57SD0050101	1/1	NA	2070	2070	1382	460,468 (10)	460,468 (10)	N	No	BSL, NUT
7439-96-5	Manganese	150		150		mg/kg	S57SD0050101	1/1	NA	150	150	2248	160	4100	N	No	BSL, BKG
7439-97-6	Mercury	0.45		0.45		mg/kg	S57SD0050101	1/1	NA	0.45	0.45	0.087	2.3 (9)	61 (9)	N	No	BSL
7440-02-0	Nickel	24.9		24.9		mg/kg	S57SD0050101	1/1	NA	24.9	24.9	18.2	160	4100	N	No	BSL
7440-09-7	Potassium	187		187		mg/kg	S57SD0050101	1/1	NA	187	187	1874	1,000,000 (10)	1,000,000 (10)		No	BSL, NUT, BKG
7440-22-4	Silver	0.15	K	0.15	K	mg/kg	S57SD0050101	1/1	NA	0.15	0.15	ND	39	1000	N	No	BSL
7440-23-5	Sodium	118	L	118	L	mg/kg	S57SD0050101	1/1	NA	118	118	51.9	1,000,000 (10)	1,000,000 (10)		No	BSL, NUT
7440-62-2	Vanadium	118		118		mg/kg	S57SD0050101	1/1	NA	118	118	53.5	55	1400	N	Yes	ASL
7440-66-6	Zinc	183		183		mg/kg	S57SD0050101	1/1	NA	183	183	38.1	2300	61000	N	No	BSL
AVS/Simultaneously Extracted Metals																	
	Acid Volatile Sulfide	64.4		64.4		mg/kg	S57SD0050101	1/1	NA	64.4	64.4	NA	NA	NA		No	NTX
	Cadmium (sem)	0.25		0.25		mg/kg	S57SD0050101	1/1	NA	0.25	0.25	NA	NA	NA		No	NTX
	Copper (sem)	62.9		62.9		mg/kg	S57SD0050101	1/1	NA	62.9	62.9	NA	NA	NA		No	NTX
	Lead (sem)	140	J	140	J	mg/kg	S57SD0050101	1/1	NA	140	140	NA	NA	NA		No	NTX
	Mercury (sem)	0.006	L	0.006	L	mg/kg	S57SD0050101	1/1	NA	0.006	0.006	NA	NA	NA		No	NTX
	Nickel (sem)	3.9		3.9		mg/kg	S57SD0050101	1/1	NA	3.9	3.9	NA	NA	NA		No	NTX
	Zinc (sem)	78		78		mg/kg	S57SD0050101	1/1	NA	78	78	NA	NA	NA		No	NTX
Miscellaneous																	
	pH	7.21		7.21			S57SD0050101	1/1	NA	7.21	7.21	NA	NA	NA		No	NTX
	Total Organic Carbon	16000	J	16000	J	mg/kg	S57SD0050101	1/1	NA	16000	16000	NA	NA	NA		No	NTX

Notes:
Samples included in table include: S57SD0050101
1 Minimum/maximum detected concentration.
2 Surface soil background concentrations from Background Investigation Report for Indian Head and Stump Neck Annex, Brown & Root Environmental, December 1997.
3 USEPA Region III Risk-Based Concentration Table, October 1, 1998. (Cancer benchmark value = 1E-06, HI = 0.1)
4 Rationale Codes Selection Reason: Above Screening Levels (ASL)
Deletion Reason: Background Levels (BKG)
No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)
5 Value is for naphthalene.
6 Value is for hexavalent chromium.
7 Value is based on OSWER Soil Screening Level for residential land use (USEPA, July 1994).
8 EPA Region III.
9 Value is for mercuric chloride.
10 Essential nutrient screening level based on dietary allowance (see Appendix K).

Definitions:
NA = Not Applicable
COPC = Chemical of Potential Concern
J = Estimated Value
C = Carcinogenic
N = Non-Carcinogenic
K = Biased High
L = Biased Low



TAG LEGEND

Sample No.	S57SB0140101		
Sample Location	S57SB014		
Sample Depth	3' - 5'		
Analytical Results	Volatiles (ug/kg)		
	METHYLENE CHLORIDE	17	B
	TRICHLOROETHENE	11	U
	CIS-1,2-DICHLOROETHENE	11	U
	S57SB0140201		
	S57SB014		
Sample Depth	7' - 8'		
Analytical Results	Volatiles (ug/kg)		
	METHYLENE CHLORIDE	11	B
	TRICHLOROETHENE	12	U
	CIS-1,2-DICHLOROETHENE	12	U

SYMBOL	DESCRIPTION	DATE	APPROVED
	REVISIONS		

403	DBA		
404	DA		
405	E.I.C.		
406			
408			
DAB	REVIEWED BY/ROC:	DATE	
401	TITLE	DATE	
402		DATE	

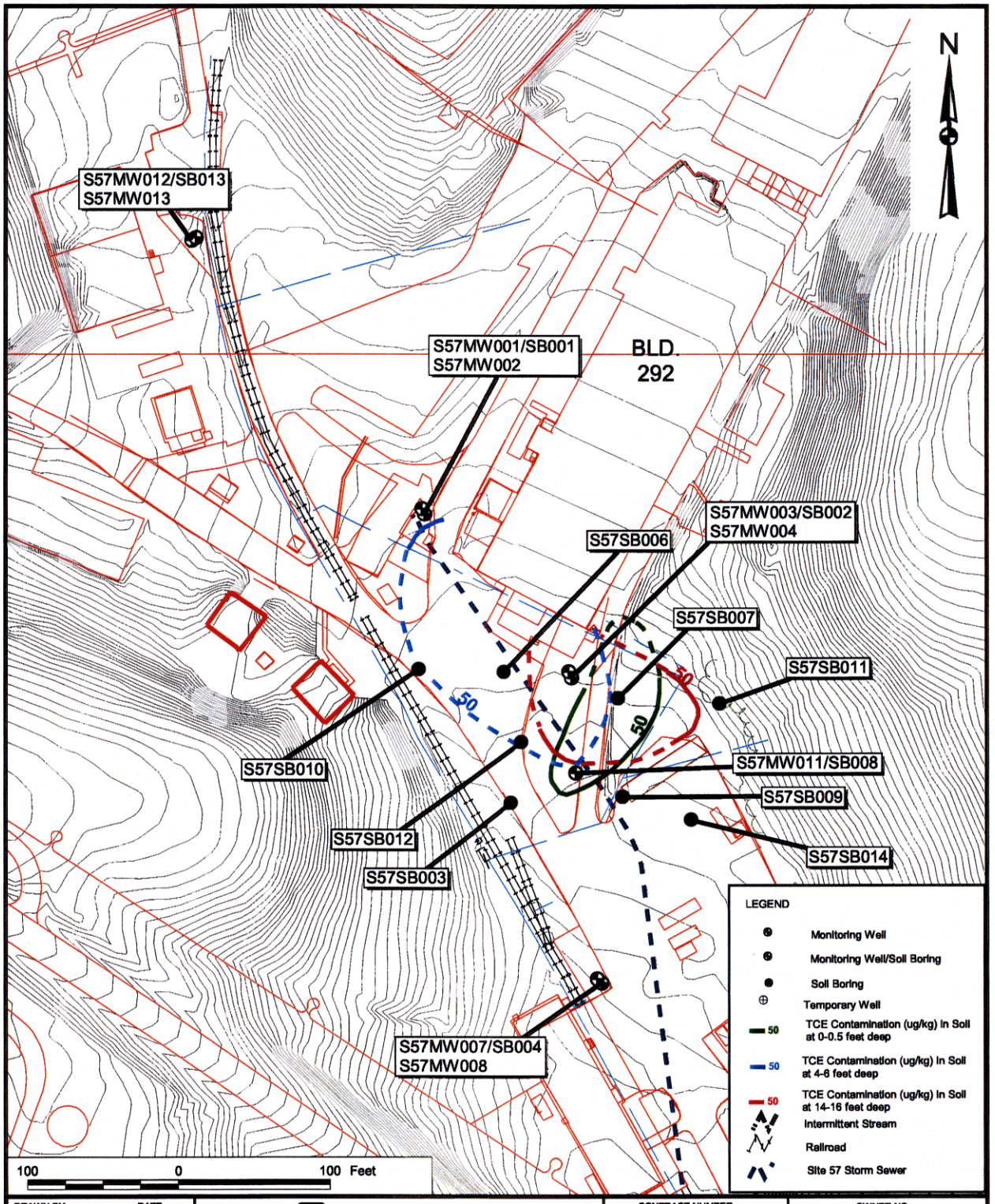
Tetra Tech NUS, INC.
AUTHORIZED
APPROVED BY
DSG. DR. J. ESCUDERO, PE
CHK. GTZ
SUBMITTED BY:
PROGRAM MANAGER
APPROVED: GTZ 2/4/00
EFD/JAX COMMANDER NAVFAC

NAVAL FACILITIES ENGINEERING COMMAND
DEPARTMENT OF THE NAVY
CHESAPEAKE DIVISION
NSWC INDIAN HEAD
INDIAN HEAD, MD

SURFACE SOIL COPC DATA SUMMARY
SITE 57 - FORMER DRUM LOADING AREA

CODE I.D. NO. 80091
DRAWING SIZE: D
CONST. CONT. NO.
XXXXXX-XX-X-XXXX
SPEC. XX-XX-XXXX
NAVFAC DRAWING NO.
SHEET _ OF _

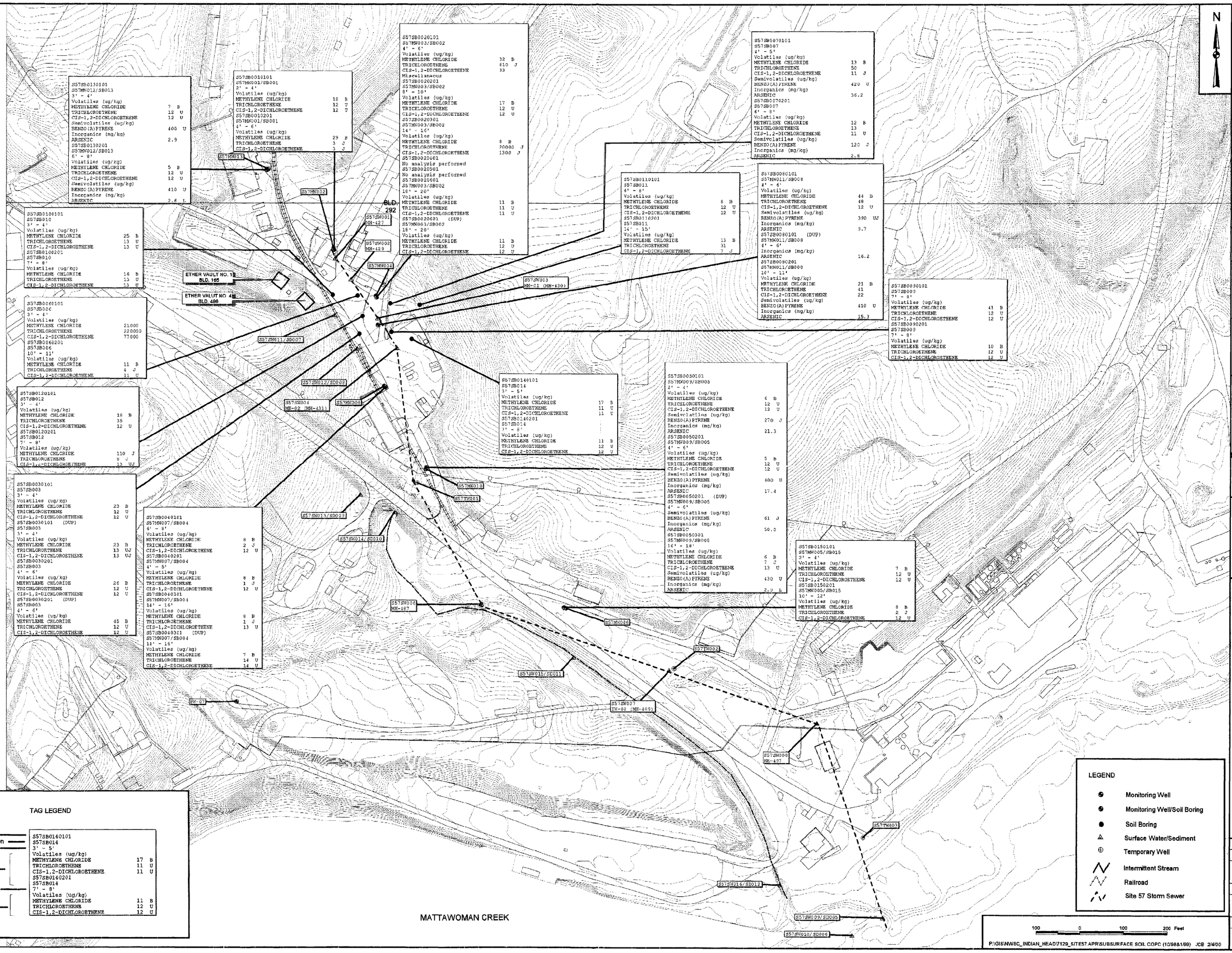
FIGURE 7-1



DRAWN BY J. BELLONE — DATE 2/4/00	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7129	OWNER NO. —
CHECKED BY GJL — DATE 2/7/00	TCE IN SOIL SITE 57 - FORMER DRUM LOADING AREA NSWC INDIAN HEAD INDIAN HEAD, MARYLAND	APPROVED BY G. J. LATULIPPE — DATE 2/7/00	
COST/SCHEDULE-AREA		APPROVED BY — DATE —	
SCALE AS NOTED		DRAWING NO. FIGURE 7-2	REV 0

P:\GIS\INDIAN HEAD\7129_SITE57.APR\TCE IN SOIL LAYOUT JCB 2/5/00

00668C08Y



S57SB0130101
S57MW012/SB013
3' - 4'
Volatiles (ug/kg)
METHYLENE CHLORIDE 7 B
TRICHLOROETHENE 12 U
CIS-1,2-DICHLOROETHENE 12 U
Semivolatiles (ug/kg)
BENZO(A)PYRENE 400 U
Inorganics (mg/kg)
ARSENIC 2.9
S57SB0130201
S57MW012/SB013
6' - 8'
Volatiles (ug/kg)
METHYLENE CHLORIDE 5 B
TRICHLOROETHENE 12 U
CIS-1,2-DICHLOROETHENE 12 U
Semivolatiles (ug/kg)
BENZO(A)PYRENE 410 U
Inorganics (mg/kg)
ARSENIC 2.6 L

S57SB0010101
S57MW001/SB001
2' - 4'
Volatiles (ug/kg)
METHYLENE CHLORIDE 18 B
TRICHLOROETHENE 12 U
CIS-1,2-DICHLOROETHENE 12 U
S57SB0010201
S57MW001/SB001
4' - 6'
Volatiles (ug/kg)
METHYLENE CHLORIDE 29 B
TRICHLOROETHENE 3 J
CIS-1,2-DICHLOROETHENE 3 J

S57SB0020101
S57MW003/SB002
4' - 6'
Volatiles (ug/kg)
METHYLENE CHLORIDE 32 B
TRICHLOROETHENE 810 J
CIS-1,2-DICHLOROETHENE 33
Miscellaneous
S57SB0020201
S57MW003/SB002
8' - 10'
Volatiles (ug/kg)
METHYLENE CHLORIDE 17 B
TRICHLOROETHENE 12 U
CIS-1,2-DICHLOROETHENE 12 U
S57SB0020301
S57MW003/SB002
14' - 16'
Volatiles (ug/kg)
METHYLENE CHLORIDE 8 B
TRICHLOROETHENE 20000 J
CIS-1,2-DICHLOROETHENE 1300 J
S57SB0020401
No analysis performed
S57SB0020501
No analysis performed
S57SB0020601
S57MW003/SB002
16' - 20'
Volatiles (ug/kg)
METHYLENE CHLORIDE 11 B
TRICHLOROETHENE 11 U
CIS-1,2-DICHLOROETHENE 11 U
S57SB0020601 (DUP)
S57MW003/SB002
16' - 20'
Volatiles (ug/kg)
METHYLENE CHLORIDE 11 B
TRICHLOROETHENE 12 U
CIS-1,2-DICHLOROETHENE 12 U

S57SB0070101
S57SB007
4' - 6'
Volatiles (ug/kg)
METHYLENE CHLORIDE 13 B
TRICHLOROETHENE 50
CIS-1,2-DICHLOROETHENE 11 J
Semivolatiles (ug/kg)
BENZO(A)PYRENE 420 U
Inorganics (mg/kg)
ARSENIC 36.2
S57SB0070201
S57SB007
6' - 8'
Volatiles (ug/kg)
METHYLENE CHLORIDE 12 B
TRICHLOROETHENE 13
CIS-1,2-DICHLOROETHENE 11 U
Semivolatiles (ug/kg)
BENZO(A)PYRENE 120 J
Inorganics (mg/kg)
ARSENIC 2.6

S57SB0110101
S57SB011
6' - 8'
Volatiles (ug/kg)
METHYLENE CHLORIDE 8 B
TRICHLOROETHENE 12 U
CIS-1,2-DICHLOROETHENE 12 U
S57SB0110201
S57SB011
14' - 15'
Volatiles (ug/kg)
METHYLENE CHLORIDE 13 B
TRICHLOROETHENE 31
CIS-1,2-DICHLOROETHENE 7 J

S57SB0080101
S57MW011/SB008
4' - 6'
Volatiles (ug/kg)
METHYLENE CHLORIDE 44 B
TRICHLOROETHENE 48
CIS-1,2-DICHLOROETHENE 12 U
Semivolatiles (ug/kg)
BENZO(A)PYRENE 390 UJ
Inorganics (mg/kg)
ARSENIC 9.7
S57SB0080101 (DUP)
S57MW011/SB008
4' - 6'
Inorganics (mg/kg)
ARSENIC 16.2
S57SB0080201
S57MW011/SB008
10' - 11'
Volatiles (ug/kg)
METHYLENE CHLORIDE 21 B
TRICHLOROETHENE 41
CIS-1,2-DICHLOROETHENE 22
Semivolatiles (ug/kg)
BENZO(A)PYRENE 410 U
Inorganics (mg/kg)
ARSENIC 15.3

S57SB0100101
S57SB010
3' - 4'
Volatiles (ug/kg)
METHYLENE CHLORIDE 25 B
TRICHLOROETHENE 13 U
CIS-1,2-DICHLOROETHENE 13 U
S57SB0100201
S57SB010
7' - 8'
Volatiles (ug/kg)
METHYLENE CHLORIDE 16 B
TRICHLOROETHENE 13 U
CIS-1,2-DICHLOROETHENE 13 U

S57SB0060101
S57SB006
3' - 4'
Volatiles (ug/kg)
METHYLENE CHLORIDE 21000
TRICHLOROETHENE 220000
CIS-1,2-DICHLOROETHENE 77000
S57SB0060201
S57SB006
10' - 11'
Volatiles (ug/kg)
METHYLENE CHLORIDE 11 B
TRICHLOROETHENE 4 J
CIS-1,2-DICHLOROETHENE 11 U

S57SB0090101
S57SB009
7' - 8'
Volatiles (ug/kg)
METHYLENE CHLORIDE 41 B
TRICHLOROETHENE 12 U
CIS-1,2-DICHLOROETHENE 12 U
S57SB0090201
S57SB009
7' - 8'
Volatiles (ug/kg)
METHYLENE CHLORIDE 10 B
TRICHLOROETHENE 12 U
CIS-1,2-DICHLOROETHENE 12 U

S57SB0120101
S57SB012
3' - 4'
Volatiles (ug/kg)
METHYLENE CHLORIDE 16 B
TRICHLOROETHENE 35
CIS-1,2-DICHLOROETHENE 12 U
S57SB0120201
S57SB012
7' - 8'
Volatiles (ug/kg)
METHYLENE CHLORIDE 110 J
TRICHLOROETHENE 8 J
CIS-1,2-DICHLOROETHENE 13 UJ

S57SB0140101
S57SB014
3' - 5'
Volatiles (ug/kg)
METHYLENE CHLORIDE 17 B
TRICHLOROETHENE 11 U
CIS-1,2-DICHLOROETHENE 11 U
S57SB0140201
S57SB014
7' - 8'
Volatiles (ug/kg)
METHYLENE CHLORIDE 11 B
TRICHLOROETHENE 12 U
CIS-1,2-DICHLOROETHENE 12 U

S57SB0050101
S57MW009/SB005
2' - 4'
Volatiles (ug/kg)
METHYLENE CHLORIDE 6 B
TRICHLOROETHENE 12 U
CIS-1,2-DICHLOROETHENE 12 U
Semivolatiles (ug/kg)
BENZO(A)PYRENE 270 J
Inorganics (mg/kg)
ARSENIC 21.3
S57SB0050201
S57MW009/SB005
4' - 6'
Volatiles (ug/kg)
METHYLENE CHLORIDE 5 B
TRICHLOROETHENE 12 U
CIS-1,2-DICHLOROETHENE 12 U
Semivolatiles (ug/kg)
BENZO(A)PYRENE 400 U
Inorganics (mg/kg)
ARSENIC 17.4
S57SB0050201 (DUP)
S57MW009/SB005
4' - 6'
Semivolatiles (ug/kg)
BENZO(A)PYRENE 61 J
Inorganics (mg/kg)
ARSENIC 50.0
S57SB0050301
S57MW009/SB005
16' - 18'
Volatiles (ug/kg)
METHYLENE CHLORIDE 6 B
TRICHLOROETHENE 7 J
CIS-1,2-DICHLOROETHENE 13 U
Semivolatiles (ug/kg)
BENZO(A)PYRENE 430 U
Inorganics (mg/kg)
ARSENIC 2.9 L

S57SB0150101
S57MW005/SB015
2' - 4'
Volatiles (ug/kg)
METHYLENE CHLORIDE 7 B
TRICHLOROETHENE 12 U
CIS-1,2-DICHLOROETHENE 12 U
S57SB0150201
S57MW005/SB015
10' - 12'
Volatiles (ug/kg)
METHYLENE CHLORIDE 8 B
TRICHLOROETHENE 2 J
CIS-1,2-DICHLOROETHENE 12 U

S57SB0030101
S57SB003
3' - 4'
Volatiles (ug/kg)
METHYLENE CHLORIDE 23 B
TRICHLOROETHENE 12 U
CIS-1,2-DICHLOROETHENE 12 U
S57SB0030101 (DUP)
S57SB003
3' - 4'
Volatiles (ug/kg)
METHYLENE CHLORIDE 23 B
TRICHLOROETHENE 13 UJ
CIS-1,2-DICHLOROETHENE 13 UJ
S57SB0030201
S57SB003
4' - 6'
Volatiles (ug/kg)
METHYLENE CHLORIDE 26 B
TRICHLOROETHENE 12 U
CIS-1,2-DICHLOROETHENE 12 U
S57SB0030201 (DUP)
S57SB003
4' - 6'
Volatiles (ug/kg)
METHYLENE CHLORIDE 45 B
TRICHLOROETHENE 12 U
CIS-1,2-DICHLOROETHENE 12 U

S57SB0040101
S57MW007/SB004
6' - 8'
Volatiles (ug/kg)
METHYLENE CHLORIDE 8 B
TRICHLOROETHENE 2 J
CIS-1,2-DICHLOROETHENE 12 U
S57SB0040201
S57MW007/SB004
4' - 5'
Volatiles (ug/kg)
METHYLENE CHLORIDE 8 B
TRICHLOROETHENE 1 J
CIS-1,2-DICHLOROETHENE 12 U
S57SB0040301
S57MW007/SB004
14' - 16'
Volatiles (ug/kg)
METHYLENE CHLORIDE 8 B
TRICHLOROETHENE 1 J
CIS-1,2-DICHLOROETHENE 13 U
S57SB0040301 (DUP)
S57MW007/SB004
14' - 16'
Volatiles (ug/kg)
METHYLENE CHLORIDE 7 B
TRICHLOROETHENE 14 U
CIS-1,2-DICHLOROETHENE 14 U

TAG LEGEND

Sample No. — S57SB0140101
Sample Location — S57SB014
Sample Depth — 3' - 5'
Analytical Results — Volatiles (ug/kg)
METHYLENE CHLORIDE 17 B
TRICHLOROETHENE 11 U
CIS-1,2-DICHLOROETHENE 11 U
Sample Depth — S57SB0140201
S57SB014
7' - 8'
Analytical Results — Volatiles (ug/kg)
METHYLENE CHLORIDE 11 B
TRICHLOROETHENE 12 U
CIS-1,2-DICHLOROETHENE 12 U

SYMBOL	DESCRIPTION	DATE	APPROVED

REVISIONS

03A	403		
04	404	E.I.C.	405
401	402	DATE	406
408	DATE		

RENEWED BY PROC

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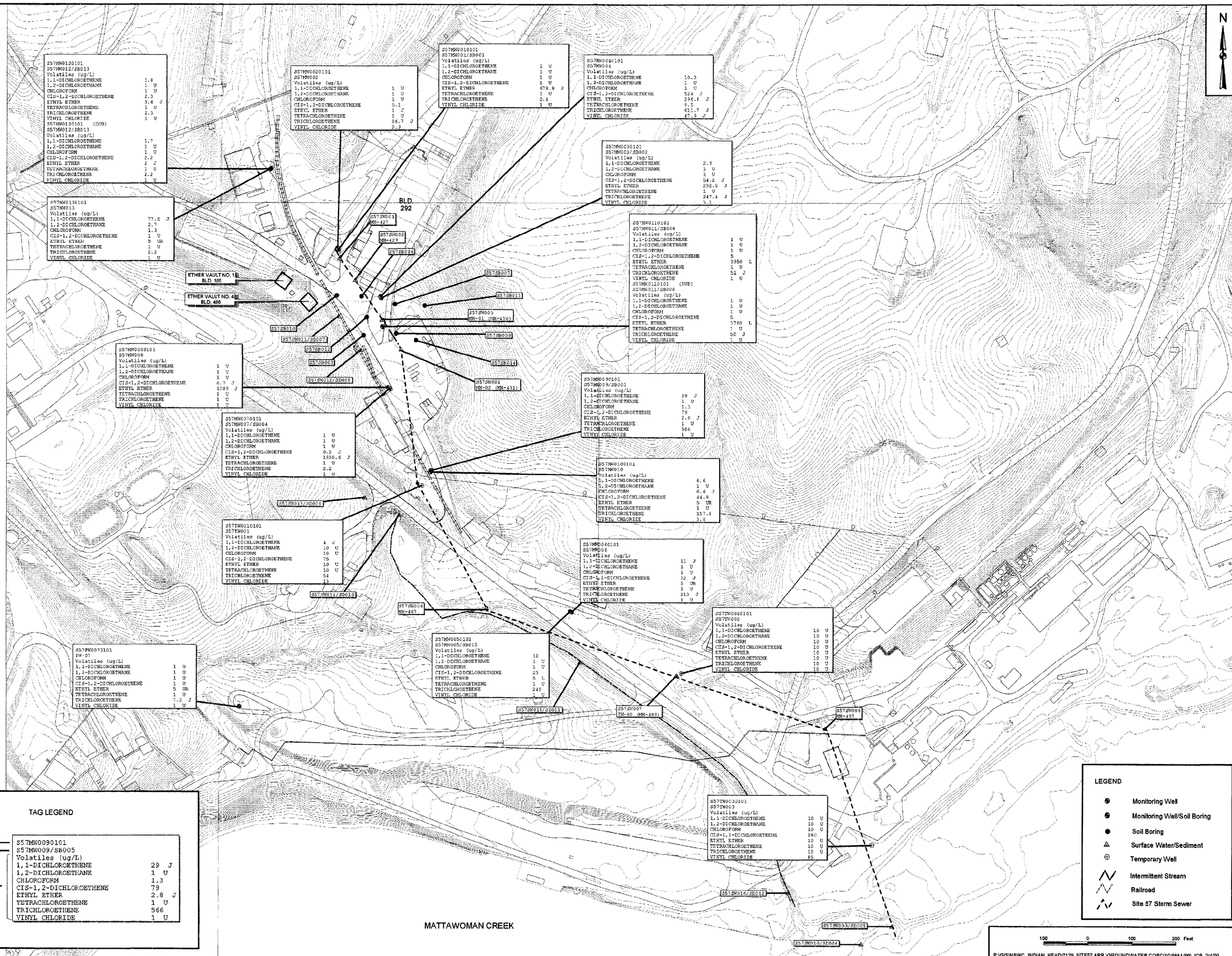
PROVIDED AS INFORMATION ONLY. INTERPRETATION NOT RECOMMENDED

DES. DR. J BELLONE CHK. GJL DATE
SUBMITTED BY: TITLE
PROGRAM MANAGER DATE
APPROVED GJL DATE
IFB FOR COMMANDER NAVFAC

NAVAL FACILITIES ENGINEERING COMMAND
DEPARTMENT OF THE NAVY
CHESAPEAKE DIVISION
NSWC INDIAN HEAD
INDIAN HEAD, MD
SUBSURFACE SOIL COPC DATA SUMMARY
SITE 57 - FORMER DRUM LOADING AREA

CODE I.D. NO. 89091
DRAWING SIZE: D
CONST. CONT. NO.
XXXXXX-XX-X-XXXX
SPEC. XX-XX-XXXX
NAVFAC DRAWING NO.
SHEET _ OF _

FIGURE 7-3



TAG LEGEND

Sample No. — S57MW0090101
Sample Location — S57MW009/SB005
Analytical Results —

Volatiles (ug/L)	
1,1-DICHLOROETHENE	29 J
1,2-DICHLOROETHANE	1 U
CHLOROFORM	1.3
CIS-1,2-DICHLOROETHENE	79
ETHYL ETHER	2.8 J
TETRACHLOROETHENE	1 U
TRICHLOROETHENE	566
VINYL CHLORIDE	1 U

SYMBOL	DESCRIPTION	DATE	APPROVED
	REVISIONS		

DSA	403		
C4	404		
E.I.C.	405		
401	406		
402	048		
REVIEWED BY RDCC	DATE		

Tetra Tech NUS, Inc.
10306 EATON
SUITE 300
FAIRFAX, VA 22030

DRS | DR. J. BELLONE | CHK. GZZ | DATE
SUBMITTED BY: | TITLE | DATE
PROGRAM MANAGER | DATE
APPROVED: GZZ | DATE 2/4/00
EFD FOR COMMANDER NAVFAC

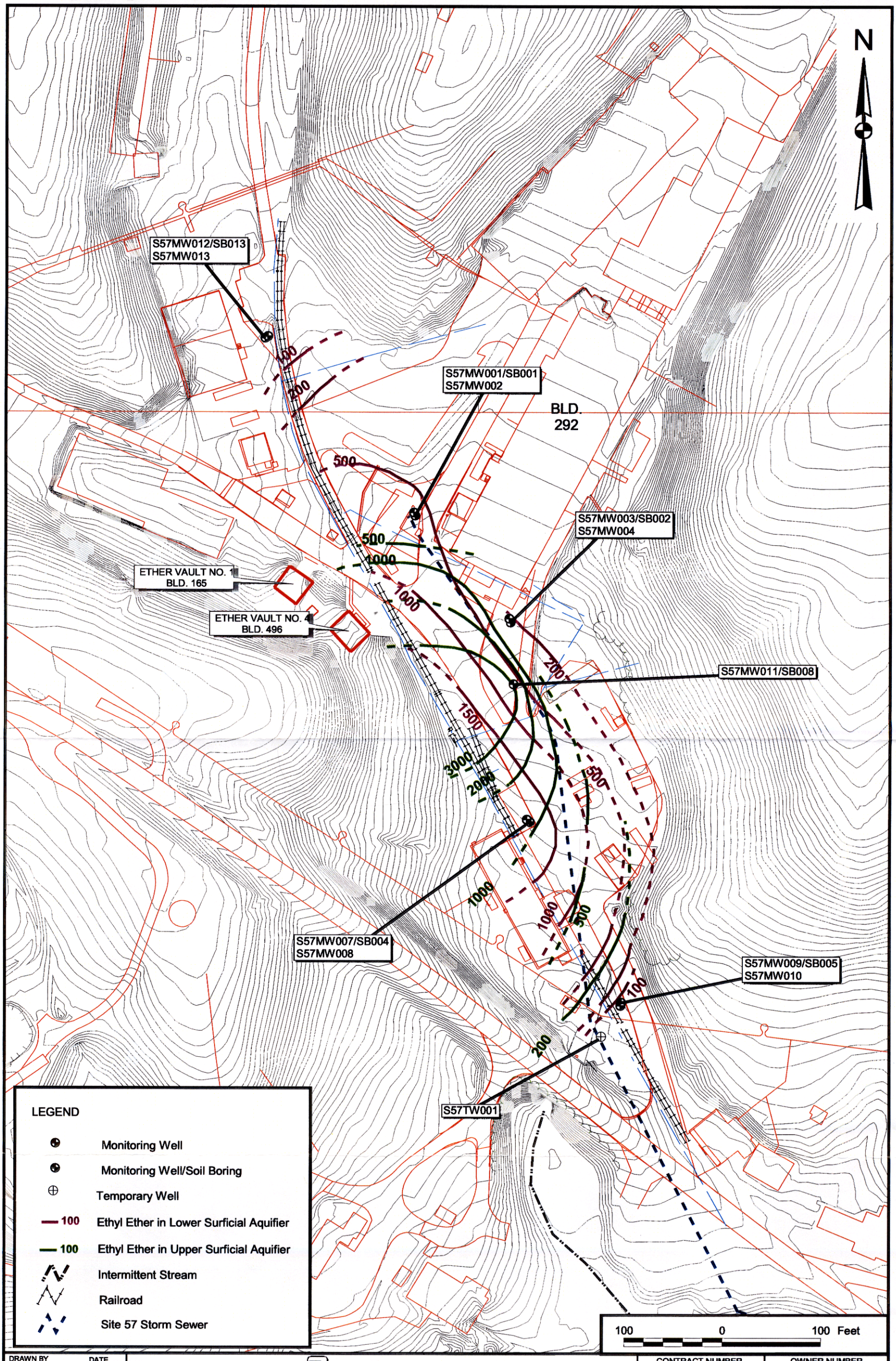
NAVAL FACILITIES ENGINEERING COMMAND
DEPARTMENT OF THE NAVY
CHESAPEAKE DIVISION
NSWC INDIAN HEAD
INDIAN HEAD, MD

GROUNDWATER COPC DATA SUMMARY
SITE 57 - FORMER DRUM LOADING AREA

CODE I.D. NO. 8009/1
DRAWING SIZE: D
CONST. CONT. NO.
XXXXXX-XX-X-XXXX
SPEC. XX-XX-XXXX
NAVFAC DRAWING NO.
SHEET _ OF _

FIGURE 7-4

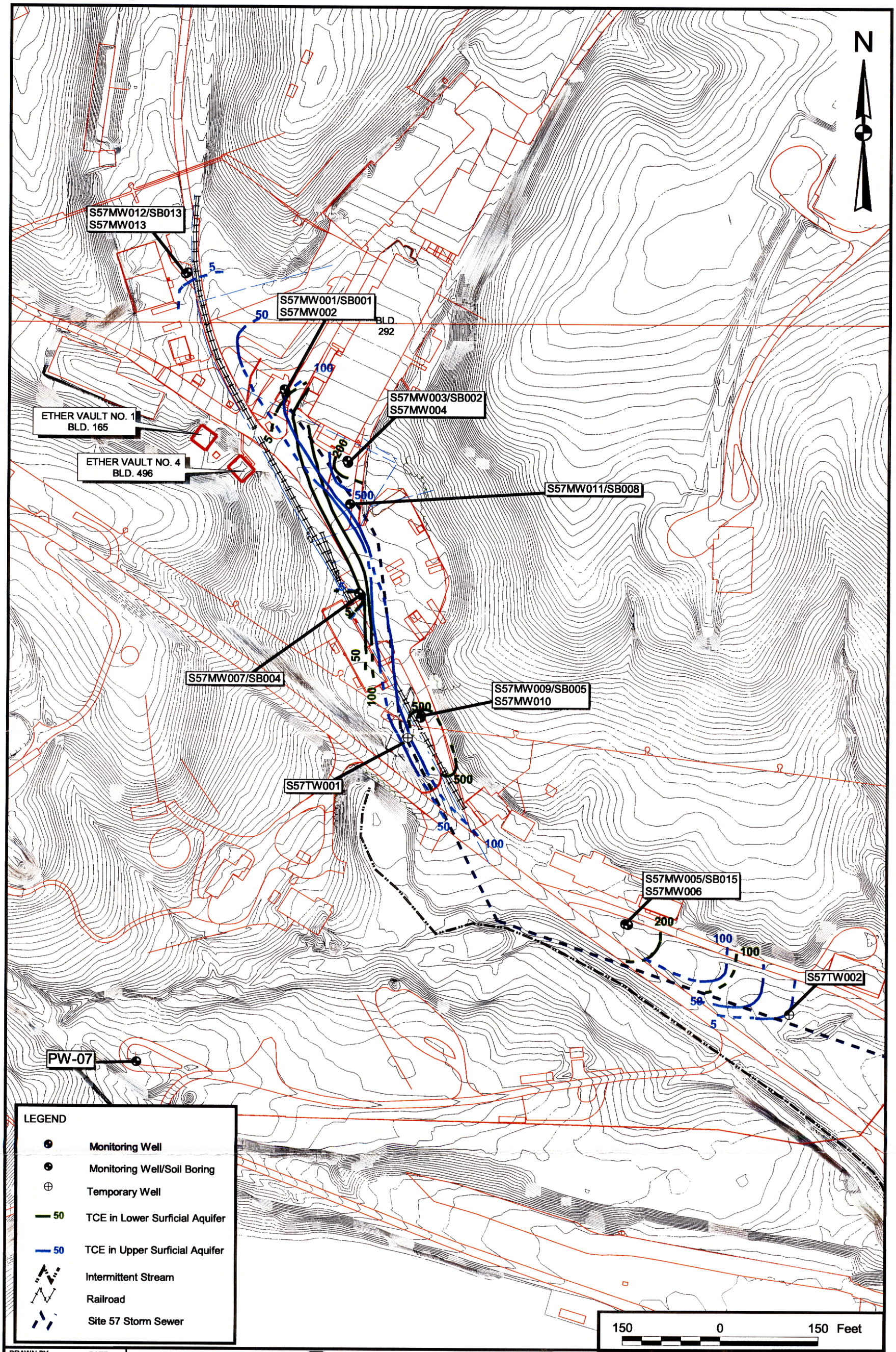
P:\GIS\INDIAN_HEAD\7129_SITE57.APR\ETHYL ETHER CONTOURS LAYOUT JCB 2/5/00



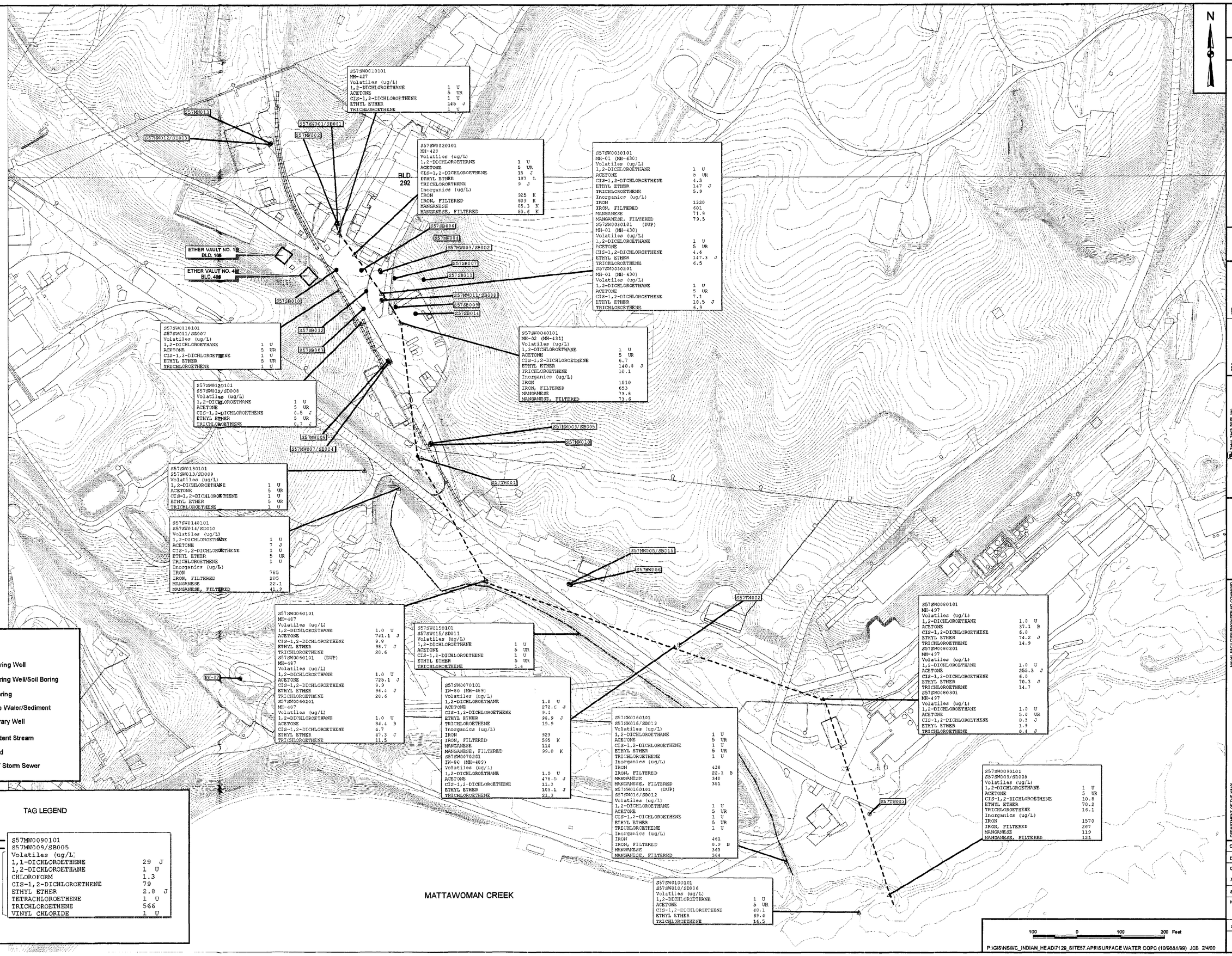
DRAWN BY J. BELLONE	DATE 2/4/00	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7129 / OWNER NUMBER —
CHECKED BY GJL	DATE 2/7/00	ETHYL ETHER IN SURFICIAL GROUNDWATER SITE 57 - FORMER DRUM LOADING AREA NSWC INDIAN HEAD INDIAN HEAD, MARYLAND	APPROVED BY G. J. LATULIPPE / DATE 2/7/00
COST/SCHEDULE-AREA			APPROVED BY — / DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 7-5 / REV 0

00668B10X

P:\GIS\INDIAN HEAD\7129_SITE57.APR\TCE CONTOURS LAYOUT JCB 2/5/00



DRAWN BY J. BELLONE	DATE 2/4/00	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7129 / OWNER NUMBER —
CHECKED BY GJL	DATE 2/7/00	TCE IN SURFICIAL GROUNDWATER SITE 57 - FORMER DRUM LOADING AREA NSWC INDIAN HEAD INDIAN HEAD, MARYLAND	APPROVED BY G. J. LATULIPPE / DATE 2/7/00
COST/SCHEDULE-AREA			APPROVED BY — / DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 7-6 / REV 0



SYMBOL	DESCRIPTION	DATE	APPROVED

REVISIONS

09A	403		
04	404		
E.I.C.	405		
401	408		
402	CHB	DATE	

REVIEWED BY NSWCC DATE

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PARTNERSHIPS

DES DR. J BELLOMS CHK. 2/4/00
SUBMITTED BY: TITLE DATE
PROGRAM MANAGER DATE
APPROVED: 2/4/00
EFD NOR COMMANDER NAVFAC DATE

NAVAL FACILITIES ENGINEERING COMMAND
CHESAPEAKE DIVISION
INDIAN HEAD, MARYLAND

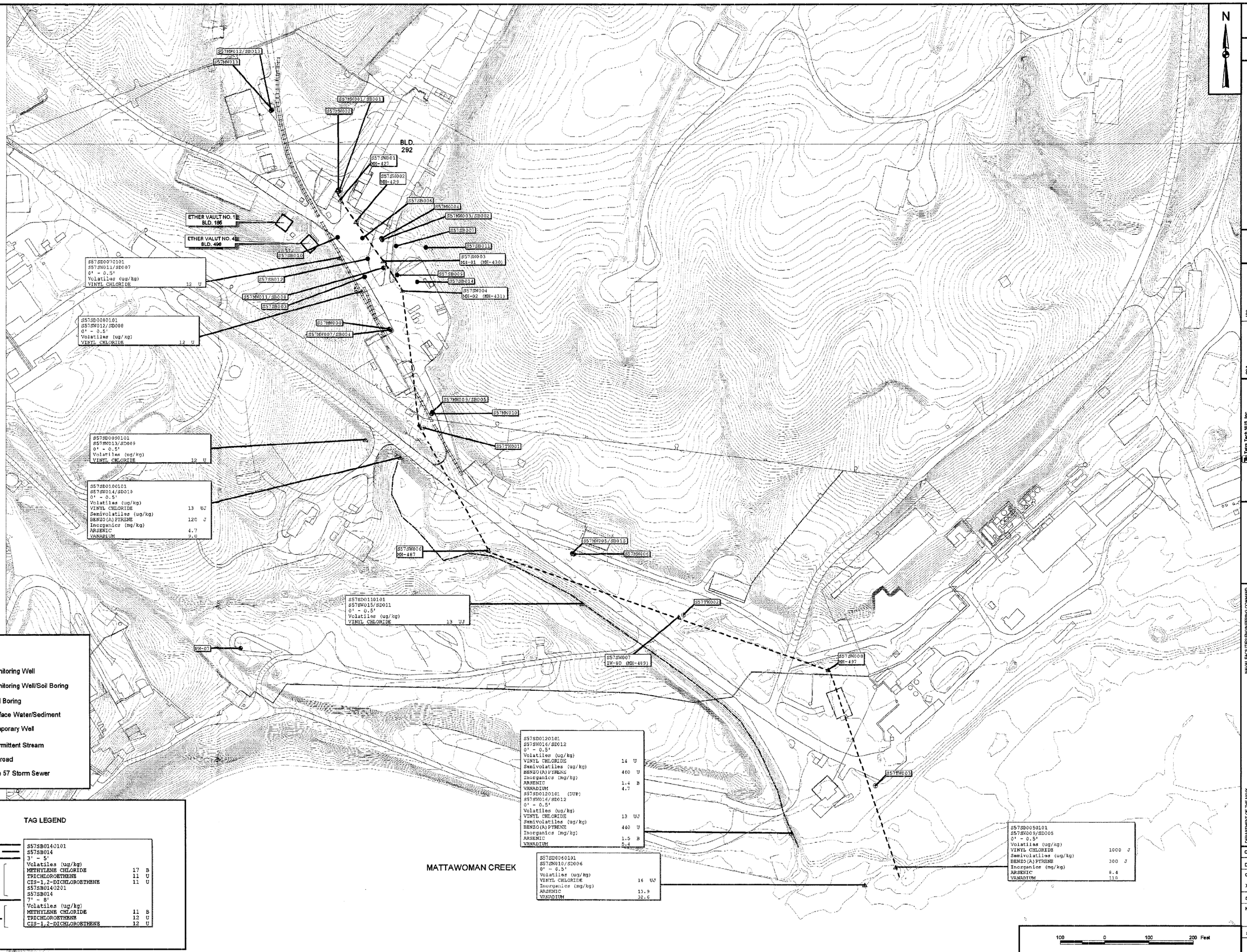
DEPARTMENT OF THE NAVY
NSWC INDIAN HEAD

SURFACE WATER COPC DATA SUMMARY
SITE 57 - FORMER DRUM LOADING AREA

CODE I.D. NO. 80091
DRAWING SIZE: D
CONST. CONT. NO.
XXXXXX-XX-X-XXXX
SPEC. XX-XX-XXXX
NAVFAC DRAWING NO.
SHEET _ OF _

FIGURE 7-7

00668CB11



SYMBOL	DESCRIPTION	DATE	APPROVED
03A			
04			
403			
404			
405			
406			
04B			

REVISIONS

Tetra Tech NUS, Inc.
PORTER PLAZA
401 WOODVILLE ROAD
NORFOLK, VA 23502

DES.	DR. J. BELLONE	CHK.	
SUBMITTED BY:	TITLE	DATE	
PROGRAM MANAGER		DATE	
APPROVED		DATE	
EFD FOR COMMANDER NAVFAC			

401			
402			

REVIEWED BY FOSC: DATE

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
CHESAPEAKE DIVISION
NSWC INDIAN HEAD
INDIAN HEAD, MD

SEDIMENT COPC DATA SUMMARY
SITE 57 - FORMER DRUM LOADING AREA

CODE I.D. NO. 80091
DRAWING SIZE: D
CONST. CONT. NO.
XXXXXX-XX-X-XXXX
SPEC. XX-XX-XXXX
NAVFAC DRAWING NO.
SHEET _ OF _

FIGURE 7-8

8.0 CHEMICAL FATE AND TRANSPORT ANALYSIS

This section contains information on contaminant fate and transport and the chemical properties affecting contaminant migration at the IHDIV-NSWC. Section 8.1 contains a discussion of the chemical and physical properties of the analytes detected in all media. Section 8.2 presents brief discussions of contaminant persistence, Section 8.3 presents a brief overview of contaminant fate and transport issues for several major chemical classes detected at IHDIV-NSWC, and Section 8.4 presents a discussion of site-specific chemical fate and transport.

