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FINAL BASELINE ECOLOGICAL RISK ASSESSMENT PROBLEM FORMULATION AND WORK PLAN SITES 11 AND 17 NSWC INDIAN HEAD MD

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Final

Baseline Ecological Risk Assessment Problem Formulation and Work Plan Sites 11 and 17

Naval District Washington, Indian Head
Indian Head, Maryland

Prepared for

Department of the Navy

Engineering Field Activity Chesapeake
Naval Facilities Engineering Command
Norfolk, Virginia

Contract No. N62470-95-D-6007
CTO-0122

May 2004

Prepared by

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May 6, 2004

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04-JB-0269

Commander
EFA Chesapeake
Mr. Jeff Morris, Code C21CE
Washington Navy Yard, Bldg. 212
1314 Harwood St., SE
Washington Navy Yard, DC 20374-5018

Subject: Navy CLEAN II Program
Contract N62470-95-D-6007
Contract Task Order 0122
Final BERA Work Plan for Sites 11 and 17
Naval District Washington Indian Head, Indian Head, MD

Dear Jeff:

CH2M HILL is pleased to submit one hard copy of the above-referenced document and one CD containing an electronic version of the document in pdf format. Copies of the document and CD have also been distributed as shown below.

If you have any questions regarding this deliverable, please call Margaret Kasim at (703) 471-1441.

Sincerely,

CH2M HILL

John R. Burgess

John Burgess
Ecological Risk Assessor

WDC\cover letter for Final BERA for Sites 11-17.doc

Cc: Shawn Jorgensen/NDWIH (4 hard copies, 10 CDs)
Curtis DeTore/MDE (1 hard copy, 1 CD)
Dennis Orenshaw/USEPA (1 hard copy, 1 CD)
George Latulippe/TTNUS (1 CD)
CH2M HILL (3 hard copies, 2 CDs)
Noelle Cuti/File/CH2M HILL (cover letter only)

MARYLAND DEPARTMENT OF THE ENVIRONMENT
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June 28, 2004

Shawn Jorgensen
Naval District Washington
Indian Head Division
ATTN: Code 044SJ, Bldg. D-327
101 Strauss Avenue
Indian Head, MD 20640-5035

RE: Final Baseline Ecological Risk Assessment Problem Formulation and Work Plan for Sites 11 and 17, Naval District Washington Indian Head, May 2004

Dear Mr. Jorgensen:

The Federal Facilities Division of the Maryland Department of the Environment's Waste Management Administration has no further comment on the above referenced document. This document accurately addresses the comments previously provided during the draft version of the document and during Indian Head Installation Restoration Team meetings.

If you have any questions, please contact me at (410) 537-3791.

Sincerely,

Curtis DeTore
Remedial Project Manager
Federal Facilities Division

CD:mh

cc: Mr. Dennis Orenshaw
Mr. Jeff Morris
Mr. Horacio Tablada
Mr. Harold L. Dye, Jr.

MARYLAND DEPARTMENT OF THE ENVIRONMENT

MDE

1800 Washington Boulevard • Baltimore MD 21230
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December 19, 2003

Ms. Heidi Morgan
Indian Head Division
Naval Surface Warfare Center
Attn: Code 044HM, Building D-327
101 Strauss Avenue
Indian Head MD 20640-5035

Re: Draft Final Baseline Ecological Risk Assessment Problem Formulation and Work Plan for Sites 11 and 17, Indian Head NSWC, October 2003

Dear Ms. Morgan:

The Federal Facilities Section of the Maryland Department of the Environment's Waste Management Administration has no further comments on the above-referenced document. This document accurately addresses the comments previously provided during the draft version of the document and during Indian Head Installation Restoration Team meetings.

If you have any questions, please contact me at (410) 537-3791.

Sincerely,

Curtis DeTore
Remedial Project Manager
Federal/NPL Superfund Division

CD:bjm

cc: Mr. Jeff Morris
Mr. Dennis Orenshaw
Mr. Jonas Jacobson
Mr. Karl Kalbacher

Final

Baseline Ecological Risk Assessment Problem Formulation and Work Plan Sites 11 & 17

Naval District Washington, Indian Head
Indian Head, Maryland

Contract Task Order 0122

May 2004

Prepared for

Department of the Navy
Engineering Field Activity, Chesapeake
Naval Facilities Engineering Command

Under the

LANTDIV Clean II Program
Contract N62470-95-D-6007

Prepared by

CH2MHILL

Herndon, Virginia

SIGNATURE PAGE

Final

Baseline Ecological Risk Assessment
Problem Formulation and Work Plan
Sites 11 & 17

Naval Surface Warfare Center
Indian Head Division
Indian Head, Maryland

Contract Task Order - 0122
Contract Number N62470-95-D-6007
Navy CLEAN II Program

Prepared by

CH2M HILL

May 2004

Approved by: John R. Burgess Date: May 6, 2004
John Burgess
Ecological Risk Assessor

Approved by: Margaret Kasim Date: May 6, 2004
Margaret Kasim, Ph.D.
Project Manager

Approved by: Anne Estabrook Date: May 6, 2004
Anne Estabrook, P.E.
Activity Manager

Contents

Figures (Figures are located at the end of each section.)

Acronyms and Abbreviations

ASTM	American Society for Testing and Materials
B&RE	Brown & Root Environmental
BERA	Baseline Ecological Risk Assessment
CLEAN	Comprehensive Long-term Environmental Action Navy
CLP	Contract Laboratory Program
CNO	Chief of Naval Operations
COC	Chemical of Concern
COPC	Chemical of Potential Concern
CTO	Contract Task Order
ERA	Ecological Risk Assessment
ER-L	Effects Range-Low
ER-M	Effects Range-Median
HASP	Health and Safety Plan
HQ	Hazard Quotient
NDWIH	Naval District Washington, Indian Head
IHIRT	Indian Head Installation Restoration Team
IR	Installation Restoration
LC50	Lethal Concentration 50 Percent
LOAEL	Lowest Observed Adverse Effect Level
MFO	Mixed Function Oxidase
mg/kg	Milligrams per Kilogram
MS/MSD	Matrix Spike and Matrix Spike Duplicate
NOAEL	No-Observed-Adverse-Effect-Level
PEL	Probable Effects Level
ppm	parts per million
PRG	Preliminary Remediation Goals
QAPP	Quality Assurance Project Plan
RI	Remedial Investigation
SERA	Screening Ecological Risk Assessment
SOP	Standard Operating Procedure
TAL	Target Analyte List
TEL	Threshold Effects Level
TOC	Total Organic Carbon
µg/L	Micrograms per Liter
USEPA	United States Environmental Protection Agency

SECTION 1

Introduction

This document presents Step 3B and Step 4 of the ecological risk assessment (ERA) process for Sites 11 and 17 at the Naval District Washington, Indian Head (NDWIH), Indian Head, Maryland. This document was prepared in accordance with USEPA guidance (USEPA, 1997) and Chief of Naval Operations (CNO) policy (CNO, 1999). Step 3B is the problem formulation phase of the baseline ERA (BERA). It involves an evaluation of the toxicity of site-related chemicals, based on the results of Steps 1 through 3A, and the refinement of the assessment endpoints and conceptual model developed in the screening ERA (SERA). Step 4 involves developing a study design to fill data gaps and address areas of uncertainty identified in Step 3B.

In addition to the BERA investigation for Sites 11 and 17, a separate sediment sampling effort in Mattawoman Creek is included in this work plan. The separate investigation is focused around Bullit's Neck on the opposite shore of Mattawoman Creek. The Bullit's Neck sampling has been included to address the NDWIH Restoration Advisory Board (RAB) concerns regarding recreational use of the area and a lack of sediment chemical data. Additionally, there were potential data gaps identified in the Mattawoman Creek Study regarding the distribution and deposition of chemicals in the creek. Thus, the Navy agreed to collect samples around Bullit's Neck to address these concerns. The Bullit's Neck sampling effort is described in Section 4.2.2.

The organization of this document is as follows:

- Section 2: Step 3B. Presents the problem formulation for the BERA
- Section 3: Step 4. Presents the study design for the BERA
- Section 4: Step 4 (cont.) Presents the sampling and analysis plan
- Section 5: References

This work plan was prepared for Contract Task Order (CTO) 0122, under the Comprehensive Long-term Environmental Action Navy (CLEAN), contract number N62470-95-D-6007.

This work plan is a supplement to the following master planning documents:

- Master Work Plan, prepared by Brown & Root Environmental (B&RE), April 1997a
- Master Field Sampling Plan, prepared by B&RE, April 1997b
- Standard Operating Procedures (SOPs), prepared by B&RE, April 1997e
- Master Quality Assurance Project Plan (QAPP), prepared by B&RE, April 1997c
- Health and Safety Guidance Document, prepared by B&RE, April 1997d
- Addendum to B&RE Master Work Plans, prepared by CH2M HILL, March 2000
- Addendum to Health and Safety Plan, prepared by CH2M HILL, January 2000

The above-referenced master planning documents provide the methods and procedures that will be used to perform the environmental investigative work proposed herein for Sites 11 and 17. Unless otherwise noted, all SOPs referenced in this work plan are contained in the Master Work Plan.

1.1 Site Background

Site 11 includes the Caffee Road Landfill (Area A) and the adjacent burn pit area (Area B) (Figure 1-1). The landfill is bordered by an unnamed tidal creek and associated emergent wetland to the west and Mattawoman Creek to the south (Figure 1-1). Review of historical aerial photos indicated that filling activities have extended the shoreline into Mattawoman Creek as much as 150 feet from its original position. Site reconnaissance by two CH2M HILL ecologists in September 2002 verified that the much of the Mattawoman Creek shoreline next to Site 11 consists of concrete, debris, and fill.

Until the early 1960s, Site 11 was used for the disposal of bulk metal items and trash, rocket motor casings, exploded building debris, rifles, demilitarized ordnance, propellant grains residues and open burning residues. The surface covering the landfill was until recently used as the Decontamination Burn Point where a large collection of flashed metal parts were stored. Flashed metal refers to metal debris that has been burned to remove trace amounts of explosive residue. The metal parts were removed periodically by a metal recycling contractor. With the exception of a new gravel pad, which is now the Decontamination Burn Point, the landfill area has been regraded and seeded. Prior to sample data collected for the Remedial Investigation (RI) (July-August, 2000 and February-March, 2002), there were no historical sampling data available for Site 11.

The initial Remedial Investigation (RI) focused on the central and western portions of the site believed to have been the areas of disposal activities. However, a subsequent literature search conducted at NDWIH revealed that four open burning pits previously existed along the western edge of Site 11 (Area B). Therefore, additional sampling was conducted in this area to investigate potential impacts to environmental media at the site.

Habitats within the vicinity of Site 11 include mixed hardwood and pine forest, tidal emergent and open water wetland, the intermittent stream which discharges into the wetland, and Mattawoman Creek. Mixed hardwood and pine forest is located on the hillsides north of the landfill and west of the wetland. The forest is second or third growth and is dominated by several species of oaks (*Quercus* spp.) with red maple (*Acer rubrum*), sweet gum (*Liquidambar styraciflua*), and Virginia pine (*Pinus virginiana*). The forest understory is dominated by American holly (*Ilex opaca*). The landfill itself is grass covered.

The tidal wetland is located at the confluence of the unnamed creek and Mattawoman Creek. The marsh is approximately 0.75 acres in size with exposed mudflats at low tide. The low marsh is dominated by cattail (*Typha* spp.), and the high marsh is dominated by rose mallow (*Hibiscus palustris*), wool grass (*Scirpus cyperinus*), and soft rush (*Juncus effusus*). A sparse mixture of immature trees, including sycamore (*Platanus occidentalis*) and black willow (*Salix nigra*), has established itself in the marsh. The marsh edge abutting the landfill is dominated by clumps of wild rye (*Elymus villosus*) and black locust (*Robinia pseudoacacia*).

Fauna previously observed at Site 11 by CH2M HILL natural resources staff include marsh wren (*Cistothorus palustris*), northern flicker (*Colaptes auratus*), American crow (*Corvas* *brachyrhynchos*), gulls (*Larus* spp.), gray squirrel (*Scirius carolinensis*), and white-tailed deer (*Odocoileus virginianus*).

Site 17 is located east of and immediately adjacent to Site 11 (Figure 1-2). Site 17 is defined as a 1,000-foot stretch of shoreline along Mattawoman Creek where metal parts were discarded from the 1960s until the early 1980s. The disposed materials included rocket motor casings, shipping containers, empty drums, and various metal parts. The defined area of this site was expanded in 1997 to include the forested area 100 feet from the shoreline where dozens of rusted drums were identified. Prior to the data collected for the RI in July-August, 2000, there are no historic sampling data available for Site 17.

Mattawoman Creek supports spawning populations of fish including white perch (*Morone americana*), yellow perch (*Perca flavenscens*), American shad (*Alosa sapidissima*), blueback herring (*Alosa aestivalis*), alewife (*Alosa pseudoharengus*), and largemouth bass (*Micropterus salmoides*). Mattawoman Creek also supports channel catfish (*Ictalurus punctatus*) and bluegill (*Lepomis macrochirus*). The shoreline of Mattawoman Creek is gravelly and degraded with discarded metal parts, concrete, and other debris used for erosion control. Vegetation within the intertidal shore includes wild rye (*E. villosus*), rose-mallow (*H. palustris*), and *Hydrilla verticillata*, an invasive, non-native species.

The riparian forested buffer is sparsely vegetated with black locust (*R. pseudoacacia*) and sweet gum (*L. styraciflua*). Japanese honeysuckle (*Lonicera japonica*) is also common within the buffer. Wild rye (*E. villosus*) dominates the herbaceous layer. The ground surface is littered with rusted drums.

