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Work Plan
for
Mattawoman Creek

Indian Head Division
Naval Surface Warfare Center
Indian Head, Maryland

Engineering Field Activity Chesapeake
Naval Facilities Engineering Command

Contract Number N62472-90-D-1298

Contract Task Order 0320

August 2001

TETRA TECH NUS, INC.

080113/P

WORK PLAN
FOR
MATTAWOMAN CREEK

INDIAN HEAD DIVISION
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

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

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ACRONYMS

µg/L	microgram per liter
ARARS	applicable or relevant and appropriate requirements
ATSDR	Agency for Toxic Substance and Disease Registry
AVS/SEM	acid volatile sulfide/simultaneously extractable metals
AWQC	ambient water quality criteria
B&RE	Brown and Root Environmental, Inc.
BTAG	Biological Technical Assistance Group
CLEAN	Comprehensive Long-Term Environmental Action Navy
CLP	Contract Laboratory Procedure
COC	chain of custody
COPC	chemical of potential concern
CRAVE	Carcinogenic Risk Assessment Verification Endeavor
CSC	cancer slope factor
CSM	conceptual site model
CTE	central tendency exposure
CTO	Contract Task Order
DO	dissolved oxygen
DQO	data quality objective
E/A&H	ENSAFE/Allen and Hoshall
EPA	United States Environmental Protection Agency
ERA	ecological risk assessment
ER-L	Effects Range-Low
ER-M	Effects Range-Medium
FOL	Field Operations Leader
HASP	Health and Safety Plan
HEAST	Health Effects Assessment Summary Table
HHRA	human health risk assessment
HI	Hazard Index
HQ	Hazard Quotient
HSM	program health and safety manager
ICR	Incremental Cancer Risk
IDW	investigation-derived waste
IHIRT	Indian Head Installation Restoration Team
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program

mg/L	milligrams per liter
MS/MSD	matrix spike/matrix spike duplicate
MSDS	Material Safety Data Sheet
NCEA	National Center for Environmental Assessment
NPDES	National Pollution Discharge Elimination System
NSWC	Naval Surface Warfare Center
OPPTS	Office of Prevention, Pesticides, and Toxic Substances
ORP	Oxidation Reduction Potential
OSWER	Office of Solid Waste and Environmental Response
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PPE	personal protective equipment
QA/QC	quality assurance/quality control
QAM	quality assurance manager
QAPP	Quality Assurance Plan
QC	quality control
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RFD	Referenced Dose
RFI	RCRA facility investigation
RI	remedial investigation
RME	reasonable maximum exposure
RPM	remedial project manager
SAV	submerged aquatic vegetation
SC	specific conductance
SDWA	Safe Drinking Water Act
SI	site inspection
SMDP	scientific-management decision point
SOP	standard operating procedure
SOW	Statement of Work
SVOC	semivolatile organic compound
TAL	Target Analyte List
TBC	to be considered
TCL	Target Contaminant List
TIC	tentatively identified compounds
TIE	toxicity identification evaluation
TOC	total dissolved solids

TRW	Technical Review Workgroup
TSS	total suspended solids
TtNUS	Tetra Tech NUS, Inc.
UCL	upper confidence limit
USATHAMA	United States Army Toxic and Hazardous Material Agency
USFWS	United States Fish and Wildlife Service
VIMS	Virginia Institute of Marine Science
VOA	Volatile Organic Aromatics or Volatile Organic Analysis
VOC	volatile organic compound
WP	work plan

1.0 INTRODUCTION

This Work Plan (WP) was prepared by Tetra Tech NUS, Inc. (TtNUS) under the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract No. N62472-90-D-1298, Contract Task Order (CTO) 320. This WP was prepared to develop the field, laboratory, and risk assessment investigations to be conducted as part of the Mattawoman Creek ecological risk assessment (ERA) and human health risk assessment (HHRA), also known as the Mattawoman Creek Study, Indian Head Division, Naval Surface Warfare Center (IHDIV-NSWC), Indian Head, Maryland.

The purpose of the Mattawoman Creek Study is to determine the magnitude of impacts on Mattawoman Creek from base-related activities and to assess the potential ecological and human health risks resulting from those impacts.

1.1 DOCUMENT ORGANIZATION

Section 1.0 of this report presents this introduction, a detailed site description, an overview of existing data, and a summary of the project organization. Section 2.0 presents the field investigation scope, including an overview of the ecological risk assessment, and the human health risk assessment methodology. Section 3.0 describes the detailed field activities. Section 4.0 describes the approach to field operations. Section 5.0 discusses the environmental sampling procedures. The Mattawoman Creek ERA problem formulation, which describes the ERA activities to be conducted, is provided in Appendix A. The Health and Safety Plan (HASP) is provided in Appendix B. The Quality Assurance Project Plan (QAPP) is presented in Appendix C. Field sampling forms are provided in Appendix D.

1.2 SITE DESCRIPTION

Mattawoman Creek drains a 79-square-mile area in northern Charles County and southern Prince George's County, Maryland (Figure 1-1). The creek originates southwest of Brandywine and flows for 30 miles until it empties into the Potomac River at river mile 71. The average annual discharge rate of Mattawoman Creek to the Potomac River is 54.2 cubic feet per second, which is a small proportion (less than 0.4 percent) of the total Potomac River freshwater flow (Lippson et al., 1979). The first 25 miles of the creek are free flowing, and the last 5 miles are a tidal embayment. Tidal amplitude in the lower Mattawoman Creek averages about 0.5 meter but fluctuates considerably depending on weather, season, and moon phase (Lippson et al., 1979). The lower portion of the creek is classified as a tidal freshwater stream throughout most of the year. During low freshwater flow periods, usually late summer and early fall, salinity near the mouth of the creek can reach 3-4 parts per thousand. When salinity is present, stratification can occur, mainly near the mouth of the creek.

The main portion of IHDIV-NSWC is located along the northern shoreline of Mattawoman Creek, from its confluence with the Potomac River upgradient for approximately 3 miles. Stump Neck Annex is located along the southern shoreline of Mattawoman Creek, from its confluence with the Potomac River to approximately 1 mile upgradient of the confluence. The Mattawoman Creek basin is mostly rural but includes INDIV-NSWC, the town of Indian Head, and a rapidly developing suburban area in northern Charles County. Concerns about increased development in the upper Mattawoman Creek basin have led to ongoing studies by the Smithsonian Environmental Research Center and Charles County and the U.S. Army Corps of Engineers. These studies focus on the development of a watershed management plan (Jordon et al., 2000). The Indian Head Waste Water Treatment Plant (WWTP) discharges to a small creek known as Harrison Cut, which empties into Mattawoman Creek at a point along the northern shoreline, approximately 1,000 feet upgradient of the eastern base boundary.

The width of Mattawoman Creek increases as it approaches IHDIV-NSWC (Figure 1-2). A defined creek channel is present in the reach of the creek near the southern base boundary. Project biologists measured depths ranging from approximately 9 feet to 17 feet in this area during an August 2000 site visit. This clearly defined channel flows past the Scrap Yard area and then becomes more diffuse. The entire creek becomes shallower near Thoroughfare Island and Marsh Island. Depths in these areas ranged from 2 to 6 feet in August 2000. A large flat is present in the area south of Thoroughfare Island. From Bullit's Neck to the mouth of the Potomac, Mattawoman Creek becomes broad and open, with depths ranging from 3 to 8 feet. Highly variable depths down to 14 feet were present in this broad area in August 2000. A diffuse channel is present in the middle of this final stretch of lower Mattawoman Creek.

1.2.1 Mattawoman Creek Ecology

At least 33 species of fish inhabit Mattawoman Creek or adjacent areas, including several anadromous and semi-anadromous species such as the blueback herring (*Alosa aestivalis*), alewife (*A. pseudoharengus*), white perch (*Morone americana*), gizzard shad (*Dorsoma cepedianum*), and striped bass (*Morone saxatilis*). Marine species that use Mattawoman Creek as a nursery include the Atlantic menhaden (*Brevoortia tyrannus*), spot (*Leiosomus xanthrus*), and winter flounder (*Pseudopleuronectes americanus*). The catadromous American eel (*Anguilla rostrata*) spawns at sea and the young migrate to Mattawoman Creek to mature. Several freshwater species of gamefish are common in Mattawoman Creek, including the largemouth bass (*Micropterus salmoides*), black crappie (*Pomoxis nigromaculatus*), yellow perch (*Perca flavescens*), and bluegill (*Lepomis macrochirus*) as well as several species of catfish (*Ictalurus* spp.).

The bald eagle (*Haliaetus leucocephalus*) and osprey (*Pandion haliaetus*) are present along Mattawoman Creek. Five bald eagle nests have been identified in the Mattawoman Creek area. Other piscivorous birds along the creek include the great blue heron (*Ardea herodias*), green-backed heron (*Butorides*

striatus), Forster's tern (*Sterna forsteri*), and belted kingfisher (*Ceryle alcyon*). Abundant waterfowl use Mattawoman Creek, including the mallard (*Anas platyrhynchos*), American black duck (*Anas rubripes*), and wood duck (*Aix sponsa*). The base natural resources department is currently performing a survey of wintering waterfowl present in Mattawoman Creek. An abundance of turtles and aquatic snakes are regularly observed, including during an August 2000 site visit by project biologists. The base has completed a survey of herptiles in Mattawoman Creek.

Extensive aquatic vegetation is found throughout Mattawoman Creek. In the middle and upper reaches of the creek, some wooded swamps are present. In middle and lower Mattawoman Creek, extensive beds of the macrophyte spatterdock (*Nuphar luteum*) are present. The emergent pickerel weed (*Pontederia cordata*) is common, including nearly all of Marsh Island. Some wild rice (*Zizania aquatica*) is also present; it is generally present along the periphery of the spatterdock and pickerel weed beds. Emergent vegetation is less abundant from Bullit's Neck to the mouth of Mattawoman Creek. The creek also contains abundant submerged aquatic vegetation (SAV). The Virginia Institute of Marine Science (VIMS) has conducted mapping of the SAV in the Chesapeake Bay watershed. SAV in Mattawoman Creek is dominated by hydrilla (*Hydrilla verticillata*), najas (*Najas minor*), and wild celery (*Vallisneria americana*). Some coontail (*Ceratophyllum demersum*) is present in the upper reaches of Mattawoman Creek near IHDIV-NSWC. Riparian vegetation is also present along the margins of the creek, including many of the species described above, as well as cattail (*Typha* spp.), common reed (*Phragmites australis*), maples (*Acer* spp.), tulip poplar (*Liriodendron tulipera*), and oaks (*Quercus* spp.). The riparian vegetation appears to be consistent along most of the banks of Mattawoman Creek associated with the Installation; the dominant vegetation types generally remain consistent.

1.3 SUMMARY OF PREVIOUS INVESTIGATIONS

Limited surface water and sediment sampling, primarily sediment sampling, was conducted in Mattawoman Creek during the SI (E/A&H, 1994). Samples were collected near Site 39, the Organics Plant, and Site 41, the Scrap Yard. Site 41 is immediately upstream of Site 39 (Figure 1-2). Generally low concentrations of volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides, and metals were detected in SI sediment samples. Nitroguanidine, 1,1-dimethylhydrazine, and nitrocellulose were also detected in these samples. As a result, additional surface water and sediment sampling was conducted in these areas as part of a remedial investigation (RI) (TtNUS, 1999a) for Sites 39 and 41.

Six surface water and eight sediment samples were collected in Mattawoman Creek near Sites 39 and 41 as part of the RI. In general, concentrations of all analytes were low in surface water, and concentrations of VOCs, SVOCs, and pesticides were low in sediments. In contrast, concentrations of nitrocellulose and several metals, including mercury and silver, were elevated in sediments. It should also be noted that

some limited Mattawoman Creek chemistry data associated with Site 57 (TtNUS, 1999b) and Site 42 (TtNUS, 2000a) are available, but they are of limited scope. The RI included a screening-level risk assessment and Step 3A – Refinement of COPCs evaluation. That ERA concluded that potential risks were present for aquatic and semi-aquatic receptors in the portion of Mattawoman Creek near sites 39 and 41 and that additional risk assessment was necessary to more fully characterize potential risks. The Indian Head Installation Restoration Team (IHIRT) agreed that further study of Mattawoman Creek would be deferred until a broader ecological study of Mattawoman Creek could be conducted (The Mattawoman Creek Study).

An HHRA was also conducted as part of the Sites 39 and 41 RI. The HHRA for Site 39 considered current/future adult recreational users exposed to surface water, sediment, and fish, and future construction workers exposed to sediment. All cancer risks and hazard indices for those scenarios were less than or within U.S. Environmental Protection Agency (EPA) acceptable risk levels.

The HHRA for Site 41 considered potential exposures to sediments by future construction workers, future residents, and current/future adult recreational users. All cancer risks and hazard indices for those scenarios were less than or within EPA acceptable risk levels.

In addition to the RI studies conducted for sites located along Mattawoman Creek, in 1986, IHDIV-NSWC asked the United States Fish and Wildlife Service (USFWS) to perform a 5-year study of mercury accumulation in Mattawoman Creek fish. In response to this request, the USFWS collected bluegill, largemouth bass, and channel catfish at two sampling stations in Mattawoman Creek annually for 5 years, beginning in 1986. One sampling site was located at Marsh Island and one was an upgradient location just downstream of the Highway 225 Bridge over Mattawoman Creek. The conclusions from the sampling and analysis are summarized below by reporting year:

- 1987 – Total mercury concentrations in Mattawoman Creek fish in the vicinity of the IHDIV-HSWC were not significantly different than those at the upgradient reference station. All Marsh Island fish had mercury concentrations below the 1 mg/kg "contaminated threshold" applied by the USFWS.

- 1988 - Total mercury concentrations in Mattawoman Creek fish in the vicinity of the IHDIV-NSWC were not significantly different than those at the upgradient reference station. All Marsh Island fish had mercury concentrations below 1 mg/kg. However, channel catfish were not available from the Marsh Island site and, thus, all data analyzed at that station were largemouth bass and bluegill.

- 1989 - Total mercury concentrations in Mattawoman Creek fish in the vicinity of IHDIV-NSWC were not significantly different than those at the upgradient reference station. All Marsh Island fish had mercury concentrations below 1 mg/kg.

- 1990 - Total mercury concentrations in Mattawoman Creek largemouth bass and bluegill in the vicinity of IHDIV-NSWC were not significantly different than those at the upgradient reference station, and channel catfish concentrations were significantly higher than the upgradient station. All Marsh Island fish had mercury concentrations below 1 mg/kg.

- 1991 – An additional reference site in Nanjemoy Creek was added to the sampling scheme. Total mercury concentrations in Mattawoman Creek channel catfish and bluegill in the vicinity of IHDIV-NSWC were not significantly different than those at the upgradient reference station, and largemouth bass concentrations were significantly higher than the upgradient station. All Marsh Island fish had mercury concentrations below 1 mg/kg, with the exception of one largemouth bass sample. Bluegills from the upgradient site had higher mercury concentrations than bluegills collected at the Marsh Island site and the Nanjemoy Creek reference site.

Based on the results of the 5-year study, primarily the levels found in Marsh Island largemouth bass in 1991 and the upgradient bluegills in 1991, the USFWS concluded that further study into the effects of mercury on fish and wildlife in Mattawoman Creek may be warranted.

In addition to the 5-year study of mercury in Mattawoman Creek fish, USFWS conducted a study in 1989 to gauge the effectiveness of the IHDIV-NSWC National Pollution Discharge Elimination System (NPDES) permit. Analyses included measurement of metals residues in sediment and in several species of fish, clams, and aquatic vegetation. Bioassay tests using Mattawoman Creek surface water were conducted with larval fathead minnows, *Ceriodaphnia dubia*, and Microtox bacteria. Histopathological analysis of fish tissue was also conducted. Based on several factors, including bioaccumulation potential and suspected Mattawoman Creek contaminants, USFWS analyzed biota for cadmium, copper, mercury, selenium, and zinc. Sediment was also analyzed for chromium, silver, and arsenic. Analyses were conducted on samples collected near Marsh Island and upgradient of IHDIV-NSWC near the Highway 225 Bridge. The study concluded the following:

- Marsh Island sediment samples contained higher concentrations of arsenic, chromium, lead, selenium, silver, and zinc than upgradient samples.

- Metals analyzed in fish, clams, and aquatic plants were not significantly different among sites, with the exception of elevated copper in aquatic plants near the IHDIV-NSWC.

- Bioassay tests showed no significant toxic effects of short-term exposure to ambient water near the IHDIV-NSWC.

- Fish histopathological results indicated that fish health may be negatively impacted near the IHDIV-NSWC.

Based on these results, USFWS suggested that IHDIV-NSWC reduce inputs of copper, lead, arsenic, and possibly selenium in NPDES discharges.

In addition to the RI work conducted for Sites 39 and 41, a toxicity identification evaluation (TIE) was conducted, in part, with sediments from these two sites (SAIC, 2001). The study was conducted as part of a demonstration project for the Navy that was designed to illustrate the applicability of TIE technology in resolving uncertainties associated with management of contaminated sediments. The TIE study was originally employed to help determine whether elevated bulk silver concentrations in Site 42 sediments were toxic. Site 42 is located along a swale that ultimately discharges to Mattawoman Creek. To help obtain a more broad range of sediment types and COPCs, samples were also collected from the Site 39/41 area in Mattawoman Creek, as well as one sample in an area upgradient of Sites 39/41 known as Slavin's Dock. The additional samples were collected also to address issues concerning spatial variability in chemical concentrations and potential toxicity.

The TIE consisted of a sequential series of toxicity tests using *Hyalella* and fathead minnow *(Pimephales promelas*) larvae, as well as bulk and pore water sediment chemical analyses. Each species was exposed to bulk sediment toxicity tests, untreated pore water sediment toxicity tests, and the series of treated pore waters to remove various chemicals and classes of chemicals. The sequential removal of specific chemicals allows for determination of potential causative agents associated with observed toxicity.

All bulk sediments exhibited significant toxicity to *Hyalella.* The extent of toxicity for both test organisms in pore water was generally less than that observed in bulk sediments. In general, the potential causative agent(s) of toxicity varied among samples. The following principal findings were noted:

- Observed toxicity at two sampling stations was likely due to particulates in the samples.

- PAHs, pesticides, and PCBs did not appear to be responsible for toxicity in the TIE samples, with the possible exception of beta-BHC in one sample.

- Silver did not appear to elicit toxicity, with the possible exception of one sample, which had the highest detected bulk sediment concentration of silver.

- Divalent metals may be at least partially responsible for toxicity at three sampling locations, especially elevated zinc in one sample.

- Ammonia appeared to be at least partially responsible for toxicity in four samples.

- Toxicity at one sampling location was not removed in any of the TIE treatments, suggesting an unidentified confounding factor, such as water hardness, TOC/DOC, or exotics (explosives). However, explosives were detected quite infrequently in sediments from the study.

1.4 PROJECT ORGANIZATION

The ecological risk assessment, human health risk assessment, and supporting field investigations described in this work plan will be performed by TtNUS with support from the Navy. The Navy Remedial Project Manager (RPM) will be:

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The TtNUS project organization is shown on Figure 1-3.

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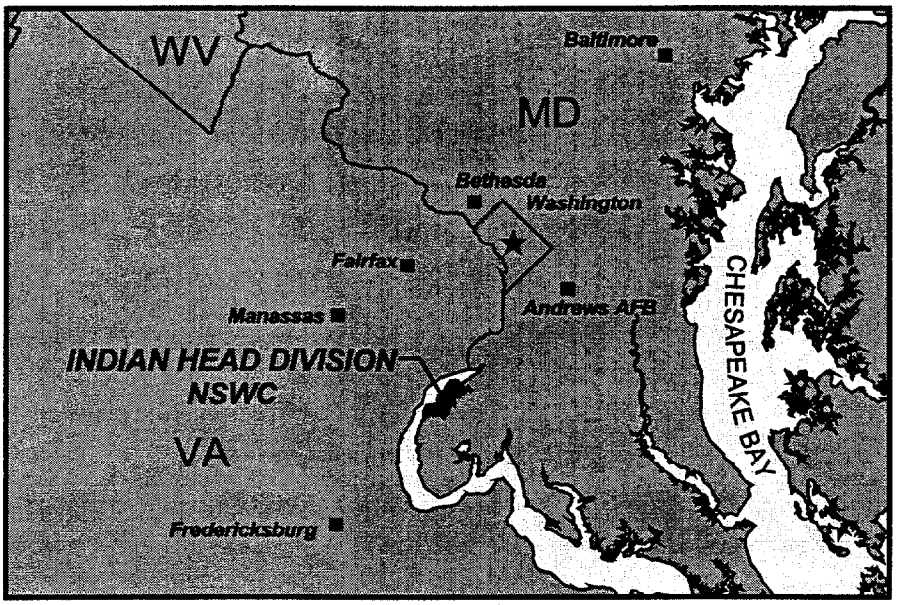
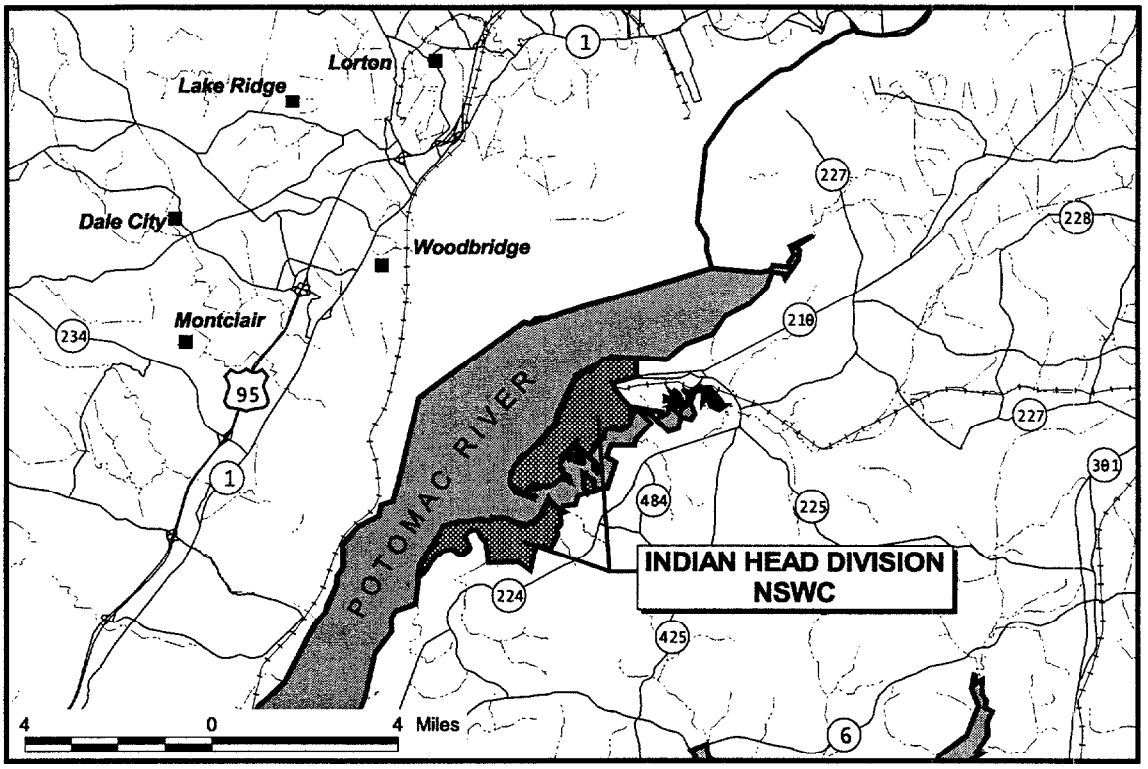


LEGEND

- City
- Highway
- Railroad
- River



DRAWN BY J. LAMEY — DATE 8/2/01	Tetra Tech NUS, Inc.	CONTRACT NUMBER —	OWNER NO. —
CHECKED BY GJL — DATE 8/3/01	FACILITY LOCATION MAP INDIAN HEAD DIVISION, NSWC INDIAN HEAD, MARYLAND	APPROVED BY GJL	DATE 8/3/01
COST/SCHEDULE-AREA		APPROVED BY —	DATE —
SCALE AS NOTED		DRAWING NO. FIGURE 1-1	REV 0

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DRAWN BY MDB DATE 02/21/01
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

TETRA TECH NUS, INC.

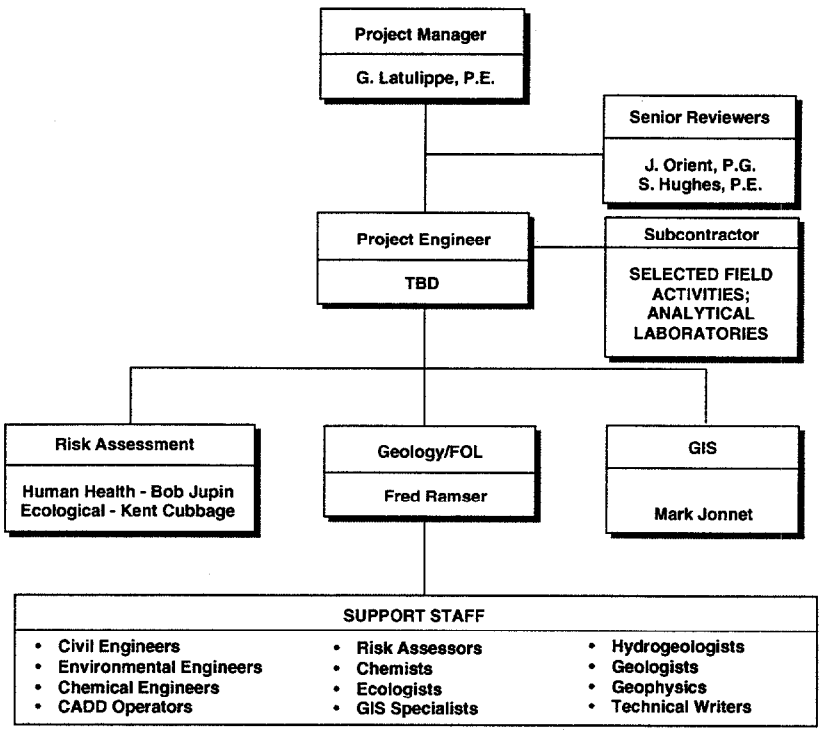
FIGURE 1-2
SITES 39 AND 41
LOCATION MAP
MATTAWOMAN CREEK
IHDIV-NSWC, INDIAN HEAD, MARYLAND

CONTRACT NO. | OWNER NO.
APPROVED BY | DATE
APPROVED BY | DATE
DRAWING NO. | REV. 0

FORM CADD NO. SDV_BH12.DGN - REV 0 - 1/20/98

FIGURE 1-3

TETRA TECH NUS, INC. PROJECT ORGANIZATION CHART
WORK PLAN FOR MATTAWOMAN CREEK
IHDIV-NSWC
INDIAN HEAD, MARYLAND



2.0 FIELD INVESTIGATION SCOPE DEVELOPMENT

2.1 REMEDIAL INVESTIGATION OBJECTIVES

The objective of the Mattawoman Creek Study is to investigate the magnitude of impacts of base-related activities on Mattawoman Creek and to assess the potential ecological and human health risks associated with the impacts. The objectives of the field sampling and laboratory analyses detailed in this WP are to provide data to support the project objectives, including an ERA and an HHRA for the creek near the installation. The scope of the field activities includes collecting both abiotic and biotic environmental samples. The data generated from these samples will ultimately be used to determine the most appropriate course of risk management for Mattawoman Creek. An overview of the ERA and the HHRA methods are discussed in the following sections.

2.2 ECOLOGICAL RISK ASSESSMENT

Two potential conceptual approaches were proposed to define the scope of the Mattawoman Creek ERA. These include a deliberate, chemical-screening approach, and a more expeditious (baseline ERA) approach, in which chemical, biological, and toxicological data are collected. Both of these approaches were detailed in an approach document for the Mattawoman Creek Study (TtNUS, 2000b). The advantages and disadvantages of each approach were discussed at an August 31, 2000 meeting attended by the IHIRT and EPA Region 3 Biological Technical Assistance Group (BTAG) members. During the meeting, it was agreed that the baseline ERA approach would be used. This was decided upon, in part, by the fact that the limited available data indicated that some chemicals were present in concentrations that would likely be carried past a screening-level ERA. The decision to proceed directly to the baseline ERA was considered to be the scientific management decision point (SMDP) for this step in the ERA process (USEPA, 1997a). It should be noted that a rapid screening of the nature and extent of sediment chemistry will be performed before the main field event, but this should not be confused with the term "screening-level ERA."

The first step in the baseline ERA process was to construct the project problem formulation. The problem formulation describes the goals, breadth, and scope of the ERA. The end result of the problem formulation is a list of data requirements necessary to complete the ERA and meet the goals of the study. This document contains the scope of the field and laboratory investigations necessary to meet the data requirements of the ERA. The problem formulation document is provided in Appendix A.

The problem formulation contains several elements that are used to ultimately identify the data requirements. To begin with, the habitats and potential receptors present are identified. This was done

for Mattawoman Creek using existing site ecological information and information obtained by project biologists during an August 2000 site visit. Generally speaking, for Mattawoman Creek, the receptors potentially at risk are aquatic and semi-aquatic biota. A list of chemicals of potential concern (COPCs) was generated as well, using the data from previous investigations and information on historical and current waste management practices, including IRP site information and documented historical spills. A wide range of COPCs was identified, including inorganics, SVOCs [including polynuclear aromatic hydrocarbons (PAHs)], pesticides, polychlorinated biphenyls (PCBs), and energetics. The site ecological information is combined with toxicity and fate and transport information for the COPCs to develop a conceptual model that diagrammatically depicts the sources of chemicals, their fate and transport, their exposure routes, and receptors potentially at risk (see Appendix A). When the conceptual model was completed for Mattawoman Creek, a series of risk questions was developed. The risk questions are ultimately defined by the conceptual model and represent the "big picture" in terms of potential risks that need to be assessed.

From these risk questions, the most appropriate assessment endpoints were selected for Mattawoman Creek. An assessment endpoint is defined as "an explicit expression of actual environmental values that are to be protected" (EPA, 1997a). The assessment endpoints support the risk questions. Finally, measurement endpoints, also known as "measures of effects," which represent "measurable ecological characteristics that are related to the valued characteristic chosen as the assessment endpoint" (EPA, 1997a), were selected for the Mattawoman Creek ERA. Specifically, they provide analyses to investigate the assessment endpoints and ultimately answer the project risk questions. The measurement endpoints and their attendant data quality objectives (DQOs) essentially comprise the data needs for the ERA, including sampling media, types of samples for each medium, and analytes. The risk questions, assessment endpoints, and measurement endpoints (analyses) from the Mattawoman Creek problem formulation are summarized on Table 2-1. This table also summarizes the media that will be sampled to fulfill the data needs for the ERA. Appendix A contains the supporting rationale for and development of the risk questions, assessment endpoints, and measurement endpoints. Detailed DQO construction for each measurement endpoint and related analysis is currently being developed under separate cover. That document will contain detailed DQO processes and specific data interpretation methodologies for each measurement endpoint.

Also, a concerted effort was made in this document to integrate the data needs of both the ERA and HHRA to ensure the most appropriate use of resources during the field activities and the laboratory analyses.

2.3 HUMAN HEALTH RISK ASSESSMENT

The objective of a HHRA is to determine whether detected concentrations of chemicals pose a significant threat to potential human receptors under current and/or future land use scenarios. The potential risks to human health for the site will be estimated based on the assumption that no actions will be taken to control chemical releases. The following sections contain the methodologies to be used to evaluate potential site-specific human health risks at the site.

The risk assessment will be structured and reported according to the guidelines of the Risk Assessment for Superfund (RAGS), Human Health Evaluation Manual, Part D: Standardized Planning, Reporting, and Review of Superfund Risk Assessments (RAGS Part D) (EPA, 1998). In addition, the methodology presented in this WP is consistent with the methodology used for the HHRAs presented in the various RIs/RFIs (B&R Environmental 1998; TtNUS, 1999a, 1999b) that have been conducted at IHDIV-NSWC.

A HHRA consists of five components: data evaluation, exposure assessment, toxicity assessment, risk characterization, and uncertainty analysis. Sections 2.3.1 through 2.3.5 below contain detailed discussions of the methodologies followed for each component of a HHRA. A schematic diagram of the general risk assessment process is provided as Figure 2-1.

To assess potential public health risks, four major aspects of chemical contamination and exposure must be considered: contaminants with toxic characteristics must be found in environmental media; the contaminants must be released by either natural processes or by human action; potential exposure points must exist; and human receptors must be present at the point of exposure. Risk is a function of both toxicity and exposure; without one of the factors listed above, there is no risk.

2.3.1 Data Evaluation

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

2.3.1.1 Quantitative vs. Qualitative Use of Analytical Data

All sample data collected during the Mattawoman Creek Ecological Field Investigation will be used to assess risks to potential human receptors. All analytical data used in the quantitative estimation of potential risks will be subjected to data validation. Only data of adequate quality will be used in the quantitative risk assessment.

Fixed-base analytical results from the Target Analyte Lists will be used in the quantitative risk evaluation. Unfiltered results for surface water will be used to assess risks associated with this medium. Field screening results (preliminary assessments using field test kits), data regarded as unreliable (i.e., qualified as "B" or "R" during the data validation process), and results of tentatively identified compound (TIC) analyses are not used quantitatively. However, these data may be used qualitatively to substantiate the conclusions of the quantitative risk analysis or to identify potential data gaps.

2.3.1.2 COPC Selection

The selection of COPCs for use in HHRA development is a qualitative screening process limiting the number of chemicals that are quantitatively evaluated in an HHRA to those site-related constituents that dominate overall potential risks. Screening levels based on the most current EPA Region 3 risk-based concentrations (RBCs) will be employed to focus the risk assessment on appropriate chemicals and exposure routes.

In general, a chemical is selected as a COPC and retained for further risk evaluation if the maximum detected concentration in a sampled medium exceeds the risk-based COPC screening level. Frequency of detection is used to exclude chemicals when data sets of 20 samples or greater are available. Generally, a detection rate of five percent or less justifies elimination of the chemical from further consideration provided that the detected concentrations are not representative of a "hot spot" area. Chemicals eliminated from further evaluation at this step are assumed to present minimal risks to potential human receptors.

2.3.1.2.1 COPC Screening Level Development

COPCs will be identified by a comparison of maximum detected chemical concentrations with screening levels based on EPA Region 3 RBCs (EPA, 2000a). The risk-based COPC screening levels correspond to a systemic Hazard Quotient of 0.1 (for noncarcinogens) or a lifetime cancer risk of 1 $x10^{-6}$ (for carcinogens). The Region 3 RBCs are developed using protective default exposure scenarios suggested by EPA and currently available reference doses and cancer slope factors. A chemical will be retained as a COPC if its maximum detected concentration exceeds its screening level.

There are no RBCs for sediment; therefore, COPCs will be selected by comparing detected site concentrations to residential soil ingestion screening levels. The use of soil ingestion screening levels for sediment COPC identification is regarded as a conservative approach because exposure to sediment is less than anticipated exposure to soil.

Risk-based COPC screening levels for tap water ingestion, which are based on daily, residential exposure assumptions, will be used to select COPCs for surface water. In general, the use of tap water screening levels is regarded as an extremely conservative approach to COPC selection because the surface water in the vicinity of the site is not used as a potable drinking water source

COPCs in fish tissue will be identified by comparing maximum detected concentrations of chemicals detected in fish tissue samples with screening levels based on EPA Region 3 RBCs (EPA, 2000a) for fish ingestion. The Region 3 RBCs are based on the assumption that a receptor ingests 54 grams of fish per day, 350 days per year for 30 years and that 100 percent of the fish ingested is from the contaminated source. The use of the Region 3 screening levels is considered conservative because it is unlikely that fish caught in Mattawoman Creek would constitute a significant fraction of an individual's diet.

2.3.1.2.2 Lead as a COPC

RBCs are not calculated for lead because the EPA has not derived toxicity values for this constituent. However, guidance from both the Office of Prevention, Pesticides, and Toxic Substances (OPPTS) and Office of Solid Waste and Environmental Response (OSWER) recommend 400 mg/kg as the lowest screening level for lead-contaminated soil in a residential setting where children are frequently present (EPA, 1994a and 1994b). Based on this recommendation, a value of 400 mg/kg will be used as a screening level for sediment in Mattawoman Creek. The Safe Drinking Water Act (SDWA) action level of 15 μg/L (EPA, 2000b) will be used as the screening level for lead in surface water.

2.3.1.2.3 Essential Nutrients and Chemicals Without Toxicity Criteria

The essential nutrients calcium, magnesium, potassium, and sodium are not identified as COPCs. These inorganic chemicals are naturally abundant in environmental matrices and are only toxic at high doses. In addition, because of the lack of toxicity criteria, risk-based COPC screening levels are not available for some chemicals commonly detected at sites [e.g., several noncarcinogenic polycyclic aromatic hydrocarbons (PAHs) (acenaphthylene, benzo(g,h,i)perylene, and phenanthrene)]. These chemicals are generally not selected as COPCs because they cannot be quantitatively addressed in the risk assessment. However, if appropriate surrogate chemicals (which have toxicity criteria) are identified, they may be used for screening purposes. If appropriate surrogates cannot be found, the chemicals will be discussed in the data evaluation section and qualitatively addressed in the uncertainty section of the risk assessment.