8.1 CHEMICAL AND PHYSICAL PROPERTIES

Various chemical and physical properties of the compounds detected on site are presented and discussed in this section. These parameters are used to estimate the environmental behavior of site chemicals. Physical and chemical properties of the organic chemicals detected at the IHDIV-NSWC are provided in Table 8-1.

Empirically determined literature values of the water solubility, octanol/water partition coefficient, organic carbon partition coefficient, vapor pressure, Henry's Law constant, bioconcentration factor, and specific gravity are presented, when available. Calculated values that were obtained using approximation methods are presented when literature values are not available. A discussion of the environmental significance of each of these parameters follows.

8.1.1 Specific Gravity

Specific gravity is the ratio of the weight of a given volume of pure chemical at a specified temperature to the weight of the same volume of water at a specified temperature (4°C), which has a specific gravity of 1. Its primary use is to determine whether a contaminant will have a tendency to float or sink in water if it is present as a pure compound or at very high concentrations. Contaminants with a specific gravity greater than 1 will tend to sink, and contaminants with a specific gravity less than 1 will tend to float. This parameter becomes important in discussions regarding the potential presence of free product or nonaqueous-phase liquids.

Of the commonly detected chemicals at these sites, the ketones, and monocyclic aromatics have specific gravities less than 1. The halogenated aliphatics, polycyclic aromatic hydrocarbons (PAHs), pesticides, and phthalate esters have specific gravities greater than 1.

8.1.2 Vapor Pressure

Vapor pressure provides an indication of the rate at which a chemical volatilizes from both soil and water. It is of primary importance at environmental interfaces such as surface soil/air and surface water/air. Volatilization is not as important when evaluating contaminated groundwater and subsurface soils. Vapor pressures for ketones, monocyclic aromatics, and halogenated aliphatics are generally many times higher than vapor pressures for PAHs and pesticides. Chemicals with higher vapor pressures are expected to enter the atmosphere much more readily than chemicals with lower vapor pressures. Volatilization is a significant loss process for volatile organics in surface water or surface soil. Volatilization is not significant for inorganics.

8.1.3 Solubility

The rate at which a chemical is leached from a waste deposit by infiltrating precipitation is directly proportional to its water solubility. More soluble chemicals are more readily leached than less soluble chemicals. The water solubilities presented in Table 8-1 indicate that the volatile organic chemicals (ketones, monocyclic aromatics, halogenated aliphatics) are usually several orders of magnitude more water soluble than the PAHs and pesticides.

The solubility of inorganics is strongly influenced by their valence state(s) and forms (hydroxides, oxides, carbonates, etc.). The solubility is also dependent on pH, Eh, and other ionic species in solution (the Debye-Hückel theory). The solubility products reported in the literature vary with the type of complex formed, but generally it can be noted that, for example, cadmium and copper complexes are more soluble than lead and nickel complexes.

8.1.4 Octanol/Water Partition Coefficient

The octanol/water partition coefficient (K_{ow}) is a measure of the equilibrium partitioning of chemicals between octanol and water. It is also useful in characterizing the sorption of compounds by organic soils where experimental values are not available. PAHs and pesticides are several orders of magnitude more likely to partition to fatty tissues than the more soluble volatile organics. The K_{ow} is also used to estimate bioconcentration factors in aquatic organisms. A linear relationship between the K_{ow} and the uptake of chemicals by fatty tissues of animal and human receptors (the bioconcentration factor) has been determined (Lyman et al., 1990).

8.1.5 Organic Carbon Partition Coefficient

The organic carbon partition coefficient (K_{oc}) indicates the tendency of a chemical to bind to soil particles containing organic carbon. A chemical with a high K_{oc} generally has a low water solubility and vice versa.

This parameter may be used to infer the relative rates at which the more mobile chemicals (ketones, monocyclic aromatics, and halogenated aliphatics) are transported in the groundwater. Chemicals such as PAHs and pesticides are relatively immobile in the soil and are preferentially bound to the soil. These compounds are not subject to groundwater transport to the extent that compounds with higher water solubilities are. However, these immobile chemicals are easily transported by erosional processes when they are present in surface soils.

8.1.6 Henry's Law Constant

Both the vapor pressure and the water solubility are of use in determining volatilization rates from surface water bodies and from groundwater. The ratio of these two parameters (the Henry's Law constant) is used to calculate the equilibrium chemical concentrations in the vapor (air) phase versus the liquid (water) phase for the dilute solutions commonly encountered in environmental settings. In general, chemicals with a Henry's Law constant of less than 5×10^{-6} atm-m^3/mole, such as pesticides, volatilize very little and are present only in minute amounts in the atmosphere or soil gas. For chemicals with a Henry's Law constant greater than 5×10^{-3} atm-m^3/mole, such as many of the halogenated aliphatics, volatilization and diffusion in soil gas are significant.

8.1.7 Bioconcentration Factor

Bioconcentration factors (BCFs) represent the ratio of an aquatic-animal-tissue concentration to a water concentration. The ratio is both contaminant and species specific. When site-specific values are not determined, literature values are used or the BCF is derived from the octanol/water partition coefficient. Many of the PAHs and pesticides will bioconcentrate at levels several orders of magnitude greater than those concentrations found in the water, and volatile organics and nitrogen-containing compounds are not as readily bioconcentrated.

8.1.8 Distribution Coefficient

The distribution coefficient (K_d) is a measure of the equilibrium distribution of a chemical or ion in soil/water systems. The distribution of organic chemicals is a function of both the K_{oc} and the amount of organic carbon in the soil. For ions (e.g., metals), K_d is the ratio of the concentration adsorbed on soil surfaces to the concentration in water. Distribution coefficients for metals vary over several orders of magnitude because the K_d is dependent on the size and charge of the ion and the soil properties governing exchange sites on soil surfaces. Coulomb's Law predicts that the ion with the smallest hydrated radius and the largest charge will be preferentially accumulated over ions with larger radii and smaller charges. Distribution coefficients for several metals are shown in Table 8-2.

8.2 CHEMICAL PERSISTENCE

The persistence of various classes of chemicals is discussed in this section. Several transformation mechanisms affect chemical persistence, such as hydrolysis, biodegradation, photolysis, and oxidation/reduction reactions. The following general classes of compounds are discussed:

- Ketones
- Monocyclic aromatics
- Halogenated aliphatics
- PAHs
- Phthalate esters
- Pesticides
- Metals

8.2.1 Ketones

Ketones are highly volatile and soluble, and these two processes dominate the fate of these compounds in the environment. Hydrolysis is generally not a significant fate process for this class of chemicals, nor is bioconcentration significant, based on the low K_{ow} values (Howard, 1990).

Acetone is completely miscible in water and is unlikely to adsorb to soil or sediments or bioaccumulate. It has a high vapor pressure and, once released to the air, photolysis and reaction with hydroxyl radicals result in an average half-life of 22 days (Howard, 1990).

2-Butanone will partially evaporate into the atmosphere if released to the soil and may also leach into the groundwater. Once in the groundwater, 2-butanone may slowly degrade. In surface water, 2-butanone has a half-life of approximately 3 to 12 days. Hydrolysis, photolysis, bioconcentration, and adsorption are not significant fate processes for this chemical (Howard, 1990).

8.2.2 Monocyclic Aromatics

Monocyclic aromatic compounds such as benzene, toluene, and xylenes are not considered to be persistent in the environment, particularly in comparison to chemicals such as pesticides. Monocyclic aromatics are subject to degradation via the action of both soil and aquatic microorganisms. The biodegradation of these compounds in the soil matrix is dependent on the abundance of microflora, macronutrient availability, soil reaction (pH), temperature, etc.

Although these compounds are amenable to microbial degradation, it is not anticipated that degradation will occur at an appreciable rate, although macronutrient availability is not known. In the event that these compounds discharge to surface water bodies, volatilization and biodegradation may occur relatively rapidly. For example, a reported biodegradation rate constant for benzene is 0.11 day^{-1} in aquatic systems (Lyman et al., 1990). This corresponds to an aquatic half life of approximately 6 days. Other monocyclic aromatics are subject to similar degradation processes in aquatic environments (EPA, 1982). However, chlorinated monocyclic aromatics such as chlorobenzene are not expected to be as susceptible to microbial degradation. For example, a reported first-order biodegradation rate constant for chlorobenzene is 0.0045 day^{-1} in aquatic systems (Lyman et al., 1990), which corresponds to an aquatic half-life of approximately 150 days.

Additional environmental degradation processes, such as hydrolysis and photolysis, are considered to be insignificant fate mechanisms for monocyclic aromatics in aquatic systems (EPA, 1982). However, some monocyclic aromatics, such as benzene and toluene, have been shown to undergo clay-, mineral-, and soil-catalyzed oxidation (Dragun, 1988).

8.2.3 Halogenated Aliphatics

Halogenated aliphatic hydrocarbons such as 1,1,1-trichloroethane, PCE, and TCE, are subject to abiotic dehydrohalogenation. This process is an elimination reaction that results in the formation of an ethene from a saturated halogenated compound (Olsen and Davis, 1990). Research indicates that microbial degradation of highly chlorinated ethanes is a relatively slow process. 1,1,1-Trichloroethane has been shown to break down to 1,1-dichloroethane and chloroethane (Smith and Dragun, 1984), with half-lives reported on the order of 6 to 8 months. Hydrolysis, photolysis, and oxidation are generally not considered to be significant fate processes for the chlorinated ethanes.

Although TCE is reportedly susceptible to degradation, the primary end product is reportedly vinyl chloride, which degrades slowly (Cline and Viste, 1984). It does not appear that appreciable degradation of halogenated aliphatics occurs in aerobic aquatic systems (EPA, 1982) or in unsaturated soils (Lyman et al., 1990).

For vinyl chloride, volatilization is the most significant dissipation mechanism in all environmental media. However, any vinyl chloride that is not rapidly volatilized will rapidly leach to groundwater. Data suggest that vinyl chloride is resistant to biodegradation in aerobic systems (Howard, 1989).

Releases of chloroform to land and water will rapidly evaporate to the atmosphere. In the atmosphere, chloroform may be transported long distances and react in the gas phase with photochemically produced hydroxyl radicals, with a reaction half-life of several months. Chloroform may leach to groundwater, from

where it may discharge to surface water bodies. Half-lives for this compound in various surface water bodies range from 30 hours to 10 days (Howard, 1989).

Several other aliphatic hydrocarbons will rapidly volatilize when released to soil and water. These compounds also significantly biodegrade under aerobic conditions. Releases to the atmosphere will react with hydroxyl radicals. These reactions have estimated half lives of several months (Howard, 1990).

Photolysis is not considered to be a relevant degradation mechanism for this class of compounds (EPA, 1982). Limited hydrolysis of saturated aliphatics (i.e., alkanes) may occur, but it does not appear to be a significant degradation mechanism for unsaturated species (i.e., alkenes) (EPA, 1982).

Under certain conditions, volatilization is a significant fate process for these compounds. Volatilization is only significant at the air-soil or air-water interface. Adsorption should not be considered as an important fate for these types of compounds when compared to more hydrophobic compounds (PCBs for example).

8.2.4 Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs have very low solubilities, vapor pressures, and Henry's Law constants and high K_{oc}s and K_{ow}s. The low-molecular-weight PAHs (e.g., acenaphthene, anthracene, fluorene, phenanthrene) may volatilize from surface waters, and the high-molecular-weight PAHs [e.g., benzo(a)pyrene, benzo(a)anthracene, chrysene, etc.] are less likely to volatilize. PAHs in soil are much more likely to bind to soil and be transported via mass transport mechanisms than to go into solution.

Bioconcentration of PAHs in aquatic organisms is greater for the higher-molecular-weight compounds than the lower-molecular-weight compounds. PAHs can be bioaccumulated from water, sediments, or lower organisms in the food chain.

Land spreading applications have indicated that PAHs are highly amenable to microbial degradation in soil. The rate of degradation is influenced by temperature, pH, oxygen concentrations, initial chemical concentrations, and moisture. Photolysis, hydrolysis, and oxidation are not important fate processes for the degradation of PAHs in soil (ATSDR, 1989c).

The most important fates of PAHs in water are photo-oxidation, chemical oxidation, and biodegradation. PAHs do not contain functional groups that are susceptible to hydrolytic action; therefore, hydrolysis is considered to be an insignificant degradation mechanism. The rate of photodegradation is influenced by water depth, turbidity, and temperature. Benzo(a)pyrene, chrysene, fluorene, and pyrene are reported to be resistant to photodegradation. PAHs may also be oxidized by chlorination and ozonation and may be metabolized by microbes under oxygenated conditions (ATSDR, 1989c).

8.2.5 Phthalate Esters

Phthalate esters are considered to be relatively persistent chemicals in the environment. Although numerous studies have demonstrated that phthalate esters undergo biodegradation, it appears that this is a slow process in both soils and surface waters. Certain microorganisms have been shown to excrete products that increase the solubility of phthalate esters and enhance their biodegradation (Gibbons and Alexander, 1989).

Biodegradation of bis(2-ethylhexyl)phthalate and other phthalates in water is an important fate mechanism, with a half-life of 2 to 3 weeks reported for bis(2-ethylhexyl)phthalate (Howard, 1989). Bioaccumulation is also a significant fate process. Hydrolysis of phthalate esters is very slow, with calculated half-lives of 3 years (dimethyl phthalate) to 2000 years [bis(2-ethylhexyl)phthalate] (EPA, 1979). Similarly, photolysis and volatilization are considered to be insignificant degradation mechanisms (EPA, 1979; Howard, 1989).

8.2.6 Pesticides

Whether pesticides are sprayed, dusted, or applied directly to the soil, the soil is the ultimate sink for these chemicals. Runoff may carry pesticides to adjacent surface water bodies. Bioconcentration of pesticides in the food chain is another important fate mechanism. Hydrolysis, oxidation, and photolysis are not generally important fate mechanisms for pesticides in soil or water. Hydrolysis half-lives for several pesticides are reported in periods of months to years (EPA, 1979).

4,4'-DDT and its metabolites are considered to be persistent chemicals. They undergo extensive adsorption to soil and are not highly soluble. Biodegradation may occur under both aerobic and anaerobic conditions in the presence of certain soil microorganisms. Under aerobic conditions, DDT may be transformed to DDE, whereas under anaerobic conditions, DDD may result. These compounds, however, are somewhat volatile, with a reported half-life of 100 days for DDT. These compounds are highly lipophilic and therefore readily bioaccumulate (ATSDR, 1992). DDT is no longer in production in the United States.

8.2.7 Metals

Metals are highly persistent environmental contaminants. They do not biodegrade, photolyze, hydrolyze, etc. The major fate mechanisms for metals are adsorption to the soil matrix (as compared to being part of the soil structure) and bioaccumulation.

The mobility of metals is influenced primarily by their physical and chemical properties in combination with the physical and chemical characteristics of the soil matrix. Factors that assist in predicting the mobility of inorganic species are the soil/pore water pH, soil/pore water Eh, and cation exchange capacity. The mobility of metals generally increases with decreasing soil pH and cation exchange capacity.

8.2.8 Chemical Migration

This section presents a brief overview of contaminant fate and transport issues for several major chemical classes detected at the IHDIV-NSWC.

Volatile Organics

Volatile organic chemicals (VOCs) are considered to be fairly soluble and have a low capacity for retention by soil organic carbon and therefore are the organic compounds most frequently detected in groundwater. These types of chemicals may migrate through the soil column after being released by a spill event or by subsurface waste burial as infiltrating precipitation solubilizes them. Some fraction of these chemicals is retained by the soil, but most will continue migrating downward to the water table. At that time, migration is primarily laterally with the hydraulic gradient. Again, some portion of the chemical may be retained by the saturated soil.

Several of these compounds have specific gravities less than that of water (e.g., toluene). These compounds are typically found in fuels, and if a large enough fuel spill occurs, these compounds may move through the soil column as a bulk liquid until they reach the water table. There, instead of going into solution, the majority of the release may remain as a discrete fuel layer on the water table surface, with some of the material going into solution at the water/fuel interface.

Similarly, compounds with specific gravities greater than that of water (e.g., TCE) are often used in various industrial applications such as degreasing. If a large enough spill of these solvents occurs, these chemicals may also migrate as a bulk liquid but will not stop at the water table.

Polynuclear Aromatic Hydrocarbons

PAHs are generally considered to be fairly immobile chemicals in the environment. They are large molecules with high organic carbon partition coefficients and low solubilities when compared to the volatile organics. These compounds, when found in the soil, generally do not migrate vertically to a great extent. Instead, they are more likely to adhere to soil particles and be removed from the site via surface runoff and erosional processes.

Pesticides

Pesticides were widely used at this installation. Many of the compounds detected are no longer licensed for general sale and use in the United States. Therefore, it is assumed that much of what was detected in the soil and sediments is representative of past application for insect control.

Like the PAHs, pesticides as a class of compounds are not considered to be very mobile in the environment. These chemicals, upon application or disposal, tend to remain affixed to soil particles. Migration of pesticides occurs primarily by erosion via the action of wind or water.

Inorganics

Because metals are frequently incorporated into the soil matrix and remain bound to particulate matter, they also migrate from the source areas via bulk movement processes (erosion). The larger particles (>0.45 microns, which are removed via the filtration step prior to water analysis) are not generally considered to be mobile in groundwater. The metals detected in unfiltered groundwater samples are often representative of suspended soil material in the samples.

8.2.9 Site-Specific Fate and Transport

The analytical data for Site 57 indicate that organic chemicals have migrated from the source area to downgradient soil, groundwater, surface water, and sediment. VOCs (e.g., TCE and cis-1,2-dichloroethene) were detected in surface and subsurface soil. Concentrations of VOCs were higher in subsurface soil than in surface soil. VOCs were also detected in groundwater samples, which indicates the chemicals have migrated from soil to groundwater. TCE and cis-1,2-dichloroethene were detected in surface water samples collected from the unnamed stream. As discussed in Section 6.0, shallow groundwater may be discharging to the unnamed stream; if so, groundwater may be the source of TCE and cis-1,2-dichloroethene in the no name stream. Several VOCs (e.g., 1,1,1-trichloroethene, 1,1-dichloroethene, acetone, ethyl ether, toluene, cis-1,2-dichloroethene, trans-1,2-dichloroethene, and vinyl chloride) were detected in both groundwater samples and storm sewer surface water samples. This suggests that groundwater may be infiltrating into the storm sewer, although several VOCs (2-butanone, bromodichloromethane, bromoform, dibromochloromethane, ethylbenzene, and styrene) were only detected in the storm sewer samples and not in soil or groundwater samples. This suggests that there might be another source of contamination for the storm sewer.

As noted in Section 4.3, the degradation products for TCE include cis-1,2-cidhloroethene, 1,1-dichloroethene, trans-1,2-dichloroethene, and vinyl chloride, among others. Of the total of 14 downgradient upper and lower surficial groundwater sampled collected during the RI field investigation,

TCE was detected in 11 samples. Although not the only degradation product detected, cis-1,2-dichloroethene was found in 12 of the 14 samples. Other detected degradation products included 1,1-dichloroethene (7 of the 14 samples), trans-1,2-dichloroethene (4 of 14 samples) and vinyl chloride (6 of 14 samples).

Additionally, it is noteworthy that technical-grade TCE contains 1,1,1-trichloroethane (detected in 8 of 14 samples) which includes 1,1-dichloroethane (detected in 8 of 14 samples) among its degradation products.

With the exception of S57MW004 (at the southern corner of Building 292) where the concentrations of TCE and cis-1,2-dichloroethene were 611.7 µg/L and 528 µg/L respectively, the highest concentration of cis-1,2-dichloroethene (260 µg/L) occurred at S57TW003 which is the most downgradient groundwater sampling location. That same location also exhibited the highest concentration of vinyl chloride at 85 µg/L.

The presence of TCE degradation products at a large number of groundwater samples and their occurrence at relatively significant concentrations at the most downgradient location suggests that natural attenuation of TCE in the groundwater may be taking place.

Concentrations of inorganics were typically within background levels for surface soil, subsurface soil, groundwater, and sediment. In addition, concentrations of inorganics in upgradient samples were comparable to those in downgradient samples. Consequently, inorganics do not appear to be migrating from the source areas at the site.

TABLE 8-1

FATE AND TRANSPORT PHYSICAL AND CHEMICAL CONSTANTS FOR ORGANICS
SITE 57- FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

CAS Number	Chemical	Molecular Weight (g/mol)[1]	Specific Gravity (20/4 C)[1]	Vapor Pressure (25 C) (mm Hg)[1]	Solubility (25 C) (mg/L)[1]	Log Organic Carbon Partition Coefficient (Koc)[2]	Log Octanol Water Partition Coefficient (Kow)[1]	Henry's Law Constant (25 C) (atm-m^3/mol)[1]	Bioconcentration Factor (L/kg)[2]
Ketones									
78-93-3	2-Butanone	72.11	0.8054	100	275000 (UT)	0.647	0.26	4.66E-05	9.30E-01
67-64-1	Acetone	58.08	0.7899	266	miscible	0.73	-0.24	4.276E-05	6.90E-01
Monocyclic Aromatics									
108-88-3	Toluene	92.14	0.8669	28	515 (20 C)	2.48	2.69	5.920E-03	1.48E+02
1330-20-7	Xylenes, Total	106	0.86104 - 0.8801	1E+1 (27.3 - 32.1°C	1.6E+2 - 1.75E+2(6)	5.89E+2 - 1.58E+3	3.63E+02 - 4.07E+02 (11)	4.184E-3 - 6.662E-3 (25°C)	7.5E+1 - 1.59E+2(7)
Halogenated Aliphatics									
71-55-6	1,1,1-Trichloroethane	133.4	1.339	100 (20 C)	4400 (20 C)	2.18	2.47	4.08E-03	8.10E+01
67-66-3	Chloroform	119	1.4832	160	7.92E+3 (25°C)	1.6	1.97	3.66E-03	2.60E+01
75-34-3	1,1-Dichloroethane	99	1.1757	2.34E+2 (25°C)	5.50E+03	1.67E+01	3.13E+01 (11)	5.871E-3 (25°C)	1.90E+01
107-06-2	1,2-Dichloroethane	99	1.2351	7.9E+1 (25°C)	8.52E+03	1.24E+00	1.45E+00	9.78E-04	9.00E+00
73-35-4	1,1-Dichloroethene	97	1.218	5.91E+2 (25°C)	2.25E+03	1.77E+00	1.48E+00	2.61E-02	5.30E+01
156-59-2	cis-1,2-dichloroethene	97	1.2837	2.02E+2 (25°C)	8.00E+02	NA	3.55E+01 (11)	4.08E-3 (24.8°C)	1.4E+1(3)
75-09-2	Methylene Chloride	84.93	1.3266	429	16700	0.94	1.25	3.190E-03	6.00E+00
127-18-4	Tetrachloroethene	165.83	1.6227	19	150	2.56	2.53	2.680E-02	2.52E+02
156-60-5	trans-1,2-dichloroethene	96.94	1.2565	331	600 (20 C)	1.77	1.48	6.673E-03	4.80E+01
79-01-6	Trichloroethene	131.39	1.4642	77	1100	2.1	2.53	1.170E-02	9.70E+01
75-01-4	Vinyl Chloride	63	0.9106	2.58E+03	1.1E+3 (25°C)	3.98E+00	1.86E+01 (11)	2.78E-2 (25°C)	5.70E+00
Miscellaneous Volatile Organics									
75-15-0	Carbon Disulfide	76.13	1.2632	298 (20 C)	2900 (20 C)	1.7	2.16	1.921E-02	2.60E+01
60-29-7	Ethyl Ether	74	0.7135	442 (20 C)	1.00E+04	1.38	1.64	6.800E-04	2.80E+00
Polynuclear Aromatic Hydrocarbons (PAHs)									
91-57-6	2-Methylnaphthalene	142.2	1.0058	1E+1 (105°C)	2.6E+1 (25°C)	7.24E+03	7.27E+2(10)	4.99E-4 (25°C)	5.1E+2(7)
83-32-9	Acenaphthene	154.21	1.0242 (90/4 C)	10 (131 C)	3.42	3.66	3.92	2.410E-04	1.80E+03
208-96-8	Acenaphthylene		0.8988 (16/2 C)	2.90E-02	3.93E+0 (25°C)	4.07	3.4	1.14E-4 (25°C)	1.00E+03
120-12-7	Anthracene	178.23	1.283 (25/4 C)	0.000195	1.29	4.15	4.45	8.600E-05	4.70E+03
56-55-3	Benzo(a)anthracene	228.29	1.274	5E-09 (20 C)	0.01 (24 C)	5.3	5.61	6.6E-07 (UT)	5.30E+04
50-32-8	Benzo(a)pyrene	252.32	1.351 (UT)	5E-09 (20 C)	0.0038	6.74	5.98	4.90E-07	1.40E+05
205-99-2	Benzo(b)fluoranthene	252.32	NA	5E-07 (20 C)	0.0012	5.74	6.57	1.200E-05	1.40E+05
191-24-2	Benzo(g,h,i)perylene	276.34	NA	1E-10 (20 C)	0.00026	6.2	7.23	1.40E-07	3.50E+05
207-08-9	Benzo(k)fluoranthene	252.32	NA	9.59E-11 (20 C)	0.00055	5.74	6.84	1.04E-03 (UT)	1.40E+05
218-01-9	Chrysene	228.29	1.274 (20 C)	6.30E-09	0.006	5.3	5.61	1.05E-06	5.30E+04
53-70-3	Dibenzo(a,h)anthracene	278.35	1.282 (UT)	1E-10 (20 C)	0.0005	6.52	5.97	7.30E-08	6.90E+05
206-44-0	Fluoranthene	202.26	1.252 (UT)	5.00E-06	0.265	4.58	5.33	6.50E-06	1.20E+04
86-73-7	Fluorene	166.22	1.202 (UT)	10 (146 C)	1.9	3.86	4.18	1.170E-04	3.80E+03
193-39-5	Indeno(1,2,3-cd)pyrene	276.34	NA	1.00E-10	0.062 (UT)	6.2	7.66	6.95E-08	3.50E+05
91-20-3	Naphthalene	128.17	1.162	0.082	30	2.97	3.37	4.830E-04	4.20E+02
85-01-8	Phenanthrene	178.23	0.98 (4 C)	1 (118.2 C)	0.816 (21 C)	4.15	4.46	3.93E-05	4.70E+03
129-00-0	Pyrene	202.26	1.271 (23/4 C)	2.5 (200 C)	0.16 (26 C)	4.58	5.18	5.10E-06	1.20E+04
Phthalate Esters									
117-81-7	Bis(2-ethylhexyl)phthalate	390.54	0.99 (20/20 C)	1.2 (200 C)	0.4	9.3	5.3	3E-07 (20 C)	6.29E+03
84-74-2	Di-n-butyl phthalate	278	1.047 (20/20°C)	1E-1 (115°C)	4E+2 (25°C)	1.58E+05	3.39E+04 (11)	2.8E-7 (25°C)	4.70E+04
Miscellaneous Semivolatile Organics									
120-82-1	1,2,4-Trichlorobenzene	181	1.4542	1.0E+0 (38.4°C)	1.9E+1 (22°C)	9.55E+03	9.20E+03	1.42E-3 (25°C)	3.30E+03
86-74-8	Carbazole	167.2	1.1 (18°C/4°C)	4.0E+2 (323°C)	7.48	1.95E+3(8)	3.39E+03 (11)	1.53E-08	1.86E+2(7)
Pesticides									
72-54-8	4,4'-DDD	320.05	1.476	1E-06 (30 C)	0.16 (24 C)	5.89	5.99	2.16E-05 (UT)	1.80E+05
72-55-9	4,4'-DDE	319.03	NA	6.5E-06 (20 C)	0.04 (20 C)	6.64	5.69	2.34E-05 (UT)	8.90E+05
50-29-3	4,4'-DDT	354.49	1.56 (15/4 C)	1.5E-07 (20 C)	0.0031	6.59	6.19	3.89E-05	8.00E+06
5103-74-2	Gamma-Chlordane	409.80(8)	1.59-1.63(25C)(8)	1.0E-05 (8)	5.6E-02 (UT) (8)	3.6	2.78 (8)	4.79E-05 (8)	4.00E+04

TABLE 8-1

FATE AND TRANSPORT PHYSICAL AND CHEMICAL CONSTANTS FOR ORGANICS
SITE 57- FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Notes:

1 Handbook of RCRA Ground-Water Monitoring Constituents: Chemical and Physical Properties, September 1992.
2 Aquatic Fate Process Data for Organic Priority Pollutants, December 1982.
3 McGrath, C., August 1995. Review of Formulations for Processes Affecting the Subsurface Transport of Explosives, U.S. Army Corps of Engineers, Waterways Experiment Station (WES
4 Lyman, W., Reehl, W., and Rosenblatt, D., 1990. Handbook of Chemical Property Estimation Methods.
5 Chemical, Physical, and Biological Properties of Compounds Present at Hazardous Waste Sites, Clement Associates, September 1985.
6 Howard, P., 1989. Handbook of Environmental Fate and Exposure Data for Organic Chemicals, Volume I.
7 The Condensed Chemical Dictionary, Van Nostrand Reinhold Company, New York,1971.
8 This value is for chlordane.
9 Howard, P., 1989. Handbook of Environmental Fate and Exposure Data for Organic Chemicals, Volume III.
10 The value presented is for endrin.
UT - There is no reference temperature available.
NA - Not available

TABLE 8-2

FATE AND TRANSPORT PARAMETERS FOR INORGANIC CHEMICALS
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

CAS Number	Chemical	Molecular Weight (g/mole)	Soil / Water Distribution Coefficient (Kd) (mL/g)[1]	Bioconcentration Factor (L/kg)[2]
7429-90-5	Aluminum	26.98	NR	NR
7440-36-0	Antimony	121.75	NR	1[4]
7440-38-2	Arsenic	74.92	29[3]	44
7440-39-3	Barium	137.34	41[3]	NR
7440-41-7	Beryllium	9.01	790[3]	19[4]
7440-43-9	Cadmium	112.4	75[3]	64
7440-70-2	Calcium	40.08	1.2 - 9.8	NR
16065-83-1	Chromium III	52	1600000[3]	16
18540-29-9	Chromium VI	52	19[3]	16
7440-48-4	Cobalt	58.93	0.2 - 3,800	NR
7440-50-8	Copper	63.54	1.4 - 333	36
57-12-5	Cyanide	26.02	NR	1
7439-89-6	Iron	55.847	NR	NR
7439-92-1	Lead	207.19	4.5 - 7,640	49[4]
7439-95-4	Magnesium	24.312	1.6 - 13.5	NR
7439-96-5	Manganese	54.93	0.2 - 10,000	NR
7439-97-6	Mercury	200.59	52[3]	5500[4]
7440-02-0	Nickel	58.71	65[3]	47[4]
7440-09-7	Potassium	39.1	2.0 - 9.0	NR
7782-49-2	Selenium	78.96	5[3]	4.8
7440-23-5	Sodium	22.99	NR	NR
7440-62-2	Vanadium	50.94	NR	NR
7440-66-6	Zinc	65.38	62[3]	47

Notes:

1 Dragun, 1988, The Soil Chemistry of Hazardous Materials.
2 USEPA/Army Corps of Engineers, 1991, Evaluation of Dredged Material Proposed for Ocean Disposal Testing Manual.
3 U.S. EPA, 1996, Soil Screening Guidance
4 Deminimus Waste Impacts Analysis Methodology, NUREG/CR-3585, 1984.

9.0 HUMAN HEALTH RISK ASSESSMENT

The objective of a human health risk assessment for Site 57 is to determine whether detected concentrations of chemicals pose a significant threat to potential human receptors under current and/or future land use. To determine the baseline conditions, the potential risks to human health at Site 57 at the IHDIV-NSWC are estimated based on the assumption that no actions will be taken to control chemical releases.

This section contains the methodologies used to evaluate site-specific human health risks at the IHDIV-NSWC. The following current EPA risk assessment guidance and EPA Region III supplements were the primary references used to develop the framework contained in this section:

- EPA (U.S. Environmental Protection Agency), December 1989. Risk Assessment Guidance for Superfund: Volume I, Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response, Washington, D.C. EPA 540/1-89/002.

- EPA (U.S. Environmental Protection Agency), March 25, 1991. Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. Washington, D.C. OSWER Directive 9285.6-03.

- EPA (U.S. Environmental Protection Agency), January 1992. Dermal Exposure Assessment: Principles and Applications. Interim Report. Office of Research and Development, Washington, D.C. EPA/600/8-91/011B.

- EPA (U.S. Environmental Protection Agency), May 1992. Supplemental Guidance to RAGS: Calculating the Concentration Term. OSWER Publication No. 9285.7-081.

- EPA (U.S. Environmental Protection Agency) Region III, January 1993. Selecting Exposure Routes and Contaminants by Risk-Based Screening. Hazardous Waste Management Division, Philadelphia, PA. EPA/903/R-93-001.

- EPA (U.S. Environmental Protection Agency), May 1993. Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure. Office of Solid Waste and Emergency Response, Washington, DC.

- EPA (U.S. Environmental Protection Agency) Region III, December 1995. Assessing Dermal Exposure from Soil. Hazardous Waste Management Division, Philadelphia, PA. EPA/903-K-95-003.

- EPA (U.S. Environmental Protection Agency), August 1997. Exposure Factors Handbook. National Center for Environmental Assessment, Washington, D.C. EPA/600/P-95/002Fa.

A human health risk assessment consists of five components: data evaluation; exposure assessment; toxicity assessment; risk characterization, and uncertainty analysis. Sections 9.1 through 9.5 of this section contain detailed discussions of the methodologies followed for each component of a human health risk assessment. A schematic diagram of the general risk assessment process is provided as Figure 9-1.

In order to evaluate potential risks, three major requirements must be fulfilled: (1) contaminants with toxic characteristics must be found in environmental media and must be released by either natural processes or by human action; (2) potential exposure points must exist; and (3) human receptors must be present at the point of exposure. Risk is a function of both toxicity and exposure. If any one of the requirements listed above is absent for a specific site, the exposure pathways are regarded as incomplete and no potential risks will be considered for human receptors.

The data evaluation section of the risk assessment is primarily concerned with the selection of chemicals of potential concern (COPCs) that are representative of the type and magnitude of potential human health effects. In turn, these COPCs are used to evaluate potential risks.

The toxicity assessment section presents the available human health criteria for all the selected COPCs. Quantitative toxicity indices are presented where they are available. These include dose-response parameters such as reference doses (RfDs) and cancer slope factors (CSFs), enforceable standards such as maximum contaminant levels (MCLs), and regulatory guidelines such as drinking water health advisories.

The exposure assessment section identifies potential human exposure pathways at Site 57. Exposure routes are developed from information on source area chemical concentrations, chemical release mechanisms, patterns of human activity, and other pertinent information to develop a conceptual site model. Section 9.3 presents the equations and relevant input parameters for estimating chemical intake.

The risk characterization section (Section 9.4) describes how the estimated intakes are combined with the toxicity information to estimate risks. General uncertainties associated with the risk assessment process are discussed qualitatively in Section 9.5. Uncertainties associated with a particular site are provided in the site-specific sections.

9.1 DATA EVALUATION

Data evaluation, the first component of a human health risk assessment, is a site-specific task involving the compilation and evaluation of analytical data. The main objective of data evaluation is to develop a medium-specific list of COPCs that is used to quantitatively determine potential human health risks.

The selection of COPCs is a qualitative screening process limiting the number of chemicals that are quantitatively evaluated in a human health risk assessment to those site-related constituents that dominate overall potential risks. Screening against risk-based concentrations and background is employed to focus the risk assessment on appropriate chemicals and exposure routes.

In general, a chemical is selected as a COPC and retained for further risk evaluation if the maximum detected concentration in a sampled medium exceeds a risk-based concentration, referred to as the COPC screening level, and the chemical is determined to be present at concentrations exceeding background. Frequency of detection is used to exclude chemicals when data sets of 20 samples or greater are available. Generally, a detection rate of 5 percent or less justifies elimination of the chemical from further consideration provided that the detected concentrations are not representative of a "hot spot" area. Chemicals eliminated from further evaluation at this step are assumed to present minimal risks to potential human receptors. Risk-based COPC screening levels and other health-based standards for solid media are presented in Table 9-1. Risk-based COPC screening levels and other health-based standards for aqueous media are presented in Table 9-2.

9.1.1 COPC Screening Level Development

The risk-based COPC screening levels correspond to a systemic hazard quotient (HQ) of 0.1 (for noncarcinogens) or a lifetime cancer risk of 1 $\times 10^{-6}$ (for carcinogens) and are based on the current EPA Region III Risk-Based Concentration (RBC) Table (EPA, 1999a). The RBCs presented in the Region III table were developed using protective default exposure scenarios suggested by EPA (EPA, 1991) and currently available reference doses and cancer slope factors.

Risk-based COPC screening levels for tap water ingestion, which are based on daily, residential exposure assumptions, are used to select COPCs for groundwater and surface water. In general, the use of tap water screening levels is regarded as an extremely conservative approach to COPC selection because surficial groundwater at the IHDIV-NSWC is not used as a potable drinking water source. Drinking water supplies are obtained from the relatively deep Potomac Group aquifers, with most production wells screened at between 200 and 300 feet below mean sea level (Hiortdahl, 1997).