1.2 Previous Ecological Risk Assessment

A preliminary draft SERA (Steps 1 and 2) and Step 3A report was prepared and included in the Draft RI Report for Sites 11, 13, 17, 21, and 25 in July 2001 (CH2M HILL, 2001). Sites 11 and 17 were combined for the evaluation because they abut and are hydrologically connected by Mattawoman Creek. The results of the SERA and Step 3A were as follows:

- Cadmium, chromium, copper, iron, lead, mercury, silver, and zinc in soil may pose a risk to soil invertebrates and plants. Maximum concentrations of these inorganics were detected at Site 11, each at a different sampling location.
- Barium, cadmium, copper, cyanide, lead, silver, and zinc in sediment may pose a risk to benthic invertebrates or aquatic plants. Maximum concentrations of these inorganics were observed in Mattawoman Creek, not in the stream or tidal wetland abutting the western edge of Site 11. Although the maximum concentration of cadmium was detected in a Site 17 sample, it was the sediment sample (SD06) closest to Site 11.
- Benzo(a)anthracene and explosives (1,3,5-trinitrobenzene, 2,6-dinitrotoluene, 2-amino-4,6-dinitrotoluene, 3-nitrotoluene, and 4-nitrotoluene) in sediment along a 300-foot stretch of Mattawoman Creek in the area between sample locations SD01 and SD03 may pose a risk to benthic invertebrates and aquatic plants.
- Copper, lead, and mercury were identified as Chemicals of Potential Concern (COPC) for upper trophic level receptors from potential food web exposures. Copper may pose a

risk to insectivorous terrestrial mammals. Mercury may pose a risk to insectivorous terrestrial mammals and piscivorous birds. Lead may pose a risk to insectivorous terrestrial mammals, insectivorous terrestrial birds, carnivorous terrestrial birds, piscivorous birds, and wetland insectivorous birds.

A summary of direct contact and food chain COPCs identified in the draft SERA/Step 3A report (both sites combined) is as follows:

Soil Invertebrates and Plants	Benthic Invertebrates and Plants	Insectivorous Terrestrial Mammals	Insectivorous Terrestrial Birds	Carnivorous Terrestrial Birds	Insectivorous Wetland Birds	Piscivorous Birds
Cadmium	Barium	Copper	Lead	Lead	Lead	Lead
Chromium	Cadmium	Lead				Mercury
Copper	Copper	Mercury				
Iron	Cyanide					
Lead	Lead					
Mercury	Silver					
Silver	Zinc					
Zinc	PAHs					
	Explosives					

Based on visual inspection of the areas delineated as requiring more work (excluding the landfill area), vegetation (aquatic and terrestrial) is growing and shows no obvious signs of stress. Although the absence of gross chemically induced adverse effects on the physical structure of these environments does not preclude the potential for other, less apparent effects, it demonstrates that the substrate will support a vegetative community. Additionally, the ecological risk assessment findings presented in the Mattawoman Creek Study (TetraTech NUS, 2002) suggest that aquatic vegetation in the creek is not at risk. This conclusion was based on chemical analysis of hydrilla samples and the documented steady increase in submerged aquatic vegetation in the creek since 1995. As such, plants are excluded from further consideration in the BERA.

1.2.1 Spatial Distribution of COPCs

The sediment chemical results are provided in Appendix A. Cyanide was detected at only 1 (IS11SD04) of the 13 sediment sampling locations at an estimated concentration of 0.12 mg/kg, which is slightly above the ecological screening value of 0.10 mg/kg. Based on the low frequency of detection and the slight exceedance, the potential risk to the benthic invertebrate community from cyanide will not be evaluated further in the BERA. Location IS11SD04, however, exhibited the maximum zinc concentration of 1,910 mg/kg. Consequently, this location will be further evaluated in this BERA to better define the potential risk to the benthic community.

Mercury was excluded as a COC for sediment after Step 3A because the mean concentration of mercury at the site (0.19 mg/kg) was less than the background average (0.3 mg/kg).

However, mercury concentration at 7 of the 13 sampling locations exceeded the ecological screening value. Thus, there may be areas of the shoreline where mercury may pose a risk to the benthic invertebrate community, although there is no apparent spatial trend to the exceedances. Given the frequency of the exceedances, mercury is included as a COC in the BERA for the benthic invertebrate community.

All of the remaining inorganic COPCs for sediment, listed above, exceeded the ecological screening values at the majority of the sediment sampling locations at Site 11. For Site 17, only locations IS17SD05 and IS17SD06, the two locations furthest downstream, contained concentrations of multiple inorganics exceeding the screening values. Additionally, sample location IS17SD02 had the highest number of explosives detected with four compounds, 1,3,5-trinitrotoluene (TNT), 1,3-dinitrotoluene, 2,4,6-trinitrotoluene (alpha-TNT), and 3-nitrotoluene. At 5 of 12 locations, only one or two explosive compounds were detected.

PAHs were not analyzed for in the Site 17 sediment samples. In the Site 11 sediment samples, PAHs were detected in four of the seven samples, but only two of the samples (IS11SD02 and IS11SD06) contained multiple individual PAH compounds. No PAHs were detected in samples IS11SD01, IS11SD04, and IS11SD05. All of the PAHs, except benzo(a)anthracene, were detected below the ecological screening values. Only sample IS11SD02 contained benzo(a)anthracene at a concentration (250 μg/kg) slightly above the screening value of 191.4 μg/kg.

1.3 BERA Areas of Concern

This work plan is designed to assess potential ecological risk from contaminants in the sediment along the shoreline of Sites 11 and 17 and the surface soil from Area B at Site 11. This reason came about following the July 2003 IHIRT meeting and a conference call held on August 4, 2003. The Consensus Agreement reached by the team during the July 2003 IHIRT meeting at Indian Head, MD is provided below.

Consensus Agreement: Site 11 7/16/03 at 11:40 a.m. *- Team agrees that for Site 11, the BERA for sediments in the unnamed creek and Mattawoman Creek shoreline will be started concurrently with an FS for the waste soil and the upland soils (i.e., Building 24). If the BERA indicates ecological risk for the sediment, then the sediment will be addressed in the FS.*

Consequently, the BERA for Site 11 will be for soil in Area B and sediment in the unnamed creek and Mattawoman Creek. Soil from the landfill and the upland area will not be evaluated because the landfill will be capped, and the team agreed that soils at Site 11 that pose a potential ecological risk will be removed and placed under the cap during cap construction.

During a conference call held on August 4, 2003 to discuss the path forward for Site 17, the team (including BTAG) agreed that following soil and drum removal, post-verification sampling of the soil will be conducted to make sure that regulatory-approved ecological risk-based action levels for lead, mercury, and zinc (COCs for soil) are achieved. Thus, the BERA for Site 17 will focus only on the sediment and not on the soil.

Based on comments received from the USEPA Region III BTAG, the COPC list for upper trophic level receptors was expanded to include chemicals estimated to exceed the NOAEL-based toxicity threshold (i.e., zinc for piscivorous birds and insectivorous wetland birds). Additionally, mercury and silver exposure for upper trophic level receptors will also be further evaluated to reduce the uncertainty in the risk estimates for these metals, although silver was not identified as exceeding the NOAEL-based toxicity value.

Potential risks to fishes from contaminants in the sediments were not evaluated directly in the SERA. Although findings from the Mattawoman Creek Study (TTNUS, 2002) for Area 1 (portion of the creek adjacent to Sites 11 and 17) suggest that minimal risks to fishes exist, the fish collected for the study were not collected immediately adjacent to the site. Therefore, the potential for the sediments at the site to pose a risk to fishes as a potential hotspot area is unknown. Thus, epibenthic fishes are included as potential receptors in the BERA. Potential risks to epibenthic fishes will be evaluated for the four bioaccumulative metals (lead, mercury, silver, and zinc) identified for other upper trophic level receptors. Benzo(a)anthracene and explosive compounds were detected at low frequencies and at low concentrations. PAHs, in general, are metabolized and depurated rapidly and the fate and transport information for the nitro compounds (explosives) suggests that they have limited persistence in aquatic environments. Therefore, it is unlikely that these compounds pose a significant risk to mobile aquatic receptors, such as fishes.

A summary of the direct contact and foodchain COCs on which the remaining steps of the BERA will be focused are as follows:

Benthic Invertebrates	Epibenthic Fishes	Piscivorous Birds	Insectivorous Wetland Birds
Barium	Lead	Lead	Lead
Cadmium	Mercury	Mercury	Mercury
Copper	Silver	Silver	Silver
Lead	Zinc	Zinc	Zinc
Mercury			
Silver			
Zinc			
Benzo(a)anthracene			
1,3,5-trinitrobenzene			
2,6-dinitrotoluene			
2-amino-4,6-dinitrotoluene			
3-nitrotoluene			
4-nitrotoluene			

Spatial or numeric preliminary remediation goals (PRGs) will be developed for individual or groups of COCs if the baseline ecological risk assessment concludes at the end of Step 7 that they pose a significant risk to ecological receptor populations. Whether PRGs are spatial, numeric, or both, will be dependent on the character of the data set. For a spatial PRG, the weight of evidence from laboratory toxicity tests, chemical analyses, and in-field surveys/qualitative observations might suggest that one area of the site is impaired relative to the rest. The impairment may not be clearly related to any one contaminant or contaminant concentration. In contrast, numeric PRGs are typically derived from laboratory toxicity test results. The results of toxicity tests may show a clear relationship between the concentration of one or more chemicals and biological response. With such a relationship, a chemical-specific remediation goal(s) may be developed.

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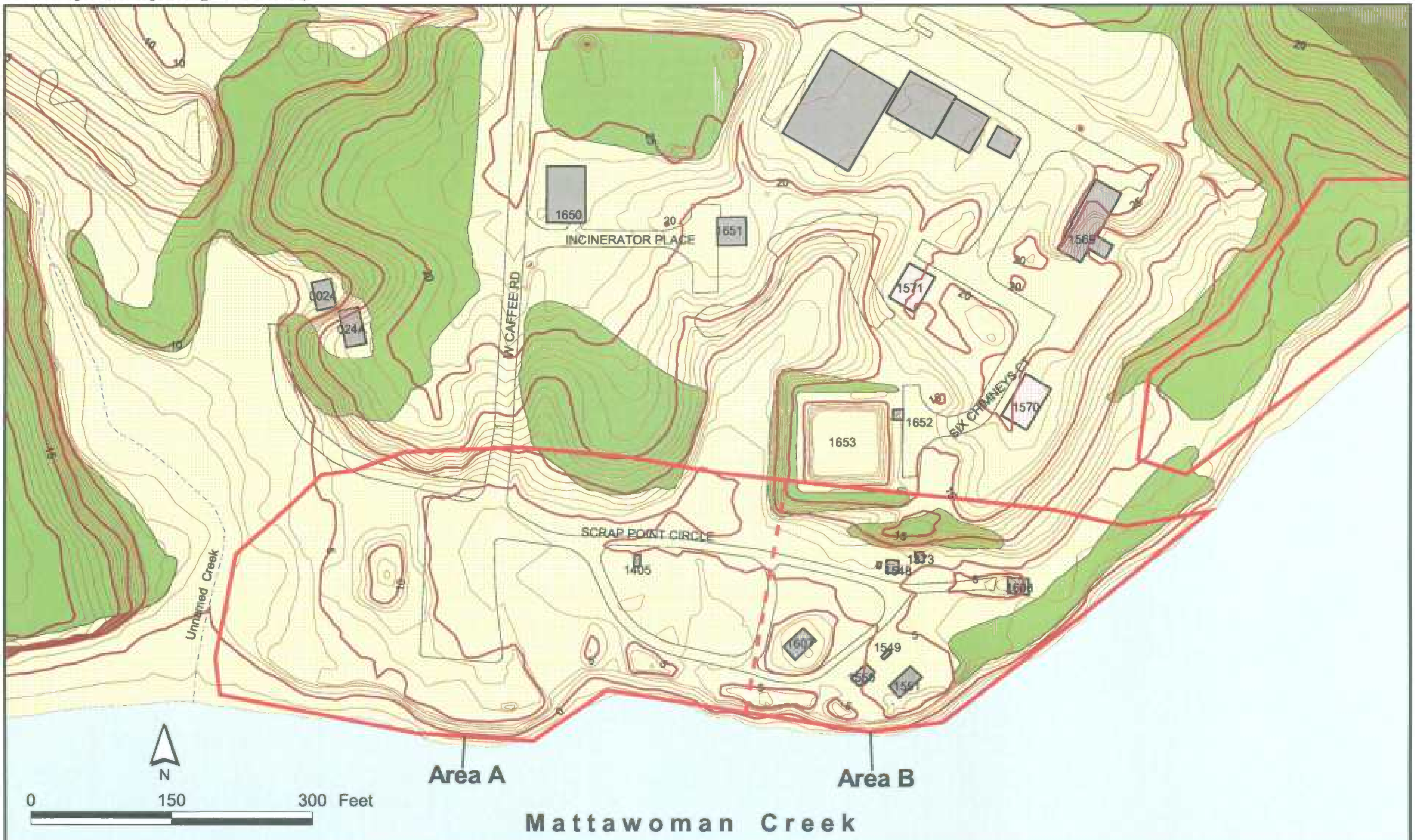

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- IR Sites
- Buildings
- Demolished Buildings
- Railroads
- Topographic Contours (1 foot Intervals)
- Topographic Index Contours (5 foot Intervals)
- Roads
- Wooded Area
- Dense Wooded Area
- Unidentified Creek
- Boundary Between Area A and Area B
  -- Area A Sampled July 20, 2000 - August 9, 2000
  -- Area B Sampled February 25, 2002 - March 26, 2002

Figure 1-1
Site 11 Topography
Site 11/17 BERA Work Plan
NDWIH, Indian Head, Maryland