2.3.1.2.4 Determination of Site-Related Chemicals

If site-specific background data are available for the site, concentrations of constituents detected in environmental samples will be screened against background concentrations according to the policy set forth in the *Navy Interim Final Policy on the Use of Background Chemical Levels* (U.S. Navy, September 2000). The chemicals found at concentrations indicative of background levels are not considered to be site-related contaminants and will not be retained as COPCs. Site-specific background data will be used to determine whether detected chemicals are present at naturally occurring levels. Conventional statistical methods (e.g., Bartlett's Test for homogeneity, T-test, Wilcoxon Rank Sum Test, comparison of maximum detected concentrations to the background upper tolerance limits, etc.) will be employed to compare site concentrations to available site background data.

2.3.1.3 COPC Summary Screening Tables

Medium-specific tables summarizing the selection of COPCs in the format specified in RAGS Part D will be presented in the risk assessment. The COPC screening tables will include the following: minimum and maximum concentrations of all detected chemicals with data validation qualifiers, frequency of detection, location of maximum detected concentration, range of analytical detection limits, COPC screening level(s), and results of COPC screening process.

Other pertinent health-based criteria (e.g., state and federal drinking water standards, ambient water quality criteria, etc.) will also be incorporated in the COPC summary tables. Although these additional criteria are not used to select COPCs, they can be used for informative purposes and to satisfy regulatory agency requests for comparison of site data to applicable standards.

2.3.2 Exposure Assessment

This portion of the risk assessment defines and evaluates, quantitatively or qualitatively, the type and magnitude of human exposure to the chemicals present at or migrating from a site. The exposure assessment is designed to depict the physical setting of the site, identify potentially exposed populations and applicable exposure pathways, calculate concentrations of COPCs to which receptors might be exposed, and estimate chemical intakes under the identified exposure scenarios.

Actual or potential exposures at the site will be based on the most likely pathways of contaminant release and transport, as well as human activity patterns. A complete exposure pathway has three components: a source of chemicals that can be released to the environment, a route of contaminant transport through an environmental medium, and an exposure or contact point for a human receptor. This compilation of likely exposure pathways and receptors is referred to as the conceptual site model (CSM).

2.3.2.1 Conceptual Site Model

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

Exposure Setting

The exposure setting consists of a description of the physical characteristics of a site. A site description appears in Section 1.2.

Potential Exposure Pathways/Receptors

The course that a chemical takes from the source to the exposed individual is defined as the exposure pathway. The characterization of exposure factors is necessary so that only potentially complete exposure pathways are evaluated in the risk assessment.

Potential receptors can be exposed to site contaminants, directly or indirectly, via surface water and sediment. Potential exposure routes for these media include ingestion (swallowing) and dermal contact (skin exposure).

In general, the following exposure scenarios may be applicable under current and/or future land use. A summary of the potential receptors and exposure pathways is presented in Table 2-2.

- For sites involving current or potential future construction or excavation activities, **current/future construction workers** are evaluated for exposure to surface water, and sediment. Exposure to surface water will be limited to dermal contact. Ingestion of surface water during routine work activities is expected to be negligible and is not evaluated. Construction workers will be evaluated for exposure to sediment by incidental ingestion and dermal contact.

- **Current/future adolescent (ages 7 to 16) and adult recreational users** are considered as potential receptors. Exposure to surface water and sediment is evaluated for incidental ingestion and dermal exposure. Small children (6 years or younger) are not included in this receptor group because they are expected to be supervised by an adult. Fish tissue samples will be collected from Mattawoman

Creek. Therefore, potential risks to the recreational user who may ingest caught fish will be evaluated.

- **Residents (adults and children)** are evaluated as potential receptors. For this study, residential receptors are individuals living near, but not on, the study area (i.e., Mattawoman Creek). Residents will be evaluated for exposure to surface water and sediment by incidental ingestion and dermal contact as well as fish ingestion.

Current or future employees are not considered to be a potential receptor group since they are not anticipated to contact surface water or sediment during their normal work routine. Potential dermal exposures to surface water by current/future recreational users or residents will be limited to wading since Mattawoman Creek is not used for swimming. Recreational users do use Mattawoman Creek for water skiing, and at times there will be swimming in the creek but such exposures are expected to be of short duration. Residents may also consume fish caught from Mattawoman Creek, but their exposures would be similar to those of recreational users. There are no physical barriers that would prevent a receptor from visiting a section of the study area. Also, there are no features within the study area that would make one area more attractive than another area to a receptor. Therefore, the entire study area will be treated as one exposure unit in the HHRA.

2.3.2.2 CTE vs. RME

Traditionally, exposures evaluated in the HHRA are based on the concept of a reasonable maximum exposure (RME) only, which is defined as " the maximum exposure that is reasonably expected to occur at a site" (EPA, 1989). However, more recent risk assessment guidance (EPA, 1992a) recommends addressing an average case or central tendency exposure (CTE). The RME and CTE will be evaluated in the risk assessment. CTE exposure assumptions and results will be presented in the uncertainty section of the risk assessment. It should be noted that the available guidance (EPA, 1993a) concerning the evaluation of CTE is limited and at times vague. Therefore, professional judgment is exercised when defining CTE conditions for a particular receptor.

2.3.2.3 Exposure Point Concentrations

The exposure point concentration, which is calculated for COPCs only, is a reasonable maximum estimate of the chemical concentration that is likely to be contacted over time and is used to calculate estimated exposure intakes. The 95 percent upper confidence limit (UCL), which is based on the distribution of a data set, is considered to be the best estimate of the exposure point concentration for data sets with 10 or more samples (EPA, 1992b). The 95 percent UCL will be used as the exposure point concentration to assess RME and CTE risks (EPA, 1993a). For data sets with fewer than 10 samples,

the UCL is considered to be a poor estimate of the mean, and the maximum detection will be used as the exposure concentration for the RME and CTE scenarios.

2.3.2.4 Chemical Intake Estimation

The methodologies and techniques that are used to estimate exposure intakes are presented in this section. Intakes for the identified potential receptor groups will be calculated using current EPA risk assessment guidance (EPA, 1989 and 2000c) and will be presented in risk assessment spreadsheets that will be appended to the risk assessment.

Noncarcinogenic intakes are estimated using the concept of an average annual exposure. Carcinogenic intakes are calculated as an incremental lifetime exposure, which assumes a life expectancy of 70 years. Equations used to calculate estimated intakes are provided below. Assumptions regarding exposure for all receptors and exposure pathways will be presented in the RAGS Part D Tables.

2.3.2.4.1 Incidental Ingestion of Sediment

Direct physical contact with sediment may result in the incidental ingestion of chemicals. Chemical intake for incidental ingestion of sediment is estimated in the following manner (EPA, 1989):

$$\text{Intake}_{si} = (C_{si})(IR_s)(FI)(EF)(ED)(CF)/(BW)(AT)$$

where:

Intake_{si}	=	intake of contaminant "i" from sediment (mg/kg/day)
C_{si}	=	concentration of contaminant "i" in sediment (mg/kg)
IR_s	=	incidental ingestion rate (mg/day)
FI	=	fraction ingested from contaminated source (dimensionless)
EF	=	exposure frequency (days/yr)
ED	=	exposure duration (yr)
CF	=	conversion factor (1E-6 kg/mg)
BW	=	body weight (kg)
AT	=	averaging time (days);
		for noncarcinogens, AT = ED x 365 days/yr;
		for carcinogens, AT = 70 yr x 365 days/yr

For the RME scenario, the ingestion rate is set at 240 mg/day for the construction worker, 200 mg/day for the child resident, and 100 mg/day for all other potential receptors (adolescent recreational user, adult

recreational user, and adult resident) (EPA, 1993a). For the CTE scenario, the ingestion rate is set at 120 mg/day for the construction worker, 100 mg/day for the child resident, and 50 mg/day for all other potential receptors (EPA, 1993a). Exposure frequencies of 60 days/per year for the construction worker and 16 days/per year (1 day a week during the summer months) for all other potential receptors are used for the RME scenarios. Exposure frequencies of 30 days/per year for the construction worker and 8 days/per year for all other potential receptors are used for the CTE scenarios. For the RME scenario, exposure durations are set at 1 year for the construction worker, 10 years for the adolescent recreational user, 30 years for the adult recreational users, 6 years for the child resident, and 24 years for the adult residents. For the CTE scenario, exposure durations are set at 1 year for the excavation worker, 10 years for the adolescent recreational user, 9 years for the adult recreational users, 2 years for the child resident, and 7 years for the adult residents.

2.3.2.4.2 Dermal Contact with Sediment

Direct physical contact with sediment may result in the dermal absorption of chemicals. Exposure associated with dermal contact with sediment is estimated in the following manner (EPA, 1989):

$$\text{Intake}_{si} = (C_{si})(SA)(AF)(ABS)(CF)(EF)(ED)/(BW)(AT)$$

where:

Intake_{si}	=	amount of chemical "i" absorbed during contact with sediment (mg/kg/day)
C_{si}	=	concentration of chemical "i" in sediment (mg/kg)
SA	=	skin surface area available for contact (cm^2/day)
AF	=	skin adherence factor (mg/cm^2)
ABS	=	absorption factor (dimensionless)
CF	=	conversion factor (1×10^{-6} kg/mg)
EF	=	exposure frequency (days/yr)
ED	=	exposure duration (yr)
BW	=	body weight (kg)
AT	=	averaging time (days);
		for noncarcinogens, AT = ED x 365 days/yr;
		for carcinogens, AT = 70 yr x 365 days/yr

The same exposure frequencies and durations used in the estimation of incidental ingestion intakes of soil/sediment are used to estimate exposure via dermal contact. Exposed surface areas of the body available for dermal contact are determined on a receptor-specific basis since they correspond with

assumed human activities and clothing worn during exposure events. Current guidance (EPA, 2000c and EPA, 1997b) was used to develop the following assumptions concerning the amount of skin surface area available for contact for a receptor:

- For construction workers, the surface area assumed to be available for sediment contact (4,300 cm^2) is the arithmetic mean value for the head, arms, and hands.

- For adolescent recreational users, 30 percent (3,720 cm^2) of the total body surface area is assumed to be available for sediment contact.

- For adult recreational users, 30 percent (6,000 cm^2) of the total body surface area is assumed to be available for sediment contact.

- For child residents, 25 percent of the total body surface area (1,743 cm^2) is assumed to be available for sediment contact.

- For adult residents, 25 percent of the total body surface area (5,000 cm^2) is assumed to be available for sediment contact.

Current EPA Guidance (EPA, 1997b and 2000c) is used to determine soil adherence factors and chemical-specific absorption factors. For COPCs in sediment, the following soil adherence factors will be used for the RME and CTE exposure scenarios:

- Construction workers – 0.2 mg/cm^2 for the RME and 0.02 mg/cm^2 for the CTE
- Adolescent recreational users – 0.2 mg/cm^2 for the RME and 0.02 mg/cm^2 for the CTE
- Adult recreational users – 0.07 mg/cm^2 for the RME and 0.01 mg/cm^2 for the CTE
- Child residents – 0.02 mg/cm^2 for the RME and 0.06 mg/cm^2 for the CTE
- Adult residents – 0.07 mg/cm^2 for the RME and 0.01 mg/cm^2 for the CTE

For the constituents identified as COPCs in sediment, the following absorption factors will be used (EPA, 2000c, unless otherwise noted):

- PCBs – 0.14
- PAHS – 0.13
- DDD, DDE, and DDT – 0.03
- Arsenic – 0.03

- Cadmium – 0.001
- Semivolatile Organics – 0.1
- Other Inorganics and Volatile Organics – not evaluated for dermal contact with soil (USEPA, 2000c)

2.3.2.4.3 Ingestion of Surface Water

The exposure routes relevant to surface water contact include incidental ingestion and dermal contact. Direct contact with surface waters while swimming or wading could result in the inadvertent ingestion of small amounts of water. Intakes for incidental ingestion of surface water are estimated using the following general equation (EPA, 1989):

$$Intake_{wi} = (C_{wi})(IR_w)(ET)(EF)(ED)/(BW)(AT)$$

where:

$Intake_{wi}$	=	ingestion intake (mg/kg-day)
C_{wi}	=	chemical concentration in surface water (mg/L)
IR_w	=	ingestion rate (L/hour)
ET	=	exposure time (hour/day)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
BW	=	body weight (kg)
AT	=	averaging time (days);
		for noncarcinogens, AT = ED x 365 days/yr;
		for carcinogens, AT = 70 yr x 365 days/yr

No receptor- and activity-specific information is available to estimate contact rates for potential recreational users. Therefore, the conventional value of 0.05 L/hour (EPA, 1988) is used for all applicable receptors under CTE and RME conditions. Exposure times are based on professional judgment for construction workers, recreational users, and residents, with consideration of anticipated activities. Construction workers are assumed to be exposed 8 hours/per day for the RME and 4 hours/per day for the CTE. Recreational users and residents are assumed to be exposed 4 hours/per day for the RME and 2 hours/per day for the CTE. The same exposure frequencies and durations used for estimating exposures to sediment are used to estimate exposures to surface water.

2.3.2.4.4 Dermal Contact with Surface Water

Dermal contact with surface water may also occur while receptors are involved in recreational or work activities. The following equation is used to assess exposures resulting from dermal contact with water (EPA, 2000c):

$$DAD_{wi} = (DA_{event})(EV)(ED)(EF)(A)/(BW)(AT)$$

where:

DAD_{wi}	=	dermal absorbed dose of chemical "i" from water (mg/kg/day)
DA_{event}	=	absorbed dose per event (mg/cm^2-event)
EV	=	event frequency (events/day)
ED	=	exposure duration (yr)
EF	=	exposure frequency (days/yr)
A	=	skin surface area available for contact (cm^2)
BW	=	body weight (kg)
AT	=	averaging time (days);
		for noncarcinogens, AT = ED x 365 days/yr;
		for carcinogens, AT = 70 yr x 365 days/yr

The same exposed body areas, exposure times, exposure frequencies, and exposure durations used to evaluate dermal exposures to sediment are used for evaluating dermal contact with surface water.

The absorbed dose per event is estimated using a nonsteady-state approach for organic compounds and a traditional steady-state approach for inorganics. For organics, the following equations apply:

$$\textit{If } t_{event} < t^*, \text{then}: DA_{event} = 2(FA)(K_p)(C_{wi})(CF)\left[\frac{\sqrt{6\tau t_{event}}}{\pi}\right]$$

$$\textit{If } t_{event} > t^*, \text{then}: DA_{event} = (FA)(K_p)(C_{wi})(CF)\left[\frac{t_{event}}{1+B} + 2\tau\left[\frac{1+3B+3B^2}{(1+B)^2}\right]\right]$$

where:

(DA_{event})	=	absorbed dose per event
FA	=	fraction absorbed (dimensionless) – chemical specific
t_{event}	=	duration of event (hr/event)

t^*	=	time it takes to reach steady-state conditions (hr)
K_p	=	permeability coefficient from water through skin (cm/hr)
C_{wi}	=	concentration of chemical "i" in water (mg/L)
τ	=	lag time (hr)
π	=	constant (dimensionless; equal to 3.1416)
CF	=	conversion factor (0.001 L/cm^3)
B	=	partitioning constant derived by Bunge Model (dimensionless)

Values for the chemical-specific parameters (t_{event}, t^*, K_p, τ, and B) are obtained from the current dermal guidance (EPA, 2000c). If no published values are available for a particular compound, they will be calculated using equations provided in the EPA dermal guidance.

The following nonsteady-state equation is used to estimate absorbed dose per event for inorganics:

$$DA_{event} = (K_p)(C_{wi})(t_{event})$$

The dermal permeability (K_p) values recommended in the EPA dermal guidance (USEPA, 2000c) will be used to calculate DA_{event} for inorganic COPCs.

2.3.2.4.5 Fish Ingestion

The fish consumption exposure pathway is evaluated for adolescent and adult recreational users. Since exposure for child and adolescent recreational users is expected to be similar, exposure for child recreational users is not addressed quantitatively. Intakes for the fish ingestion exposure route are estimated using the following equation (EPA, 1989):

$$\text{Intake} = \frac{(C \times IR \times FI \times EF \times ED)}{(BW \times AT)}$$

where:

Intake	=	ingestion intake (mg/kg-day)
C	=	chemical concentration in fish tissue (mg/kg)
IR	=	ingestion rate (kg/meal)
FI	=	fraction ingested from contaminated source (unitless)
EF	=	exposure frequency (meals/year)
ED	=	exposure duration (years)
BW	=	body weight (kg)

AT = averaging time (days);
for noncarcinogens, AT = ED x 365 days/yr;
for carcinogens, AT = 70 yr x 365 days/yr

The ingestion rates of fish are assumed to be 0.145 kg/per meal for the RME and CTE (EPA, 1993a). Under the RME scenario, it will be assumed that a recreational user eats fish caught at the Mattawoman Creek approximately once a week for 48 meals/per year.

2.3.2.4.6 Summary of Exposure Parameters

In general, standard default parameters that combine mid-range and upper-end exposure factors are used to assess RME. CTE is assessed primarily by the use of mid-range exposure factors presented in current risk assessment guidance (EPA, 1989 and 1993a). The exposure input parameters for the identified potential receptor groups at the site are presented in RAGS Part D, Tables 4.1 through 4.12.

2.3.2.5 Exposure to Lead

The equations and methodology presented in the previous sections cannot be used to evaluate exposure to lead because of the lack of published dose-response parameters. Exposure to lead will be assessed using the latest version of EPA's Integrated Exposure Uptake Biokinetic (IEUBK) Model for lead (EPA, 1994c). This model is designed to estimate blood levels of lead in children under 7 years of age; this group is extremely susceptible to adverse effects from exposure to lead (including behavioral and developmental impairments). The IEUBK Model is based on either default or site-specific input values for air, drinking water, diet, dust, and soil exposure. Blood-lead levels greater than 10 μg/dL are considered to be potentially harmful. Estimated blood-lead levels and probability density histograms will be presented as support documentation for this analysis and appended to the site-specific risk assessment. The IEUBK Model will be used to address exposure to lead in children when detected concentrations exceed the screening levels discussed in Section 2.3.1.2.

The Technical Review Workgroup (TRW) Lead Model for Adult Exposure (EPA, 1996) will be used to address exposure to lead in adult recreational users based on fetal blood-lead concentrations in women exposed to lead in contaminated soils. Estimated blood-lead levels and probabilities will be presented as support documentation for this analysis and appended to the site-specific risk assessment. The average lead concentration (EPA, 1994c and 1999) and default parameters for some input parameters will be employed in the model calculations.

2.3.3 Toxicity Assessment

The objective of the toxicity assessment is to identify the potential adverse health effects in exposed populations. Quantitative estimates of the relationship between the magnitude and type of exposures and the severity or probability of human health effects are defined for the identified COPCs. Quantitative toxicity values determined during this component of the risk assessment are integrated with outputs of the exposure assessment to characterize the potential for the occurrence of adverse health effects for each receptor group.

The toxicity value used to evaluate noncarcinogenic health effects is the reference dose (RfD). The RfD is an estimate of the daily exposure level for the human population that is likely to be without appreciable risk during a portion or all of a lifetime. It is based on a review of available animal and/or human toxicity data, with adjustments for various uncertainties associated with the data. Carcinogenic effects are quantified using the cancer slope factor (CSF), which is a plausible upper-bound estimate of the probability of development of cancer per unit intake of chemical over a lifetime. It is based on available dose-response data from human and/or animal studies.

2.3.3.1 Toxicity Criteria for Oral and Inhalation Exposures

Oral and inhalation RfDs and CSFs to be used in the site-specific risk assessments for the site will be obtained from the following primary EPA literature sources:

- Integrated Risk Information System (IRIS) (Online)
- Annual Health Effects Assessment Summary Tables (HEAST) (USEPA, 1997c)
- National Center for Environmental Assessment (NCEA) Superfund Health Risk Technical Support Center
- Although RfDs and CSFs can be found in several toxicological sources, EPA's IRIS on-line database is the preferred source of toxicity values. This database is continuously updated and presented values have been verified by EPA RfD and Carcinogenic Risk Assessment Verification Endeavor (CRAVE) work groups. The EPA Region 3 BC Table will also be used as a source of toxicity criteria.

2.3.3.2 Toxicity Criteria for Dermal Exposure

RfDs and CSFs found in literature are typically expressed as administered (not absorbed) doses. Therefore, these values are considered to be inappropriate for estimating the risks associated with dermal

routes of exposure. Oral dose-response parameters based on administered doses must be adjusted to absorbed doses before the comparison to estimated dermal exposure intakes is made. Because information on administered dermal doses is not always readily available, all oral dose-response parameters are adjusted to provide values for dermal contact.

The adjustment to an absorbed dose is made using chemical-specific gastrointestinal absorption efficiencies published in available guidance [i.e., EPA dermal guidance (EPA, 2000c)], IRIS, Agency for Toxic Substances and Disease Registry (ATSDR) toxicological profiles, etc.) and the following equations:

$$RfD_{dermal} = (RfD_{oral})(ABS_{GI})$$

$$CSF_{dermal} = (CSF_{oral}) / (ABS_{GI})$$

where:

ABS_{GI} = absorption efficiency in the gastrointestinal tract

2.3.3.3 Toxicity Criteria for Carcinogenic Effects of Polynuclear Aromatic Hydrocarbons

Limited toxicity values are available to evaluate the carcinogenic effects from exposure to Polynuclear PAHs. The most extensively studied PAH is benzo(a)pyrene, which is classified by EPA as a probable human carcinogen. Although a CSF is available for benzo(a)pyrene, insufficient data are available to calculate CSFs for other carcinogenic PAHs. Toxic effects for these chemicals are expressed in terms of estimated orders of potential potency (EPA, 1993b), based on the carcinogenicity of benzo(a)pyrene. The equivalent oral and inhalation CSF for these chemicals is derived by multiplying the CSF for benzo(a)pyrene by the order of potential potency. The EPA Region 3 RBC tables present the CSFs for the carcinogenic PAHs, as derived from this process.

2.3.3.4 Toxicity Criteria for Chromium

Toxicity criteria are available for two different forms of chromium, the trivalent state and the hexavalent state; the latter is considered to be more toxic. Unless chromium speciation is performed at a site, screening of chromium is conducted by assuming that 100 percent of the reported total chromium result is hexavalent. Should chromium, assumed to be all hexavalent, prove to be a significant contributor to risk, further investigation regarding the presence and valence state of chromium may be necessary.

2.3.3.5 Identification of Other Human Health-Based Criteria

Medium-specific regulatory and human health-based criteria for COPCs, other than dose-response parameters, are also provided in the risk assessment. These criteria, which consist of applicable or relevant and appropriate requirements (ARARs) and to be considered (TBC) values, can also be used to indicate the potential for adverse health effects in human receptors. ARARs are clean-up standards and other environmental protection requirements and criteria promulgated under federal or state law. TBCs (i.e., health advisories for drinking water) are nonpromulgated, nonenforceable standards or criteria that may be helpful in determining what concentration of a particular chemical is protective of human health.

2.3.4 Risk Characterization

Potential risks (noncarcinogenic and carcinogenic) for human receptors resulting from the exposures to contaminated media are quantitatively determined during the risk characterization component of the HHRA.

A summary and interpretive discussion of the quantitative risk estimates will be provided in the text of the risk assessment. COPCs that contribute significantly to elevated risks will be identified as "risk drivers" during the interpretive risk discussion. The chemical-specific numeric estimates of risk will be contained in the risk assessment spreadsheets provided in the appendices to the risk assessment.

2.3.4.1 Risk Estimation Methods

Quantitative estimates of risk are calculated using intake and toxicity values according to risk assessment methods outlined in current EPA guidance (EPA, 1989). Lifetime cancer risks are expressed in the form of dimensionless probabilities, referred to as Incremental Cancer Risks (ICRs), which are derived using published CSFs. Noncarcinogenic risk estimates are presented in the form of Hazard Quotients (HQs) that are derived using published RfDs.

ICR estimates are generated for each COPC using estimated exposure intakes and published CSFs, as follows:

$$ICR = (\text{Estimated Exposure Intake})(CSF)$$

If the above equation results in an ICR greater than 0.01, the following equation is used:

$$ICR = 1 - [\exp(-\text{Estimated Exposure Intake})(CSF)]$$

The ICRs for all COPCs in an exposure scenario are summed to give a cumulative ICR. An ICR of 10^{-6} indicates that the exposed receptor has a one-in-one-million chance of developing cancer under the defined exposure scenario. Alternatively, such a risk may be interpreted as representing one additional case of cancer in an exposed population of one million persons.

Noncarcinogenic risks are assessed using the concept of HQs and Hazard Indices (HIs). The HQ for a COPC is the ratio of the estimated intake to the RfD, as follows:

$$HQ = (\text{Estimated Exposure Intake}) / (RfD)$$

An HI is generated by summing the individual HQs for all of the COPCs. It should be noted that HI is not a mathematical prediction of the severity of toxic effects and therefore is not a true "risk"; it is simply a numerical indicator of the possibility of the occurrence of noncarcinogenic (threshold) effects.

2.3.4.2 Comparison of Quantitative Risk Estimates to Benchmarks

In order to interpret the quantitative risks and to aid risk managers in determining the need for remediation at a site, quantitative risk estimates will be compared to typical benchmarks. EPA has defined the range of 10^{-4} to 10^{-6} as the ICR "target range" for most hazardous waste facilities addressed under CERCLA. Cumulative ICRs greater than 10^{-4} generally will indicate that some degree of remediation is required, and ICRs below 10^{-6} normally will not result in remedial efforts. Whenever ICRs fall between 10^{-4} and 10^{-6}, decisions for remediation will be made on a case-specific basis. Individual chemicals contributing significantly to risks above the target range are considered to be chemicals of concern.

An HI exceeding unity (1.0) indicates that there may be potential noncarcinogenic health risks associated with exposure. If an HI exceeds unity, target organ effects from individual COPCs contributing to the risk are considered. Only those chemicals that impact the same target organ(s) or exhibit similar critical effect(s) will be regarded as truly additive. Thus, COPCs contributing to an HI greater than 1.0 on the basis of a single target organ/effect are considered to be chemicals of concern.

2.3.5 Uncertainty Analysis

The goal of the uncertainty analysis is to identify important uncertainties and limitations associated with the HHRA. Uncertainties related to each component of the assessment (i.e., data evaluation, exposure assessment, toxicity assessment, and risk characterization) will be presented in the risk assessment. In addition, the effect of a particular uncertainty on the outcome of the assessment (i.e., risk estimates) will also be indicated, where possible.

2.4 AREAS OF STUDY

Sampling will focus primarily on the portion of Mattawoman Creek near the base because this is the most likely area of chemical impacts. The data from the TIE study and Sites 39 and 41 RI indicated that contamination due to chemicals released from these sites does not extend long distances from their point of entry into Mattawoman Creek. Thus, the confluence of Mattawoman Creek and the Potomac will constitute the downgradient boundary of the overall area of study. The upgradient base boundary will constitute the farthest upgradient study boundary, with the exception of the proposed upgradient reference samples (see below).

The length of Mattawoman Creek along IHDIV-NSWC is extensive and includes an undulating shoreline, islands, and areas of emergent aquatic vegetation. This creates a large area of the creek that could potentially have been impacted by base activities. Several criteria were evaluated to determine the most appropriate sampling areas in Mattawoman Creek near the base, primarily with regard to ecological risks:

Mattawoman Creek hydrology was evaluated, including sediment depositional areas. These areas were identified from recent aerial photographs and an August 2000 site visit by project biologists.

Locations of potential sources of chemicals near the base were evaluated, including active and inactive outfalls, feeder creeks, and IRP sites. These areas were identified from active and historical records of base activities and recent IRP investigations.

Locations of aquatic and semi-aquatic habitat, including beds of aquatic vegetation were evaluated. These areas were identified from aerial photographs, discussions with the base natural resources manager, and the August 2000 site visit by project biologists.

Based on the above criteria, five general areas were selected to be the focus of sampling for this study. Additional samples are proposed at selected locations to fill in data gaps. These five sampling areas, along with the additional data gap sampling locations, are described in Table 2-3 and depicted on Figure 2-3.

In addition, Table 2-3 presents a discussion of selected reference sites. Area 6 was selected as an upgradient reference site located near the Highway 225 Bridge (Figure 2-3). This area was used as an upgradient area by USFWS in its historical studies. Samples in this area would likely be collected just downstream of the bridge, as the creek narrows dramatically upgradient of the bridge and the physico-chemistry of the sediments are likely to be different. Nanjemoy Creek was selected as an additional reference sampling area (Figure 2-4). Nanjemoy Creek is located along the Potomac River downgradient

of Mattawoman Creek (Figure 1-1). This creek was used as a reference creek by USFWS in historical studies and was suggested as a reference creek by the IHDIV-NSWC natural resources manager.

A detailed discussion of the samples to be collected in Mattawoman and Nanjemoy Creeks is presented in Section 3.0. This includes two field events: a rapid screening assessment event and the main field event (see Section 3.0).

TABLE 2-1

PROBLEM FORMULATION SUMMARY
WORK PLAN FOR MATTAWOMAN CREEK
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Risk Question[1]	Assessment Endpoint(s)	Measurement Endpoint (Measure of Effects)	Sample Media for Data Needs
Do base-related chemical concentrations in Mattawoman Creek present an unacceptable risk to benthic macroinvertebrates?	Survival and growth of healthy benthic macroinvertebrate populations.	1. *Hyalella azteca* 10-day survival and growth toxicity tests (ASTM, EPA methods). 2. Community analysis metrics and indices (as an indicator of reproduction). 3. Comparison of sediment chemical concentrations to sediment screening guidelines (e.g., ER-Ls, ER-Ms).	Sediments
Do base-related concentrations of bioaccumulatable chemicals in Mattawoman Creek present an unacceptable risk to piscivorous birds[2]?	Survival, growth, and reproduction of healthy piscivorous bird populations.	Model potential risks (doses) to the great blue heron using site-specific prey concentrations.	Surface Water, Sediment, and Fish
Do base-related concentrations of bioaccumulatable chemicals in Mattawoman Creek present an unacceptable risk to carnivorous mammals[2]?	Survival, growth, and reproduction of healthy carnivorous mammal populations.	Model potential risks (doses) to the raccoon using site-specific prey concentrations.	Surface Water, Sediment, and Fish
Do base-related concentrations of bioaccumulatable chemicals in Mattawoman Creek present an unacceptable risk to herbivorous birds[2]?	Survival, growth, and reproduction of healthy herbivorous bird populations.	Model potential risks (doses) to the mallard using site-specific forage concentrations.	Surface Water, Sediment, and Aquatic Vegetation
Do base-related concentrations of inorganics in Mattawoman Creek present an unacceptable risk to aquatic vegetation?[3]	Survival, growth, and reproduction of healthy emergent vegetation communities.	1. Compare tissue concentrations of hydrilla to upgradient/reference locations. 2. Compare tissue concentrations of vegetation screening levels.	Aquatic Vegetation
Do base-related concentrations of chemicals in Mattawoman Creek present an unacceptable risk to aquatic invertebrates?	Survival, growth, and reproduction of aquatic invertebrates.	Compare Mattawoman Creek surface water chemical concentrations to screening guidelines (e.g., AWQCs)	Surface Water

TABLE 2-1

PROBLEM FORMULATION SUMMARY
WORK PLAN FOR MATTAWOMAN CREEK
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Risk Question[1]	Assessment Endpoint(s)	Measurement Endpoint (Measure of Effects)	Sample Media for Data Needs
Do base-related chemical concentrations in Mattawoman Creek present an unacceptable risk to fish (at different trophic levels)?	Survival, growth, and reproduction of fish communities.	1. Compare Mattawoman Creek surface water chemical concentrations to screening guidelines (e.g., AWQCs). 2. Compare body burdens of chemicals in fish tissue collected for this study to upgradient/reference locations and tissue-effects levels. 3. Compare fish tissue body burdens of chemicals from historical USFWS studies to tissue-specific levels.	Fish

1 Reptiles/amphibians are acknowledged as receptors of concern but cannot be quantitatively evaluated due to the absence of acceptable benchmark values, Bioassays for risks to herptiles are available but not planned at this time.
2 See Appendix A for list of detected sediment chemicals known to bioaccumulate.
3 See Appendix A for list of detected inorganics in Mattawoman Creek sediments.
ER-L = Effects Range-Low
ER-M = Effects Range-Medium
AWQC = Ambient and Water Quality Criteria

TABLE 2-2

SELECTION OF HUMAN HEALTH EXPOSURE PATHWAYS
WORK PLAN FOR MATTAWOMAN CREEK
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future	Sediment	Sediment	Mattawoman Creek	Construction Workers	Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Construction workers may contact sediment during construction activities.
				Recreational Users	Adolescents	Ingestion Dermal	On-Site On-Site	Quant Quant	Recreational users may be exposed to sediment in Mattawoman Creek.
				Recreational Users	Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Recreational users may be exposed to sediment in Mattawoman Creek.
	Surface Water	Surface Water	Mattawoman Creek	Construction Workers	Adult	Ingestion Dermal	On-Site On-Site	None Quant	Construction workers are not anticipated to ingested surface water. Construction workers may contact surface water during construction activities.
				Recreational Users	Adolescents	Ingestion Dermal	On-Site On-Site	Quant Quant	Recreational users may be exposed to surface water in Mattawoman Creek.
				Recreational Users	Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Recreational users may be exposed to surface water in Mattawoman Creek.
		Fish	Mattawoman Creek	Recreational Users	Adolescents	Ingestion	On-site	Quant	Recreational users may fish at the site.
				Recreational Users	Adult	Ingestion	On-site	Quant	Recreational users may fish at the site.
	Sediment	Sediment	Mattawoman Creek	Residents	Child	Ingestion Dermal	On-Site On-Site	Quant Quant	Future child residents may contact sediment in Mattawoman Creek.
					Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Future adult residents may contact sediment in Mattawoman Creek.
	Surface Water	Surface Water	Mattawoman Creek	Residents	Child	Ingestion Dermal	On-Site On-Site	Quant Quant	Future child residents may contact surface water in Mattawoman Creek.
					Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Future adult residents may contact surface water in Mattawoman Creek.
		Fish	Mattawoman Creek	Resident Users	Adolescents	Ingestion	On-site	Quant	Nearby residents may fish at the site.
				Resident Users	Adult	Ingestion	On-site	Quant	Nearby residents may fish at the site.