Risk-based COPC screening levels for soil ingestion and SSLs for transfers from soil to air are used to select COPCs for soil. Conservatively, the risk-based COPC screening levels presented on Table 9-1 were developed assuming a future residential land use scenario. The EPA generic SSLs for transfers from soil to air were developed using the OSWER soil screening guidance (EPA, 1996a) and are used to evaluate chemicals that may volatilize from soil, as well as contaminated particulates that may be present in air (fugitive dust) as a result of particulate entrainment in soil. These SSLs are also used to justify the inclusion/exclusion of the inhalation exposure pathway in the quantitative risk assessment. OSWER generic SSLs for transfers from soil to groundwater are not used for COPC selection but are presented to assist in the evaluation of groundwater protection issues. Chemicals with concentrations exceeding the SSLs may potentially migrate from the soil to groundwater in sufficient quantities to pose concerns about groundwater quality. It should be noted that the underlying assumptions used to develop the SSLs were reviewed to assure that they are suitable for use as conservative screening values. Both the inhalation and migration to groundwater SSLs are calculated using default, residential land use exposure factors, infinite source models, and conservative default assumptions for source delineation. Therefore, these values are conservative and are designed to be protective of potential exposure at most sites. EPA has calculated generic SSLs for approximately 110 organic and inorganic chemicals. SSLs for carcinogenic chemicals are based on a 1×10^{-6} target incremental lifetime cancer risk. For noncarcinogenic chemicals, the SSLs are based on a target HQ of 1.

The risk-based COPC screening levels for soils (Table 9-1) are used to select COPCs for sediments. SSLs for transfers from soil to air are not considered to be appropriate for sediment screening because of high moisture content associated with sediment matrices. The use of soil ingestion screening levels for sediment COPC identification is regarded as a conservative approach since anticipated exposure to sediment is less than anticipated exposure to soil.

Lead as a COPC

Risk-based concentrations are not calculated for lead because EPA has not derived toxicity values for this chemical. However, guidance from both the Office of Prevention, Pesticides, and Toxic Substances (OPPTS) and the OSWER recommends 400 mg/kg as the lowest screening level for lead-contaminated soil in a residential setting where children are frequently present (EPA, 1994a and EPA, 1994b). OPPTS identifies 2,000 to 5,000 mg/kg as an appropriate range for areas where contact with soil by children in a residential setting is less frequent. Based on these recommendations, a value of 400 mg/kg is used as a screening level for soil and sediment. The Safe Drinking Water Act action level of 15 µg/L is used as the screening level for lead in groundwater and surface water.

Nitrocellulose

Toxicity values are not currently available for nitrocellulose. Consequently, risk-based screening levels used for the selection of chemicals of potential concern are not currently published. However, a review of the conclusions and recommendations of the U.S. EPA Health Advisory for Nitrocellulose indicates that the chemical has a very low toxicity: "Based on available toxicity data and chemical and physical properties of the compound, nitrocellulose is apparently non-toxic to dogs, rats, and mice and is not digested or absorbed in these species. These data, along with the relative insolubility of nitrocellulose in water, suggest that Health Advisory values for nitrocellulose in drinking water are unnecessary. The physical characteristics of the drinking water as they relate to turbidity, clarity, taste and similar indicators of palatability appear to be the only guidelines necessary." Toxicity information presented in Appendix K suggest that the LD_{50} (lethal dose for 50 percent of the test animals) is greater than 5 grams per kilogram. It should be noted that published risk-based concentrations for other chemicals that are considered relatively non-toxic (e.g., aluminum) typically exceed 10,000 µg/L (tap-water) and 10,000 mg/kg (residential soil). Nitrocellulose concentrations detected in the environmental media at Site 57 do not exceed these concentrations.

Essential Nutrients and Chemicals without Toxicity Criteria

EPA region III RBCs are not available for the essential nutrients calcium, magnesium, potassium, and sodium. Therefore, essential nutrient screening concentrations were developed for these chemicals. Recommended daily allowances advocated by the Food and Nutrition Board are used as the basis for the calculation of the essential nutrient screening concentrations. The development of the essential nutrient screening levels is discussed in Appendix K. In addition, because of the lack of toxicity criteria, risk-based COPC screening levels are not available for some chemicals commonly detected at sites [i.e., benzo(g,h,i)perylene, phenanthrene]. Surrogates were selected for these chemicals.

Comparison to Background

Inorganic chemicals detected at concentrations indicative of background levels are not considered to be site-related contaminants and are not retained as COPCs. Background data collected by B&R Environmental during a basewide background study (B&R Environmental, 1997c) are used to determine whether detected chemicals are present at naturally occurring levels. The maximum detected concentration of a chemical in soil, groundwater, and sediment was compared to its respective background 95 percent upper tolerance limit (UTL) value and eliminated as a COPC if the maximum detected concentration was less than its background UTL. Background UTL concentrations for soil, groundwater, and sediment are presented in Table 9-3.

9.1.2 Selection of Chemicals of Potential Concern

Chemicals of potential concern at Site 57 were selected for soil, groundwater, sediment, and surface water using the risk-based COPC screening levels described in Section 9.1.1. A discussion of the chemicals identified as COPCs and the rationale for COPC selection are provided in the following subsections. Chemicals retained as COPCs are presented in Tables 9-4 through 9-6. COPC selection tables for each medium were presented in Section 7.0. RAGS Part D tables for COPC selection are included in Appendix K.

Upgradient Surface Soil

Four SVOCs and 20 metals were detected in the one upgradient surface soil sample. A comparison of the maximum detected surface soil concentrations to EPA Region III RBCs and EPA SSLs for soil to air is presented in Table 7-9. Concentrations of all SVOCs were less than the screening levels based, on EPA Region III RBCs for residential and industrial exposures. The maximum detected concentration of arsenic exceeded the EPA Region III RBCs for residential exposures and the background UTL concentration; therefore, arsenic will be retained as a COPC in upgradient surface soil. The maximum detected concentration of iron exceeded the EPA Region III RBC for residential exposures but was less than the background UTL concentration. Consequently, iron will not be retained as a COPC in upgradient surface soil. Concentrations of the remaining metals were below the screening criteria. Concentrations of all chemicals detected in upgradient surface soil were less than the EPA SSLs for soil to air.

Maximum upgradient surface soil concentrations were also compared to EPA SSLs for migration from soil to groundwater (Table 7-9). Concentrations of all chemicals in upgradient surface soil were less than their respective SSLs for migration from soil to groundwater.

Upgradient Subsurface Soil

Two VOCs, two SVOCs, and 19 metals were detected in the two upgradient subsurface soil samples. A comparison of the maximum detected subsurface soil concentrations to EPA Region III RBCs and EPA SSLs for soil to air are presented in Table 7-11. Concentrations of all SVOCs, VOCs, and metals were less than the screening levels based on EPA Region III RBCs for residential and industrial exposures, with the exception of arsenic and iron. Maximum detected concentrations of arsenic and iron in upgradient subsurface soil exceeded their respective EPA Region III RBCs for residential exposures but were less then their background UTL concentrations. Consequently, arsenic and iron will not be retained as COPCs in upgradient subsurface soil. Concentrations of the remaining metals were below the screening criteria. Concentrations of all chemicals detected in upgradient subsurface soil were less than the EPA SSLs for soil to air.

Maximum upgradient subsurface soil concentrations were also compared to EPA SSLs for migration from soil to groundwater (Table 7-11). Concentrations of all chemicals in upgradient surface soil were less than their respective SSLs for migration from soil to groundwater.

Upgradient Groundwater

Six VOCs and 11 metals were detected in the one upgradient upper surficial groundwater sample. A comparison of the maximum detected shallow groundwater concentrations to screening levels, based on EPA Region III RBCs for tap water ingestion, is presented in Table 7-13. Maximum detected concentrations of 1,1-dichloroethene, 1,2-dichloroethane, chloroform, and TCE exceeded the RBCs for ingestion of tap water and background UTL concentrations; therefore, these chemicals will be retained as COPCs in upgradient upper surficial groundwater. Maximum detected concentrations of manganese in upgradient upper surficial unfiltered and filtered samples exceeded the screening level based on the EPA Region III RBC for tap water ingestion but were below the background UTL concentration. Consequently, manganese will not be retained as a COPC in upgradient upper surficial groundwater. Concentrations of the remaining metals were below the screening criteria.

Six VOCs, one SVOC, and 11 metals were detected in the one upgradient lower surficial groundwater sample. A comparison of the maximum detected lower surficial groundwater concentrations to screening levels, based on EPA Region III RBCs for tap water ingestion, is presented in Table 7-14. Maximum detected concentrations of 1,1-dichloroethene and trichloroethene exceed the RBCs for ingestion of tap water and background UTL concentrations; therefore, these chemicals will be retained as COPCs in upgradient lower surficial groundwater. Maximum detected concentrations of iron and manganese in upgradient lower surficial unfiltered and filtered samples exceeded the screening levels based on the EPA Region III RBCs for tap water ingestion but were below the background UTL concentrations. Consequently, iron and manganese will not be retained as COPCs in upgradient lower surficial groundwater. Concentrations of the remaining metals were below the screening criteria.

Upgradient Surface Water

The Upgradient surface water sample was analyzed only for VOCs. No VOCs were detected in this sample.

Upgradient Sediment

The upgradient sediment sample was analyzed only for VOCs. No VOCs were detected in this sample.

Downgradient Surface Soil

Three VOCs, 18 SVOCs, three pesticides, and 20 metals were detected in downgradient surface soil samples. A comparison of the maximum detected downgradient surface soil concentrations to EPA Region III RBCs and EPA SSLs for soil to air is presented in Table 7-10. Concentrations of all VOCs were less than the screening levels based on EPA Region III RBCs for residential and industrial exposures. and the background UTL concentrations. The maximum detected concentrations of benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, and arsenic exceeded the EPA Region III RBCs for residential exposures and the background UTL concentrations. The maximum detected concentration of benzo(a)pyrene also exceed the screening level, based on EPA Region III RBCs for industrial exposures. The maximum detected concentration of lead exceed the OSWER screening level for residential exposures by children. Therefore, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, arsenic, and lead will be retained as a COPCs in downgradient surface soil. The maximum detected concentrations of aluminum and iron exceeded the EPA Region III RBCs for residential exposures but were less than the background UTL concentration. Concentrations of the remaining metals were below the screening criteria. Concentrations of all chemicals detected in downgradient surface soil were less than the EPA SSLs for soil to air.

Maximum downgradient surface soil concentrations were also compared to EPA SSLs for migration from soil to groundwater (Table 7-10). Concentrations of all chemicals in downgradient surface soil were less than their respective SSLs for migration from soil to groundwater.

Downgradient Subsurface Soil

Ten VOCs, 12 SVOCs, two pesticides, and 19 metals were detected in downgradient subsurface soil samples. A comparison of the maximum detected downgradient subsurface soil concentrations to EPA Region III RBCs and EPA SSLs for soil to air is presented in Table 7-12. The maximum detected concentrations of TCE, benzo(a)pyrene, and arsenic exceeded the EPA Region III RBCs for residential exposures and the background UTL concentrations. The maximum detected concentration of arsenic also exceeded the screening level, based on EPA Region III RBCs for industrial exposures. Therefore, TCE, benzo(a)pyrene, and arsenic will be retained as COPCs in downgradient subsurface soil. The maximum detected concentrations of aluminum, iron, manganese, and vanadium exceeded the EPA Region III RBCs for residential exposures but were less than their background UTL concentrations. Concentrations of the remaining metals were below the screening criteria. Concentrations of all chemicals detected in downgradient surface soil were less than the EPA SSLs for soil to air, with the exception of TCE. Consequently, TCE will be retained as a COPC for the inhalation pathway for downgradient subsurface soil.

Maximum downgradient surface soil concentrations were also compared to EPA SSLs for migration from soil to groundwater (Table 7-12). Maximum detected concentrations of methylene chloride, TCE, xylenes, and arsenic exceeded their respective SSLs for migration from soil to groundwater.

Downgradient Groundwater

Twelve VOCs, three SVOCs, and 12 metals were detected in the downgradient upper surficial groundwater samples. A comparison of the maximum detected downgradient upper surficial groundwater concentrations to screening levels, based on EPA Region III RBCs for tap water ingestion, is presented in Table 7-15. Maximum detected concentrations of 1,1-dichloroethene, chloroform, ethyl ether, PCE, TCE, vinyl chloride, and cis-1,2-dichloroethene exceeded the RBCs for ingestion of tap water and background UTL concentrations; therefore, these chemicals will be retained as COPCs in downgradient upper surficial groundwater. Maximum detected concentrations of iron and manganese in downgradient upper surficial unfiltered and filtered samples exceeded the screening levels, based on the EPA Region III RBC for tap water ingestion, but were below their background UTL concentrations. Consequently, iron and manganese will not be retained as COPCs in downgradient upper surficial groundwater. Concentrations of the remaining metals were below the screening criteria.

Nine VOCs, one SVOC, and 11 metals were detected in the downgradient lower surficial groundwater samples. A comparison of the maximum detected lower surficial groundwater concentrations to screening levels, based on EPA Region III RBCs for tap water ingestion, is presented in Table 7-16. Maximum detected concentrations of 1,1-dichloroethene, chloroform, ethyl ether, TCE, vinyl chloride, and cis-1,2-dichloroethene exceeded the RBCs for ingestion of tap water and background UTL concentrations; therefore, these chemicals will be retained as COPCs in downgradient lower surficial groundwater. Maximum detected concentrations of manganese in downgradient lower surficial unfiltered and filtered samples exceeded the screening level, based on the EPA Region III RBCs for tap water ingestions, but were below the background UTL concentration. Consequently, manganese will not be retained as a COPC in downgradient lower surficial groundwater. Concentrations of the remaining metals were below the screening criteria.

Downgradient Surface Water

Four VOCs and 17 metals were detected in the downgradient surface water samples. A comparison of the maximum detected downgradient surface water concentrations to screening levels, based on Federal Ambient Water Quality Criteria (AWQC) and EPA Region III RBCs for tap water ingestion, are presented in Table 7-18. Maximum detected concentrations of iron and manganese exceeded the screening levels;

therefore, these chemicals will be retained as COPCs in downgradient surface water. Concentrations of the remaining metals were below the screening criteria.

Downgradient Sediment

Two VOCs, 14 SVOCs, three pesticides, and 20 metals were detected in the downgradient sediment samples. A comparison of the maximum detected downgradient sediment concentrations to screening levels, based on EPA Region III RBCs for residential and industrial exposures, is presented in Table 7-20. Maximum detected concentrations of benzo(a)pyrene and arsenic exceeded the EPA Region III RBCs for residential exposures and the background UTL concentrations; therefore, these chemicals will be retained as COPCs. The maximum detected concentration of iron exceeded the EPA Region III RBCs for residential exposures but was less than the background UTL concentration. Consequently, iron will not be retained as a COPC in downgradient sediment samples. Concentrations of the remaining metals were below the screening criteria.

Surface Water in Sewer

Sixteen VOCs and 16 metals were detected in the surface water samples collected from the sewer. A comparison of the maximum detected surface water concentrations to screening levels based on federal AWQC and EPA Region III RBCs for tap water ingestion, is presented in Table 7-21. Maximum detected concentrations of 1,1-dichloroethene, acetone, ethyl ether, TCE, cis-1,2-dichloroethene, iron, and manganese exceeded the screening levels; therefore, these chemicals will be retained as COPCs in sewer surface water.

Sediment in Sewer

Eight VOCs, 20 SVOCs, one pesticide, and 22 metals were detected in sediment samples collected from the sewer. A comparison of the maximum detected sediment concentrations to screening levels, based on EPA Region III RBCs for residential and industrial exposures, is presented in Table 7-22. Maximum detected concentrations of vinyl chloride, benzo(a)pyrene, arsenic, and vanadium exceeded the EPA Region III RBCs for residential exposures and the background UTL concentrations. The maximum detected concentration of arsenic also exceeded the screening level, based on EPA Region III RBCs for industrial exposures. Therefore, vinyl chloride, benzo(a)pyrene, arsenic, and vanadium will be retained as COPCs. The maximum detected concentration of iron exceeded the EPA Region III RBCs for residential exposures but was less than the background UTL concentration. Consequently, iron will not be retained as a COPC in sewer sediment. Concentrations of the remaining metals were below the screening criteria.

9.2 TOXICITY ASSESSMENT

The toxicity assessment for the COPCs examines information concerning the potential human health effects of exposure to COPCs. The goal of the toxicity assessment is to provide, for each COPC, a quantitative estimate of the relationship between the magnitude and type of exposure and the severity or probability of human health effects. The toxicity values presented in this section are integrated with the exposure assessment (Section 9.3) to characterize the potential for the occurrence of adverse health effects.

The toxicological evaluation involves a critical review and interpretation of toxicity data from epidemiological, clinical, animal, and in vitro studies. This review of the data ideally determines both the nature of the health effects associated with a particular chemical and the probability that a given quantity of a chemical could result in the referenced effect. This analysis defines the relationship between the dose received and the incidence of an adverse effect for the chemicals of potential concern.

The entire toxicological database is used to guide the derivation of CSFs for carcinogenic effects and RfDs for noncarcinogenic effects. These data may include epidemiological studies, long-term animal bioassays, short-term tests, and evaluations of molecular structure. Data from these sources are reviewed to determine if a chemical is likely to be toxic to humans. Because of the lack of available human studies, however, the majority of toxicity data used to derive CSFs and RfDs come from animal studies.

For noncarcinogenic effects, the most appropriate animal model (i.e., the species most biologically similar to the human) is identified. Pharmacokinetic data often enter into this determination. In the absence of sufficient data to identify the most appropriate animal model, the most sensitive species is chosen. The RfD is generally derived from the most comprehensive toxicology study that characterizes the dose-response relationship for the critical effect of the chemical. Preference is given to studies using the exposure route of concern; in the absence of such data, however, an RfD for one route of exposure may be extrapolated from data from a study that evaluated a different route of exposure. Such extrapolation must take into account pharmacokinetic and toxicological differences between the routes of exposure. Uncertainty factors are applied to the highest no-observed-adverse-effect-level (NOAEL) to adjust for inter- and intraspecies variation, deficiencies in the toxicological database, and use of subchronic rather than chronic animal studies. Additional uncertainty factors may be applied to estimate a NOAEL from a lowest-observed-adverse-effect-level (LOAEL) if the key study failed to determine a NOAEL. When chemical-specific data are not sufficient, an RfD may be derived from data for a chemical with structural and toxicologic similarity.

CSFs for weight-of-evidence Group A or B chemicals are generally derived from positive cancer studies that adequately identify the target organ in the test animal data and characterize the dose-response relationship. CSFs are derived for Group C compounds for which the data are sufficient but are not derived for Group D or E chemicals. (An explanation/definition of these weight-of-evidence classes is provided in subsection 9.2.1.) No consideration is given to similarity in the animal and human target organ(s), because a chemical capable of inducing cancer in any animal tissue is considered potentially carcinogenic to humans. Preference is given to studies using the route of exposure of concern, in which normal physiologic function was not impaired and in which exposure occurred during most of the animal's lifetime. Exposure and pharmacokinetic considerations are used to estimate equivalent human doses for computation of the CSF. When a number of studies of similar quality are available, the data may be combined in the derivation of the CSF.

Toxicological profiles for each of the COPCs are presented in Appendix K. These profiles present a summary of the available literature on carcinogenic and noncarcinogenic effects associated with human exposure to the chemical.

9.2.1 Carcinogenic Effects

The toxicity information considered in the assessment of potential carcinogenic risks includes a weight-of-evidence classification and a slope factor. The weight-of-evidence classification qualitatively describes the likelihood that a chemical is a human carcinogen and is based on an evaluation of the available data from human and animal studies. A chemical may be placed in one of three groups in EPA's classification system to denote its potential for carcinogenic effects:

- Group A - known human carcinogen
- Group B1 or B2 - probable human carcinogen
- Group C - possible human carcinogen

Chemicals that cannot be classified as a human carcinogen because of a lack of data are placed in Group D, and those for which there is evidence of noncarcinogenicity in humans are in Group E.

The CSF is the toxicity value used to quantitatively express the carcinogenic hazard of cancer-causing chemicals. It is defined as the upperbound estimate of the probability of cancer incidence per unit dose averaged over a lifetime. Slope factors are derived from studies of carcinogenicity in humans and/or laboratory animals and are typically calculated for compounds in Groups A, B1, and B2, although some Group C carcinogens also have slope factors and some B2 carcinogens have none (e.g., lead). Slope factors are specific to a chemical and route of exposure and are expressed in units of $(mg/kg/day)^{-1}$ for both oral and inhalation routes. Inhalation cancer toxicity values are usually expressed as inhalation unit

risks in units of reciprocal $\mu g/m^3$ [$1/(\mu g/m^3)$]. Because cancer risk characterization requires an estimate of reciprocal dose in units of 1/(mg/kg/day), the inhalation unit risk must be converted to the mathematical equivalent of an inhalation cancer slope factor, or risk per unit dose (mg/kg/day). This is done by assuming that humans weigh 70 kilograms and inhale 20 m^3 of air per day [i.e., the inhalation unit risk ($1/\mu g/m^3$) is divided by 20 m^3, multiplied by 70 kg, and multiplied by 1,000 µg/mg to yield the mathematical equivalent of an inhalation slope factor (1/mg/kg/day)]. CSFs for COPCs are presented in Tables 9-7 and 9-8. The primary sources of information for these values are EPA (EPA, 1997a and 1999b) and EPA Region III (EPA, 1999a).

EPA's database (IRIS - the Integrated Risk Information System; EPA, 1999b) was consulted as the primary source for CSF values, as well as for RfDs. EPA intends that IRIS supersede all other sources of toxicity information for risk assessment. If values are not available in IRIS, the annual Health Effects Assessment Summary Tables (HEAST, 1997a) were consulted, as well as the current EPA Region III Risk-Based Concentration table (EPA, 1999a). If no CSF is available from any of these sources, carcinogenic risks are not quantified and potential exposures are addressed in the uncertainty section.

CSFs exist for several (but not all) Class C compounds, which are identified as "possible" human carcinogens. These compounds typically exhibit inadequate evidence of carcinogenicity in humans and limited evidence in animals. In this human health risk assessment, Class C compounds are evaluated quantitatively as class A/B1/B2 compounds, but the risks associated with exposure to Class C compounds are also discussed separately if these chemicals are major risk drivers, underscoring the uncertainty associated with these estimations.

Dermal CSFs are derived from the corresponding oral values. In the derivation of a dermal CSF, the oral CSF is divided by the gastrointestinal absorption efficiency to determine a CSF based on an absorbed dose rather than an administered dose. The oral CSF is divided by the absorption efficiency because CSFs are expressed as reciprocal doses. Dermal CSFs and the absorption efficiencies used in their determination are also included in Table 9-7. When no absorption rate is available in the literature, no adjustment is made.

Risk estimates for PAHs have, in the past, assumed that all carcinogenic PAHs have a potency equal to that for benzo(a)pyrene. While benzo(a)pyrene was well studied, other Class B2 PAHs had insufficient data with which to calculate a CSF. EPA has published provisional guidance to assess PAHs (EPA, 1993a). Estimated orders of potential potency (rather than a toxicity equivalence factor or TEF) were developed based on skin painting tests and are rounded to one significant figure (based on an order of magnitude). The values are based on a comparable endpoint (complete carcinogenesis after repeated

exposure to mouse skin). The quality of the data does not support any greater precision. The orders of potential potency used in this health risk assessment are presented in Table 9-9.

9.2.2 Noncarcinogenic Effects

For noncarcinogens, it is assumed that there exists a dose below which no adverse health effects will be seen. Below this "threshold" dose, exposure to a chemical can be tolerated without adverse effects. For noncarcinogens, a range of exposure exists that can be tolerated. Toxic effects are manifested only when physiologic protective mechanisms are overcome by exposures to a chemical above its threshold level. Maternal and developmental endpoints are considered systemic toxicity.

The potential for noncarcinogenic health effects resulting from exposure to chemicals is assessed by comparing an exposure estimate (intake or dose) to a RfD. The RfD is expressed in units of mg/kg/day and represents a daily intake of contaminant per kilogram of body weight that is not sufficient to cause the threshold effect of concern. An RfD is specific to the chemical, the route of exposure, and the duration over which the exposure occurs. Separate RfDs are presented for ingestion and inhalation pathways. In particular, reference concentrations (RfCs) in units of mg/m^3 are typically presented for the inhalation pathway. Because characterization of noncarcinogenic effects requires an estimate of dose in units of mg/kg/day, the inhalation RfC must be converted to an inhalation RfD. The conversion is performed by assuming that humans weigh 70 kg and inhale 20 m^3 of air per day [i.e., the inhalation RfC (mg/m^3) is multiplied by 20 m^3/day and divided by 70 kg to yield an inhalation RfD (mg/kg/day)].

To derive an RfD, EPA reviews all relevant human and animal studies for each compound and selects the study (studies) pertinent to the derivation of the specific RfD. Each study is evaluated to determine the NOAEL or, if the data are inadequate for such a determination, the LOAEL. The NOAEL corresponds to the dose (in mg/kg/day) that can be administered over a lifetime without inducing observable adverse effects. The LOAEL corresponds to the lowest daily dose that induces an observable adverse effect. The toxic effect characterized by the LOAEL is referred to as the "critical effect." To derive an RfD, the NOAEL (or LOAEL) is divided by uncertainty factors to ensure that the RfD will be protective of human health. Uncertainty factors are applied to account for extrapolation of data from laboratory animals to humans (interspecies extrapolation), variation in human sensitivity to the toxic effects of a compound (intraspecies differences), derivation of a chronic RfD based on a subchronic rather than a chronic study, or derivation of an RfD from the LOAEL rather than the NOAEL. In addition to these uncertainty factors, modifying factors between 1 and 10 may be applied to reflect additional qualitative considerations in evaluating the data. For most compounds, the modifying factor is one.

A dermal RfD is developed by multiplying an oral RfD (based on an administered dose) by the gastrointestinal tract absorption factor. The resulting dermal RfD, based on an absorbed dose, is used to evaluate the dermal (absorbed) dose calculated by the dermal exposure algorithms.

Reference doses for the COPCs are presented in Table 9-10 and 9-11. The primary source of these values is the IRIS database, followed by other EPA sources described for the carcinogens. This table also includes the primary target organs affected by a particular chemical. This information may be used in the risk characterization section to segregate risks by target organ effects, unless the total Hazard Index is below unity.

9.3 EXPOSURE ASSESSMENT METHODOLOGY

The exposure assessment defines and evaluates, quantitatively or qualitatively, the type and magnitude of human exposure to the chemicals present at or migrating from a site. The exposure assessment is designed to depict the physical setting of the site, identify potentially exposed populations, and estimate chemical intakes under the identified exposure scenarios.

Actual or potential exposures at the IHDIV-NSWC are based on the most likely pathways of contaminant release and transport, as well as human activity patterns. The course that a chemical takes from the source to the potentially exposed individual is defined as the exposure pathway. A complete exposure pathway has three components: a source of chemicals that can be released to the environment; a route of contaminant transport through an environmental medium; and an exposure or contact point for a human receptor. This compilation of contaminant sources, likely exposure pathways, and receptors is often depicted in a conceptual site model.

9.3.1 Conceptual Site Model

The development of a conceptual site model (CSM) is an essential component of the exposure assessment. The CSM graphically integrates information regarding the physical characteristics of the site (i.e., the exposure setting), exposed populations, sources of contamination, and contaminant mobility (fate and transport) to identify potential exposure routes and receptors evaluated in the risk assessment. A well-defined CSM allows for a better understanding of the risks at a site and aids the risk managers in the identification of the potential need for remediation. The CSM for Site 57 is shown in Figure 9-2.

Exposure Setting

The exposure setting consists of a description of the physical characteristics (climate, meteorology, geology, groundwater hydrology, vegetation, and nearby surface water bodies) of a site. A synopsis of the information pertinent to the assessment of potential exposure is presented below.

The climate of Indian Head, Maryland is best described as continental with well-defined seasons and moderating effects from the Chesapeake Bay and Potomac River. Summers are warm, and winters are wet and cold. Seasonal average temperatures range from 21° F to 89° F. Annual precipitation averages 47 inches (19 inches as frozen precipitation), which is fairly evenly distributed over the year.

Shallow groundwater is reported to be hydrologically connected to the adjacent surface water systems, and flow appears to be mostly lateral. The area is part of the Potomac River estuary, which is affected by tidal, diurnal, and seasonal changes. These influence the quality and elevation of groundwater. Groundwater in the middle and lower parts of the Patapsco aquifer is relatively confined by overlying deposits but is probably hydraulically connected to the Potomac River. The Arundel Formation effectively isolates the lower (Patuxent) aquifers. Groundwater from the shallow aquifer is not used as a potable water supply and is not anticipated to be used in the future. Drinking water is obtained from the deep aquifer (190 to 240 feet below ground surface).

The Potomac River, Chicamuxen Creek, and Mattawoman Creek, which bound the IHDIV-NSWC, are Maryland Class I and/or II waterways. Therefore, they are protected resources for aquatic life, recreational activities, fishing, and/or shellfish harvesting.

Sources of Contamination

The suspected or known source(s) of contamination at Site 57 are surface and subsurface soil that may have been impacted as a result of direct contact with solvents, primarily TCE, as a result of spills during past drum loading operations.

Contaminant Release and Migration Mechanisms

Chemicals may be released from environmental media in a study area by a variety of mechanisms, including stormwater runoff and subsequent erosion of surface soil, infiltration of soluble chemicals and subsequent migration through the subsurface soil to the water table where the chemicals may migrate downgradient, and wind erosion of surface soil from unpaved areas.

Storms generate runoff, which is directed toward stormwater drainageways. Initially, this water may move across an area as sheet flow, which can entrain loose soil material. This soil is moved as a sediment and will be deposited where the flow velocity diminishes below that needed to carry a particular grain size. Typically, this soil/sediment is deposited in the drainageway and migrates farther downstream with each new storm, which also adds new material. Within the study area, contaminants entrained in/dissolved in surface water may migrate to Mattawoman Creek.

Soluble chemicals released to the ground surface may also migrate downward through the soil column with infiltrating precipitation. The migration of these chemicals may be somewhat impeded by the chemical's tendency to bind to soil organic material. Eventually, these soluble chemicals may reach the water table. Once in the groundwater, chemicals may continue to migrate via dispersion and advection in the downgradient direction. Eventually, these chemicals may discharge with the groundwater to surface bodies (e.g., Mattawoman Creek).

Chemicals adsorbed to surface soil may also be released from a site via wind erosion of loose soil material. These particulates are carried downwind and potentially off site if the grain size is small enough and the wind velocity is great enough. Additionally, chemicals may also be released from soil via volatilization.

Potential Routes of Exposure

A receptor can come into contact with contaminants in a variety of ways, which are generally the result of interactions between a receptor's behavior or lifestyle and an exposure medium. This assessment defines an exposure route as a stylized description of the behavior that brings a receptor into contact with a contaminated medium.

Air

This pathway is based on the scenario that a receptor is immersed in air that contains suspended particulates and volatile organic vapors originating from the source areas as part of daily living. Subsequent exposure of the receptor occurs upon inhalation of the ambient air.

Initially, a qualitative comparison of maximum detected soil concentrations and EPA generic SSLs for inhalation, based on intermedia transfer (from soil to air), was performed to determine if additional quantitative analysis of this potential exposure pathway was warranted. The inhalation SSLs are based on residential land use and lifetime exposure scenarios and are therefore relatively conservative values for potential receptors under current land use conditions. Exposures to fugitive dust and volatile organic

compounds released from soil were found to be insignificant based on the qualitative screening, with the exception of TCE in subsurface soil.

Direct Contact with Soil/Sediment

Receptors may come into direct contact with soil/sediments affected by the release of chemicals from the source areas. During the receptor's period of contact, the individual may be exposed via inadvertent ingestion of a small amount of soil or via dermal absorption of certain contaminants from the soil. Various factors affect the rate of dermal absorption, including the amount of soil on the skin surface, soil characteristics (moisture, pH, organic carbon content, etc.), skin characteristics (thickness, temperature, hydration, etc.), volatilization losses, and chemical-specific properties.

Direct Contact with Groundwater

Conservatively and for purposes of completeness, domestic use of the groundwater resource will be evaluated in this baseline risk assessment. The shallow groundwater resource at the IHDIV-NSWC is not currently used as a potable water supply and is not anticipated to be used in the future. Additionally, it is possible that an excavation during construction activities could be deep enough to come into contact with groundwater. In such an instance, workers could be exposed to the shallow groundwater (e.g., via dermal contact). The shallow groundwater (upper and lower surficial) will be evaluated as one unit in the risk assessment.

Direct Contact with Surface Water

Receptors may also come into direct contact with surface water containing chemicals in a suspended or dissolved phase. In most cases, this exposure would be of short duration, and individuals may be exposed via dermal contact and/or incidental ingestion.

Potential Receptors

Several potential receptors have been identified under both current and future land use conditions. These receptors were identified by analyzing the interaction of current and anticipated future land use practices and the identified sources of contamination. These receptors are as follows:

- **Full-time employees** may be exposed to site media while performing maintenance activities (e.g., mowing, landscaping), site inspections, or daily duties. Typically, these receptors are evaluated for exposure to surface soil only. Exposures to subsurface soil are not evaluated for these receptors since full-time employees and are not typically exposed to subsurface soil. Exposures to subsurface soil are addressed by the construction worker scenario. Exposure to groundwater is not evaluated for

these receptors because groundwater at the IHDIV-NSWC is not used as a potable water supply under current conditions and is not anticipated to be used as a potable water supply in the future. Exposure to surface water and sediment is expected to be minimal for these receptors.

- **Construction workers** are evaluated for exposure to surface soil, subsurface soil, surface water, and sediments. In addition, it will also be assumed that constructions workers could come into contact with surface water and sediment inside the storm sewer. Dermal exposure to shallow groundwater or inhalation of organics volatilizing from groundwater is also possible for this receptor if excavation occurs below the water table.

- **Hypothetical on-site residents** are evaluated as potential receptors. Hypothetical future on-site residents are assumed to be exposed to surface and subsurface soil and groundwater on a daily basis and to surface waters and sediments, less frequently. This document considers three hypothetical on-site residential scenarios: a resident child, a resident adult, and life-long resident (an individual resident from childhood through adulthood). A future residential scenario is not considered to be likely at Site 57 located at the IHDIV-NSWC. Off-site residents, commonly considered because of their potential exposure to site media indirectly through the generation of fugitive dust and/or volatile emissions and migration of groundwater, are not evaluated for the IHDIV-NSWC. Site 57 is isolated from true residential areas by the creeks, rivers, or IHDIV-NSWC access restrictions, and exposure to off-site residents is highly unlikely.

Potential exposures to adolescent trespassers are not evaluated since Site 57 is located in a secure area of IHDIV-NSWC.

A summary of the anticipated receptors and exposure routes is provided in Table 9-12. Two variations of each receptor are considered in this baseline risk assessment: the RME receptor and the CTE receptor.

Traditionally, exposures evaluated in the human health risk assessment were based on the concept of a reasonable maximum exposure (RME) only, which is defined as "the highest exposure that is reasonably expected to occur at a site" (EPA, 1989). However, more recent risk assessment guidance (EPA, 1992b) indicates the need to address an average case or CTE. In order to provide a full characterization of potential exposure, both RME and CTE are evaluated in the risk assessment for the IHDIV-NSWC. It should be noted that the available guidance (EPA, 1993c) concerning the evaluation of CTE is limited and at times vague. Therefore, professional judgment is exercised when defining CTE conditions for a particular receptor at a site.

9.3.2 Exposure Concentrations

The exposure point concentration, which is calculated for COPCs only, is a reasonable maximum estimate of the chemical concentration that is likely to be contacted over time and is used to calculate estimated exposure intakes.

The 95 percent upper confidence limit (UCL) on the mean, which is based on the distribution of a data set, is considered to be the best estimate of the exposure concentration for data sets with 10 or more samples (EPA, 1992c). The 95 percent UCL is used as the exposure point concentration to assess RME and CTE risks (EPA, 1993c). If the calculated 95 percent UCL exceeds the maximum detected concentration, the maximum is used as the exposure point concentration in place of the UCL. If the data set has an undefined distribution, it is assumed to be log-normally distributed and the 95 percent UCL is used as the exposure point concentration providing that the value does not exceed the maximum concentration. The maximum detected concentration is used as the exposure concentration when the 95 percent UCL exceeds the maximum.

For data sets with less than 10 samples, the UCL is considered to be a poor estimate of the mean, and the exposure concentration is defined as the maximum detection or arithmetic mean (if less than maximum) for RME and CTE scenarios, respectively (EPA, 1993c).

Conventional statistical methods are used to determine the distribution and UCL of a particular data set (Gilbert, 1987 and EPA, 1992c). Sample and duplicate analytical results are averaged for statistical use. Nondetected data points are utilized; in general, one-half the sample-specific quantitation limit is used for these analytical results. Detailed sample calculations, as well as general methodology for the statistical evaluation, are presented in Appendix K. The following paragraphs detail the calculation of the 95 percent UCL.

For normally distributed data, the calculation of the exposure point concentration (i.e., UCL) is a two-step process. First the standard deviation of the sample set must be determined, as follows:

$$S = \left[\frac{\Sigma(X_i - \overline{X})^2}{(n-1)}\right]^{1/2}$$

where: S = standard deviation

X_i = individual sample value

n = number of samples

$\overline{X}$ = mean sample value

The one-sided UCL on the mean is then calculated as follows:

$$UCL = \overline{X} + t\left(\frac{S}{n^{1/2}}\right)$$

where:	UCL	=	95 percent Upper confidence limit of the mean
	$\bar{X}$	=	Arithmetic average
	t	=	One-sided t distribution factor ($t_{0.95}$)
	S	=	standard deviation
	n	=	number of samples

For log-normally distributed data sets, the exposure point concentration is calculated using the following equation:

$$UCL = \exp\left(\overline{X} + 0.5S^2 + \frac{Hs}{(n-1)^{1/2}}\right)$$

where:	UCL	=	95 percent UCL of the mean
	exp	=	Constant (base of the natural log, e)
	$\overline{X}$	=	Mean of the transformed data
	S	=	Standard deviation of the transformed data
	H	=	H-statistic (from Gilbert, 1987; $H_{0.95}$)
	n	=	Number of samples

This equation uses individual sample results that have been transformed using the natural logarithm function.

Exposure point concentrations for the evaluated receptors are present in Table 9-13. Supporting statistics for the exposure point concentrations are included in Appendix J. RAGS Part D tables for the exposure point concentrations are provided in Appendix K.

9.3.3 Quantification of Exposure

Estimates of exposure are based on the contaminant concentrations at the exposure points and on scenario-specific assumptions and intake parameters. The models and equations used to quantify intakes are described in this section and have been obtained from a variety of EPA guidance documents, which are cited in the specific intake estimation sections that follow.

Exposures are dependent on the predicted concentrations of chemicals in environmental media and local land use practices, and both are subject to change over time. This results in a large number of possible combinations of receptors, media, exposure pathways, and concentrations. As mentioned previously, Table 9-12 presents a summary of the receptors and exposure pathways to be evaluated in the quantitative risk assessment. Some of these scenarios (such as occupational, trespassing, and recreational scenarios) may be applicable under both current and future land use conditions.

Exposure model parameters are presented in Tables 9-14 through 9-26 for the exposure assessment of the various receptors evaluated in the quantitative risk assessment. The values reflect current EPA guidance and recent comments received from EPA Region III on similar Navy projects. All parameters are referenced in footnotes on each table. These parameters are used in the equations presented in this section, along with the exposure point concentrations presented in the site-specific sections, to calculate intakes, which will be used to determine risks. Individual chemical intakes for each receptor/exposure route combination are presented in the spreadsheets in Appendix K.

Noncarcinogenic intakes are estimated using the concept of an average annual exposure. Carcinogenic intakes are calculated as an incremental lifetime exposure, which assumes a life expectancy of 70 years.

Incidental Ingestion of Soil/Sediment

Direct physical contact with soil (and sediment) may result in the incidental ingestion of chemicals. Exposure associated with the oral route is estimated in the following manner (EPA, 1989):

$$\text{Intake}_{si} = \frac{(C_{si})(IR_s)(FI)(EF)(ED)(CF)}{(BW)(AT)}$$

where:

Intake_{si}	=	intake of chemical "i" from soil or sediment (mg/kg/day)
C_{si}	=	concentration of chemical "i" in soil or sediment (mg/kg)
IR_s	=	ingestion rate (mg/day)
FI	=	fraction ingested from contaminated source (dimensionless)
EF	=	exposure frequency (days/yr)
ED	=	exposure duration (yr)
CF	=	conversion factor (1×10^{-6} kg/mg)
BW	=	body weight (kg)
AT	=	averaging time (days);
		for noncarcinogens, AT = ED x 365 days/yr;
		for carcinogens, AT = 70 yr x 365 days/yr

Soil/sediment ingestion rates ranging from 50 mg/day to 480 mg/day will be used to evaluate the RME receptor; ingestion rates ranging from 25 mg/day to 240 mg/day will be used to evaluate the CTE receptor. The exposure frequency and exposure durations assumed for the receptors vary. EPA standard default values were used for the exposure frequency for full-time employees and residents exposed to soil. It is assumed that the RME construction worker will only be exposed to sediments 60 days per year for the duration of 1 year. Residents are assumed to be exposed to sediment one day a week during the summer months or 16 days a year for the RME scenario. One-half of the RME exposure frequencies were used for the CTE exposure frequencies for incidental ingestion of sediment. As detailed in the footnotes presented in Table 9-14 through 9-26, federal EPA and EPA Region III guidance was used whenever possible.

The fraction of soil/sediment ingested was assumed to be 1.0 for both the RME and CTE scenarios.

Dermal contact with Soil/Sediment

Direct physical contact with soil (and sediment) may result in the dermal absorption of chemicals. Exposure associated with the dermal route is estimated in the following manner (EPA, 1989 and 1992a):

$$\text{Intake}_{si} = \frac{(C_{si})(SA)(AF)(ABS)(CF)(EF)(ED)}{(BW)(AT)}$$

where: Intake_{si} = amount of chemical "i" absorbed during contact with soil/sediment (mg/kg/day)

C_{si} = concentration of chemical "i" in soil/sediment (mg/kg)

SA = skin surface area available for contact (cm^2/day)

AF = skin adherence factor (mg/cm^2)

ABS = absorption factor (dimensionless)

CF = conversion factor (1×10^{-6} kg/mg)

EF = exposure frequency (days/yr)

ED = exposure duration (yr)

BW = body weight (kg)

AT = averaging time (days);
for noncarcinogens, AT = ED x 365 days/yr;
for carcinogens, AT = 70 yr x 365 days/yr

The same exposure frequencies and durations used in the estimation of incidental ingestion intakes of soil/sediment are used to estimate exposure via dermal contact. Exposed surface areas (SA) of the body available for dermal contact are determined on a receptor-specific basis since the SA assumptions should reflect the human activities and clothing worn during exposure events. Current guidance (EPA, 1992a) is used to develop the following default assumptions concerning the amount of skin surface area available for contact for a receptor:

- For full-time employees/maintenance workers, the surface area assumed to be available for soil/sediment contact (4,300 cm^2) is the arithmetic mean value for the head, arms, and hands.

- For the construction worker, the surface area assumed to be available for soil/sediment contact (5,300 cm^2) is the arithmetic mean value for the head, hands, arms, and lower legs.

- For hypothetical future on-site residents, 25 percent of the total body surface area is assumed to be available for soil/sediment contact.