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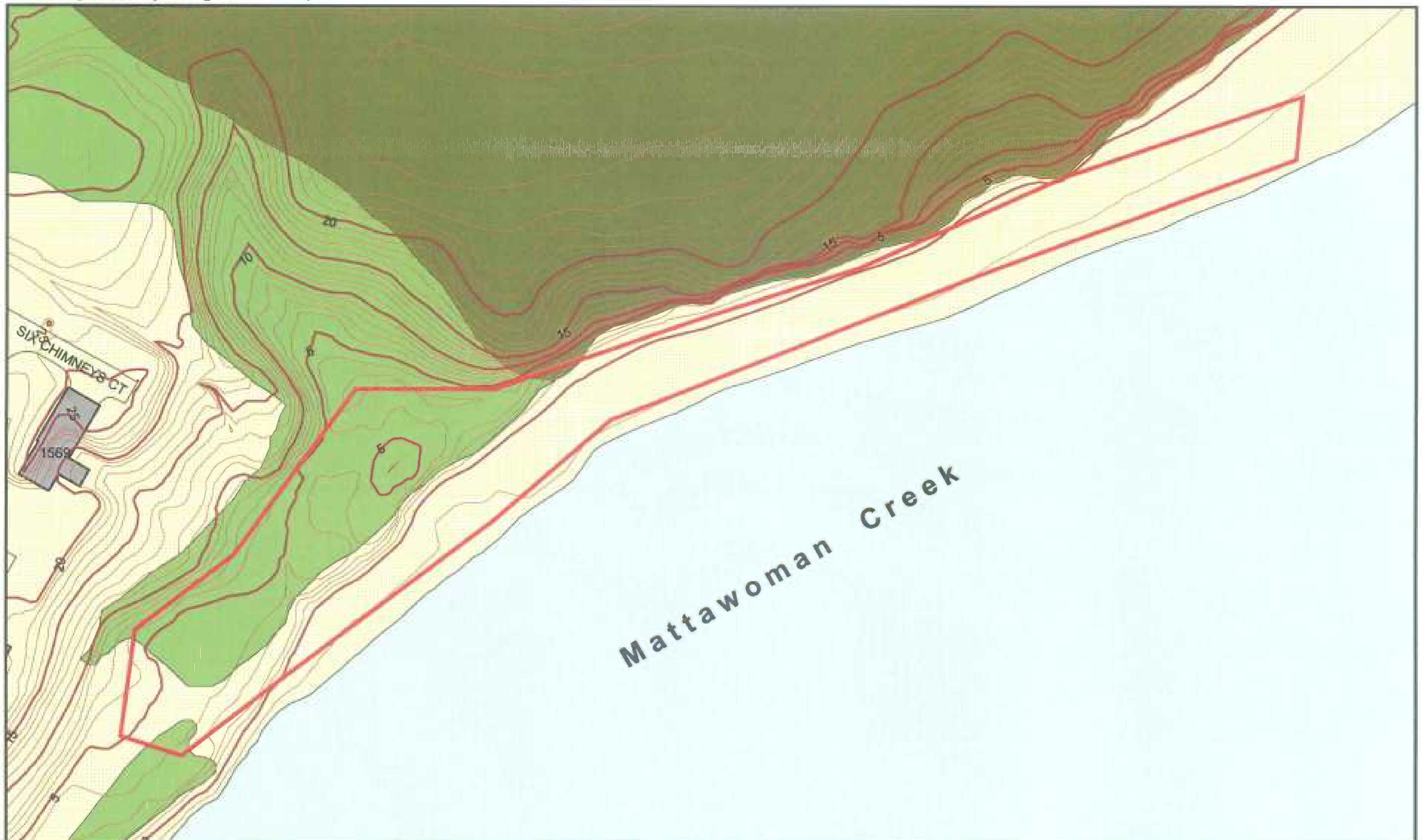

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- IR Sites
- Buildings
- Railroads
- Road
- Wooded Area
- Topographic Contours (1 foot Intervals)
- Topographic Index Contours (5 foot Intervals)
- Dense Wooded Area

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Figure 1-2
Site 17 Topography
Site 11/17 BERA Work Plan
NDWIH, Indian Head, Maryland

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SECTION 2

Baseline ERA Problem Formulation (Step 3B)

The baseline ERA problem formulation is a revision of the previous problem formulation from the SERA and focuses the BERA on the key chemicals, exposure pathways, and receptors that were identified in previous steps of the assessment. This revised problem formulation consists of an evaluation of the toxicity of COCs and a refined conceptual model. The conceptual model includes a discussion of exposure pathways, assessment endpoints, and risk hypotheses.

2.1 Toxicity Evaluation

The COCs selected include inorganics (barium, cadmium, copper, iron, lead, mercury, silver, and zinc), benzo(a)anthracene, and explosives (1,3,5-trinitrobenzene, 2,6-dinitrotoluene, 2-amino-4,6-dinitrotoluene, 3-nitrotoluene, and 4-nitrotoluene). Based on the results of Step 3A, COCs may pose a risk to populations of soil invertebrates and insectivorous terrestrial birds inhabiting upland areas surrounding the landfill (Area A), the burn pit area (Area B), and drum storage area (Site 17). COCs may also pose a risk to populations of benthic invertebrates in Mattawoman Creek. Although this work plan is focused on evaluating potential risks from COCs in sediment only (after the Consensus Agreement reached by the IHIRT, see Section 1.3) a toxicity evaluation was also included for the soil COCs for informational purposes.

2.1.1 Inorganics

Several inorganics were selected as COCs. Copper, iron, lead, mercury, silver, and zinc exceeded both benchmark values and background concentrations for soil. Barium, cadmium, copper, lead, silver, and zinc were selected as COCs for sediment. A profile is provided for each COC.

Barium. Barium was selected as a COC for benthic invertebrates at Sites 11/17. Barium occurs in nature combined with other chemicals such as sulfur or carbon with oxygen, in the common mineral forms barite ($BaSO_4$) and witherite ($BaCO_3$). Approximately 400 mg/kg of barium is found in the earth's crust (Sample et al., 1997). Some barium compounds dissolve easily in water and are found in lakes, rivers, and streams. Barium is found in most soils and foods at low levels.

Cadmium. Cadmium was selected as a COC for benthic invertebrates at Sites 11/17. Freshwater aquatic species are most sensitive to toxic effects of cadmium than are marine organisms. Cadmium has a toxic impact upon reproduction functions in fish and other aquatic life (Eisler, 1985). Most of the toxicity data available for cadmium are from marine sediments, with toxic concentrations reported from 0.3 to 41.6 mg/kg (Sample et al., 1997). The screening value used in the ERA is 1.2 mg/kg and is based on an Effects Range-Low (ER-L), which is based on adverse effects to benthic marine organisms (Long et al., 1995).

Copper. Copper was identified as a COC for both soil and benthic invertebrates. Copper is a minor nutrient for animals at low concentrations, but is toxic to aquatic life at slightly higher concentrations. There is considerable variation in reported toxic concentrations in freshwater sediment, with concentrations ranging from 45 to 1,800 mg/kg (Sample et al., 1997). The variability of the results suggests that various sediment characteristics affect the bioavailability of copper, and thus its toxicity. Earthworms bioconcentrate copper and can be negatively affected via a decrease in growth, reproduction, or survival (Beyer, 1990).

Iron. Iron was identified as a COC for soil invertebrates. Iron in the soil at Sites 11/17 is expected to pose minimal risks to ecological receptors. The average concentration of iron in site samples was about 28,900 mg/kg (excluding the cap area). The screening value of 200 mg/kg was obtained from Efroymson et al., (1997b). In the pertinent experiment (Liang and Tabatabai, 1977 *cited in* Efroymson et al., 1997b), the nitrogen mineralization by soil microflora was reduced by iron (III). The iron was added as a salt solution (i.e., the iron was soluble). The experimental program does not necessarily reflect the exposures that are likely to occur in nature. Merck (1989) indicates that hematite, magnetite, limonite, and siderite are important iron ores. At least three of these (hematite, magnetite, and limonite) are considered insoluble (Merck, 1989; Cornell University, 2000). Insoluble forms, which would be expected to occur in nature, would be less bioavailable and thus less toxic.

Although site iron concentrations were higher than background iron concentrations, the bioavailability discussion above suggests that iron in the soils at Sites 11/17 is unlikely to pose a hazard to ecological receptors. The average background iron concentration for NDWIH is about 18,000 mg/kg, much higher than the screening level of 200 mg/kg. This is additional evidence that the majority of the iron present in soils at the NDWIH is likely not in the bioavailable form.

Lead. Lead was identified as a COC for soil invertebrates, benthic invertebrates, and insectivorous terrestrial birds. Lead tends to be strongly retained in soil, allowing for very little to reach surface water or groundwater. Leaching from soil to groundwater is very slow under natural conditions, but increases with increasing soil lead concentration (Boggess, 1977; ATSDR, 1999). In spite of its tendency for strong retention in soil, lead may be transported in particulate form into surface water as a result of soil erosion. Once in surface water, lead can quickly be removed from solution by precipitation of insoluble salts and by adsorption to particulate organic matter and clay minerals.

Due to strong absorption of lead to soil organic matter, the bioavailability of the lead is limited. Organic compounds of lead are more bioavailable than inorganic lead. Lead can be bioaccumulated by plants and animals. In aquatic organisms, the highest lead concentrations are usually seen in benthic organisms and algae, whereas the lowest concentrations tend to be evident in upper trophic level predators like carnivorous fish (Eisler, 1988). In vertebrates, lead tends to concentrate in bone matter instead of soft tissue minimizing movement to higher trophic levels and uptake of lead by predators, especially raptors that regurgitate undigestible material (Stansley and Roscoe, 1996).

Earthworm (*Eisenia fetida*) growth and survival have been shown to be reduced following exposure to soil-associated lead (as $Pb(NO)_3$) for 8 weeks (Spurgeon et al., 1994). In this study, the LC50 (50 percent lethal concentration) and EC50 (50 percent effects concentration, cocoon production) values for *E. fetida* were 3760 and 1940 mg/kg, respectively. The 14-day

LC50 value for adult *E. fetida* exposed to lead (as $Pb(NO_3)$) in artificial soil was 5941 mg/kg (Neuhauser et al. 1985). A 4-month study was carried out to determine the effects of lead to the earthworm (*Dendrobaena rubida*) at varying soil pH (Bengtsson et al., 1986). Following exposure to pH 4.5 and 500 mg/kg lead, the number of cocoons produced/worm, hatchlings/cocoon, and percent hatched cocoons were reduced by 75, 100, and 100 percent, respectively, while 100 mg/kg had no effect. At pH 5.5 and 6.5, lead exposure elicited no effect at 500 mg/kg. Based on this study, an ecological benchmark of 500 mg/kg was established for lead in soils (Efroymson et al., 1997b).

In a feeding study, Japanese quail where exposed to dietary lead (as lead acetate) for 12 weeks and were shown to exhibit reproductive effects (Edens et al., 1976). In this study quail were exposed to 1, 10, 100 and 1,000 mg/kg lead in their feed. The LOAEL for this study was 100 mg/kg since hatching success was adversely affected at this exposure level, but reproduction was not impaired at 10 mg/kg (i.e., the NOAEL). Final LOAEL and NOAEL values of 11.13 and 1.13 mg/kg/day, respectively, were calculated based on body weight and food consumption factors (Sample et al., 1996).

Mercury. Mercury was identified as a COC for soil invertebrates. Mercury occurs in the environment as elemental mercury ($Hg_2(II)$ and Hg(II)), the latter of which is naturally oxidized from elemental mercury (Eisler, 1987). Mercury can combine with other elements, like chlorine, sulfur, and oxygen, to form inorganic mercury compounds, or salts, that usually exist as white powders or crystals. In addition, microbial activity can transform mercury into organic methylmercury (MeHg).

Numerous studies have shown the negative effects of mercury exposure on the growth, survival, and reproduction of organisms in soil. Survival and cocoon production in the earthworm *Octochaetus pattoni* were reduced by 65 and 40 percent respectively, following exposure to 0.5 mg/kg mercury (Abbasi and Soni, 1983). However, exposure did not affect the number of juveniles produced. Studies have shown the effect of methylmercury on survivorship and segment regeneration in the earthworm *Eisenia fetida,* in which a concentration of 12.5 mg/kg mercury reduced survival by 21 percent and the ability to regenerate excised segments was reduced by 69 percent (Beyer et al., 1985).

Silver. Silver was determined to be a COC for both soil invertebrates and benthic invertebrates. Silver adheres strongly to clay particles found in suspended particulates and sediments. The impact of silver is most likely to occur at the soil/water interface. Silver is highly toxic to aquatic organisms (USEPA, 1992) and may also biomagnify in some aquatic invertebrates (Adriano, 1986). Elevated concentrations can cause larval mortality, developmental abnormalities, and reduced larval growth in fish (Klein-MacPhee et al., 1984); growth reduction in juvenile mussels (Calabrese et al., 1984); and adverse effects on reproduction in gastropods (Nelson et al., 1983). Silver is toxic to soil microbes and can therefore inhibit the biological transformation of chemicals in the soil (ATSDR, 1990b).

Currently, there are no established sediment quality guidelines (SQGs) for silver in freshwater sediments except for the upper effects threshold (UET) of 4.5 mg/kg that is based on the results of Hyalella azteca bioassays (Buchman, 1999). However, there are marine values available, including the threshold effect level (TEL) of 0.73 mg/kg and probable effect level (PEL) of 1.77 mg/kg (MacDonald, 1994), and the effects-range low

(ER-L) and effects-range median (ER-M) of 1.0 and 3.7 mg/kg, respectively (Long et al., 1995).

Zinc. Zinc was determined to be a COC for soil invertebrates, benthic invertebrates, and insectivorous terrestrial birds. Zinc occurs in soil solution in the +2 state. Metallic zinc is insoluble while the solubility of other zinc compounds range from insoluble (oxides, carbonates, phosphates, silicates) to very soluble (sulfates and chlorides). Zinc is an essential element for animal life at low concentrations. It is important in many physiological processes and is involved in cell replication (USEPA, 2000). However, in terrestrial species, chronic exposure to excessive zinc can result in softening of bone, anemia, enteropathy, and kidney damage. Zinc is not known to magnify in food chains because the body regulates it and excess zinc is eliminated.

2.1.2 Polycyclic Aromatic Hydrocarbons

The PAH group of chemicals was selected as a COC for benthic invertebrates. Low-weight PAHs are more soluble than high-molecular weight PAHs and tend to be acutely toxic to aquatic organisms. In aquatic environments, PAHs rapidly become adsorbed to organic and inorganic particulate materials and are deposited in sediments (Neff, 1985). Once adsorbed to sediment, PAHs have limited bioavailability to aquatic organisms (Neff, 1985). However, PAHs deposited in sediments can be toxic to benthic invertebrates. In sediment toxicity tests with the tubificid, *Limnodrilus hoffmeisteri*, Lotufo and Fleeger (1996) observed a median lethal phenanthrene level of 298 mg/kg (sediment organic carbon content = 0.7 percent). In the same study, pyrene levels up to 841 mg/kg were not acutely toxic. Decreases in tubificid reproduction were observed at much lower levels (IC_{25} s [concentration associated with a 25 percent inhibition in measured endpoint relative to control] of 40.5 mg/kg and 59.1 mg/kg for phenanthrene and pyrene, respectively).