TABLE 2-3

GENERAL AREAS FOR SAMPLING OF MATTAWOMAN CREEK AND NANJEMOY CREEK
WORK PLAN FOR MATTAWOMAN CREEK
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Sampling	Location	Rationale for Focus of Sampling	Sample Types (number of samples)
Area 1	Tip of Indian Head peninsula at mouth of Creek of the developed area to the east	The tip of the peninsula contains a sediment depositional area. Site 42 stream (Cornwallis Neck Marshes) discharges in this area. Site 11 (Caffee Road Landfill) and Site 17 (Shoreline Metal Parts Disposal) are located along Mattawoman Creek. In addition, some outfalls are also present.	• Surface Water/Sediment (4) • Sediment Toxicity (4) • Benthic Invertebrates (4) • Fish (1) • Aquatic Vegetation (1)
Area 2	Marsh Island and environs	Marsh Island contains excellent aquatic and semi-aquatic habitat and was the focus of USFWS historical sampling. Several IRP sites are located along the base shoreline across from Marsh Island, including the outlet of the Site 8 Pond and Site 18 (Hog Island). Several outfalls are present as well.	• Surface Water/Sediment (4) • Sediment Toxicity (4) • Benthic Invertebrates (4) • Fish (1) • Aquatic Vegetation (1)
Area 3	Area from the point near Thoroughfare Island to the next point to the northeast	Site 23 (Hydraulic Oil Spill Discharges from Extrusion Plant) and Site 25 (X-Ray Building Number 2) are located along Mattawoman Creek in this area. Several outfalls are present in this area. Several beds of aquatic vegetation are present parallel to the shoreline.	• Surface Water/Sediment (4) • Sediment Toxicity (4) • Benthic Invertebrates (4) • Fish (1) • Aquatic Vegetation (1)
Area 4	Sites 39/41 area	Area of known surface water and sediment contamination from Site 39 (Organics Plant Outfall) and Site 41 (Scrap Yard). Extensive beds of aquatic vegetation are present offshore, which also may have served as historical sediment depositional areas.	• Surface Water/Sediment (4) • Sediment Toxicity (4) • Benthic Invertebrates (4) • Fish (1) • Aquatic Vegetation (1)
Area 5	From final bend in the creek near the base upgradient to the eastern base boundary along the creek	Massive beds of aquatic vegetation are present. Comprises the main creek channel at the uppermost reach of the base. Site 28 (Original Burning Ground) is located along Mattawoman Creek in this area, as well as a terrestrial area of elevated zinc. Several outfalls are present.	• Surface Water/Sediment (4) • Sediment Toxicity (4) • Benthic Invertebrates (4) • Fish (1) • Aquatic Vegetation (1)
Data Gap Area 1	Southern side of the point due west of Bullit's Neck	Fills in an extensive spatial data gap between sampling Areas 1 and 2.	• Surface Water (2) • Sediment (2)
Data Gap Area 2	Northern side of the point due west of Bullit's Neck	Fills in an extensive spatial data gap between sampling Areas 1 and 2. Some isolated outfalls are present. Site 22 (NG Slums Burning Site) is located in this area.	• Surface Water (2) • Sediment (2)
Data Gap Area 3	Point between Areas 4 and 5	A depositional area containing extensive aquatic vegetation is present, along with an IRP site (Site 27 – Thermal Destructor 1) and outfalls.	• Surface Water (2) • Sediment (2)
Area 6	Upgradient of the base near Highway 225 Bridge (slightly downgradient of bridge)	Selected for upgradient reference area sampling. This site was used as the upgradient area from USFWS historical studies.	• Surface Water/Sediment (2) • Sediment Toxicity (2) • Benthic Invertebrates (2) • Fish (2) • Aquatic Vegetation (2)
Area 7*	Nanjemoy Creek, located along the Potomac downgradient of Mattawoman Creek	Selected for reference creek data; similar to Mattawoman Creek in hydrology and habitat. This site was used as a reference creek from USFWS historical studies.	• Surface Water/Sediment (2) • Sediment Toxicity (2) • Benthic Invertebrates (2) • Fish (2) • Aquatic Vegetation (2)

* In Nanjemoy Creek

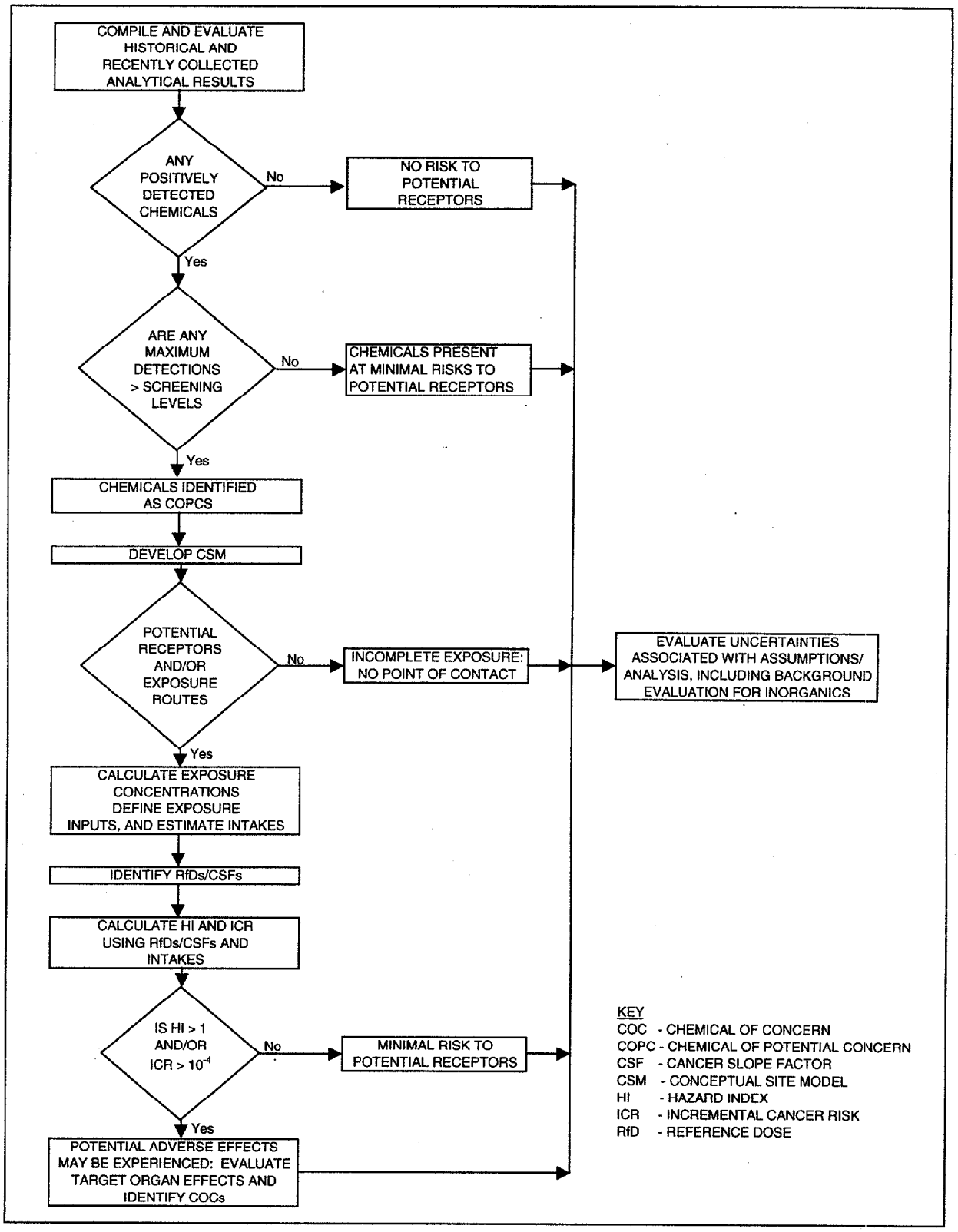


FIGURE 2-1

SUMMARY OF HUMAN HEALTH RISK ASSESSMENT PROCESS
WORK PLAN FOR MATTAWOMAN CREEK
IHDIV-NSWC, INDIAN HEAD, MARYLAND

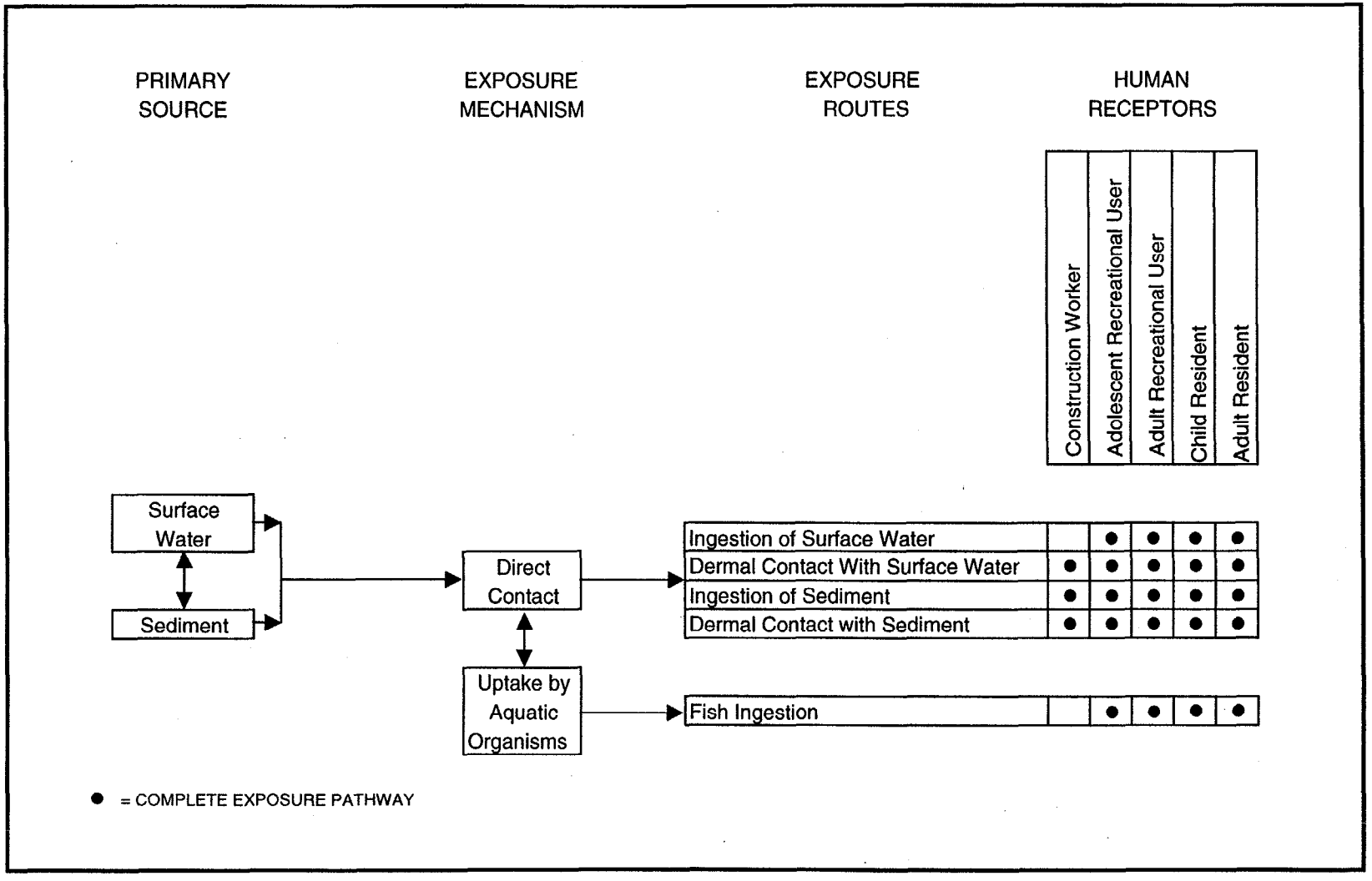


FIGURE 2-2

HUMAN HEALTH CONCEPTUAL SITE MODEL
WORK PLAN FOR MATTAWOMAN CREEK
IHDIV-NSWC, INDIAN HEAD, MARYLAND

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NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY MDB DATE 02/21/01
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

TETRA TECH NUS, INC.

FIGURE 2-3
MATTAWOMAN CREEK
SAMPLING AREAS
MATTAWOMAN CREEK STUDY
IHDIV-NSWC, INDIAN HEAD, MARYLAND

CONTRACT NO. | OWNER NO.
APPROVED BY | DATE
APPROVED BY | DATE
DRAWING NO. | REV. 0

FORM CADD NO. STV_BH12.DGN - REV 0 - 1/20/98

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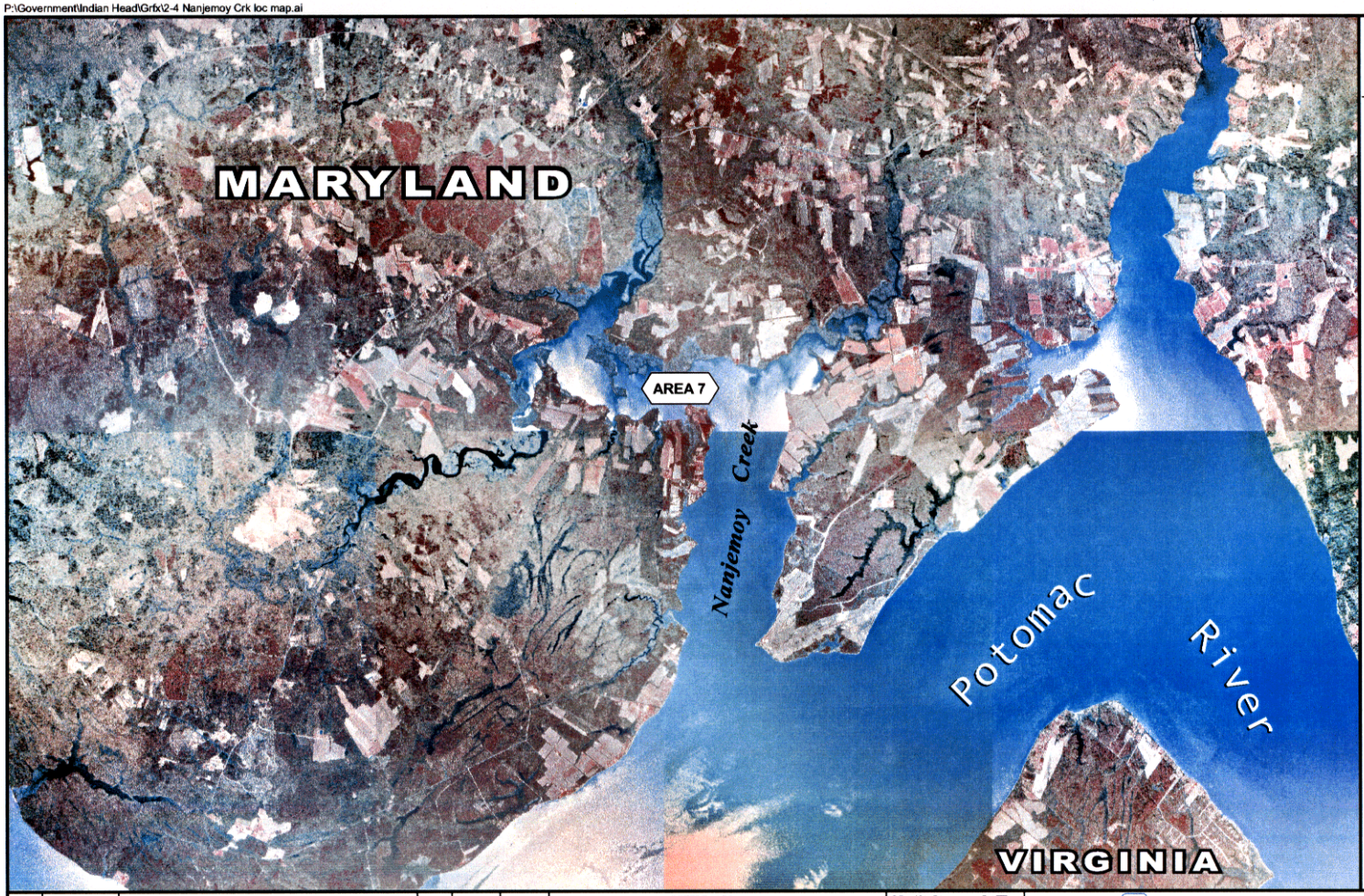

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY MDB DATE 02/21/01
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

TETRA TECH NUS, INC.

FIGURE 2-4
NANJEMOY CREEK
SAMPLING AREA
MATTAWOMAN CREEK STUDY
IHDIV-NSWC, INDIAN HEAD, MARYLAND

CONTRACT NO. | OWNER NO.
APPROVED BY | DATE
APPROVED BY | DATE
DRAWING NO. | REV. 0

FORM CADD NO. SDV_BH12.DGN - REV 0 - 1/20/98

3.0 DETAILED FIELD ACTIVITIES

The field activities for this study will consist of two field events. The objectives of the initial field event will be to perform rapid screening of the nature and extent of contamination in sediment chemistry. The chemistry data from the rapid screening will be used as the basis for determining the most appropriate locations of samples to be collected in the subsequent main field event, which will consist of surface water (fixed-base laboratory), sediment (fixed-base laboratory), biological, and toxicological samples. The activities for these two field events, as well as the relationship between the two events, is described below. The rationale for the need for data to be obtained from the field events was described in Section 2.0 and in Appendix A.

3.1 RAPID SEDIMENT SCREENING ASSESSMENT

The initial field event will be comprised of sediment sample collection for rapid assessment of the nature and extent of contamination in sediment or, "rapid field sediment screening." The purpose of this sampling is to obtain a better understanding of the nature and extent of sediment contamination in Mattawoman Creek with emphasis on the portion of Mattawoman Creek near the base, to best focus biological and toxicological samples that will be collected as part of the main field event. This is critical to this study due to the extensive size of the study area. That is, without adequate characterization of the existing chemical conditions, selection of the proper locations for the biological and toxicological samples could be difficult. The field screening methods developed the Navy's Space and Naval Warfare Systems Center (SPAWAR) will be employed. These methods allow for the collection and analysis of a high number of relatively inexpensive samples in a short period of time and, therefore, provide a rapid assessment of sediment chemistry over a large area. A Work Plan containing details of the SPAWAR Mattawoman Creek sampling and analysis was prepared by others. A brief description of SPAWAR's field and laboratory methods is provided below.

Samples will be collected using a propriety sediment sampling device developed by SPAWAR. The device will be lowered to the sediment surface and a grab sample of approximately 400 grams from the upper sediment stratum will be collected. It is anticipated that approximately 100 samples will be collected. Sampling will focus on the areas of greatest likely potential impacts described above, but will be collected primarily, though not exclusively, along the length of the Mattawoman Creek shoreline near the base. Samples will be collected also in the upgradient location and, if logistically possible, in Nanjemoy Creek. Within each area, sampling locations will be selected based on the criteria described earlier (e.g., sediment depositional areas, aquatic habitat), but the higher number of samples that can be collected with field screening than would be possible with collection of only fixed-base laboratory samples

will allow for sampling parallel to the shoreline and perpendicular from the shoreline (extending out into Mattawoman Creek).

Samples will be shipped to SPAWAR's laboratory in San Diego, CA, and will be analyzed for the COPCs and COPC classes identified in previous sampling in Mattawoman Creek. These will include metals, pesticides, SVOCs (mainly PAHs), and PCBs. No rapid screening analytical methods for are available for energetics. Data should be available from these rapid screening samples in approximately 48 hours. If possible, samples will be analyzed for grain size and TOC. Field sampling will consist also of water depth measurements and surface water physical parameters, including salinity, dissolved oxygen (DO), oxidation-reduction potential (ORP), pH, specific conductance, temperature, and turbidity. The locations of all samples collected will be recorded with a Global Positioning System® (GPS) device.

Concentrations of most metals in sediment samples will be determined using SPAWAR analytical methods. For most metals this consists of x-ray fluorescence (XRF) analysis. For PAHs, a total PAH value will be generated using ultraviolet fluorescence (UVF) analysis. Other organics (e.g., PCBs) will be analyzed using various SPAWAR immunoassay methods. A complete description of these methods and their detection limits will be included in the field screening assessment work plan for Mattawoman Creek. It is anticipated that detection limits will generally not be as low as those obtained in fixed-base laboratory analysis using CLP or NOAA Status and Trends methods. Nonetheless, the detection limits should be adequate to serve the purposes of the field screening. For the most part, no risk management decisions will be based solely on the results of the field chemistry screening data.

In addition to the sediment material used for rapid screening analysis, split samples will be sent to a fixed-base laboratory for confirmation analysis. It is anticipated that approximately 10 percent of the samples collected will be sent for confirmation. However, due to the uncertainties inherent in sediment chemistry in Mattawoman Creek near the base (i.e., no available data, no rapid screening methods for energetics), the percentage of confirmatory samples may be higher. Confirmation samples will be analyzed for full TAL/TCL analytes and energetics.

As stated above, one of the main objectives of the field screening analyses is to help determine the most appropriate locations for the samples to be collected in the main field event. The better understanding of the nature and extent of contamination affords the ability to select main field event sampling locations that focus on the areas of most impacts and allow for the collection of a range of concentrations for the major COPCs. The data will be reviewed as they become available and the nature and extent of contamination will be determined. The sampling locations for the main field event will then be determined.

It should be noted that surface water samples will not be collected as part of rapid field screening. This is mainly due to the general focus of the overall study on sediment impacts and the ephemeral nature of surface water chemical conditions, especially in a dynamic system such as Mattawoman Creek. However, surface water samples will be collected as part of the main field event as described below to attempt to correlate surface water chemical concentrations with sediment chemical concentrations. The other field activities that constitute the main field even are also discussed below.

3.2 SURFACE WATER SAMPLING

Samples will be collected for surface water chemistry analysis in Mattawoman Creek as part of the main field event. Four samples will be collected in each of five areas of Mattawoman Creek near the base that have been identified as most appropriate for sampling. The specific sample locations will be selected based predominantly on the field screening data described above. Spatial coverage of each area will also be considered as a criterion for sample locations. Six additional samples to fill in data gaps will be collected, as well as two more samples that may be collected if field conditions suggest additional data gaps. These samples may be collected in locations between the major areas of identified potential impacts, in areas of localized sediment deposition, and in areas of substantial aquatic habitat that are determined in the field. Two surface water samples will be collected upgradient of the base near the Highway 225 bridge to serve as reference samples. In addition, two samples will be collected in Nanjemoy Creek, which is located along the Potomac downgradient of Mattawoman Creek, to also serve as reference samples. The exact locations of these samples will also be dependent on the results of the rapid field screening. Surface water samples will be co-located with the sediment samples discussed below. Thus, a total of up to 32 surface water samples are proposed, plus Quality Assurance/Quality Control (QA/QC) samples. Preliminary surface water sampling locations for Mattawoman Creek and Nanjemoy Creek are presented on Figures 3-1 and 3-2, respectively. Selected analytes for surface water sampling are presented on Table 3-1. The analytes reflect the list of COPCs that was generated during the problem formulation.

3.3 SEDIMENT SAMPLING

Samples will be collected for sediment chemistry analysis in Mattawoman Creek as part of the main field event. Four samples will be collected in each of five areas that have been identified as most appropriate for the surface water sampling, as mentioned above. Six samples will be collected to fill in data gaps between the five areas of concern. Two additional samples may be collected if field conditions suggest that data gaps still exist. Two sediment samples will be collected upgradient of the base near the Highway 225 bridge to serve as reference samples. Mattawoman Creek sediment locations are presented on Figure 3-1. In addition, two sediment samples will be collected in Nanjemoy Creek to also serve as reference samples. Preliminary sediment sampling locations for Nanjemoy Creek are presented

on Figure 3-2. Selected analytes for sediment sampling are presented on Table 3-1. The analytes reflect the list of COPCs that was generated during the problem formulation. A total of up to 32 samples will be collected, plus QA/QC samples.

Sediment samples will also be collected for sediment toxicity testing. Four samples will be collected in each of five areas that have been identified as most appropriate for sampling. Two samples will be collected upgradient of the base near the Highway 225 bridge to serve as reference samples. These samples will be co-located with the sediment chemistry and sediment macroinvertebrate samples (i.e., the sediment "triad"). Preliminary Mattawoman Creek sediment triad sampling locations are presented on Figure 3-1. In addition, two sediment samples will be collected in Nanjemoy Creek to also serve as reference samples (Figure 3-2). Thus, a total of 24 investigative samples will be collected. Two duplicates in Mattawoman Creek near the base and one duplicate in each of the two selected reference areas will also be collected for QA/QC. This toxicological analysis will consist of 10-day mortality and growth testing using *Hyalella azteca* (ASTM, 1998). Laboratory analytical methods associated with these samples are summarized on Table 3-1.

Biological analysis will consist of benthic macroinvertebrate community analysis by a subcontracted laboratory. Samples will be co-located with sediment chemistry and toxicity testing samples (i.e., the sediment triad) for a total of 24 samples. The subcontracting laboratory will calculate specified diversity and abundance metrics and indices specified in the concurrent data interpretation document. Two duplicates in Mattawoman Creek near the base and one duplicate in the each of the two selected reference areas will also be collected for QA/QC. Locations of preliminary sediment triad sampling locations for Mattawoman Creek and Nanjemoy Creek are presented on Figures 3-1 and 3-2, respectively. Laboratory methods associated with analysis of these samples are summarized on Table 3-1.

3.4 FISH SAMPLING

Fish tissue samples will be collected as part of the main field event at each of the five identified investigative areas mentioned above. An upgradient location near the Highway 225 bridge will be sampled in one location, as will the reference sampling location located in Nanjemoy Creek. One whole-body composite sample and one fillet composite sample for catfish will be collected at each location (see below). One whole-body composite sample for mummichog will be collected in each area (see below). Thus, 14 whole-body and 7 fillet samples will be collected, for a total of 21 samples, plus QA/QC samples (Table 3-1). Figures 3-3 and 3-4 present the fish sampling locations in Mattawoman Creek and Nanjemoy Creek, respectively. Table 3-1 presents the analytes for fish tissue samples, which are based on the COPCs from the problem formulation, as well as a summary of the laboratory analytical methods for these samples.

The proposed target species are channel catfish (*Ictalurus punctatus*), for both the human health and ecological risk assessments, and mummichog (*Fundulus heteroclitus*) for the ecological risk assessment. The criteria used in selecting the target species were 1) edibility, 2) abundance in Mattawoman Creek, and 3) relatively non-migratory.

Channel catfish are bottom feeders. Therefore, they have a high exposure to contaminants in the sediment. They are edible, although they are less frequently eaten than some other catfish species. They are abundant in Mattawoman Creek, and are regularly caught by both sportfishermen and commercial fishermen. Their movement out of Mattawoman Creek is expected to be restricted because of the higher salinity in the Potomac River. Largemouth bass are present, but largemouth bass fishing is catch-and-release in Mattawoman Creek. Other fish species (e.g., bream) are caught by sportfishermen in Mattawoman Creek but are not generally not kept and eaten to any appreciable degree. Carp (*Cyprinus carpio*) are also regularly caught and eaten, but essentially occupy the same ecological niche as catfish. However, if insufficient numbers of channel catfish cannot be caught during sampling, carp or other species of catfish may be sought. In the unlikely event that catfish or carp prove troublesome to catch, various species of bream may be sought.

Mummichog were selected for the ecological risk assessment due to their versatility of uses in the risk assessment. To begin with, mummichog have a high site fidelity and would be expected to reflect chemical conditions in specific areas. Body burden data for mummichog can be used as input data to evaluate potential risks to wading birds or semi-aquatic mammals, who forage on mummichog and similarly-sized fish. Also, mummichog body burdens can be used to model concentrations of chemicals in other fish, such as bass and large bream. In generally, mummichog are relatively easy to collect. However, if mummichog proves to be difficult to catch, bream or bass may be sought.

It is anticipated that approximately three to five similarly sized catfish will be collected and composited for each of the composite samples at each station. Several mummichog will likely be caught at each sampling location and will composited with mummichog from other locations within a sampling area. The exact locations of the fish collected in each area will be dependent on risk assessment receptors' feeding habits (e.g., human, heron). Whole-body and fillet samples will be collected for the ERA and HHRA, respectively. For fillet compositing, the left fillet of each of the three to five fish will be combined for one sample. The remaining portion of the fish will be frozen for possible analysis at a later time. In addition, all the fish in the composite samples will be of good condition (i.e., no punctures; live or recently dead).

At some of the stations, it is possible that adequate numbers of fish for a composite sample will be collected in a single day. More likely, at least for catfish it may take a few days to collect three to five

similarly sized *edible* fish of the same species for a particular station. This may occur because the movement of fish is highly variable and may be affected by a variety of natural factors (i.e., weather, tidal cycle, and food supply). As such, traps such as gill nets may be set in the same location for 2 consecutive days and, although it is possible that no fish will be collected on day one, five channel catfish may be collected on day two. Therefore, different size fish of the same species from the same station may be sent to the laboratory for "temporary" storage until adequate numbers of similarly sized fish are collected for a sample. If adequate numbers of fish for a complete composite sample are collected in one day, then those fish will be packaged in the field by placing them into one plastic bag after they are individually wrapped in foil and given separate sample identification numbers.

The following data shall be recorded for each fish: species, date/time collected, length, weight, and external gross morphological abnormalities (i.e., tumors, skeletal anomalies).

3.5 AQUATIC VEGETATION SAMPLING

Hydrilla will be collected as part of the main field event from locations identified in the field near the base, preferably the same general areas as the fish samples. Samples will be collected at each of the five investigative areas mentioned above. One upgradient location near the Highway 225 bridge will be sampled, as well as one reference sampling location in Nanjemoy Creek. Composite samples will be collected. Each will consist of samples from several locations within a given sampling area (i.e., the four chemistry sampling locations per sampling area). Thus, seven samples will be collected, plus QA/QC samples. Vegetation sampling locations in Mattawoman Creek and in Nanjemoy Creek are presented on Figures 3-3 and 3-4, respectively. Table 3-1 presents the analytes for vegetation tissue as well as laboratory analytical methods. The analytes are based on the COPC list from the problem formulation.

Hydrilla was selected as representative of chemical accumulation and potential risks to aquatic vegetation. This species is common throughout Mattawoman Creek and is eaten by many types of herbivorous species, including waterfowl. Samples of leafy tissue will be collected. An initial goal of a minimum of 30 grams per sampling location will be established. The following data shall be recorded for each sample: species, date and time collected, length, and weight. If Hydrilla is not present at a sampling area, suitable surrogate species will be collected, such as wild celery.

3.6 QUALITY CONTROL SAMPLES

Field QC sample requirements for field duplicates, source water blanks, equipment rinsate blanks, trip blanks and matrix spike/matrix spike duplicates required for this project are described below:

Field Duplicates. Field duplicates are obtained during a single act of sampling and are used to assess the overall precision of the sampling and analysis program. Duplicate samples will be collected at a rate of 1 for every 10 environmental samples of the same matrix or one per matrix per sampling day, whichever is greater. All duplicate samples will be analyzed for the same parameters in the laboratory as their environmental sample counterparts. Duplicate samples will be preferentially collected where field evidence indicates that contamination is likely to be present in the environmental sample. This will minimize the chance of collecting duplicate samples with undetectable chemical concentrations that provide no precision information.

Equipment Rinsate Blanks. Equipment rinsate blanks will be obtained under representative field conditions by running analyte-free water through sample collection equipment after decontamination and placing it in the appropriate sample containers for analysis. Equipment rinsate blanks will be collected for non-dedicated equipment for all sampling activities. One equipment rinsate blank will be collected for each type of sampling equipment used per day, with a minimum of 1 in 10. Surface water samples will be collected directly from the surface water body, and only a new disposable spoon will be used to collect sediment samples. Equipment rinsate blanks will not be collected for fish and vegetation samples.

Source Water or Field Blanks. Source water blanks will be obtained by collecting a sample of water used for equipment decontamination. Source water blanks will be used to determine if water used to decontaminate sampling equipment is contributing to sample contamination. Source water blanks will be collected at a frequency of one per individual contiguous area of sampling. Source water blanks will be analyzed for the entire suite of parameters under investigation.

Trip Blanks. Trip blank samples are 40-mL glass vials that contain analyte-free water and are prepared by the analytical laboratory prior to the start of field activities. They should be stored in a sealed container until they are needed. During sampling activities, one trip blank, consisting of one vial, shall be placed in each cooler that contains environmental samples destined for VOC analysis. The trip blank shall be properly labeled, and added to the chain-of-custody form belonging to the cooler. Trip blanks are only analyzed for VOCs.

Matrix Spike/Matrix Spike Duplicates. The Matrix Spike and Matrix Spike Duplicates (MS/MSDs) are not field QC samples but are performed in the laboratory. However, additional sample must be collected in the field to provide a sufficient amount for the laboratory to perform the QC test. The usual amount of sample collected for MS/MSD analyses is three times that needed to perform analyses for the analytes of concern. Additional sample will be collected so that MS/MSD analyses can be performed on 1 in every 20 samples.

TABLE 3-1

SUMMARY OF ANALYSIS, METHODOLOGY, BOTTLE REQUIREMENTS, PRESERVATION REQUIREMENTS, AND HOLDING TIMES
WORK PLAN FOR MATTAWOMAN CREEK
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Analysis	Analytical Method	Number of Samples[1]	Number of Containers per Sample	Container Type	Sample Volume	Preservation Requirements	Holding Times
SEDIMENT MATRIX							
TCL VOCs (with ethyl ether)	CLP SOW OLM0 3.1	32	2	2 oz glass jars with teflon cap liners	4 oz	Cool to 4°C	14 days to analysis
TCL SVOCs	CLP SOW OLM0 3.1	32	1	8 oz glass jar with teflon cap liner.	8 oz	Cool to 4°C	7 days to extraction; analysis within 40 days after extraction
TCL Pest/PCBs	CLP SOW OLM0 3.1	32	1	8 oz glass jar with teflon cap liner.	8 oz	Cool to 4°C	7 days to extraction; analysis within 40 days after extraction
TAL Metals (Total) (with cyanide)	CLP SOW ILM0 4.0	32	1	8 oz wide mouth glass	8 oz	Cool to 4°C	6 months to analysis (Cyanide - 14 days; mercury – 26 days)
Explosives	SW-846 8330	32	1	8 oz wide mouth glass	8 oz	Cool to 4°C	7 days to extraction; analysis within 40 days after extraction
Nitroglycerin	SW-846 8332	32	1	8 oz wide mouth glass	8 oz	Cool to 4°C	7 days to extraction; analysis within 40 days after extraction
Nitrocellulose and Nitroguanidine	USATHAMA	32	1	8 oz wide mouth glass	8 oz	Cool to 4°C	7 days to extraction; analysis within 40 days after extraction
TOC	SW-846 9060	32	1	1-liter wide mouth plastic or Shelby Tube	1-liter	Cool to 4°C	28 days to analysis

TABLE 3-1

SUMMARY OF ANALYSIS, METHODOLOGY, BOTTLE REQUIREMENTS, PRESERVATION REQUIREMENTS, AND HOLDING TIMES
WORK PLAN FOR MATTAWOMAN CREEK
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Analysis	Analytical Method	Number of Samples[1]	Number of Containers per Sample	Container Type	Sample Volume	Preservation Requirements	Holding Times
AVS/SEM	EPA Draft Method	32	1	8 oz clear wide mouth glass jar	8 oz	Cool to 4°C	14 days to analysis
Benthic Macroinvertebrate Community Analysis	APHA, 1989 EPA, 1990	24	2	Double Ziplock and hazardous shipping container	NA (variable)	90% denatured alcohol	NA
10-day *Hyalella azteca* Toxicity Tests	ASTM	24	1	1-liter wide mouth high density polyethylene	1-liter	Cool to 4°C, protect from light	Toxicity testing to be started as soon as possible, but no more than two weeks, after collection.
Grain Size Distribution	ASTM 422	24	1	1-liter wide mouth plastic jar	1-liter	None	NA
SURFACE WATER MATRIX							
TCL VOCs (with ethyl ether)	CLP SOW OLC0 2.1	32	3	40-ml VOA vials (Borosilicate glass)	120-ml	Cool to 4°C HCL to ≤ 2	14 days to analysis
TCL SVOCs	CLP SOW OLC0 2.1	32	2	1-liter amber glass jar with Teflon-lined screw cap	2-liters	Cool to 4°C	7 days to extraction; analysis within 40 days after extraction
TCL Pest/PCBs	CLP SOW OLC0 2.1	32	2	1-liter amber glass jar with Teflon-lined screw cap	2-liters	Cool to 4°C	7 days to extraction; analysis within 40 days after extraction
TAL Metals (Total)	CLP SOW ILM0 4.0	32	1	1-liter high-density polyethylene	1-liter	HNO3 to pH ≤ 2	6 months to analysis (mercury – 26 days)
TAL Metals (Dissolved)	CLP SOW ILM0 4.0	32	1	1-liter high-density polyethylene	1-liter	HNO3 to pH ≤ 2	6 months to analysis

TABLE 3-1

SUMMARY OF ANALYSIS, METHODOLOGY, BOTTLE REQUIREMENTS, PRESERVATION REQUIREMENTS, AND HOLDING TIMES
WORK PLAN FOR MATTAWOMAN CREEK
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Analysis	Analytical Method	Number of Samples[1]	Number of Containers per Sample	Container Type	Sample Volume	Preservation Requirements	Holding Times
Cyanide	CLP SOW ILM0 4.0	32	1	1-liter High-density polyethylene	1-liter	NaOH to pH > 12 Cool to 4°C	14 days to analysis
Explosives	SW-846 8330	32	1	1-liter amber glass jar	1-liter	Cool to 4°C, if residual chlorine present, 0.008% $Na_2S_2O_3$	7 days to extraction; analysis within 40 days after extraction
Nitroglycerin	SW-846 8332	32	1	1-liter amber glass jar	1-liter	Cool to 4°C, if residual chlorine present, 0.008% $Na_2S_2O_3$	7 days to extraction; analysis within 40 days after extraction
Nitrocellulose and Nitroguanidine	USATHAMA	32	1	1-liter amber glass jar	1-liter	Cool to 4°C, if residual chlorine present, 0.008% $Na_2S_2O_3$	7 days to extraction; analysis within 40 days after extraction
Turbidity	EPA 108.1	32	1	250-ml high-density polyethylene	250-ml	Cool to 4°C Dark	48 hours to analysis
TDS	EPA 160.1	32	1	250-ml high-density polyethylene	250-ml	Cool to 4°C	7 days to analysis
TSS	EPA 160.2	32	1	250-ml high-density polyethylene	250-ml	Cool to 4°C	7 days to analysis
Nitrate/Nitrite	EPA 300.0	32	1	500-ml high-density polyethylene	250-ml	Cool to 4°C	48 hours to analysis
Chloride, Sulfiate, Fluoride	EPA 300.0	32	1	500-ml high-density polyethylene	250-ml	Cool to 4°C	28 days to analysis

TABLE 3-1

SUMMARY OF ANALYSIS, METHODOLOGY, BOTTLE REQUIREMENTS, PRESERVATION REQUIREMENTS, AND HOLDING TIMES
WORK PLAN FOR MATTAWOMAN CREEK
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Analysis	Analytical Method	Number of Samples[1]	Number of Containers per Sample	Container Type	Sample Volume	Preservation Requirements	Holding Times
Perchlorate	EPA 314	32	1	1-liter	1-liter	Cool to 4°C	28 days to analysis
TOC	EPA 415.1	32	1	0.5-liter high-density polyethylene	0.5-liter	HCL to pH $\leq$ 2 Cool to 4°C	28 days to analysis
Salinity	Field	32	NA	NA	NA	NA	NA
Dissolved Oxygen	Field	32	NA	NA	NA	NA	NA
pH	EPA 150.1	32	1	60-ml high-density polyethylene or glass	0.5-liter	Cool to 4°C	Analyze immediately
Hardness	EPA 130.2	32	1	250-ml high-density polyethylene	250-ml	Cool to 4°C	6 months to analysis
FISH (WHOLE BODY)							
TCL SVOCs	CLP SOW OLM04.2	14[2]	1	FOR ALL FISH: Each fish wrapped in aluminum foil and placed into a water-proof plastic bag.	100g total[3]	FOR ALL FISH: Cool to 4°C on wet ice (or freeze on dry ice)	FOR ALL FISH: 24 hours to initial processing (48 hours if frozen)
TCL Pest/PCBs	CLP SOW OLM04.2	14[2]	1				
Explosives	SW-846 8330	14[2]	1		50g total[3]		
Nitroglycerin	SW-846 8332	14[2]	1				
Nitrocellulose and Nitroguanidine	USATHAMA	14[2]	1				
TAL Metals (Total)	CLP SOW ILM04.0	14[2]	1		50g total[3]		
Cyanide	CLP SOW ILM04.0	14[2]	1				
Perchlorate	EPA 314	14[2]	1				

TABLE 3-1

SUMMARY OF ANALYSIS, METHODOLOGY, BOTTLE REQUIREMENTS, PRESERVATION REQUIREMENTS, AND HOLDING TIMES
WORK PLAN FOR MATTAWOMAN CREEK
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Analysis	Analytical Method	Number of Samples[1]	Number of Containers per Sample	Container Type	Sample Volume	Preservation Requirements	Holding Times
FISH (FILLETS)							
TCL SVOCs	CLP SOW OLM04.2	7[2]	1	FOR ALL FISH: Each fish wrapped in aluminum foil and placed into a water-proof plastic bag.	100g total[3]	FOR ALL FISH: Cool to 4°C on wet ice (or freeze on dry ice)	FOR ALL FISH: 24 hours to initial processing (48 hours if frozen)
TCL Pest/PCBs	CLP SOW OLM04.2	7[2]	1				
Explosives	SW-846 8330	7[2]	1		50g total[3]		
Nitroglycerin	SW-846 8332	7[2]	1				
Nitrocellulose and Nitroguanidine	USATHAMA	7[2]	1				
TAL Metals (Total)	CLP SOW ILM04.0	7[2]	1		50g total[3]		
Cyanide	CLP SOW ILM04.0	7[2]	1				
Perchlorate	EPA 314	7[2]	1				
AQUATIC VEGETATION							
TCL Pest/PCBs	CLP SOW OLM04.2	7	1	Double Ziplock Bag	>30 g	Cool over ice	7 days to analysis
TAL Metals (Total)	CLP SOW ILM04.0	7	1	Double Ziplock Bag	>30 g	Cool over ice	7 days to analysis

1 Number does not include QA/QC samples to be analyzed.
2 The actual quantity of fish required to make up each sample will be determined in the field.
3 Sample volume requirements to be verified following procurement of the analytical laboratory.