The published range for the soil adherence factor is 0.07 to 0.2 mg/cm^2 for RME values and 0.01 to 0.06 mg/cm^2 for CTE values (EPA, 1997). Current EPA Region III guidance (EPA, 1995) is used to determine chemical-specific absorption factors, which are presented in Table 9-27.

Inhalation of Air and Fugitive Dust/Volatile Emissions

A qualitative evaluation (comparison of study area data to EPA SSLs for transfers from soil to air) of this exposure pathway was performed. TCE that in downgradient subsurface soil was the only chemical with a maximum detected concentration that exceeded its respective SSL. Consequently, exposures via inhalation will only be evaluated for TCE. Future construction workers and hypothetical future residents are the only receptors exposed to subsurface soil; therefore, exposures via inhalation will only be evaluated for these receptors. The following equation will be used to determine exposure doses resulting from the inhalation of fugitive dust and volatile emissions (EPA, 1989):

$$Intake_{ai} = \frac{(C_{ai})(IR_a)(ET)(EF)(ED)}{(BW)(AT)}$$

where: $Intake_{ai}$ = intake of chemical "i" from air via inhalation (mg/kg/day)

C_{ai} = concentration of chemical "i" in air (mg/m^3)

IR_a = inhalation rate (m^3/hr)

ET = exposure time (hours/day)

EF	=	exposure frequency (days/yr)
ED	=	exposure duration (yr)
BW	=	body weight (kg)
AT	=	averaging time (days);
		for noncarcinogens, AT = ED x 365 days/yr;
		for carcinogens, AT = 70 yr x 365 days/yr

As detailed in Tables 9-14, 9-16, 9-19, 9-23, and 9-24, inhalation rates vary for the receptors evaluated and reflect the assumed activity pattern for each receptor.

The concentrations of chemicals in air resulting from emissions from soil were developed following procedures presented in EPA Soil Screening Guidance (EPA, 1996a). The chemical concentration in air is calculated from:

$$C_a = C_s \times \left[\frac{1}{PEF} + \frac{1}{VF}\right]$$

where:			
	C_a	=	chemical concentration in air, mg/m^3
	C_s	=	chemical concentration in soil, mg/kg
	PEF	=	Particulate emission factor, m^3/kg
	VF	=	volatilization factor, m^3/kg

The particulate emissions factor relates the concentration of the chemical in soil with the concentration of dust particles in air. The default value for EPA's Soil Screening Guidance of 1.32 x 10^9 m^3/kg was used for all receptors.

Ambient air concentrations resulting from the volatilization of COPCs from soil are chemical dependent and were calculated using the following equation for EPA's Soil Screening Guidance:

$$VF = \frac{Q/C \cdot (3.14 \cdot D_a \cdot T)^{0.5} \cdot 10^{-4}\ (m^2 / cm^2)}{(2 \cdot \rho_b \cdot D_a)}$$

and

$$D_a = \frac{[(\theta_a^{10/3} \cdot D_i \cdot H' + \theta_w^{10/3} \cdot D_w)/n^2]}{\rho_b \cdot K_d + \theta_w + \theta_a \cdot H'}$$

where:

VF	=	volatilization factor (m^3-air/kg-soil)
Q/C	=	inverse of the mean concentration at the center of a 0.5 acre-square source (79.14 gm/m^2-sec per kg/m^3)
D_a	=	apparent diffusivity, chemical specific, (cm^2/sec)
T	=	exposure interval, exposure specific, (sec)
ρ_b	=	dry bulk soil particle density (1.5 g/cm^3)
θ_a	=	air-filled soil porosity (0.284 L_{air}/L_{soil})
D_i	=	diffusivity in air, chemical specific, (cm^2/sec)
n	=	total soil porosity (0.38 L_{pore}/L_{soil})
θ_w	=	water-filled soil porosity (0.15 L_{air}/L_{soil})
D_w	=	diffusivity in water, chemical specific, (cm^2/sec)
K_d	=	soil-water partition coefficient, chemical specific
H'	=	dimensionless Henry's law constant, chemical specific

Incidental/Direct Ingestion of Groundwater/Surface Water

Direct ingestion of groundwater will be evaluated for the hypothetical future resident only. Incidental ingestion of surface water will be evaluated for the future construction worker and hypothetical future resident. Exposure to surface water is considered to be minimal for full time employees; therefore, this exposure pathway will not be evaluated for this receptor group.

Intakes associated with ingestion of groundwater or surface water are evaluated using the following equations (EPA, 1989):

$$\text{Intake}_{wi} = \frac{(C_{wi})(IR_w)(EF)(ED)}{(BW)(AT)} \quad \text{for groundwater}$$

$$\text{Intake}_{wi} = \frac{(C_{wi})(CR)(ET)(EF)(ED)}{(BW)(AT)} \quad \text{for surface water}$$

where:	Intake_{wi}	=	intake of chemical "i" from water (mg/kg/day)
	C_{wi}	=	concentration of chemical "i" in water (mg/L)
	IR_w	=	ingestion rate for groundwater (L/day)
	CR	=	contact rate for surface water (L/hr)
	ET	=	exposure time for surface water (hr/day)
	EF	=	exposure frequency (days/yr)
	ED	=	exposure duration (yr)
	BW	=	body weight (kg)

AT = averaging time (days);
for noncarcinogens, AT = ED x 365 days/yr;
for carcinogens, AT = 70 yr x 365 days/yr

Groundwater ingestion by residential receptors is assumed to occur on a daily basis. Exposure to surface water for receptor groups is anticipated to be limited to infrequent, site-specific exposure events. No receptor- and activity-specific information is available to estimate surface water contact rates for the identified receptors. The conventional value of 0.050 L/hr will be used for all receptors under CTE and RME conditions (EPA, 1989). Under the RME scenario, construction workers are assumed to be exposed to groundwater 40 days a year (2 work months) and surface water 60 days a year (3 working months). Residents are assumed to be exposed to surface water one day a week during the summer months or 16 days a year for the RME scenario. Exposures for the CTE scenario are assumed to be 50 percent of the RME scenario; consequently, construction workers are assumed to be exposed to groundwater 20 days a year and surface water 30 days a year and residents are assumed to be exposed to surface water 8 days a year.

Dermal Contact with Groundwater/Surface Water

The quantitative risk assessment will be performed assuming that receptors ingesting groundwater or surface water will also be dermally exposed to groundwater and/or surface water. Residential receptors are assumed to use groundwater for domestic purposes (i.e., bathing, showering, washing dishes), which could result in dermal exposure. It is also possible under future land use conditions that deep excavations at the IHDIV-NSWC for activities such as utility maintenance and construction could result in a dermal exposure to the shallow groundwater. Dermal contact with surface water may also occur while receptors are involved in certain activities, such as wading.

The following equation is used to assess exposures resulting from dermal contact with water (EPA, 1992a):

$$DAD_{wi} = \frac{(DA_{event})(EV)(ED)(EF)(A)}{(BW)(AT)}$$

where: DAD_{wi} = dermally absorbed dose of chemical "i" from water (mg/kg/day)
DA_{event} = absorbed dose per event (mg/cm^2-event)
EV = event frequency (events/day)
ED = exposure duration (yr)
EF = exposure frequency (days/yr)
A = skin surface area available for contact (cm^2)
BW = body weight (kg)

AT = averaging time (days);
for noncarcinogens, AT = ED x 365 days/yr;
for carcinogens, AT = 70 yr x 365 days/yr

Groundwater exposure for residential receptors is assumed to occur on a daily basis, and exposure to surface water is limited to infrequent, site-specific exposure events. Dermal exposure to groundwater intakes for residents assume total body exposure. For other construction workers, the surface area assumed to be available for groundwater contact (4,050 cm^2), is the arithmetic mean value for the hands, forearms, and lower legs. It was assumed that 25 percent of the today body area was available for exposure to surface water by hypothetical future residents. Tables 9-16, 9-18, 9-20, 9-22, 9-24, and 9-26, detail the surface areas assumed to be available for each receptor being evaluated. Exposure frequencies for dermal contact with groundwater and surface water are assumed to be the same as those for ingestion of groundwater and surface water.

The absorbed dose per event (DA_{event}) is estimated using a nonsteady-state approach for organic compounds and a traditional steady-state approach for inorganics. For organics, the following equations apply:

$$\text{If } t_{event} < t^*, \text{ then: } DA_{event} = (2K_p)(C_{wi})(CF)\left[\frac{\sqrt{6\tau t_{event}}}{\pi}\right]$$

$$\text{If } t_{event} > t^*, \text{ then: } DA_{event} = (K_p)(C_{wi})(CF)\left[\frac{t_{event}}{1+B} + 2\tau\left[\frac{1+3B}{1+B}\right]\right]$$

where: t_{event} = duration of event (hr/event)
t^* = time it takes to reach steady-state conditions (hr)
K_p = permeability coefficient from water through skin (cm/hr)
C_{wi} = concentration of chemical "i" in water (mg/L)
τ = lag time (hr)
π = constant (dimensionless; equal to 3.141592654)
CF = conversion factor (0.001 L/cm^3)
B = partitioning constant derived by Bunge Model (dimensionless)

Values for the chemical-specific parameters (t_{event}, t^*, K_p, τ, and B) are obtained from the current dermal guidance (EPA, 1992a, Table 5-8) and are included in Appendix K.

The following nonsteady-state equation is used to estimate DA_{event} for inorganics:

$$DA_{event} = (K_p)(C_{wi})(t_{event})$$

In general, the recommended default value of 0.001 is used for the dermal permeability of inorganic constituents.

Inhalation of Volatiles in Groundwater

Groundwater exposure may also result in inhalation of volatiles, typically for residential receptors who may be exposed while showering, bathing, washing dishes, etc. or for the construction worker who may contact shallow groundwater. For other receptors who may come in contact with groundwater, the inhalation pathway is assumed to be minimal and will not be evaluated. Inhalation exposures for the resident are estimated using a mass transfer model, developed specifically for this exposure route, in combination with an air intake estimation model. The mass transfer model accounts for inhalation that occurs during a shower and after a shower while the receptor remains in the closed bathroom. The method employed is as follows (EPA, 1989, and Foster and Chrostowski, 1987):

$$Intake_{wi} = (S)(IR_{sh})(K)(EF)(ED) / (BW)(AT)(R_a)(CF)$$

$$K = D_s + \frac{\exp(-R_a \times D_t)}{R_a} - \frac{\exp[R_a \times (D_s - D_t)]}{R_a}$$

where: $Intake_{wi}$ = intake of chemical "i" from water via inhalation (mg/kg/day)

S	=	volatile chemical generation rate ($\mu g/m^3$-min - shower)
IR_{sh}	=	inhalation rate (L/min)
EF	=	exposure frequency (showers/yr)
ED	=	exposure duration (yr)
BW	=	body weight (kg)
AT	=	averaging time or period of exposure (days)
R_a	=	air exchange rate (min^{-1})
K	=	mass transfer coefficient (min)
D_s	=	shower duration (min)
D_t	=	total time in bathroom (min)
CF	=	conversion factor ($1x10^{+6}$ μg-L/mg-m^3)

The estimated volatile chemical generation rate is based on two-phase film theory. The model employs contaminant-specific mass transfer coefficients, Henry's Law constants, droplet diameter, drop time, viscosity, temperature, etc. A sample calculation is found in Appendix K.

Ambient air concentrations resulting from the volatilization of COPCs from groundwater were calculated by using the following equation from American Society for Testing and Materials E 1739-95 Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites:

$$VF = \frac{H}{1+\left[\frac{U_{air} \cdot \delta_{air} \cdot L_{GW}}{W \cdot D^{eff}_{ws}}\right]} \cdot 10^3 \cdot \frac{L}{m^3}$$

where:

VF	=	Volatilization Factor (L - H_2O/m^3-air)
H	=	Henry's law constant, chemical specific, (cm^3-H_2O)/(cm^3-air)
U_{air}	=	wind speed above ground surface in mixing zone, 420 cm/sec (average wind speed for Baltimore, Maryland)
δ_{air}	=	ambient air mixing zone, 200 cm
L_{GW}	=	depth to groundwater, cm;
	=	$h_v + h_{cap}$
		h_v = thickness of vadose zone, 0 cm
		h_{cap} = thickness of capillary fringe; 0.1 cm
W	=	width of source parallel to groundwater flow direction, 1500 cm
D^{eff}_{ws}	=	effective diffusion coefficient between groundwater and surface soil, chemical specific, cm^2/sec

Because exposure to constituents that have volatilized from groundwater is a result of direct exposure, the depth to groundwater is simply (L_{gw}) defined as the thickness of the capillary fringe (h_{cap}).

Default values were used for all input parameters for the calculation of volatilization from groundwater to outdoor ambient air except for the thickness of capillary fringe (h_{cap}), thickness of the vadose zone (h_v), and wind speed above ground surface in mixing zone (U_{air}). It was assumed that excavation would occur to the water table; therefore, the thickness of the vadose zone was set equal to 0 and the thickness of the capillary fringe was set equal to 0.1 cm. The average wind speed for Baltimore, Maryland of 420 cm was used for wind speed above ground surface in mixing zone (EPA, 1985a).

The effective diffusion coefficient between groundwater and surface soil, D^{eff}_{ws} is calculated from:

$$D_{ws}^{eff} = \left(h_{cap} + h_v\right) \cdot \left[\frac{h_{cap}}{D_{cap}^{eff}} + \frac{h_v}{D_s^{eff}}\right]^{-1}$$

Where:

D^{eff}_{cap}	=	effective diffusion through capillary fringe, chemical specific, cm^2/sec
D^{eff}_{s}	=	effective diffusion in soil based on vapor-phase concentration, chemical specific, cm^2/sec
h_v	=	thickness of vadose zone, 0 cm
h_{cap}	=	thickness of capillary fringe, 0.1 cm

Because h_v is equal to zero, this equation reduces to show that the effective diffusion between groundwater and surface soil (D^{eff}_{ws}) is equal to the effective diffusion through the capillary fringe (D^{eff}_{cap}).

The effective diffusion through the capillary fringe, D^{eff}_{cap}, is calculated from:

$$D_{cap}^{eff} = D^{air} \cdot \frac{\theta_{acap}^{3.33}}{\theta_T^2} + D^{wat} \cdot \frac{1}{H} \cdot \frac{\theta_{wcap}^{3.33}}{\theta_T^2}$$

where:

D^{air}	=	diffusion coefficient in air, chemical specific, cm^2/sec
D^{wat}	=	diffusion coefficient in water, chemical specific, cm^2/sec
θ_{acap}	=	volumetric air content in capillary fringe soils, 0.038 cm^3-air/cm^3-soil
θ_{wcap}	=	volumetric water content in capillary fringe soils, 0.342 cm^3-H_2O/cm^3-soil
θ_T	=	total soil porosity, 0.38 cm^3/cm^3-soil

9.3.4 Exposure to Lead

The equations and methodology presented in the previous section cannot be used to evaluate exposure to lead because of the absence of published dose-response parameters for this chemical. Exposure to lead can be evaluated using the EPA IEUBK Model for lead, version 0.99D (EPA, 1994a). This model is designed to estimate blood levels of lead in children (under 7 years of age) based on either default or site-specific input values for air, drinking water, diet, dust, and soil exposure. Exposures to lead by nonresidential adults are evaluated by use of a slope-factor approach developed by the EPA Technical Review Workgroup for Lead (EPA, 1996b). The approach focuses on estimating fetal blood lead concentrations in women exposed to lead-contaminated soils.

Studies indicate that infants and young children are extremely susceptible to adverse effects from exposure to lead. Considerable behavioral and developmental impairments have been noted in children with elevated blood-lead levels. The threshold for toxic effects to children from this chemical is believed to be in the range of 10 µg/dL to 15 µg/dL. Blood-lead levels greater than 10 µg/dL are considered to be a "concern."

In general, the IEUBK Model and Technical Review Work Group Model for lead were used to address exposure to lead when groundwater and surface water concentrations exceed the 15 µg/L Federal Action Level promulgated under the Safe Drinking Water Act and when detected soil concentrations exceeded the OSWER soil screening level of 400 mg/kg for residential land use (EPA, 1994c). Exposure concentrations, as well as default parameters for some input parameters, were used in the evaluation. The input parameters used and the results of lead models, estimated blood-lead levels, and probability density histograms are presented in the site-specific appendices.

9.4 RISK CHARACTERIZATION

Potential risks (noncarcinogenic and carcinogenic) for human receptors resulting from the exposures to contaminated media are quantitatively determined during the risk characterization component of the human health risk assessment.

A summary and interpretive discussion of the quantitative risk estimates are provided in the text of the site-specific risk assessments. COPCs that contribute significantly to elevated risks are identified as "risk drivers" during the interpretive risk discussion. The numeric estimates of risk will be contained in the risk assessment spreadsheets, which are appended to the site-specific assessments.

9.4.1 Risk Estimation Methods

Quantitative estimates of risk are calculated using intake and toxicity values according to risk assessment methods outlined in current EPA guidance (EPA, 1989). Lifetime cancer risks are expressed in the form of dimensionless probabilities, referred to as Incremental Cancer Risks (ICRs), which are derived using published CSFs. Noncarcinogenic risk estimated are presented in the form of HQs that are derived using published RfDs.

ICR estimates are generated for each COPC using estimated exposure intakes and published CSFs, as follows:

$$ICR = (\text{Estimated Exposure Intake})(CSF)$$

If the above equation results in an ICR greater than 0.01, the following equation is used:

$$ICR = 1 - [\exp(-\text{Estimated Exposure Intake})(CSF)]$$

The ICRs for all COPCs in an exposure scenario are summed to give a cumulative ICR. An ICR of 1×10^{-6} indicates that the exposed receptor has a one-in-one-million chance of developing cancer under the defined exposure scenario. Alternatively, such a risk may be interpreted as representing one additional case of cancer in an exposed population of one million persons.

Noncarcinogenic risks are assessed using the concept of HQs and Hazard Indices (HIs). The HQ for a COPC is the ratio of the estimated intake to the RfD, as follows:

$$HQ = (\text{Estimated Exposure Intake}) / (RfD)$$

An HI is generated by summing the individual HQs for all of the COPCs. It should be noted that HI is not a mathematical prediction of the severity of toxic effects and therefore is not a true "risk"; it is simply a numerical indicator of the possibility of the occurrence of noncarcinogenic (threshold) effects.

9.4.2 Comparison of Quantitative Risk Estimates to Benchmarks

In order to interpret the quantitative risks and to aid risk managers in determining the need for remediation at a site, quantitative risk estimates are compared to typical benchmarks. EPA has defined the range of 10^{-4} to 10^{-6} as the ICR "target range" for most hazardous waste facilities addressed under CERCLA. Cumulative ICRs greater than 1×10^{-4} generally will indicate that some degree of remediation is required, and ICRs below 1×10^{-6} will normally indicate that remedial efforts are not necessary. Whenever ICRs fall between 10^{-4} and 10^{-6}, decisions for remediation will be made on a case-specific basis. Individual chemicals contributing significantly to risks above the target range are considered to be chemicals of concern (COCs).

An HI exceeding unity (1.0) indicates that there may be potential noncarcinogenic health risks associated with exposure. If an HI exceeds unity, target organ effects from individual COPCs contributing to the risk are considered. Only those chemicals that impact the same target organ(s) or exhibit similar critical effect(s) will be regarded as truly additive. Thus, COPCs contributing to an HI greater than 1.0 on the basis of a single target organ/effect are considered to be COCs.

9.4.3 Upgradient Area

Potential cancer risks and HIs were calculated for current/future full-time employees, future construction workers, and hypothetical future residents exposed to upgradient soil and groundwater. Although upper surficial and lower surficial groundwater were discussed separately for COPC selection, they were combined for evaluating risks. Both RME and CTE exposures were evaluated. No COPCs were identified for surface water and sediment consequently no cancer risks or HIs were calculated for exposures to these media. Tables 9-28 and 9-29 present a summary of the cancer risks and HIs for the upgradient area at Site 57. Chemical-specific risks are presented in Appendix K. The following text presents a summary of the results of the risk assessment.

Current/Future Full-Time Employees

The excess lifetime cancer risks for the current/future full time employee exposed to surface soil were within or less than the EPA target risk range of 10^{-4} to 10^{-6}. The cancer risks for the full-time employee were 3.8×10^{-6} and 2.4×10^{-7} for the RME and CTE scenarios, respectively. The cumulative HI for the full-time employee was 2.4×10^{-2} for the RME scenario and 7.6×10^{-3} for the CTE scenario. These results are less than the acceptable level of 1.0, which indicates that there is minimal potential for adverse health effects under the conditions established in the risk assessment.

Future Construction Workers

The excess lifetime cancer risks for the future construction worker exposed to surface/subsurface soil and groundwater were within or less than the EPA target risk range of 10^{-4} to 10^{-6}. The combined cancer risks for the construction worker were 1.7×10^{-6} and 7.5×10^{-7} for the RME and CTE scenarios, respectively. The cumulative HI for the construction worker was 1.7×10^{-1} for the RME scenario and 7.1×10^{-2} for the CTE scenario. These results are less than the acceptable level of 1.0, which indicates that there is minimal potential for adverse health effects under the conditions established in the risk assessment.

Hypothetical Future Residents

The excess lifetime cancer risks for a lifelong resident exposed to surface/subsurface soil and groundwater were 1.0×10^{-3} and 1.5×10^{-4} for the RME and CTE scenarios, respectively. Potential exposures to groundwater under the RME and CTE scenarios were greater than EPA's target risk range of 10^{-4} to 10^{-6}. Cancer risks for exposures to groundwater were 9.8×10^{-4} and 1.5×10^{-4}. Potential exposure to 1,1-dichloroethene in groundwater was the main contributor to the cancer risk. Cancer risks for exposures to soil were 2.7×10^{-5} and 2.5×10^{-6} for the RME and CTE scenarios, respectively, which are within EPA's target risk range.

The total HIs for a hypothetical future child exposed to surface/subsurface soil were 3.7×10^{-1} and 1.4×10^{-1} for the RME and CTE scenarios, respectively. The total HI for exposures to groundwater were 6.4×10^{-1} and 4.2×10^{-1} for the RME and CTE scenarios, respectively. The total cumulative HI for exposures to surface/subsurface soil and groundwater were 1.0 for the RME and 5.6×10^{-1} for the CTE scenarios. The HI for the target organs under the RME scenario were 6.1×10^{-1} for the liver and 4.3×10^{-1} for the skin. These results are less than the acceptable level of 1.0, which indicates that there is minimal potential for adverse health effects under the conditions established in the risk assessment.

The total cumulative HI for a hypothetical future adult resident exposed to surface/subsurface soil and groundwater was 8.5×10^{-1} and 3.4×10^{-1} for the RME and CTE scenarios, respectively. These results are less than the acceptable level of 1.0, which indicates that there is minimal potential for adverse health effects under the conditions established in the risk assessment.

9.4.4 Downgradient Area

Potential cancer risks and HIs were calculated for current/future full-time employees, future construction workers, hypothetical future residents exposed to downgradient soil, groundwater, surface water and sediment. Although shallow and deep groundwater were discussed separately for COPC selection, they were combined for evaluating risks. Both RME and CTE exposures were evaluated. Tables 9-30 and 9-31 present a summary of the cancer risks and HIs for the downgradient area at Site 57. Chemical-specific risks are presented in Appendix K. The following text presents a summary of the results of the risk assessment.

Current/Future Full-Time Employees

The excess lifetime cancer risks for the current/future full-time employee exposed to surface soil were within the EPA target risk range of 10^{-4} to 10^{-6}. The cancer risks for the full-time employee were 5.2×10^{-5} and 3.1×10^{-6} for the RME and CTE scenarios, respectively. The cumulative HI for the full-time employee was 2.5×10^{-1} for the RME scenario and 8.1×10^{-2} for the CTE scenario. These results are less than the acceptable level of 1.0, which indicates that there is minimal potential for adverse health effects under the conditions established in the risk assessment.

Future Construction Workers

The excess lifetime cancer risks for the future construction worker exposed to surface/subsurface soil, groundwater, surface water, and sediment were within the EPA target risk range of 10^{-4} to 10^{-6}. The combined cancer risks for the construction worker were 1.0×10^{-5} and 4.4×10^{-6} for the RME and CTE scenarios, respectively.

The cumulative HI for the construction worker exposed to surface/subsurface soil, groundwater, surface water, and sediment was 1.3 for the RME scenario, which slightly exceeds the acceptable level of 1.0. Incidental ingestion of arsenic in surface/subsurface soil (HI=1.1) was the main contributor to the HI. As discussed in Section 7.1.2, elevated concentrations of arsenic were limited to a hot spot at boring SS57SB007. If boring SS57SB007 was removed from the database, then the HI for construction workers exposed to surface/subsurface soil would be 0.7 and the HI for exposure to all media would be 0.85 which is less than the acceptable level of 1.0. The cumulative HI under the CTE scenario was 5.8×10^{-1}, which is less than the acceptable level of 1.0, which indicates that there is minimal potential for adverse health effects under the conditions established in the risk assessment.

Hypothetical Future Residents

The excess lifetime cancer risks for a lifelong resident exposed to surface/subsurface soil, groundwater, surface water, and sediment were 3.8×10^{-3} and 5.6×10^{-4} for the RME and CTE scenarios, respectively. Cancer risks for exposures to soil and groundwater under the RME and CTE scenarios were greater than EPA's target risk range of 10^{-4} to 10^{-6}. Incidental ingestion of arsenic (RME CR = 2.8×10^{-4}) was the main contributor to the risk for exposure to soil. Ingestion of TCE (RME CR = 1.6×10^{-4}) and ingestion and inhalation of vinyl chloride (RME CR = 3.5×10^{-3}) were the main contributors to the cancer risk for exposures to groundwater. Cancer risks for exposures to surface water and sediment for the RME and CTE scenarios were within or less than EPA's target risk range.

The total cumulative HI for a hypothetical future child exposed to surface/subsurface soil, groundwater, surface water, and sediment were 16 and 9.2 for the RME and CTE scenarios, respectively. HIs for exposures to soil and groundwater were above the acceptable level of 1.0. Incidental ingestion of arsenic (RME HI = 3.2) was the main contributor to the HI for exposures to soil. Ingestion of cis-1,2-dichloroethene (RME HI = 3.6), ethyl ether (RME HI = 1.3), and TCE (RME HI = 7.3) were the main contributors to the HI for groundwater. The HIs for exposures to surface water and sediment were less than the acceptable level of 1.0.

The total cumulative HI for a hypothetical future adult resident exposed to surface/subsurface soil, groundwater, surface water, and sediment were 6.7 and 2.8 for the RME and CTE scenarios, respectively. The HI for exposure to groundwater (HI = 5.5) was above the acceptable level of 1.0. Ingestion of cis-1,2-dichloroethene (RME HI = 1.6) and TCE (RME HI = 3.3) was the main contributor to the HI for groundwater. The HIs for exposures to surface water and sediment were less than the acceptable level of 1.0.

9.4.5 Sewer

Potential cancer risks and hazard indices were calculated for the future construction workers exposed to surface water and sediment in the sewer. Both RME and CTE exposures were evaluated. Table 9-32 presents a summary of the cancer risks and HIs for the upgradient area at Site 57. Chemical-specific risks are presented in Appendix K. The following text presents a summary of the results of the risk assessment.

The excess lifetime cancer risks for the future construction worker exposed to surface water and sediment in the sewer were less than the EPA target risk range of 10^{-4} to 10^{-6}. The combined cancer risks for the construction worker were 1.6×10^{-7} and 4.5×10^{-8} for the RME and CTE scenarios, respectively. The cumulative HI for the construction worker was 5.1×10^{-2} for the RME scenario and 8.0×10^{-2} for the CTE scenario. These results are less than the acceptable level of 1.0, which indicates that there is minimal potential for adverse health effects under the conditions established in the risk assessment.

9.4.6 Lead

Lead was identified as a COPC in downgradient surface soil at Site 57. Lead was detected at a maximum concentration of 487 mg/kg, which exceeds the OSWER soil screening level of 400 mg/kg for residential land use but is less than the EPA screening level of 1000 mg/kg for industrial land use.

Exposure to lead in soil was evaluated using the EPA IEUBK Model, as discussed in Section 9.3.4. As recommended by the model, the average concentration of lead in surface/subsurface soil of 102 mg/kg was used for the exposure point concentration. Default parameters were used for the rest of the model input parameters. IEUBK model outputs are included in Appendix K. The estimated geometric mean blood-lead level for children exposed to lead in surface/subsurface soil was 2.6 μg/dL, which is less than the level of concern of 10 μg/dL. The IEUBK Model estimates that 0.91 percent of children are expected to have blood-lead levels greater than 10 μg/dL. These results indicate that no adverse effects are anticipated for hypothetical future child residents exposed to lead in surface/subsurface soil at Site 57.

9.4.7 Potable Well

As discussed in Section 7, TCE was the only chemical detected in a water sample collected from the on-site potable well. The detected concentration of 7.2 μg/L exceeded the EPA Region III RBC for ingestion of tap water; therefore, cancer risks and HIs were estimated for residential exposure to groundwater from the potable well. Excess lifetime cancer risks for a lifelong resident exposed to groundwater from the potable well were within or less than the EPA target risk range of 10^{-4} to 10^{-6}. The cancer risks for the lifelong resident were 1.9×10^{-6} and 2.8×10^{-7} for the RME and CTE scenarios, respectively. The

cumulative HIs for child and adult residents were less than the acceptable level of 1.0, which indicates that there is minimal potential for adverse health effects under the conditions established in the risk assessment. The HIs for a child resident were 8.5×10^{-2} and 5.6×10^{-2} for the RME and CTE scenarios, respectively. The HIs for an adult resident were 3.8×10^{-2} and 1.8×10^{-2} for the RME and CTE scenarios, respectively.

9.5 UNCERTAINTY ANALYSIS

The goal of the uncertainty analysis is to identify important uncertainties and limitations associated with the human health risk assessment. Uncertainties related to each component of the assessment (i.e., data evaluation, exposure assessment, toxicity assessment, and risk characterization) are presented in the site-specific assessments. In addition, the effect of a particular uncertainty on the outcome of the assessment (i.e., risk estimates) is also indicated, where possible.

9.5.1 Data Evaluation

The most significant uncertainty associated with this section is associated with the selection of COPCs, those chemicals considered to be representative of site contamination. Measured background concentrations and risk-based screening concentrations were both used to identify COPCs.

Some degree of uncertainty is associated with the use of established background values since the background database is limited by the number of samples collected and their locations. Actual concentrations of naturally occurring inorganics may, in fact, be lower or higher. The use of single-route screening concentrations may lead to the underestimation of risks since they do not account for the additive effects across various exposure pathways. The resultant effects of the risks are not considered significant because conservative values, derived from a target HI of 0.1 for noncarcinogens and a target risk of 1×10^{-6} for carcinogens, were employed. In addition, screening concentrations for groundwater (which were also used for the surface water) are very conservative since they assume direct ingestion occurs at a rate of 2 L/day.

Additionally, the chemical analytical database has some limitations regarding the representativeness of the laboratory results, the inclusion of nondetected data, data gaps, number of samples collected, and heterogeneity of sample data. The effects of these limitations on the results of the risk assessment are varied. However, every effort was made to collect and use samples that reflect actual site conditions. Nondetected results were treated using one-half the detection limit in all statistical functions. These actions should minimize uncertainty in the data base.

9.5.2 Exposure Assessment

Major uncertainties related to the estimates of exposure are as follows:

- The likelihood of the occurrence of the defined exposure scenarios is not always known. Identified land use and activity patterns at a site are limited to the observations made during the field investigation and known land uses in the surrounding area.

- Several receptor characteristics, such as age, body weight, and exposure duration, are based on professional judgment.

- There are limitations to using various models and/or equations to estimate exposure doses or contaminant concentrations. For example, the use of modeled concentrations (i.e., generated fugitive dust concentrations) in place of monitored values may not be indicative of actual site conditions during a future potential construction project.

- Maximum detected concentrations are sometimes used as representative concentrations.

In general, the underestimation of risks was prevented using conservative exposure assumptions and exposure concentrations. Although maximum concentrations are not a reasonable estimate of the concentration expected to be experienced by a receptor over time, the use of these values does provide a highly conservative estimate of risk to potential receptors.

9.5.3 Toxicity Assessment

The toxicological data used as the basis for all risk assessments contain uncertainty in the following areas:

- Nonthreshold (carcinogenic) effects are extrapolated from the high doses administered to laboratory animals to the low doses received under more common human exposure scenarios.

- Results of laboratory animal studies are extrapolated to human or environmental receptors.

- There is considerable interspecies variation in toxicological endpoints used in characterizing potential health effects resulting from exposure to a chemical.

- There is considerable variability in sensitivity among individuals of any particular species.

- Short-time toxicological studies are used to predict long-term effects.

Uncertainty Associated with Evaluation of Arsenic

Although the more restrictive basis for evaluating risk associated with exposure to arsenic is to assume it is a carcinogen, carcinogenic effects are not the primary health effects expected to be manifested upon exposure to arsenic. The preponderance of scientific information indicates that humans are capable of metabolizing arsenic to expedite its elimination from the body (ATSDR, 1991a). Its elimination from the body obviously mitigates the possibility for arsenic to manifest carcinogenic effects. Therefore, evaluating arsenic as a noncarcinogen would be more appropriate.

Specifically, the body methylates the arsenic to form monomethyl arsenic and dimethyl arsenic. There is a limited capacity for the body to methylate arsenic, but this limit is generally reached when the body's intake of arsenic approximately exceeds 500 ug/day. For example, the maximum detected concentration of arsenic and the average arsenic concentration in downgradient surface/subsurface soil at the site are 103 mg/kg and 38.1 mg/kg, respectively. Assuming a soil ingestion rate of 200 mg/day, exposure to these concentrations corresponds to approximate intakes of 20.6 ug/day and 7.62 ug/day, respectively. These concentrations result in intakes that are well within the body's ability to metabolize arsenic. Although some humans may be more sensitive to arsenic, in that they are "poor methylators," the average exposure concentration for the site is more than two orders of magnitude below the normal limit of metabolic saturation and is most likely below levels that would trigger responses in sensitive individuals.

9.5.4 Risk Characterization

ICRs and HIs are summed for all potential COPCs and for all applicable routes of exposure. Summing the risks implies that no antagonistic or synergistic effects exist among chemicals. It also assumes that similar mechanisms of action and metabolism are prevalent. Therefore, the use of this approach may either underestimate or overestimate the risks, depending on the chemical-specific interactions, which cannot be predicted. The direction of the uncertainty cannot be defined, but the methodology used is based on current EPA guidance. Risks to any individual may also be overestimated by summing multiple assumed exposure pathway risks for any single receptor. Although every effort was made to develop reasonable scenarios, not all individual receptors may be exposed via
all pathways considered.

9.5.5 Summary

In summary, noncarcinogenic hazards and carcinogenic health risks are estimated using a number of assumptions. Consequently, the values presented for a site contain an inherent level of uncertainty. The extent to which health risks can be characterized is primarily dependent upon the accuracy with which the toxicity of a chemical can be estimated and the accuracy of the exposure scenario assumptions.

TABLE 9-1

CRITERIA FOR QUALITATIVE COMPARISON FOR SOIL AND SEDIMENT
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

CAS Number	Chemical	EPA Region III Risk-Based Concentration[1]			EPA Soil Screening Level[2]	
		Industrial (mg/kg)	Residential (mg/kg)	Basis	Soil to Air (mg/kg)	Soil to Groundwater[3] (mg/kg)
Volatile Organic Compounds						
71-55-6	1,1,1-Trichloroethane	41000	1600	N	1200 (sat)	2
75-34-3	1,1-Dichloroethane	200000	7800	N	1300	23
73-35-4	1,1-Dichloroethene	9.5	1.1	C	0.07	0.06
120-82-1	1,2,4-Tricholorbenzene	20000	780	N	3200 (sat)	5
107-06-2	1,2-Dichloroethane	63	7	C	0.4	0.02
78-93-3	2-Butanone	1200000	47000	N	NA	NA
67-64-1	Acetone	200000	7800	N	100000 (sat)	16
75-15-0	Carbon Disulfide	200000	7800	N	720 (sat)	32
67-66-3	Chloroform	940	100	C	0.3	0.6
156-59-2	cis-1,2-Dichloroethene	20000	780	N	1200 (sat)	0.4
60-29-7	Ethyl Ether	410000	16000	N	NA	NA
75-09-2	Methylene Chloride	760	85	C	13	0.02
127-18-4	Tetrachloroethane	110	12	C	11	0.06
108-88-3	Toluene	410000	16000	N	650 (sat)	12
156-80-5	trans-1,2-Dichloroethene	41000	1600	N	3100 (sat)	0.7
79-01-6	Trichloroethene	520	58	C	5	0.06
75-01-4	Vinyl Chloride	3	0.34	C	0.03	0.01
1330-20-7	Xylenes, Total	4100000	160000	N	410[5]	190[5]
Semivolatile Organic Compounds						
91-57-6	2-Methylnaphthalene	41000	1600	N	NA	NA
83-32-9	Acenaphthene	120000	4700	N	NA	570
208-96-8	Acenaphthylene	41000[6]	1600[6]	N	NA	NA
120-12-7	Anthracene	610000	23000	N	NA	12000
56-55-3	Benzo(a)anthracene	7.8	0.87	C	NA	2
50-32-8	Benzo(a)pyrene	0.78	0.087	C	NA	8
205-99-2	Benzo(b)fluoranthene	7.8	0.87	C	NA	5
191-24-2	Benzo(g,h,i)perylene	41000[6]	1600[6]	C	NA	84[6]
207-08-9	Benzo(k)fluoranthene	78	8.7	C	NA	49
117-81-7	Bis(2-ethylhexyl)phthalate	410	46	C	31000 (sat)	3600
86-74-8	Carbazole	290	32	C	NA	0.6
218-01-9	Chrysene	780	87	C	NA	160
53-70-3	Dibenzo(a,h)anthracene	0.78	0.087	C	NA	2
84-74-2	Di-n-butyl phthalate	200000	7800	N	2300 (sat)	2300
206-44-0	Fluoranthene	82000	3100	N	NA	4300
86-73-7	Fluorene	82000	3100	N	NA	560
193-39-5	Indeno(1,2,3-cd)pyrene	7.8	0.87	C	NA	14
91-20-3	Naphthalene	41000	1600	N	NA	84
85-01-8	Phenanthrene	41000[6]	1600[6]	N	NA	NA
129-00-0	Pyrene	61000	2300	N	NA	4200
Pesticides/PCBs						
72-54-8	4,4'-DDD	24	2.7	C	NA	16
72-55-9	4,4'-DDE	17	1.9	C	NA	54
50-29-3	4,4'-DDT	17	1.9	C	NA	32
5103719	Gamma-Chlordane	16[7]	1.8[7]	C	20[7]	10[7]
Inorganics						
7429-90-5	Aluminum	2000000	78000	N	NA	NA
7440-36-0	Antimony	820	31	N	NA	5
7440-38-2	Arsenic	3.8	0.43	C	750	29
7440-39-3	Barium	140000	5500	N	690000	1600
7440-41-7	Beryllium	4100	160	N	1300	63
7440-43-9	Cadmium	1000[9]	39[9]	N	1800[9]	8[9]
7440-47-3	Chromium	6100[10]	230[10]	C	270[10]	38[10]
7440-48-4	Cobalt	120000	4700	N	NA	NA

TABLE 9-1

CRITERIA FOR QUALITATIVE COMPARISON FOR SOIL AND SEDIMENT
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

CAS Number	Chemical	EPA Region III Risk-Based Concentration[1]			EPA Soil Screening Level[2]	
		Industrial (mg/kg)	Residential (mg/kg)	Basis	Soil to Air (mg/kg)	Soil to Groundwater[3] (mg/kg)
7440-50-8	Copper	82000	3100	N	150	NA
57-12-5	Cyanide	41000[11]	1600[11]	N	NA	40[11]
7439-89-6	Iron	610000	23000	N	NA	NA
7439-92-1	Lead	1000[12]	400[13]		NA	NA
7439-96-5	Manganese	41000[14]	1600[14]	N	NA	NA
7439-97-6	Mercury	610[15]	23[15]	N	NA	NA
7440-02-0	Nickel	41000	1600	N	13000	130
7782-49-2	Selenium	10000	390	N	NA	5
7440-62-2	Vanadium	14000	550	N	NA	6000
7440-66-6	Zinc	610000	23000	N	NA	12000

Notes:

N - Noncarcinogenic
C - Carcinogenic
sat - Soil saturation concentration.
1 - U.S. EPA Region III Risk-Based Concentration Table, April 12, 1999.
2 - U.S. EPA Soil Screening Guidance, May 1996.
3 - Assumes a dilution attenuation factor (DAF) of 20.
4 - Value for cis-1,2-dichloroethene used.
5 - Value for o-xylene used.
6 - Value for naphthalene used.
7 - Value for chlordane used.
8 - Value for endosulfan used.
9 - Water value for cadmium used.
10 - Value for hexavalent chromium used.
11 - Value for free cyanide used.
12 - EPA Region III.
13 - Value is based on OSWER Soil Screening Level for residential land use (USEPA, July 1994).
14 - Nonfood value for manganese used.