In aquatic environments, exposure to ultraviolet light can result in photomodification of some PAHs to products with increased polarity, water solubility, and toxicity compared to the parent compound (Duxbury *et al.*, 1997). Ireland *et al.* (1996) showed that the photo-induced toxicity of PAHs to the daphnid, *Ceriodaphnia dubia*, occurred frequently during low-flow conditions and wet weather runoff, and was reduced in turbid conditions. In studies on the marine amphipod, *Rhepoxynius abronius*, ultraviolet radiation exposure enhanced the toxicity of fluoranthene and pyrene in sediments, but did not affect the toxicity of acenaphthene and phenanthrene (Swartz *et al.*, 1997). Pelletier *et al.* (1997) found that the phototoxicity of individual PAHs (anthracene, fluoranthene, pyrene) to marine bivalves *(Mulinia lateralis)* and marine shrimp (*Mysidopsis bahia*) were 12 to >50,000 times that of conventional toxicity.

The capacity to metabolize PAHs varies among organisms. Varanasi *et al.* (1985 *cited in* ATSDR, 1995) ranked the extent of benzo(a)pyrene metabolism by aquatic organisms as follows: fish ➠ shrimp ➠ amphipod ➠ crustaceans ➠ mussels. The fact that mussels are ranked last may be because mussels show no or limited mixed function oxidase (MFO) activity. MFO is an enzyme system responsible for the initiation of metabolism of various lipophilic organic compounds, including PAHs (Neff, 1985).

2.1.3 Explosives

Explosives chemicals were identified as COCs for benthic invertebrates at Sites 11/17. Three of these compounds, 1,3,5–trinitrobenzene (TNB), 1,3-dinitrobenzene (DNB), and 2,6-dinitrotoluene(DNT), exceeded the screening values, but were detected at only one location. Three other explosive chemicals, 2-amino-4,6-dinitrotoluene, 3-nitrotoluene (TNT), and 4-nitrotoluene were detected for at low frequency, but there are no screening values available to evaluate the potential risk from these chemicals.

TNT is a munitions compound currently used for commercial and military purposes. It is only slightly soluble in water and is not volatile. TNT has been shown to be toxic to benthic invertebrates through aqueous exposure. Reported 48-hour LC50 values for *Hyalella azetca* (ampipod), *Tanytarsus dissimilis* (midge), and *Lubriculus variegatus* (worm), are 6.5 mg/L, 27.0 mg/L, and 5.2 mg/L (ACOE, 1996).

In general, explosive compounds have one or more nitro groups on the parent molecule. Nitro compounds are reduced to amino compounds and bind to organic matter when released to soil and sediment (Roberts and Hartley, 1992). No information regarding the specific ecotoxicity of 2-amino-4,6-dinitrotoluene, 3-nitrotoluene, and 4-nitrotoluene was found. However, in general, the fate and transport information for nitro compounds suggests that these compounds have limited persistence in aquatic environments.

2.2 Conceptual Model

Information on the habitat features of the site, and the fate and transport of the COCs, are used to build the conceptual model (Figure 2-1). The conceptual model addresses complete exposure pathways, receptors, assessment endpoints, measurement endpoints, and risk hypotheses/questions. It has been revised to reflect the results of the SERA and Step 3A.

2.2.1 Transport and Exposure Pathways

Erosion of contaminated soils and subsequent surface runoff from the landfill area (Area A), the burn pit area (Area B), and Site 17 may have released COCs to the sediments in the unnamed stream and to Mattawoman Creek. Additionally, at Site 11 wastes were placed directly in Mattawoman Creek to extend the shoreline outward. COCs may have also entered the wetland and creek by groundwater discharge.

Benthic invertebrates and aquatic plants are potentially exposed to COCs since many of these organisms live directly in or on the sediments. Key exposure routes for invertebrates include ingestion of COCs adsorbed to sediment, and ingestion and direct contact with COCs in the pore water. Aquatic plants are potentially exposed through direct contact and root uptake. However, based on the ecological risk assessment findings presented in the Mattawoman Creek Study (TetraTech NUS, 2002), there does not appear to be a risk to aquatic vegetation in the creek. This conclusion was based on chemical analysis of hydrilla samples and the documented steady increase in submerged aquatic vegetation in the creek since 1995. Therefore, given the dense growth of hydrilla along the shoreline of Sites 11 and 17, aquatic plants do not appear to be adversely affected by COCs in the sediments at the site. Thus, aquatic plants will not be evaluated further in the ecological risk assessment.

Fishes are potentially exposed to COCs through direct contact with sediments, incidental ingestion of sediment during foraging, and consumption of prey that have accumulated COCs in their tissues. The primary risk to fishes at Site 11/17 is likely from ingestion of contaminated prey items.

Soil invertebrates are potentially exposed to COCs through direct contact and ingestion of COCs adsorbed to soil. Terrestrial plants are potentially exposed through direct contact and root uptake. However, further evaluation of potential risks to soil invertebrates and terrestrial plants are not considered in the work plan because the areas of Site 11 that contain COC concentrations that pose unacceptable levels of risk will be excavated and placed under the landfill cap. Additionally, a soil removal action is planned for Site 17 to reduce the level of risk to acceptable levels for terrestrial receptors.

Wetland invertebrates may develop body burdens of bioaccumulative COCs. Predators such as the marsh wren and other insectivorous birds may be exposed to COCs by preying on these organisms. Lead and zinc may be accumulated, but do not biomagnify through foodchains. Concentrations of other chemicals have been shown to be low enough in the wetland sediment that they do not pose a risk to predators, but may still be impacting the invertebrate community. To varying degrees, some animals inhabiting the area may also be exposed to COCs through incidental ingestion of contaminated sediment.

2.2.2 Assessment Endpoints

Assessment endpoints for the BERA are as follows:

Survival, growth, and reproduction of the benthic invertebrate community. Benthic invertebrates serve as a forage base for many aquatic and semi-aquatic species. They also play an important role in the processing and breakdown of organic matter in aquatic systems. Because they have significant direct contact with, and may even consume sediment, benthic invertebrates may be highly exposed to contaminants and develop body burdens. A benthic invertebrate community limited by chemical contamination would support fewer aquatic birds, fish, and amphibians.

Survival, growth, and reproduction of epibenthic fishes. Epibenthic fishes live and forage on the sediment surface. These receptors feed on benthic invertebrates and other fishes and are thus susceptible to exposure to bioaccumulative chemicals.

Growth, survival, and reproduction of piscivorous birds. Avian piscivores (fish eaters), such as the great blue heron (*Ardea herodias*), are important upper trophic level consumers in aquatic ecosystems. In this function, they are often reflective of ecosystem health, and are particularly susceptible to toxins that bioaccumulate in the food chain. In their function as a predator, they serve to maintain a balance in fish populations versus forage abundance and available habitat. Many such birds are also valued by society for their visual and vocal traits. The great blue heron was chosen as the surrogate species to represent this assessment endpoint. Fish are preferred prey, but they also feed on amphibians, reptiles, insects, crustaceans, birds, and mammals (Alexander, 1977; Peifer, 1979).

Survival, growth, and reproduction of insectivorous wetland birds. These receptors are 2nd order consumers and are susceptible to exposure to bioaccumulative chemicals. The marsh wren (*Cistothorus palustris*) was selected to represent this endpoint. Marsh wrens inhabit emergent wetlands and consume insects.

2.2.3 Risk Hypotheses

Risk hypotheses are questions about how assessment endpoints could be affected. Risk hypotheses clarify and articulate relationships that are possible through consideration of available data, information from the scientific literature, and the best professional judgement of risk assessors. The risk hypotheses/questions associated with the assessment endpoints are:

1. Are the concentrations of the COCs (identified in Section 1.3) in the sediments at Sites 11/17 sufficient to impair the growth, survival, and reproduction in the benthic invertebrate community to the extent that the prey base to support fish and other aquatic insectivores has been adversely affected?
2. Is lead, mercury, silver, or lead in the sediments at Sites 11/17 bioaccumulating in epibenthic fishes to the extent the their growth, survival, or reproduction may be impaired?
3. Is lead, mercury, silver, or zinc in the sediments at Sites 11/17 bioaccumulating in forages fishes to the extent that the growth, survival, or reproduction of piscivorous birds that forage at the site may be impaired?
4. Is lead, mercury, silver, or zinc in the sediments of the unnamed creek and wetland adjacent to Site 11 bioaccumulating in wetland invertebrates to the extent that the growth, survival, or reproduction of insectivorous terrestrial birds may be impaired?

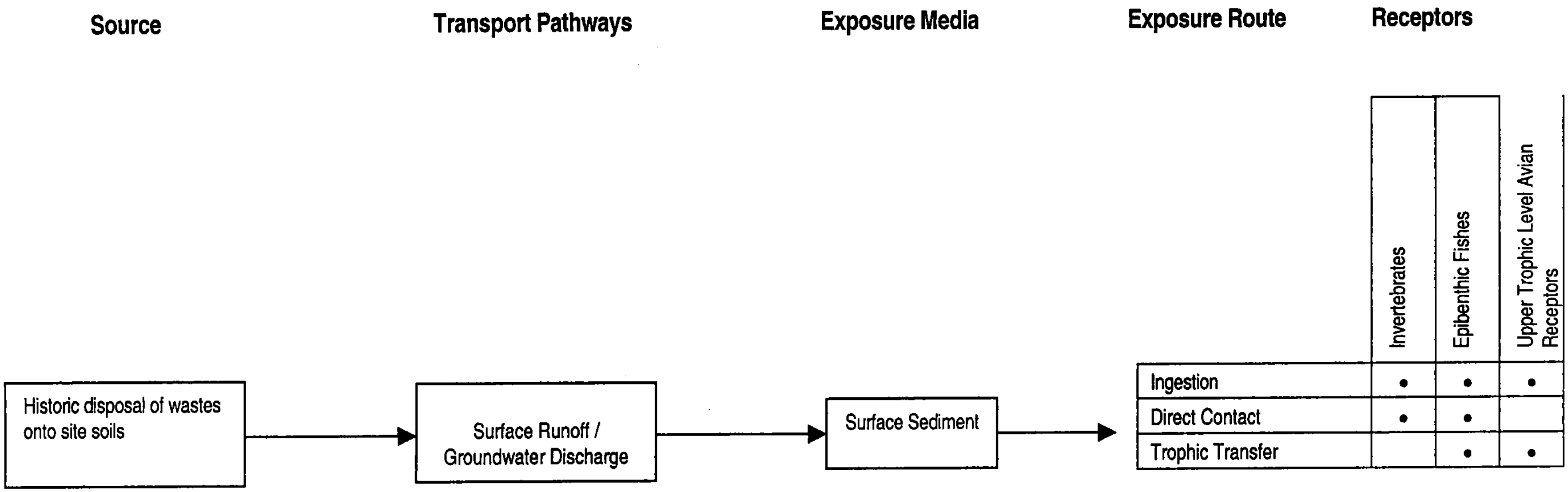

Figure 2-1
Conceptual Site Model
Sites 11/17 BERA Work Plan
NDWIH, Indian Head, Maryland

Step 4: Study Design/Data Quality Objectives

Step 4 of the ERA establishes the measurement endpoints, the study design, and data quality objectives for the additional site investigations necessary to complete the ecological risk assessment (USEPA, 1997). Another element of Step 4 is the sampling and analysis plan, which is provided in Section 4 of this document. The field sampling is designed to address areas identified as having the greatest potential risk and/or degree of uncertainty in earlier steps of the ERA process.

3.1 Measurement Endpoints

Measurement endpoints are measures of biological effects (e.g., laboratory toxicity test results) that are related to each respective assessment endpoint (USEPA, 1997). For the areas of concern at Sites 11/17, measurement endpoints associated with each assessment endpoint are defined as follows:

Assessment Endpoints	Measurement Endpoints
Survival, growth, and reproduction of benthic invertebrate community	Comparison of sediment chemistry results with freshwater consensus-based sediment quality guidelines (SQGs) proposed by MacDonald et al., 2000). Comparison of results of 42-day sediment laboratory toxicity tests (growth, survival, and reproduction) with the amphipod, *Hyalella azteca*, using site, reference, and control sediment. Results of benthic community structure analysis using metrics from the Benthic Index of Biotic Integrity (B-IBI) for tidal freshwater sediments.
Survival, growth, and reproduction of epibenthic fishes	Comparison of lead, mercury, silver, and zinc concentrations in epibenthic fish tissue with critical residue values from the literature.
Survival, growth, and reproduction of piscivorous birds	Comparison of estimated exposure dose to toxicity reference value using site-specific bioaccumulation data obtained from lead, mercury, silver, and zinc concentrations in forage fish tissue to a reference HQ of 1.
Survival, growth, and reproduction of insectivorous wetland birds	Comparison of estimated exposure dose to toxicity reference value using site-specific bioaccumulation data obtained from lead, mercury, silver, and zinc concentrations in invertebrate tissue to a reference HQ of 1. Exposure estimates will also include the chemical contribution from sediment ingestion.

3.2 Additional Site Investigation

This section presents the general scope of the additional sampling planned for Sites 11/17 to address potential risks and uncertainties in the ERA. A detailed description of the proposed sampling activities and analyses is presented in Section 4 (Sampling and Analysis Plan).

3.2.1 Sediment Quality Triad

A sediment quality triad approach was selected to evaluate potential risk to the benthic invertebrate community. This approach consists of collecting co-located data on sediment chemistry, bulk sediment toxicity, and benthic community structure.

Hyalella azeteca (*H. azteca*) (amphipod) will be used for sediment toxicity testing. This organism was selected because its use is widely accepted, it is tolerant of a wide range of salinity and grain sizes, and quality information on reproduction can be obtained during a 42-day test. Additionally, this species is more sensitive to copper, lead, and zinc than is *Chironomus tentans* (midge) (ASTM, 2000; USEPA, 2000).