TABLE 3-1

SUMMARY OF ANALYSIS, METHODOLOGY, BOTTLE REQUIREMENTS, PRESERVATION REQUIREMENTS, AND HOLDING TIMES
WORK PLAN FOR MATTAWOMAN CREEK
IHDIV-NSWC, INDIAN HEAD, MARYLAND

AVS/SEM	Acid Volatile Sulfide/Simultaneously Extracted Metals
CLP SOW	Contract Laboratory Program Statement of Work
HCL	Hydrochloric Acid
HNO_3	Nitric Acid
MSA	Methods of soil analysis
NA	Not applicable
$Na_2S_2O_3$	Sodium Bisulfite
TAL	Target Analyte List
TCL	Target Compound List
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
TSS	Total Suspended Solids
USATHAMA	United States Army Toxic and Hazardous Material Agency
VOA	Volatile Organic Compound

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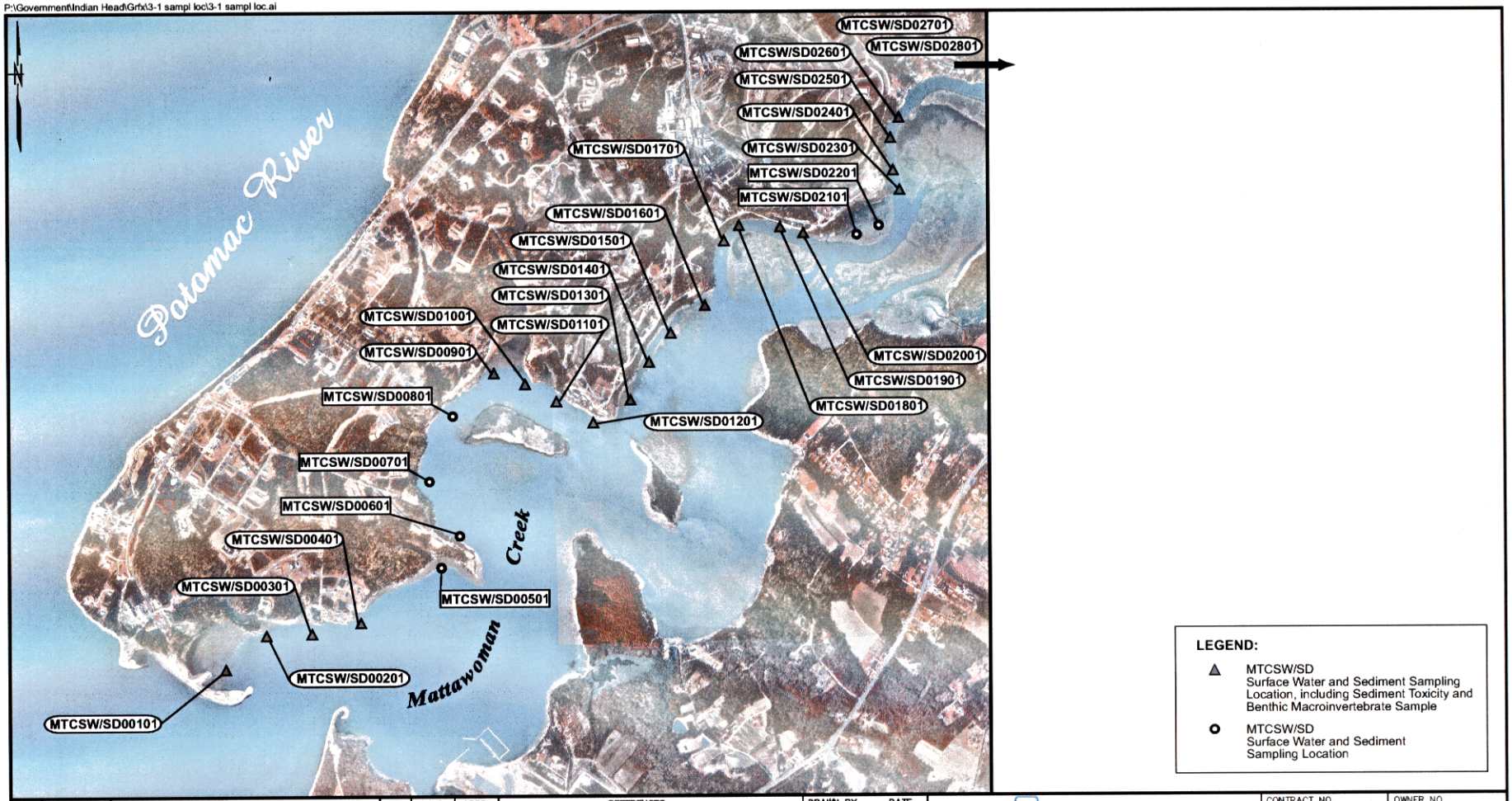

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

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COST/SCHED-AREA
SCALE AS NOTED

TETRA TECH NUS, INC.

FIGURE 3-1
PROPOSED SURFACE WATER, SEDIMENT, AND SEDIMENT TRIAD SAMPLING LOCATIONS
MATTAWOMAN CREEK STUDY
IHDIV-NSWC, INDIAN HEAD, MARYLAND

CONTRACT NO. | OWNER NO.
APPROVED BY | DATE
APPROVED BY | DATE
DRAWING NO. | REV. 0

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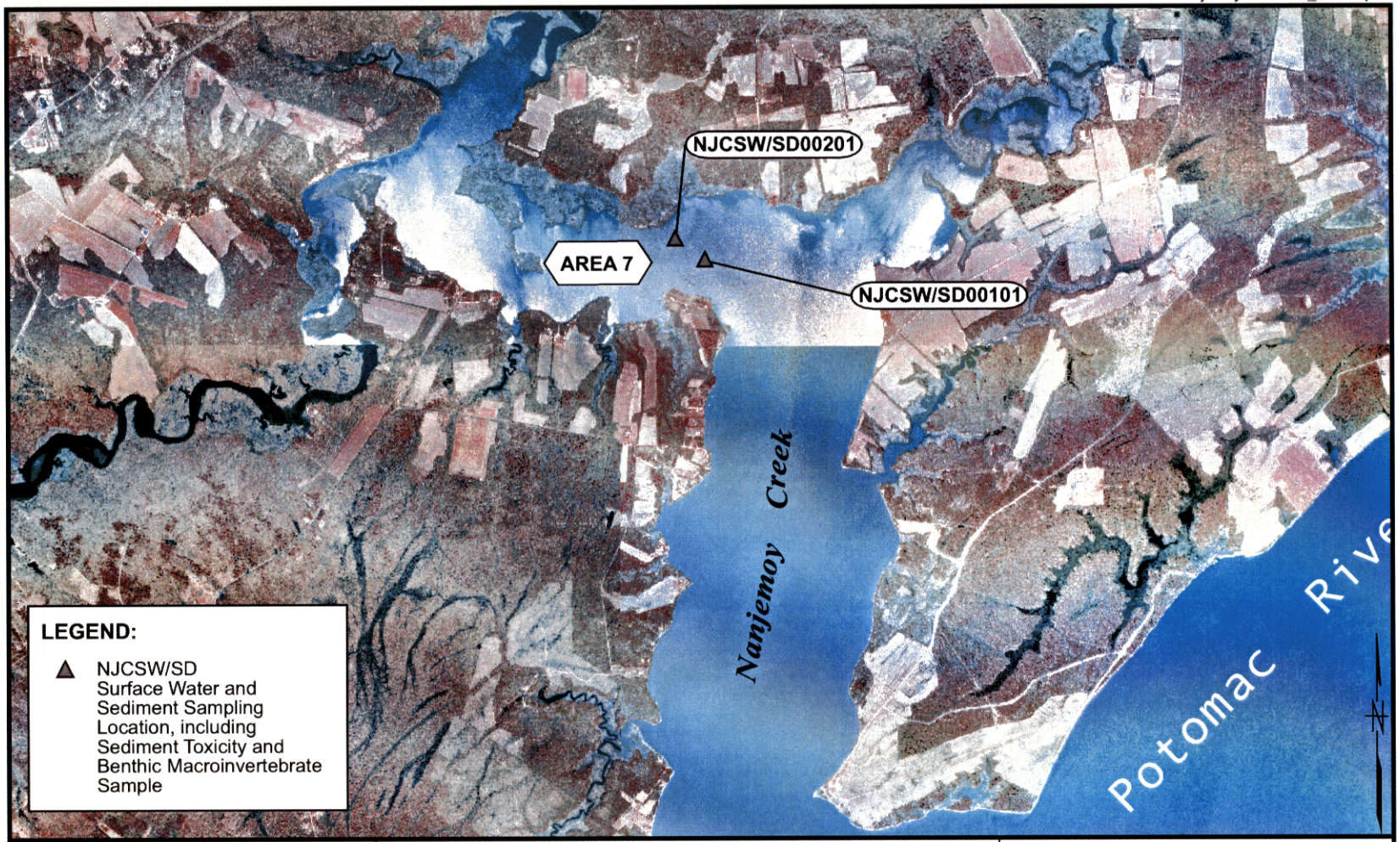

DRAWN BY MDB	DATE 02/21/01	FIGURE 3-2 NANJEMOY CREEK PROPOSED SURFACE WATER, SEDIMENT, SEDIMENT TOXICITY, AND BENTHIC MACROINVERTEBRATE SAMPLING LOCATIONS MATTAWOMAN CREEK STUDY IHDIV-NSWC, INDIAN HEAD, MARYLAND	CONTRACT NO.
CHECKED BY	DATE		APPROVED BY DATE
COST/SCHED–AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. REV. 0

FORM CADD NO. SDV_AH12.DWG - REV 0 - 1/20/98

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LEGEND:

X Fish Sampling Area (fillet and whole body)

▽ Aquatic Vegetation Sampling Area

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY MDB DATE 02/21/01
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

TETRA TECH NUS, INC.

FIGURE 3-3
PROPOSED FISH AND VEGETATION SAMPLING LOCATIONS
MATTAWOMAN CREEK STUDY
IHDIV-NSWC, INDIAN HEAD, MARYLAND

CONTRACT NO. | OWNER NO.
APPROVED BY | DATE
APPROVED BY | DATE
DRAWING NO. | REV. 0

FORM CADD NO. SDV_BH12.DGN - REV 0 - 1/20/98

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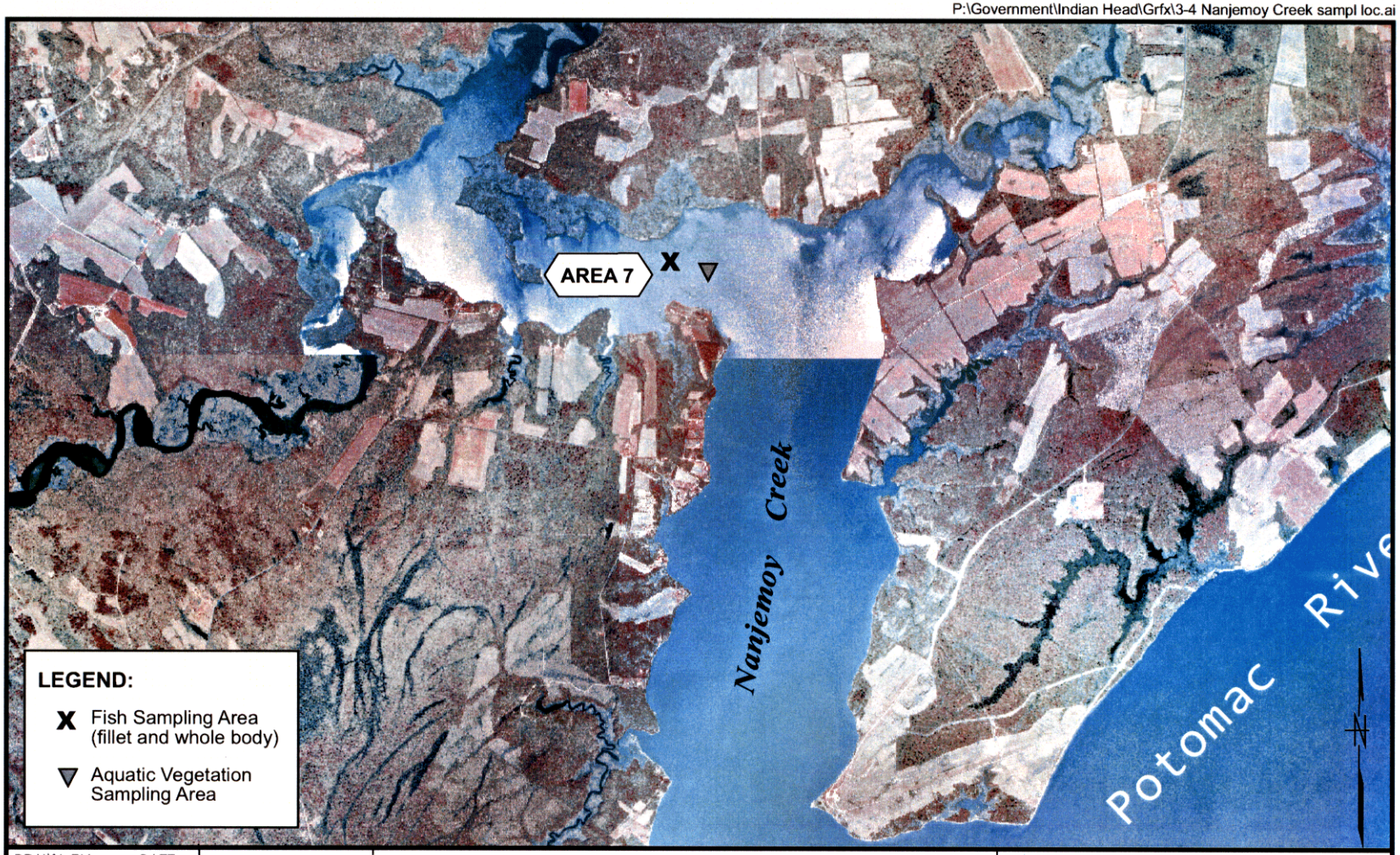

DRAWN BY MDB	DATE 02/21/01	FIGURE 3-4 NANJEMOY CREEK PREPOSED FISH AND VEGETATION SAMPLING LOCATIONS MATTAWOMAN CREEK STUDY IHDIV-NSWC, INDIAN HEAD, MARYLAND	CONTRACT NO.
CHECKED BY	DATE		APPROVED BY DATE
COST/SCHED–AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. REV. 0

FORM CADD NO. SDV_AH12.DWG - REV 0 - 1/20/98

4.0 FIELD OPERATIONS

4.1 MOBILIZATION/DEMOBILIZATION

Following approval of this WP, TtNUS will procure the required subcontractors and begin mobilization activities for both the field screening field event and main field event. Mobilization/demobilization includes

- Mobilizing all required subcontractors, equipment, and materials to the site
- Obtaining all necessary sampling permits, including a fish sampling permit. Conducting an approximately 1-hour site-specific health and safety review meeting
- Delineating work zones required by the Health and Safety Plan (HASP)
- Arranging an area to perform decontamination procedures
- Demobilizing all equipment and materials from the site; and
- Performing general site cleanup and removal of trash

All field team members will review the WP, the Site Emergency Procedures Plan, and the HASP. Mobilization includes attendance at a site-specific health and safety meeting during the initiation of on-site activities. This meeting will also include field team orientation in order to familiarize all personnel with the scope of field activities.

The field operations leader (FOL) will coordinate mobilization activities. These include responsibilities such as initiating and conducting equipment inventories to ensure that equipment is available; purchasing equipment as required; staging equipment for efficient loading and transport from the TtNUS Pittsburgh office to the site; and, after field activities are completed, demobilizing the equipment.

4.2 DECONTAMINATION

The non-disposable equipment involved in main field event sampling activities will be decontaminated prior to and upon completion of sampling activities. Personnel will also perform decontamination procedures as required by the HASP before departing from the site. Rapid field screening sampling decontamination procedures will be described in the rapid field screening work plan.

Non-disposable sampling equipment decontamination will be performed using analyte-free water and phosphate-free soap (e.g., Alconox®) will be used for incidental cleaning of equipment. Field analytical equipment such as water-quality meters and probes will be rinsed with analyte-free water first and then with the sample liquid, before sampling water.

The analyte-free water used for rinsing of field equipment will consist of Reagent Grade Type I water prepared using reverse osmosis, mixed bed deionization, activated carbon filtration, and final filtration to 0.2 micron.

4.2 INVESTIGATION-DERIVED WASTE (IDW) MANAGEMENT

4.3.1 Decontamination Fluids

All liquid IDW accumulated during the main field event activities will be collected, containerized, and stored in Department-of-Transportation approved (specification 17-C/H) 55-gallon drums at the site. The drums will be labeled as soon as possible after they are filled and will be kept onsite, pending the results of surface water and sediment analyses. Upon receipt of the analytical results, a determination will be made whether offsite disposal or treatment is required.

4.3.2 Personal Protective Equipment (PPE) and Miscellaneous Waste

The field team PPE will be disposed as required. These items, such as disposable latex gloves and paper towels, will be temporarily stored in plastic bags, with a daily transfer to dumpsters at the end of each workday.

4.4 SURVEYING

TtNUS personnel will survey sampled locations in the screening and main field field events using a portable Global Positioning System®. Horizontal locations will be referenced to the Maryland State Plane coordinate system. Because the planned sampling will be conducted from boats on Mattawoman Creek, the vertical position of sampling points will not be recorded.

5.0 ENVIRONMENTAL SAMPLING PROCEDURES

5.1 SAMPLING PROCEDURES

The sampling procedures for the rapid sediment chemistry screening were described briefly in Section 3.1. A detailed description of those sampling procedures will be provided in the rapid field chemistry screening work plan. A description of sampling procedures for the main field event for this study is provided below.

5.1.1 Surface Water Chemical Sampling

A total of 32 surface water samples will be collected from the locations described in Section 3.1 of this work plan and submitted to a fixed-based laboratory. All surface water sampling will meet the requirements of the project QAP and IHDIV-NSWC SOP SA-02.

At each sampling location, surface water samples will be collected before sediment samples are collected, just below the water surface. For VOCs, sample containers will be filled directly from the surface water body, using no transfer bottle. For all other parameters, the water will be sampled with any type of clean stainless-steel pitcher, jar, or an extra, unpreserved clean glass sample bottle supplied by the laboratory. Filtered and unfiltered surface water will be collected for metals analysis. For filtration of surface water samples, unpreserved polyethylene bottles will be used to transfer samples. Immediately after collection, samples will be sealed and placed in a cooler at 4°C.

A sampling location description form (Appendix D) will be completed for each sampling point, either during an initial survey or at the time of sample collection. However, field measurements will be taken at the time of sampling, including dissolved oxygen (DO), oxidation-reduction potential (ORP), pH, specific conductance, temperature, and turbidity. Suitable meters that have been calibrated will be used for pH and temperature, but DO will be measured with an instrument with a polarographic probe.

5.1.2 Sediment Chemistry Sampling

A total of 32 sediment samples will be collected from the locations described in Section 3.2 of this work plan and submitted to a fixed-based laboratory. All sediment sampling will meet the requirements of the project QAP and IHDIV-NSWC SOP SA-02.

After surface water samples have been collected, sediment will be sampled in the same location. Areas likely to have sediment accumulation (e.g. inside of bends, behind islands or boulders, quiet shallow

areas, or very deep, low-velocity areas) will be sampled and areas likely to show net erosion (i.e., high-velocity, turbulent areas) and suspension of fine solid materials, will be avoided.

Sediment samples will be restricted to the aerobic zone, up to a maximum depth of 6 inches (the anaerobic zone may be characterized by darker colors and sulfide odor.) Any sampler that can be decontaminated and that is able to collect samples at depths of 10 feet or greater is suitable for sampling. A hand auger with extensions and a ponar dredge are examples of such equipment. Samples for VOC analysis will be taken first and immediately sealed. Immediately after collection, all samples will be placed in a cooler at 4 °C.

5.1.3 Sediment Toxicity Testing Sampling

A total of 24 sediment samples will be collected for sediment toxicity testing from the locations described in Section 3.2 of this work plan and submitted to a fixed-based laboratory. Sediment samples will be restricted to the aerobic zone, up to a maximum depth of 6 inches (the anaerobic zone may be characterized by darker colors and sulfide odor.) Any sampler that can be decontaminated and that is able to collect samples at water column depths of 10 feet or greater is suitable for sampling. A hand auger with extensions and a ponar dredge are examples of such equipment. Immediately after collection, all samples will be placed in a cooler at 4 °C.

5.1.4 Sediment Macroinvertebrate Sampling

A total of 24 sediment samples will be collected for benthic macroinvertebrate community analysis from the locations described in Section 3.2 of this work plan and submitted to a fixed-based laboratory. Sediment samples will be restricted to the aerobic zone, up to a maximum depth of six inches (the anaerobic zone may be characterized by darker colors and sulfide odor.) Any sampler that can be decontaminated and that is able to collect samples at water column depths of 10 feet or greater is suitable for sampling. A hand auger with extensions and a ponar dredge are examples of such equipment. Immediately after collection, all samples will be placed in a cooler at 4 °C. Samples collected for benthic macroinvertebrate community analysis will be preserved with 90% denatured alcohol, which is a flammable preservative. All sediment macroinvertebrate sampling will be conducted in accordance with IHDIV-NSWC SOP SA-09.

5.1.5 Fish Tissue Sampling

Fish samples will be collected using electrofishing, gill nets, trap nets, trot lines, and/or hook-and-line methods. Only live or recently dead fish (i.e., no bloating, gills still red) will be collected and retained for chemical analysis. Upon collection, fish will be separated by species and immediately placed on wet ice

for processing to include size measurement and weight. Live, non-target fish will not be collected during this investigation and will be returned to the water. However, if extreme difficulties are encountered collecting target species, similar, surrogate species will be sought. Disabled or expired fish will be disposed in accordance with provisions in the scientific collecting permit issued for this work.

Electrofishing involves running an electrical current through the water to stun fish within the impacted radius using a boat-mounted or backpack electrofishing unit. This investigation is expected to only use a boat-mounted unit. The stunned fish will be captured with dip nets and sorted appropriately. Electrofishing is not suitable for waters with low conductivity (the water cannot conduct a current) or waters with high conductivity (the current flows around the fish and does not stun them). There may be portions of Mattawoman Creek or Nanjemoy Creek that will be too conductive to electrofish effectively. Also, electrofishing may not be an effective way to collect the channel catfish because they usually reside in deeper waters that may be out of the range of the current.

Gill nets are made of monofilament resembling tennis nets. They are stretched across the water bodies to capture fish as they pass through the net by snagging them as they retreat. The nets are available in various lengths, heights, and mesh opening sizes. The mesh openings are sized for the type of fish to be collected. Because gill nets tend to kill the fish, the nets will be checked at least twice each day to obtain fish that are still usable for analysis.

Trap nets are cone-shaped nets with successively smaller hoops and openings from the front to the back. The nets are available in various lengths, diameters, and mesh opening sizes; however, they typically sample a smaller area than gill nets. The nets can be fitted with "wings" to help direct the fish into the nets. The fish are "funneled" into the back of the nets and have a difficult time swimming out of the nets because of the small opening after the last hoop and are thus trapped. These nets are useful in collecting various sizes of fish because they are less size restrictive than the gill nets. They are especially useful in collecting sunfish that are sometimes difficult to catch in gill nets. The other advantage of these nets is that they keep the fish alive and do not physically harm the fish as much as gill nets.

Finally, fish may be collected by hook-and-line (i.e., fishing pole) or trot lines. Trot lines are strings of hooks (usually at least 20) that are uniformly secured to a thick line. The hooks are baited and deployed on the bottom of the water body with at least one end secured to the shore. They are useful for collecting bottom feeders such as channel catfish. All fish tissue sampling will be conducted in accordance with IHDIV-NSWC SOP SA-09.

5.1.6 Aquatic Vegetation Sampling

A total of nine Hydrilla samples will be collected at locations discussed in Section 3.4 of this Work Plan. The samples will be collected using a decontaminated cutting instrument. Vegetation samples will be placed in new plastic bags, labeled, and placed upon wet ice once sampled.

5.1.7 Field Parameters

Field parameters will be collected for surface water and will consist of water temperature, salinity, dissolved oxygen (DO), pH, and conductivity measurements.

5.1.8 Equipment calibration

A Horiba U-22 water-quality meter/probe will be used in the field to collect field parameters. A YSI unit may be used for DO and turbidity measurement. Calibration will be documented on an equipment calibration log. During calibration, an appropriate maintenance check will be performed on each piece of equipment. If damaged or defective parts are identified during the maintenance check and it is determined that the damage could have an impact on the instrument's performance, the instrument will be removed from service until the defective parts are repaired or replaced.

5.1.9 Equipment Maintenance

Measuring equipment used in environmental monitoring or analysis and test equipment used for calibration and maintenance will be maintained by established procedures.

TtNUS maintains a large inventory of sampling and measuring equipment. If the warehouse cannot supply the equipment, a rental company will be contacted to acquire the equipment. If an instrument does not meet performance specifications during operation, the instrument will be tagged out of service until the instrument is demonstrated to be performing within specifications. In the event that failed equipment cannot be repaired, the supplier of the equipment will be notified and an overnight carrier will ship replacement equipment to the site in order to minimize downtime.

5.2 SAMPLE HANDLING

Sample handling includes the field-related considerations concerning field sample documentation, nomenclature, packaging, shipping, and custody.

5.2.1 Field Sample Documentation

Sample documentation consists of the completion of chain of custody (COC) forms and matrix-specific sample logsheets. A bound weatherproof site logbook will be maintained by the FOL. All information related to sampling or field activities will be recorded in the site logbook and/or logsheets. This information will include, but is not limited to, sample type, sampling time and date, weather conditions, method of sample collection, unusual events, field measurements, descriptions of any photographs taken, etc. Sample logsheets are sequentially numbered and placed in a sample logbook. Field documentation forms can be found in Appendix D.

All samples collected at IHDIV-NSWC will be properly labeled with a sample label affixed on the sample container. The following information will be printed on the labels and tags prior to field activities.

- Project number (CTO 803)
- Project Location (IHDIV-NSWC)
- Sample ID
- Preservative
- Analysis to be preformed
- Matrix type, and
- Laboratory name.

Date, time, and sampler's initials will be filled in when in the field. Extra blank labels will be brought to the site for additional environmental samples not anticipated prior to mobilization.

5.2.2 Sample Nomenclature

Each collected sample will be assigned a unique sample tracking number. The sample tracking number will consist of a 12-digit alpha-numeric code, in accordance with IHDIV-NSWC SOP CT-02. Any other pertinent information regarding sample identification will be recorded in the field logbooks and on the sample log sheet.

The alpha-numeric code to be used in the sample system is explained below:

Character Type:

A	=	Alpha
N	=	Numeric
E	=	Either alpha or numeric

(AAA)	(AA)	(EEE)	(NN)	(NN)
[Site]	[Sample Type]	[Location]	[Individual or Depth]	[Round]

No dashes are to be used in the sample number.

Site:

MTC	=	Mattawoman Creek
NJC	=	Nanjemoy Creek

Sample Type:

SW	=	Surface Water
SD	=	Sediment
VG	=	Vegetation sample
LB	=	Largemouth Bass
CT	=	Catfish
BG	=	Bluegill
FS	=	Other species of fish

The sample-type may also be used for QA/QC designation:

TB	=	Trip blank
FB	=	Field blank
RB	=	Rinsate blank

The second rinsate blank collected during the first sampling round would be labeled as below:

MTCRB0020001

Duplicate samples will be reported blind to the laboratory. The three-digit sample location identifier field will be assigned with the designation "DUP." The time designated on the sample label and COC will be 0000 hours. The location at which the duplicate is collected will be noted on the sample log sheet and in the field notebook.

The third surface water duplicate sample collected during the first round of sampling would be labeled as below:

MTCSWDUP0301

Sample location :

EEE = Assigned sample number for each sample location of a particular medium; QA/QC samples will be numbered sequentially in the order of collection, beginning with 001.

Individual or Depth:

NN = For fish samples, individual fish from the same species and location are assigned a sequential number from 01 through 99. This number allows identification of the individual fish used to make up a composite sample.

For non-fish samples where a depth indication is necessary, samples are numbered sequentially in the order the samples are collected from a single location, each number representing a unique sampling depth.

Sampling round:

NN = The sampling round is straightforward. It can range from 01 to 99.

Additional guidance is provided in the IHDIV-NSWC SOP CT-02.

As mentioned earlier, different size fish of the same species from the same station may be sent to the laboratory for "temporary" storage until adequate numbers of similar-sized fish are collected for a sample. If adequate numbers of fish for a complete composite sample are collected in one day, then those fish will be placed into one plastic bag after they are individually wrapped in foil and given a separate sample identification number.

5.2.3 Sample Packaging And Shipping

Surface Water/Sediment samples

Sampling handling and preservation requirements for surface water and sediment samples include the following:

- Table 3-1 of this WP establishes requirements for sample preservation. The laboratory provides sample containers that are certified clean for the analytical parameter for which the sample is to be

analyzed. All samples will be held, stored, and shipped at 4°C ± 2°C. This will be accomplished through refrigeration (used to hold samples prior to shipment) and/or ice.

- Package samples separately for shipment.

- The sampler is to maintain custody of the samples.

- Check that the sample container is properly identified on the label and tag, the lid securely fastened, and the container sealed in a ZipLoc bag.

- Place the sample container into a bubble-out shipping bag and seal the bag using the self-sealing, pressure-sensitive tape supplied with the bag.

- Inspect the insulated shipping cooler. Check for any cracks, holes, broken handles, etc. If the cooler has a drain plug, make certain it is sealed shut. If the cooler is questionable for shipping, the cooler must be discarded.

- Place the sample container into a shipping cooler in an upright position (all containers, except VOCs, will be upright for shipment). Continue filling the cooler with samples and packing material until the cooler is full and the movement of the sample containers is limited.

- Place a temperature blank in the cooler.

- Fill the voids in between the bubble-out shipping bags with ice and continue filling the cooler with ice to the top, using a minimum of 8 pounds of ice for a medium-size cooler.

- Complete a COC form. List on the COC each sample bottle contained in the cooler. Include the air bill number on the COC. Use a ballpoint pen and make sure that all the carbon forms are legible.

- Place the original (top) signed copy of the COC form inside a large ZipLoc bag. Tape the bag to the inside of the lid of the shipping cooler.

- Close the cooler and seal the cooler with approximately four wraps of strapping tape at each end of the cooler. Prior to wrapping the last wrap of strapping tape, apply a signed and dated custody seal to each side of the cooler (a total of four signed custody seals must be used per cooler). Cover the

custody seal with the last wrap of tape. This will provide a tamper-evident custody seal system for the sample shipment.

- The sediment samples that are collected for benthic macroinvertebrate community analysis are to be shipped with 90% denatured alcohol as a preservative. These samples will be shipped as hazardous (flammable) materials.

- Affix a shipping label to the top of the cooler containing all the shipping information. Overnight (e.g., FedEx Priority Overnight) courier services will be used for all sample shipments. Include the air bill number on the COC.

- All samples are to be shipped to the laboratory no more than 72 hours after completion of sampling. Under no circumstances will sample holding times be exceeded for hold times (See Table 3-1).

Fish samples

Sample handling and preservation requirements for fish samples will include the following:

- Package samples separately for shipment.

- Fish separated by species are to be placed in new plastic bags, labeled, and placed upon wet ice upon collection.

- Individual fish samples are then to be wrapped in aluminum foil, placed into plastic bags, identified by a unique tag, and either frozen for later shipment or packed in wet ice for immediate shipment. Frozen samples are to be packed in dry ice to preclude the possibility of thawing.

- Inspect the insulated shipping cooler. Check for any cracks, holes, broken handles, etc. If the cooler has a drain plug, make certain it is sealed shut. If the cooler is questionable for shipping, the cooler must be discarded.

- Fill the cooler with samples and packing material until the cooler is full and the movement of the sample containers is limited.

- Place a temperature blank in the cooler.

- Fill the voids in between the shipping bags with ice and continue filling the cooler with ice to the top, using wet ice or dry ice depending on the state of the fish.

- Complete a COC form. List on the COC each sample contained in the cooler. Include the air bill number on the COC. Use a ballpoint pen and make sure that all the carbon forms are legible.

- Place the original (top) signed copy of the COC form, inside a large ZipLoc bag. Tape the bag to the inside of the lid of the shipping cooler.

- Close the cooler and seal the cooler with approximately four wraps of strapping tape at each end of the cooler. Prior to wrapping the last wrap of strapping tape, apply a signed and dated custody seal to each side of the cooler (a total of four signed custody seals must be used per cooler). Cover the custody seal with the last wrap of tape. This will provide a tamper-evident custody seal system for the sample shipment.

- Affix a shipping label to the top of the cooler containing all of the shipping information. Overnight (e.g., FedEx Priority Overnight) courier services will be used for all sample shipments. Include the air bill number on the COC.

- Fresh, unfrozen samples shipped in wet ice are to be received by the analytical laboratory within 24 hours unless sampling is conducted on the weekend. In that case, the fish are to be frozen and shipped in dry ice.

Vegetation Samples

Sample handling and preservation requirements for vegetation samples will include the following:

Vegetation samples are to be placed in new plastic bags, labeled, and placed upon wet ice upon collection.

- Individual vegetation samples are to then be wrapped in aluminum foil, placed into plastic bags, identified by a unique tag, and either frozen for later shipment or packed in wet ice for immediate shipment. Frozen samples are to be packed in dry ice to preclude the possibility of thawing.

- Inspect the insulated shipping cooler. Check for any cracks, holes, broken handles, etc. If the cooler has a drain plug, make certain it is sealed shut. If the cooler is questionable for shipping, the cooler must be discarded.

- Fill the cooler with samples and packing material until the cooler is full and the movement of the sample containers is limited.

- Place a temperature blank in the cooler.

- Fill the voids in between the shipping bags with ice and continue filling the cooler with ice to the top, using wet ice or dry ice depending on the state of the sample.

- Complete a COC form. List on the COC each sample contained in the cooler. Include the air bill number on the COC. Use a ballpoint pen and make sure that all the carbon forms are legible.

- Place the original (top) signed copy of the COC form, inside a large ZipLoc bag. Tape the bag to the inside of the lid of the shipping cooler.

- Close the cooler and seal the cooler with approximately four wraps of strapping tape at each end of the cooler. Prior to wrapping the last wrap of strapping tape, apply a signed and dated custody seal to each side of the cooler (a total of four signed custody seals must be used per cooler). Cover the custody seal with the last wrap of tape. This will provide a tamper-evident custody seal system for the sample shipment.

- Affix a shipping label to the top of the cooler containing all of the shipping information. Overnight (e.g., FedEx Priority Overnight) courier services are to be used for all sample shipments. Include the air bill number on the COC.

- Fresh unfrozen samples shipped in wet ice are to be received by the analytical laboratory within 24 hours unless sampling is conducted on the weekend. In that case, the vegetation will be frozen and shipped in dry ice.

5.2.4 Sample Containers, Preservatives, and Holding Times

Table 3-1 provides details concerning sample containers, volume requirements, preservatives, allowable holding times, and analyses requested.

5.3 SAMPLE CUSTODY

The FOL will be responsible for completion of the following forms:

- Sample labels
- COC forms
- Appropriate labels applied to shipping coolers
- COC seals
- Shipping bills

All samples will be packaged and shipped in accordance with IHDIV-NSWC SOP SA-11.