TABLE 9-2

SUMMARY OF WATER CRITERIA AND STANDARDS
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

CAS Number	Chemical	EPA Region III Risk-Based Concentration[1]		EPA Drinking Water Standard[2]		EPA Drinking Water Health Advisories[2]		EPA AWQC[3] Water & Organisms (ug/L)
		Tap Water (ug/L)	Basis	MCL (ug/L)	MCLG (ug/L)	Value (ug/L)	Receptor	
Volatile Organic Compounds								
71-55-6	1,1,1-Trichloroethane	540	N	200	200	200	Lifetime, Adult	NA
75-34-3	1,1-Dichloroethane	800	N	NA	NA	NA	NA	NA
75-35-4	1,1-Dichloroethene	0.044	C	7	7	7	Lifetime, Adult	0.057
120-82-1	1,2,4-Tricholorbenzene	190	N	70	70	40	DWEL, Adult	NA
107-06-2	1,2-Dichloroethane	0.12	C	5	0	700	Long Term, Child	0.38
78-93-3	2-Butanone	1900	N	NA	NA	NA	NA	NA
67-64-1	Acetone	3700	N	NA	NA	NA	NA	NA
75-15-0	Carbon Disulfide	1000	N	NA	NA	NA	NA	NA
67-66-3	Chloroform	0.15	C	80	0	400	DWEL, Adult	5.7
156-59-2	cis-1,2-dichloroethene	61	N	70	70	70	Lifetime, Adult	NA
60-29-7	Ethyl Ether	1200	N	NA	NA	NA	NA	NA
100-41-4	Ethylbenzene	1300	N	700	700	700	Lifetime, Adult	3100
75-09-2	Methylene Chloride	4.1	C	5	0	2000	DWEL, Adult	4.7
127-18-4	Tetrachloroethene	1.1	C	5	0	500	DWEL, Adult	0.8
108-88-3	Toluene	750	N	1000	1000	1000	Lifetime, Adult	6800
156-60-5	trans-1,2-dichloroethene	120	N	100	100	100	Lifetime, Adult	700
79-01-6	Trichloroethene	1.6	C	5	0	300	DWEL, Adult	2.7
75-01-4	Vinyl Chloride	0.019	C	2	0	50	Long Term, Adult	2
1330-20-7	Xylenes, Total	12000	N	10000	10000	10000	Lifetime, Adult	NA
Semivolatile Organic Compounds								
91-57-6	2-Methylnaphthalene	120	N	NA	NA	NA	NA	NA
83-32-9	Acenaphthene	370	N	NA	NA	NA	NA	1200
208-96-8	Acenaphthylene	6.5[4]	N	NA	NA	NA	NA	NA
120-12-7	Anthracene	1800	N	NA	NA	NA	NA	9600
56-55-3	Benzo(a)anthracene	0.092	C	NA	NA	NA	NA	0.0044
50-32-8	Benzo(a)pyrene	0.0092	C	0.2	NA	NA	NA	0.0044
205-99-2	Benzo(b)fluoranthene	0.092	C	NA	NA	NA	NA	0.0044
191-24-2	Benzo(g,h,i)perylene	6.5[4]	N	NA	NA	NA	NA	NA
207-08-9	Benzo(k)fluoranthene	0.92	C	NA	NA	NA	NA	0.0044
117-81-7	Bis(2-Ethylhexyl)phthalate	4.8	C	6	0	NA	NA	1.8
86-74-8	Carbazole	3.3	C	NA	NA	NA	NA	NA
218-01-9	Chrysene	9.2	C	NA	NA	NA	NA	0.0044
53-70-3	Dibenzo(a,h)anthracene	0.0092	C	NA	NA	NA	NA	0.0044
84-74-2	Di-n-butyl phthalate	3700	N	NA	NA	NA	NA	2700
206-44-0	Fluoranthene	1500	N	NA	NA	NA	NA	300
86-73-7	Fluorene	240	N	NA	NA	NA	NA	1300
193-39-5	Indeno(1,2,3-cd)pyrene	0.092	C	NA	NA	NA	NA	0.0044
91-20-3	Naphthalene	6.5	N	NA	NA	NA	NA	NA
85-01-8	Phenanthrene	6.5[4]	N	NA	NA	NA	NA	NA
129-00-0	Pyrene	180	N	NA	NA	NA	NA	960
Pesticides								
72-54-8	4,4'-DDD	0.28	C	NA	NA	NA	NA	0.00059
72-55-9	4,4'-DDE	0.2	C	NA	NA	NA	NA	0.00059
50-29-3	4,4'-DDT	0.2	C	NA	NA	NA	NA	0.00059
5103-74-2	Gamma-Chlordane	0.19[5]	C	2[5]	0[5]	2[5]	DWEL, Adult	0.0021[5]
Inorganics								
7429-90-5	Aluminum	37000	N	50 To 200[6]	NA	NA	NA	NA
7440-36-0	Antimony	15	N	6	6	10	DWEL, Adult	14
7440-38-2	Arsenic	0.045	C	50	NA	NA	NA	0.018
7440-39-3	Barium	2600	N	2000	2000	2	Lifetime, Adult	1000
7440-41-7	Beryllium	73	N	4	4	200	DWEL, Adult	NA
7440-43-9	Cadmium	18	N	5	5	5	Lifetime, Adult	NA
7440-47-3	Chromium (total)	110[7]	N	100	100	100	Lifetime, Adult	NA
7440-48-4	Cobalt	2200	N	NA	NA	NA	NA	NA
7440-50-8	Copper	15000	N	1300[8]	1300	NA	NA	1300
57-12-5	Cyanide	730	N	200	200	200	Lifetime, Adult	700
7439-89-6	Iron	11000	N	NA	NA	NA	NA	300
7439-92-1	Lead	NA		15[8]	0	NA	NA	NA
7439-96-5	Manganese	730	N	50[6]	NA	NA	NA	50

TABLE 9-2

SUMMARY OF WATER CRITERIA AND STANDARDS
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

CAS Number	Chemical	EPA Region III Risk-Based Concentration[1]		EPA Drinking Water Standard[2]		EPA Drinking Water Health Advisories[2]		EPA AWQC[3] Water & Organisms (ug/L)
		Tap Water (ug/L)	Basis	MCL (ug/L)	MCLG (ug/L)	Value (ug/L)	Receptor	
7439-97-6	Mercury	11[(S)]	N	2	2	2	Lifetime, Adult	0.05
7440-02-0	Nickel	730	N	100	100	100	Lifetime, Adult	610
7782-49-2	Selenium	180	N	50	50	NA	NA	170
7440-22-4	Silver	180	N	NA	NA	100	Lifetime, Adult	NA
7440-62-2	Vanadium	260	N	NA	NA	NA	NA	NA
7440-66-6	Zinc	11000	N	5000[6]	NA	2000	Lifetime, Adult	9100

Notes:

1 - U.S. EPA Region III Risk-based Concentration Table, April 12, 1999

2 - U.S. EPA Drinking Water Regulations and Health Advisories, October 1996.

3 - Ambient Water Quality Criteria, FR19781, April 22, 1999.

4 - Value is for naphthalene.

5 - Value for chlordane.

6 - Secondary MCL.

7 - Value for hexavalent chromium used.

8 - Action Level.

9 - Value is for mercuric chloride.

AWQC - Ambient Water Quality Criteria.

C - Carcinogenic.

N - Noncarcinogenic.

MCL - Maximum Contaminant Level.

MCLG - Maximum Contaminant Level Goal.

TABLE 9-3

BACKGROUND CONCENTRATIONS
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Chemical	Surface Soil (mg/kg)	Subsurface Soil (mg/kg)	Groundwater (ug/L)	Sediment[1] (mg/kg)
Aluminum	18329	34406	286545198	18329
Arsenic	4.25	24.4	ND	4.25
Barium	144	191	254	144
Beryllium	0.905	2.46	ND	0.905
Cadmium	0.26	0.388	2.8	0.26
Calcium	409	196	599450	409
Chromium	24.2	101	20.9	24.2
Cobalt	39.7	133	39.6	39.7
Copper	18.7	56.5	22.4	18.7
Iron	43170	151453	57199	43170
Lead	149	37.5	ND	149
Magnesium	1382	4307	31254	1382
Manganese	2248	1270	28160	2248
Mercury	0.087	0.13	0.13	0.087
Nickel	18.2	22.1	39	18.2
Potassium	1874	5998	83058	1874
Selenium	1.09	8.93	ND	1.09
Sodium	51.9	826	79585	51.9
Vanadium	53.5	133	24.1	53.5
Zinc	38.1	79.5	45.2	38.1

Notes:

1 *Surface soil background concentrations are used for background sediment* concentrations because on-site sediment samples are collected from intermittent drainage ditches.

Source: Background Investigation Report for Indian Head Stump Neck Annex, Indian Head and Stump Neck Annex, Brown & Root Environmental, December 1997.

TABLE 9-4

CHEMICALS RETAINED AS COPCs
UPGRADIENT AREA
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Chemical	Surface Soil	Subsurface Soil	Shallow Groundwater	Deep Groundwater	Surface Water	Sediment	Soil to Air	Soil to Groundwater
Volatiles								
1,1-Dichloroethene			X	X				
1,2-Dichloroethane			X					
Chloroform			X					
Trichloroethene			X	X				
Metals								
Arsenic	X							

Notes:
X - Indicates chemical was retained as a chemical of concern (COPC).

TABLE 9-5

CHEMICALS RETAINED AS COPCs
DOWNGRADIENT AREA
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Chemical	Surface Soil	Subsurface Soil	Shallow Groundwater	Deep Groundwater	Surface Water	Sediment	Soil to Air	Soil to Groundwater
Volatiles								
1,1-Dichloroethene			X	X				
Chloroform			X	X				
Ethyl Ether			X	X				
Methylene Chloride								X
Tetrachloroethene			X					
Trichloroethene		X	X	X			X	X
Vinyl Chloride			X	X				
cis-1,2-dichloroethene			X	X				X
Semivolatiles								
Benzo(a)anthracene	X							
Benzo(a)pyrene	X	X				X		
Benzo(b)fluoranthene	X							
Dibenzo(a,h)anthracene	X							
Indeno(1,2,3-cd)pyrene	X							
Metals								
Arsenic	X	X				X		X
Iron					X			
Lead	X							
Manganese					X			

Notes:
X - Indicates chemical was retained as a chemical of concern (COPC).

TABLE 9-6

CHEMICALS RETAINED AS COPCs
SEWER
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Chemical	Surface Water	Sediment
Volatiles		
1,1-Dichloroethene	X	
Acetone	X	
Ethyl Ether	X	
Trichloroethene	X	
Vinyl Chloride		X
cis-1,2-dichloroethene	X	
Semivolatiles		
Benzo(a)pyrene		X
Metals		
Arsenic		X
Iron	X	
Manganese	X	
Vanadium		X

Notes:
X - Indicates chemical was retained as a chemical of concern (COPC).

TABLE 9-7

CANCER TOXICITY DATA - ORAL/DERMAL
SITE 57 - FORMER DRUM STORAGE AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Chemical of Potential Concern	Oral Cancer Slope Factor	Oral to Dermal Adjustment Factor[1]	Adjusted Dermal Cancer Slope Factor[2]	Units	Weight of Evidence/ Cancer Guideline Description	Source	Date[3] (MM/DD/YY)
VOCs							
1,1-Dichloroethene	6.0E-01	100%	6.0E-01	$(mg/kg/day)^{-1}$	C	IRIS	06/01/99
1,2-Dichloroethane	9.1E-02	100%	9.1E-02	$(mg/kg/day)^{-1}$	B2	IRIS	06/01/99
cis-1,2-Dichloroethene	N/A	100%	N/A	$(mg/kg/day)^{-1}$	D	IRIS	06/01/99
Acetone	N/A	100%	N/A	$(mg/kg/day)^{-1}$	D	IRIS	06/01/99
Chloroform	6.1E-03	100%	6.1E-03	$(mg/kg/day)^{-1}$	B2	IRIS	06/01/99
Ethyl Ether	N/A	100%	N/A	$(mg/kg/day)^{-1}$	N/A	IRIS	06/01/99
Tetrachloroethene	5.2E-02	100%	5.2E-02	$(mg/kg/day)^{-1}$	N/A	EPAIII	4/12/99
Trichloroethene	1.1E-02	100%	1.1E-02	$(mg/kg/day)^{-1}$	N/A	EPAIII	4/12/99
Vinyl Chloride	1.9E+00	100%	1.9E+00	$(mg/kg/day)^{-1}$	N/A	HEAST	7/97
SVOCs							
Benzo(a)anthracene	7.3E-01	100%	7.3E-01	$(mg/kg/day)^{-1}$	B2	N/A	N/A
Benzo(b)fluoranthene	7.3E-01	100%	7.3E-01	$(mg/kg/day)^{-1}$	B2	N/A	N/A
Benzo(a)pyrene	7.3E+00	100%	7.3E+00	$(mg/kg/day)^{-1}$	B2	IRIS	06/01/99
Dibenzo(a,h)anthracene	7.3E+00	100%	7.3E+00	$(mg/kg/day)^{-1}$	B2	N/A	N/A
Indeno(1,2,3-cd)pyrene	7.3E-01	100%	7.3E-01	$(mg/kg/day)^{-1}$	B2	N/A	N/A
Inorganics							
Arsenic	1.5E+00	100%	1.5E+00	$(mg/kg/day)^{-1}$	A	IRIS	06/01/99
Iron	N/A	100%	N/A	$(mg/kg/day)^{-1}$	N/A	N/A	N/A
Lead	N/A	N/A	N/A	$(mg/kg/day)^{-1}$	B2	IRIS	06/01/99
Manganese	N/A	6%	N/A	$(mg/kg/day)^{-1}$	D	N/A	N/A
Vanadium	N/A	100%	N/A	$(mg/kg/day)^{-1}$	N/A	N/A	N/A

TABLE 9-7

CANCER TOXICITY DATA - ORAL/DERMAL
SITE 57 - FORMER DRUM STORAGE AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND
PAGE 2 OF 2

Notes:

IRIS = Integrated Risk Information System

HEAST= Health Effects Assessment Summary Tables

1 - USEPA Region III

2 - CSFdermal = CSForal/Oral to Dermal Adjustment Factor.

3 - For IRIS values, provide the date IRIS was searched.
For HEAST values, provide the date of HEAST.

EPA Group:

A - Human carcinogen

B1 - Probable human carcinogen - indicates that limited human data are available

B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans

C - Possible human carcinogen

D - Not classifiable as a human carcinogen

E - Evidence of noncarcinogenicity

Weight of Evidence:

Known/Likely

Cannot be Determined

Not Likely

TABLE 9-8

CANCER TOXICITY DATA - INHALATION
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Chemical of Potential Concern	Unit Risk	Units	Adjustment	Inhalation Cancer Slope Factor	Units	Weight of Evidence/ Cancer Guideline Description	Source	Date [1] (MM/DD/YY)
VOCs								
1,1-Dichloroethene	5.0E-05	$(ug/m^3)^{-1}$	3,500	1.8E-01	$(mg/kg/day)^{-1}$	C	IRIS	06/01/99
1,2-Dichloroethane	2.6E-05	$(ug/m^3)^{-1}$	3,500	9.1E-02	$(mg/kg/day)^{-1}$	B2	IRIS	06/01/99
cis-1,2-Dichloroethene	N/A	N/A	N/A	N/A	N/A	D	N/A	N/A
Acetone	N/A	N/A	N/A	N/A	N/A	D	N/A	N/A
Chloroform	2.3E-05	$(ug/m^3)^{-1}$	3,500	8.1E-02	$(mg/kg/day)^{-1}$	B2	IRIS	06/01/99
Ethyl Ether	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tetrachloroethene	N/A	$(ug/m^3)^{-1}$	3,500	2.0E-03	$(mg/kg/day)^{-1}$	N/A	EPAIII	4/12'99
Trichloroethene	N/A	N/A	N/A	6.0E-03	$(mg/kg/day)^{-1}$	N/A	EPAIII	4/12'99
Vinyl Chloride	8.4E-05	$(ug/m^3)^{-1}$	3,500	3.0E-01	$(mg/kg/day)^{-1}$	N/A	HEAST	7/97
SVOCs								
Benzo(a)anthracene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benzo(b)fluoranthene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benzo(a)pyrene	N/A	N/A	N/A	3.1E+00	$(mg/kg/day)^{-1}$	B2	EPAIII	4/12'99
Dibenzo(a,h)anthracene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Indeno(1,2,3-cd)pyrene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Inorganics								
Arsenic	4.3E-03	$(ug/m^3)^{-1}$	3,500	1.5E+01	$(mg/kg/day)^{-1}$	A	IRIS	06/01/99
Iron	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lead	N/A	N/A	N/A	N/A	B2	N/A	N/A	N/A
Manganese	N/A	N/A	N/A	N/A	D	N/A	N/A	N/A
Vanadium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

IRIS = Integrated Risk Information System

EPA Group:

TABLE 9-8

CANCER TOXICITY DATA - INHALATION
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND
PAGE 2 OF 2

HEAST= Health Effects Assessment Summary Tables

Weight of Evidence:

Known/Likely

Cannot be Determined

Not Likely

1 For IRIS values, date IRIS was searched.
For HEAST values, date of HEAST.

A - Human carcinogen

B1 - Probable human carcinogen - indicates that limited human data are available

B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans

C - Possible human carcinogen

D - Not classifiable as a human carcinogen

E - Evidence of noncarcinogenicity

TABLE 9-9

ESTIMATED ORDERS OF POTENTIAL POTENCY FOR CARCINOGENIC PAHs[1]
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Chemical	Weight-of-Evidence	Order of Potential Potency
Benzo(a)anthracene	B2	0.1
Benzo(b)fluoranthene	B2	0.1
Benzo(k)fluoranthene	B2	0.01
Benzo(a)pyrene	B2	1.0
Chrysene	B2	0.001
Dibenzo(a,h)anthracene	B2	1.0
Indeno(1,2,3-cd)pyrene	B2	0.1

1 EPA, 1993c; EPA Region I, 1994.

TABLE 9-10

NON-CANCER TOXICITY DATA - ORAL/DERMAL
SITE 57 - FORMER DRUM STORAGE AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD Value	Oral RfD Units	Oral to Dermal Adjustment Factor (1)	Adjusted Dermal RfD (2)	Units	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfD: Target Organ	Dates of RfD: Target Organ (3) (MM/DD/YY)
VOCs										
1,1-Dichloroethene	Chronic	9.0E-03	mg/kg/day	100%	9.0E-03	mg/kg/day	Liver	1000/1	IRIS	06/01/99
1,2-Dichloroethane	Chronic	3.0E-02	mg/kg/day	100%	3.0E-02	mg/kg/day	N/A	N/A	EPAIII	04/12/99
cis-1,2-Dichloroethene	Chronic	1.0E-02	mg/kg/day	100%	1.0E-02	mg/kg/day	Blood	3000	HEAST	7/97
Acetone	Chronic	1.0E-01	mg/kg/day	100%	1.0E-01	mg/kg/day	Liver	1000/1	IRIS	06/01/99
Chloroform	Chronic	1.0E-02	mg/kg/day	100%	1.0E-02	mg/kg/day	Liver	1000/1	IRIS	06/01/99
Ethyl Ether	Chronic	2.0E-01	mg/kg/day	100%	2.0E-01	mg/kg/day	N/A	3000/1	IRIS	06/01/99
Tetrachloroethene	Chronic	1.0E-02	mg/kg/day	100%	1.0E-02	mg/kg/day	Liver	1000/1	IRIS	06/01/99
Trichloroethene	Chronic	6.0E-03	mg/kg/day	100%	6.0E-03	mg/kg/day	N/A	N/A	EPAIII	04/12/99
Vinyl Chloride	Chronic	N/A	mg/kg/day	100%	N/A	mg/kg/day	N/A	N/A	N/A	06/01/99
SVOCs										
Benzo(a)anthracene	Chronic	N/A	mg/kg/day	100%	N/A	mg/kg/day	N/A	N/A	N/A	N/A
Benzo(b)fluoranthene	Chronic	N/A	mg/kg/day	100%	N/A	mg/kg/day	N/A	N/A	N/A	N/A
Benzo(a)pyrene	Chronic	N/A	mg/kg/day	100%	N/A	mg/kg/day	N/A	N/A	N/A	N/A
Dibenzo(a,h)anthracene	Chronic	N/A	mg/kg/day	100%	N/A	mg/kg/day	N/A	N/A	N/A	N/A
Indeno(1,2,3-cd)pyrene	Chronic	N/A	mg/kg/day	100%	N/A	mg/kg/day	N/A	N/A	N/A	N/A
Inorganics										
Arsenic	Chronic	3.0E-04	mg/kg/day	100%	3.0E-04	mg/kg/day	Skin	3/1	IRIS	06/01/99
Iron	Chronic	3.0E-01	mg/kg/day	100%	3.0E-01	mg/kg/day	Liver	N/A	EPAIII	N/A
Lead	Chronic	N/A	mg/kg/day	N/A	N/A	mg/kg/day	Blood, CNS	N/A	N/A	N/A
Manganese	Chronic	2.0E-02	mg/kg/day	6%	1.2E-03	mg/kg/day	CNS	1/1	IRIS	06/01/99
Vanadium	Chronic	7.0E-03	mg/kg/day	6%	4.2E-04	mg/kg/day	N/A	100	HEAST	7/97

Notes;

1 USEPA Region III

2 RfDdermal = RfDoral x Oral to Dermal Adjustment Factor

3 For IRIS values date that IRIS was searched.
For HEAST values, the date of HEAST.
FOR EPAIII, date of RBC Table.

N/A = Not Applicable

IRIS = Integrated Risk Information System

HEAST= Health Effects Assessment Summary Tables

EPAIII = USEPA Region III Risk-Based Concentration Table, April 12, 1999.

TABLE 9-11

NON-CANCER TOXICITY DATA - INHALATION
SITE 57 - FORMER DRUM STORAGE AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Chemical of Potential Concern	Chronic/ Subchronic	Value Inhalation RfC	Units	Adjusted Inhalation RfD[1]	Imots	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfC:RfD: Target Organ	Dates[2] (MM/DD/YY)
VOCs									
1,1-Dichloroethene	N/A	N/A	N/A	N/A	(mg/kg/day)	N/A	N/A	N/A	N/A
1,2-Dichloroethane	Chronic	N/A	N/A	1.4E-03	(mg/kg/day)	N/A	N/A	EPAIII	4/12/99
cis-1,2-Dichloroethene	N/A	N/A	N/A	N/A	(mg/kg/day)	N/A	N/A	N/A	N/A
Acetone	N/A	N/A	N/A	N/A	(mg/kg/day)	N/A	N/A	N/A	N/A
Chloroform	Chronic	N/A	N/A	8.6E-05	(mg/kg/day)	N/A	N/A	EPAIII	4/12/99
Ethyl Ether	N/A	N/A	N/A	N/A	(mg/kg/day)	N/A	N/A	N/A	N/A
Tetrachloroethene	Chronic	N/A	N/A	1.4E-01	(mg/kg/day)	N/A	N/A	EPAIII	4/12/99
Trichloroethene	N/A	N/A	N/A	N/A	(mg/kg/day)	N/A	N/A	N/A	N/A
Vinyl Chloride	N/A	N/A	N/A	N/A	(mg/kg/day)	N/A	N/A	N/A	N/A
SVOCs									
Benzo(a)anthracene	N/A	N/A	N/A	N/A	(mg/kg/day)	N/A	N/A	N/A	N/A
Benzo(b)fluoranthene	N/A	N/A	N/A	N/A	(mg/kg/day)	N/A	N/A	N/A	N/A
Benzo(a)pyrene	N/A	N/A	N/A	N/A	(mg/kg/day)	N/A	N/A	N/A	N/A
Dibenzo(a,h)anthracene	N/A	N/A	N/A	N/A	(mg/kg/day)	N/A	N/A	N/A	N/A
Indeno(1,2,3-cd)pyrene	N/A	N/A	N/A	N/A	(mg/kg/day)	N/A	N/A	N/A	N/A
Inorganics									
Arsenic	N/A	N/A	N/A	N/A	(mg/kg/day)	N/A	N/A	N/A	N/A
Iron	N/A	N/A	N/A	N/A	(mg/kg/day)	N/A	N/A	N/A	N/A
Lead	N/A	N/A	N/A	N/A	(mg/kg/day)	N/A	N/A	N/A	N/A
Manganese	Chronic	5E-05	(mg/m^3)	1.4E-05	(mg/kg/day)	CNS	1000/1	IRIS	06/01/99
Vanadium	N/A	N/A	N/A	N/A	(mg/kg/day)	N/A	N/A	N/A	N/A

N/A = Not Applicable

1 Provide equation used for derivation in text.

2 For IRIS values, date IRIS was searched.
For HEAST values, date of HEAST.

TABLE 9-12

SELECTION OF EXPOSURE PATHWAYS
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ On-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future	Surface Soil	Surface Soil	Upgradient	Full-Time Employee	Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Full-Time employees may be exposed to COPCs in soil during normal work activities.
				Trespassers	Adolescents	Ingestion Dermal	On-Site On-Site	None None	Access to site is restricted.
		Air	Upgradient	Full-Time Employee	Adult	Inhalation	On-site	None	No COPCs identified for this pathway.
				Trespassers	Adolescents	Inhalation	On-site	None	Access to site is restricted.
		Surface Soil	Downgradient	Full-Time Employee	Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Full-Time employees may be exposed to COPCs in soil during normal work activities.
				Trespassers	Adolescents	Ingestion Dermal	On-Site On-Site	None None	Access to site is restricted.
		Air	Downgradient	Full-Time Employee	Adult	Inhalation	On-site	None	No COPCs identified for this pathway.
				Trespassers	Adolescents	Inhalation	On-site	None	Access to site is restricted.
	Groundwater	Groundwater	Upgradient	Full-Time Employee	Adult	Ingestion Dermal	On-Site On-Site	None None	Full-time employee is not exposed to groundwater.
				Trespassers	Adolescents	Ingestion Dermal	On-Site On-Site	None None	Access to site is restricted.
			Downgradient	Full-Time Employee	Adult	Ingestion Dermal	On-Site On-Site	None None	Full-time employee is not exposed to groundwater.
				Trespassers	Adolescents	Ingestion Dermal	On-Site On-Site	None None	Access to site is restricted.
	Sediment	Sediment	Upgradient	Full-Time Employee	Adult	Ingestion Dermal	On-Site On-Site	None None	No COPCs identified for this pathway.
				Trespassers	Adolescents	Ingestion Dermal	On-Site On-Site	None None	Access to site is restricted.
			Downgradient	Full-Time Employee	Adult	Ingestion Dermal	On-Site On-Site	None None	Full-time employee is not exposed to sediment.
				Trespassers	Adolescents	Ingestion Dermal	On-Site On-Site	None None	Access to site is restricted.
	Surface Water	Surface Water	Upgradient	Full-Time Employee	Adult	Ingestion Dermal	On-Site On-Site	None None	No COPCs identified for this pathway.
				Trespassers	Adolescents	Ingestion Dermal	On-Site On-Site	None None	Access to site is restricted.
			Downgradient	Full-Time Employee	Adult	Ingestion Dermal	On-Site On-Site	None None	Full-time employee is not exposed to surface water.
				Trespassers	Adolescents	Ingestion Dermal	On-Site On-Site	None None	Access to site is restricted.

TABLE 9-12

SELECTION OF EXPOSURE PATHWAYS
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ On-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Future	Surface/ Subsurface Soil	Surface/ Subsurface Soil	Upgradient	Construction Worker	Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Construction worker my be exposed to COPCs in soil during excavation activities.
				Residents	Child	Ingestion Dermal	On-Site On-Site	Quant Quant	Residents may be exposed to COPCs in soil.
					Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Residents may be exposed to COPCs in soil.
		Air	Upgradient	Construction Worker	Adult	Inhalation	On-site	None	No COPCs identified for this pathway.
				Residents	Child	Inhalation	On-Site	None	No COPCs identified for this pathway.
					Adult	Inhalation	On-Site	None	No COPCs identified for this pathway.
		Surface/ Subsurface Soil	Downgradient	Construction Worker	Adult	Ingestion Dermal	On-site On-site	Quant Quant	Construction worker my be exposed to COPCs in soil during excavation activities.
				Residents	Child	Ingestion Dermal	On-site On-site	Quant Quant	Residents may be exposed to COPCs in soil.
					Adult	Ingestion Dermal	On-site On-site	Quant Quant	Residents may be exposed to COPCs in soil.
		Air	Downgradient	Construction Worker	Adult	Inhalation	On-site	Quant	Concentrations of TCE exceeded EPA SSLs for soil to air in subsurface soil.
				Residents	Child	Inhalation	On-site	Quant	Concentrations of TCE exceeded EPA SSLs for soil to air in subsurface soil.
					Adult	Inhalation	On-site	Quant	Concentrations of TCE exceeded EPA SSLs for soil to air in subsurface soil.
	Groundwater	Groundwater	Upgradient	Construction Worker	Adult	Dermal	On-site	Quant	Construction workers may be exposed to COPCs in groundwater during excavation activities.
				Residents	Child	Ingestion Dermal	On-site On-site	Quant Quant	Residents may be exposed to COPCs in groundwater if groundwater is used as a potable water supply.
					Adult	Ingestion Dermal	On-site On-site	Quant Quant	Residents may be exposed to COPCs in groundwater if groundwater is used as a potable water supply.
		Air	Upgradient	Construction Worker	Adult	Inhalation	On-Site	Quant	Construction workers may be exposed to COPCs in groundwater during excavation activities.
				Residents	Adult	Inhalation	On-Site	Quant	Adults may be exposed to COPCS while showering.
					Child	Inhalation	On-Site	None	Child is not assumed to shower.

TABLE 9-12

SELECTION OF EXPOSURE PATHWAYS
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ On-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
		Groundwater	Downgradient	Construction Worker	Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Construction workers may be exposed to COPCs in groundwater during excavation activities.
				Residents	Child	Ingestion Dermal	On-site On-site	Quant Quant	Residents may be exposed to COPCs in groundwater if groundwater is used as a potable water supply.
					Adult	Ingestion Dermal	On-site On-site	Quant Quant	Residents may be exposed to COPCs in groundwater if groundwater is used as a potable water supply.
		Air	Downgradient	Construction Worker	Adult	Inhalation	On-Site	Quant	Construction workers may be exposed to COPCs in groundwater during excavation activities.
				Residents	Adult	Inhalation	On-Site	Quant	Adults may be exposed to COPCS while showering.
					Child	Inhalation	On-Site	None	Child is not assumed to shower.
	Sediment	Sediment	Upgradient	Construction Worker	Adult	Ingestion Dermal	On-Site On-Site	None None	No COPCs identified for this pathway.
				Residents	Child	Ingestion Dermal	On-Site On-Site	None None	No COPCs identified for this pathway.
					Adult	Ingestion Dermal	On-Site On-Site	None None	No COPCs identified for this pathway.
			Downgradient	Construction Worker	Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Construction worker may be exposed to COPCs in sediment during construction activities.
				Residents	Child	Ingestion Dermal	On-Site On-Site	Quant Quant	Residents may be exposed to COPCs in sediment during recreational activities.
					Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Residents may be exposed to COPCs in sediment during recreational activities.
			Sewer	Construction Worker	Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Construction worker may be exposed to COPCs in sediment during construction activities.
	Surface Water	Surface Water	Upgradient	Construction Worker	Adult	Ingestion Dermal	On-Site On-Site	None None	No COPCs identified for this pathway.
				Residents	Child	Ingestion Dermal	On-Site On-Site	None None	No COPCs identified for this pathway.
					Adult	Ingestion Dermal	On-Site On-Site	None None	No COPCs identified for this pathway.
			Downgradient	Construction Worker	Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Construction worker may be exposed to COPCs in surface water during construction activities.
				Residents	Child	Ingestion Dermal	On-Site On-Site	Quant Quant	Residents may be exposed to COPCs in surface water during recreational activities.
					Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Residents may be exposed to COPCs in surface water during recreational activities.
			Sewer	Construction Worker	Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Construction worker may be exposed to COPCs in surface water during construction activities.

TABLE 9-13

EXPOSURE POINT CONCENTRATIONS
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Chemical	Upgradient			DownGradient						
	Surface Soil (mg/kg)	Surface/ Subsurface Soil (mg/kg)	Groundwater (mg/L)	Surface Soil (mg/kg)	Surface/ Subsurface Soil (mg/kg)	Groundwater (mg/L)	Surface Water (ug/L)	Sediment (mg/kg)	Sewer Surface Water (ug/L)	Sediment (mg/kg)
Volatile Organic Compounds										
1,1-Dichloroethene	NA	NA	0.0775[1]	NA	NA	0.029[4]	NA	NA	0.2[4]	NA
1,2-Dichloroethane	NA	NA	0.0027[1]	NA	NA	NA	NA	NA	NA	NA
Acetone	NA	NA	NA	NA	NA	NA	NA	NA	725[4]	NA
Chloroform	NA	NA	0.0013[1]	NA	NA	0.0013[4]	NA	NA	NA	NA
Ethyl Ether	NA	NA	NA	NA	NA	3.95[4]	NA	NA	120[2]	NA
Tetrachloroethene	NA	NA	NA	NA	NA	0.00541[2]	NA	NA	NA	NA
Trichloroethene	NA	NA	0.0023[1]	NA	0.504[2]	0.612[4]	NA	NA	15.2[2]	NA
Vinyl Chloride	NA	NA	NA	NA	NA	0.085[4]	NA	NA	NA	1[1]
cis-1,2-Dichloroethene	NA	NA	NA	NA	NA	0.528[4]	NA	NA	9.1[2]	NA
Semivolatile Organic Compounds										
Benzo(a)anthracene	NA	NA	NA	2.3[2]	1.46[1]	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	1.7[2]	1.13[1]	NA	NA	0.12[1]	NA	0.3[1]
Benzo(b)fluoranthene	NA	NA	NA	4.2[2]	3.43[1]	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	NA	0.35[2]	0.259[1]	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	0.97[2]	0.788[1]	NA	NA	NA	NA	NA
Metals										
Arsenic	9.6[1]	9.6[1]	NA	103[2]	71.7[1]	NA	NA	4.7[1]	NA	8.4[1]
Iron	NA	NA	NA	NA	NA	NA	785[1]	NA	1546[2]	NA
Lead	NA	NA	NA	NA	102[3]	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	NA	NA	NA	363[1]	NA	119[2]	NA
Vanadium	NA	NA	NA	NA	NA	NA	NA	NA	NA	118[1]

Notes:
Supporting statistics are provided in Appendix J.
RAGS Part D Tables for exposure point concentrations are provided in Appendix K.
NA - Chemical is not a COPC for this media.
1 - Maximum detected concentration; not enough samples to calculate an upper confidence limit.
2 - 95 percent upper confidence limit.
3 - Mean concentration used as exposure point concentration for lead in accordance with EPA guidance.
4 - Upper confidence interval is greater than maximum detected concentration; therefore, maximum detected concentration is used as exposure point concentration.

TABLE 9-14

VALUES USED FOR DAILY INTAKE CALCULATIONS
FULL TIME EMPLOYEES EXPOSED TO SURFACE SOIL
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CS	Chemical concentration in soil	mg/kg	See Text	See Text	See Text	See Text	Intake (mg/kg/day) =
	IR-S	Ingestion Rate	mg/day	50	EPA, 1999	25	(2)	$\frac{Cs \times IRS \times CF3 \times FI \times EF \times ED}{BW \times AT}$
	CF3	Conversion Factor 3	kg/mg	1.0E-06	- -	1.0E-06	- -	
	FI	Fraction Ingested	unitless	1	EPA, 1993	1	EPA, 1993	
	EF	Exposure Frequency	days/year	250	EPA, 1993	219	EPA, 1993	
	ED	Exposure Duration	years	25	EPA, 1993	5	USDL, 1992	
	BW	Body Weight	kg	70	EPA, 1993	70	EPA, 1993	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	9125	EPA, 1989	1825	EPA, 1989	
Dermal	CS	Chemical concentration in soil	mg/kg	See Text	See Text	See Text	See Text	Dermally Absorbed Dose (mg/kg/day) =
	CF3	Conversion Factor 3	kg/mg	1.0E-06	- -	1.0E-06	- -	$\frac{Cs \times CF3 \times SA \times SSAF \times DABS \times EF \times ED}{BW \times AT}$
	SA	Skin Surface Available for Contact	cm2.	4300	(1)	4300	(1)	
	SSAF	Soil to Skin Adherence Factor	mg/cm2/event	0.2	EPA, 1997	0.02	EPA, 1997	
	DABS	Absorption Factor	unitless	See Text	(2)	See Text	(2)	
	EF	Exposure Frequency	days/year	250	EPA, 1993	219	EPA, 1993	
	ED	Exposure Duration	years	25	EPA, 1993	5	USDL, 1992	
	BW	Body Weight	kg	70	EPA, 1993	70	EPA, 1993	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	9125	EPA, 1989	1825	EPA, 1989	

Notes:

1 - Mean value for head, arms, and hands

2 - Professional judgment.

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1993: Superfund Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

EPA, 1997: Exposure Factors Handbook, EPA/600/P-95/002Fa.

TABLE 9-15

VALUES USED FOR DAILY INTAKE CALCULATIONS
CONSTRUCTION WORKERS EXPOSED TO SURFACE/SUBSURFACE SOIL
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CS	Chemical concentration in soil	mg/kg	See Text	See Text	See Text	See Text	Intake (mg/kg/day) =
	IR-S	Ingestion Rate	mg/day	480	EPA, 1993	240	EPA, 1993	$\frac{Cs \times IRS \times CF3 \times FI \times EF \times ED}{BW \times AT}$
	CF3	Conversion Factor 3	kg/mg	1.0E-06	- -	1.0E-06	- -	
	FI	Fraction Ingested	unitless	1	EPA, 1993	1	EPA, 1993	
	EF	Exposure Frequency	days/year	250	EPA, 1993	219	EPA, 1993	
	ED	Exposure Duration	years	1	(1)	1	(1)	
	BW	Body Weight	kg	70	EPA, 1993	70	EPA, 1993	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	365	EPA, 1989	365	EPA, 1989	
Dermal	CS	Chemical concentration in soil	mg/kg	See Text	See Text	See Text	See Text	Dermally Absorbed Dose (mg/kg/day) =
	CF3	Conversion Factor 3	kg/mg	1.0E-06	- -	1.0E-06	- -	$\frac{Cs \times CF3 \times SA \times SSAF \times DABS \times EF \times ED}{BW \times AT}$
	SA	Skin Surface Available for Contact	cm2	5300	(2)	5300	(2)	
	SSAF	Soil to Skin Adherence Factor	mg/cm2/event	0.2	EPA, 1997	0.02	EPA, 1997	
	DABS	Absorption Factor	unitless	See Text	(2)	See Text	(2)	
	EF	Exposure Frequency	days/year	250	EPA, 1993	219	EPA, 1993	
	ED	Exposure Duration	years	1	(1)	1	(1)	
	BW	Body Weight	kg	70	EPA, 1993	70	EPA, 1993	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	365	EPA, 1989	365	EPA, 1989	
Inhalation	CA	Chemical concentration in air	mg/m3	See Text	See Text	See Text	See Text	Intake (mg/kg/day) =
	IR	Inhalation Rate	m3/hour	3.3	EPA, 1989	3.3	EPA, 1989	$\frac{CA \times IR \times ET \times EF \times ED}{BW \times AT}$
	ET	Exposure Time	hours/day	8	(1)	8	(1)	
	EF	Exposure Frequency	days/year	250	EPA, 1993	219	EPA, 1993	
	ED	Exposure Duration	years	1	(1)	1	(1)	
	BW	Body Weight	kg	70	EPA, 1993	70	EPA, 1993	
	AT-C	Averaging Time (Cancer)	days	25550	EPA, 1989	25550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	365	EPA, 1989	365	EPA, 1989	

Notes:
1 - Professional judgment.
2 - Refer to supporting text.
Sources:
EPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.
EPA, 1993: Superfund Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

TABLE 9-16

VALUES USED FOR DAILY INTAKE CALCULATIONS
CONSTRUCTION WORKERS EXPOSED TO GROUNDWATER
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Dermal	DAevent	Absorbed dose per event	mg/cm2-event	See Text	See Text	See Text	See Text	Dermally Absorbed Dose (mg/kg/day)
	SA	Skin Surface Available for Contact	cm2	4050	(1)	4050	(1)	$= \frac{DAevent \times EV \times EF \times ED \times SA}{BW \times AT}$
	EV	Event Frequency	events/day	1	(2)	1	(2)	
	ET	Exposure Time	hours/event	8	(2)	8	(2)	
	EF	Exposure Frequency	days/year	40	(2)	20	(2)	
	ED	Exposure Duration	years	1	(2)	1	(2)	See text for calculation of DAevent.
	BW	Body Weight	kg	70	EPA, 1993	70	EPA, 1993	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	365	EPA, 1989	365	EPA, 1989	
Inhalation	CA	Chemical concentration in air	mg/m3	See Text	See Text	See Text	See Text	Intake (mg/kg/day) =
	IR	Inhalation Rate	m3/hour	3.3	EPA, 1989	3.3	EPA, 1989	$\frac{CA \times IR \times ET \times EF \times ED}{BW \times AT}$
	ET	Exposure Time	hours/day	8	(2)	8	(2)	
	EF	Exposure Frequency	days/year	40	(2)	20	(2)	
	ED	Exposure Duration	years	1	(2)	1	(2)	
	BW	Body Weight	kg	70	EPA, 1993	70	EPA, 1993	
	AT-C	Averaging Time (Cancer)	days	25550	EPA, 1989	25550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	365	EPA, 1989	365	EPA, 1989	

Notes:
1 - Assumes hands, forearms, and lower legs are exposed.
2 - Professional judgment.
Sources:
EPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.
EPA, 1993: Superfund Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure..

TABLE 9-17

VALUES USED FOR DAILY INTAKE CALCULATIONS
CONSTRUCTION WORKERS EXPOSED TO SEDIMENT
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CS	Chemical concentration in soil	mg/kg	See Text	See Text	See Text	See Text	Intake (mg/kg/day) =
	IR-S	Ingestion Rate	mg/day	240	(1)	120	(1)	$\frac{Cs \times IRS \times CF3 \times FI \times EF \times ED}{BW \times AT}$
	CF3	Conversion Factor 3	kg/mg	1.0E-06	- -	1.0E-06	- -	
	FI	Fraction Ingested	unitless	1	EPA, 1993	1	EPA, 1993	
	EF	Exposure Frequency	days/year	60	(1)	30	(1)	
	ED	Exposure Duration	years	1	(1)	1	(1)	
	BW	Body Weight	kg	70	EPA, 1993	70	EPA, 1993	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	365	EPA, 1989	365	EPA, 1989	
Dermal	CS	Chemical concentration in soil	mg/kg	See Text	See Text	See Text	See Text	Dermally Absorbed Dose (mg/kg/day) =
	CF3	Conversion Factor 3	kg/mg	1.0E-06	- -	1.0E-06	- -	$\frac{Cs \times CF3 \times SA \times SSAF \times DABS \times EF \times ED}{BW \times AT}$
	SA	Skin Surface Available for Contact	cm2	4300	(2)	4300	(2)	
	SSAF	Soil to Skin Adherence Factor	mg/cm2/event	0.2	EPA, 1997	0.02	EPA, 1997	
	DABS	Absorption Factor	unitless	See Text	See Text	See Text	See Text	
	EF	Exposure Frequency	days/year	60	(1)	30	(1)	
	ED	Exposure Duration	years	1	(1)	1	(1)	
	BW	Body Weight	kg	70	EPA, 1993	70	EPA, 1993	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	365	EPA, 1989	365	EPA, 1989	

Notes:

1 - *Professional judgment.*

2 - Mean value for head, arms, and hands

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1993: Superfund Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

TABLE 9-18

VALUES USED FOR DAILY INTAKE CALCULATIONS
CONSTRUCTION WORKERS EXPOSED TO SURFACE WATER
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CW	Chemical Concentration in Water	ug/L	See Text	See Text	See Text	See Text	Intake (mg/kg/day) =
	CR	Contact Rate	L/hour	0.01	EPA, 1995	0.01	EPA, 1995	$\frac{CW \times CR \times CF \times ET \times EF \times ED}{BW \times AT}$
	CF	Conversion factor	ug/mg	0.001	- -	0.001	- -	
	ET	Exposure Time	hours/event	8	(1)	8	(1)	
	EF	Exposure Frequency	events/year	60	(1)	30	(1)	
	ED	Exposure Duration	years	1	(1)	1	(1)	
	BW	Body Weight	kg	70	EPA, 1993	70	EPA, 1993	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	365	EPA, 1989	365	EPA, 1989	
Dermal	DAevent	Absorbed dose per event	mg/cm2-event	See Text	See Text	See Text	See Text	Dermally Absorbed Dose (mg/kg/day)
	SA	Skin Surface Available for Contact	cm2	4300	(2)	4300	(2)	$= \frac{DAevent \times EV \times EF \times ED \times SA}{BW \times AT}$
	EV	Event Frequency	events/day	1	(1)	1	(1)	
	ET	Exposure Time	hours/event	8	EPA, 1989	8	EPA, 1989	
	EF	Exposure Frequency	days/year	60	(1)	30	(1)	
	ED	Exposure Duration	years	1	(1)	1	(1)	See text for calculation of DAevent.
	BW	Body Weight	kg	70	EPA, 1993	70	EPA, 1993	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	365	EPA, 1989	365	EPA, 1989	

Notes:

1 - Professional judgment.

2 - Assumes hand., forearms, and lower legs are exposed.

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1993: Superfund Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure..