Each test will provide information on growth, survival, and reproduction. Chemical analyses of sediment will support the toxicological analyses. A control will be run to ensure that the population used in the toxicity testing is healthy. Good health is demonstrated when the organism's performance meets or exceeds some threshold (e.g., 80 percent survival). The toxicity testing laboratory will determine the appropriate substrate for control testing.

The sampling locations and accompanying rational for their selection are described below.

Sample Location	Rationale for Selection
IS11SD01	Maximum barium, copper, and lead concentrations at this location.
IS11SD02	Only location where benzo(a)anthracene exceeded the screening value.
IS11SD03	Maximum cadmium, mercury, and silver concentrations at this location.
IS11SD04	Maximum zinc concentration at this location.
IS11SD05	To fill gap in spatial coverage for sediment quality triad.
IS11SD07	Location of maximum lead, mercury, and zinc concentrations in unnamed creek.
IS17SD02	Location with greatest number of explosive compounds detected.
IS17SD06	To fill gap in spatial coverage for sediment quality triad.

3.2.2 Reference Sample

The response of organisms to reference and control sediment will be statistically compared to the response of organisms exposed to site sediment. The number of different reference samples will be defined during the Step 5 reconnaissance and verified during the actual sampling event (i.e., if soil or sediment varies considerably in different areas of the site, then various types of reference soil or sediment will be required). The similarities and differences between each reference area and the group of samples it is used for will be described and presented in the BERA report.

The sediment reference location will be an area upstream of the site likely to have no influence from site-related source areas The reference site will be located at least as far upstream as the upgradient area (Area 6) used in the Mattawoman Creek BERA (Tetra Tech NUS, 2002). Care will be taken to ensure that the reference sediment closely resembles the physical characteristics of the site sediment (i.e., similar grain size and amount of organic material). If a representative reference location is unavailable, a known area of minimal contamination in the vicinity of the site samples will be used as the reference.

3.2.3 Tissue Samples

To more accurately quantify the risk epibenthic fishes and piscivorous birds, forage-size epibenthic fishes will be collected from the littoral zone along the shoreline of Sites 11/17. The fish samples will be submitted for whole-body chemical analysis (lead, mercury, silver, and zinc). *Fundulus spp.* will be collected preferentially if present in abundance since these fish have relatively small home ranges and feed on a variety of benthic invertebrates. Therefore, tissue samples from this fish should reflect exposure to site-related bioaccumulative COCs.

To more accurately quantify the risk to insectivorous wetland birds, common prey items of the marsh wren will be collected from the area of the unnamed creek and surrounding wetland and submitted for chemical analysis (lead, mercury, silver, and zinc). Common prey items of the marsh wren include aquatic insects, other insects, and spiders.

3.3 Uncertainties

As at any field site, there is local variability in chemical, physical and biological characteristics. Because of this variability, it is often difficult to discern the cause of biological responses in laboratory toxicity tests. The suite of data that have been proposed for collection should serve to decrease the uncertainty and assist in directly answering the question of whether chemicals have adversely affected the communities of soil invertebrates, benthic invertebrates, and insectivorous birds at the site. Field staff will adhere to the list of parameters and methods to the extent possible. However, adjustments may have to be made in the field based on site-specific conditions.

3.4 Data Quality Objectives

Step 1. State the Problem.

Site 11 includes the Caffee Road Landfill and the adjacent burn pit area. The landfill is bordered by an unnamed tidal creek and associated emergent wetland to the west and Mattawoman Creek to the south. Until the early 1960s, Site 11 was used for the disposal of bulk metal items and trash, rocket motor casings, exploded building debris, rifles, demilitarized ordnance, propellant grains residues and open burning residues.

Site 17 is located east of and immediately adjacent to Site 11 and is defined as a 1,000-foot stretch of shoreline along Mattawoman Creek where metal parts were discarded from the

1960s until the early 1980s. The disposed materials included rocket motor casings, shipping containers, empty drums, and various metal parts.

Review of historical aerial photos indicated that filling activities have extended the shoreline into Mattawoman Creek as much as 150 feet from its original position. Site reconnaissance by two CH2M HILL ecologists in September 2002 verified that the much of the Mattawoman Creek shoreline next to Site 11 consists of concrete, debris, and fill.

Chemical constituents associated with the discarded material at Sites 11/17 have potentially affected sediment quality along the shoreline of the sites and in the unnamed creek and may be posing a risk to ecological receptors.

Step 2. Identify the Decisions

Primary Question:

What are the potential ecological risks related to COCs in sediments along the shoreline of Sites 11/17?

Secondary Questions:

Are the chemical constituents in the sediment toxic to the benthic community?

Are the chemical constituents in the sediment toxic to the epibenthic fish community?

Are lead, mercury, silver, and zinc bioaccumulating in the prey of piscivorous birds and insectivorous wetland birds at the site to the extent to pose a risk?

Step 3. Identify Inputs to the Decision

1. Results of previous sediment sampling events
   - Several metals, one PAH, and several explosives are elevated relative to reference areas in Mattawoman Creek and pose potentially unacceptable ecological risk.

2. Sediment Quality Triad (risk to benthic invertebrate community)
   - Sediment chemistry
   - Bulk sediment toxicity
   - Benthic community structure analysis

3. Tissue Analysis
   - COC residues in fish tissue
   - COC residues in invertebrate tissue

4. Ecological risk assessment models
   - COC residues measured in fish and invertebrate tissue will be used to replace modeled values used in Step 3A to estimate risk to upper trophic level receptors, including great blue heron (avian piscivore) and marsh wren (avian wetland insectivore).

Step 4. Define the Study Boundaries

1. COCs in surface sediments, based on the results of Step 3A include several metals, and one PAH, and several explosives.

2. Sampling depth for sediments will be 5 cm, an estimate of the biologically active zone. Benthic macroinvertebrates are generally found in the top 5 cm of freshwater sediments. Consumption of benthic macroinvertebrates by higher-trophic-level consumers can facilitate movement of sediment contamination through the food web.

3. Reference area is defined by upgradient areas of Mattawoman Creek, identified in the Mattawoman Creek Study (TTNUS, 2002), that were considered to be unaffected by point-source releases.

Step 5. Develop Decision Rules

Benthic Invertebrate Community – The following criteria will be used to weigh the results of the sediment quality triad data collection effort to assess potential risk to the benthic invertebrate community.

1. Sediment Chemistry - Associations between biological and chemical data will be evaluated by examining the relationship between sediment quality guidelines (SQGs) and biological endpoints (i.e., sediment toxicity and indices of benthic community health). The SQG that will be used are the freshwater consensus-based SQGs proposed by MacDonald et al. (2000). The consensus-based SQGs were derived for threshold effect concentrations (TEC), the concentration below which adverse effects are not expected to occur, and probable effect concentrations (PEC), the level above which adverse effects are expected to occur more often than not. To develop baseline risk estimates, COC concentrations in the sediment will be compared to PECs. Hazard quotients (HQs) will be developed by dividing the COC concentrations at each station by PEC. In addition, to help address the potential biological effects associated with mixtures of contaminants, a mean PEC quotient will be calculated by dividing the COC concentration at a station by the PEC for that COC and averaging the quotients. The mean PEC quotient provides a hazard index for sediment contamination by integrating the number and magnitude of PEC exceedances into one unitless number.

   The sediment chemistry results will be ranked as follows for use in the risk characterization:

   "-" No COC concentrations exceed the PEC values (HQs < 1)
   "+" Some COC concentrations exceed PEC values, but mean PEC quotient is <1.0.
   "++" Mean PEC quotient >1.0

2. Bulk Sediment Toxicity – The growth, survival, and reproduction of test organisms in site sediment will be statistically compared with the results of these parameters from reference and control sediment. If significant (alpha level of 0.05) adverse effects are found, the sediments will be considered toxic at a given station.

   The results of the toxicity tests will be ranked as follows for use in the risk characterization:

   "-" no effects for all endpoints

"+"	effects observed for one endpoint
"++"	effects observed for two or more endpoints

3. Benthic Community Structure Analysis – The following benthic community parameters will be calculated for each station: taxa richness (i.e., number of species), total abundance, proportion of oligochaetes, and the Benthic Index of Biotic Integrity (B-IBI). The B-IBI is a multiple metric index developed to identify the degree to which the benthic community meets the Chesapeake Bay Program's Benthic Community Restoration Goals (Weisberg et al., 1997). The B-IBI scores ranges from 1-5. Sites with scores greater than or equal to 3 are considered to meet restoration goals, scores from 2.7 to 2.9 are considered marginally degraded, scores from 2.1 to 2.6 are degraded, and scores of 2 or less are severely degraded. This approach has been applied to tidal freshwater systems by including total abundance, percent abundance of pollution-indicative taxa, percent abundance of deposit feeders, and a tolerance score based on tolerance values assigned in Lenat (1993). The B-IBI score will be used to assess health of the benthic community at each sampling station.

   The results of the benthic community structure analysis will be ranked as follows for use in the risk characterization:

"-"	B-IBI score indicates no degradation or marginally degraded, but similar to reference
"+"	B-IBI score indicates degraded community
"++"	B-IBI score indicates severely degraded community

A weight of evidence approach will be used to characterize ecological risk to the benthic community from at Sites 11/17. The weight of evidence will be based on an analysis of exposures and effects. The line of evidence for exposure will be PEC quotients and the lines of evidence for effects will be laboratory toxicity test results and benthic community structure.

Important to the interpretation of risk is the extent to which elevated exposure relative to reference conditions and adverse effects occur concurrently. Where this concurrence exists, there is strong evidence that there is a complete exposure pathway between the contaminants and the receptors of concern. The joint probability of exposure and effects will be used to presume the probability of risk for each station, as follows:

- Baseline Risk: No greater than baseline (-) ranking for both exposure or effects
- Low Risk: No greater than low (+) ranking for either exposure or effects and no greater than baseline (-) ranking for the other
- Intermediate Risk: High (++) ranking for exposure or effects, but no greater than low (+) ranking for other measures
- High Risk: High (++) ranking for both exposure and effects

4. Fish Tissue Analysis

The COCs measured in fish tissue collected at the site will be compared with reference fish tissue results from the Mattawoman Creek Study (TTNUS, 2002) and critical residue values from the literature. Exceedance of critical tissue residues and reference tissue levels will constitute a risk to the epibenthic fish community at the site. If critical residue values are exceeded, but not reference tissue levels for the same COC, then the risk will not be considered site-related, but rather representative of background risk levels.

The COCs measured in fish tissue will also be used to model exposure to piscivorous birds that might forage at the site. Unacceptable risk will be constituted by exceedance of LOAEL-based reference toxicity values for birds.

5. Invertebrate Tissue Analysis

The COCs measured in invertebrate tissue (marsh wren prey species) will be used to model exposure to insectivorous wetland birds. Unacceptable risk will be constituted by exceedance of LOAEL-based reference toxicity values for birds.

Step 6. Evaluate Decision Errors

The intent of this data collection effort is to reduce uncertainty in the risk estimates arrived at after the conclusion of Step 3A. The results of this effort will determine the baseline ecological risk posed by COCs in the sediments at Sites 11/17.

Baseline Decision Rule Errors:

1. Deciding that the COCs in the sediments are not posing a risk to ecological receptors.

The first consequence of this error is failing to proceed with remediation when an unacceptable risk is present. The second consequence of making the error is deciding to proceed with remediation when there is no unacceptable risk.

Step 7. Optimize the Design for Obtaining Data

The uncertainty in the risk estimate for the benthic invertebrate community will be greatly reduced by collecting three lines of evidence from co-located locations along the shoreline of the site. The three lines of evidence include additional bulk sediment chemistry data, bulk sediment toxicity data, and benthic community structure data. Together these data will be weighed to develop overall risk estimates for the benthic community at each of the sampling areas. The results of this effort will identify locations along the shoreline where the weight of evidence suggests that unacceptable risk exists to the benthic invertebrate community.

The uncertainty in the risk estimates for upper trophic level receptors will be greatly reduced by measuring the COC residues in fish and invertebrate prey collected at the site. These data will provide more accurate estimates of the bioavailability and bioaccumulation potential of COCs in the sediments, rather than relying on bioaccumulation factors from the literature. Therefore the outcome of this effort should provide a realistic baseline estimate of potential ecological risk to upper trophic level receptors that forage at the site.

Necessary detection limits for metals, PAHs, and explosives in sediments are based on ecological screening criteria. Detection limits should remain below the chemical-specific screening criteria for metals and PAHs. However, obtaining detection limits for explosives below the screening criteria may not be possible for all explosives. Some of the explosive compounds do not have screening criteria available. Therefore, risks from explosives will be evaluated by correlation with bulk sediment toxicity and impairment in the benthic community structure.

3.5 Data Analysis

The results of the chemical analyses will be validated by an independent data validator using U.S. Environmental Protection Agency Region III modifications to the National Functional Guidelines, as described in CH2M HILL (2000). After validation, analyses that will be conducted fall into four areas:

Comparison of biological response between site, reference, and control toxicity tests - Statistical comparison will be conducted for growth, survival, and reproduction. The tests will determine whether organism performance is significantly different (alpha level of 0.05) when exposed to sediment collected from the site relative to the reference area and control sediment.

Existence of patterns in laboratory toxicity testing results with chemical burden and other chemical/physical characteristics of the sediments - Through multiple regressions or other appropriate statistical analyses, the data will be reviewed to determine whether there are relationships between biological response in the toxicity tests and the chemical content of the sediment. Other factors that may be used in the analyses include carbon and grain size adjustments.

Comparison of calculated daily exposure of piscivorous and insectivorous birds to lead, mercury, silver, and zinc with daily LOAEL-based toxicity values - The concentrations of COCs measured in fish and invertebrates will be used to model exposure to piscivorous and insectivorous wetland birds, respectively. This evaluation will reduce the uncertainty inherent in the previous exposure estimates and will aid in characterizing the potential risk to these bird communities.