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APPENDIX A

MATTAWOMAN CREEK ECOLOGICAL RISK ASSESSMENT
PROBLEM FORMULATION

FINAL PROBLEM FORMULATION
MATTAWOMAN CREEK ECOLOGICAL RISK ASSESSMENT
IHDIV-NSWC, INDIAN HEAD, MARYLAND

AUGUST 2001

EXECUTIVE SUMMARY

This problem formulation has been prepared by Tetra Tech NUS, Inc. (TtNUS) under the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract No. N62472-90-D-1298, Contract Task Order (CTO) 320. This Problem Formulation develops the scope, breadth, and content of the Mattawoman Creek ecological risk assessment (ERA), also known as the Mattawoman Creek Study for Indian Head Division, Naval Surface Warfare Center (IHDIV-NSWC), Indian Head, Maryland.

Historical ecological studies in Mattawoman Creek near IHDIV-NSWC concluded that ecological receptors could be at potential risk from base-related chemicals in Mattawoman Creek media. These studies also concluded that additional data were needed to more fully investigate the potential risks. Therefore, the Navy has initiated an ERA to further characterize impacts to Mattawoman Creek biota, with emphasis on the section of Mattawoman Creek near the base, where impacts are thought to be most likely. This document presents the baseline ERA problem formulation process. This constitutes Step 3B of the Navy [and United State Environmental Protection Agency (EPA)] eight-step ERA process.

Project biologists visited Mattawoman Creek in August 2000 to ascertain what receptors could potentially be at risk, what aquatic and semi-aquatic habitats were present and the locations of these habitats, and the nature of Mattawoman Creek hydrology near IHDIV-NSWC. The locations of potential chemical sources associated with IHDIV-NSWC were observed, as was the location of the wastewater treatment plant outfall immediately upstream of the eastern base boundary. Qualitatively, Mattawoman Creek was observed to have a diverse and abundant aquatic and semi-aquatic ecology, with an abundance of wildlife and aquatic vegetation.

Also, the historical and more recent studies were reviewed, along with available information regarding past and current waste management practices, to develop a list of proposed chemicals of potential concern (COPCs). Environmental fate and transport information was gathered for these chemicals, which included inorganics, semivolatiles [including polycyclic aromatic hydrocarbons (PAHs)], pesticides, polychlorinated biphenyls (PCBs), and energetics.

The available ecological information, physiographic information, and chemistry information was used to develop a site conceptual model. From this conceptual model, a list of project risk questions was generated. The most appropriate assessment endpoints were derived from the risk questions, and the most appropriate measurement endpoints were developed to address the assessment endpoints and ultimately answer the risk questions. The measurement endpoints selected for this ERA essentially dictate the types of field investigations and laboratory analyses that will be performed. For this ERA, they include the following: the sediment "triad" (chemistry, toxicity, and benthic community analysis), surface

water chemistry, chemical analysis of aquatic vegetation tissue, and chemical analysis of fish tissue. This information was used to generate a work plan for the study.

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ATTACHMENT

A FATE AND TRANSPORT INFORMATION FOR MATTAWOMAN CREEK COPCS

1.0 INTRODUCTION

This problem formulation has been prepared by Tetra Tech NUS, Inc. (TtNUS) under the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract No. N62472-90-D-1298, Contract Task Order (CTO) 320. This problem formulation develops the scope, breadth, and content of the Mattawoman Creek ecological risk assessment (ERA), also known as the Mattawoman Creek Study for Indian Head Division, Naval Surface Warfare Center (IHDIV-NSWC), Indian Head, Maryland.

This section presents a discussion of the project background, including an overview of historical ecological studies conducted in Mattawoman Creek. A discussion of the physical and ecological setting of Mattawoman Creek is also presented in this section. Section 2.0 presents the proposed project chemicals of potential (COPCs). Section 3.0 presents an overview of the environmental fate and transport of the COPCs. Section 4.0 presents the ecological site conceptual model. Section 5.0 presents the risk questions and assessment endpoints for the ERA, and Section 6.0 presents the measurement endpoints. Attachment A presents detailed environmental fate and transport information for all the COPCs.

1.1 PROJECT BACKGROUND

The United States Fish and Wildlife Service (USFWS) conducted a series of ecological studies in Mattawoman Creek in the late 1980s and early 1990s. The results of these studies indicated that some potential risks could be present from inorganic chemicals in Mattawoman Creek media. The results of the remedial investigation (RI) conducted for Site 39, Organics Plant, and Site 41, Scrap Yard indicated the presence of elevated concentrations of some metals and organic compounds in sediments of Mattawoman Creek adjacent to these sites (TtNUS, 1999). The RI included a screening-level and Step 3A – Refinement of COPCs ecological risk assessment (ERA) that concluded that potential risks were present for aquatic and semi-aquatic receptors in that portion of Mattawoman Creek. At that time, it was determined that all further investigations for Mattawoman Creek would be deferred until a broader ecological study of Mattawoman Creek could be conducted. This document represents the initial scoping for the Mattawoman Creek Study and presents the methodologies to be used in the conduct of the study.

Two potential conceptual approaches were proposed to define the scope of the Mattawoman Creek ERA. The first approach was to follow a broad chemical screening approach to the ERA. The second potential approach was a more expeditious (baseline ERA) approach to the ERA, in which chemical, biological, and toxicological data are collected. Both of these approaches were detailed in an approach document for the Mattawoman Creek Study (TtNUS, 2000). The Indian Head Installation Restoration Team (IHIRT) and EPA Region III Biological Technical Assistance Group (BTAG) discussed the advantages and

disadvantages of each approach at an August 31, 2000 meeting. During the meeting, it was agreed to undertake the baseline ERA approach. This was considered to be the scientific-management decision point (SMDP) for this step in the ERA process (EPA, 1997).

The first step in the baseline ERA process was to construct the project problem formulation. This document outlines the problem formulation for the Mattawoman Creek baseline ERA and follows national EPA (1997) guidance. As a result of discussions with Region 3 BTAG personnel, elements of the study design/data quality objective step (Step 4 in the eight-step ERA process) have also been incorporated into this document. This final version of the Mattawoman Creek problem formulation incorporates comments by Region 3 BTAG on the draft problem formulation from a December 8, 2000 IHIRT ecological sub-group conference call, as well as comments from IHIRT members.

1.2 ECOLOGICAL SETTING

The initial stages of the baseline ERA (EPA, 1997) require a description of the habitats present, receptors present, and ecosystems at risk, which are described in the following sections. A thorough understanding of the habitats and receptors that are present allows for selection of appropriate risk questions, assessment endpoints, and measurement endpoints.

1.2.1 Physical Attributes

Mattawoman Creek drains a 79-square-mile area in northern Charles County and southern Prince George's County, Maryland. The creek originates southwest of Brandywine and flows for 30 miles where it empties into the Potomac River at river mile 71. The average annual discharge rate of Mattawoman Creek to the Potomac River is 54.2 cubic feet per second, which is a small proportion (less than 0.4 percent) of the total Potomac River freshwater flow (Lippson et al., 1979). The first 25 miles of the creek are free flowing, and the last 5 miles are a tidal embayment. Tidal amplitude in the lower Mattawoman Creek averages about 0.5 meter but fluctuates considerably depending on weather, season, and moon phase (Lippson et al., 1979). The lower portion of the creek is classified as a tidal freshwater stream throughout most of the year. During low freshwater flow periods, usually late summer and early fall, salinity near the mouth of the creek can reach 3 to 4 parts per thousand. When salinity is present, stratification can occur, mainly near the mouth of the creek.

The main portion of NSWC Indian Head is located along the northern shoreline of Mattawoman Creek, from its confluence with the Potomac River upgradient for approximately 3 miles (Figure 1-1). Stump Neck Annex of NSWC Indian Head is located along the southern shoreline, from the Potomac River confluence approximately 1 mile upgradient. The basin is mostly rural but includes a rapidly developing suburban area in northern Charles County, the town of Indian Head, and IHDIV-NSWC. Concerns about

increased development in the upper Mattawoman Creek basin have led to ongoing studies by the Smithsonian Environmental Research Center and Charles County/Corps of Engineers that are focus on the development of a watershed management plan (Jordon et al., 2000). The Indian Head Waste Water Treatment Plant (WWTP) discharges to a small creek known as Harrison Cut, which empties into Mattawoman Creek approximately 1,000 feet upgradient of the base boundary.

The width of Mattawoman Creek becomes broader as it approaches IHDIV-NSWC. A defined creek channel is present in the stretch of the creek near the eastern base boundary. Depths ranging from approximately 9 feet to 17 feet were measured in this area by project biologists during an August, 2000 site visit. This clearly defined channel continues past the Scrap Yard area, then becomes more diffuse. The entire creek becomes shallower near Thoroughfare Island and Marsh Island. Depths in these areas ranged from 2 to 6 feet in August 2000. A large flat is present in the area south of Thoroughfare Island. From Bullit's Neck to the mouth of the Potomac, Mattawoman Creek becomes broad and open, with depths ranging from 3 to 8 feet. Highly variable depths down to 14 feet were present in this broad area in August, 2000. A diffuse channel is present in the middle of this final stretch of lower Mattawoman Creek.

1.2.2 Aquatic and Semi-Aquatic Biota

At least 33 species of fish inhabit Mattawoman Creek or adjacent area, including several anadromous and semi-anadromous species such as the blueback herring (*Alosa aestivalis*), alewife (*A. pseudoharengus*), white perch (*Morone americana*), gizzard shad (*Dorsoma cepedianum*), and striped bass (*Morone saxatilis*). Marine species that use Mattawoman Creek as a nursery include the Atlantic menhaden (*Brevoortia tyrannus*), spot (*Leiosomus xanthrus*), and winter flounder (*Pseudopleuronectes americanus*). The catadromous American eel (*Anguilla rostrata*) spawns at sea and the young migrate to Mattawoman Creek to mature. Several freshwater species of gamefish are common in Mattawoman Creek, including the largemouth bass (*Micropterus salmoides*), black crappie (*Pomoxis nigromaculatus*), yellow perch (*Perca flavescens*), and bluegill (*Lepomis macrochirus*), as well as several species of catfish (*Ictalurus* spp.).

The bald eagle (*Haliaetus leucocephalus*) and osprey (*Pandion haliaetus*) are present along Mattawoman Creek. Five bald eagle nests have been identified in the general Mattawoman Creek area. Other piscivorous birds present at the creek include the great blue heron (*Ardea herodias*), green heron (*Butorides virescens*), Forster's tern (*Sterna forsteri*), and belted kingfisher (*Ceryle alcyon*). Abundant waterfowl use Mattawoman Creek, including the mallard (*Anas platyrhynchos*), American black duck (*Anas rubripes*), and wood duck (*Aix sponsa*). The base natural resources department is currently conducting a survey of wintering waterfowl present in Mattawoman Creek. An abundance of turtles and aquatic snakes are regularly observed, including during an August 2000 site visit by project biologists. The base has completed a survey of herptiles in Mattawoman Creek.

1.2.3 Aquatic Vegetation

Extensive aquatic vegetation is found throughout Mattawoman Creek. In the middle and upper reaches of the creek, some wooded swamps are present. In middle and lower Mattawoman Creek, extensive beds of the macrophyte spatterdock (*Nuphar luteum*) are present. The emergent pickerel weed (*Pontederia cordata*) is common, including nearly all of Marsh Island. Some wild rice (*Zizania aquatica*) is also present and is generally present along the periphery of the spatterdock and pickerelweed beds. Emergent vegetation is less abundant from Bullit's Neck to the mouth of Mattawoman Creek. The creek also contains abundant submerged aquatic vegetation (SAV). The Virginia Institute of Marine Science (VIMS) has conducted mapping of the SAV in the Chesapeake Bay watershed, which is presented in Figure 1-2. SAV in Mattawoman Creek is dominated by hydrilla (*Hydrilla verticillata*), najas (*Najas minor*), and wild celery (*Vallisneria americana*). Some coontail (*Ceratophyllum demersum*) is present in the upper reaches of Mattawoman Creek near IHDIV-NSWC. Riparian vegetation is also present along the margins of the creek, including many of the species described above, as well as cattail (*Typha* spp.), common reed (*Phragmites australis*), maples (*Acer* spp.), tulip poplar (*Liriodendron tulipera*), and oaks (*Quercus* spp.). The riparian vegetation appears to be consistent along most of the banks of Mattawoman Creek associated with the installation; the dominant vegetation types generally remain consistent.

1.2.4 Listed Species

Several rare, threatened, and endangered species of flora and fauna could be found in Mattawoman Creek. These species are provided in Table 1-1.

TABLE 1-1

LISTED SPECIES PRESENT IN MATTAWOMAN CREEK
NSWC INDIAN HEAD, MARYLAND

Common Name	Scientific Name	Federal Status	State Status*
Flora			
Twining bartonia	*Bartonia paniculata*	No Status	No Status
Tickseed sunflower	*Bidens coronata*	No Status	No Status
Swamp beggar-ticks	*Bidens discoidea*	No Status	No Status
Pumpkin ash	*Fraxinus profunda*	No Status	No Status
Coolwort	*Pilea fontana*	No Status	No Status
Wafer-ash	*Ptelea trifoliata*	No Status	No Status
Pussy willow	*Salix discolor*	No Status	No Status
Fauna			
Bald eagle	*Haliaeetus leucocephalus*	Threatened	Threatened
Least bittern	*Ixobrychus exilis*	No Status	In need of conservation

* No Status indicates rarity in the state or within its ranges in the state.

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DRAWN BY MDB DATE 03/09/01			CONTRACT NO.
CHECKED BY DATE			APPROVED BY DATE
COST/SCHED-AREA			APPROVED BY DATE
SCALE			DRAWING NO. REV. 0

FIGURE 1-1
APPENDIX A
MATTAWOMAN CREEK HABITAT
IHDIV-NSWC, INDIAN HEAD, MARYLAND

FORM CADD NO. SDV_AV12.DWG - REV 0 - 1/20/98

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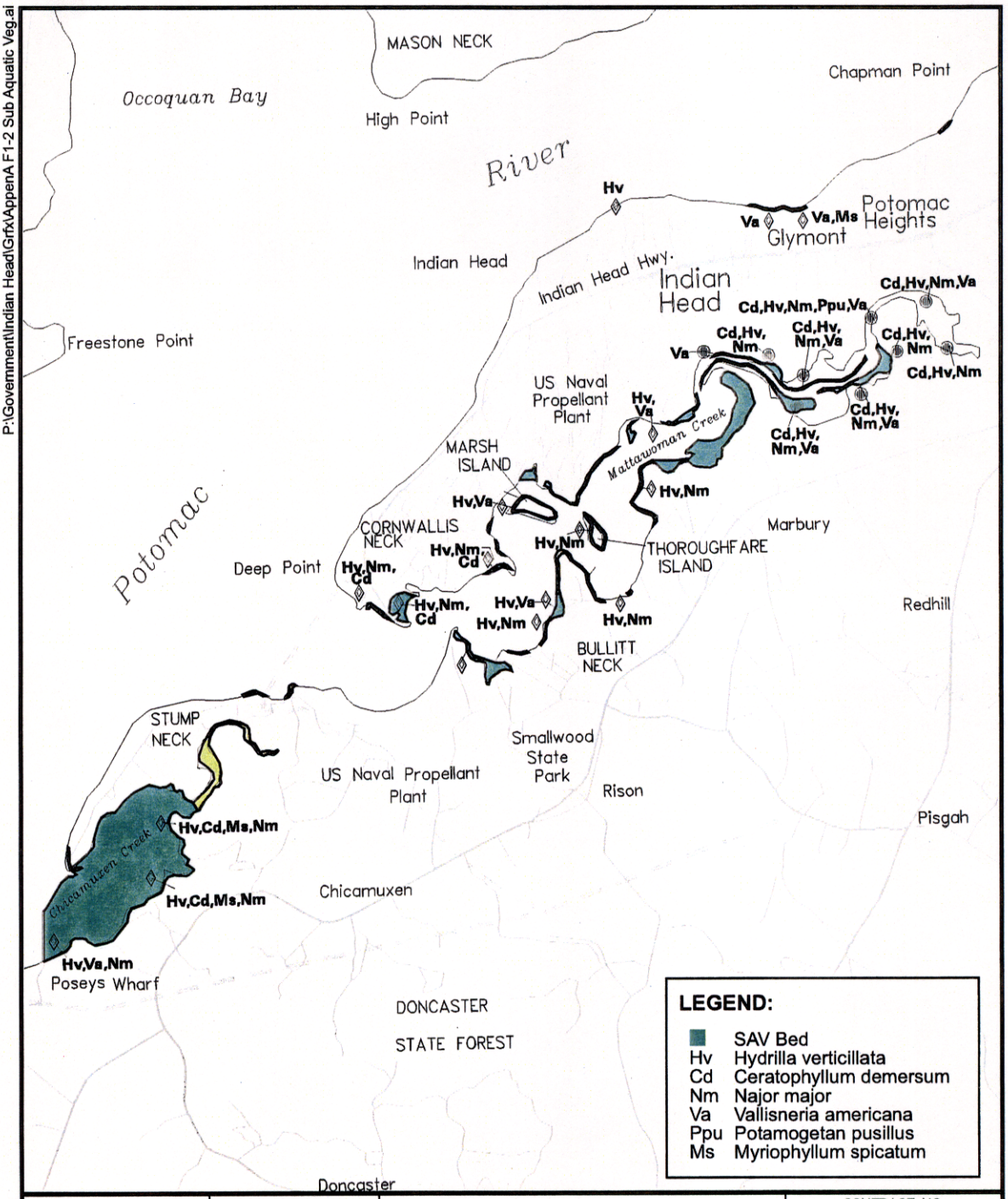

DRAWN BY MDB	DATE 03/09/01	FIGURE 1-2 APPENDIX A SUBMERGED AQUATIC VEGETATION MATTAWOMAN CREEK STUDY IHDIV-NSWC, INDIAN HEAD, MARYLAND	CONTRACT NO.
CHECKED BY	DATE		APPROVED BY DATE
COST/SCHED—AREA			APPROVED BY DATE
SCALE			DRAWING NO. REV. 0

FORM CADD NO. SDV_AV12.DWG - REV 0 - 1/20/98

2.0 CHEMICALS OF POTENTIAL CONCERN

Another critical, initial aspect of baseline ERA problem formulation is the identification of chemicals of potential concern (COPCs). When a definitive list of COPCs is constructed, the assessment and measurement endpoints can be tailored to specific chemicals or classes of chemicals, allowing for the proper focusing of the ERA. The COPC list for this ERA, presented later in this Section, was based on chemicals identified in historical USFWS studies, IRP data, and information regarding past and current waste management practices at IHDIV-NSWC. In addition, the recent toxicity identification evaluation (TIE) testing study that was performed at IHDIV-NSWC was reviewed to determine in any additional COPCs could be present.

The USFWS studies focused primarily on mercury but also identified additional selected metals as COPCs for some aspects of their study, including arsenic, cadmium, copper, cyanide, chromium, lead, silver, selenium, and zinc (USFWS, 1990). No organics were included as COPCs in the USFWS studies. All the metals emphasized in the USFWS studies were detected in Sites 39/41 media, with the exception of cyanide. A description of the USFWS studies is provided below.

In 1986, IHDIV-NSWC asked USFWS to perform a 5-year study of mercury accumulation in Mattawoman Creek fish. In response to this request, USFWS collected bluegill, largemouth bass, and channel catfish at two sampling stations in Mattawoman Creek for 5 years, beginning in 1986. One sampling site was located at Marsh Island and one was an upgradient location just downstream of the Highway 225 bridge over Mattawoman Creek. The conclusions from the sampling and analysis are summarized below by reporting year:

- 1987 – Total mercury concentrations in Mattawoman Creek fish in the vicinity of the IHDIV-NSWC were not significantly different than those at the upgradient reference station. All Marsh Island fish had mercury concentrations below 1 mg/kg, which USFWS cited as a "contaminated threshold."

- 1988 - Total mercury concentrations in Mattawoman Creek fish in the vicinity of the IHDIV-NSWC were not significantly different than those at the upgradient reference station. All Marsh Island fish had mercury concentrations below 1 mg/kg. However, channel catfish were not available from the Marsh Island site and, thus, all data analyzed at that station were largemouth bass and bluegill.

- 1989 - Total mercury concentrations in Mattawoman Creek fish in the vicinity of the IHDIV-NSWC were not significantly different than those at the upgradient reference station. All Marsh Island fish had mercury concentrations below 1 mg/kg.

- 1990 - Total mercury concentrations in Mattawoman Creek largemouth bass and bluegill in the vicinity of the IHDIV-NSWC were not significantly different than those at the upgradient reference station, and channel catfish concentrations were significantly higher than the upgradient station. All Marsh Island fish had mercury concentrations below 1 mg/kg.

- 1991 - An additional reference site in Nanjemoy Creek was added to the sampling scheme. Total mercury concentrations in Mattawoman Creek channel catfish and bluegill in the vicinity of the IHDIV-NSWC were not significantly different than those at the upgradient reference station, and largemouth bass concentrations were significantly higher than the upgradient station. All Marsh Island fish had mercury concentrations below 1 mg/kg, with the exception of one largemouth bass sample. Bluegills from the upgradient site had higher mercury concentrations than bluegills collected at the Marsh Island site and the Nanjemoy Creek reference site.

Based on the results of the 5-year study, primarily the levels found in Marsh Island largemouth bass in 1991 and the upgradient bluegills in 1991, USFWS concluded that further study into the effects of mercury on fish and wildlife in Mattawoman Creek may be warranted.

In addition to the 5-year study of mercury in Mattawoman Creek fish, USFWS conducted a study in 1989 to gauge the effectiveness of the IHDIV-NSWC National Pollution Discharge Elimination System (NPDES) permit. Analyses included measurement of metals residues in sediment and in several species of fish, clams, and aquatic vegetation. Bioassay tests using Mattawoman Creek surface water were conducted with larval fathead minnows, *Ceriodaphnia dubia*, and Microtox bacteria. Histopathological analysis of fish tissue was also conducted. Based on several factors, including bioaccumulation potential and suspected Mattawoman Creek contaminants, USFWS analyzed biota for cadmium, copper, mercury, selenium, and zinc. Sediment was also analyzed for chromium, silver, and arsenic. Analyses were conducted on samples collected near Marsh Island and upgradient of the IHDIV-NSWC near the Highway 225 bridge. The study concluded the following:

- Marsh Island sediment samples contained higher concentrations of arsenic, chromium, lead, selenium, silver, and zinc than upgradient samples.

- Metals analyzed for in fish, clams, and aquatic plants were not significantly different among sites, with the exception of elevated copper in aquatic plants near the Facility.

- Bioassay tests showed no significant toxic effects of short-term exposure to ambient water near the Facility.

- Fish histopathological results indicated that fish health may be negatively impacted near the Facility.

Based on these results, USFWS suggested that IHDIV-NSWC reduce inputs of copper, lead, arsenic, and possibly selenium in NPDES discharges.

Several COPCs were identified in Mattawoman Creek as part of the Step 3A process, Refinement of Chemicals of Concern. The initial data used for the Step 3A process were surface water and sediment data from the RI for Site 39, Organics Plant, and Site 41, Scrap Yard (TtNUS, 1999). The major COPCs for Sites 39 and 41 were as follows:

- Surface water - cadmium, chromium, copper, lead, mercury, silver, zinc, and Aroclor 1260.

- Sediment - mercury, nickel, silver, 1,1-dimethylhydrazine, nitrocellulose, and N-nitrosodiphenylamine.

- Aquatic foodchain - chromium, lead, mercury, silver, and zinc.

In addition to the RI work conducted for Sites 39 and 41, a toxicity identification evaluation (TIE) was conducted, in part, with sediments from these two sites (SAIC, 2001). The study was conducted as part of a demonstration project for the Navy that was designed to illustrate the applicability of TIE technology in resolving uncertainties associated with management of contaminated sediments. The TIE study was originally employed to help determine whether elevated bulk silver concentrations in Site 42 sediments were toxic. Site 42 is located along a swale that ultimately discharges to Mattawoman Creek. To help obtain a more broad range of sediment types and COPCs, samples were also collected from the Site 39/41 area in Mattawoman Creek, as well as one sample from an area upgradient of Sites 39/41 known as Slavin's Dock. The additional samples were collected also to address issues concerning spatial variability in chemical concentrations and potential toxicity.

The TIE consisted of a sequential series of toxicity tests using *Hyalella* and fathead minnow *(Pimephales promelas)* larvae, as well as bulk and pore water sediment chemical analyses. Each species was exposed to bulk sediment toxicity tests, untreated pore water sediment toxicity tests, and the series of treated pore waters to remove various chemicals and classes of chemicals. The sequential removal of specific chemicals allows for determination of potential causative agents associated with observed toxicity.

All bulk sediments exhibited significant toxicity to *Hyalella*. The extent of toxicity for both test organisms in pore water was generally less than that observed in bulk sediments. In general, the potential causative agent(s) of toxicity varied among samples. The following principal findings were noted:

- Toxicity at two sampling stations was likely due to particulates in the samples.

- PAHs, pesticides, and PCBs did not appear to be responsible for toxicity in TIE samples, with the possible exception of beta-BHC in one sample.

- Silver did not appear to elicit toxicity, with the possible exception of one sample, which had the highest detected bulk sediment concentration of silver.

- Divalent metals may be at least partially responsible for toxicity at three sampling locations, especially elevated zinc in one sample.

- Ammonia appeared to be at least partially responsible for toxicity in four samples.

- Toxicity at one sampling location was note removed in any of the TIE treatments, suggesting an unidentified confounding factor, such as water hardness, TOC/DOC, or exotics (explosives). However, explosives were detected quite infrequently in sediments from the study.

The presence or absence of the RI COPCs and chemicals detected as part of TIE analyses in sediments along other portions of Mattawoman Creek adjacent to the base is generally unknown. In addition, several outfalls associated with the installation are located along Mattawoman Creek. At present, these outfalls are under the NPDES permit. However, historical operations at the base have resulted in introduction of base-related chemicals to Mattawoman Creek from past waste management practices, documented spills, and other accidental discharges. Historical information describing the activities, waste management practices, and specific chemicals related to many of the outfalls on the base is scarce and complex. Furthermore, the hydrological conditions in Mattawoman Creek have changed over time, including movement of the main channel, sediment loading from on-base and off-base sources, and dynamic movement of sediment depositional areas. The creek is also subject to tidal influences. Therefore, difficulties arise when attempting to associate particular base-related chemicals that could be present in Mattawoman Creek media with certain segments of Mattawoman Creek near the base.

For these reasons, the tentative list of COPCs for the baseline ERA includes all chemicals detected in Mattawoman Creek media near Sites 39 and 41, COPCs from the USFWS studies, TIE study, selected chemicals from the current NPDES permit, and energetic compounds that may have been used or stored on the base. This list of chemicals, by chemical class, is presented on Table 2-1.

If further analysis suggests that additional chemicals may be potentially present in Mattawoman Creek media, they may be proposed for addition to the list of COPCs. If further analysis suggests that any of the proposed COPCs may be ecotoxicologically inert, they may be proposed for deletion from the list. This will likely be the case for selected energetics, many of which appear to have low ecotoxicities and low environmental persistence.

EPA (2000) has published a list of bioaccumulatable chemicals in the environment. If detected in sampled media, these chemicals will be included in any foodchain analysis in this ERA. Of the chemicals on the EPA list, the following have been detected in Mattawoman Creek media or are suspected to be present as sister/daughter products:

- Polycyclic aromatic hydrocarbons (PAHs) - acenaphthene, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, fluoranthene, phenanthrene, and pyrene.

- Total PCBs.

- Organochlorine pesticides - chlordane, DDT, DDD, DDE, dieldrin, and heptachlor.

- Metals - arsenic, cadmium, copper, lead, mercury, nickel, selenium, and zinc.

Silver was a foodchain COPC from the Sites 39/41 ERA, but it was not on the EPA list. However, it will be included in foodchain analyses due to elevated concentrations in the Sites 39/41 area. No energetics were on the EPA list and the literature doesn't indicate that energetics are prone to bioaccumulation. In general, the classes of chemicals presented in Table 2-1 contain similar modes of toxicity. That is, most individual PCBs cause deleterious effects via the same sub-cellular and molecular mechanisms. The same is true for organochlorine pesticides, PAHs, phthalates, energetics, and some divalent metals. These similarities among modes of action will play a role in selecting risk questions and endpoints.

TABLE 2-1

PROPOSED CHEMICALS OF POTENTIAL CONCERN
WORK PLAN FOR MATTAWOMAN CREEK
IHDIV-NSWC
INDIAN HEAD, MARYLAND

Compound/Class	Primary Reason for Inclusion[3]	Reactant and Degredation Products/Related Compounds Potentially Present
PAHs[1]	Detected in Site 39/41 surface water and/or sediment	
Other SVOCs		
1,2,4-Trichlorobenzene	Detected in Site 39/41 surface water and/or sediment	NA
N-Nitrosodiphenylamine	Detected in Site 39/41 surface water and/or sediment	NA
Phthalates	Detected in Site 39/41 surface water and/or sediment	
Energetics		
Nitrocellulose	Detected in Site 39/41 surface water and/or sediment	TBD
Nitroguanidine	Detected in Site 39/41 surface water and/or sediment	TBD
Nitrate Esters	NPDES analytes	TEGDN, PGDN, BTTN, TMETN, and NG
PETN	Common Energetic	TBD
HMX	Detected in Site 42 swale (empties into Mattawoman Creek)	TBD
RDX	Common Energetic	TBD
Nitrobenzene	Detected in Site 39/41 surface water and/or sediment	NA
Tetryl	Common Energetic	TBD
1,1-Dimethylhydrazine	Detected in Site 39/41 surface water and/or sediment	TBD
Trinitrotoluene/Dinitrotoluene (TNT/DNT)	Common Energetic	TBD
Organochlorine Pesticides[1]	Several detected in Site 39/41 surface water and/or sediment	Breakdown/Daughter Products
PCBs[1]	Aroclor 1260 Detected in Site 39/41 media	Other Aroclors
Divalent Metals	Detected in Site 39/41 surface water and/or sediment	Cadmium, copper[2], nickel, lead, silver[2], and zinc
Bioaccu./Biomag. Metals[1]		
Mercury[2]	Detected in Site 39/41 surface water and/or sediment/NPDES	NA
Arsenic[2]	Detected in Site 39/41 surface water and/or sediment	NA
Cadmium[2]	Detected in Site 39/41 surface water and/or sediment	NA
Lead	Detected in Site 39/41 surface water and/or sediment/NPDES	NA
Copper	Detected in Site 39/41 surface water and/or sediment/NPDES	NA
Nickel	Detected in Site 39/41 surface water and/or sediment/NPDES	NA
Selenium[2]	Detected in Site 39/41 surface water and/or sediment	NA
Silver	Detected in Site 39/41 surface water and/or sediment	NA
Zinc[2]	Detected in Site 39/41 surface water and/or sediment/NPDES	NA
Misc. Metals		
Aluminum	Detected in Site 39/41 surface water and/or sediment	NA
Antimony	Detected in Site 39/41 surface water and/or sediment	NA
Barium	Detected in Site 39/41 surface water and/or sediment	NA
Beryllium	Detected in Site 39/41 surface water and/or sediment	NA
Chromium (Tri- and Hex-)[2]	Detected in Site 39/41 surface water and/or sediment/NPDES	NA
Cobalt	Detected in Site 39/41 surface water and/or sediment	NA
Iron	Detected in Site 39/41 surface water and/or sediment/NPDES	NA
Manganese	Detected in Site 39/41 surface water and/or sediment	NA
Vanadium	Detected in Site 39/41 surface water and/or sediment	NA
Misc. Chemicals		
Ammonium Perchlorate	Concurrent Study	NA
TPH	Oil and Grease are NPDES analytes	NA
Cyanide[2]	NPDES analyte	NA

NA = Not Applicable.
1 From EPA (2000) bioaccumulatable chemicals.
2 Analyzed as part of USFWS studies.
3 Site 39/41 samples include both RI and TIE studies

3.0 FATE AND TRANSPORT OF COPCS

Baseline ERA problem formulation requires a discussion of the fate and transport of proposed COPCs. Knowledge of the fate and transport of COPCs enables the risk assessors to better determine the potential chemical species that could be present in creek media and better focus the site conceptual model. In particular, knowledge of the fate and transport of COPCs is necessary before the exposure routes for receptors of concern can be established (EPA, 1997). Furthermore, the list of COPCs can be modified as a result of fate and transport information about certain chemicals. For instance, a COPC from the Step 3A analysis may be eliminated from the list of COPCs if newly available fate and transport information indicates that it is readily broken down (i.e., non-persistent) in the environment. As mentioned earlier, the list of COPCs includes several chemical classes: inorganics, semivolatile organic compounds (SVOCs) (including PAHs), pesticides/PCBs, and energetics. Thus, a voluminous amount of fate and transport data was obtained for Mattawoman Creek COPCs. This information is presented in Attachment A.

4.0 CONCEPTUAL MODEL

The conceptual model is designed to diagrammatically identify potentially exposed receptor populations and applicable exposure pathways, based on the physical nature of the site and the potential chemical source areas. A complete exposure pathway has three components: a source of chemicals that can be released to the environment; a route of chemical transport through an environmental medium; and an exposure route or contact point for an ecological receptor. Incomplete exposure routes will be eliminated from consideration in this ERA.

Actual or potential exposures to chemicals for ecological receptors associated with Mattawoman Creek were determined by identifying the habitats/receptors present, the COPCs, and the most likely pathways of chemical release and transport. A site visit was conducted in August, 2000 by the project risk assessor, base natural resources manager, and representatives from Region 3 BTAG. Information critical to the construction of the conceptual model was obtained during the site visit. Proposed COPCs were presented in Table 2-1. The ecological conceptual model for the Mattawoman Creek Study is presented in Figure 4-1.

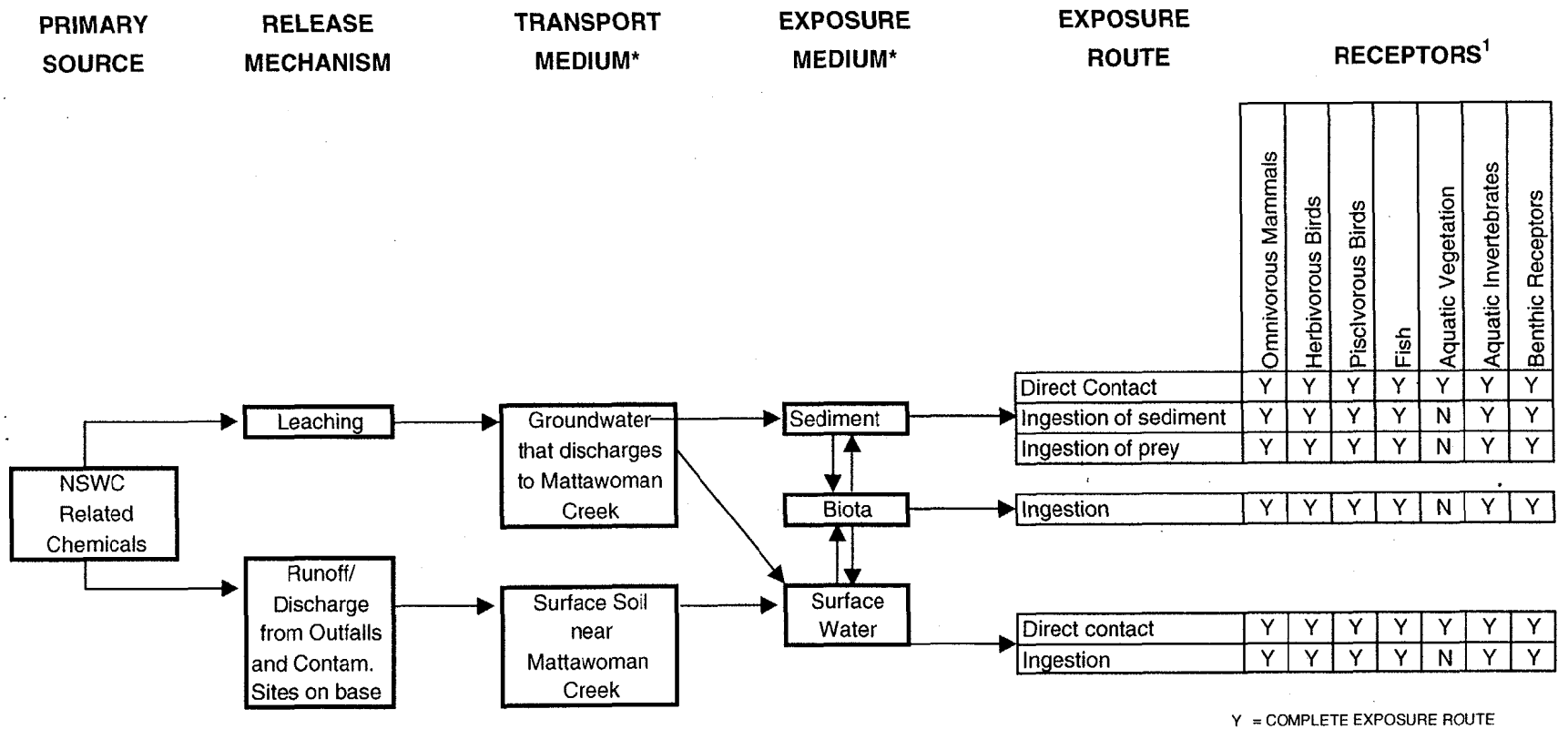

FIGURE 4-1
ECOLOGICAL SITE CONCEPTUAL SITE MODEL
MATTAWOMAN CREEK
IHDIV-NSWC
INDIAN HEAD, MARYLAND

5.0 RISK QUESTIONS AND ASSESSMENT ENDPOINTS

Information from the preceding sections, including information regarding the habitats/receptors present, the COPCs, and the fate and transport of COPCs, is ultimately used to describe the risk questions for the ERA (EPA, 1997). The risk questions are ultimately defined by the conceptual model, as presented in Section 4.0, and represent the "big picture" in terms of potential risks that need to be assessed. From these risk questions, outlined in Table 5-1, the most appropriate assessments can be selected. An assessment endpoint is defined as "an explicit expression of actual environmental values that are to be protected" (EPA, 1997). The assessment endpoints support the risk questions.