TABLE 9-19

VALUES USED FOR DAILY INTAKE CALCULATIONS
HYPOTHETICAL CHILD RESIDENTS EXPOSED TO SURFACE/SUBSURFACE SOIL
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CS	Chemical concentration in soil	mg/kg	See Text	See Text	See Text	See Text	Intake (mg/kg/day) =
	IR-S	Ingestion Rate	mg/day	200	EPA, 1993	100	EPA, 1993	$\frac{Cs \times IRS \times CF3 \times FI \times EF \times ED}{BW \times AT}$
	CF3	Conversion Factor 3	kg/mg	1.0E-06	- -	1.0E-06	- -	
	FI	Fraction Ingested	unitless	1	EPA, 1993	1	EPA, 1993	
	EF	Exposure Frequency	days/year	350	EPA, 1993	234	EPA, 1993	
	ED	Exposure Duration	years	6	EPA, 1993	2	EPA, 1993	
	BW	Body Weight	kg	15	EPA, 1993	15	EPA, 1993	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	2190	EPA, 1989	730	EPA, 1989	
Dermal	CS	Chemical concentration in soil	mg/kg	See Text	See Text	See Text	See Text	Dermally Absorbed Dose (mg/kg/day) =
	CF3	Conversion Factor 3	kg/mg	1.0E-06	- -	1.0E-06	- -	$\frac{Cs \times CF3 \times SA \times SSAF \times DABS \times EF \times ED}{BW \times AT}$
	SA	Skin Surface Available for Contact	cm2	1743	(1)	1743	(1)	
	SSAF	Soil to Skin Adherence Factor	mg/cm2/event	0.2	EPA, 1997	0.06	EPA, 1997	
	DABS	Absorption Factor	unitless	See Text	(2)	See Text	(2)	
	EF	Exposure Frequency	days/year	350	EPA, 1993	234	EPA, 1993	
	ED	Exposure Duration	years	6	EPA, 1993	2	EPA, 1993	
	BW	Body Weight	kg	15	EPA, 1993	15	EPA, 1993	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	2190	EPA, 1989	730	EPA, 1989	
Inhalation	CA	Chemical concentration in air	mg/m3	See Text	See Text	See Text	See Text	Intake (mg/kg/day) =
	IR	Inhalation Rate	m3/hour	0.5	EPA III, 1999	0.5	EPA III, 1999	$\frac{CA \times IR \times ET \times EF \times ED}{BW \times AT}$
	ET	Exposure Time	hours/day	24	EPA, 1993	24	EPA, 1993	
	EF	Exposure Frequency	days/year	350	EPA, 1993	234	EPA, 1993	
	ED	Exposure Duration	years	6	EPA, 1993	2	EPA, 1993	
	BW	Body Weight	kg	15	EPA, 1993	15	EPA, 1993	
	AT-C	Averaging Time (Cancer)	days	25550	EPA, 1989	25550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	2190	EPA, 1989	730	EPA, 1989	

Notes:

1 - Assume 25 percent of total body surface area available for contact.

2 - See text.

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1993: Superfund Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

EPA, 1997: Exposure Factors Handbook, EPA/600/P-95/002Fa.

TABLE 9-20

VALUES USED FOR DAILY INTAKE CALCULATIONS
HYPOTHETICAL CHILD RESIDENTS EXPOSED TO GROUNDWATER
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CW	Chemical Concentration in Water	mg/L	See Text	See Text	See Text	See Text	Intake (mg/kg/day) =
	IR	Ingestion Rate	L/day	1	EPA, 1993	1	EPA, 1993	$\frac{CW \times IR \times EF \times ED}{BW \times AT}$
	EF	Exposure Frequency	days/year	350	EPA, 1993	234	EPA, 1993	
	ED	Exposure Duration	years	7	EPA, 1993	2	EPA, 1993	
	BW	Body Weight	kg	15	EPA, 1993	15	EPA, 1993	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	2555	EPA, 1989	730	EPA, 1989	
Dermal	DAevent	Absorbed dose per event	mg/cm2-event	See Text	See Text	See Text	See Text	Dermally Absorbed Dose (mg/kg/day)
	SA	Skin Surface Available for Contact	cm2	6970	EPA, 1992	6970	EPA, 1992	$= \frac{DAevent \times EV \times EF \times ED \times SA}{BW \times AT}$
	EV	Event Frequency	events/day	1	EPA, 1992	1	EPA, 1992	
	ET	Exposure Time	hours/event	0.25	EPA, 1992	0.167	EPA, 1992	
	EF	Exposure Frequency	days/year	350	EPA, 1993	234	EPA, 1993	
	ED	Exposure Duration	years	7	EPA, 1993	2	EPA, 1993	See text for calculation of DAevent.
	BW	Body Weight	kg	15	EPA, 1993	15	EPA, 1993	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	2,555	EPA, 1989	730	EPA, 1989	

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1992a: Dermal Exposure Assessment: Principles and Applications. EPA/600/8-91/011B.

EPA, 1993: Superfund Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure..

TABLE 9-21

VALUES USED FOR DAILY INTAKE CALCULATIONS
HYPOTHETICAL CHILD RESIDENTS EXPOSED TO SEDIMENT
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CS	Chemical concentration in soil	mg/kg	See Text	See Text	See Text	See Text	Intake (mg/kg/day) =
	IR-S	Ingestion Rate	mg/day	200	EPA, 1993	100	EPA, 1993	$\frac{Cs \times IRS \times CF3 \times FI \times EF \times ED}{BW \times AT}$
	CF3	Conversion Factor 3	kg/mg	1.0E-06	- -	1.0E-06	- -	
	FI	Fraction Ingested	unitless	1	EPA, 1993	1	EPA, 1993	
	EF	Exposure Frequency	days/year	16	(1)	8	(1)	
	ED	Exposure Duration	years	6	EPA, 1993	2	EPA, 1993	
	BW	Body Weight	kg	15	EPA, 1993	15	EPA, 1993	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	2190	EPA, 1989	730	EPA, 1989	
Dermal	CS	Chemical concentration in soil	mg/kg	See Text	See Text	See Text	See Text	Dermally Absorbed Dose (mg/kg/day) =
	CF3	Conversion Factor 3	kg/mg	1.0E-06	- -	1.0E-06	- -	$\frac{Cs \times CF3 \times SA \times SSAF \times DABS \times EF \times ED}{BW \times AT}$
	SA	Skin Surface Available for Contact	cm2	1743	(2)	1743	(2)	
	SSAF	Soil to Skin Adherence Factor	mg/cm2/event	0.2	EPA, 1997	0.06	EPA, 1997	
	DABS	Absorption Factor	unitless	See Text	(3)	See Text	(3)	
	EF	Exposure Frequency	days/year	16	(1)	8	(1)	
	ED	Exposure Duration	years	6	EPA, 1993	2	EPA, 1993	
	BW	Body Weight	kg	15	EPA, 1993	15	EPA, 1993	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	2190	EPA, 1989	730	EPA, 1989	

Notes:

1 - Assumes 1 day a week for summer months (May through August). CTE is 50 percent of RME.

2 - Assume 25 percent of total body surface area available for contact.

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1993: Superfund Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

EPA, 1997: Exposure Factors Handbook, EPA/600/P-95/002Fa.

TABLE 9-22

VALUES USED FOR DAILY INTAKE CALCULATIONS
HYPOTHETICAL CHILD RESIDENTS EXPOSED TO SURFACE WATER
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CW	Chemical Concentration in Water	ug/L	See Text	See Text	See Text	See Text	Intake (mg/kg/day) =
	CR	Contact Rate	L/hour	0.05	EPA, 1988	0.05	EPA, 1988	$\frac{CW \times CR \times CF \times ET \times EF \times ED}{BW \times AT}$
	CF	Conversion factor	ug/mg	0.001	- -	0.001	- -	
	ET	Exposure Time	hours/event	4	(1)	2	(1)	
	EF	Exposure Frequency	events/year	16	(1)	8	(1)	
	ED	Exposure Duration	years	6	EPA, 1993	2	EPA, 1993	
	BW	Body Weight	kg	15	EPA, 1993	15	EPA, 1993	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	2190	EPA, 1989	730	EPA, 1989	
Dermal	DAevent	Absorbed dose per event	mg/cm2-event	See Text	(2)	See Text	(2)	Dermally Absorbed Dose (mg/kg/day)
	SA	Skin Surface Available for Contact	cm2	1743	(3)	1743	(3)	$= \frac{DAevent \times EV \times EF \times ED \times SA}{BW \times AT}$
	EV	Event Frequency	events/day	1	(1)	1	(1)	
	ET	Exposure Time	hours/event	4	(1)	2	(1)	
	EF	Exposure Frequency	days/year	16	(1)	8	(1)	
	ED	Exposure Duration	years	6	EPA, 1993	2	EPA, 1993	See text for calculation of DAevent.
	BW	Body Weight	kg	15	EPA, 1993	15	EPA, 1993	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	2190	EPA, 1989	730	EPA, 1989	

Notes:
1 - Professional judgment. Assumes 1 day a week for summer months (May through August). CTE is 50 percent of RME.
2 - Refer to supporting text.
3 - Assume 25 percent of total body surface area available for contact.
Sources:
EPA, 1988: Superfund Exposure Assessment Manual.

TABLE 9-23

VALUES USED FOR DAILY INTAKE CALCULATIONS
HYPOTHETICAL ADULT RESIDENTS EXPOSED TO SURFACE/SUBSURFACE SOIL
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CTE Value	CTE Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CS	Chemical concentration in soil	mg/kg	See Text	See Text	See Text	See Text	Intake (mg/kg/day) =
	IR-S	Ingestion Rate	mg/day	100	EPA, 1993	50	EPA, 1993	$\frac{Cs \times IRS \times CF3 \times FI \times EF \times ED}{BW \times AT}$
	CF3	Conversion Factor 3	kg/mg	1.0E-06	- -	1.0E-06	- -	
	FI	Fraction Ingested	unitless	1	EPA, 1993	1	EPA, 1993	
	EF	Exposure Frequency	days/year	350	EPA, 1993	234	EPA, 1993	
	ED	Exposure Duration	years	24	EPA, 1993	7	EPA, 1993	
	BW	Body Weight	kg	70	EPA, 1993	70	EPA, 1993	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	8760	EPA, 1989	2555	EPA, 1989	
Dermal	CS	Chemical concentration in soil	mg/kg	See Text	See Text	See Text	See Text	Dermally Absorbed Dose (mg/kg/day) =
	CF3	Conversion Factor 3	kg/mg	1.0E-06	- -	1.0E-06	- -	$\frac{Cs \times CF3 \times SA \times SSAF \times DABS \times EF \times ED}{BW \times AT}$
	SA	Skin Surface Available for Contact	cm2	5000	(1)	5000	(1)	
	SSAF	Soil to Skin Adherence Factor	mg/cm2/event	0.07	EPA, 1997	0.01	EPA, 1997	
	DABS	Absorption Factor	unitless	See Text	See Text	See Text	See Text	
	EF	Exposure Frequency	days/year	350	EPA, 1993	234	EPA, 1993	
	ED	Exposure Duration	years	24	EPA, 1993	7	EPA, 1993	
	BW	Body Weight	kg	70	EPA, 1993	70	EPA, 1993	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	8760	EPA, 1989	2555	EPA, 1989	
Inhalation	CA	Chemical concentration in air	mg/m3	See Text	See Text	See Text	See Text	Intake (mg/kg/day) =
	IR	Inhalation Rate	m3/hour	0.83	EPA, 1993	0.83	EPA, 1993	$\frac{CA \times IR \times ET \times EF \times ED}{BW \times AT}$
	ET	Exposure Time	hours/day	24	EPA, 1993	24	EPA, 1993	
	EF	Exposure Frequency	days/year	350	EPA, 1993	234	EPA, 1993	
	ED	Exposure Duration	years	24	EPA, 1993	7	EPA, 1993	
	BW	Body Weight	kg	70	EPA, 1993	70	EPA, 1993	
	AT-C	Averaging Time (Cancer)	days	25550	EPA, 1989	25550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	8760	EPA, 1989	2555	EPA, 1989	

Notes:

1 - Assume 25 percent of total body surface area available for contact.

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1993c: Superfund Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

EPA, 1997b: Exposure Factors Handbook, EPA/600/P-95/002Fa.

TABLE 9-24

VALUES USED FOR DAILY INTAKE CALCULATIONS
HYPOTHETICAL ADULT RESIDENTS EXPOSED TO GROUNDWATER
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CTE Value	CTE Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CW	Chemical Concentration in Water	mg/L	See Text	See Text	See Text	See Text	Intake (mg/kg/day) =
	IR	Ingestion Rate	L/day	2	EPA, 1993	1.4	EPA, 1993	$\frac{CW \times IR \times EF \times ED}{BW \times AT}$
	EF	Exposure Frequency	days/year	350	EPA, 1993	234	EPA, 1993	
	ED	Exposure Duration	years	24	EPA, 1993	7	EPA, 1993	
	BW	Body Weight	kg	70	EPA, 1993	70	EPA, 1993	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	8760	EPA, 1989	2555	EPA, 1989	
Dermal	DAevent	Absorbed dose per event	mg/cm2-event	See Text	See Text	See Text	See Text	Dermally Absorbed Dose (mg/kg/day)
	SA	Skin Surface Available for Contact	cm2	20000	EPA, 1992	20000	EPA, 1992	$= \frac{DAevent \times EV \times EF \times ED \times SA}{BW \times AT}$
	EV	Event Frequency	events/day	1	EPA, 1992	1	EPA, 1992	
	ET	Exposure Time	hours/event	0.25	EPA, 1992	0.167	EPA, 1992	
	EF	Exposure Frequency	days/year	350	EPA, 1993	234	EPA, 1993	
	ED	Exposure Duration	years	24	EPA, 1993	7	EPA, 1993	See text for calculation of DAevent.
	BW	Body Weight	kg	70	EPA, 1993	70	EPA, 1993	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	8,760	EPA, 1989	2,555	EPA, 1989	
Inhalation	CW	Chemical Concentration in Water	mg/L	See Text	See Text	See Text	See Text	Foster & Chrostowski Inhalation Model
	Ra	Air Exchange Rate	min^{-1}	0.0166	default value	0.0166	default value	
	Ds	Shower Duration	min	15	default value	10	default value	
	Dt	Total Time in Bathroom	min	20	default value	15	default value	
	Fr	Shower Water Flow Rate	L/min	20	default value	20	default value	
	Sv	Shower Room Air Volume	m3	6	default value	6	default value	
	Ts	Shower Droplet Drop Time	sec	2	default value	2	default value	
	d	Shower Droplet Diameter	mm	1	default value	1	default value	
	T1	Calibration Water Temperature	K	293	default value	293	default value	
	Ts	Shower Water Temperature	K	318	default value	318	default value	
	m1	Water Viscosity at T1	cp	0.982	default value	0.982	default value	
	ms	Water Viscosity at Ts	cp	0.616	default value	0.616	default value	
	K	Mass Transfer Coefficient	min	2.78	default value	2.78	default value	
	IRsh	Inhalation Rate	L/min	10	default value	10	default value	
	EF	Exposure Frequency	days/year	350	EPA, 1993	234	EPA, 1993	
	ED	Exposure Duration	years	24	EPA, 1993	7	EPA, 1993	
	BW	Body Weight	kg	70	EPA, 1993	70	EPA, 1993	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	8,760	EPA, 1989	2,555	EPA, 1989	

Notes:

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1992a: Dermal Exposure Assessment: Principles and Applications. EPA/600/8-91/011B.

EPA, 1993c: Superfund Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure..

TABLE 9-25

VALUES USED FOR DAILY INTAKE CALCULATIONS
HYPOTHETICAL ADULT RESIDENTS EXPOSED TO SEDIMENT
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CTE Value	CTE Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CS	Chemical concentration in soil	mg/kg	See Text	See Text	See Text	See Text	Intake (mg/kg/day) =
	IR-S	Ingestion Rate	mg/day	100	EPA, 1993	50	EPA, 1993	$\frac{Cs \times IRS \times CF3 \times FI \times EF \times ED}{BW \times AT}$
	CF3	Conversion Factor 3	kg/mg	1.0E-06	- -	1.0E-06	- -	
	FI	Fraction Ingested	unitless	1	EPA, 1993	1	EPA, 1993	
	EF	Exposure Frequency	days/year	16	(1)	8	(1)	
	ED	Exposure Duration	years	24	EPA, 1993	7	EPA, 1993	
	BW	Body Weight	kg	70	EPA, 1993	70	EPA, 1993	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	8760	EPA, 1989	2555	EPA, 1989	
Dermal	CS	Chemical concentration in soil	mg/kg	See Text	See Text	See Text	See Text	Dermally Absorbed Dose (mg/kg/day) =
	CF3	Conversion Factor 3	kg/mg	1.0E-06	- -	1.0E-06	- -	$\frac{Cs \times CF3 \times SA \times SSAF \times DABS \times EF \times ED}{BW \times AT}$
	SA	Skin Surface Available for Contact	cm2	5000	(2)	5000	(2)	
	SSAF	Soil to Skin Adherence Factor	mg/cm2/event	0.07	EPA, 1997	0.01	EPA, 1997	
	DABS	Absorption Factor	unitless	See Text	See Text	See Text	See Text	
	EF	Exposure Frequency	days/year	350	EPA, 1993	234	EPA, 1993	
	ED	Exposure Duration	years	24	EPA, 1993	7	EPA, 1993	
	BW	Body Weight	kg	70	EPA, 1993	70	EPA, 1993	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	8760	EPA, 1989	2555	EPA, 1989	

Notes:

1 - Assumes 1 day a week for summer months (May through August). CTE is 50 percent of RME.

2 - Assume 25 percent of total body surface area available for contact.

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1993c: Superfund Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

EPA, 1997b: Exposure Factors Handbook, EPA/600/P-95/002Fa.

TABLE 9-26

VALUES USED FOR DAILY INTAKE CALCULATIONS
HYPOTHETICAL ADULT RESIDENTS EXPOSED TO SURFACE WATER
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CTE Value	CTE Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CW	Chemical Concentration in Water	ug/L	See Text	See Text	See Text	See Text	Intake (mg/kg/day) =
	CR	Contact Rate	L/hour	0.05	EPA, 1988	0.05	EPA, 1988	$\frac{CW \times CR \times CF \times ET \times EF \times ED}{BW \times AT}$
	CF	Conversion factor	ug/mg	0.001	- -	0.001	- -	
	ET	Exposure Time	hours/event	4	(1)	2	(1)	
	EF	Exposure Frequency	events/year	16	(1)	8	(1)	
	ED	Exposure Duration	years	24	EPA, 1993	7	EPA, 1993	
	BW	Body Weight	kg	70	EPA, 1993	70	EPA, 1993	
	AT-C	Averaging Time (Cancer)	days	25550	EPA, 1989	25550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	8760	EPA, 1989	2555	EPA, 1989	
Dermal	DAevent	Absorbed dose per event	mg/cm2-event	See Text	See Text	See Text	See Text	Dermally Absorbed Dose (mg/kg/day)
	SA	Skin Surface Available for Contact	cm2	5000	(2)	5000	(2)	$= \frac{DAevent \times EV \times EF \times ED \times SA}{BW \times AT}$
	EV	Event Frequency	events/day	1	(1)	1	N/A	
	ET	Exposure Time	hours/event	4	(1)	2	(1)	
	EF	Exposure Frequency	days/year	16	(1)	8	(1)	
	ED	Exposure Duration	years	24	EPA, 1993	7	EPA, 1993	See text for calculation of DAevent.
	BW	Body Weight	kg	70	EPA, 1993	70	EPA, 1993	
	AT-C	Averaging Time (Cancer)	days	25550	EPA, 1989	25550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	8760	EPA, 1989	2555	EPA, 1989	

Notes:

1 - Professional judgement. Assumes 1 day a week for summer months (May through August). CTE is 50 percent of RME.

2 - Assume 25 percent of total body surface area available for contact.

Sources:

EPA, 1999: Risk Assessment Guidance for Superfund.

EPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1993c: Superfund Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure..

TABLE 9-27

DERMAL ABSORPTION VALUES (ABS)
SITE 57 - FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Chemical	Value
VOCs	
Trichloroethene	0.03
Vinyl Chloride	0.03
SVOCs	
Benzo(a)anthracene	0.13
Benzo(b)fluoranthene	0.13
Benzo(a)pyrene	0.13
Dibenzo(a,h)anthracene	0.13
Indeno(1,2,3-cd)pyrene	0.13
Inorganics	
Arsenic	0.03
Vanadium	0.01

Source: Assessing Dermal Exposure From Soil, U.S. EPA Region III, 1995.

TABLE 9-28

ESTIMATED CANCER RISKS AND HAZARD INDICES
REASONABLE MAXIMUM EXPOSURES
SITE 57 - FORMER DRUM LOADING AREA - UPGRADIENT
IHDIV - NSWC, INDIAN HEAD, MARYLAND

Exposure Route	Full Time Employee	Construction Worker	Child Resident	Adult Resident	Lifelong Resident
INCREMENTAL CANCER RISK					
Surface Soil					
Incidental Ingestion	2.5E-06	NA	NA	NA	NA
Dermal Contact	1.3E-06	NA	NA	NA	NA
Total	3.8E-06	NA	NA	NA	NA
All Soil					
Incidental Ingestion	NA	9.7E-07	1.6E-05	6.8E-06	2.3E-05
Dermal Contact	NA	6.4E-08	8.3E-07	7.1E-07	1.5E-06
Total	NA	1.0E-06	1.7E-05	7.5E-06	2.4E-05
Groundwater					
Incidental Ingestion	NA	NA	3.0E-04	4.4E-04	7.4E-04
Dermal Contact	NA	5.8E-07	2.3E-05	5.6E-05	8.3E-05
Inhalation	NA	6.2E-08	NA	1.6E-04	1.6E-04
Total	NA	6.4E-07	3.3E-04	6.6E-04	9.8E-04
Surface Water					
Incidental Ingestion	NA	NA	NA	NA	NA
Dermal Contact	NA	NA	NA	NA	NA
Total	NA	NA	NA	NA	NA
Sediment					
Incidental Ingestion	NA	NA	NA	NA	NA
Dermal Contact	NA	NA	NA	NA	NA
Total	NA	NA	NA	NA	NA
Total All Pathways	3.8E-06	1.7E-06	3.4E-04	6.6E-04	1.0E-03
HAZARD INDEX					
Surface Soil					
Incidental Ingestion	1.6E-02	NA	NA	NA	NA
Dermal Contact	8.1E-03	NA	NA	NA	NA
Total	2.4E-02	NA	NA	NA	NA
All Soil					
Incidental Ingestion	NA	1.5E-01	3.5E-01	4.4E-02	NA
Dermal Contact	NA	1.0E-02	1.8E-02	4.6E-03	NA
Total	NA	1.6E-01	3.7E-01	4.8E-02	NA
Groundwater					
Incidental Ingestion	NA	NA	5.9E-01	2.5E-01	NA
Dermal Contact	NA	7.9E-03	5.3E-02	3.3E-02	NA
Inhalation	NA	7.2E-04	NA	5.2E-01	NA
Total	NA	8.7E-03	6.4E-01	8.0E-01	NA
Surface Water					
Incidental Ingestion	NA	NA	NA	NA	NA
Dermal Contact	NA	NA	NA	NA	NA
Total	NA	NA	NA	NA	NA
Sediment					
Incidental Ingestion	NA	NA	NA	NA	NA
Dermal Contact	NA	NA	NA	NA	NA
Total	NA	NA	NA	NA	NA
Total All Pathways	2.4E-02	1.7E-01	1.0E+00	8.5E-01	NA

Notes:
NA - Not applicable for this receptor.
NT - Not toxicity criteria available.

TABLE 9-29

ESTIMATED CANCER RISKS AND HAZARD INDICES
CENTRAL TENDENCY EXPOSURES
SITE 57 - FORMER DRUM LOADING AREA - UPGRADIENT
IHDIV - NSWC, INDIAN HEAD, MARYLAND

Exposure Route	Full Time Employee	Construction Worker	Child Resident	Adult Resident	Lifelong Resident
INCREMENTAL CANCER RISK					
Surface Soil					
Incidental Ingestion	2.2E-07	NA	NA	NA	NA
Dermal Contact	2.3E-08	NA	NA	NA	NA
Total	2.4E-07	NA	NA	NA	NA
All Soil					
Incidental Ingestion	NA	4.2E-07	1.8E-06	6.6E-07	2.4E-06
Dermal Contact	NA	5.6E-09	5.5E-08	2.0E-08	7.5E-08
Total	NA	4.3E-07	1.8E-06	6.8E-07	2.5E-06
Groundwater					
Incidental Ingestion	NA	NA	5.7E-05	6.0E-05	1.2E-04
Dermal Contact	NA	2.9E-07	4.2E-06	9.0E-06	1.3E-05
Inhalation	NA	3.1E-08	NA	1.7E-05	1.7E-05
Total	NA	3.2E-07	6.1E-05	8.6E-05	1.5E-04
Surface Water					
Incidental Ingestion	NA	NA	NA	NA	NA
Dermal Contact	NA	NA	NA	NA	NA
Total	NA	NA	NA	NA	NA
Sediment					
Incidental Ingestion	NA	NA	NA	NA	NA
Dermal Contact	NA	NA	NA	NA	NA
Total	NA	NA	NA	NA	NA
Total All Pathways	2.4E-07	7.5E-07	6.3E-05	8.7E-05	1.5E-04
HAZARD INDEX					
Surface Soil					
Incidental Ingestion	6.9E-03	NA	NA	NA	NA
Dermal Contact	7.1E-04	NA	NA	NA	NA
Total	7.6E-03	NA	NA	NA	NA
All Soil					
Incidental Ingestion	NA	6.6E-02	1.4E-01	1.5E-02	NA
Dermal Contact	NA	8.7E-04	4.3E-03	4.4E-04	NA
Total	NA	6.7E-02	1.4E-01	1.5E-02	NA
Groundwater					
Incidental Ingestion	NA	NA	3.9E-01	1.2E-01	NA
Dermal Contact	NA	4.0E-03	2.9E-02	1.8E-02	NA
Inhalation	NA	7.2E-04	NA	1.9E-01	NA
Total	NA	4.7E-03	4.2E-01	3.3E-01	NA
Surface Water					
Incidental Ingestion	NA	NA	NA	NA	NA
Dermal Contact	NA	NA	NA	NA	NA
Total	NA	NA	NA	NA	NA
Sediment					
Incidental Ingestion	NA	NA	NA	NA	NA
Dermal Contact	NA	NA	NA	NA	NA
Total	NA	NA	NA	NA	NA
Total All Pathways	7.6E-03	7.1E-02	5.6E-01	3.4E-01	NA

Notes:
NA - Not applicable for this receptor.
NT - Not toxicity criteria available.

TABLE 9-30

ESTIMATED CANCER RISKS AND HAZARD INDICES
REASONABLE MAXIMUM EXPOSURES
SITE 57 - FORMER DRUM LOADING AREA - DOWNGRADIENT
IHDIV - NSWC, INDIAN HEAD, MARYLAND

Exposure Route	Full Time Employee	Construction Worker	Child Resident	Adult Resident	Lifelong Resident
INCREMENTAL CANCER RISK					
Surface Soil					
Incidental Ingestion	3.1E-05	NA	NA	NA	NA
Dermal Contact	2.2E-05	NA	NA	NA	NA
Total	5.2E-05	NA	NA	NA	NA
All Soil					
Incidental Ingestion	NA	8.2E-06	1.4E-04	5.7E-05	1.9E-04
Dermal Contact	NA	7.5E-07	1.0E-05	1.3E-04	9.1E-05
Inhalation	NA	6.4E-09	4.3E-08	3.3E-08	7.7E-08
Total	NA	8.9E-06	1.5E-04	1.4E-04	2.8E-04
Groundwater					
Incidental Ingestion	NA	NA	1.2E-03	1.7E-03	2.9E-03
Dermal Contact	NA	1.2E-06	4.2E-05	1.0E-04	1.5E-04
Inhalation	NA	1.5E-07	NA	4.4E-04	4.4E-04
Total	NA	1.4E-06	1.2E-03	2.3E-03	3.5E-03
Surface Water					
Incidental Ingestion	NA	NT	NT	NT	NT
Dermal Contact	NA	NT	NT	NT	NT
Total	NA	NT	NT	NT	NT
Sediment					
Incidental Ingestion	NA	6.4E-08	4.0E-07	1.7E-07	5.7E-07
Dermal Contact	NA	9.4E-09	2.8E-08	5.3E-07	5.6E-07
Total	NA	7.3E-08	4.3E-07	7.1E-07	1.2E-06
Total All Pathways	5.2E-05	1.0E-05	1.4E-03	2.4E-03	3.8E-03
HAZARD INDEX					
Surface Soil					
Incidental Ingestion	1.7E-01	NA	NA	NA	NA
Dermal Contact	8.7E-02	NA	NA	NA	NA
Total	2.5E-01	NA	NA	NA	NA
All Soil					
Incidental Ingestion	NA	1.1E+00	3.1E+00	6.6E-01	NA
Dermal Contact	NA	6.3E-03	1.6E-01	6.9E-02	NA
Inhalation	NA	NT	NT	NT	NA
Total	NA	1.1E+00	3.2E+00	7.2E-01	NA
Groundwater					
Incidental Ingestion	NA	NA	1.1E+01	4.9E+00	NA
Dermal Contact	NA	1.3E-01	9.9E-01	6.1E-01	NA
Inhalation	NA	1.3E-03	NA	3.6E-06	NA
Total	NA	1.3E-01	1.2E+01	5.5E+00	NA
Surface Water					
Incidental Ingestion	NA	3.9E-03	1.2E-02	2.6E-03	NA
Dermal Contact	NA	2.5E-02	1.2E-02	3.8E-03	NA
Total	NA	2.9E-02	2.4E-02	6.4E-03	NA
Sediment					
Incidental Ingestion	NA	8.8E-03	9.2E-03	9.8E-04	NA
Dermal Contact	NA	9.5E-04	4.8E-04	2.3E-03	NA
Total	NA	9.8E-03	9.6E-03	3.2E-03	NA
Total All Pathways	2.5E-01	1.3E+00	1.6E+01	6.7E+00	NA

Notes:
NA - Not applicable for this receptor.
NT - Not toxicity criteria available.

TABLE 9-31

ESTIMATED CANCER RISKS AND HAZARD INDICES
CENTRAL TENDENCY EXPOSURES
SITE 57 - FORMER DRUM LOADING AREA - DOWNGRADIENT
IHDIV - NSWC, INDIAN HEAD, MARYLAND

Exposure Route	Full Time Employee	Construction Worker	Child Resident	Adult Resident	Lifelong Resident
INCREMENTAL CANCER RISK					
Surface Soil					
Incidental Ingestion	2.7E-06	NA	NA	NA	NA
Dermal Contact	3.8E-07	NA	NA	NA	NA
Total	3.1E-06	NA	NA	NA	NA
All Soil					
Incidental Ingestion	NA	3.6E-06	1.5E-05	5.6E-06	2.1E-05
Dermal Contact	NA	6.6E-08	6.7E-07	6.2E-06	6.9E-06
Inhalation	NA	1.7E-08	1.8E-08	1.2E-08	3.0E-08
Total	NA	3.7E-06	1.6E-05	1.2E-05	2.8E-05
Groundwater					
Incidental Ingestion	NA	NA	2.3E-04	2.4E-04	4.7E-04
Dermal Contact	NA	6.1E-07	7.6E-06	1.6E-05	2.4E-05
Inhalation	NA	7.7E-08	NA	4.7E-05	4.7E-05
Total	NA	6.8E-07	2.3E-04	3.0E-04	5.4E-04
Surface Water					
Incidental Ingestion	NA	NT	NT	NT	NT
Dermal Contact	NA	NT	NT	NT	NT
Total	NA	NT	NT	NT	NT
Sediment					
Incidental Ingestion	NA	1.6E-08	3.3E-08	1.2E-08	4.5E-08
Dermal Contact	NA	4.7E-10	1.4E-09	1.5E-08	1.6E-08
Total	NA	1.6E-08	3.5E-08	2.7E-08	6.2E-08
Total All Pathways	3.1E-06	4.4E-06	2.5E-04	3.1E-04	5.6E-04
HAZARD INDEX					
Surface Soil					
Incidental Ingestion	7.4E-02	NA	NA	NA	NA
Dermal Contact	7.6E-03	NA	NA	NA	NA
Total	8.1E-02	NA	NA	NA	NA
All Soil					
Incidental Ingestion	NA	4.9E-01	1.0E+00	2.2E-01	NA
Dermal Contact	NA	6.3E-03	3.2E-02	6.6E-03	NA
Inhalation	NA	NT	NT	NT	NA
Total	NA	5.0E-01	1.1E+00	2.3E-01	NA
Groundwater					
Incidental Ingestion	NA	NA	7.6E+00	2.3E+00	NA
Dermal Contact	NA	6.4E-02	5.4E-01	3.3E-01	NA
Inhalation	NA	6.7E-04	NA	4.7E-05	NA
Total	NA	6.5E-02	8.2E+00	2.6E+00	NA
Surface Water					
Incidental Ingestion	NA	2.0E-03	3.0E-03	6.5E-04	NA
Dermal Contact	NA	1.2E-02	1.6E-03	9.6E-04	NA
Total	NA	1.4E-02	4.6E-03	1.6E-03	NA
Sediment					
Incidental Ingestion	NA	2.2E-03	2.3E-03	2.5E-04	NA
Dermal Contact	NA	4.7E-05	7.2E-05	2.2E-04	NA
Total	NA	2.3E-03	2.4E-03	4.6E-04	NA
Total All Pathways	8.1E-02	5.8E-01	9.2E+00	2.8E+00	NA

Notes:
NA - Not applicable for this receptor.
NT - Not toxicity criteria available.

TABLE 9-32

ESTIMATED CANCER RISKS AND HAZARD INDICES
SITE 57 - FORMER DRUM LOADING AREA - SEWERS
IHDIV - NSWC, INDIAN HEAD, MARYLAND

Exposure Route	Construction Workers	
	RME	CTE
INCREMENTAL CANCER RISK		
Surface Water		
Incidental Ingestion	7.7E-10	7.5E-09
Dermal Contact	5.8E-09	2.9E-09
Total	6.6E-09	1.0E-08
Sediment		
Incidental Ingestion	1.3E-07	3.4E-08
Dermal Contact	2.1E-08	1.0E-09
Total	1.6E-07	3.5E-08
Total All Pathways	1.6E-07	4.5E-08
HAZARD INDEX		
Surface Water		
Incidental Ingestion	4.2E-03	6.7E-02
Dermal Contact	1.4E-02	6.9E-03
Total	1.8E-02	7.4E-02
Sediment		
Incidental Ingestion	2.5E-02	6.3E-03
Dermal Contact	7.4E-03	3.7E-04
Total	3.3E-02	6.7E-03
Total All Pathways	5.1E-02	8.0E-02

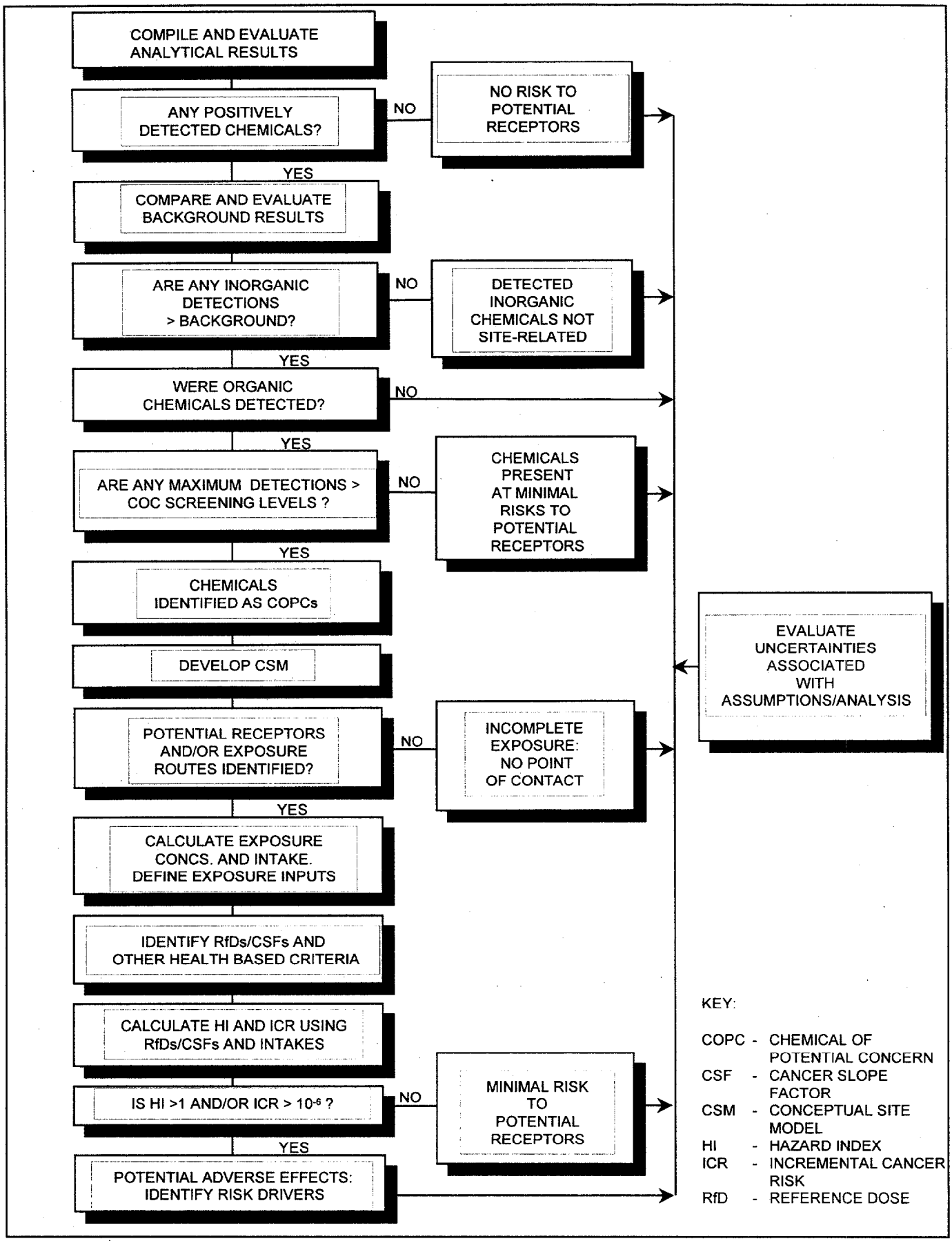
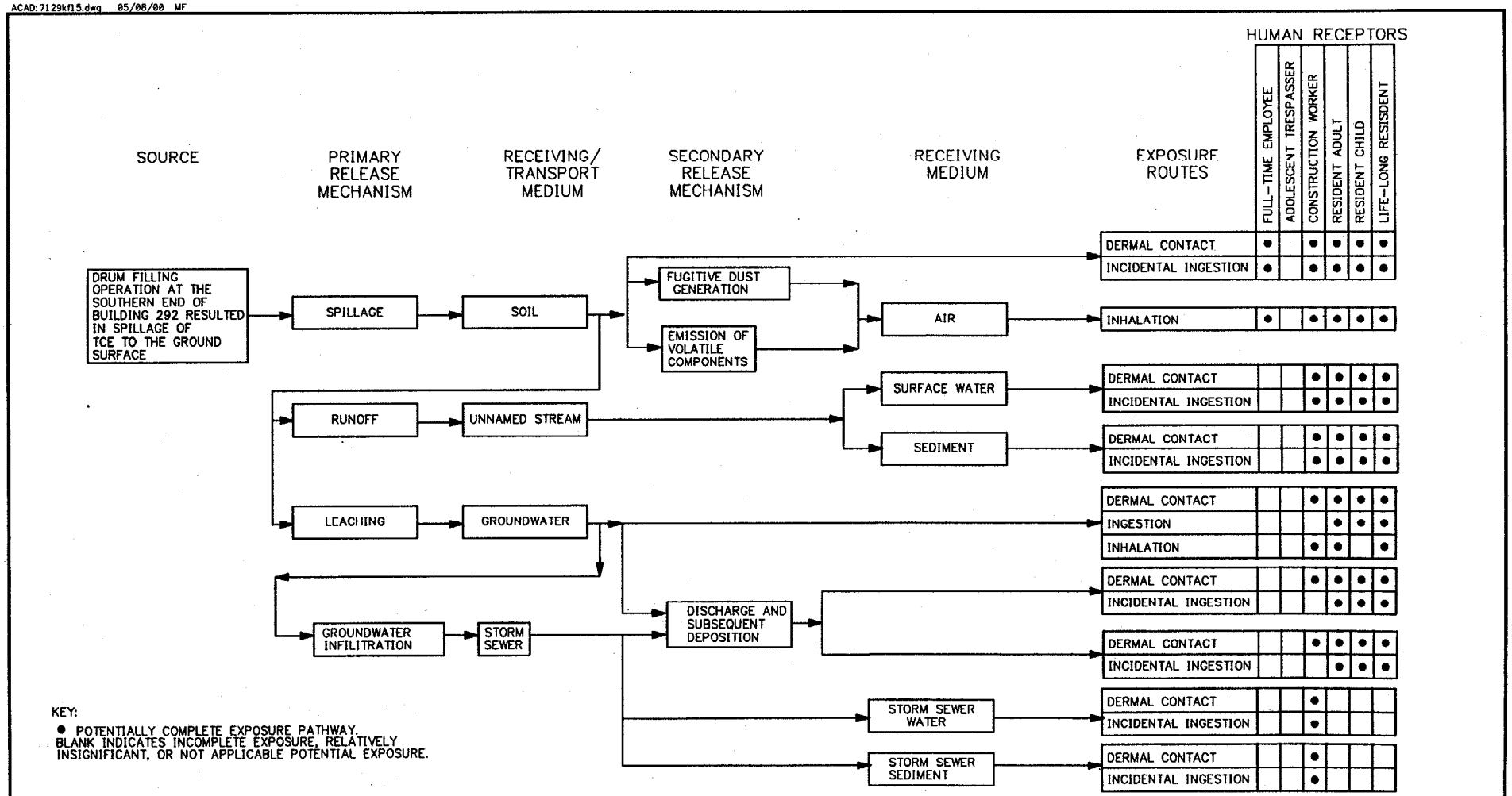


FIGURE 9-1
SUMMARY OF HUMAN HEALTH RISK ASSESSMENT PROCESS
IHDIV-NSWC, INDIAN HEAD, MARYLAND

ACAD: 7129kf15.dwg 05/08/00 MF



KEY:

● POTENTIALLY COMPLETE EXPOSURE PATHWAY.
BLANK INDICATES INCOMPLETE EXPOSURE, RELATIVELY INSIGNIFICANT, OR NOT APPLICABLE POTENTIAL EXPOSURE.

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY MF DATE 5/8/00
CHECKED BY DATE 7/27/00
COST/SCHED-AREA
SCALE AS NOTED

Tetra Tech NUS, Inc.