SECTION 4
Sampling and Analysis Plan

4.1 Quality Assurance Project Plan

Quality assurance procedures are described in the Master QAPP (B&RE, 1997).

Field QC samples will be collected as follows for analytical samples:

Type of QC Sample	Frequency Collected
Field Duplicate	One per matrix for each group of up to 10 samples
Field Blank	One for the event
Equipment Blank	One every day if equipment is decontaminated for reuse
Matrix Spike/Matrix Spike Duplicate	One pair for each group of up to 20 samples per media sent to a single laboratory

No field QC samples will be collected for the laboratory toxicity tests. Analytical results will be validated by an independent data validator using U.S. Environmental Protection Agency Region III modifications to the National Functional Guidelines, as described in the Master Project Plans (CH2M HILL, 2000).

4.2 Field Sampling Program and Operations

4.2.1 Sites 11 and 17

Surface sediment (0-5 cm) will be collected for chemical analysis and bulk sediment toxicity testing at ten locations, eight at Site 11/17 and 2 at a suitable reference site. The samples will be collected using a petite Ponar dredge in the littoral zone along the shoreline. It is likely that a boat will be needed for sampling along the Site 11 boundary because the water depth increases rapidly in that area. Figure 4-1 shows the proposed samples locations at Site 11. Figure 4-2 shows the proposed sample locations at Site 17. The rationale supporting these sampling locations is described in Section 3.2.1.

Benthic community structure samples will be collected at each sampling station using a petite Ponar dredge. Three replicate grabs will be collected at each sampling station. The grab samples will be sieved (500-µm mesh) in the field. Each grab sample will be preserved in the field using a 5 percent formalin solution and shipped to a laboratory for identification and enumeration.

To more accurately quantify the risk epibenthic fishes and piscivorous birds, forage-size epibenthic fishes will be collected from the littoral zone along the shoreline of Sites 11/17. The fish samples will be submitted for whole-body chemical analysis (lead, mercury, silver, and zinc). *Fundulus spp.* will be collected preferentially if present in abundance since these fish have relatively small home ranges and feed on a variety of benthic invertebrates. If possible, two composite samples of several individual fish of the same species will be collected, one sample from the unnamed creek and one sample from the shoreline adjacent to Sites 11/17. The lengths and weights of the fish will be recorded.

To more accurately quantify the risk to insectivorous wetland birds, common prey items of the marsh wren will be collected from the area of the unnamed creek and surrounding wetland and submitted for chemical analysis (lead, mercury, silver, and zinc). Common prey items of the marsh wren include aquatic insects, other insects, and spiders. If enough prey items are caught, two composite samples of these prey items will be collected and submitted for chemical analysis (lead, mercury, silver, and zinc). The approximate proportions of the various prey items will be recorded by type.

Sediment and tissue samples will be collected for the following analyses:

Summary of Samples to be Submitted to the Laboratory

Matrix	Laboratory Parameter	Samples	Field Duplicates	Field Blanks	Equipment Blanks	Matrix Spikes	Total Samples
Sediment	TAL metals	10	1	1	2	1/1	16
	PAHs	10	1	1	2	1/1	16
	Explosives	10	1	1	2	1/1	16
	TOC	10					10
	pH	10					10
	Grain size (sieve)	10					10
Tissue (fish and invertebrates)	Lead, mercury, silver, and zinc	4				1/1	6
Toxicity Testing							
Sediment	Toxicity Test	10					10

Notes: One field blank will be collected during the sampling event. An equipment blank will be collected for each sampling day. Matrix spikes are two samples, one matrix spike and one matrix spike duplicate.

Toxicity test to be conducted in a bioassay laboratory.

At each sampling location, the sediment will be homogenized following the *SOP for Homogenization of Soil and Sediment Samples* in the *Master Field Sampling Plan* (B&RE, April 1997) and *Addendum to B&RE Master Work Plans* (CH2M HILL, March 2000) and then split two ways (one part for chemical analysis and one part for laboratory toxicity testing). All surface sediment samples will be collected following the *SOP for Surface Sediment Sampling* and the *SOP for Surface Soil Sampling* in the *Master Project Plans*.

Analytical methods to be used are as follows:

Analytical Methods

Analysis	Methodology
TAL Metals	U.S. EPA CLP Inorganics SOW ILM04
PAHs	SW-846 Method 8310
Explosives	SW-846 8330
TOC	Lloyd Kahn Method
PH	SW-846 Method 9045
Grain Size	ASTM D-422
42-day Toxicity Test	ASTM E 1706-00 (ASTM 2001); EPA/R-99/064 (EPA 2000)

All sample containers will be provided by the laboratory subcontractor in a clean and, if appropriate, pre-preserved state, as defined in the *Master QAPP*. Laboratory-grade deionized water will be provided by the laboratory subcontractor for equipment blanks. A standard 28-day turnaround time will be used for all analytical samples.

4.2.2 Bullit's Neck Investigation

Surface sediment (0-6 inches) will be collected for chemical analysis at three locations near Bullit's Neck (Figure 4-3). The samples will be collected using a petite Ponar dredge in the littoral zone along the shoreline at each location. The samples will be analyzed for Target Compound List (TCL) volatile organic compounds (VOCs), TCL semivolatile organic compounds (SVOCs), Target Analyte List (TAL) metals, explosives (including nitroguanidine [NG], nitroglycerin [NQ], pentaerythritol tetranitrate [PETN], and perchlorate), pH, TOC, and grain-size (sieve). Associated quality assurance and quality control (QA/QC) samples, consisting of matrix spike and matrix spike duplicates (MS/MSDs), field duplicates, field blanks, equipment rinsate blanks, and trip blanks, will also be collected.

Summary of Samples to be Submitted to the Laboratory

Matrix	Laboratory Parameter	Samples	Field Duplicates	Trip Blanks	Field Blanks	Equipment Blanks	Matrix Spikes	Total Samples
Sediment	VOCs	3	1	1	1	1	1/1	9
	SVOCs	3	1	1	1	1	1/1	9
	Metals	3	1	1	1	1	1/1	9
	Explosives	3	1	1	1	1	1/1	9
	pH	3						3
	TOC	3						3
	Grain size (sieve)	3						3

4.2.3 Sample Identification System

Each sample will be designated by an alphanumeric code that identifies the site and matrix sampled and contains a sequential sample number. Site-specific procedures are elaborated below.

The following is a general guide for sample identification:

First Segment of Sample Number	Second Segment of Sample Number	Third Segment of Sample Number		
Naval Installation Abbreviation	Site Number	Sample Type	Sample Location	Additional Qualifiers (sample depth, date)
A	ANN	AA	NN	NNNN

Symbol Definition:

"A"	=	Alphabetic
"N"	=	Numeric

Site Abbreviation:

A = One letter abbreviation identifying the Naval Installation where the sample was collected (i.e., Indian Head = I)

Site Number:

ANN = One letter and two numbers identifying the site on the facility where the sample was collected (i.e., S11 = Site 11)

Sample Type:

SD	=	Sediment Sample
BG	=	Benthic Grab
FT	=	Fish Tissue
IT	=	Invertebrate Tissue
EB	=	Equipment Blank
FB	=	Field Blank

Sample Location:

MM	=	QC Samples – 2-digit month of sampling event
NN	=	Primary Samples - 2-digit number indicating sample location

Additional Qualifiers:

BDED = Sediment or Surface Soil Samples – 2-digit begin depth and 2-digit end depth rounded up to nearest foot (i.e., 2′ – 2′ 6″ = 0203)

DDYY = QC Samples – 2-digit day and 2-digit year of sampling event

An example of this numbering approach is:

IS11SD040001 The 4th surface sediment sample collected from 0 ft to 1 ft at Site 11

An example of this numbering approach for QA/QC samples is:

IS11EB031502 Equipment blank collected at Site 11 on March 15, 2002

Field duplicates will be "blind duplicates," and thus labeled in the same manner as regular samples. Their locations and corresponding sample numbers will be recorded in the logbook.

4.2.4 Sample Packaging and Shipping

Samples will be packaged in accordance with NDWIH SOP SA-11, *Non-Radiological Sample Handling*. The sample will be tightly packed in a cooler with bubble wrap packaging material and ice as a preservative. The samples will be either picked up at the site by the analytical laboratory or shipped to the laboratory via Federal Express. The field team leader is responsible for completion of the following forms:

- Sample labels and Chain of Custody seals;
- Chain of Custody forms; and
- Appropriate labels and forms required for shipment.

Custody of the samples will be maintained and documented at all times. Chain-of-Custody will begin with the collection of the samples in the field and will continue through the analysis of the sample at the analytical laboratory.

4.3 Health and Safety

The Master Health and Safety Plan for INDIV-NSWC (B&RE, 1997d) and the addendum to the Master Plans (CH2M HILL, 2000) cover all the sampling activities outlined in this work plan, with the exception of those that require the use of a boat. A new addendum to the Master Health and Safety Plan will be prepared prior to the commencement of field activities to address health and safety issues related to sampling from a boat. The field team will consult these documents for health and safety guidance while conducting work at Sites 11/17.

4.4 Investigation-Derived Waste Management

Small amounts of liquid investigation-derived waste (IDW) will be generated during decontamination of sampling equipment. IDW used during the sampling will be disposed of per the *Master Field Sampling Plan* (B&RE, 1997).

4.5 Project Reporting

The methods, results, analyses, and risk characterization conclusions will be reported in the draft Baseline Ecological Risk Assessment. The report will evaluate the potential risk to ecological receptor populations at Sites 11/17. If a risk exists, the report will identify the spatial extent that should be considered for remedial action by the NDWIH Installation Restoration Team (IHIRT).

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LEGEND

- △ Proposed Sediment Sample Locations (Sediment Quality Triad)
- Surface Water
- Sediment Samples
- Road
- Unidentified Creek
- General Area for Insect Collection
- General Area for Fish Collection
- IR Sites
- Buildings
- Demolished Building
- Wooded Area
- Dense Wooded Area
- Boundary Between Area A and Area B
- -- Area A Sampled July 20, 2000 - August 9, 2000
- -- Area B Sampled February 25, 2002 - March 26, 2002

N

80 0 80 160 Feet

Figure 4-1
Site 11 Proposed Sample Locations
Site 11/17 BERA Work Plan
NDWIH, Indian Head, Maryland

CH2MHILL

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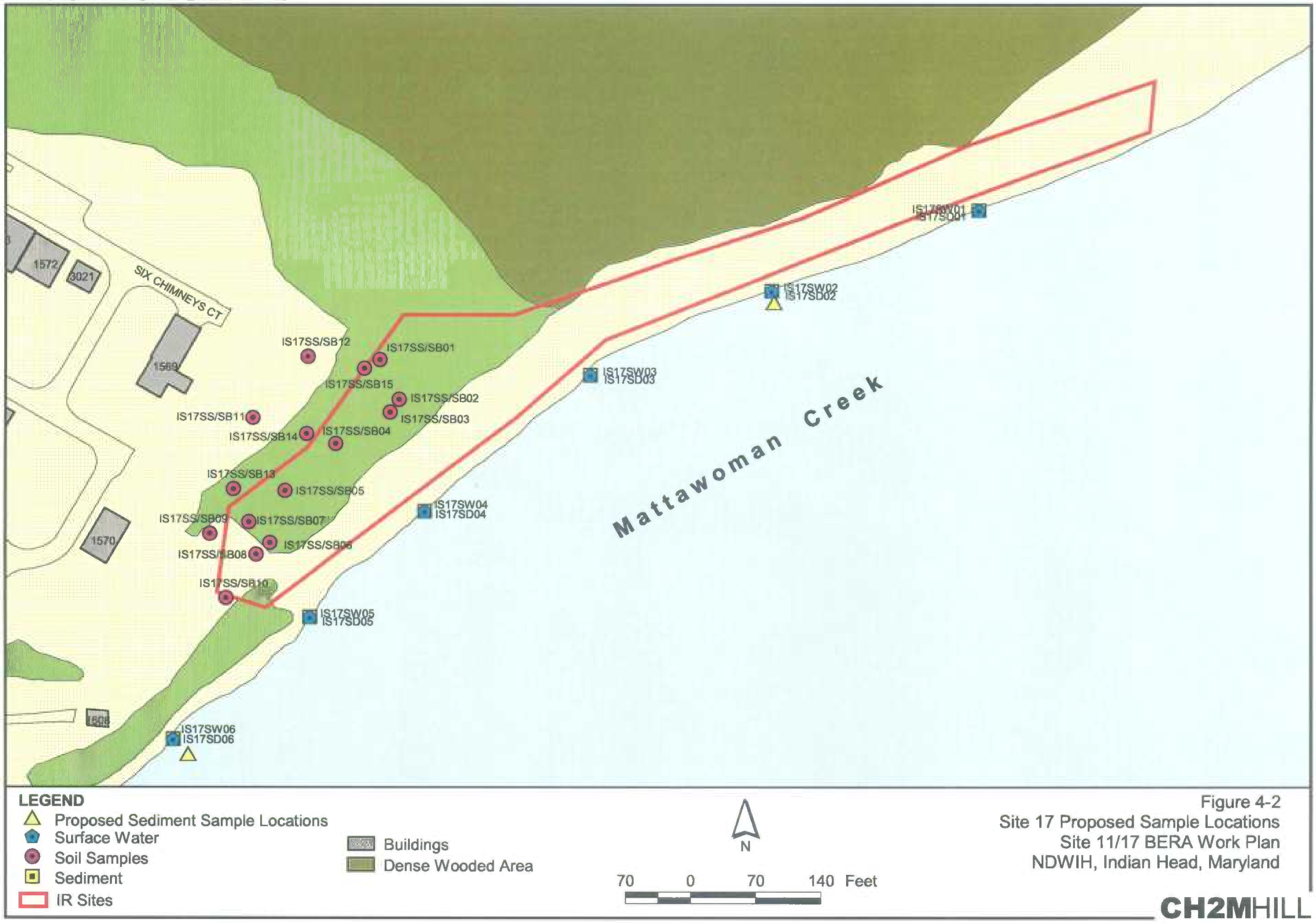

Figure 4-2
Site 17 Proposed Sample Locations
Site 11/17 BERA Work Plan
NDWIH, Indian Head, Maryland