Consensus on the proper course of action regarding the risk questions and assessment endpoints will be documented in a SMDP. Table 5-1 also presents the proposed assessment and measurement endpoints for the Mattawoman Creek Study. Measurement endpoints for the ERA are discussed in detail in Section 6.0. The project Work Plan (WP) followed finalization of the problem formulation and will be accompanied by an SMDP following Step 4 (Study Design) of the 8-step process.

TABLE 5-1

RISK QUESTIONS AND ASSESSMENT ENDPOINTS
WORK PLAN FOR MATTAWOMAN CREEK
NSWC INDIAN HEAD, MARYLAND
PAGE 1 OF 2

Risk Question[1]	Assessment Endpoint(s)	Measurement Endpoint (Measure of Effects)	Rely on Existing Data?	Requires New Data based on DQO Specification?
Do base-related chemical concentrations in Mattawoman Creek present an unacceptable risk to benthic macroinvertebrates?	Survival and growth of healthy benthic macroinvertebrate populations.	1. *Hyalella azteca* 10-day survival and growth toxicity tests. 2. Community analysis metrics and indices (as an indicator of reproduction). 3. Comparison of sediment chemical concentrations to sediment screening guidelines (e.g., ER-Ls, ER-Ms).	No	Yes
Do base-related concentrations of bioaccumulatable chemicals in Mattawoman Creek present an unacceptable risk to piscivorous birds[2]?	Survival, growth, and reproduction of healthy piscivorous bird populations.	Model potential risks (doses) to the great blue heron using site-specific prey concentrations.	No	Yes
Do base-related concentrations of bioaccumulatable chemicals in Mattawoman Creek present an unacceptable risk to carnivorous mammals[2]?	Survival, growth, and reproduction of healthy carnivorous mammal populations.	Model potential risks (doses) to the raccon using site-specific prey concentrations.	No	Yes
Do base-related concentrations of bioaccumulatable chemicals in Mattawoman Creek present an unacceptable risk to herbivorous birds[2]?	Survival, growth, and reproduction of healthy herbivorous bird populations.	Model potential risks (doses) to the mallard using site-specific forage concentrations.	No	Yes
Do base-related concentrations of inorganics and pesticides/PCBs in Mattawoman Creek present an unacceptable risk to aquatic vegetation?[3]	Survival, growth, and reproduction of healthy emergent vegetation communities.	1. Compare tissue concentrations of hydrilla to upgradient/reference locations. 2. Compare tissue concentrations of vegetation screening levels.	No	Yes

Do base-related concentrations of chemicals in Mattawoman Creek present an unacceptable risk to aquatic invertebrates?	Survival, growth, and reproduction of aquatic invertebrates.	Compare Mattawoman Creek surface water chemical concentrations to screening guidelines (e.g., AWQCs)	No	Yes

TABLE 5-1

RISK QUESTIONS AND ASSESSMENT ENDPOINTS
WORK PLAN FOR MATTAWOMAN CREEK
NSWC INDIAN HEAD, MARYLAND
PAGE 2 OF 2

Risk Question	Assessment Endpoint(s)	Measurement Endpoint (Measure of Effects)	Rely on Existing Data?	Requires New Data based on DQO Specification?
Do base-related chemical concentrations in Mattawoman Creek present an unacceptable risk to fish (at different trophic levels)?	Survival, growth, and reproduction of fish communities.	1. Compare Mattawoman Creek surface water chemical concentrations to screening guidelines (e.g., AWQCs) 2. Compare body burdens of chemicals in fish tissue to upgradient/reference locations and tissue-effects levels.	No	Yes

[1] Reptiles/amphibians are acknowledged as receptors of concern but cannot be quantitatively evaluated due to the absence of acceptable benchmark values. Bioassays for risks to herptiles are available but not planned at this time.

[2] See Section 2.0 and Table 2-1 for list of detected sediment chemicals known to bioaccumulate.

[3] See Table 2-1 for list of detected inorganics, pesticides, and PCBs in Mattawoman Creek sediments.

6.0 MEASUREMENT ENDPOINTS

Measurement endpoints, also known as "measures of effects," represent "measurable ecological characteristics that are related to the valued characteristic chosen as the assessment endpoint" (EPA, 1997). Specifically, they provide analyses to investigate the assessment endpoints and ultimately answer the project risk questions. Under the eight-step ERA guidance, selection of baseline ERA measurement endpoints occurs in Step 4. The measurement endpoints outlined in Table 5-1 and their specific analyses are discussed in detail in this section. Justification is provided below when certain analyses that have been suggested by members of the IHIRT ecological sub-group were considered for inclusion in this ERA but are not planned at this time. It should be noted that concurrence on the measurement endpoints will be included in the problem formulation SMDP. Specific data interpretation methodologies for each of the measurement endpoints will be presented under separate cover. The data interpretation document will contain detailed data quality objectives (DQOs) for each of the measurement endpoints. Also, the data interpretation document will discuss data interpretation strategies for assessing larger scale risks. That is, the interpretation and relationships of the magnitude of potential risks in each sampling area of Mattawoman Creek vs. all of Mattawoman Creek that has been impacted by base activities. This will be critical to the ultimate conclusions of the ERA because most of the assessment endpoints would only be compromised if widespread, unacceptable risks were present.

6.1 AMPHIPOD (*HYALELLA AZTECA*) TOXICITY TESTING

Base-related chemicals have been detected in Mattawoman Creek sediments near the base. As indicated on the conceptual model, sediment-dwelling organisms, or benthic macroinvertebrates, serve in part as the base of the aquatic foodchain. As a result, benthic macroinvertebrates represent a portion of the Mattawoman Creek ecosystem potentially at risk. In addition, several chemicals are present or potentially present in Mattawoman Creek sediments for which no screening guidelines are available. This is primarily the case for energetics. To assess these risks, 10-day toxicity testing using the amphipod *Hyalella azteca* is proposed. This test organism is proposed for inclusion due to its widely accepted use and standard protocols, relative sensitivity to chemicals, and its tolerance of a range of salinity (from zero to several parts per thousand) and grain sizes. Ten-day testing is proposed due to potential complications with longer test duration (e.g., ammonia buildup) and strong anecdotal evidence from contract laboratories that any adverse effects that would be observed in longer tests are usually observed during the first 10 days.

Results will be used in concert with sediment chemistry and benthic macroinvertebrate community analysis in the decision-making process. These three analyses comprise the sediment "triad."

6.2 BENTHIC MACROINVERTEBRATE COMMUNITY ANALYSIS

Base-related chemicals have been detected in Mattawoman Creek sediments near the base. As indicated on the conceptual model, sediment-dwelling organisms, or benthic macroinvertebrates, serve in part as the base of the aquatic foodchain. As a result, benthic macroinvertebrates represent a portion of the Mattawoman Creek ecosystem potentially at risk. To assess these risks, benthic macroinvertebrate community analysis will be conducted.

Specific metrics and indices to be analyzed will be presented in the data interpretation document. Agreement regarding specific decisions on the interpretability of each metric or index will be sought in that document. In general, evidence of a healthy benthic macroinvertebrate community will be interpreted as successful reproduction of benthic species. Results will be used in concert with sediment chemistry and toxicity testing in the decision-making process.

Epibenthic analysis has been suggested as another means of investigating bioavailability of Mattawoman Creek sediment chemicals. These types of analyses were evaluated for their technical merit and relevance to this project, interpretability, and usefulness in the decision-making process. Although some of these analyses, such as collection of clams, were strongly considered for inclusion in this problem formulation, none are planned at this time. It should be noted that concentrations of cadmium, mercury, and zinc in clams collected in Mattawoman Creek by USFWS in the late 1980s did not appear to be elevated. If the bioavailability of sediment chemicals appears to be elevated from the results of the other, planned analyses, collection of epibenthic organisms may be considered.

6.3 SEDIMENT CHEMISTRY

Base-related chemicals have been detected in Mattawoman Creek sediments near the base. As indicated on the conceptual model, sediment-dwelling organisms, or benthic macroinvertebrates, serve in part as the base of the aquatic foodchain. As a result, benthic macroinvertebrates represent a portion of the Mattawoman Creek ecosystem potentially at risk. In addition, sediment chemicals could bioaccumulate in the aquatic and semi-aquatic foodchains. To assess these risks, sediment chemistry analysis will be conducted.

Agreement regarding specific analytes in sediment samples will be reached prior to field sampling. Agreement regarding specific screening levels will be reached prior to initiation of the risk assessment via the data interpretation document. Effects Range-Low (ER-Ls) and Effects Range-Medium (ER-Ms) will likely be proposed as primary guidelines.

Results will be used in concert with benthic community analysis and toxicity testing in the decision-making process.

6.4 GREAT BLUE HERON (*ARDEA HERODIAS*) FOODCHAIN MODELING

Base-related chemicals have been detected in Mattawoman Creek surface water, sediments, and fish near the base. As indicated on the conceptual model, fish-eating birds, or piscivorous birds, are an important and sensitive portion of the food web. As a result, piscivorous birds could potentially be at risk. To assess these risks, in part, foodchain modeling is proposed using the great blue heron as an indicator species for the piscivorous bird guild. This organism is proposed for inclusion due to its widely accepted use, availability of exposure parameters, and abundance in Mattawoman Creek. It is also representative of most species in its guild.

Exposure parameters (e.g., body weights) will be obtained primarily from EPA's Exposure Factors Handbook (1993) and Toxicity Reference Values (TRVs) will preferentially be obtained from Oak Ridge National Laboratory documents. However, several other oft-used sources will be consulted. Exposure parameters for the great blue heron, as well as TRVs, will be presented in the data interpretation document.

TRVs will preferentially be sought for reproductive endpoints, which is the most sensitive endpoint and should be indicative of survival and of growth, to a lesser extent. These input data will be agreed upon prior to initiation of the risk assessment as outlined in the data interpretation document. Initially, the most conservative and appropriate values will be used. Subsequent iterations will include less conservative input parameters, such as mean or median available body weights and area-use factors. The chemicals included in the foodchain modeling will be those incorporated into EPA's list of bioaccumulatable chemicals (please see proposed COPC text).

6.5 RACCOON (*PROCYON LOTOR*) FOODCHAIN MODELING

Base-related chemicals have been detected in Mattawoman Creek surface water, sediments, and fish near the base. As indicated on the conceptual model, carnivorous mammals are an important and sensitive portion of the food web. As a result, these receptors could potentially be at risk. To assess these risks, in part, foodchain modeling using the raccoon as an indicator species for the carnivorous mammal guild is proposed. This organism is proposed for inclusion due to its widely accepted use, availability of exposure parameters; and abundance in Mattawoman Creek. Although the raccoon is an omnivore, it is representative of the carnivorous mammal guild.

Exposure parameters (e.g., body weights) for the raccoon will be obtained primarily from EPA's Exposure Factors Handbook (1993) and Toxicity Reference Values (TRVs) will preferentially be obtained from Oak Ridge National Laboratory documents. However, several other oft-used sources will be consulted. Exposure parameters for the great blue heron, as well as TRVs, will be presented in the data interpretation document.

TRVs will preferentially be sought for reproductive endpoints, which is the most sensitive endpoint and should be indicative of survival and of growth, to a lesser extent. These input data will be agreed upon prior to initiation of the risk assessment as outlined in the data interpretation document. Initially, the most conservative and appropriate values will be used. Subsequent iterations will include less conservative input parameters, such as mean or median available body weights and area-use factors. The chemicals included in the foodchain modeling will be those incorporated into EPA's list of bioaccumulatable chemicals (please see proposed COPC text).

6.6 MALLARD (*ANAS PLATYRHYNCHOS*) FOODCHAIN MODELING

Base-related chemicals have been detected in Mattawoman Creek surface water, sediments, and plants near the base. As indicated on the conceptual model, herbivorous birds are an important and sensitive portion of the food web. As a result, these receptors could potentially not at risk. To assess these risks, in part, foodchain modeling using the mallard as an indicator species for the herbivorous bird guild is proposed. This organism is proposed for inclusion due to its widely accepted use, availability of exposure parameters, and abundance in Mattawoman Creek. It is representative of a wide range of species within its guild.

Exposure parameters (e.g., body weights) for the mallard will be obtained primarily from EPA's Exposure Factors Handbook (1993) and Toxicity Reference Values (TRVs) will preferentially be obtained from Oak Ridge National Laboratory documents. However, several other oft-used sources will be consulted. Exposure parameters for the great blue heron, as well as TRVs, will be presented in the data interpretation document.

TRVs will preferentially be sought for reproductive endpoints, which is the most sensitive endpoint and should be indicative of survival and of growth, to a lesser extent. These input data will be agreed upon prior to initiation of the risk assessment as outlined in the data interpretation document. Initially, the most conservative and appropriate values will be used. Subsequent iterations will include less conservative input parameters, such as mean or median available body weights and area-use factors. The chemicals included in the foodchain modeling will be those incorporated into EPA's list of bioaccumulatable chemicals (please see proposed COPC text).

In addition, bioassays to investigate risks to herbivorous birds were considered for this ERA but are not planned at this time. These analyses are discussed below.

More site-specific bioassays are available to investigate potential risks to herbivorous birds that inhabit Mattawoman Creek. These include collection of waterfowl for body burdens and collection of nesting waterfowl chicks for blood chemistry (e.g., blood-lead level). As for the former test, it was decided that body burdens in adult waterfowl would not necessarily provide evidence of any adverse effects. That is, the presence of chemical residues in waterfowl does not indicate a cause-and-effect relationship between those residues and adverse health effects on waterfowl. Effects at the population or community level for waterfowl would be made difficult by the transient and migratory nature of these receptors. Difficulties would also arise in determining the percentage of body burden that is due to base-related chemicals as opposed to other sources of chemicals, especially because most waterfowl are migratory. As for the latter test mentioned above, the same uncertainties and difficulties inherent in data interpretation apply. If the results of the planned analyses suggest potential risks to waterfowl and other herbivorous birds and further study for these receptors appears to be warranted, additional studies will be considered at that time.

6.7 ACCUMULATION OF INORGANICS IN HYDRILLA

Base-related chemicals have been detected in Mattawoman Creek surface water, sediments, and plants near the base. As indicated on the conceptual model, aquatic vegetation is an important component of the food web. As a result, these receptors could potentially at risk. To assess these risks, in part, hydrilla will be collected and analyzed for inorganics and pesticides/PCBs. Other organics will be selected as analytes of concern due to the tendency of some of these chemicals to accumulate in plant material. Although some organics can accumulate in aquatic vegetation, absorption and significant accumulation of these chemicals in plants are usually minor. Data from the vegetation will be used to calculate bioconcentration factors (BCFs). The base natural resources manager has indicated that wild rice and wild celery (two other species considered for use) are uncommon near the base and, thus, would not serve as a widespread foodsource.

These data will be used as forage data for the mallard. Parts of the plant species that are eaten by herbivorous birds will be preferentially collected.

Although mesocosm studies were suggested to investigate potential risks to the macrophyte community in Mattawoman Creek, they are not planned at this time. The decision was made to begin only with modeling of inorganic and pesticide/PCB uptake into plants and evaluations of tissue concentrations. As suggested by Region 3 BTAG, qualitative observations regarding the apparent health of the standing crop of emergent vegetation will be incorporated in the ERA.

6.8 SURFACE WATER CHEMISTRY

Base-related chemicals have been detected in Mattawoman Creek surface water near the base. As indicated on the conceptual model, aquatic organisms (in the water column) serve in part as the base of the aquatic foodchain. As a result, these organisms represent a portion of the Mattawoman Creek ecosystem potentially at risk. In addition, surface water chemicals could bioaccumulate in the aquatic and semi-aquatic foodchains. To assess these risks, in part, surface water analysis will be conducted.

Agreement regarding specific analytes in surface water samples will be reached prior to field sampling as outlined in the data interpretation document. Agreement regarding specific screening levels will also be sought via the data interpretation document. Ambient Water Quality Criteria (AWQCs) and state WQS are proposed as primary guidelines. Site-specific hardness will be used in samples determined to be freshwater to calculate site-specific guidelines for selected inorganics.

Bioassays such as zooplankton toxicity testing, mysid shrimp toxicity testing, and larval fish toxicity testing have been suggested but are not planned at this time. Although these types of tests could provide useful information, the decision was made to investigate water quality before these tests are considered. That is, sediments are anticipated to be the medium of interest from a standpoint of contamination. Thus, if surface water is generally uncontaminated, surface water bioassays could be conducted when they were not useful from a decision-making standpoint. Also, *Ceriodaphnia*, Microtox, and fathead minnow studies conducted using Mattawoman Creek media by USFWS indicated low toxicity associated with Marsh Island surface water. It should be noted that some of these tests are based on sediment resuspension. It is acknowledged that resuspension of sediment chemicals into the water column is possible. Surface water-based bioassays may be useful later in the ERA if impacts to surface water are observed and additional risk characterization appears to be necessary.

6.9 ACCUMULATION OF CHEMICALS IN FISH

Base-related chemicals have been detected in Mattawoman Creek surface water, sediments, and fish near the base. As indicated on the conceptual model, the fish community is an important component of the Mattawoman Creek food web. As a result, these receptors could potentially be at risk. To assess these risks, in part, fish will be collected and analyzed for COPCs. Whole-body samples are proposed for use in the ecological risk assessment. Data from the fish will be used to calculate BCFs.

Mummichog will be the primary species of fish collected. Channel catfish will be collected as part of the HHRA and will likely be analyzed for the ERA as well. These species were preferably collected as part of earlier USFWS studies. Tissue-effects levels for COPCs will be agreed upon prior to initiation of the risk

assessment, as outlined in the data interpretation document. Tentatively proposed values will be obtained from Jarvinen and Ankley (1999), Linkage of Effects to Tissue Residues: Development of a Comprehensive Database for Aquatic Organisms Exposed to Inorganic and Organic Chemicals.

Fish pathology was suggested as an additional analysis for the Mattawoman Creek ERA. This would likely involve fish necropsy and analysis of lesions and parasites. Although this could provide some insight into effects, difficulties would arise in ascribing chemical-related histological effects from base-related chemicals versus those present from natural stressors. These uncertainties were observed in the USFWS fish pathology studies conducted in Mattawoman Creek, although the USFWS observed higher incidences of lesions in Marsh Island fish versus reference site fish.

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ATTACHMENT A

FATE AND TRANSPORT INFORMATION FOR MATTAWOMAN CREEK COPCS

DIVALENT METALS

Numerous studies have demonstrated that the concentration of acid-volatile sulfides (AVS) present in sediments represents a major factor in influencing the pore water concentration and bioavailability of divalent metals (cadmium, copper, nickel, lead, and zinc; silver to a lesser extent) in sediments. Sediments with concentrations of AVS in excess of the concentration of those metals will have very low metal activity in the interstitial water (Ankley et al., 1996); AVS metals present in these sediments are unlikely to bioaccumulate or elicit toxic effects. The fate and transport of divalent metals are discussed below.

CADMIUM

Cadmium is a soft, blue-white, malleable metal or gray-blue powder. Cadmium is used for electroplating, in pigment production, and in the manufacture f plastic stabilizers and batteries. Sources of cadmium include smelter fumes and dusts, incineration products from cadmium-containing materials, fertilizer, and municipal wastewater and sludge discharges. It also is an industrial by-product of the manufacture of zinc, copper, and lead (ASTDR, 1991a).

Cadmium compounds have varying degrees of solubility ranging from very soluble (cadmium salts) to nearly insoluble (cadmium metal) (ASTDR, 1991a). Cadmium may exist in water as a hydrated ion or as metal inorganic complexes and it is more mobile in aquatic environments than most heavy metals (Eisler, 1985).

Adsorption and desorption rates of cadmium are rapid on mud solids and particles of clay, silica, humic material, and other naturally occurring solids. Changes in the physical chemistry of a waterbody (especially pH and redox potential) influence the suspension of cadmium from the sediments into the water column. During anaerobic conditions, cadmium is more likely to release from the sediments into the water column (ASTDR, 1991a).

Cadmium exists in soil as free cadmium compounds. Cadmium released to soils may leach into water, especially under acidic conditions (ASTDR, 1991a).

Freshwater and marine aquatic organisms accumulate cadmium from water at levels that may not be hazardous to aquatic life (Eisler, 1985). However, the evidence for cadmium transfer through various trophic levels suggests that only the lower trophic levels exhibit biomagnification (Eisler, 1985).

Cadmium is not essential for plant growth. If present in available form, cadmium is readily taken up by plant roots and tranlocated through the plant and accumulated.

COPPER

Copper is a reddish-colored metal that occurs naturally in rock, soil, water, sediment, air, plants, and animals. Copper is used primarily as a metal or alloy in the manufacture of wire, sheet metals, pipe, and other metal products. Copper compounds are used in agriculture to treat plant diseases, for water treatment, and as preservatives for wood, leather, and fabrics (ATSDR, 1989a).

Copper is released to water through natural weathering of soil and discharges from industries and sewage treatment plants. Copper released into water will most likely take the form of copper (II). Most copper in water is bound to organic matter; little is present in the free or readily exchangeable form. The concentration of dissolved copper in water is dependent on such factors as pH, the oxidation-reduction potential of the water, the presence of competing cations and anions of soluble cupric salts, and the presence of organic/inorganic complexing agents (ATSDR, 1989a).

Copper released into water tends to bind to the bottom sediments. Organics and iron oxides are the most important contributor to binding of copper by aerobic sediments. However, copper is typically associated with carbonates. In anaerobic sediment, copper (II) will be reduced to copper (I) and insoluble cuprous salts will form (ATSDR, 1989a).

Copper released to soil will be strongly adsorbed and remain in the upper few centimeters of soil. In most soils, the pH, organic matter, and ionic strength of the soil solutions are the key factors affected adsorption. Copper will adsorb to organic matter, carbonate minerals, clay minerals, or hydrous iron and manganese oxides. Sandy soils with low pH have the greatest potential for leaching (ATSDR, 1989a).

Copper is a micronutrient essential for plant nutrition. Copper can be transported in the xylem and phloem of plants complexed with amino acids.

LEAD

Lead is ubiquitous and is a characteristic trace constituent in rocks, soils, water, plants, animals, and air. Lead is used in the manufacture of storage batteries, gasoline additives, pigments, alloys, and ammunition (Eisler, 1988).

Lead compounds are extremely persistent in water and soil. Lead readily combines with hydroxide, carbonate, and sulfate ions to form insoluble compounds. These compounds precipitate and settle in the

bottom sediment. Lead is not volatile; therefore, volatilization is not an important transport process from the aquatic environment (EPA, 1985).

In water, lead is most soluble and bioavailable under conditions of low pH, low organic content, low concentrations of suspended sediments and low concentrations of the salts of calcium, cadmium, iron, manganese, and zinc. Lead tends to concentrate in the water surface microlayer (the upper 0.3 mm of water), especially when surface organic matter is present in thin films. However, most lead entering natural waters will precipitate to the sediment bottom as carbonates or hydroxides. Migration and speciation of lead in water are influenced by the water flow rate; increased flow rate results in increased concentrations of particulate and labile lead and a decrease in bound forms. At low stream flow, lead is rapidly removed from the water column by sedimentation (Eisler, 1988).

Sorption is a dominant effect on the distribution of lead in soil. Lead readily adsorbs to inorganic solids, organic material and hydrous iron and manganese oxides. Because of leads affinity for other materials, and its solubility characteristics, the mobility of lead in soil is low (EPA, 1985). Most lead is retained in soil and not transported via leaching or runoff to surface water (ATSDR, 1990).

Lead does not appear to significantly bioaccumulate in most fish (ATSDR, 1990). Microcosm studies indicate that lead is not biomagnified through the food chain (EPA, 1985). Lead concentrations tended to decrease markedly with increasing trophic level in both detritus-based and grazing aquatic food chains. However, lead is toxic to all phyla of aquatic biota, though effects are modified significantly by various biological and abiotic conditions (Eisler, 1988).

Lead is considered a nonessential element to plants (CCME, 1997). Lead is taken up passively by roots and translocation to shoots is limited.

NICKEL

Nickel released into water will exist in both soluble and insoluble forms depending on the chemical and physical properties of the water. Nickel is significantly bioaccumulated in some but not all aquatic species (ATSDR, 1988). Nickel is extremely persistent in soil; however, it still has the potential to leach through soil into groundwater. The sorption of nickel into soils has found to correlate with suspension pH, total iron, and surface area. Organic complexing agents in soil tend to restrict the movement and availability of nickel in soil by forming organo-nickel complexes.

ZINC

Zinc is bluish-white metal that dissolves readily in strong acids. Zinc compounds are found naturally in air, soil, and water and are present in all foods. It is commonly used as a protective coating for other metals. Zinc also is used in alloys such as bronze and brass, for electrical apparatus in many common goods, and in organic chemical extractions and reductions. Zinc chloride is used by the military to create smoke bombs. In pharmaceuticals, salts of zinc are used as solubilizing agents in many drugs. In addition, zinc is used with copper to make United States pennies (ATSDR, 1989b).

Zinc released into surface water primarily settles into the bottom sediments. Zinc can be present in water as either suspended or dissolved compounds. Suspended (undissolved) zinc may be dissolved following minor changes in the water chemistry or may be sorbed to suspended matter. Zinc tends to be more absorbed at higher pH concentration (>7). Desorption of zinc from sediments occurs as salinity increases (ATSDR, 1989b).

Zinc released onto soil is likely to be strongly absorbed. The mobility of zinc in soil is dependent upon the solubility of the speciated forms of the compound and on the soil properties (sorption potential, pH, and salinity; anaerobic). Little land-disposed zinc is in a soluble form; therefore, mobility is limited by a slow dissolution. Consequently, zinc is not likely to migrate into groundwater (ATSDR, 1989b).

Zinc is actively accumulated in aquatic systems. However, biota appear to represent a minor sink for zinc compared with the sediments (ATSDR, 1989b). Zinc bioavailability and toxicity to aquatic organisms are highest under conditions of low pH, low alkalinity, low dissolved oxygen, and elevated temperatures. Soluble species of zinc are the most bioavailable and most toxic (Eisler, 1993).

Zinc is an essential element for plant growth. Zinc is actively taken up by roots and is fairly uniformly distributed between roots and shoots.

MISCELLANEOUS METALS

ALUMINUM

Although present in food in varying amounts, aluminum is not an essential element for mammals. The lack of accumulation of aluminum in animals with age or of any increase in tissue levels of aluminum following fairly high dietary intake suggests that mammals possess a homeostatic mechanism for this element. For most terrestrial organisms, aluminum compounds are generally not harmful and are considered to be toxicologically inert, except in cases of high experimental doses or prolonged inhalation (Venugopal and Luckey, 1978).

Data on the toxicity of aluminum to aquatic organisms are somewhat limited. EPA (1988) stated that freshwater organisms should not be adversely affected if aluminum concentrations do not exceed 87 µg/L when pH is between 6.5 and 9.0. Some studies have shown that the acute toxicity of aluminum increases with pH, whereas other studies found the opposite to be true (EPA, 1988).

ANTIMONY

Antimony is used in metal alloys for producing fireproofing chemicals, ceramics, glassware, and pigments. Along with its industrial uses, it is used to medicinally treat people infected with parasites (ATSDR, 1995).

Antimony is considered a nonessential metal and is easily taken up by plants if present in a soluble form (Kabata-Pendias and Pendias, 1992). Plants growing in soils contaminated by industrial emissions contain elevated tissue concentrations of this metal. However, there are no reports of plant toxicity resulting from uptake of antimony (Kabata-Pendias and Pendias, 1992).

ARSENIC

Arsenic in the environment may undergo a complex cycle of chemical interconversions and transfers among media. Arsenic in water may undergo either reduction or oxidation, depending on pH, the electrochemical oxidation-reduction potential (Eh), and other ions present. Soluble forms of arsenic tend to be quite mobile in water, and less soluble species adsorb to clay or soil particles (ATSDR, 1989c).

BARIUM

Barium chloride and nitrate are soluble in water. The carbonate is much less soluble in water and the sulfate is one of the least soluble compounds in any medium (Friberg, 1986). Barium is relatively abundant in nature and is found in plant and animal tissue. Plants accumulate barium from the soil (Klaassen et al., 1986). The free ion is readily absorbed from the lung or gastrointestinal tract, but barium sulfate remains essentially unabsorbed. After absorption, barium accumulates in the skeleton. An accumulation also takes place in the pigmented parts of the eye (Friberg, 1986).

BERYLLIUM

Beryllium occurs as a chemical component of certain rocks, soils, and volcanic dust. Beryllium is naturally emitted to the atmosphere by windblown dust and volcanic particles (ATSDR, 1991b). The major emission source to the environment is the combustion of coal and fuel oil, which release particulates and fly ash that contain beryllium into the atmosphere.

Sediment is the ultimate sink for beryllium in water, and its association with sediment would decrease the mobility in water. Beryllium does not bioconcentrate to high levels in aquatic animals, although the bioconcentration in bottom-dwelling animals may be higher than nonbottom-dwelling animals. There is no evidence of biomagnification of beryllium within terrestrial or aquatic food chains (ATSDR, 1991b). Soluble forms of beryllium are easily taken up by plant roots, but it is not easily translocated from the roots to the shoots.

CHROMIUM

This metallic element naturally occurs in rocks, animals, plants, soil, and volcanic dust and gases (USDHHS, 1993). However, the toxic forms of the metal are mostly produced from anthropogenic activities, particularly chromite ore mining (Irwin et al., 1997). Since the trivalent (Cr^{3+}) and hexavalent (Cr^{6+}) forms have been found to be more stable than other ionic forms, these are the forms mostly found in the environment (Eisler, 1986). Cr^{6+} is more toxic because it has a high oxidizing potential and can easily penetrate biological membranes, thus causing cellular damage (Eisler, 1986; Irwin et al., 1997). Although not as toxic as Cr^{6+}, Cr^{3+} can impose damage by inhibiting different enzyme systems or reacting with organic molecules (Irwin et al., 1997).

Chromium toxicity is not prevalent in mammals because normal stomach pH converts Cr^{6+} to Cr^{3+}, which has low membrane permeability (Irwin et al., 1997). However, plants are adversely affected by chromium because it interferes with uptake translocation and iron metabolism (Irwin et al., 1997). For aquatic organisms, the pH, salinity, hardness, organic matter content, species and temperature are some of the factors that affect chromium toxicity (Eisler, 1986; Irwin et al., 1997). It has been found that Cr^{6+} is more toxic to freshwater species in soft and acidic waters (Eisler, 1986).

Chromium is not an essential element in plants. The (VI) form is more soluble and available to plants that the (III) form and is considered the more toxic form. After plant uptake, chromium generally remains in the roots (Efroymson, et al., 1997a). In fact, concentrations of chromium in the edible portions of the plant remain low, even when growing on contaminated chromium soil (CCME, 1997). Symptoms of plant toxicity include stunted growth, poorly developed roots, and leaf curling (Efroymson, et al., 1997a).

COBALT

Cobalt released into water is expected to take a soluble form. The mobility of cobalt is controlled by its characteristic of adsorbing to the clay minerals and hydrous oxides of iron, manganese, and aluminum available in sediments and soils. Chelation of cobalt is possible in sediments and soil.

IRON

Iron is the fourth most abundant (by weight) of the elements that compose the earth's crust and is a major constituent of clay soils. The bivalent and trivalent are the primary forms of concern in the aquatic environment. The ferrous or bivalent form is soluble in waters void of dissolved oxygen, and the ferric or trivalent form is insoluble. Iron can exist in natural organometallic or humic compounds and colloidal forms. Black or brown swamp waters may contain iron concentrations of several milligrams per liter, but this iron form has little effect on aquatic life. The majority of iron entering water bodies is likely to partition into the bottom sediments (EPA, 1985). Iron released into soil has relatively low mobility potential.

MANGANESE

Manganese is a brittle silvery metal that usually occurs as a complex with other metals such as iron. Manganese and its compounds are used in the making of steel alloys, dry-cell batteries, electrical coils, and other metallic fabrication applications (Klaassen et al., 1986; Hawley, 1987).

Manganese can occur in soil, water, or air. Although manganese can be transported in dusts or in water, the main source of routine manganese exposure is through ingestion of food. Vegetables, the germinal portions of grains, fruits, nuts, tea, and some spices are rich in manganese (Klaassen et al., 1986).

In the soil, the concentrations and chemical form in which manganese can occur are affected by pH, cation exchange capacity, drainage, and other factors. Lower pH and reducing conditions tend to favor solubility and, hence, the mobility of manganese. Manganese often occurs at higher concentrations in the bottom of stratified lakes as a result of its release from bottom sediments as manganese ion under reducing conditions (EPA, 1985).

Manganese is essential for plant growth. Toxicity symptoms include marginal chlorosis and necrosis of leaves and root browning. It is fairly uniformly distributed between the roots and shoots (Efroymson, et al., 1997a). Oak Ridge National Laboratory (ORNL) (1998) calculated mean and 90th percentile reported soil-to-plant bioaccumulation factors (BAFs) of 0.113 and 0.234, respectively. They must be multiplied by the percent dry weight of a plant (about 30 percent) for use in exposure equations to yield BAFs of 0.0339 (mean) and 0.070 (90 percentile) (Sample et al., 1997).

MERCURY

Mercury is a silvery, heavy liquid that exists as insoluble elemental mercury, organic species, and inorganic species. Solubility depends upon the reduction-oxidation potential and the pH of the environment (EPA, 1985). Mercury is commonly used for amalgams, catalysts, electrical apparatuses,

instruments such as thermometers and barometers, and neutron absorbers in nuclear power plants (Hawley, 1987).

Mercury released to the environment will remain there indefinitely. The form that mercury exists in (organic or inorganic) may change with time. Chemical speciation is probably the most important variable influencing the ecotoxicology of mercury (Eisler, 1987). Inorganic mercury can be methylated by microorganisms indigenous to soils, freshwater, and salt water. This process is mediated by various microbial populations under both aerobic and anaerobic conditions. Methyl mercury is the most hazardous mercury species due to its high stability, its lipid solubility, and its possession of ionic properties that create a high ability to penetrate membranes in living organisms. Methylmercury in surface waters is rapidly accumulated by aquatic organisms. The top-level predator species usually contain the highest concentrations of methyl mercury (Eisler, 1987).

Volatile forms of mercury present in surface water are expected to evaporate into the air; whereas, solid forms of mercury partition to particulates or are transported in the water column, depending on their solubility. The two most important transformation processes in the fate of mercury in surface waters are biotransformation and bioaccumulation. Photolysis of organomercurials also may occur in surface waters (ATSDR, 1988).

Mercury released into soils may undergo the same chemical and biological transformations as mercury released into surface waters. Mercuric mercury usually forms complexes with chloride and hydroxide ions in soils. The specific compounds is dependent on pH, salt content, and composition of the soil solution (ATSDR, 1988).

Freshwater plants exhibit a wide range of sensitivity to mercury; however, the most sensitive aquatic plant is less sensitive than the most sensitive freshwater animal. Fish tend to be more resistant to mercury than mollusks and crustaceans (Eisler, 1987).

Mercury and its compounds taken up by roots are translocated to only a limited extent in plants. Organic forms of mercury may be translocated to a greater degree than inorganic forms in some plants (Efroymson, et al., 1997a).

SELENIUM

Selenium is essential in amounts from trace to part-per-billion concentrations for humans and certain plants and animals but toxic at some concentrations present in the environment. Selenium is widely distributed in nature, being especially abundant with sulfide minerals of various metals, such as iron, lead, and copper. Selenium was used in the early 1900s as a pesticide to control plant pests and is still used

sparingly to control pests of greenhouse chrysanthemums and carnations. It has been used to control cotton pests, mites and spiders that attack citrus, and mites that damage apples. Selenium is used extensively in the manufacture and production of glass, pigments, rubber, metal alloys, textiles, petroleum, medical therapeutic agents, and photographic emulsions (ATSDR, 1989d).

Selenium metabolism and degradation are significantly modified by interaction with heavy metals, agricultural chemicals, microorganisms, and a variety of physicochemical factors. In addition, anthropogenic activities (including fossil fuel combustion and metal smelting) and naturally seleniferous areas pose the greatest hazards to fish and wildlife (ATSDR, 1989d).

Selenium is not proven to be essential for plant growth. Selenium is translocated to all parts of the plant, including the seed, in low molecular weight compounds.

VANADIUM

Vanadium released into surface water is expected to exist primarily in the tetravalent and pentavalent forms (HSDB, 2000). Both species are known to bind strongly to mineral or biogenic surfaces by adsorption or complexing. Adsorption to organic matter as well as to manganese oxide and ferric hydroxide results in precipitation of dissolved vanadium. Some marine organisms bioconcentrate vanadium. In soil, vanadium's mobility is expected to be dictated by soil pH; mobility is expected to be lower in acidic soils.