HUMAN HEALTH RISK ASSESSMENT SITE MODEL
SITE 57-FORMER DRUM LOADING AREA
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

CONTRACT NO. 7129
OWNER NO. 0245
APPROVED BY DATE 7/27/00
APPROVED BY DATE
DRAWING NO. FIGURE 9-2
REV. 0

FORM CADD NO. TNNUS_IHLDGN - REV 0 - 1/20/98

10.0 ECOLOGICAL RISK ASSESSMENT

In addition to characterizing the nature and extent of site contamination and assessing potential risks to human health, the RI process requires an assessment of the potential adverse effects of site contamination on the environment. Specifically, ecological receptors may be at risk from environmental contamination associated with Site 57 at IHDIV-NSWC. Accordingly, an ecological risk assessment (ERA) was performed to characterize the potential risks from Site-57-related contaminants to ecological receptors that inhabit the installation area. This section presents the general approach that was taken to assess the impacts of site contamination on ecological receptors and the habitats that support these organisms. This assessment generally followed a two-step process:

Step 1: Preliminary Problem Formulation and Ecological Effects Evaluation

- Preliminary Problem Formulation - This is the first phase of an ERA, which discusses the goals, breadth, and focus of the assessment. It includes general descriptions of the RI sites to be investigated with emphasis on the habitats and ecological receptors present. This phase also involves characterization of contaminant sources and migration pathways, evaluation of routes of contaminant exposure, and selection of analytes to be assessed. Assessment and measurement endpoints are also selected in this phase. Finally, a conceptual model is developed that describes how contaminants associated with the RI site may come into contact with ecological receptors.

- Ecological Effects Evaluation - In this phase, medium-specific ecological screening levels for each analyte (i.e., concentrations of each contaminant above which adverse effects to ecological receptors may occur) are identified. This step is undertaken concurrently with the exposure assessment described below.

Step 2: Preliminary Exposure Assessment and Risk Calculation

- Preliminary Exposure Assessment - This portion of the ERA includes the identification of the data used to represent concentrations of contaminants to which ecological receptors may be exposed in various media and the actual selection of exposure point contaminant concentrations from those data.

- Preliminary Risk Calculation - In this step, exposure point concentrations are compared to screening levels in order to characterize potential risk to ecological receptors of concern from contaminant exposure. TRVs are also compared to contaminant doses. Analytes found to pose potential risk after these comparisons are selected COPCs.

When these two steps are completed, the results can be interpreted and the uncertainties associated with the ERA can be addressed. The above process, described in further detail below, represents the general ERA approach recommended in most recent EPA guidance for performing ERAs (EPA, 1997; 1998). Furthermore, the ERA was conducted in accordance with other available, current ERA guidance documents (Wentsel et al., 1996; Ingersoll et al., 1997).

Due to the potential complexity of ERAs, they are often conducted using a tiered approach and punctuated with Scientific/Management Decision Points (SMDPs), which are meetings involving the risk assessors, risk managers, and client. SMDPs are used to reach consensus on how to proceed, thereby controlling costs, preventing unnecessary analyses, and ensuring that the ERA is proceeding in an efficient, timely manner. Information analyzed in one tier is evaluated to determine whether the objectives of the study have been met and then may be used to identify the data required for the next tier, if necessary. This Tier 1 ERA can be considered a "screening-level" assessment since it is based on comparing contaminant concentrations to conservative screening values. The purpose of the screening level ERA is to determine which chemicals detected in site media do not pose potential ecological risks. The next tier is a baseline ERA (BERA), which is a more focused study that incorporates the initial screening but also encompasses detailed laboratory and field studies or extensive modeling. The BERA comprises Steps 3 through 7 of the 8-step ERA process. Step 8 is risk management. Based on discussions with Region III BTAG and a recent Department of the Navy (DON, 1999) policy memorandum, a portion of Step 3 was included in this assessment (Section 10.5).

10.1 PRELIMINARY PROBLEM FORMULATION

10.1.1 Site Background

Site 57, the Former Drum Loading Area at Building 292, is located in the northeastern portion of NSWC Indian Head. Building 292 is adjacent to Bailey Road (Figure 4-1). Operations that could potentially have resulted in residual contamination at the site were performed along the western and southwestern sections of Building 292 and inside the building. These activities include use of TCE for degreasing; solvent dip tanks for general cleaning; and piping of spent TCE to drums outside the building. These operations lasted from approximately the mid-1960s until 1989.

10.1.2 Habitat Types and Ecological Receptors

Building 292 is located in a developed area of the base. The sections of Building 292 that could have received surface contamination are mainly comprised of asphalt and gravel, providing no terrestrial habitat. Runoff from the potentially impacted areas near the building is to the south into a ditch lined with half a metal pipe. The only potentially impacted area of ecological concern near the building is a patch of

mowed turfgrass approximately 100 feet long by 30 feet wide surrounded on all sides by concrete. A wooden gazebo is present in this area that is used by Building 292 personnel on work breaks. For these reasons, the potential for ecological risks on and near the site proper (surface soil and related terrestrial risks) is negligible.

Runoff from the metal-lined ditch flows under Bailey Road into a concrete-lined drainage ditch. The concrete-lined drainage ditch originates opposite Bailey Road and upgradient of Building 292. After the confluence with the metal-lined ditch, the concrete-lined ditch continues south under the Building 160 loading dock where another culvert under Bailey Road meets it. The ditch continues under Hersey Road, connects with a drainage ditch from the northwest, and runs along the south side of Hersey Road until it empties into Mattawoman Creek approximately 2,200 feet from Building 292. The ditch substrate becomes natural from where it exits the culverts under Hersey Road until the discharge to Mattawoman Creek. It can be characterized as a small stream through this stretch. The small stream has a maximum width of approximately 5 to 6 feet, with some gravelly substrate in its lower reach.

Also, an underground storm sewer runs past Building 292 and continues southward along roughly the same path as the concrete ditch and small stream. Runoff from the Building 292 area and possibly groundwater discharge to the storm sewer. The storm sewer discharges to Mattawoman Creek approximately 200 feet from the small stream.

Due to the small and man-made (e.g., concrete) nature of the ditches and the underground nature of the storm sewer, potential exposures to ecological receptors are probably insignificant. The likelihood of exposure would probably increase in the lower reach of the small stream, as benthic invertebrates would likely be present. The small nature of the stream would severely inhibit use and exposure to surface water and sediment chemicals by terrestrial wildlife. However, Mattawoman Creek provides excellent aquatic and semi-aquatic habitat. Thus, the main area of interest in this ERA is determining the contributions of drainage ditch/small-stream-related inputs of chemicals into Mattawoman Creek, although benthos in the lower reach of the stream are also of concern.

These evaluations are somewhat confounded by the myriad of other chemical inputs into the drainage ditch and small creek both up- and downgradient of Building 292. In addition, TCE is the main concern for Site 57, but TCE is rarely of ecological concern due to its volatile nature and toxicological properties. Furthermore, a broad, watershed study of the impacts of NSWC Indian Head on Mattawoman Creek is forthcoming. As a result, the scope of the Site 57 ERA is limited, and most evaluations (including foodchain concerns in Mattawoman Creek) will be deferred to the Mattawoman Creek study. This ERA can serve, nevertheless, to identify potential chemical inputs to Mattawoman Creek near the small stream and storm sewer discharges.

10.1.3 Major Contaminant Sources, Migration Pathways, and Exposure Routes

Precipitation runoff may carry constituents from Building 292 to the drainage ditch along the building and ultimately to Mattawoman Creek. Infiltrating precipitation may cause the migration of contamination in surface soil to subsurface soil and groundwater. Upon infiltrating the soil and reaching the water table, a contaminant may be carried with the flow of groundwater to downgradient locations. Groundwater from the site may eventually discharge to a surface water drainage ditch near the site or possibly to the storm sewer; contaminants may be subsequently deposited in sediment or they may accumulate in the tissues of aquatic organisms in the lower reach of the small stream and Mattawoman Creek.

10.1.4 Exposure Routes

Aquatic and semi-aquatic organisms that use the stream downgradient of Site 57 and Mattawoman Creek may be exposed to contaminants via direct contact with surface water and sediments, incidental ingestion of surface water and sediments, and consumption of contaminated food items. As mentioned above, exposure for terrestrial and semi-aquatic wildlife via the foodchain is possible for the stream area but is more germane for Mattawoman Creek. These exposure routes will be studied during the Mattawoman Creek watershed study. No terrestrial habitat is present on the site proper, precluding the need for an assessment of terrestrial exposure routes at Site 57.

10.1.5 Selection of Analytes to be Assessed

Analytes initially assessed in the ERA were all contaminants detected in surface water and sediment samples collected in the drainage ditch, small stream, storm sewer, and Mattawoman Creek for the Site 57 RI. Groundwater data were also used in this ERA. Several surface water and sediment samples were collected in the ditch, stream, and sewer, and two were collected near the outfalls of the small stream and storm sewer in Mattawoman Creek. It should be noted that difficulties were encountered in obtaining sediment from the storm sewer because the line had been recently cleaned. A discussion of the analytes tested for in each sample is provided is Section 5.0. Calcium, magnesium, potassium, and sodium were excluded as analytes to be assessed since they are essential nutrients that are toxic only at extremely high concentrations.

10.1.6 Assessment and Measurement Endpoints

As discussed by EPA (EPA, 1997) and Wentsel (Wentsel et al., 1996), one of the major tasks in preliminary problem formulation is the selection of assessment and measurement endpoints. An assessment endpoint is defined as "an explicit expression of actual environmental values that are to be protected" (EPA, 1997). Measurement endpoints are "measurable ecological characteristics that are

related to the valued characteristic chosen as the assessment endpoint" (EPA, 1997). For this ERA, the assessment endpoints are protection of the following groups of receptors from adverse effects of contaminants on their growth, survival, and reproduction:

- Benthic invertebrate communities
- Surface water invertebrate communities
- Fish communities
- Aquatic plants

As indicated above, measurement endpoints are related to assessment endpoints, but these endpoints are more easily quantified or observed. In essence, measurement endpoints serve as surrogates for assessment endpoints. While declines in populations and shifts in community structure can be quantified, studies of this nature are generally time consuming and difficult to interpret. However, measurement endpoints indicative of observed adverse effects on individuals are relatively easy to measure in toxicity studies and can be related to the assessment endpoint. For example, contaminant concentrations that lead to decreased reproductive success or increased mortality of individuals in toxicity tests could, if found in the environment, result in shifts in population structure, potentially altering the community composition of the areas potentially impacted by Site 57.

For fish, aquatic vegetation, and surface water invertebrates, the measurement endpoints were contaminant concentrations in surface water associated with adverse effects on growth, survival, and reproduction (surface water screening levels). For benthic organisms, the measurement endpoints were contaminant concentrations in sediment associated with adverse effects on growth, survival, and reproduction (sediment screening levels).

10.1.7 Conceptual Site Model

The conceptual model diagrams potentially exposed receptor populations and applicable exposure pathways, based on the physical nature of the site and the potential contaminant source areas. Actual or potential exposures of ecological receptors associated with the sites assessed in this ERA were determined by identifying the most likely pathways of contaminant release and transport. A complete exposure pathway has three components: a source of contaminants that can be released to the environment; a route of contaminant transport through an environmental medium; and an exposure or contact point for an ecological receptor. The site conceptual model is presented on Figure 10-1.

10.2 ECOLOGICAL EFFECTS EVALUATION

For this ERA, exposure-point concentrations of analytes in surface water and sediment were compared to ecologically based screening levels in the risk calculation step to determine if they should be selected as COPCs. Methods used for the selection of medium-specific screening levels are provided below.

10.2.1 Selection of Surface Water Screening Levels

Actual exposures of aquatic receptors to preliminary contaminants of concern are assumed to be primarily chronic (long-term) exposures. For this ERA, screening levels used were chronic federal AWQC (EPA, 1999). These screening levels are protective of a wide variety of sensitive species and are, therefore, conservative. Since surface waters on and near IHDIV-NSWC are freshwater, freshwater values were used. Surface water screening levels were also used for comparison to groundwater chemical concentrations.

Site-specific screening levels for some metals (cadmium, chromium, copper, lead, nickel, and zinc) can be calculated using site-specific hardness as per EPA guidance (EPA, 1999). The degree of hardness in surface water can influence the toxicity of certain metals in fresh surface water. As a general rule, toxicity increases as hardness decreases. Therefore, as hardness decreases in surface water, so will hardness-dependent criteria. Hardness data were available for three samples, which were all collected in the small stream. The average value from these three samples, 62.7 mg/L (as $CaCO_3$), was used to calculate site-specific, hardness-based screening levels.

10.2.2 Selection of Sediment Screening Levels

Contaminant screening levels for benthic organisms were preferentially obtained from EPA (1996). These values were generated as part of EPA's Great Lakes water quality studies, or the "Assessment and Remediation of Contaminated Sediments (ARCS) Program." Unlike other commonly used sediment guidelines, the ARCS values are based on freshwater sediments and are, therefore, more applicable to NSWC Indian Head. These values were also recommended for use by Region III. In particular, threshold effects concentrations (TECs) were used. TECs are considered to be conservative and are roughly analogous to National Oceanic and Atmospheric Administration's (NOAA's) Effects Range-Low values (Jones et al., 1996). In instances where no TEC was available for a chemical, Ontario Ministry of the Environment (MOE) values were used as surrogate values (Jones et al., 1996). Conservative, MOE "low effect levels (LELs)" were used. MOE values are based also on freshwater sediments. NOAA's ER-Ls were considered for use as surrogates, but NOAA used marine and estuarine data, and the list of ER-Ls is much less comprehensive than that presented by MOE (i.e., fewer data gaps).

10.3 PRELIMINARY EXPOSURE ASSESSMENT

Data used to obtain exposure point contaminant concentrations in this ERA were gathered from recent RI sampling at each site. A detailed description of the data included in risk assessment for each site is provided in Section 7.0. Data for were evaluated separately for each of the following areas and related media:

- Sewer water/sediment
- Concrete ditch/stream surface water/sediment ("downgradient" surface water/sediment)
- Mattawoman Creek surface water/sediment
- Groundwater downgradient of Building 292 (upper surficial and lower surficial)

The maximum detected concentrations of contaminants in surface water (total), sediment, and groundwater were used as exposure point contaminant concentrations to be compared to ecological screening levels in the risk calculation step for each of the areas listed above. It should be noted that two surface water and sediment samples were to be collected in Mattawoman Creek near the discharges of the stream and sewer line, respectively. However, the sample to be collected near the end of the sewer line was collected in the end of the line itself. As a result, only one sample was collected in Mattawoman Creek. It was collected near the discharge of the stream.

10.4 RISK CALCULATION

As identified by EPA (EPA, 1997), the preliminary risk calculation step compares exposure-point contaminant concentrations with screening levels protective of ecological receptors. The ratio of the exposure-point contaminant concentration to the screening level is called the HQ and is defined as follows:

$$HQ_i = EPC_i/ESL_i$$

where: HQ_i = Hazard Quotient for Analyte "i" (unitless)
EPC_i = Exposure Point Concentration for Analyte "i" (mg/kg or mg/L)
ESL_i = Ecological Screening Level for Analyte "i" (mg/kg or mg/L)

When the ratio of the exposure-point concentration to its respective screening level equaled or exceeded 1.0, adverse impacts were considered possible, and the contaminant was selected as a COPC. The HQ value should not be construed as being probabilistic; rather, it is a numerical indicator of the extent to which an exposure-point concentration exceeds or is less than a screening level. When HQ values equal or exceed 1.0, it is an indication that ecological receptors are potentially at risk; additional evaluation or

data may be necessary to confirm with greater certainty whether ecological receptors are actually at risk. The use of HQs is probably the most common method used for risk characterization in ERAs. Advantages of this method, according to Barnthouse (Barnthouse et al., 1986), include the following:

- The HQ method is relatively easy to use, is generally accepted, and can be applied to any data.
- The method is useful when a large number of contaminants must be screened.

This method of risk characterization has some inherent limitations. One primary limitation is that it is a "no/maybe" method for relating toxicity to exposure. That is, it uses single values for exposure concentrations and screening levels and does not account for the variability in both these parameters or for incremental or cumulative toxicity. The uncertainties associated with incremental or cumulative toxicity are discussed in Section 10.5.2.

The comparisons described above are presented in site-specific screening tables, which include the frequency of detection for each analyte, the exposure point concentration, and contaminant-specific screening levels.

10.4.1 Screening Results

10.4.1.1 Downgradient Surface Water/Sediment

Aluminum, lead, and zinc had HQs greater than 1.0 in downgradient surface water and, hence, were selected as COPCs (Table 10-1). Several VOCs and inorganics were selected as COPCs in surface water because no AWQCs were available. Mercury, anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, fluoranthene, fluorene, and indeno(1,2,3-cd)pyrene had HQs greater than 1.0 in sediment, and therefore, were selected as COPCs (Table 10-2). Two VOCs, two phthalates, and several inorganics were selected as sediment COPCs because no ARCS or Ontario MOE screening levels were available.

10.4.1.2 Sewer Water/Sediment

Aluminum, copper, iron, lead, and zinc had HQs greater than 1.0 in sewer water and, therefore, were selected as COPCs (Table 10-3). Several VOCs and inorganics were selected as COPCs in sewer water because no AWQCs were available. Cadmium, copper, iron, lead, mercury, zinc, anthracene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, napthalene, phenanthrene, and pyrene had HQs greater than 1.0 in sewer sediment and were selected as COPCs (Table 10-4). Several VOCs, one phthalate, dibenzofuran,

N-nitrosodiphenylamine, and several inorganics were selected as sewer sediment COPCs because no ARCS or Ontario MOE screening levels were available.

10.4.1.3 Mattwoman Creek Surface Water/Sediment

Several VOCs were selected as surface water COPCs in Mattawoman Creek because no AWQCs were available (Table 10-5). Arsenic, cadmium, copper, iron, lead, and zinc had HQs greater than 1.0 in Mattawoman Creek sediment and were selected as COPCs (Table 10-6). Several VOCs and inorganics were selected as sediment COPCs because they had no ARCS or Ontario MOE screening levels.

10.4.1.4 Downgradient Groundwater

Iron had an HQ greater than 1.0 in upper surficial downgradient groundwater (Table 10-7). No AWQCs were available for several VOCs, several inorganics, and two phthalates detected in upper surficial downgradient groundwater. No chemicals had an HQ greater than 1.0 in lower surficial downgradient groundwater (Table 10-8). No AWQCs were available for several VOCs, one phthalate, and several inorganics.

10.5 STEP 3A - REFINEMENT OF CONTAMINANTS OF POTENTIAL CONCERN

The following sections provide a discussion of the technical approach to Step 3A – Refinement of Contaminants of Potential Concern (10.5.1) and the associated discussion for COPCs from Steps 1 and 2 (10.5.2).

10.5.1 Step 3A Considerations

The use of conservative guidelines and maximum detected concentrations in the screening-level assessment is necessary to ensure that potential risks are not underestimated. However, if the HQs from conservative comparisons are used without consideration of other relevant information, additional ecological studies could be undertaken to investigate risks that are not significant. Hence, refinement of COPCs from the screening level assessment, the first sub-step of Step 3 of the process, was incorporated into this RI. This sub-step is informally referred to as "Step 3A," as defined by the Department of the Navy (DON, 1999).

Step 3A involves using certain tools to reduce the uncertainties and conservativeness in the screening-level ERA (DON, 1999). These items include the following, which are described in detail below:

- Alternate guidelines
- Toxicological evaluation of COPCs

- background data (mainly for inorganics)
- evaluation of average contaminant concentrations
- frequency of detection)/spatial analysis of concentrations exceeding guidelines

It should be noted that Step 3A discussion was somewhat limited in this ERA because most of these analyses will be deferred to the larger Mattawoman Creek watershed study. Also, Step 3A discussion was primarily for sediments due to the potentially ephemeral nature of surface water contamination, general lack of alternative toxicity data (i.e., alternate guidelines) for surface water COPCs, and the indirect groundwater exposure route.

10.5.1.1 Alternate Guidelines

Less conservative guidelines are used in tables for Step 3A of this ERA to provide balance to the conservative screening-level assessment. These include ARCS Probable Effects Concentrations (PECs) and Ontario Severe Effects Levels (SELs), as summarized in Jones et al. (1997). PECs and SELs are less conservative counterparts to the TECs and LELs, respectively, that were used in Steps 1 and 2. NOAA effects range-medians (ER-Ms) from Long et al. (1995) were presented also as less conservative screening levels, when available. The ER-M is the point below which adverse effects "would occasionally occur" (Long et al., 1995).

The weight-of-evidence was used when comparing maximum concentrations to alternate sediment guidelines to better determine potential risks. In general, if the maximum concentration of a COPC exceeded none or one of the alternate guidelines, it was dropped from further consideration. If it exceeded two or more alternate guidelines, it was retained.

10.5.1.2 Toxicological Evaluation of COPCs

As part of Step 3A, toxicity data and information from various sources in the literature are discussed as they relate to the interpretation of potential risks from each COPC. These sources include the United States Fish and Wildlife Service (USFWS) Chemical Hazard Reviews, commonly referred to as the "Eisler" publications, ATSDR Toxicity Profiles on CD-ROM, and ecotoxicological journals.

10.5.1.3 Background Data

Background data for qualitative comparisons to site concentrations of inorganics were obtained from recent sediment background sampling performed by B&R Environmental on the installation (the base "background study"). For conservativeness, emphasis was placed on the average base-wide background concentrations in sediments in the discussion. Only averages of reported detections were available for

base-specific background data. For sediments, additional background data for Mattawoman Creek from samples collected upstream of the base are presented for comparative purposes and can also be considered base-specific data. These data were collected by the USFWS (USFWS, 1990). The arithmetic means from these data for each COPC are presented on the Step 3A sediment table (Table 10-9).

In addition, site-specific upgradient surface water and sediment data were available. One surface water (S57SW013) and one sediment sample (S57SD009) were collected in the drainageway that empties into the stream downgradient of Site 57 (Figures 7-4 and 7-5). The samples were co-located approximately 50 feet upgradient of the confluence of the drainageway and stream. Data from this sample are presented on the Step 3A sediment table (Table 10-9).

10.5.1.4 Average Concentrations

Average concentrations of COPCs were used for comparative purposes in Step 3A. Averages of all samples (using one-half the detection limits for non-detects) and all positive detections are presented on Table 10-9. For balance, emphasis was placed on comparisons of average concentrations of inorganic COPCs to average base-wide background concentrations. In general, if the average concentration of a COPC was comparable to or less than the average base-wide background concentration it was dropped from further consideration. In some instances, only one sample was collected (e.g., sewer sediment) and therefore, average concentrations were not calculated.

10.5.1.5 Frequencies of Detection and Spatial Analysis of Concentrations Exceeding Guidelines

Factors such as frequency of detection and spatial analysis of concentrations exceeding guidelines were also considered. These factors were used to supplement those described above and were not generally used alone to eliminate COPCs. Evaluation of frequencies of detection and spatial analysis of elevated concentrations allow for determination of the spatial and geographical nature of potential risks. That is, these factors can help elucidate whether potential risks from a COPC are widespread or limited to one or more "hot-spots" of contamination. Spatial analysis of elevated concentrations is particularly germane in this RI because surface water and sediment samples were collected in four different environments, including concrete-lined drainage ditches, a small stream, storm sewers, and Mattawoman Creek.

10.5.2 Step 3A Discussion

Step 3A considerations are discussed below for each COPC.

10.5.2.1 Aluminum

Aluminum had an HQ greater than 1.0 in downgradient and sewer surface water and no sediment screening levels were available. As summarized in Venugopal and Luckey (Venugopal et al., 1978), aluminum is not readily absorbed through the skin and gastrointestinal absorption of ingested aluminum is poor due to the transformation of aluminum salts into insoluble aluminum phosphate. Another factor in the lack of accumulation of aluminum in animals with age or the absence of any increase in tissue levels of aluminum following fairly high dietary intake may be that mammals possess a homeostatic mechanism for this element. Also, aluminum is one of the most common elements in the earth's crust. Data on the toxicity of aluminum to aquatic organisms are somewhat limited. One alternate guideline was available, the ARCS PEC (Table 10-9). The PEC was an order of magnitude higher than the maximum concentrations of aluminum in sediments in all areas. These concentrations were also less than the basewide background concentrations (Table 10-9). Aluminum was not detected in groundwater. For these reasons, aluminum should be dropped from further consideration for Site 57.

10.5.2.2 Arsenic

Arsenic was a COPC in sewer and Mattawoman Creek sediment. The concentrations in these areas were higher than the basewide background concentration. However, the maximum concentrations of arsenic in sewer and Mattawoman Creek sediments were much less than the three alternative guidelines presented on Table 10-9. Arsenic was not detected in surface water or groundwater. For these reasons, arsenic should be dropped from further consideration for the purpose of Site 57 ecological risk assessment.

10.5.2.3 Antimony

Antimony was a COPC in sewer and Mattawoman Creek sediment because no screening levels were available. No alternate guidelines were available for antimony and it was not detected in basewide background or the upgradient sediment sample. The concentrations of antimony in sewer and Mattawoman Creek sediments, 3 and 0.63 mg/kg, respectively, appear to be qualitatively low. Antimony was not detected in surface water or groundwater in any area. For these reasons, antimony should be dropped from further consideration for Site 57.

10.5.2.4 Barium

Barium was a COPC in sediments in all areas because no screening level was available. No alternate guidelines were available. Barium was detected in upper surficial and lower surficial groundwater as well as in downgradient and sewer surface water. Barium is a common element in both sediments and surface soils and is not generally associated with significant toxicity (ATSDR, 1997). The maximum

concentration of barium in sediments from all areas were less than the basewide background concentration (Table 10-9). For these reasons, barium should be dropped from further consideration for Site 57.

10.5.2.5 Beryllium

Beryllium was a COPC in sediment in all areas and in downgradient surface water because no screening level was available. It was detected in groundwater. No suitable alternate guidelines were available for barium in sediments. The compound occurs as a chemical component of several substrates. Beryllium is naturally emitted to the atmosphere by windblown dust and volcanic particles (ATSDR, 1991b). Beryllium does not bioconcentrate to high levels in aquatic animals, although the bioconcentration in bottom dwelling animals may be higher than nonbottom-dwelling animals. There is no evidence of biomagnification of beryllium within terrestrial or aquatic food chains (ATSDR, 1991b). For these reasons, beryllium should be dropped from further consideration for Site 57.

10.5.2.6 Cadmium

Cadmium was a COPC in sewer and Mattawoman Creek sediment. The concentrations in these two areas were higher than basewide background and upgradient concentrations. However, the maximum concentrations of cadmium in sediment are much less than the three alternative guidelines presented on Table 10-9. It was not detected in surface water or groundwater. For these reasons, cadmium should be dropped from further consideration for Site 57.

10.5.2.7 Cobalt

Cobalt was a COPC in sediment in all areas. It was detected in all surface waters and groundwater (no screening level was available). No alternate sediment guidelines were available in sediments. Other toxicity data for this inorganic are scarce. All of the sediment concentrations were less than the basewide background concentration. Cobalt is present in all natural media and is found in tissues of most higher organisms (ATSDR, 1997). The mobility of cobalt is controlled by its characteristic of adsorbing to the clay minerals and hydrous oxides of iron, manganese, and aluminum available in sediments. Therefore, cobalt may be present in Site 57 sediments in forms that are not bioavailable. Moreover, cobalt is a component of certain B vitamins, which are essential for many organisms. Thus, cobalt should be dropped from further consideration for Site 57.

10.5.2.8 Copper

Copper was a COPC in sewer and Mattawoman Creek sediments. It was a COPC also in sewer surface water. The maximum concentrations of copper in sewer and Mattawoman Creek sediments were greater

than two of the three alternative guidelines presented on Table 10-9. These concentrations were also higher than basewide background and the upgradient concentration (Table 10-9). For these reasons, copper should be retained as a COPC in sewer and Mattawoman Creek sediments and sewer surface water.

10.5.2.9 Cyanide

Cyanide was a COPC in sediments from all areas because no screening level was available. No alternate guidelines were available and it was not detected in basewide background or the upgradient sample. It was not detected in groundwater but was detected at sewer (1 of 5 samples) and downgradient surface water (1 of 2 samples). However, it was detected at concentrations (1.0 mg/kg or less) that appear to be qualitatively low concentrations in sediments. Therefore, cyanide should be dropped from further consideration for Site 57.

10.5.2.10 Iron

Iron was a COPC in sewer and Mattawoman Creek sediments, sewer surface water, and upper surficial groundwater. Iron is an essential nutrient and is one of the most common elements in the earth's crust (fourth most abundant). It is rarely toxic in aquatic media at normal pH; all the surface water samples collected for Site 57 contained typical pH values (Appendix A.1). Alternate guidelines for iron are scarce, but the maximum concentrations of iron in sediments were less than the SEL and basewide background concentrations (Table 10-9). For these reasons, iron should be dropped from further consideration for Site 57.

10.5.2.11 Lead

Lead was a COPC in sewer and Mattawoman Creek sediments as well as sewer and downgradient surface water. It was not a COPC in groundwater. It appears that some risks are present (based on HQ values) from lead in surface water. Nevertheless, the maximum concentrations of lead in sediments were less than all of the alternate guidelines presented on Table 10-9 and were comparable to or less than the basewide background concentration. For these reasons, lead should be dropped from further consideration at Site 57.

10.5.2.12 Mercury

Mercury was a COPC in all sediments. It was not detected in any other medium. The maximum concentration of mercury in downgradient sediments was higher than the two alternate guidelines and the concentration in Mattawoman Creek sediments was higher than one of the two alternate guidelines (Table 10-9). The concentration in sewer sediments was less than the alternate guidelines. All

maximums were higher than basewide background. For these reasons, mercury should be retained as a COPC in Mattawoman Creek and downgradient sediment.

10.5.2.13 Selenium

Selenium was a COPC in Mattawoman Creek sediment because no screening level was available. It was not a COPC in any other medium. No alternate guidelines were available. It was not detected in basewide background samples or the upgradient sample, but the one detection appears to be qualitatively low (1.5 mg/kg). Selenium can be harmful at elevated concentrations but is an essential nutrient. For these reasons, selenium should be dropped from further consideration for Site 57.

10.5.2.14 Silver

Silver was a COPC in sewer and Mattawoman Creek sediments. The maximum concentrations of silver in these areas were much less than the ER-M (Table 10-9). It was not detected in any other medium. For these reasons, silver should be dropped from further consideration at Site 57.

10.5.2.15 Vanadium

Vanadium was a COPC in all sediments because no screening level was available. It was a COPC in downgradient and sewer water also because no screening level was available. The concentration in sewer sediment was higher than the basewide background concentration. No suitable alternate guidelines were available for vanadium. Vanadium is a common element found in all types of substrates (ATSDR, 1997). It can also be found in all types of organisms due to its ubiquitous nature (Klaassen et al., 1986). Toxicity data for this element are scarce, but it is not generally considered to be toxic in the environment (Mailman, 1980). For these reasons, vanadium should be dropped from further consideration for Site 57.

10.5.2.16 Zinc

Zinc was a COPC in sewer and Mattawoman Creek sediments, as well as downgradient surface water. The HQ in surface water was low (1.5). The maximum concentration of zinc in sewer sediments was less than all of the alternate guidelines presented on Table 10-9, and the maximum concentration in Mattawoman Creek sediments was less than two of the three alternate guidelines. Zinc is one of the most common elements in the earth's crust and is found naturally in all types of higher-level organisms. Zinc is actively accumulated in aquatic systems. However, biota appear to represent a minor sink for zinc compared with the sediments (ATSDR, 1989a). Zinc bioavailability and toxicity to aquatic organisms are highest under conditions of low pH (Eisler, 1993). The pH of surface water near Site 57 is in the normal pH range. For these reasons, zinc should be dropped from further consideration for Site 57.

10.5.2.17 Organics

PAHs

Several PAHs were COPCs in sewer and downgradient sediment. However, the maximum concentrations of all individual PAHs were less than all the alternate guidelines for PAHs, often by orders of magnitude (Table 10-9). PAHs were not detected in surface water or groundwater. PAHs have strong affinities for organic carbon in sediments, which generally reduces their bioavailability. Although PAHs can accumulate in terrestrial and aquatic organisms, most organisms are able to metabolize and eliminate these compounds. Vertebrates can readily metabolize most PAHs (ATSDR, 1990). For these reasons, PAHs should be dropped from further consideration for Site 57.

Miscellaneous Organics

Bis(2-ethylhexyl)phthalate was a COPC in sewer and downgradient sediment and di-n-butyl phthalate was a COPC in downgradient sediments because no screening levels were available. No alternate guidelines were available, but the concentrations in sediments appear to be qualitatively low (all less than 1.0 mg/kg). Phthalates are ubiquitous in industrialized areas such as IHDIV-NSWC and are generally associated with low vertebrate toxicity (ATSDR, 1997). Dibenzofuran was a COPC in sediments and soils, but no alternate guidelines are available. This compound is generally not associated with ecotoxicity and its maximum concentration in sediments (80 ug/kg) appears to be qualitatively low. N-nitrosodiphenylamine was a COPC in sewer sediments, and no guidelines were available. Its maximum concentration also appears to be qualitatively low (50 ug/kg). Several VOCs were detected in all media associated with Site 57. It is unlikely that these compounds would biaccumulate or biomagnify. Their mode of action, generally carcinogenicity, is not considered to be ecologically relevant. However, the concentrations in surface water appear to be qualitatively elevated, as do those in sewer water/sediment, downgradient shallow groundwater, and Mattawoman Creek surface water/sediment. As a result, it may be helpful to include assessment of VOCs in the Mattawoman Creek study if samples are collected at the outfall of the stream and sewer in particular.

10.6 UNCERTAINTY ANALYSIS

Uncertainty is associated with all aspects of the ERA process. This section provides a summary of the general uncertainties involved in this ERA, with a discussion of how they may affect the final risk values and conclusions. Some additional discussions of site-specific uncertainties are also contained in site-specific assessment sections.

Once an ERA is complete, the results must be reviewed and evaluated to identify the types and magnitudes of uncertainties involved. Relying on results from a risk assessment without consideration of uncertainties, limitations, and assumptions inherent in the process can be misleading. If numerous conservative assumptions are combined in the ERA process, the resulting calculations will propagate the uncertainties associated with each of those assumptions. The resulting bias is toward overpredicting risks. Thus, both the results of the risk assessment and the uncertainties associated with those results must be considered when making risk management decisions.

Generally, risk assessments carry two types of uncertainty: measurement and informational. Measurement uncertainty refers to the variability inherent in measured data. The risk assessment reflects the accumulated variances of the individual values used for several different parameters. Informational uncertainty stems from the limited availability of necessary information. Often the gap between what is needed and what is available is significant; information regarding the effects of some contaminants on wildlife receptors, the biological mechanism of a contaminant, the impact of physiological differences on exposure pathways, or the behavior of a contaminant in various environmental media is often absent.

Uncertainty is associated with each of the steps of the risk assessment process:

- Uncertainty in preliminary problem formulation can result from limited information regarding contaminant sources, release mechanisms, and exposure routes.

- Uncertainty in the ecological effects characterization arises from the quality of the existing screening values and toxicity data to support a determination of potential adverse impacts to ecological receptors.

- Uncertainty associated with the exposure assessment includes the methods used and the assumptions made to determine exposure point concentrations or calculate contaminant doses.

- Uncertainty in risk characterization includes that associated with combining conservative assumptions made in earlier activities.

10.6.1 Uncertainty in the Preliminary Problem Formulation

The sites investigated in this ERA receive contaminant inputs from more than one source, although initially, contaminants are conservatively assumed to stem directly from site-related activities. For example, the sewer system and downgradient ditches and stream presumably receive contaminant inputs from several other sources. Since contaminant concentrations may reflect inputs from many sources, uncertainties exist regarding whether risk characterized at a discrete site stems from site-related

contaminants. Also, different sites and their contaminants may possess different contaminant exposure routes for ecological receptors. Difficulties and limitations exist in trying to obtain exposure routes for individual sites for individual receptors. Since exposure routes may be quite different for different species, risk may be over- or underestimated if this information is not known.

10.6.2 Uncertainty in the Ecological Effects Evaluation

A great deal of uncertainty in this risk assessment arises from the nature and quality of the available toxicity data used to derive screening levels. This uncertainty is reduced when similar effects are observed across species, strain, sex, and exposure route; when the magnitude of the response is clearly dose related; and when mechanisms of toxicity are similar for laboratory and wildlife species. Most of the screening levels used in this ERA are based on conservative assumptions. Although conservativeness is needed in a screening-level ecological risk assessment to ensure that the most sensitive receptors are protected, conservative screening levels may overestimate potential risks and the resulting HQ values may be misleading. Again, AWQC (as used in Region III screening levels) and some sediment screening values used in this assessment are based on laboratory studies that do not take into account mitigating or ameliorating physical and chemical conditions in the environment. For example, surface water toxicity tests are usually conducted using filtered water and toxic forms of chemicals. That is, a bioavailable (i.e., toxic) form of the contaminant is usually applied to the exposure medium. In reality, bioavailability is rarely, if ever, 100 percent. Therefore, uncertainty is introduced into the assessment, and the results tend to overestimate potential risks.

In addition, ERAs, unlike human health risk assessments, must consider risks to many different species. Calculation of risk values for every potential receptor species is not possible. For this ERA, conservative screening levels protective of a wide range of ecological receptors were sought. The underlying assumption associated with the use of these screening levels is that contaminant concentrations in excess of these values are indicative of potential impacts to actual receptors inhabiting the area. However, species-specific physiological differences that may influence an organism's response to a contaminant or subtle behavioral differences that may increase/decrease a receptor's contact with a contaminant are seldom known. Also, some contaminants were present in some media for which no suitable screening levels were available, and as a result, they could not be quantitatively assessed. Risks may, therefore, be biased low in these instances. For these reasons, the use of screening levels will introduce error into the results of an assessment.

Potential risks may also be under or over estimated due to the interactive effects of contaminants. Contaminants with similar modes of action may have additive effects (e.g., organochlorine pesticides) or synergistic effects. In this case, potential risks could be underestimated. Contaminants can also have ameliorating effects on certain receptors. In this case, potential risks could be overestimated.

The absence of a thorough database regarding the effects of VOCs on ecological receptors also adds uncertainty to the ERA.

10.6.3 Uncertainty in the Exposure Assessment

Uncertainty in the exposure assessment arises mainly in the methods used to obtain exposure-point concentrations. The maximum detected contaminant concentrations were generally used to represent the highest contaminant concentrations to which ecological receptors might be exposed. If the samples evaluated in this ERA are representative of contaminant concentrations associated with the sites, then this approach is conservative and should overestimate potential risks to ecological receptors. The maximum concentration of a contaminant in a given medium may have been collected in a "hot spot" of contamination and may be much higher than the remaining values in the data set. Again, although use of maximum values is appropriate for screening in an ERA, they may overpredict potential risks. In contrast, if insufficient aerial coverage or total number of samples has been obtained, areas of higher contamination may have been missed and risks could be underestimated. For the most part, sampling sizes in this RI were small. This was partially due to the recent cleaning of the sewer system, which removed sediments from the system.

Screening of groundwater contaminant concentrations against surface water guidelines has a multitude of uncertainties. As discussed earlier, screening of groundwater concentrations against AWQCs is performed as a conservative estimation of potential impacts to aquatic biota from contaminated groundwater discharge. It does not take into account several mitigating factors. For example, a maximum concentration of a contaminant in groundwater could significantly exceed a Region III screening level, but the maximum could be in a well farthest from potential points of surface water discharge. Also, dilution of groundwater in surface water would be substantial.

10.6.4 Uncertainty in the Risk Calculation

Uncertainty in the risk calculation is affected by all aspects of the ERA process described in the above sections. Uncertainty in risk characterization also stems, in part, from the fact that different components of the ERA are combined and compared in this step. Each of those components already contains different types of uncertainty, as discussed above. Thus, uncertainties may be propagated when these components are combined. To try to reduce the overall uncertainty in the risk assessment, the weight-of-evidence approach is used to make risk decisions. This approach takes the results of all aspects of the assessment into account, including the uncertainties, to make determinations of potential risk/no risk.