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Figure 4-3
Bullit's Neck Proposed Sample Locations
Site 11/17 BERA Work Plan
NDWIH, Indian Head, Maryland

CH2MHILL

SECTION 5
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Appendix A

Table A-1
Raw Results
Site 11/17 Sediment
NSWC Indian Head, Maryland

Sample ID	IS11SD010001	IS11SD020001	IS11SD030001	IS11SD040001	IS11SD050001	IS11SD060001	IS11SD070001	IS17SD010001
Chemical Name								
Inorganics (MG/KG)								
Aluminum	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Antimony	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1.8 UL	2.4 UL	1.1 U
Arsenic	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Barium	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Beryllium	0.055 U	0.095 B	0.058 B	0.072 B	0.52 B	0.44 B	0.76 B	[redacted]
Cadmium	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Calcium	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	198 B
Chromium	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Cobalt	5.1 B	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Copper	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Cyanide	2.7 U	2.6 U	2.6 U	[redacted]	5.1 U	4.1 U	5.7 U	0.66 U
Iron	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Lead	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Magnesium	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Manganese	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Mercury	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	0.066 UL
Nickel	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	2 B
Potassium	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Selenium	1.2 UL	1.1 UL	[redacted]	2.2 UL	2.2 UL	1.8 UL	2.4 UL	1.1 U
Silver	[redacted]	0.82 U	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	0.82 U
Sodium	428 B	332 B	226 B	378 B	638 B	603 B	807 B	329 B
Thallium	[redacted]	1.4 U	[redacted]	2.7 U	2.7 U	2.2 U	3 U	1.4 U
Vanadium	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Zinc	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

NA - Not analyzed
B - Analyte not detected above associated blank
E - Estimated
J - Reported value is estimated
L - Reported value may be biased low

R - Unreliable result
U - Analyte not detected

Table A-1
Raw Results
Site 11/17 Sediment
NSWC Indian Head, Maryland

Sample ID	IS11SD010001		IS11SD020001		IS11SD030001		IS11SD040001		IS11SD050001		IS11SD060001		IS11SD070001		IS17SD010001	
Chemical Name																
Semivolatile Organic Compounds (UG/KG)																
1,1-Biphenyl	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
2,2'-Oxybis(1-chloropropane)	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
2,4,5-Trichlorophenol	1,100	U	1,100	U	1,100	U	1,100	U	2,100	U	1,700	U	2,400	U	NA	
2,4,6-Trichlorophenol	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
2,4-Dichlorophenol	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
2,4-Dimethylphenol	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
2,4-Dinitrophenol	1,100	U	1,100	R	1,100	R	1,100	R	2,100	R	1,700	R	2,400	U	NA	
2-Chloronaphthalene	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
2-Chlorophenol	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
2-Methylnaphthalene	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
2-Methylphenol	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
2-Nitroaniline	1,100	U	1,100	U	1,100	U	1,100	U	2,100	U	1,700	U	2,400	U	NA	
2-Nitrophenol	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
3,3'-Dichlorobenzidine	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
3-Nitroaniline	1,100	U	1,100	U	1,100	U	1,100	U	2,100	U	1,700	U	2,400	U	NA	
4,6-Dinitro-2-methylphenol	1,100	R	1,100	U	1,100	U	1,100	U	2,100	U	1,700	U	2,400	U	NA	
4-Bromophenyl-phenylether	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
4-Chloro-3-methylphenol	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
4-Chloroaniline	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
4-Chlorophenyl-phenylether	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
4-Methylphenol	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
4-Nitroaniline	1,100	U	1,100	U	1,100	U	1,100	U	2,100	U	1,700	U	2,400	U	NA	
4-Nitrophenol	1,100	U	1,100	U	1,100	U	1,100	U	2,100	U	1,700	U	2,400	U	NA	
Acenaphthene	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
Acenaphthylene	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
Acetophenone	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
Anthracene	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
Atrazine	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
Benzaldehyde	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
Benzo(a)anthracene	450	U	[redacted]		420	U	420	U	850	U	[redacted]		940	U	NA	
Benzo(a)pyrene	450	U	[redacted]		420	U	420	U	850	U	680	U	940	U	NA	
Benzo(b)fluoranthene	450	U	[redacted]				420	U	850	U	[redacted]		940	U	NA	
Benzo(g,h,i)perylene	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
Benzo(k)fluoranthene	450	U	[redacted]		420	U	420	U	850	U	680	U	940	U	NA	

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Table A-1
Raw Results
Site 11/17 Sediment
NSWC Indian Head, Maryland

Sample ID	IS11SD010001		IS11SD020001		IS11SD030001		IS11SD040001		IS11SD050001		IS11SD060001		IS11SD070001		IS17SD010001	
Chemical Name																
Butylbenzylphthalate	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
Caprolactam	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
Carbazole	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
Chrysene	450	U	[redacted]				420	U	850	U	[redacted]		940	U	NA	
Di-n-butylphthalate	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
Di-n-octylphthalate	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
Dibenz(a,h)anthracene	450	U	[redacted]		420	U	420	U	850	U	680	U	940	U	NA	
Dibenzofuran	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
Diethylphthalate	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
Dimethyl phthalate	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
Fluoranthene	450	U	[redacted]				420	U	850	U	[redacted]				NA	
Fluorene	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
Hexachlorobenzene	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
Hexachlorobutadiene	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
Hexachlorocyclopentadiene	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
Hexachloroethane	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
Indeno(1,2,3-cd)pyrene	450	U	[redacted]		420	U	420	U	850	U	680	U	940	U	NA	
Isophorone	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
Naphthalene	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
Pentachlorophenol	1,100	U	1,100	U	1,000	U	1,000	U	2,100	U	1,600	U	2,300	U	NA	
Phenanthrene	450	U	[redacted]		420	U	420	U	850	U	[redacted]		940	U	NA	
Phenol	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
Pyrene	450	U	[redacted]				420	U	850	U	[redacted]				NA	
bis(2-Chloroethoxy)methane	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
bis(2-Chloroethyl)ether	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
bis(2-Ethylhexyl)phthalate	450	U	440	U	[redacted]								940	U	NA	
n-Nitroso-di-n-propylamine	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
n-Nitrosodiphenylamine	450	U	440	U	420	U	420	U	850	U	680	U	940	U	NA	
Explosives (UG/KG)																
1,3,5-Trinitrobenzene	250	U	250	U	250	U	250	U	250	U	250	U	250	U	250	U
1,3-Dinitrobenzene	250	U	250	U	250	U	250	U	250	U	250	U	250	U	250	U
2,4,6-Trinitrotoluene	250	U	250	U	250	U	250	U	250	U	250	U	250	U	250	U
2,4-Dinitrotoluene	250	U	250	U	250	U	250	U	250	U	250	U	250	U	250	U
2,6-Dinitrotoluene	250	U	250	U	250	U	250	U	250	U	250	U	250	U	250	U

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Site 11/17 Sediment
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Sample ID	IS11SD010001	IS11SD020001	IS11SD030001	IS11SD040001	IS11SD050001	IS11SD060001	IS11SD070001	IS17SD010001
Chemical Name								
2-Amino-4,6-dinitrotoluene	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U
2-Nitrotoluene	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U
3-Nitrotoluene	[redacted]	250 U	250 U	250 U	250 U	[redacted]	250 U	250 U
4-Amino-2,6-dinitrotoluene	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U
4-Nitrotoluene	250 U	250 U	250 U	[redacted]	250 U	[redacted]	250 U	160 B
Ammonium perchlorate	130 U	230 U	110 U	100 U	150 U	160 U	220 U	120 U
HMX	500 U	500 U	500 U	500 U	500 U	500 U	500 U	500 U
Nitrobenzene	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U
Nitroglycerin	1,200 U	1,200 U	1,300 U	1,200 U	2,600 U	2,100 U	3,000 U	1,300 U
Nitroguanidine	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U
PETN	2,500 U	2,500 U	2,500 U	2,500 U	2,500 U	2,500 U	2,500 U	2,500 U
RDX	500 U	500 U	500 U	500 U	500 U	500 U	500 U	500 U
Tetryl	650 U	650 U	650 U	650 U	650 U	650 U	650 U	650 R
Volatile Organic Compounds (UG/KG)								
1,1,1-Trichloroethane	14.0 U	13.0 U	13.0 U	13.0 U	26.0 U	21.0 U	28.0 U	NA
1,1,2,2-Tetrachloroethane	14.0 U	13.0 U	13.0 U	13.0 U	26.0 U	21.0 U	28.0 U	NA
1,1,2-Trichloro-1,2,2- trifluoroethane	14.0 U	13.0 U	13.0 U	13.0 U	26.0 U	21.0 U	28.0 U	NA
1,1,2-Trichloroethane	14.0 U	13.0 U	13.0 U	13.0 U	26.0 U	21.0 U	28.0 U	NA
1,1-Dichloroethane	14.0 U	13.0 U	13.0 U	13.0 U	26.0 U	21.0 U	28.0 U	NA
1,1-Dichloroethene	14.0 U	13.0 U	13.0 U	13.0 U	26.0 U	21.0 U	28.0 U	NA
1,2,4-Trichlorobenzene	14.0 U	13.0 U	13.0 U	13.0 U	26.0 U	21.0 U	28.0 U	NA
1,2-Dibromo-3-chloropropane	14.0 U	13.0 U	13.0 U	13.0 U	26.0 U	21.0 U	28.0 U	NA
1,2-Dibromoethane	14.0 U	13.0 U	13.0 U	13.0 U	26.0 U	21.0 U	28.0 U	NA
1,2-Dichlorobenzene	14.0 U	13.0 U	13.0 U	13.0 U	26.0 U	21.0 U	28.0 U	NA
1,2-Dichloroethane	14.0 U	13.0 U	13.0 U	13.0 U	26.0 U	21.0 U	28.0 U	NA
1,2-Dichloroethene (total)	14.0 U	NA	NA	NA	NA	NA	28.0 U	NA
1,2-Dichloropropane	14.0 U	13.0 U	13.0 U	13.0 U	26.0 U	21.0 U	28.0 U	NA
1,3-Dichlorobenzene	14.0 U	13.0 U	13.0 U	13.0 U	26.0 U	21.0 U	28.0 U	NA
1,4-Dichlorobenzene	14.0 U	13.0 U	13.0 U	13.0 U	26.0 U	21.0 U	28.0 U	NA
2-Butanone	[redacted]	13.0 U	13.0 U	13.0 U	[redacted]			NA
2-Hexanone	14.0 U	13.0 U	13.0 U	13.0 U	26.0 U	21.0 U	28.0 U	NA
4-Methyl-2-pentanone	14.0 U	13.0 U	13.0 U	13.0 U	26.0 U	21.0 U	28.0 U	NA
Acetone	8.7 B	13.0 U	13.0 U	13.0 U	[redacted]			NA
Benzene	14.0 U	13.0 U	13.0 U	13.0 U	26.0 U	21.0 U	28.0 U	NA

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Raw Results
Site 11/17 Sediment
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Sample ID	IS11SD010001		IS11SD020001		IS11SD030001		IS11SD040001		IS11SD050001		IS11SD060001		IS11SD070001		IS17SD010001	
Chemical Name																
Bromodichloromethane	14.0	U	13.0	U	13.0	U	13.0	U	26.0	U	21.0	U	28.0	U	NA	
Bromoform	14.0	U	13.0	U	13.0	U	13.0	U	26.0	U	21.0	U	28.0	U	NA	
Bromomethane	14.0	U	13.0	U	13.0	U	13.0	U	26.0	U	21.0	U	28.0	U	NA	
Carbon disulfide	14.0	U	13.0	U	13.0	U	13.0	U	26.0	U	21.0	U	28.0	U	NA	
Carbon tetrachloride	14.0	U	13.0	U	13.0	U	13.0	U	26.0	U	21.0	U	28.0	U	NA	
Chlorobenzene	14.0	U	13.0	U	13.0	U	13.0	U	26.0	U	21.0	U	28.0	U	NA	
Chloroethane	14.0	U	13.0	U	13.0	U	13.0	U	26.0	U	21.0	U	28.0	U	NA	
Chloroform	14.0	U	13.0	U	13.0	U	13.0	U	26.0	U	21.0	U	28.0	U	NA	
Chloromethane	[redacted]		13.0	U	13.0	U	13.0	U	[redacted]				28.0	U	NA	
Cumene	14.0	U	13.0	U	13.0	U	13.0	U	26.0	U	21.0	U	28.0	U	NA	
Cyclohexane	14.0	U	13.0	U	13.0	U	13.0	U	26.0	U	21.0	U	28.0	U	NA	
Dibromochloromethane	14.0	U	13.0	U	13.0	U	13.0	U	26.0	U	21.0	U	28.0	U	NA	
Dichlorodifluoromethane	14.0	U	13.0	U	13.0	U	13.0	U	26.0	U	21.0	U	28.0	U	NA	
Ethylbenzene	14.0	U	13.0	U	13.0	U	13.0	U	26.0	U	21.0	U	28.0	U	NA	
Methyl acetate	14.0	U	13.0	U	13.0	U	13.0	U	26.0	U	21.0	U	28.0	U	NA	
Methyl-tert-butyl ether (MTBE)	14.0	U	13.0	U	13.0	U	13.0	U	26.0	U	21.0	U	28.0	U	NA	
Methylcyclohexane	14.0	U	13.0	U	13.0	U	13.0	U	26.0	U	21.0	U	28.0	U	NA	
Methylene chloride	14.0	U	13.0	U	13.0	U	13.0	U	26.0	U	21.0	U	28.0	U	NA	
Styrene	14.0	U	13.0	U	13.0	U	13.0	U	26.0	U	21.0	U	28.0	U	NA	
Tetrachloroethene	14.0	U	13.0	U	13.0	U	13.0	U	26.0	U	21.0	U	28.0	U	NA	
Toluene	14.0	U	13.0	U	13.0	U	13.0	U	[redacted]		21.0	U	28.0	U	NA	
Trichloroethene	14.0	U	13.0	U	13.0	U	13.0	U	26.0	U	21.0	U	28.0	U	NA	
Trichlorofluoromethane	14.0	U	13.0	U	13.0	U	13.0	U	26.0	U	21.0	U	28.0	U	NA	
Vinyl chloride	14.0	U	13.0	U	13.0	U	13.0	U	26.0	U	21.0	U	28.0	U	NA	
Xylene, total	14.0	U	13.0	U	13.0	U	13.0	U	26.0	U	21.0	U	28.0	U	NA	
cis-1,2-Dichloroethene	14.0	U	13.0	U	13.0	U	13.0	U	26.0	U	21.0	U	28.0	U	NA	
cis-1,3-Dichloropropene	14.0	U	13.0	U	13.0	U	13.0	U	26.0	U	21.0	U	28.0	U	NA	
trans-1,2-Dichloroethene	14.0	U	13.0	U	13.0	U	13.0	U	26.0	U	21.0	U	28.0	U	NA	
trans-1,3-Dichloropropene	14.0	U	13.0	U	13.0	U	13.0	U	26.0	U	21.0	U	28.0	U	NA	