SILVER

Numerous studies have indicated that free soluble silver (Ag) is among the most toxic metals to freshwater organisms. In most natural waters, the monovalent form of silver is of greatest concern. Silver may exist as a simple hydrated monovalent ion, or it may exist in various degrees of association with inorganic ions such as sulfate, bicarbonate, or nitrate (EPA 1980). Silver is more toxic in soft water than in hard water (EPA 1980). Although elemental silver and silver salts have relatively high aquatic toxicity, high concentrations of iron sulfides in natural sediments favor the formation of silver sulfide (Hirsch, 1998). Silver sulfide is, in general, toxicologically inert. Moreover, silver sulfide is a breakdown product of silver thiosulfate, which is a major source of silver discharged from human activities.

Silver exhibits a limited ability to bioconcentrate. Bioconcentration factors for freshwater species reported by EPA (1980) ranged from <1 for bluegill sunfish (*Lepomis macrochirus*) to 240 for a mayfly (*Ephemeralla grandis)* with a geometric mean bioconcentration factor of 57.

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SVOCs

PAHs

The PAHs are a diverse group of compounds consisting of two or more substituted and unsubstituted polycyclic aromatic rings formed by the incomplete combustion of carbonaceous materials. They include the following compounds: acenaphthylene, acenaphthene, anthracene, benzo(a)anthracene, benz(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, benzo(a)pyrene, carbozole, chrysene, dibenzofuran, fluoranthene, indeno(1,2,3-cd)pyrene, naphthalene, 2-methylnaphthalene, phenanthrene, pyrene, (ATSDR, 1989).

PAHs are ubiquitous in the modern environment and commonly are constituents of coal tar, soot, vehicular exhausts, cigarette smoke, certain petroleum products, road tar, mineral oils, creosote, and many cooked foods. PAHs also are released to the environment through natural sources such as volcano and forest fire emissions. However, most of the emissions result from anthropogenic sources, largely wood burning for homes. Vehicular emissions are another primary source of PAHs. Hazardous waste sites can be a concentrated source on a local scale. Examples of such sites include former manufactured gas sites (i.e., sources of coal tar) and abandoned wood treatment plants (i.e., sources of creosote) (ATSDR, 1989).

PAHs are transferred from surface water by volatilization and sorption to settling particles. The compounds are transformed in surface water by photooxidation, chemical oxidation, and microbial metabolism (ATSDR, 1989).

In soil and sediments, microbial metabolism is the major process for degradation of PAHs (ATSDR, 1989). Although PAHs accumulate in terrestrial and aquatic plants, many organisms are able to metabolize and eliminate these compounds. Vertebrates can readily metabolize PAHs whereas lower forms (insects and worms) cannot metabolize PAHs as quickly. Food-chain uptake does not appear to be a major exposure source to PAHs for aquatic animals (ATSDR, 1989).

Plants and vegetables can absorb PAHs from soils through their roots and translocate them to other plant parts such as developing shoots. Lower molecular weight PAHs are absorbed by plants more readily than higher molecular weight PAHs. The biomagnification potential of vegetation in terrestrial and aquatic food chains has not been measured. Finally, many higher plants can catabolize benzo(a)pyrene and possible other PAHs, (Eisler, 1987).

PAHs vary substantially in their toxicity to aquatic organisms. In general, toxicity increases as molecular weight increases, with the exception of some high molecular weight PAHs that have low acute toxicity.

Most species of aquatic organisms rapidly accumulate PAHs from low concentrations in the ambient medium. However, uptake of PAHs is highly species specific, being higher in algae, mollusks, and other species that are incapable of metabolizing PAHs (Eisler, 1987). The ability of fish to metabolize PAHs may explain why benzo(a)pyrene is frequently not detected or is found at only very low levels in fish from environments heavily contaminated with PAHs (ASTDR, 1989).

PHTHALATES

Bis(2-ethylhexyl) phthalate (BEHP) is a colorless liquid used in the production of polyvinyl chloride, which provides flexibility to plastics (ATSDR, 1993).

Because BEHP is likely to be released to air and water during production of plastics, it can be carried long distances. In aquatic environments, BEHP adsorbs to sediment and bioconcentrates in organisms (Spectrum Laboratories, 1999). In terrestrial habitats, BEHP will not evaporate or leach into groundwater. It may biodegrade under aerobic conditions following acclimation in soil (Spectrum Laboratories, 1999).

Butylbenzyl phthalate (BBP) is used as a plasticizer for polyvinyl and cellulose resins, primarily in polyvinyl chloride. Possible sources of BBP release to the environment are from its manufacture and distribution and from PVC blending operations. Diffusion of BBP from consumer products is expected to be minimal, (Howard, 1989).

If BBP is released to land, it will sorb to soil and should not leach appreciably. The most significant fate process in soil will be biodegradation. BBP in surface waters will partition to solids such as sediment and biota (Howard, 1989).

Bluegill sunfish exposed to BBP for 21 days at a mean BBP concentration of 9.73 mg/L had a bioconcentration factor of 663 (Howard, 1989).

Di-n-butyl-phthalate is an odorless and colorless oily liquid. It is a man-made chemical that is used mostly to help make plastics soft and flexible (ASTDR, 1989).

Di-n-butyl-phthalate is poorly soluble in water. Adsorption onto soil and sediments appears to be a significant sink for this chemical. Microorganisms in soil and sediment appear to be capable of degrading di-n-butyl-phthalate rapidly (ASTDR, 1989).

Data indicate that di-n-butyl-phthalate can be taken up by and accumulate in a variety of organisms. It was reported that bioconcentration factors (BCFs) in six species of invertebrates ranged from 1,900 to 6,600. BCFs for oysters, shrimp, and fish were reported to be 42, 31, and 12 (ASTDR, 1989).

Greenhouse studies have demonstrated dose-dependent uptake of di-n-butyl-phthalate from soils into corn, soybean, and wheat seedlings (ASTDR, 1989). It may be produced in plants and it is metabolically degraded by plants and animals.

Diethyl-phthalate (DEP) may enter the environment in air emissions, aqueous effluent, and solid waste products from manufacturing and plastics processing. Volitalization and leaching from disposed plastic materials are potential modes of transport into air, water, and soil. If released to soil or water, DEP is expected to undergo aerobic biodegradation, (Howard, 1989).

The measured bioconcentration factor for DEP in bluegill sunfish is 117 and it is 15 to 16 in mullet. BCFs of 12 and 44 have been calculated from Log (K_{ow}s). These BCFs indicate that bioaccumulation in aquatic organisms would not be significant (Howard, 1989).

Dimethyl phthalate (DMP) is released into the environment principally in industrial wasterwater from its production and use as a plasticizer and mosquito repellent. If spilled on land, it should weakly sorb to most soils unless the soil has a very high organic content. Therefore, leaching to groundwater is expected. If released to water, it will remain in the water column because it weakly sorbs to sediment (Howard, 1989).

The mean bioconcentration factors of DMP in brown shrimp and sheepshead minnows were 4.7 and 5.4 after 24 hours, which indicated a very low bioconcentration. Bluegill sunfish showed a bioconcentration of 57, which may be elevated due to experimental measurements (Howard, 1989).

Other Organics

No fate and transport information was available for N-nitrosodiphenylamine and 1,2,4-trichlorobenzene.

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ORGANOCHLRORINE PESTICIDES

CHLORDANE

Pure chlordane is a mixture composed of primarily cis-chlordane and trans-chlordane. It is a white crystalline solid with a mild, pungent odor. Chlordane is an insecticide that was used from 1948 to 1988 on food crops (specifically corn) and to control household termites. Consequently, it was intentionally applied to soils both in agricultural and urban settings. Due to its persistence indoors, its use as a termicide was stopped (ATSDR, 1989a).

Chlordane is expected to persist for more than 20 years in some soils. Volatilization appears to be the only major removal mechanism from soil. Leaching to groundwater from soil is not a likely removal mechanism. Adsorption to sediments and volatilization are significant removal mechanisms in water. In air, chlordane will degrade by photolysis and hydroxyl radical reaction (ATSDR, 1989a).

Chlordane will bioconcentrate in both marine and freshwater species, as well as in bacteria (ATSDR, 1989). In living organisms, chlordane concentrations are usually highest in samples collected near areas where chlordane was used to control termites or other pests, in predatory species, and in tissues with high lipid content. Food-chain biomagnification is low except in certain marine mammals (Eisler, 1990).

DDT, DDE, DDD

Historically, DDT was released to the environment during its formulation and extensive use as a pesticide in agricultural and vector control applications. Its primary metabolites are DDE and DDD. Although DDT was banned for use in this country in 1972, it is still being used in several areas in the world, particularly tropical countries. DDT and its primary metabolites do not occur naturally in the environment. However, due to the extensive past use of DDT worldwide and the persistence of DDT and its metabolites, these compounds are virtually ubiquitous and are continually being transformed and redistributed in the environment. DDT and its metabolites have been detected in virtually all media (ATSDR, 1989b).

DDT and its metabolites may be transported among media by the processes of solubilization, adsorption, bioaccumulation or volatilization. DDT, DDE, and DDD in the atmosphere are subject to photodegradation or redeposition by rain or dry deposition (ATSDR, 1989b).

DDT and its environmental degradation products preferentially bind to soil and sediment, where they may be subject to photodegradation on the surface and biodegradation in the subsurface. Under certain conditions, DDT may persist for long periods of time or may be converted to DDE, which persists for an even longer duration. Consequently, these compounds are not easily displaced from their site of

application, whether by runoff or leaching to groundwater. However, volatilization of DDT and DDE from soil accounts for considerable losses of these compounds. The tendency of DDD to volatilize is approximately one-third that of DDT or DDE (ATSDR, 1989b).

When DDT is released to water, it quickly absorbs to particles and is subject to sedimentation, volatilization, photodegradation, and uptake into the food chain. Similar to soil, volatilization accounts for loss of these compounds from water. One study found that DDE volatilizes from seawater 10 to 20 times faster than from freshwater (ATSDR, 1989b).

DDT, DDE, and DDD are highly lipid soluble. This lipophilic property, combined with an extremely long half-life, results in bioaccumulation. When present in ambient water, DDT and its metabolites are concentrated in freshwater and marine plankton, insects, mollusks, and other invertebrates and fish. As these organisms become part of the food chain, a progressive accumulation of residues may result in high levels of residues in organisms at the top of the food chain (ATSDR, 1989b).

DIELDRIN

Dieldrin is an organochlorine pesticide that was used extensively in the past as an insecticide for corn and termite control. Dieldrin released to soils will persist for extremely long periods of time. Its low water solubility and strong adsorption to soil make leaching into groundwater unlikely. In surface water, dieldrin will adsorb to sediment and bioconcentrate in aquatic organisms (Howard, 1991).

Moderate to significant bioconcentration in aquatic species has been reported, with bioconcentration factors (BCFs) ranging from 100 to 10,000 (Howard, 1991).

HEPTACHLOR

Heptachlor is a white powder that smells somewhat like camphor. It was used in the past (but is no longer permitted) for killing insects in homes, buildings, and on food crops. It is approved by EPA for killing fire ants in power transformers (ASTDR, 1991).

Heptachlor is expected to adsorb strongly to soil, making leaching into groundwater unlikely. Volatilization from soil particles to the atmosphere is possible. In surface water, the heptachlor will adsorb to the sediments (Howard, 1991).

Heptachlor has been reported to bioconcentrate in aquatic species. BCFs for several fish species are as follows: spot (5,744 to 8,282–whole body, 4,686-fillet); fathead minnow (9,500-19,952); mosquito fish

(3,600-3,800); and sheepshead minnow (21,379). The BCFs in snails, alga, and oysters are 37,000, 21,000, and 18,000, respectively (Howard, 1991).

POLYCHLORINATED BIPHENYLS (AROCLOR 1254, AROCLOR 1260)

The term polychlorinated biphenyls (PCBs) commonly refers to a variety of mixtures of individual biphenyl isomers, each consisting of two joined benzene rings and up to 10 chlorine atoms. Mixtures of these isomers are known by their commercial designation of Aroclor. This trade name is followed by a four-digit number: the first two numbers indicate the type of isomer mixture and the last two numbers indicate the approximate weight percent of chlorine in the mixture (EPA, 1985).

PCBs are man-made chemicals that were used widely in transformers and electrical equipment and as lubricants (ATSDR, 1989c). PCBs are inert, thermally and chemically stable compounds with dielectric properties. Because of their persistence and toxicity in the environment, their manufacture was discontinued in the United States in 1977 (EPA, 1985). However, PCB equipment manufactured before 1977 is currently still being used in the United States and this use is regulated by EPA.

PCBs released into water adsorb to sediments and other organic matter. Typically, PCB concentrations are greater in the sediment and suspended material than in the water column. Substantial quantities of PCBs in aquatic sediments can act as an environmental reservoir from which PCBs may be released slowly over a long period of time (ATSDR, 1989c). For PCBs that exist in the dissolved state in water, volatilization becomes the primary fate process. Therefore, the volatilization process is the major removal mechanism of PCBs from water sources. However, the rate of volatilization is dependent upon PCB adsorption to sediment (ATSDR, 1989c). PCBs have the capability to bioaccumulate and biomagnify (EPA, 1985).

Degradation of PCBs in the environment is dependent upon the degree of chlorination. Generally, the more chlorinated the PCB molecule, the more persistent it will be in the environment. Factors that determine biodegradability include the amount of chlorination, concentration, type of microbial population, available nutrients, and the temperature (ATSDR, 1989c).

PCBs are expected to be highly immobile in the soil due to rapid and strong sorption. Accumulation of PCBs in terrestrial vegetation can occur by uptake from soil through the root and by deposition of atmospheric particulates on aerial plant surfaces. However, the transfer of vapor-phase PCBs from air to aerial plant parts may be the main source of vegetation contamination (ATSDR, 1989c).

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MISCELLANEOUS COMPOUNDS

Cyanide

Hydrocyanic acid (HCN) is very reactive and occurs only rarely in nature. The cyanide ion (CN^-) is highly water soluble and readily forms complexes with a variety of metal ions, especially those of the transition series. Compounds containing cyanide are often associated with steel, petroleum, plastics, synthetic fibers, metal plating, and chemical industries. The toxicity to aquatic organisms of most simple cyanides and metallocyanide complexes is due mostly to the presence of HCN as derived from ionization, dissociation, and photodecomposition of cyanide-containing compounds, although the cyanide ion is also toxic. All available evidence suggests that cyanide is neither mutagenic, teratogenic, nor carcinogenic. Moreover, there are no reports of cyanide biomagnification or cycling in living organisms, probably owing to its rapid detoxification. Cyanide seldom persists in surface waters and soils owing to complexation or sedimentation, microbial metabolism, and loss from volatilization (ATSDR, 1991).

Total Petroleum Hydrocarbons

See PAH fate and transport profile.

Ammonium Perchlorate

Little information was available regarding the fate and transport of ammonium perchlorate. An ammonium perchlorate study is currently ongoing at NSWC Indian Head. Data and information from that study, when available, will be used to obtain fate and transport information.

ENERGETICS

For this ERA, the term "energetics" will be used to describe the broad class of compounds used as propellants and explosives and similar compounds used in the processes associated with propellants and explosives. As a matter of note, available fate and transport information for these compounds suggests that they have limited persistence in aquatic media.

In general, energetics are distinguished by one or more nitro- groups on the compound molecule. Nitro compounds released to soils and sediments are reduced to amino compounds and covalently bounded to soil organic matter (Roberts, 1992). A recent study has indicated that it may not be sufficient to look only for expected ordnance compounds in sediments due to breakdown of parent compounds and the possibility of degredation product toxicity.

2,4,6-Trinitrotoluene (TNT)

2,4,6-Trinitrotoluene (TNT) is used as a high explosive in military armaments and as a chemical intermediate in the manufacture of dyestuffs and photographic chemicals. TNT is least impact- and friction-sensitive of the high explosives, and the impurities formed during its production (except for tetranitromethane) do not affect its sensitivity. TNT is likely to enter the environment in wastewater effluent from production facilities and from leachate at waste disposal sites. Mobility in soil may be limited by strong adsorption to soil particles (Roberts, 1992). Several studies have indicated that sediment adsorption and volatilization are not likely to be a significant fate processes. Degradation via photolysis and biotransformation, but not hydrolysis, is considered significant. Adsorption in soil is important process affecting the migration of TNT, with the cation exchange capacity and organic carbon content most critical in determining the degree of adsorption. Molecular diffusion also is considered an important factor and is related largely to percolation rate, but vapor phase diffusion would only be significant in arid climates where soil clay content is low (Roberts, 1992).

In general, TNT binds strongly to sediments (Talmage et al., 1999). In contrast, another study showed that sorption to TNT to pond sediment is measurable but not extensive, is correlated to time and concentration, and is strongly, perhaps irreversibly, bound. Sorption of TNT to sediment is also directly related to pH and temperature. The degradation products of TNT also appear to be adsorbed to sediment. Slow biotransformation of TNT in natural water, even in the presence of small quantities of organic nutrients, has been demonstrated. The major process of transformation is via nitro-group reduction with no ring cleavage. The 2-amino and 4-aminodinitrotoluenes are the major biotransformation products. The volatilization of TNT is very slow and actual rates are consistently lower than those estimated by physical and chemical properties (Roberts, 1992).

Studies by Shugart et al. (1990) on the presence of TNT and its metabolite concentrations in the tissues of wildlife taken from the Alabama Army Ammunition Plant suggest that these materials do not accumulate; no TNT-related compounds were detected in these samples. No published literature was located regarding the metabolism of TNT isomers. Studies specifically describing release, fate, and transport of energetic compounds within aquatic ecosystems are scarce as well. Results of these studies indicate that long distance transportation TNT, RDX and DNT in aquatic systems and their degradation products is unlikely. Photolytic degradation of TNT proceeds fairly rapidly and limits the persistence of this munition in the water column (Etnier, 1987).

2,4-Dinitrotoluene (2,4-DNT) and 2,6-Dinitrotoluene (2,6-DNT)

2,4-Dinitrotoluene (2,4-DNT) and 2,6-Dinitrotoluene (2,6-DNT) are pale yellow solids and are two of six possible forms of DNT. DNT is made by mixing toluene with nitric acid. Etnier (1987) reported that

biodegradation of 2,4 DNT and 2,6 DNT occurs under anaerobic conditions in the presence of exogenous carbon source; a slight biodegradation of 2,6 DNT was found to occur under aerobic conditions. There is a potential for transport of DNT via surface water and groundwater due to the moderate solubility of DNT and the low K_{ow} value. DNT is not expected to bioacumulate in animal tissues. Photolysis is considered the major degradation route of DNTs released into oxygenated water (Robers, 1992). When released into the atmosphere, DNTs are subject to side chain oxidation, decarboxylation, ring oxidation, and/or nitroreductin in air and sunlight. Indirect photoysis also may occur (Roberts, 1992).

Nitrocellulose

Because of its fibrous nature, nitrocellulose blankets benthic habitats (limiting available oxygen) and can fill in interstitial spaces used as cover for benthic organisms. This habitat alteration is compounded by the resistance of nitrocellulose to environmental degradation.

HMX

HMX, a colorless, crystalline solid, is a completely N-nitrated, eight-member heterocyclic ring compound. HMX is used to implode fissionable material to achieve critical mass in nuclear devices and as a component in plastic-bonded explosives, solid-fuel rocket propellants, and military munitions with such applications as burster chargers. HMX has approximately 130% of the explosive power of trinitrotoluene (TNT). Environmental HMX pollution may result from propellant formulation manufacture. Photolysis is the dominant fate process for HMX in the aquatic environment. A concentration of 0.5 ppm HMX is reported to have a half-life of 4 to 5 days when exposed to natural sunlight. Major photolytic transformation products are nitrate, nitrite, and formaldehyde. Photolytic processes are inhibited in waste disposal lagoon water with poor light transmission (Roberts, 1992). Biotransformation was also identified as an important fate process for HMX in the aquatic environment. Aerobic biotransformation of HMX occurs rapidly in HMX waste stream waters but not in river or lagoon waters. Anaerobic biotransformation occurs very slowly but is accelerated in the presence of excess organic nutrients. The metabolites resulting from both aerobic and anaerobic transformation are the mono- through tetranitroso derivatives of HMX that are metabolized to 1,1-dimethylhydrazine. Hydrolysis, oxidation, and abiotic reduction are not considered major transformation processes for HMX, nor are volatilization, sediment sorption, and biosorption (Roberts, 1992). Hydrazines are ephemeral in the aquatic environment (Amidei, 2000).

RDX

RDX, a white crystalline solid, is a completely N-nitrated, six-member heterocyclic ring compound. It has been used extensively as a high-impact explosive in military munitions formulations since World War II. RDX also is used as a rat poison. RDX is usually manufactured by the nitration of hexamethylene

tetramine. RDX can enter the aquatic environment through wastewater discharges from the manufacture and loading of RDX, and migration from settling ponds into soil, with subsequent leaching to groundwater. Direct photochemical degradation is the major removal process in translucent waters. Atmospheric releases may occur from incineration of RDX-containing mixtures, with dry or wet deposition as major atmospheric removal processes. Sediment deposits in army ammunition plants may also pose an environmental problem, since seepage into the groundwater may occur (Roberts, 1992). Sediment absorption will not lead to a significant loss in the aquatic environment (Roberts, 1992). Lotufo (unpublished data) has also shown that cyclonitramines (HMX and RDX) have low affinity for sediment.

Miscellaneous Energetics

Little fate and transport information was available for nitrobenzene, nitroguanidine, PETN, and nitrate esters. Nitrate esters are a class of compounds that include triethylene glycol dinitrate, nitroglycerin, propylene glycol dinitrate, butanetriol trinitrate, trimethylolethane trinitrate.

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APPENDIX B

HEALTH AND SAFETY PLAN

Health and Safety Plan
for
Mattawoman Creek Study
Indian Head Division
Naval Surface Warfare Center
Indian Head, Maryland

Engineering Field Activity Chesapeake
Naval Facilities Engineering Command

Northern Division Contract No. N62472-90-D-1298
Contract Task Order 0320

July 2001

HEALTH AND SAFETY PLAN
FOR
MATTAWOMAN CREEK STUDY
INDIAN HEAD DIVISION - NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

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

Submitted by:
Tetra Tech NUS, Inc.
600 Clark Avenue, Suite 3
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NORTHERN DIVISION CONTRACT NO. N62472-90-D-1298
CONTRACT TASK ORDER 0320

July 2001

SUBMITTED BY:

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1.0 INTRODUCTION

The objective of this Health and Safety Plan (HASP) is to provide the minimum safety practices and procedures for Tetra Tech NUS, Inc. (TtNUS) and subcontractor personnel engaged in proposed site activities that are to be conducted at the Mattawoman Creek in the Indian Head Division Naval Surface Warfare Center (IHDIV-NSWC) Indian Head, Maryland.

In order to accomplish the objective, this HASP uses the latest available information regarding known or suspected chemical contaminants and potential and foreseeable physical hazards associated with the proposed work at the sites identified at IHDIV-NSWC. This HASP has been designed to be used in accordance with the TtNUS Health and Safety Guidance Manual. The Guidance Manual provides detailed information pertaining to procedures to be performed on site as directed by the HASP, as well as TtNUS standard operating procedures. Both the HASP and the Health and Safety Guidance Manual must be present at the site to comply with the requirements stipulated in the Occupational Safety and Health Administration (OSHA) standard 29 CFR 1910.120.

This HASP has been written to support proposed tasks and techniques associated with the scope of work as presented in Section 3.0. Should the proposed work site conditions and/or suspected hazards change, or if new information becomes available, this document will be modified. All changes to the HASP will be made with the approval of the TtNUS CLEAN Health and Safety Manager (HSM) and the Project Manager (PM). The PM will notify all affected personnel of all changes.

The elements of this HASP are in compliance with the requirements established by OSHA 29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response" (HAZWOPER) and sections of 29 CFR 1926, "Safety and Health Regulations for Construction."

1.1 AUTHORITY

This Contract Task Order (CTO) 0320 and the requirements setforth represent an integral part of an overall effort conducted under the Comprehensive Long - Term Environmental Action Navy (CLEAN) contract, administered through the U.S. Navy Engineering Field Activity Chesapeake Naval Facilities Engineering Command, as defined under Contract No. N62472-90-D-1298.

1.2 KEY PROJECT PERSONNEL AND ORGANIZATION

This section defines responsibility for site safety and health for TtNUS and subcontractor employees engaged in on site activities. Personnel assigned to these positions shall exercise the primary

responsibility for all on site health and safety. These persons will be the primary point of contact for any questions regarding the safety and health procedures and the selected control measures.

- The TtNUS Project Manager (PM) is responsible for the overall direction and implementation of health and safety for this project.

- The TtNUS Field Operations Leader (FOL) is responsible for implementation of this HASP with the assistance of an appointed Site Safety Officer (SSO). The FOL manages field activities, executes the work plan, and enforces safety procedures, as applicable to the work plan.

- The SSO supports site activities by advising the FOL on all aspects of health and safety on site. These duties may include the following:

  - Coordinates all health and safety activities with the FOL.
  - Selects, inspects, implements, and maintains personal protective equipment.
  - Establishes work zones and control points.
  - Directs and assists in the development of decontamination areas and procedures.
  - Implements air monitoring program in support of on site activities.
  - Verifies training and medical status of on site personnel status in relation to site activities.
  - Implements hazard communication, respiratory protection, and other associated safety and health programs, as necessary.
  - Coordinates emergency services.
  - Provides site-specific training for all on site personnel.

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

1.3 SITE INFORMATION AND PERSONNEL ASSIGNMENTS

Site Name: Indian Head Division Naval Surface Warfare Center (IHDIV-NSWC) **Address:** Waldorf, Maryland

Site Point of Contact: Shawn Jorgensen **Phone Number:** (301) 744-6745

Purpose of Site Visit: The purpose of the Mattawoman Creek Study is to determine the magnitude of impacts on Mattawoman Creek from base-related activities and to assess the potential ecological and human health risks resulting from those impacts.

Proposed Dates of Work: July 2001 until completion

Project Team:

TtNUS Personnel:	Discipline/Tasks Assigned:
George Latulippe, PE	Project Manager (PM)
TBD	Field Operations Leader (FOL)
TBD	Field Geologist
Matthew M. Soltis, CIH, CSP	Health and Safety Manager (HSM)
TBD	Site Safety Officer (SSO)
James K. Laffey	Project Health and Safety Officer (PHSO)

Non-TtNUS Personnel	Affiliation/Discipline/Tasks Assigned
TBD	
TBD	

Hazard Assessment (for purposes of 29 CFR 1910.132) for HASP prepartion has been conducted by:

James K. Laffey

2.0 EMERGENCY ACTION PLAN

2.1 INTRODUCTION

This section has been developed as part of a planning effort to direct and guide field personnel in the event of an emergency. All site activities will be coordinated with the client contact, Shawn Jorgensen. In the event of an emergency which cannot be mitigated using onsite resources, personnel will evacuate to a safe place of refuge and the appropriate emergency response agencies will be notified. It has been determined that the majority of potential emergency situations would be better supported by outside emergency responders. Based on this determination, TtNUS and subcontractor personnel will not provide emergency response support beyond the capabilities of onsite response. Workers who are ill or who have suffered a non-serious injury may be transported by site personnel to nearby medical facilities, provided that such transport does not aggravate or further endanger the welfare of the injured/ill person. The emergency response agencies listed in this plan are capable of providing the most effective response, and as such, will be designated as the primary responders. These agencies are located within a reasonable distance from the area of site operations, which ensures adequate emergency response time. Navy contact Shawn Jorgensen will be notified anytime outside response agencies are contacted. This Emergency Action Plan conforms to the requirements of 29 CFR 1910.38(a), as allowed in 29 CFR 1910.120(l)(1)(ii).

TtNUS will, through necessary services, provide the following emergency action measures:

- Initial stage fire fighting support and prevention
- Initial spill control and containment measures and prevention
- Removal of personnel from emergency situations such as confined space entry
- Initial medical support for injuries or illnesses requiring basic first-aid
- Site control and security measures as necessary

2.2 PRE-EMERGENCY PLANNING

Through the initial hazard/risk assessment effort, it is anticipated that emergencies resulting from chemical, physical, or fire hazards are unlikely given the nature of site activities.

Nonetheless, to minimize and eliminate the potential for any emergency situations, pre-emergency planning activities will include the following (which are the responsibility of the FOL):

- Coordinating with local Emergency Response personnel to ensure that TtNUS emergency action activities are compatible with existing emergency response procedures. Base Fire Protection and Emergency Services will be notified of scheduled events and activities. This is most imperative in situations where their services may be required such as confined space entry.

- Establishing and maintaining information at the project staging area (support zone) for easy access in the event of an emergency. This information will include the following:

  - Chemical Inventory (of chemicals used onsite), with Material Safety Data Sheets.
  - Onsite personnel medical records (Medical Data Sheets).
  - A log book identifying personnel onsite each day.
  - Hospital route maps with directions (these should also be placed in each site vehicle).
  - Emergency Notification - phone numbers.

The TtNUS FOL will be responsible for the following tasks:

- Identifying a chain of command for emergency action.

- Educating site workers to the hazards and control measures associated with planned activities at the site, and providing early recognition and prevention, where possible.

- Periodically performing practice drills to ensure site workers are familiar with incidental response measures.

- Providing the necessary equipment to safely accomplish identified tasks.

2.3 EMERGENCY RECOGNITION AND PREVENTION

2.3.1 Recognition

Emergency situations that may be encountered during site activities will generally be recognized by visual observation. To adequately recognize chemical exposures, site personnel must have a clear knowledge of signs and symptoms of exposure associated with site contaminants. This information is provided in Table 6-1. Tasks to be performed at the site, potential hazards associated with those tasks and the recommended control methods are discussed in detail in Sections 5.0 and 6.0. Additionally, early recognition of hazards will be supported by periodic site surveys to identify any situation predisposed to an emergency. The FOL will be responsible for performing surveys of work areas prior to initiating site operations and periodically while operations are being conducted. Survey findings will be documented by

the FOL in the site logbook, however, all site personnel will be responsible for reporting hazardous situations. Where potential hazards exist, TtNUS will initiate control measures to prevent adverse effects to human health and the environment.

The above actions will provide early recognition for potential emergency situations, and allow TtNUS to initiate necessary control measures. However, if the FOL determines that control measures are not sufficient to eliminate the hazard, TtNUS will withdraw from the site and notify the appropriate response agencies listed in Table 2-1.

2.3.2 Prevention

TtNUS and subcontractor personnel will minimize the potential for emergencies by following this HASP, the Health and Safety Guidance Manual, and applicable OSHA regulations. Periodic site surveys of work areas and correction of any identified deficiencies prior to the commencement of that day's activities by the FOL will also assist in prevention of illness/injuries when hazards are recognized early and control measures initiated.

2.4 EVACUATION ROUTES, PROCEDURES, AND PLACES OF REFUGE

An evacuation will be initiated whenever recommended hazard controls are insufficient to protect the health, safety or welfare of site workers. Specific examples of conditions that may initiate an evacuation include, but are not limited to the following: severe weather conditions; fire or explosion; and evidence of personnel overexposure to potential site contaminants.

In the event of an emergency requiring evacuation, all personnel will immediately stop activities and report to the designated safe place of refuge unless doing so would pose additional risks. When evacuation to the primary place of refuge is not possible, personnel will proceed to a designated alternate location and remain until further notification from the TtNUS FOL. Safe places of refuge will be identified prior to the commencement of site activities by the FOL and will be conveyed to personnel as part of the pre-activities briefing session. This information will be reiterated during daily safety meetings and indicated on the Safe Work Permits. Whenever possible, the safe place of refuge will also serve as the telephone communications point for that area. During an evacuation, personnel will remain at the refuge location until directed otherwise by the TtNUS FOL or the on-site Incident Commander of the Emergency Response Team. The FOL will perform a head count at this location to account for and to confirm the location of all site personnel. Emergency response personnel will be immediately notified of any unaccounted personnel. The FOL will document the names of all personnel onsite (on a daily basis) in the site Health and Safety Logbook. This information will be utilized to perform the head count in the event of an emergency.

Evacuation procedures will be discussed during the pre-activities training session, prior to the initiation of project tasks. Evacuation routes from the site and safe places of refuge are dependent upon the location at which work is being performed and the circumstances under which an evacuation is required. Additionally, site location and meteorological conditions (i.e., wind speed and direction) may dictate evacuation routes. As a result, assembly points will be selected and communicated to the workers relative to the site location where work is being performed. Evacuation should always take place in an upwind direction from the site and away from water bodies.

2.5 EMERGENCY ALERTING AND ACTION/RESPONSE PROCEDURES

TtNUS personnel will likely be working in close proximity to each other during planned site activities. Site personnel will initiate emergency notification to all onsite personnel by voice commands, hand signals, vehicle horns, or line of site communication to alert site personnel of an emergency. When project tasks are performed simultaneously on different sites, radios will be used to communicate emergency situations and request assistance. The Fire Department will provide rescue services. The details for notification must be documented in the permit.

If an emergency warranting evacuation occurs, the following procedures are to be initiated:

- Initiate the evacuation via appropriate and/or available communication method (hand signals, voice commands, etc.).
- Report to the designated refuge point.
- Once all non-essential personnel are evacuated, appropriate response procedures will be enacted to control the situation.
- Describe to the FOL (serving as the Incident Coordinator) pertinent incident details.

In the event that site personnel cannot mitigate the hazardous situation, the FOL will enact emergency notification procedures to secure additional assistance in the following manner:

Contact pertinent emergency contacts listed in Table 2-1 and report the incident. Give the emergency operator the location of the emergency, the type of emergency, the number of injured, and a brief description of the incident. Stay on the phone and follow the instructions given by the operator. The operator will then notify and dispatch the proper emergency response agencies.

2.6 EMERGENCY CONTACTS

Prior to initiating field activities, all personnel will be thoroughly briefed on the emergency procedures to be followed in the event of an accident. Table 2-1 provides a list of emergency contacts and their associated telephone numbers. This table must be posted where it is readily available to all site personnel. Facility maps should also be posted showing potential evacuation routes and designated meeting areas.

TABLE 2-1
EMERGENCY REFERENCE
INDIAN HEAD DIVISION - NSWC

AGENCY	TELEPHONE
EMERGENCY (fire, ambulance, rescue, police)	911
Hospital: Civista Medical Center	(301) 609-4000
Hospital: Southern Maryland Hospital	(301) 877-4646
National Capital Poison Center	(202) 625-3333
Chemtrec National Response Center	(800) 424-9300 (800) 424-8802
Site Point of Contact Shawn Jorgensen	(301) 743-6745
Navy Remedial Project Manager Jeffery W. Morris	(202) 685-3279
TtNUS, Pittsburgh Office	(412) 921-7090
Health and Safety Manager Matthew M. Soltis, CIH, CSP	(412) 921-8912
Project Health and Safety Officer James K. Laffey	(412) 921-8678
Project Manager George Latulippe, PE	(412) 921-8684

2.7 EMERGENCY ROUTE TO HOSPITALS

The closest hospital to the IHDIV-NSWC is the Civista Medical Center in La Plata, Maryland. The alternate hospital is Southern Maryland Hospital in Clinton, Maryland. Maps showing the proximity of the IHDIV-NSWC to both of the hospitals are included as Figure 2-1 and 2-1A. Directions to both Civista Medical Center and Southern Maryland Hospital are provided below:

Civista Medical Center

701 East Charles Street,
La Plata, MD 20646
301.609.4000

Exit the facility and proceed South on Bensville Road (Rt. 228) for approximately 3 miles. At the junction of Bensville and Billingsley Road take a left onto Billingsley Road. Proceed on Billingsley Road for approximately 5 miles to the junction of Route 301. Proceed South on Route 301 to La Plata, Maryland (approximately 6 miles). The hospital is on the right, about 1/2 block past the railroad tracks.

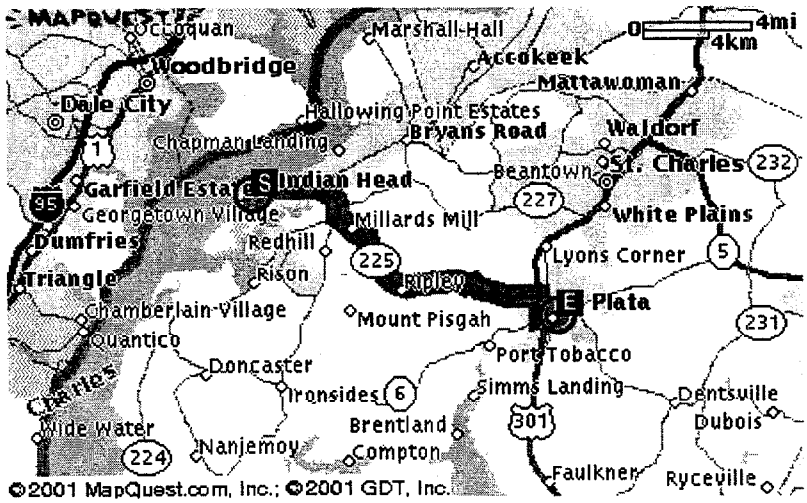
Southern Maryland Hospital

7503 Surratts Road
Clinton, Maryland 20735

Exit the facility proceed North on Bensville Road (Rt. 228) for approximately 1 mile. Take a left onto Bealle Hill Road and proceed North for approximately 1.5 miles. At the junction of Rt. 373 turn right onto Rt. 373. Follow until intersection with Branch Ave. (MD Route 5). Turn left on Branch Ave., right on Surratts Road. The hospital is just past the Colony South Hotel.