TABLE 10-1

SELECTION OF PRELIMINARY CHEMICALS OF CONCERN - DOWNGRADIENT SURFACE WATER
SITE 57 - FORMER DRUM LOADING AREA
IHDIV - NSWC, INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection	Range of Detection		Location of Maximum	AWQC	Maximum Hazard Quotient	Selected as PCOC (Y/N?)
		Min.	Max.				
Volatile Organic Compounds (ug/L)							
1,2,4-Trichlorobenzene	1/5	0.7	0.7	S57SW0150101	NA	NA	Y
Acetone	1/1	7	7	S57SW0140101	NA	NA	Y
Trichloroethene	2/5	0.7	1.4	S57SW0150101	NA	NA	Y
cis-1,2-dichloroethene	1/5	0.5	0.5	S57SW0120101	NA	NA	Y
Inorganics (ug/L)							
Aluminum	2/2	319	449	S57SW0160101-MAX	87	5.16	Y
Barium	2/2	17.3	19.7	S57SW0160101-MAX	NA	NA	Y
Beryllium	1/2	0.26	0.26	S57SW0160101-MAX	NA	NA	Y
Chromium	2/2	0.63	1	S57SW0140101	50.57	0.02	N
Cobalt	1/2	21.1	21.1	S57SW0160101-MAX	NA	NA	Y
Cyanide	2/2	6.5	10.6	S57SW0160101-MAX	NA	NA	Y
Iron	2/2	461	785	S57SW0140101	1000	0.79	N
Lead	2/2	1.5	7.9	S57SW0140101	1.51	5.23	Y
Manganese	2/2	22.1	363	S57SW0160101-MAX	NA	NA	Y
Nickel	2/2	3.1	23.4	S57SW0160101-MAX	35.04	0.67	N
Selenium	1/2	2.8	2.8	S57SW0160101-MAX	5	0.56	N
Vanadium	1/2	1.4	1.4	S57SW0140101	NA	NA	Y
Zinc	2/2	63.1	119	S57SW0140101	79.55	1.50	Y

NA = Not Available

Samples included in table are S57SW0110101, S57SW0120101, S57SW0140101, S57SW0140101-F, S57SW0150101, S57SW0160101-MAX, S57SW0160101-F-MAX

TABLE 10-2

SELECTION OF PRELIMINARY CHEMICAL OF CONCERN - DOWNGRADIENT SEDIMENT
SITE 57 - FORMER DRUM LOADING AREA
IHDIV - NWSC, INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection	Range of Detection		Location of Maximum	Sediment Screening Level	Maximum Hazard Quotient	Selected as PCOC (Y/N?)
		Min.	Max.				
Volatile Organic Compounds (ug/kg)							
Acetone	1/5	31	31	S57SD0120101-MAX	NA	NA	Y
Carbon Disulfide	1/5	3	3	S57SD0080101	NA	NA	Y
Semivolatile Organic Compounds (ug/kg)							
Anthracene	1/2	59	59	S57SD0100101	31.62	1.87	Y
Benzo(a)anthracene	1/2	180	180	S57SD0100101	260	0.69	N
Benzo(a)pyrene	1/2	120	120	S57SD0100101	350	0.34	N
Benzo(b)fluoranthene	1/2	290	290	S57SD0100101	27.2	10.66	Y
Benzo(g,h,i)perylene	1/2	57	57	S57SD0100101	290	0.20	N
Benzo(k)fluoranthene	1/2	77	77	S57SD0100101	27.2	2.83	Y
Bis(2-Ethylhexyl)phthalate	1/2	46	46	S57SD0100101	NA	NA	Y
Chrysene	1/2	160	160	S57SD0100101	500	0.32	N
Di-n-butyl phthalate	1/2	61	61	S57SD0100101	NA	NA	Y
Fluoranthene	1/2	380	380	S57SD0100101	64.23	5.92	Y
Fluorene	1/2	44	44	S57SD0100101	34.64	1.27	Y
Indeno(1,2,3-cd)pyrene	1/2	84	84	S57SD0100101	78	1.08	Y
Phenanthrene	1/2	280	280	S57SD0100101	560	0.50	N
Pyrene	1/2	330	330	S57SD0100101	570	0.58	N
Pesticides (ug/kg)							
4,4'-DDD	1/2	1.4	1.4	S57SD0120101-MAX	8	0.18	N
4,4'-DDE	1/2	0.34	0.34	S57SD0120101-MAX	5	0.07	N
4,4'-DDT	1/2	0.96	0.96	S57SD0120101-MAX	8	0.12	N
Inorganics (mg/kg)							
Aluminum	2/2	599	1480	S57SD0100101	NA	NA	Y
Arsenic	1/2	4.7	4.7	S57SD0100101	12.1	0.39	N
Barium	2/2	7.4	8	S57SD0120101-MAX	NA	NA	Y
Beryllium	2/2	0.16	0.16	S57SD0100101	NA	NA	Y

TABLE 10-2

SELECTION OF PRELIMINARY CHEMICAL OF CONCERN - DOWNGRADIENT SEDIMENT
SITE 57 - FORMER DRUM LOADING AREA
IHDIV - NWSC, INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection	Range of Detection		Location of Maximum	Sediment Screening Level	Maximum Hazard Quotient	Selected as PCOC (Y/N?)
		Min.	Max.				
Cadmium	1/2	0.26	0.26	S57SD0100101	0.592	0.44	N
Chromium	2/2	1.3	10.7	S57SD0100101	56	0.19	N
Cobalt	2/2	1.7	5	S57SD0100101	NA	NA	Y
Copper	1/2	6.9	6.9	S57SD0100101	28	0.25	N
Cyanide	2/2	0.55	0.61	S57SD0120101-MAX	NA	NA	Y
Iron	2/2	1830	7440	S57SD0100101	20000	0.37	N
Lead	1/2	18.8	18.8	S57SD0100101	34.2	0.55	N
Manganese	2/2	15.6	96.4	S57SD0100101	1673	0.06	N
Mercury	1/2	1.9	1.9	S57SD0100101	0.2	9.50	Y
Nickel	2/2	0.94	10	S57SD0100101	39.6	0.25	N
Vanadium	2/2	5.4	9	S57SD0100101	NA	NA	Y
Zinc	2/2	9.1	126	S57SD0100101	159	0.79	N

NA = Not Available

Samples included in table are S57SD0070101, S57SD0080101, S57SD0100101, S57SD0110101, S57SD0120101-MAX

TABLE 10-3

SELECTION OF PRELIMINARY CHEMICALS OF CONCERN - SEWER WATER
SITE 57 - FORMER DRUM LOADING AREA
IHDIV - NWSC, INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection	Range of Detection		Location of Maximum	AWQC	Maximum Hazard Quotient	Selected as PCOC (Y/N?)
		Min.	Max.				
Volatile Organic Compounds (ug/L)							
1,1,1-Trichloroethane	1/13	0.1	0.1	S57SW0060101-MAX	NA	NA	Y
1,1-Dichloroethene	3/13	0.1	0.2	S57SW0060101-MAX	NA	NA	Y
2-Butanone	11/11	10.7	21	S57SW0020101	NA	NA	Y
Acetone	4/6	255.3	741.1	S57SW0060101-MAX	NA	NA	Y
Bromodichloromethane	1/13	0.1	0.1	S57SW0060101-MAX	NA	NA	Y
Bromoform	6/13	0.3	0.7	S57SW0070201	NA	NA	Y
Dibromochloromethane	6/13	0.2	0.4	S57SW0060101-MAX	NA	NA	Y
Ethyl Ether	13/13	1.9	197	S57SW0020101	NA	NA	Y
Ethylbenzene	9/13	0.5	4	S57SW0020101	NA	NA	Y
Styrene	9/13	0.2	4	S57SW0020101	NA	NA	Y
Toluene	4/13	0.1	0.1	S57SW0060101-MAX	NA	NA	Y
Trans-1,2-dichloroethene	3/13	0.1	0.1	S57SW0070101	NA	NA	Y
Trichloroethene	12/13	0.4	21.3	S57SW0070201	NA	NA	Y
Vinyl Chloride	8/13	0.2	2	S57SW0020101	NA	NA	Y
Xylenes, Total	6/13	0.1	0.6	S57SW0070101	NA	NA	Y
cis-1,2-dichloroethene	12/13	0.3	15	S57SW0020101	NA	NA	Y
Inorganics (ug/L)							
Aluminum	4/5	277	924	S57SW0040101	87	10.60	Y
Barium	5/5	22.2	34	S57SW0090101	NA	NA	Y
Chromium	4/5	0.73	2.2	S57SW0040101	50.57	0.04	N
Cobalt	5/5	2.6	4	S57SW0090101	NA	NA	Y
Copper	4/5	14.9	25.2	S57SW0040101	6.01	4.19	Y
Cyanide	1/5	8.6	8.6	S57SW0090101	NA	NA	Y
Iron	5/5	925	1570	S57SW0090101	1000	1.57	Y
Lead	4/5	3.2	5.4	S57SW0040101	1.51	3.58	Y
Manganese	5/5	71.9	119	S57SW0090101	NA	NA	Y
Nickel	5/5	2.3	5.1	S57SW0040101	35.04	0.15	N
Vanadium	2/5	1.6	7.1	S57SW0040101	NA	NA	Y
Zinc	5/5	58.3	90.4	S57SW0040101	79.55	1.14	Y

NA = Not Available

Samples included in table are S57SW0010101, S57SW0020101, S57SW0020101-F, S57SW0030101-F, S57SW0030101-MAX, S57SW0030201, S57SW0040101, S57SW0040101-F, S57SW0060101-MAX, S57SW0060201, S57SW0070101, S57SW0070101-F, S57SW0070201, S57SW0080101, S57SW0080201, S57SW0080301, S57SW0090101, S57SW0090101-F.

TABLE 10-4

SELECTION OF PRELIMINARY CHEMICALS OF CONCERN - SEWER SEDIMENT
SITE 57 - FORMER DRUM LOADING AREA
IHDIV - NSWC, INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection	Range of Detection		Location of Maximum	Sediment Screening Level	Maximum Hazard Quotient	Selected as PCOC (Y/N?)
		Min.	Max.				
Volatile Organic Compounds (ug/kg)							
1,1-Dichloroethene	1/1	9	9	S57SD0050101	NA	NA	Y
Acetone	1/1	28	28	S57SD0050101	NA	NA	Y
Ethyl Ether	1/1	14	14	S57SD0050101	NA	NA	Y
Ethylbenzene	1/1	2	2	S57SD0050101	NA	NA	Y
Trans-1,2-dichloroethene	1/1	14	14	S57SD0050101	NA	NA	Y
Trichloroethene	1/1	18	18	S57SD0050101	NA	NA	Y
Vinyl Chloride	1/1	1000	1000	S57SD0050101	NA	NA	Y
cis-1,2-dichloroethene	1/1	6300	6300	S57SD0050101	NA	NA	Y
Semivolatile Organic Compounds (ug/kg)							
2-Methylnaphthalene	1/1	90	90	S57SD0050101	350	0.26	N
Acenaphthene	1/1	84	84	S57SD0050101	350	0.24	N
Anthracene	1/1	190	190	S57SD0050101	31.62	6.01	Y
Benzo(a)anthracene	1/1	420	420	S57SD0050101	260	1.62	Y
Benzo(a)pyrene	1/1	300	300	S57SD0050101	350	0.86	N
Benzo(b)fluoranthene	1/1	500	500	S57SD0050101	27.2	18.38	Y
Benzo(g,h,i)perylene	1/1	190	190	S57SD0050101	290	0.66	N
Benzo(k)fluoranthene	1/1	140	140	S57SD0050101	27.2	5.15	Y
Bis(2-Ethylhexyl)phthalate	1/1	180	180	S57SD0050101	NA	NA	Y
Carbazole	1/1	82	82	S57SD0050101	350	0.23	N
Chrysene	1/1	340	340	S57SD0050101	500	0.68	N
Dibenzo(a,h)anthracene	1/1	50	50	S57SD0050101	60	0.83	N
Dibenzofuran	1/1	80	80	S57SD0050101	NA	NA	Y
Fluoranthene	1/1	750	750	S57SD0050101	64.23	11.68	Y
Fluorene	1/1	130	130	S57SD0050101	34.64	3.75	Y
Indeno(1,2,3-cd)pyrene	1/1	160	160	S57SD0050101	78	2.05	Y
N-Nitrosodiphenylamine	1/1	50	50	S57SD0050101	NA	NA	Y
Naphthalene	1/1	180	180	S57SD0050101	32.75	5.50	Y
Phenanthrene	1/1	810	810	S57SD0050101	560	1.45	Y
Pyrene	1/1	720	720	S57SD0050101	570	1.26	Y
Pesticides (ug/kg)							

TABLE 10-4

SELECTION OF PRELIMINARY CHEMICALS OF CONCERN - SEWER SEDIMENT
SITE 57 - FORMER DRUM LOADING AREA
IHDIV - NSWC, INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection	Range of Detection		Location of Maximum	Sediment Screening Level	Maximum Hazard Quotient	Selected as PCOC (Y/N?)
		Min.	Max.				
Gamma-Chlordane	1/1	2.1	2.1	S57SD0050101	7	0.30	N
Inorganics (mg/kg)							
Aluminum	1/1	2260	2260	S57SD0050101	NA	NA	Y
Antimony	1/1	3	3	S57SD0050101	NA	NA	Y
Arsenic	1/1	8.4	8.4	S57SD0050101	12.1	0.69	N
Barium	1/1	23.2	23.2	S57SD0050101	NA	NA	Y
Beryllium	1/1	0.27	0.27	S57SD0050101	NA	NA	Y
Cadmium	1/1	0.76	0.76	S57SD0050101	0.592	1.28	Y
Chromium	1/1	12.6	12.6	S57SD0050101	56	0.23	N
Cobalt	1/1	7.7	7.7	S57SD0050101	NA	NA	Y
Copper	1/1	103	103	S57SD0050101	28	3.68	Y
Cyanide	1/1	0.76	0.76	S57SD0050101	NA	NA	Y
Iron	1/1	20800	20800	S57SD0050101	20000	1.04	Y
Lead	1/1	182	182	S57SD0050101	34.2	5.32	Y
Manganese	1/1	150	150	S57SD0050101	1673	0.09	N
Mercury	1/1	0.45	0.45	S57SD0050101	0.2	2.25	Y
Nickel	1/1	24.9	24.9	S57SD0050101	39.6	0.63	N
Silver	1/1	0.15	0.15	S57SD0050101	NA	NA	Y
Vanadium	1/1	118	118	S57SD0050101	NA	NA	Y
Zinc	1/1	183	183	S57SD0050101	159	1.15	Y

NA = Not Available
Benzo(a)pyrene was used as a surrogate for PAHs for which a screening level was not available.

Samples included in table are S57SD0050101

TABLE 10-5

SELECTION OF PRELIMINARY CHEMICALS OF CONCERN - SURFACE WATER (MATTAWOMAN CREEK)
SITE 57 - FORMER DRUM LOADING AREA
IHDIV - NWSC, INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection	Range of Detection		Location of Maximum	AWQC	Maximum Hazard Quotient	Selected as PCOC (Y/N?)
		Min.	Max.				
Volatile Organic Compounds (ug/L)							
2-Butanone	1/1	9.4	9.4	S57SW010	NA	NA	Y
Carbon Disulfide	1/1	0.9	0.9	S57SW010	NA	NA	Y
cis-1,2-Dichloroethene	1/1	40.1	40.1	S57SW010	NA	NA	Y
Ethyl Ether	1/1	69.4	69.4	S57SW010	NA	NA	Y
Trichloroethene	1/1	16.5	16.5	S57SW010	NA	NA	Y
Vinyl Chloride	1/1	3.5	3.5	S57SW010	NA	NA	Y

NA = Not Available

TABLE 10-6

SELECTION OF PRELIMINARY CHEMICALS OF CONCERN - SEDIMENT (MATTAWOMAN CREEK)
SITE 57 - FORMER DRUM LOADING AREA
IHDIV - NWSC, INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection	Range of Detection		Location of Maximum	Sediment Screening Level	Maximum Hazard Quotient	Selected as PCOC (Y/N?)
		Min.	Max.				
Volatile Organic Compounds (ug/kg)							
Acetone	1/1	34	34	S57SD006	NA	NA	Y
Cis-1,2-Dichloroethene	1/1	4	4	S57SD006	NA	NA	Y
Ethylether	1/1	7	7	S57SD006	NA	NA	Y
Methylene Chloride	1/1	15	15	S57SD006	NA	NA	Y
Inorgainic Compounds (mg/kg)							
Aluminum	1/1	3540	3540	S57SD006	NA	NA	Y
Antimony	1/1	0.63	0.63	S57SD006	NA	NA	Y
Arsenic	1/1	13.9	13.9	S57SD006	12.1	1.15	Y
Barium	1/1	52.5	52.5	S57SD006	NA	NA	Y
Beryllium	1/1	0.5	0.5	S57SD006	NA	NA	Y
Cadmium	1/1	0.69	0.69	S57SD006	0.592	1.17	Y
Chromium	1/1	13	13	S57SD006	56	0.23	N
Cobalt	1/1	8.6	8.6	S57SD006	NA	NA	Y
Copper	1/1	135	135	S57SD006	28	4.82	Y
Cyanide	1/1	1	1	S57SD006	NA	NA	Y
Iron	1/1	24200	24,000	S57SD006	20000	1.40	Y
Lead	1/1	88.9	88.9	S57SD006	34.2	2.60	Y
Manganese	1/1	239	239	S57SD006	1673	0.14	N
Mercury	1/1	0.89	0.89	S57SD006	NA	NA	Y
Nickel	1/1	19.8	19.8	S57SD006	39.6	0.50	N
Selenium	1/1	1.5	1.5	S57SD006	NA	NA	Y
Silver	1/1	0.38	0.38	S57SD006	NA	NA	Y
Vanadium	1/1	32.6	32.6	S57SD006	NA	NA	Y
Zinc	1/1	633	633	S57SD006	159	3.98	Y

NA = Not Available

TABLE 10-7

SELECTION OF PRELIMINARY CHEMICALS OF CONCERN - DOWNGRADIENT GROUNDWATER (SHALLOW)
SITE 57 - FORMER DRUM LOADING AREA
IHDIV - NWSC, INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection	Range of Detection		Location of Maximum	AWQC	Maximum Hazard Quotient	Selected as PCOC (Y/N?)
		Min.	Max.				
Volatile Organic Compounds (ug/L)							
1,1,1-Trichloroethane	5/9	1	29.5	S57MW0040101	NA	NA	Y
1,1-Dichloroethane	5/9	2	4.4	S57MW0020101	NA	NA	Y
1,1-Dichloroethene	4/9	4	11	S57MW0060101	NA	NA	Y
Acetone	1/4	29.4	29.4	S57MW0100101	NA	NA	Y
Chloroform	1/9	0.6	0.6	S57MW0100101	NA	NA	Y
Ethyl Ether	4/7	1	3950	S57MW0110101-MAX	NA	NA	Y
Tetrachloroethene	1/9	9.5	9.5	S57MW0040101	NA	NA	Y
Toluene	1/9	0.5	0.5	S57MW0040101	NA	NA	Y
Trans-1,2-dichloroethene	2/9	2	8.3	S57MW0040101	NA	NA	Y
Trichloroethene	6/9	51	611.7	S57MW0040101	NA	NA	Y
Vinyl Chloride	5/9	2.9	85	S57TW0030101	NA	NA	Y
cis-1,2-dichloroethene	8/9	0.7	528	S57MW0040101	NA	NA	Y
Semivolatile Organic Compounds (ug/L)							
Bis(2-Ethylhexyl)phthalate	1/2	2	2	S57MW0040101	NA	NA	Y
Di-n-butyl phthalate	1/2	5	5	S57MW0100101	NA	NA	Y
Inorganics (ug/L)							
Barium	2/2	35.3	57.4	S57MW0100101	NA	NA	Y
Beryllium	1/2	0.1	0.1	S57MW0040101	NA	NA	Y
Cobalt	2/2	10.5	30.7	S57MW0040101	NA	NA	Y
Iron	2/2	215	4330	S57MW0100101	1000	4.33	Y
Lead	2/2	1.2	1.3	S57MW0040101	1.51	0.86	N
Manganese	2/2	256	311	S57MW0100101	NA	NA	Y
Nickel	2/2	5.7	10.3	S57MW0040101	35.04	0.29	N
Zinc	2/2	28.5	73.3	S57MW0100101	79.55	0.92	N

NA = Not Available

Samples included in table are S57MW0020101, S57MW0040101, S57MW0040101-F, S57MW0060101, S57MW0080101, S57MW0100101, S57MW0110101-MAX, S57MW0100101-F, S57TW0010101, S57TW0020101, S57TW0030101

TABLE 10-8

SELECTION OF PRELIMINARY CHEMICALS OF CONCERN - DOWNGRADIENT GROUNDWATER (DEEP)
SITE 57 - FORMER DRUM LOADING AREA
IHDIV - NSWC, INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection	Range of Detection		Location of Maximum	AWQC	Maximum Hazard Quotient	Selected as PCOC (Y/N?)
		Min.	Max.				
Volatile Organic Compounds (ug/L)							
1,1,1-Trichloroethane	3/5	0.6	13.7	S57MW0090101	NA	NA	Y
1,1-Dichloroethane	3/5	1	5.2	S57MW0090101	NA	NA	Y
1,1-Dichloroethene	3/5	2.9	29	S57MW0090101	NA	NA	Y
Chloroform	1/5	1.3	1.3	S57MW0090101	NA	NA	Y
Ethyl Ether	5/5	2.8	1930.6	S57MW0070101	NA	NA	Y
Trans-1,2-dichloroethene	2/5	0.6	0.6	S57MW0030101	NA	NA	Y
Trichloroethene	5/5	2.2	566	S57MW0090101	NA	NA	Y
Vinyl Chloride	1/5	3.1	3.1	S57MW0030101	NA	NA	Y
cis-1,2-dichloroethene	4/5	0.5	79	S57MW0090101	NA	NA	Y
Semivolatile Organic Compounds (ug/L)							
Bis(2-Ethylhexyl)phthalate	1/2	3	3	S57MW0090101	NA	NA	Y
Inorganics (ug/L)							
Barium	2/2	27.7	38.1	S57MW0030101	NA	NA	Y
Beryllium	2/2	0.2	0.25	S57MW0090101	NA	NA	Y
Cobalt	2/2	14.5	31.9	S57MW0030101	NA	NA	Y
Iron	2/2	111	454	S57MW0030101	1000	0.45	N
Manganese	2/2	41.6	257	S57MW0030101	NA	NA	Y
Nickel	2/2	5.2	7.3	S57MW0030101	35.04	0.21	N
Zinc	2/2	22.3	26.2	S57MW0090101	79.55	0.33	N

NA = Not Available

Samples included in table are S57MW0010101, S57MW0030101, S57MW0030101-F, S57MW0050101, S57MW0070101, S57MW0090101, S57MW0090101-F

TABLE 10-9

STEP 3A - REFINEMENT OF CONTAMINANTS OF CONCERN - SEDIMENT
SITE 57 - FORMER DRUM LOADING AREA
IHDIV - NSWC, INDIAN HEAD DIVISION, MARYLAND

COPC	Sewer Maximum[1]	Mattawoman Creek Maximum[1]	Downgradient Maximum	Downgradient Average of All Detections	Basewide Background[2]	Upgradient Concentration[3]	ARCS PEC	Ontario SEL	ER-M
Inorganics (mg/kg)									
ALUMINUM	2260	3540	1480	1040	18329	ND	58030	--	--
ANTIMONY	3	0.63	NA	NA	ND	ND	--	--	--
ARSENIC	8.4	13.9	NA	NA	4.25	ND	57	33	70
BARIUM	23.2	52.5	8	7.7	144	ND	--	--	--
BERYLLIUM	0.27	0.5	0.16	0.16	0.905	ND	--	--	--
CADMIUM	0.76	0.69	NA	NA	0.26	0.1	11.7	10	9.6
COBALT	7.7	8.6	5	3.35	39.7	ND	--	--	--
COPPER	103	135	NA	NA	18.7	2.9	77.7	110	270
CYANIDE	0.76	1	0.61	0.58	ND	ND	--	--	--
IRON	20800	24,000	NA	NA	43170	ND	--	40,000	--
LEAD	182	88.9	NA	NA	149	21.7	396	250	218
MERCURY	0.45	0.89	1.9	0.955	0.087	ND	--	2	0.71
SELENIUM	NA	1.5	NA	NA	ND	ND	NA	NA	NA
SILVER	0.15	0.38	NA	NA	ND	ND	--	--	3.7
VANADIUM	118	32.6	9	7.2	53.5	ND	--	--	--
ZINC	183	633	NA	NA	38.1	13.5	1532	820	410
SVOCs (ug/kg)									
ANTHRACENE	190	NA	59	140	--	ND	548	3700	1100
BENZO(A)ANTHRACENE	420	NA	NA	NA	--	ND	4200	14,800	1600
BENZO(B)FLUORANTHENE	500	NA	290	255	--	ND	--	--	--
BENZO(K)FLUORANTHENE	140	NA	77	149	--	ND	--	--	--
BIS(2-ETHYLHEXYL)PHTHALATE	180	NA	46	133	--	ND	--	--	--
DI-N-BUTYLPHTHALATE	NA	NA	61	141	--	ND	--	--	--
DIBENZOFURAN	80	NA	NA	NA	--	ND	--	--	--
FLUORANTHENE	750	NA	380	300	--	ND	834	10,200	5100
FLUORENE	130	NA	44	132	--	ND	652	1600	540
INDENO(1,2,3-CD)PYRENE	160	NA	84	132	--	ND	--	3200	--
N-NITROSODIPHENYLAMINE	50	NA	NA	NA	--	ND	--	--	--
NAPHTHALENE	180	NA	NA	NA	--	ND	687	--	2100
PHENANTHRENE	810	NA	NA	NA	--	ND	--	9500	1500

TABLE 10-9

STEP 3A - REFINEMENT OF CONTAMINANTS OF CONCERN - SEDIMENT
SITE 57 - FORMER DRUM LOADING AREA
IHDIV - NSWC, INDIAN HEAD DIVISION, MARYLAND

COPC	Sewer Maximum[1]	Mattawoman Creek Maximum[1]	Downgradient Maximum	Downgradient Average of All Detections	Basewide Background[2]	Upgradient Concentration[3]	ARCS PEC	Ontario SEL	ER-M
PYRENE	720	NA	NA	NA	--	ND	3225	8500	2600
VOCs (ug/kg)									
1,1-DICHLOROETHENE	9	NA	NA	NA	--	ND	--	--	--
ACETONE	28	34	31	11.2	--	ND	--	--	--
CARBON DISULFIDE	NA	NA	3	5.7	--	ND	--	--	--
CIS-1,2-DICHLOROETHENE	6300	4	NA	NA	--	ND	--	--	--
ETHYL ETHER	14	7	NA	NA	--	ND	--	--	--
ETHYLBENZENE	2	NA	NA	NA	--	ND	--	--	--
METHYLENE CHLORIDE	NA	15	NA	NA	--	8	--	--	--
TRANS-1,2-DICHLOROETHENE	14	NA	NA	NA	--	ND	--	--	--
TRICHLOROETHENE	18	NA	NA	NA	--	ND	--	--	--
VINYL CHLORIDE	1000	NA	NA	NA	--	ND	--	--	--
Pesticides/PCBs (ug/kg)									
4,4'-DDD	NA	NA	1.4	1.75	--	ND	NA	60	20
4,4'-DDE	NA	NA	0.34	1.22	--	ND	NA	190	27
4,4'-DDT	NA	NA	0.96	1.53	--	ND	NA	710	7
GAMMA-CHLORDANE	2.1	NA	NA	NA	--	ND	NA	60	6

1 Only one sample was collected. Hence, averages are not presented.

2 From basewide background study (B&RE, 1997).

3 Sample S57SD009.

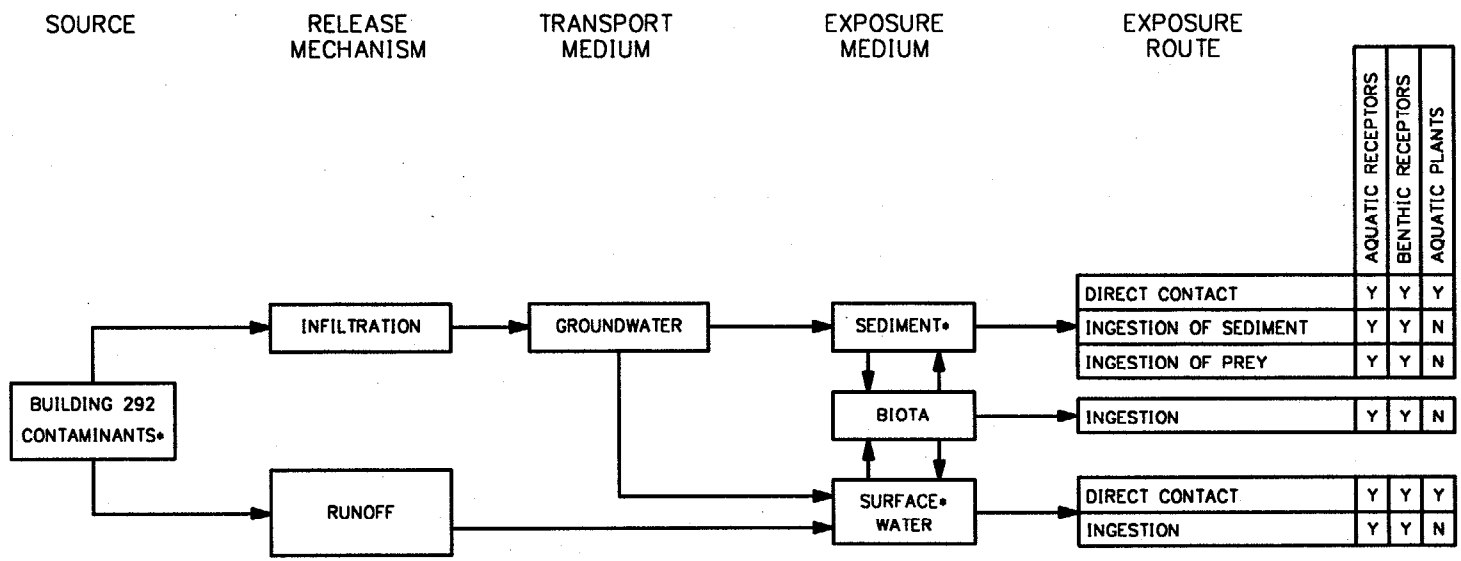
NA = Not Applicable because the analyte was not a sediment COPC from Steps 1 and 2

ND = Not detected

PEC = Probable Effects Concentration, SEL = Severe Effects Level, ER-M = Effects Range-Median

-- = No value available

ACAD: 7129kf14.dwg 06/15/99 DT



LEGEND:

Y = COMPLETE EXPOSURE ROUTE
N = INCOMPLETE EXPOSURE ROUTE
• = INCLUDES SEWER, DITCH, STREAM AND MATTAWOMAN CREEK

DRAWN BY DLT DATE 6/15/99	Tetra Tech NUS, Inc.	CONTRACT NO. 7129	OWNER NO. 0550
CHECKED BY GJL DATE 2/4/00	ECOLOGICAL CONCEPTUAL MODEL SITE 57 – FORMER DRUM LOADING AREA INDIAN HEAD DIVISION NSWC INDIAN HEAD, MARYLAND	APPROVED BY GJL	DATE 2/4/00
COST/SCHED-AREA		APPROVED BY	DATE
SCALE NOT TO SCALE		DRAWING NO. FIGURE 10-1	REV. 0

FORM CADD NO. T+NUS_AH.DWG - REV 0 - 1/22/98

11.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

11.1 SITE CHARACTERIZATION SUMMARY

The following items summarize the field investigations conducted at Site 57.

1) Field work included drilling and logging 27 borings; 13 of which were converted into permanent groundwater monitoring wells and three were converted into temporary groundwater monitoring wells. Environmental samples included 17 groundwater samples; 16 from the installed monitoring wells and one from an Indian Head NSWC supply well), 10 surface soil samples; 38 subsurface soil samples, eight surface water samples and sediment pair samples, and 12 storm sewer water samples. Solids samples were analyzed for TCL VOCs and ethyl ether. However, at selected areas, the samples were analyzed for a full list of TCL and TAL compounds plus explosives, and TOC. Additionally, at selected locations, sediment samples were analyzed for AVS/SEM, and four samples were analyzed for geotechnical parameters. Aqueous samples were analyzed for TCL VOCs and ethyl ether and, at selected areas, the samples were analyzed for a full list of TCL and TAL compounds including cyanide, explosives, hardness, and ecological parameters. Both filtered and unfiltered groundwater samples were analyzed for TAL metals.

2) The borings installed at the site revealed that subsurface conditions consisted of three lithologic layers. These are listed in order from ground surface to depth drilled: reworked natural material of gravel, sand, silt, and clay (fill); poorly sorted sand, yellow-brown and gray, with minor amounts of gravel, silt, and clay; well-sorted, very fine-grained sand, silt, and clay, olive-brown color.

3) Monitoring wells were installed in a clustered configuration consisting of two wells, with an upper surficial well screened across the water table and a lower surficial well screened at the lower portion of the water-table aquifer. The clusters were placed up-gradient, within, and down-gradient of Building 292. At four locations, only water-table wells were installed to investigate the associated storm sewer. The water-table aquifer consisted primarily of poorly sorted sand, yellow-brown and gray, with minor amounts of gravel, silt, and clay and is underlain by an aquitard consisting of olive-brown, very fine-grained sand, silt, and clay. Groundwater depth ranged from 1.8 to 7.4 feet bgs.

4) The monitoring wells were slug tested and the results indicate that the water-table aquifer has an estimated hydraulic conductivity of 2.2 feet per day. A synoptic water-level measurement was made at the monitoring wells, and the resulting data were used to generate a potentiometric surface figure illustrating the groundwater flow pattern and flow gradient. The flow gradient was

estimated to be 0.0309 feet per foot and as a result the groundwater seepage velocity was calculated to be 0.27 feet per day.

11.2 NATURE AND EXTENT OF CONTAMINATION SUMMARY

The following items summarize the nature and extent of contamination at Site 57:

1) Minimal organic contamination is present in the soil, groundwater, surface water, and sediment upgradient of Site 57. Ethyl ether, a site-related VOC, was detected in the upgradient surface soil sample (54 µg/kg) and the lower surficial upgradient groundwater sample (3.6 µg/L). Nitrocellulose was also detected in the upgradient surface soil sample (50400 µg/kg) and the lower surficial upgradient groundwater sample (223 µg/L). TCE, another site-related VOC, and several other chlorinated VOCs were detected in the upper surficial and lower surficial upgradient groundwater samples. However, with the exception of 1,1-dichloroethene in the upper surficial upgradient groundwater sample (77.5 µg/L), concentrations of the chlorinated hydrocarbons in the groundwater samples were relatively low (ranging from 0.8 µg/L to 14.6 µg/L). No organic compounds were detected in the upgradient surface water and sediment samples.

2) TCE and several chlorinated hydrocarbons were detected in downgradient soil and groundwater samples. TCE and one of its degradation products, 1,2-dichloroethene, were typically detected with the greatest frequency and at the greatest concentrations. Notable concentrations were detected in subsurface soil samples (TCE at 220000 µg/kg and cis-1,2-dichloroethene at 77000 µg/kg in a subsurface soil sample collected near the southern end of Building 292). Most of the positive results for TCE in subsurface soils were associated with samples collected within 100 feet of the former drum loading area. TCE and cis-1,2-dichloroethene, at maximum concentrations of 93 µg/kg and 4 µg/kg, respectively, were the only two chlorinated hydrocarbons detected in the surface soil samples.

3) Maximum concentrations of TCE and several other chlorinated hydrocarbons in upper surficial groundwater samples were associated with the well located at the southeastern corner of Building 292. Maximum concentrations of all detected chlorinated hydrocarbons except vinyl chloride in lower surficial groundwater samples were associated with the well located between the railroad tracks and Thomas Road, just south of the location were the paths of the railroad tracks and the concrete drainage ditch diverge. However, definitive patterns (i.e., from upgradient to downgradient or from upper surficial to lower surficial) of chlorinated hydrocarbon contamination in Site 57 upper and lower surficial downgradient groundwater could not be identified.

4) Although not detected in downgradient surface soil, subsurface soil, open channel surface water, or open channel sediment, ethyl ether was frequently detected in downgradient groundwater (upper and lower surficial), storm sewer surface water, and storm sewer sediment. The maximum concentrations of ethyl ether associated with upper and lower surficial groundwater were 3950 µg/L and 1930.6 µg/L, respectively. The greatest concentrations of ethyl ether in the groundwater samples were found in the area near or within 300 feet downgradient of Building 496, a vault used for the storage of ether. The maximum ethyl ether concentration (197 µg/L) was detected at the southern side of Building 292. In general, ethyl ether concentrations decreased in downgradient samples with the distance from Building 292. The concentrations of ethyl ether in the storm sewer surface water and sediment samples at the outfall to Mattawoman Creek were 70.2 µg/L and 14 µg/kg, respectively.

5) Very few SVOCs were detected in Site 57 groundwater or surface water samples. Several SVOCs, primarily PAHs, were sporadically detected in Site 57 downgradient surface and subsurface soil samples. The maximum concentrations of all SVOCs in surface and subsurface soil samples were associated with the samples collected from boring S57MW009/SB005, located approximately 400 feet southeast of Building 292 between the railroad tracks and Thomas Road. PAH concentrations in the surface and subsurface soil samples from this location ranged from 37 µg/kg to 4200 µg/kg and from 60 µg/kg to 510 µg/kg, respectively. The presence of PAHs at this location may be related to the past and current use of gasoline fueled vehicles and asphalt associated with Thomas Road and/or the use of creosote as a preservative for the railroad ties. Several PAHs were also detected in the drainage channel sediment sample collected at the drainage channel outlet into the unnamed creek and in the storm sewer sediment sample collected at the outfall at Mattawoman Creek.

6) Although not detected in open channel or storm sewer sediment samples, nitrocellulose was detected in a majority of the downgradient surface soil, subsurface soil, groundwater, and surface water samples analyzed for this parameter. Concentrations of nitrocellulose in downgradient surface soil samples ranged from 116000 µg/kg to 299000 µg/kg. Concentrations of nitrocellulose in downgradient subsurface soils ranged from 66000 µg/kg to 205000 µg/kg. A definitive pattern of nitrocellulose contamination in relation to soil depth could not be determined. Nitrocellulose was detected at a concentration of 148 µg/L in both an upper surficial and a lower surficial groundwater sample and was also detected in an open channel surface water sample (221 µg/L). Nitrocellulose was detected in storm sewer surface water samples collected from three manholes in the site area at concentrations of 144 µg/L, 1120 µg/L, and 1230 µg/L. Concentrations of nitrocellulose in the storm sewer surface water samples increased in association with more downgradient locations.

7) In general, detected concentrations of inorganics in all media do not appear to vary greatly among upgradient and downgradient, surface and subsurface, or upper surficial and lower surficial samples. A majority of the detected concentrations of metals in all media were less than associated background concentrations. Notable detections of metals include lead (487 mg/kg) in the surface soil sample collected from boring S57MW009/SB005 and arsenic (103 mg/kg) in the surface soil sample collected from boring S57SB007.

8) TCE was detected at a concentration of 7.2 µg/L in the water sample collected from potable well PW-07. This well is located downgradient of Site 57 (northwest of Site 41, Scrap Yard). No other VOCs were detected in this sample. Although TCE is a site-related contaminant, based upon historical sampling and analytical results for water samples from well PW-07, it is not clear whether Site 57 is, in fact, affecting the water from well PW-07. Well PW-7 was resampled in October 1999. Chemical analysis of the more recent sample resulted in a single detection (1,4-dichlorobenzene at 0.13 µg/L compared with EPA tap water criteria of 0.47 µg/L, and the Federal MCL of 75 µg/L).

9) Ethyl ether (69.4 µg/L), TCE (16.5 µg/L), cis-1,2-dichloroethene (40.1 µg/L), and vinyl chloride (3.5 µg/L) were detected in the surface water sample collected from Mattawoman Creek, downgradient of the Site 57 storm sewer outfall. Ethyl ether (7 µg/kg) and cis-1,2-dichloroethene (4 µg/kg) were also detected in the sediment sample collected from the Mattawoman Creek sampling location. These results indicate that contamination from Site 57 may be impacting the surface water and sediment of Mattawoman Creek.

11.3 SUMMARY OF HUMAN HEALTH RISK ASSESSMENT

The following items summarize the human health risk assessment for Site 57.

1) The human health risk assessment for Site 57 considered current/future full-time employees exposed to surface soil and future construction workers and future residents exposed to surface/subsurface soil, groundwater, surface water, and sediment. Exposures to current/future adolescent trespassers were not considered because the site is located in a secure area. Both RME and CTE scenarios were evaluated.

2) No COPCs were identified for upgradient surface water and sediment; consequently, no adverse health effects are anticipated for exposure to these media.

3) Incremental cancer risks for the full-time employee exposed to surface soil under the RME and CTE scenarios in the upgradient and downgradient areas were within or less than EPA's target risk range of 10^{-4} to 10^{-6}.

4) Hazard indices for the full-time employee exposed to surface soil under the RME and CTE scenarios in the upgradient and downgradient areas were less than 1.0 indicating that there is minimal potential for adverse health effects under the conditions established in the risk assessment.

5) The excess lifetime cancer risks for the future construction worker under the RME and CTE scenarios exposed to surface/subsurface soil and groundwater in the upgradient area, surface/subsurface soil, groundwater, surface water, and sediment in the downgradient area, and surface water and sediment in the storm sewer were within or less than the EPA target risk range of 10^{-4} to 10^{-6}.

6) The hazard indices for a construction worker exposed to surface/subsurface soil and groundwater in the upgradient area and surface water and sediment in the storm sewer were less than 1.0 for the RME and CTE scenarios, indicating that there is minimal potential for adverse health effects under the conditions established in the risk assessment.

7) The hazard indices for a construction worker exposed to surface/subsurface soil, groundwater, sediment, and surface water in the downgradient area exceed 1.0 for the RME scenario. Incidental ingestion of arsenic in surface/subsurface soil was the main contributor to the hazard index. Elevated concentrations of arsenic were limited to a hot spot at boring SS57SB007. If boring SS57SB007 was removed from the database, then the HI for construction workers exposed to all media in the downgradient area would be less than the acceptable level of 1.0. The hazard index for the construction worker under the CTE scenario was less than 1.0.

8) The excess lifetime cancer risks for a lifelong resident exposed to surface/subsurface soil and groundwater in the upgradient area exceeded EPA's target risk range of 10^{-4} to 10^{-6} for the RME scenario. Potential exposure to 1,1-dichloroethene in groundwater was the main contributor to the cancer risk. The excess lifetime cancer risk for a lifelong resident under the CTE scenario was within EPA's target risk range.

9) The total cumulative hazard index for a hypothetical child resident exposed to surface/subsurface soil and groundwater in the upgradient area exceeds the acceptable level of 1.0 although the hazard index per target organs were less than 1.0, which indicates that there is minimal potential

for adverse health effects under the conditions established in the risk assessment. The hazard index for the child resident under the CTE scenario was less than 1.0.

10) The total cumulative hazard indices for a hypothetical future adult resident exposed to surface/subsurface soil and groundwater in the upgradient area under the RME and CTE scenarios were less than the acceptable level of 1.0, which indicates that there is minimal potential for adverse health effects under the conditions established in the risk assessment.

11) The excess lifetime cancer risk for a lifelong resident exposed to surface/subsurface soil, groundwater, surface water, and sediment in the downgradient area exceeded EPA's target risk range of 10^{-4} to 10^{-6} for the RME and CTE scenarios. Incidental ingestion of arsenic in soil, ingestion of TCE in groundwater, and ingestion and inhalation of vinyl chloride in groundwater were the main contributors to the cancer risk.

12) The total cumulative hazard index for a hypothetical future child and adult resident exposed to surface/subsurface soil, groundwater, surface water, and sediment in the downgradient area exceeded the acceptable level of 1.0 for the RME and CTE scenarios. Incidental ingestion of arsenic in soil and ingestion of cis-1,2-dichloroethene, ethyl ether, and TCE in groundwater were the main contributors to the hazard index for the child resident. Ingestion of cis-1,2-dichloroethene and TCE in groundwater was the main contributors to the hazard index for the adult resident.

13) Incremental cancer risks for a lifelong resident exposed to groundwater from well PW-7 under the RME and CTE scenarios were within or less than EPA's target risk range of 10^{-4} to 10^{-6}.

14) Hazard indices for child and adult residents exposed to groundwater from PW-7 under the RME and CTE were less than 1.0, indicating that there is minimal potential for adverse health effects under the conditions established in the risk assessment.

15) The maximum detected concentration of lead in downgradient subsurface soil exceeded the OSWER residential screening level of 400 mg/kg. The IEUBK model was used to evaluate exposures to lead in soil by hypothetical residential children. The IEUBK model indicated that no adverse effects are anticipated for hypothetical future child residents exposed to lead in surface/subsurface soil at Site 57.

11.4 SUMMARY OF ECOLOGICAL RISK ASSESSMENT

Several chemicals were detected in the sewer near Site 57, the downgradient ditches and stream, and Mattawoman Creek, where the sewer and stream discharge. For the most part, concentrations of chemicals in surface water and sediment in these areas were relatively low and indicative of low potential risks. The exceptions are potential risks from copper in sewer and Mattawoman Creek sediments and sewer surface water and mercury in Mattawoman Creek and downgradient sediment. VOCs were elevated also in almost all media assessed in this ERA. Although VOCs are not generally associated with ecotoxicity, their elevated concentrations could be of concern. It is unclear whether activities at Building 292 have contributed copper and mercury to the environment, although it does not appear to be the case. The recent cleaning of the sewer suggests that sewer sediments are no longer a source of chemicals to downgradient areas, including Mattawoman Creek. However, due to the elevated concentrations of some chemicals in Mattawoman Creek near the stream and sewer discharge points, this area should be studied further as part of the Mattawoman Creek watershed study.

11.5 RECOMMENDATIONS

- The estimated excess lifetime cancer risk was within or less than EPA's target risk range of 10^{-4} to 10^{6} for both the full-time employee and the construction worker. The range was exceeded for residential scenarios only.

- The estimated hazard index was below the acceptable level of 1.0 for the full-time employee but was exceeded for the construction worker and the residential scenarios.

- Conditioned on continuation of the site's current use, the potential risks estimated for hypothetical future residents due to soil and groundwater contamination do not, by themselves, warrant mitigative action at this time. The need for future action to mitigate the potential health risks to residents due to soil and groundwater contamination should be reconsidered if plans evolve for modifying the land use (e.g., to a residential land use).

- Soil contamination is the major reason the hazard index for construction workers exceeds the acceptable level of 1.0. It is recommended that a feasibility study be initiated to evaluate potential alternatives for mitigating the potential risk to construction workers due to soil contamination. Particular attention should be paid to arsenic concentrations in soil.

- Some samples collected near the southern corner of Building 292 exhibited high concentrations of TCE in soil and groundwater. It is recommended that a feasibility study be initiated to evaluate

potential alternatives for addressing the apparent contamination hot spot. Particular attention should be paid to the restoration of groundwater quality.

- Elevated contaminant levels detected in Mattawoman Creek sediments near the discharge points for the unnamed stream and the storm sewer may represent potential ecological risks. It is recommended that those locations be included in the pending ecological study of Mattawoman Creek.

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