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Raw Results
Site 11/17 Sediment
NSWC Indian Head, Maryland

Sample ID	IS11SD010001		IS11SD020001		IS11SD030001		IS11SD040001		IS11SD050001		IS11SD060001		IS11SD070001		IS17SD010001	
Chemical Name																
Total Petroleum Hydrocarbons (MG/KG)																
TPH-diesel range	4.1	U													NA	
TPH-gas range	0.14	U	0.13	U	0.13	U	0.13	U	0.26	U	0.21	U	0.28	U	NA	
Other Parameters (MG/KG)																
% Moisture																
% Solids	NA		NA		NA		NA		NA		NA		NA			
Total organic carbon (TOC)	NA		NA		NA		NA		NA		NA		NA		125	U
pH	NA		NA		NA		NA		NA		NA		NA			

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Raw Results
Site 11/17 Sediment
NSWC Indian Head, Maryland

Sample ID	IS17SD020001		IS17SD030001		IS17SD040001		IS17SD050001		IS17SD060001	
Chemical Name										
Inorganics (MG/KG)										
Aluminum	[redacted]		[redacted]		[redacted]		[redacted]		[redacted]	
Antimony	1.1	U	1.1	U	[redacted]		[redacted]		[redacted]	
Arsenic	[redacted]		[redacted]		[redacted]		[redacted]		[redacted]	
Barium	[redacted]		[redacted]		[redacted]		[redacted]		[redacted]	
Beryllium	0.14	B	0.22	B	[redacted]		[redacted]		[redacted]	
Cadmium	0.10	B	0.12	B	[redacted]		[redacted]		[redacted]	
Calcium	[redacted]		[redacted]		[redacted]		[redacted]		[redacted]	
Chromium	[redacted]		[redacted]		[redacted]		[redacted]		[redacted]	
Cobalt	[redacted]		[redacted]		[redacted]		[redacted]		[redacted]	
Copper	[redacted]		[redacted]		[redacted]		[redacted]		[redacted]	
Cyanide	0.62	U	0.67	U	0.65	U	0.35	B	0.42	B
Iron	[redacted]		[redacted]		[redacted]		[redacted]		[redacted]	
Lead	[redacted]		[redacted]		[redacted]		[redacted]		[redacted]	
Magnesium	[redacted]		[redacted]		[redacted]		[redacted]		[redacted]	
Manganese	[redacted]		[redacted]		[redacted]		[redacted]		[redacted]	
Mercury	[redacted]		[redacted]		0.065	U	[redacted]		[redacted]	
Nickel	[redacted]		[redacted]		[redacted]		[redacted]		[redacted]	
Potassium	[redacted]		[redacted]		[redacted]		[redacted]		[redacted]	
Selenium	1.1	U	1.1	U	1.1	U	1.1	U	1.4	U
Silver	0.77	U	0.82	U	0.80	U	[redacted]		[redacted]	
Sodium	547	B	437	B	[redacted]		[redacted]		[redacted]	
Thallium	1.3	U	1.4	U	1.4	U	1.4	U	1.8	U
Vanadium	[redacted]		[redacted]		[redacted]		[redacted]		[redacted]	
Zinc	[redacted]		[redacted]		[redacted]		[redacted]		[redacted]	

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Raw Results
Site 11/17 Sediment
NSWC Indian Head, Maryland

Sample ID	IS17SD020001		IS17SD030001		IS17SD040001		IS17SD050001		IS17SD060001	
Chemical Name										
Semivolatile Organic Compounds (UG/KG)										
1,1-Biphenyl	NA		NA		NA		NA		NA	
2,2'-Oxybis(1-chloropropane)	NA		NA		NA		NA		NA	
2,4,5-Trichlorophenol	NA		NA		NA		NA		NA	
2,4,6-Trichlorophenol	NA		NA		NA		NA		NA	
2,4-Dichlorophenol	NA		NA		NA		NA		NA	
2,4-Dimethylphenol	NA		NA		NA		NA		NA	
2,4-Dinitrophenol	NA		NA		NA		NA		NA	
2-Chloronaphthalene	NA		NA		NA		NA		NA	
2-Chlorophenol	NA		NA		NA		NA		NA	
2-Methylnaphthalene	NA		NA		NA		NA		NA	
2-Methylphenol	NA		NA		NA		NA		NA	
2-Nitroaniline	NA		NA		NA		NA		NA	
2-Nitrophenol	NA		NA		NA		NA		NA	
3,3'-Dichlorobenzidine	NA		NA		NA		NA		NA	
3-Nitroaniline	NA		NA		NA		NA		NA	
4,6-Dinitro-2-methylphenol	NA		NA		NA		NA		NA	
4-Bromophenyl-phenylether	NA		NA		NA		NA		NA	
4-Chloro-3-methylphenol	NA		NA		NA		NA		NA	
4-Chloroaniline	NA		NA		NA		NA		NA	
4-Chlorophenyl-phenylether	NA		NA		NA		NA		NA	
4-Methylphenol	NA		NA		NA		NA		NA	
4-Nitroaniline	NA		NA		NA		NA		NA	
4-Nitrophenol	NA		NA		NA		NA		NA	
Acenaphthene	NA		NA		NA		NA		NA	
Acenaphthylene	NA		NA		NA		NA		NA	
Acetophenone	NA		NA		NA		NA		NA	
Anthracene	NA		NA		NA		NA		NA	
Atrazine	NA		NA		NA		NA		NA	
Benzaldehyde	NA		NA		NA		NA		NA	
Benzo(a)anthracene	NA		NA		NA		NA		NA	
Benzo(a)pyrene	NA		NA		NA		NA		NA	
Benzo(b)fluoranthene	NA		NA		NA		NA		NA	
Benzo(g,h,i)perylene	NA		NA		NA		NA		NA	
Benzo(k)fluoranthene	NA		NA		NA		NA		NA	

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Raw Results
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Sample ID	IS17SD020001		IS17SD030001		IS17SD040001		IS17SD050001		IS17SD060001	
Chemical Name										
Butylbenzylphthalate	NA		NA		NA		NA		NA	
Caprolactam	NA		NA		NA		NA		NA	
Carbazole	NA		NA		NA		NA		NA	
Chrysene	NA		NA		NA		NA		NA	
Di-n-butylphthalate	NA		NA		NA		NA		NA	
Di-n-octylphthalate	NA		NA		NA		NA		NA	
Dibenz(a,h)anthracene	NA		NA		NA		NA		NA	
Dibenzofuran	NA		NA		NA		NA		NA	
Diethylphthalate	NA		NA		NA		NA		NA	
Dimethyl phthalate	NA		NA		NA		NA		NA	
Fluoranthene	NA		NA		NA		NA		NA	
Fluorene	NA		NA		NA		NA		NA	
Hexachlorobenzene	NA		NA		NA		NA		NA	
Hexachlorobutadiene	NA		NA		NA		NA		NA	
Hexachlorocyclopentadiene	NA		NA		NA		NA		NA	
Hexachloroethane	NA		NA		NA		NA		NA	
Indeno(1,2,3-cd)pyrene	NA		NA		NA		NA		NA	
Isophorone	NA		NA		NA		NA		NA	
Naphthalene	NA		NA		NA		NA		NA	
Pentachlorophenol	NA		NA		NA		NA		NA	
Phenanthrene	NA		NA		NA		NA		NA	
Phenol	NA		NA		NA		NA		NA	
Pyrene	NA		NA		NA		NA		NA	
bis(2-Chloroethoxy)methane	NA		NA		NA		NA		NA	
bis(2-Chloroethyl)ether	NA		NA		NA		NA		NA	
bis(2-Ethylhexyl)phthalate	NA		NA		NA		NA		NA	
n-Nitroso-di-n-propylamine	NA		NA		NA		NA		NA	
n-Nitrosodiphenylamine	NA		NA		NA		NA		NA	
Explosives (UG/KG)										
1,3,5-Trinitrobenzene	[redacted]		250	U	250	U	250	U	250	U
1,3-Dinitrobenzene	[redacted]		250	U	250	U	250	U	250	U
2,4,6-Trinitrotoluene	[redacted]		250	U	250	U	[redacted]		250	U
2,4-Dinitrotoluene	250	U	250	U	250	U	250	U	250	U
2,6-Dinitrotoluene	250	U	[redacted]		250	U	250	U	250	U

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Chemical Name										
2-Amino-4,6-dinitrotoluene	250	U	250	U	250	U	[redacted]		250	U
2-Nitrotoluene	250	U	250	U	250	U	250	U	250	U
3-Nitrotoluene	[redacted]		250	U	250	U	250	U	250	U
4-Amino-2,6-dinitrotoluene	250	U	250	U	250	U	150	B	250	U
4-Nitrotoluene	250	U	250	U	250	U	250	U	250	U
Ammonium perchlorate	110	U	120	U	86.0	U	140	U	160	U
HMX	500	U	500	U	500	U	500	U	500	U
Nitrobenzene	98.0	B	250	U	250	U	250	U	250	U
Nitroglycerin	1,300	U	1,200	U	1,200	U	1,300	U	1,500	U
Nitroguanidine	100	U	100	U	100	U	100	U	100	U
PETN	2,500	U	2,500	U	2,500	U	2,500	U	2,500	U
RDX	500	U	500	U	500	U	500	U	500	U
Tetryl	650	R	650	R	650	R	650	R	650	R
Volatile Organic Compounds (UG/KG)										
1,1,1-Trichloroethane	NA		NA		NA		NA		NA	
1,1,2,2-Tetrachloroethane	NA		NA		NA		NA		NA	
1,1,2-Trichloro-1,2,2- trifluoroethane	NA		NA		NA		NA		NA	
1,1,2-Trichloroethane	NA		NA		NA		NA		NA	
1,1-Dichloroethane	NA		NA		NA		NA		NA	
1,1-Dichloroethene	NA		NA		NA		NA		NA	
1,2,4-Trichlorobenzene	NA		NA		NA		NA		NA	
1,2-Dibromo-3-chloropropane	NA		NA		NA		NA		NA	
1,2-Dibromoethane	NA		NA		NA		NA		NA	
1,2-Dichlorobenzene	NA		NA		NA		NA		NA	
1,2-Dichloroethane	NA		NA		NA		NA		NA	
1,2-Dichloroethene (total)	NA		NA		NA		NA		NA	
1,2-Dichloropropane	NA		NA		NA		NA		NA	
1,3-Dichlorobenzene	NA		NA		NA		NA		NA	
1,4-Dichlorobenzene	NA		NA		NA		NA		NA	
2-Butanone	NA		NA		NA		NA		NA	
2-Hexanone	NA		NA		NA		NA		NA	
4-Methyl-2-pentanone	NA		NA		NA		NA		NA	
Acetone	NA		NA		NA		NA		NA	
Benzene	NA		NA		NA		NA		NA	

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Chemical Name										
Bromodichloromethane	NA		NA		NA		NA		NA	
Bromoform	NA		NA		NA		NA		NA	
Bromomethane	NA		NA		NA		NA		NA	
Carbon disulfide	NA		NA		NA		NA		NA	
Carbon tetrachloride	NA		NA		NA		NA		NA	
Chlorobenzene	NA		NA		NA		NA		NA	
Chloroethane	NA		NA		NA		NA		NA	
Chloroform	NA		NA		NA		NA		NA	
Chloromethane	NA		NA		NA		NA		NA	
Cumene	NA		NA		NA		NA		NA	
Cyclohexane	NA		NA		NA		NA		NA	
Dibromochloromethane	NA		NA		NA		NA		NA	
Dichlorodifluoromethane	NA		NA		NA		NA		NA	
Ethylbenzene	NA		NA		NA		NA		NA	
Methyl acetate	NA		NA		NA		NA		NA	
Methyl-tert-butyl ether (MTBE)	NA		NA		NA		NA		NA	
Methylcyclohexane	NA		NA		NA		NA		NA	
Methylene chloride	NA		NA		NA		NA		NA	
Styrene	NA		NA		NA		NA		NA	
Tetrachloroethene	NA		NA		NA		NA		NA	
Toluene	NA		NA		NA		NA		NA	
Trichloroethene	NA		NA		NA		NA		NA	
Trichlorofluoromethane	NA		NA		NA		NA		NA	
Vinyl chloride	NA		NA		NA		NA		NA	
Xylene, total	NA		NA		NA		NA		NA	
cis-1,2-Dichloroethene	NA		NA		NA		NA		NA	
cis-1,3-Dichloropropene	NA		NA		NA		NA		NA	
trans-1,2-Dichloroethene	NA		NA		NA		NA		NA	
trans-1,3-Dichloropropene	NA		NA		NA		NA		NA	

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Chemical Name										
Total Petroleum Hydrocarbons (MG/KG)										
TPH-diesel range	NA		NA		NA		NA		NA	
TPH-gas range	NA		NA		NA		NA		NA	
Other Parameters (MG/KG)										
% Moisture	[redacted]		[redacted]		[redacted]		[redacted]		[redacted]	
% Solids	[redacted]		[redacted]		[redacted]		[redacted]		[redacted]	
Total organic carbon (TOC)	133	U	[redacted]		123	U	[redacted]		[redacted]	
pH	[redacted]		[redacted]		[redacted]		[redacted]		[redacted]	

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