Figure 2-1

Route To Civista Medical Center



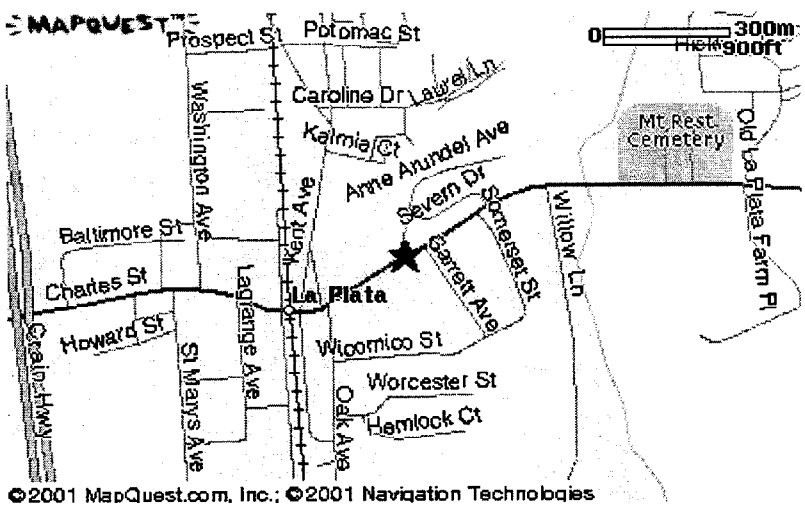
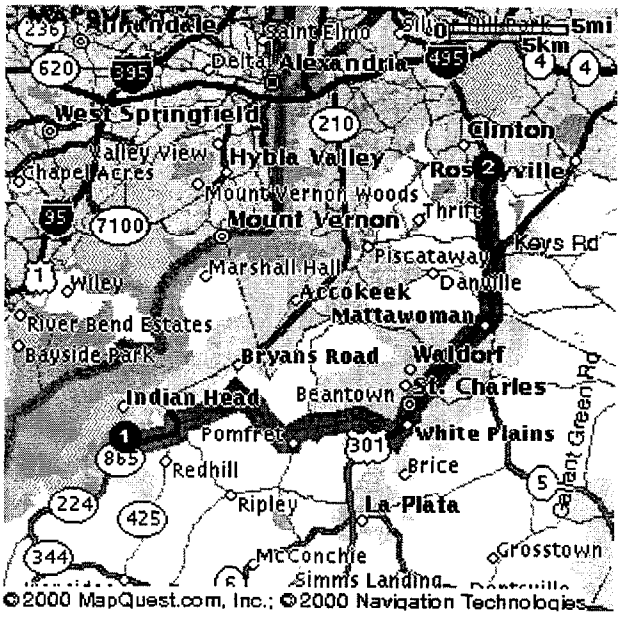
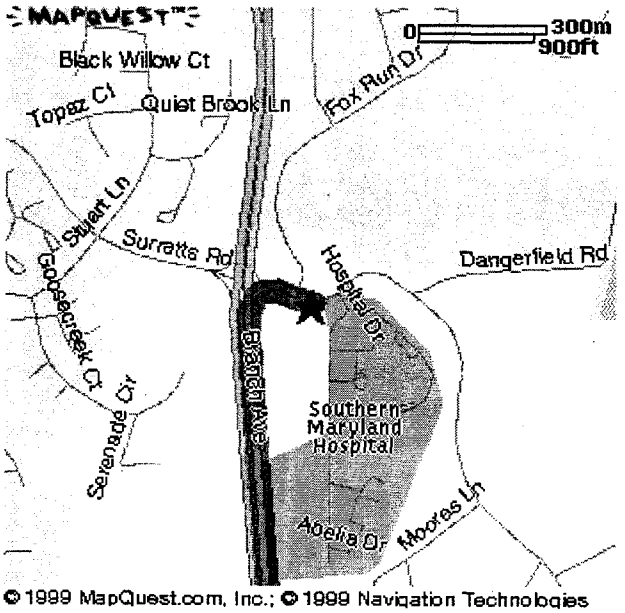


Figure 2-1A

Route To Southern Maryland Hospital Center





2.8 DECONTAMINATION PROCEDURES / EMERGENCY MEDICAL TREATMENT

During any site evacuation, decontamination procedures will be performed only if doing so does not further jeopardize the welfare of site workers. Decontamination will not be performed if the incident warrants immediate evacuation. However, it is unlikely that an evacuation would occur which would require workers to evacuate the site without first performing the necessary decontamination procedures.

TtNUS personnel will perform removal of personnel from emergency situations and may provide initial medical support for injury/illnesses requiring only first-aid level support. Medical attention above that level will require assistance and support from the designated emergency response agencies. Attachment I provides the procedure to follow when reporting an injury/illness, and the form to be used for this purpose. If the emergency involves personnel exposures to chemicals, follow the steps provided in Figure 2-2.

2.9 INJURY AND ILLNESS REPORTING

Any pertinent information regarding allergies to medications or other special conditions will be provided to medical service personnel. This information is listed on Medical Data Sheets filed onsite. If an exposure to hazardous materials has occurred, provide hazard information from Table 6-1 to medical service personnel. As soon as possible, Navy contact Shawn Jorgensen must be informed of any incident or accident that requires medical attention.

2.10 PPE AND EMERGENCY EQUIPMENT

A first-aid kit, eye wash units (or bottles of disposable eyewash solution) and a fire extinguisher will be maintained onsite and shall be immediately available for use in the event of an emergency. This equipment will be located in the field office or site vehicle. Personnel identified within the field crew with bloodborne pathogen and first-aid training will be the only personnel permitted to offer first-aid assistance.

FIGURE 2-2
EMERGENCY RESPONSE PROTOCOL

The purpose of this protocol is to provide guidance for the medical management of injury situations.

In the event of a personnel injury or accident:

- Rescue, when necessary, employing proper equipment and methods.
- Give attention to emergency health problems -- breathing, cardiac function, bleeding, and shock.
- Transfer the victim to the medical facility designated in this HASP by suitable and appropriate conveyance (i.e. ambulance for serious events)
- Obtain as much exposure history as possible (a Potential Exposure report is attached).
- If the injured person is a Tetra Tech NUS employee, call the medical facility and advise them that the patient(s) is/are being sent and that they can anticipate a call from the WorkCare physician. WorkCare will contact the medical facility and request specific testing which may be appropriate. WorkCare physicians will monitor the care of the victim. Site officers and personnel should not attempt to get this information, as this activity leads to confusion and misunderstanding.
- Call WorkCare at 1-800-455-6155 enter Extension 109, or follow the voice prompt for after hours and weekend notification, and be prepared to provide:
  - Any known information about the nature of the injury.
  - As much of the exposure history as was feasible to determine in the time allowed.
  - Name and phone number of the medical facility to which the victim(s) has/have been taken.
  - Name(s) of the involved Tetra Tech NUS, Inc. employee(s).
  - Name and phone number of an informed site officer who will be responsible for further investigations.
  - Fax appropriate information to WorkCare at (714) 456-2154.
- Contact Corporate Health and Safety Department (Matt Soltis) at 1-800-245-2730.

As data is gathered and the scenario becomes more clearly defined, this information should be forwarded to WorkCare.

WorkCare will compile the results of all data and provide a summary report of the incident. A copy of this report will be placed in each victim's medical file in addition to being distributed to appropriately designated company officials.

Each involved worker will receive a letter describing the incident but deleting any personal or individual comments. A personalized letter describing the individual findings/results will accompany this generalized summary. A copy of the personal letter will be filed in the continuing medical file maintained by WorkCare.

FIGURE 2-2 (continued)
POTENTIAL EXPOSURE REPORT

Name: _____ Date of Exposure: _____

Social Security No.: _____ Age: _____ Sex: _____

Client Contact: _____ Phone No.: _____

Company Name: _____

I. Exposing Agent

Name of Product or Chemicals (if known): _____

_____

_____

Characteristics (if the name is not known)

Solid Liquid Gas Fume Mist Vapor

II. Dose Determinants

What was individual doing? _____

How long did individual work in area before signs/symptoms developed? _____

Was protective gear being used? If yes, what was the PPE? _____

Was there skin contact? _____

Was the exposing agent inhaled? _____

Were other persons exposed? If yes, did they experience symptoms? _____

III. Signs and Symptoms (check off appropriate symptoms)

Immediately With Exposure:

Burning of eyes, nose, or throat
Tearing
Headache
Cough
Shortness of Breath
Chest Tightness / Pressure
Nausea / Vomiting
Dizziness
Weakness

Delayed Symptoms:

Weakness
Nausea / Vomiting
Shortness of Breath
Cough
Loss of Appetite
Abdominal Pain
Headache
Numbness / Tingling

IV. Present Status of Symptoms (check off appropriate symptoms)

Burning of eyes, nose, or throat
Tearing
HeadacHE
Cough
Shortness of Breath
Chest Tightness / Pressure
Cyanosis
Nausea / Vomiting
Dizziness
Weakness
Loss of Appetite
Abdominal Pain
Numbness / Tingling

Have symptoms: (please check off appropriate response and give duration of symptoms)

Improved: _____ Worsened: _____ Remained Unchanged: _____

V. Treatment of Symptoms (check off appropriate response)

None: _____ Self-Medicated: _____ Physician Treated: _____

3.0 SITE BACKGROUND

3.1 FACILITY HISTORY

The facility is located about 25 miles southwest of Washington D.C., in the northwest portion of Charles County. It encompasses about 2,253 acres, including the Indian Head peninsula (2,010 acres), Bullit's Neck peninsula (47 acres), the railroad right of way linking Indian Head to White Plains (163 acres), and two islands in Mattawoman Creek. The mailing address for the facility's environmental office is Naval Surface Warfare Center, Indian Head Division, 101 Strauss Avenue, Indian Head MD 20640.

The facility is bounded by the Potomac River to the north and west, the Mattawoman Creek to the south, and the town of Indian Head to the east. The Naval Explosive Ordnance Disposal Technology Center, which is located on the Stump Neck peninsula, is south of the Indian Head facility across the Mattawoman Creek.

In 1890, the U.S. Navy established the facility as the Naval Proving Ground, which had the responsibility for testing naval guns, powder, fuses, and other naval ordnance. A smokeless powder factory was built at the facility in 1900, and during the period from 1900 to 1932, the Navy shifted the facility from proving ground activities to smokeless powder production. The Navy renamed the facility the Naval Powder Factory in 1932.

Manufacturing responsibilities were expanded to include explosives and other propellants. These operations necessitated construction of several other factories and plants at the facility. The facility was renamed several times during the period from 1932 to 1992, when it was assigned its current designation as the Indian Head Division of the Naval Surface Warfare Center.

The materials handled during the manufacturing operations include acids, solvents, heavy metals, propellants, and explosives. The propellants, explosives, and other volatile materials are contained in storage bunkers at the facility.

The facility was placed on the U.S. Environmental Protection Agency's National Priorities List (NPL) on September 29, 1995.

3.1.1 Mattawoman Creek

Mattawoman Creek drains a 79-square-mile area in northern Charles County and southern Prince George's County, Maryland. The creek originates southwest of Brandywine and flows for 30 miles until it empties into the Potomac River at river mile 71. The average annual discharge rate of Mattawoman Creek to the Potomac River is 54.2 cubic feet per second, which is a small proportion (less than 0.4 percent) of the total Potomac River freshwater flow. The first 25 miles of the creek are free flowing, and the last 5 miles are a tidal embayment. Tidal amplitude in the lower Mattawoman Creek averages about 0.5 meter but fluctuates considerably depending on weather, season, and moon phase. The lower portion of the creek is classified as a tidal freshwater stream throughout most of the year.

The main portion of IHDIV-NSWC is located along the northern shoreline of Mattawoman Creek, from its confluence with the Potomac River upgradient for approximately 3 miles. Stump Neck Annex is located along the southern shoreline of Mattawoman Creek, from its confluence with the Potomac River to approximately 1 mile upgradient of the confluence. The Mattawoman Creek basin is mostly rural but includes INDIV-NSWC, the town of Indian Head, and a rapidly developing suburban area in northern Charles County. Concerns about increased development in the upper Mattawoman Creek basin have led to ongoing studies by the Smithsonian Environmental Research Center and Charles County and the U.S. Army Corps of Engineers. These studies focus on the development of a watershed management plan. The Indian Head Waste Water Treatment Plant discharges to a small creek known as Harrison Cut, which empties into Mattawoman Creek at a point along the northern shoreline, approximately 1,000 feet upgradient of the eastern base boundary.

The width of Mattawoman Creek increases as it approaches IHDIV-NSWC. A defined creek channel is present in the reach of the creek near the southern base boundary. Measured depths range from approximately 9 feet to 17 feet. This clearly defined channel flows past the Scrap Yard area and then becomes more diffuse. The entire creek becomes shallower near Thoroughfare Island and Marsh Island. Depths in these areas range from 2 to 6 feet. A large flat is present in the area south of Thoroughfare Island. From Bullit's Neck to the mouth of the Potomac, Mattawoman Creek becomes broad and open, with depths ranging from 3 to 8 feet. Highly variable depths down to 14 feet were measured in this broad area. A diffuse channel is present in the middle of this final stretch of lower Mattawoman Creek.

4.0 SCOPE OF WORK

This section of the HASP addresses proposed site activities that are to be conducted at IHDIV-NSWC. The objective of the Mattawoman Creek Study is to investigate the magnitude of impacts of base-related activities on Mattawoman Creek and to assess the potential ecological and human health risks associated with the impacts. The scope of the field activities includes collecting both abiotic and biotic environmental samples. The activities to be conducted as part of the scope of work are as follows:

- Mobilization/demobilization
- Multi-media sampling, including:
  - Surface Water
  - Sediment
  - Fish
  - Aquatic Vegetation
- Decontamination of sampling equipment
- IDW management This task includes the containerization, labeling, staging, monitoring, and final deposition of Investigation Derived Wastes (IDW).
- Surveying

Table 5-1, provides information related to each of these tasks that are to be performed as part of the scope of work. If other tasks, other than those identified, are to be performed at the site, this HASP will be modified.

4.1 MOBILIZATION/DEMOBILIZATION

This task includes, but not limited to, the following:

- The procurement and shipping of equipment, and materials for the field investigation.
- Review of planning documents (i.e., HASP, Work Plan, FSP Quality Assurance Plan, Applicable SOPs, etc.).
- Mobilizing all required subcontractors, equipment, and materials to the site
- Obtaining all necessary sampling permits.
- Attending an approximately 1-hour site-specific health and safety review meeting
- Delineating work zones required by the Health and Safety Plan (HASP)
- Secure, construct, or equip IDW storage facilities to support the field activities.
- Arranging an area to perform decontamination procedures

- Demobilizing all equipment and materials from the site; and
- Performing general site cleanup and removal of trash

4.2 MULTI-MEDIA SAMPLING

4.2.1 Surface Water Sampling

Samples will be collected for surface water chemistry analysis in Mattawoman Creek. Four samples will be collected in each of five areas of Mattawoman Creek near the base that have been identified as most appropriate for sampling. The specific sample locations will be selected in the field. The four samples will be placed at sites of localized ecological importance, hydrology (e.g., sediment depositional areas), and proximity to potential sources of chemicals for each area. Spatial coverage of each area will also be considered as a criterion for sample locations. Six additional samples to fill in data gaps will be collected, as well as two more samples that may be collected if field conditions suggest additional data gaps. Two surface water samples will be collected upgradient of the base near the Highway 225 bridge to serve as reference samples. In addition, two samples will be collected in Nanjemoy Creek, which is located along the Potomac downgradient of Mattawoman Creek, to also serve as reference samples. Surface water samples will be co-located with the sediment samples.

4.2.2 Sediment Sampling

Samples will be collected for sediment chemistry analysis in Mattawoman Creek. Four samples will be collected in each of five areas that have been identified as most appropriate for the surface water sampling. Six samples will be collected to fill in data gaps between the five areas of concern. Two additional samples may be collected if field conditions suggest that data gaps still exist. Two sediment samples will be collected upgradient of the base near the Highway 225 bridge to serve as reference samples. In addition, two sediment samples will be collected in Nanjemoy Creek to also serve as reference samples. A total of up to 32 samples will be collected, plus QA/QC samples. Sediment samples will also be collected for sediment toxicity testing. Four samples will be collected in each of five areas that have been identified as most appropriate for sampling. Two samples will be collected upgradient of the base near the Highway 225 bridge to serve as reference samples. These samples will be co-located with the sediment chemistry and sediment macroinvertebrate samples (i.e., the sediment "triad). In addition, two sediment samples will be collected in Nanjemoy Creek to also serve as reference samples. Thus, a total of 24 investigative samples will be collected. Two duplicates in Mattawoman Creek near the base and one duplicate in the each of the two selected reference areas will also be collected for QA/QC. This toxicological analysis will consist of 10-day mortality and growth testing using *Hyalella azteca*.

Biological analysis will consist of benthic macroinvertebrate community analysis by a subcontracted laboratory. Samples will be co-located with sediment chemistry and toxicity testing samples (i.e., the sediment triad) for a total of 24 samples. The subcontracting laboratory will calculate specified diversity and abundance metrics and indices. Two duplicates in Mattawoman Creek near the base and one duplicate in the each of the two selected reference areas will also be collected for QA/QC.

A PONAR grab sampler will be used to collect sediment samples. The PONAR grab sampler consists of two opposing semi-circular jaws that are normally held open by a trigger mechanism. The sampler is lowered to the bottom where contact with the bottom sets off the trigger and a strong spring snaps the jaws shut trapping a sample of the bottom inside. Fine copper screen covers the top of the jaws so that the trapped material will not wash out as the sampler is retrieved.

4.2.3 Fish Sampling

Fish tissue samples will be collected at each of the five identified investigative areas mentioned above. An upgradient location near the Highway 225 bridge will be sampled twice, as will the reference sampling location located in Nanjemoy Creek. One whole-body composite sample and one fillet composite sample for each of the three species will be collected at each location. Thus, 27 whole-body and 27 fillet samples will be collected, for a total of 54 samples, plus QA/QC.

The three proposed target species are channel catfish *(Ictalurus punctatus)*, largemouth bass *(Micropterus salmoides)*, and bluegill *(Lepomis macrochirus)*. The criteria used in selecting the target species were 1) edibility, 2) abundance in Mattawoman Creek, and 3) relatively non-migratory. Channel catfish are bottom feeders. Therefore, they have a high exposure to contaminants in the sediment. They are edible, although they are less frequently eaten than some other catfish species. Largemouth bass are top predators that consume insects, crayfish, and other fish. They are good indicators of contaminant transfer through the food chain. They are also regularly eaten and are generally freshwater fish. Bluegill are omnivores, with benthic macroinvertebrates constituting a substantial portion of their diet. They also are good indicators of contaminant transfer through the food chain and are regularly eaten by humans. All three fish species are abundant in Mattawoman Creek, and their movement out of Mattawoman Creek is expected to be restricted because of the higher salinity in the Potomac River.

The following methods will be used to collect the fish samples:

Gill Net Fishing

Gill nets are made of monofilament resembling tennis nets. They are stretched across the water bodies to capture fish as they pass through the net by snagging them as they retreat. The nets are available in

various lengths, heights, and mesh opening sizes. The mesh openings are sized for the type of fish to be collected. Because gill nets tend to kill the fish, the nets will be checked at least twice each day to obtain fish that are still usable for analysis.

Trap Net Fishing

Trap nets are cone-shaped nets with successively smaller hoops and openings from the front to the back. The nets are available in various lengths, diameters, and mesh opening sizes; however, they typically sample a smaller area than gill nets. The nets can be fitted with "wings" to help direct the fish into the nets. The fish are "funneled" into the back of the nets and have a difficult time swimming out of the nets because of the small opening after the last hoop and are thus trapped. These nets are useful in collecting various sizes of fish because they are less size restrictive than the gill nets. They are especially useful in collecting sunfish that are sometimes difficult to catch in gill nets. The other advantage of these nets is that they keep the fish alive and do not physically harm the fish as much as gill nets.

Hook and Line Fishing

Finally, fish may be collected by hook-and-line (i.e., fishing pole) or trot lines. Trot lines are strings of hooks (usually at least 20) that are uniformly secured to a thick line. The hooks are baited and deployed on the bottom of the water body with at least one end secured to the shore. They are useful for collecting bottom feeders such as channel catfish. All fish tissue sampling will be conducted in accordance with IHDIV-NSWC SOP SA-09.

4.2.4 Aquatic Vegetation Sampling

Wild celery will be collected from locations identified in the field near the base, preferably the same general areas as the fish samples. Samples will be collected at each of the five investigative areas mentioned above. Two upgradient locations near the Highway 225 bridge will be sampled, as well as two reference sampling locations in Nanjemoy Creek. Composite samples will be collected. Each will consist of samples from several locations within a given sampling area (i.e., the four chemistry sampling locations per sampling area). Thus, nine samples will be collected, plus QA/QC samples

4.3 DECONTAMINATION

The non-disposable equipment involved in field sampling activities will be decontaminated prior to and upon completion of sampling activities. Personnel will also perform decontamination procedures as required by the HASP before departing from the site.

Non-disposable sampling equipment decontamination will be performed using analyte-free water and phosphate-free soap (e.g., Alconox®) will be used for incidental cleaning of equipment. Field analytical equipment such as water-quality meters and probes will be rinsed with analyte-free water first and then with the sample liquid, before sampling water.

4.4 INVESTIGATION-DERIVED WASTE (IDW)MANAGEMENT

4.4.1 DecontaminaTion Fluids

All liquid IDW accumulated during the field activities will be collected, containerized, and stored in Department-of-Transportation approved (specification 17-C/H) 55-gallon drums at the site. The drums will be labeled as soon as possible after they are filled and will be kept onsite, pending the results of surface water and sediment analyses. Upon receipt of the analytical results, a determination will be made whether offsite disposal or treatment is required.

4.4.2 Personal Protective Equipment (PPE) and Miscellaneous Waste

The field team PPE will be disposed as required. These items, such as disposable latex gloves and paper towels, will be temporarily stored in plastic bags, with a daily transfer to dumpsters at the end of each workday.

4.5 SURVEYING

TtNUS personnel will survey sampled locations in the field using a portable Global Positioning System. □Horizontal locations will be referenced to the Maryland State Plane coordinate system. Because the planned sampling will be conducted from boats on Mattawoman Creek, the vertical position of sampling points will not be recorded.

5.0 TASKS/HAZARDS/ASSOCIATED CONTROL MEASURES SUMMARIZATION

Table 5-1 of this section serves as the primary portion of the site-specific HASP and identifies the tasks that are to be performed as part of the scope of work. This table will be modified and incorporated into this document as new or additional tasks are performed at the site. The anticipated hazards, recommended control measures, air monitoring recommendations, required Personal Protective Equipment (PPE), and decontamination measures for each site task are discussed in detail. This table and the associated control measures shall be changed, if the scope of work, contaminants of concern, or other conditions change.

Through using the table, site personnel can determine which hazards are associated with each task and at each site, and what associated control measures are necessary to minimize potential exposure or injuries related to those hazards. The table also assists field team members in determining which PPE and decontamination procedures to use as well as proper air monitoring techniques.

As discussed earlier, a Health and Safety Guidance Manual accompanies this table and HASP. The manual is designed to further explain supporting programs and elements for other site-specific aspects as required by 29 CFR 1910.120. The Guidance Manual should be referenced for additional information regarding decontamination activities, emergency response, hazard assessments, hazard communication program, medical surveillance, PPE, site control measures, standard work practices, and training requirements. Many of Tetra Tech NUS' SOPs are also provided in this Guidance Manual.

Safe Work Permits issued for sampling activities (See Section 10.10) will use elements defined in Table 5-1 as it's primary reference. The FOL in completing the Safe Work Permit will add additional site-specific information. In situations where the Safe Work Permit is more conservative than the direction provided in Table 5-1 due to the incorporation of site-specific elements, the Safe Work Permit will be followed.

5.1 GENERAL SAFE WORK PRACTICES

In addition to the task-specific work practices identified on Table 5-1, the follow these safe work practices when conducting work involving known and unknown site hazards. These safe work practices establish a pattern of general precautions and measures for reducing risks associated with hazardous site operations.

- Refrain from eating, drinking, chewing gum or tobacco, taking medication, or smoking in contaminated or potentially contaminated areas or where the possibility for the transfer of contamination exists.
- Wash hands and face thoroughly upon leaving a contaminated or suspected contaminated area.
- Avoid contact with potentially contaminated substances.

- Be familiar with and adhere to all instructions in the site-specific HASP.
- Place cellular telephone or two way radios in a plactic bag to protect from water.
- Attend briefings on anticipated hazards, equipment requirements, Safe Work Permits, emergency procedures, and communication methods before going on site.
- Rehearse unfamiliar operations prior to implementation.
- Use the "buddy system". Establish hand signals or other means of emergency communication in case two-way radio failure.
- Maintain visual contact with each other and with other on-site team members by remaining in close proximity in order to assist each other in case of emergency.
- Minimize the number of personnel in the sampling boat.
- Establish appropriate decontamination procedures for leaving the site.
- Immediately report all injuries, illnesses, and unsafe conditions, practices, and equipment to the Site Safety Officer (SSO).
- Observe coworkers for signs of heat stress.

5.2 ELECTROFISHING SAFE WORK PRACTICES

Fish samples will be collected using electrofishing, although gill nets, trap nets, trot lines, and/or hook-and-line methods are potential alternatives. Only live (i.e., no bloating, gills still red) fish will be collected and retained for chemical analysis. Upon collection, fish will be separated by species and immediately placed on wet ice for processing. The fish shall be shipped to the lab on the same day as they are collected or else they shall be frozen and shipped on dry ice. Live, non-target fish, shall not be collected during this investigation and will be returned to the water.

Electrofishing involves running an electrical current through the water to stun fish within the impacted radius using a boat-mounted or backpack electrofishing unit. This investigation is expected to only use a boat-mounted unit. The stunned fish will be captured with dip nets and sorted appropriately. Electrofishing is not suitable for waters with low conductivity (the water cannot conduct a current), or waters with high conductivity (the current flows around the fish and does not stun them). There may be portions of Mattawoman Creek or Nanjemoy Creek that will be too conductive to electrofish effectively. Also, electrofishing may not be an effective way to collect the channel catfish because they usually reside in deeper waters that may be out of the range of the current.

Sample collection shall be conducted in accordance with the USEPA Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume 1, Fish Sampling and Analysis, Second Edition (USEPA, 1995).

Length and weight data will be collected for the fish submitted for analysis. Length measurements are determined using a measuring board consisting of a linear metric scale on a flat wooden or plastic base with a rigid headpiece. Weight measurements will be recorded by placing the fish into a small plastic container set on a portable electronic balance. Care should be taken to ensure that the balance is reasonably level and protected from the weather to minimize any error associated with determining weight measurements under field conditions. A hanging scale is required in addition to a portable balance to determine the weight of large fish that exceed the limits of the portable balance.

5.2.1 Fish Sampling Equipment

For boat, equipment, and operational procedures, instruction sheets will be enclosed in waterproof plastic and be readily available for reference at all times during the electrofishing operation. All equipment will be turned off before making any connections or replacing parts. Noise levels will be maintained within the acceptable exposure of 85 dba for 8-hour exposure.

5.2.2 Electrofishing Boats

Electrofishing boats vary in design but usually consist of a gasoline-powered generator and an electrical output control mechanism in an aluminum boat. The electrical configuration of the boat also varies. However, generally the boat is configured as the cathode, with anode arrays consisting of single (stainless steel cable), circular (hollow stainless steel ball), or multiple (several stainless steel cables) configurations.

Electrofishing boats will provide adequate flotation and freeboard clearance consistent with equipment, cargo, and passenger weight when being operated. The boat should be equipped to meet U.S. Coast Guard or State boating regulations. The boat deck should be painted with a non-slip or skid resistant coating. General boat housekeeping must provide adequate working space to conduct safe operations. Care will be exercised to prevent clutter that may result in safety hazards. The boat and equipment should be visually inspected for safety by the supervisor or operator in charge, prior to each use. Significant deficiencies, which could result in employee injury, should be corrected prior to operation or use of the equipment.

Electrical amp-volt meters should be installed to provide adequate monitoring of boat electrical power equipment. The boat operator should be able to operate an electrical control or switch to cut the power in case of an accident. The netter should have a deadman switch connected to the power control circuit from the pulsator or generator source. This allows the current between the electrodes to be broken in case of an accident. Power control circuits will not exceed 24 volts.

All metal surfaces within a metal boat should be electrically connected, grounded, and bonded to the boat hull to eliminate differences in electrical potential that may result in electric shock. The metal boat hull may also be used as a cathode. To avoid possible electrolysis problems when the metal hull is being used as a cathode, zinc strips should be attached to the hull as "sacrificial anodes." The electrolysis will occur on the zinc strips which will preserve the integrity of the hull.

All conductors may be installed in a common raceway (conduit) provided each conductor installed is continuous (without connectors, breaks, or splicing) and is independently and correctly insulated. All low voltage (24 volts or less) circuits will be contained in separate raceways from those containing high voltage conductors. An acid proof, nonmetallic enclosure and holder should be provided for wet cell batteries.

Lighting and other auxiliary circuits should not exceed 24 volts; however, 110-volt lamps may be used if the lamp is shielded with a nonconductive cage. When the boat is operated at night, adequate on-board lighting (12-24 volts) should be provided for working areas. Adequate lighting will be provided while electrofishing to avoid safety hazards; such as striking logs, rocks, and overhead tree branches.

Safety rails should be provided around the outside of the netting area and will be at least 105 centimeters (42 inches) high and be constructed of at least 1.8 centimeters (3/4-inch) diameter heavy-walled steel pipe or 3.75 centimeters (1 1/2-inch) heavy-wall aluminum pipe. Rails should be designed to withstand a 90 kilogram (200-pound) side thrust. The work deck should be covered with nonskid material and sloped to allow drainage. The high gunnels of wooden draft boats are satisfactory as safety rails.

Each boat should be equipped with at least one 2.25 kilogram (5-pound) type ABC fire extinguisher mounted in a holder for easy access to the boat operator and away from high fire potential sources. To ensure visibility, the color red will be used to identify fire extinguishers, safety cans, and stop buttons for electrical equipment. The color fluorescent orange will be used to identify all other safety switches.

5.2.3 Electrical Equipment

AC voltage from a generator should be isolated from the ground either by removing the ground strap from the generator case or by adding an isolation transformer. Power output conductors from the generator or alternator should include a circuit breaker or fuse to provide branch circuit protection. The exhaust from gasoline powered engines and generator alternators should be directed away from the equipment operator. Exposed hot pipes should be enclosed in protective screening to reduce the potential of burn exposure to the crew. The use of galvanized pipe for exhaust is discouraged due to the potential release of toxic gases that are produced under extreme heating conditions.

To refuel the generator/alternator, all equipment will be turned off. Hot surfaces should be allowed to cool. It is recommended that all tanks be filled prior to each operation to avoid the potential for explosion or fire while refueling hot gasoline engines. Gasoline should be stored and transported in approved metal containers. Such containers, when used for storage on metal hull boats, will be grounded.

Batteries

Batteries used as an electrical power source for backpack shockers will be of the gel type that will not leak when tipped or overturned. Backpacks will be equipped with a quick release belt (hip) and shoulder straps.

Conductors

Conductors should be of the stranded type for flexibility and will be suitable for use in dampness. All conductors in the boat should be enclosed in conduits or liquid-tight flexible conduits; however, appropriate heavy-duty rubber cord can be used where flexibility is desired. Rated voltages of insulation of conductors used to deliver output current from the pulsator to the electrodes must exceed the maximum potential voltage of the pulsator or generator by the next higher rating. Conductor size (i.e., current carrying wire) will be approved for rated amperage of equipment.

Power Control

The operator should have a switch to the pulsator or power control unit so that the electricity can be turned off quickly in an emergency. All equipment purchased after October 1, 1985 must be equipped with a tilt switch that breaks the circuit if the operator falls. The switch must be a type that has to be manually reset after the operator has regained his/her footing.

Circuit Breakers

Circuit breakers or fuses used for providing branch circuit protection should be enclosed in a weatherproof enclosure or cabinet that complies with National Electric Code, Article 373-2, which states the following: "In damp or wet locations, cabinets and cutout boxes of the surface type will be so placed or equipped so as to prevent moisture or water from entering and accumulating within the cabinet or cutout box and will be mounted so that there is at least .625 centimeters (1/4-inch) air space between the enclosure and the wall or other supporting surface. Cabinets or cutout boxes installed in wet locations will be weatherproof."

Junction Boxes

All junction boxes should be cast iron, cast aluminum, fiberglass, plastic, or rubber and must either be weatherproof or raintight depending on use. Junction boxes with switching equipment must be weatherproof and junction boxes without switches may be raintight.

5.2.4 Equipment Handles

Net handles should be constructed of a nonconductive material and will be of sufficient length to avoid hand contact with the water. Electrode handles should be constructed of a nonconductive material and be long enough to avoid hand contact with the water.

5.2.5 Equipment Repairs

Splices in wiring will not be permitted. If connections are necessary, the rating of the connector must be the same or greater than the wire. Connectors used in association with flexible cords will be of the locking, waterproof type. Connectors used in association with flexible cords will be of the locking, waterproof type.

5.2.6 Equipment Training

Electrofishng is recognized as a hazardous activity for which skills training are required in accordance with the United States Fish and Wildlife Service. Satisfactory completion of the National Fisheries Academy course, "Principles and Techniques of Electrofishing" is required. Upon completion of the course, an electrofishing certificate of competency will be issued.

Training and education for electrofishing operations for the team leader will include the following:

- The basic principles of electricity and transmission of current in water.
- The basic concept and design guidelines for electrofishing equipment.
- Electrofishing equipment, the equipment's capabilities, limitations, and safety features.
- The safety precautions to employ while using electrofishing equipment.
- The team leader must have a current certification in cardiopulmonary resuscitation (CPR) training and first aid. A certificate from the Red Cross or other recognized institution will certify CPR and first aid training.
- Completion of the course, Principles and Techniques of Electrofishing, at the National Fisheries Academy or at a field location, or successful completion of the certifying examination, will serve to satisfy competency.

All members of the electrofishing crew will be briefed in the following areas:

- Hazards involved in electrofishing.
- Safe operation of electrofishing equipment.
- Basic emergency procedures for drowning, unconsciousness, and electrical shock.
- All members of the electrofishing crew will also be knowledgeable of defensive driving techniques, including towing and backing of boat trailers if an electrofishing boat is used, and safe boating operations.

5.2.7 Electrofishing Responsibility

The individual in charge of electrofishing operations is the team leader and is be responsible for the following:

- Identifying hazardous conditions associated with proposed electrofishing operations, determining measures to protect electrofishing team members, and appropriately briefing team members.
- Ensuring that employees have and utilize the proper safety equipment.
- Ensuring adequate warning is provided to the public to avoid public exposure to the potential hazards of electrofishing operations.
- Ensuring precautions are taken to avoid harm to nets, domestic animals, or wildlife.
- Ensuring that all electrofishing operations cease and all crew members go ashore in the event of a thunderstorm.
- Ensuring that only those persons necessary to conduct a safe and efficient operation, and those observers being trained engage in each electrofishing operation.
- Ensuring the availability of a well equipped, watertight first aid kit.
- Reviewing a electrofishing safety checklist (Attachment II of this HASP) and ensuring the addition of specialized items to the checklist that pertain to their Regions or operation.

5.3 HOOK AND LINE AND TROT FISHING

Careful casting is key to keeping hooks where they belong. Fly-, spin- and bait-fishing each have their own casting techniques, but all require an open area behind the caster. Fly casters need up to 30 feet behind them, and bait casters also need clear side space, depending on whether they're right- or left-handed. It's the caster's responsibility to make sure there is enough room to cast safely, but all others in the vicinity should also watch. Problems can arise when an angler's cast "catches" a nearby tree, bush or root. Many people will try to snap the hook free to avoid cutting the line and losing the hook. That wild "snapback" motion might cause the hook to imbed the the caster or others.

A trot line is a long cord with multiple fish hooks attached to it (usually around 20 –25). The advantages trot line fishing are that the line can be set in the morning and checked in the afternoon and that the width

of a channel can be covered with hooks. One procedure to install the tie line line to one side of the channel, stretch the line across and tie off to the other side - any fish passing thru will come near one of the hooks. The line can also be anchored to a floating markers. Never throw the line. A miscalculation could cause the line to wrap around person(s) installing the line or others in the area. When checking the line pull gently to see if it pulls back. If there is something that starts pulling back too vigorously it is better to cut the line and loose what is caught than to risk embedding several hooks and possibly be pulled into the water. A minimum of two persons should perform this task. The trot line is best suited for catfish, turtles and crappie.

5.3.1 Removing Imbedded Hooks

There are several methods for removing imbedded hooks. If there are any doubts about attempting to remove it, seek medical attention immediately.

One way to remove a hook is to cut off the hook's eyelet and push the hook forward through the skin until its point and barb are exposed. Then cut off the curved end of the hook and gently pull the now straightened hook through the opening. This procedure requires making an additional puncture which causes more bleeding.

Some species of fish have spines that can cause havoc on the hands of an unprepared angler. Among the most common are catfish, bullhead and walleye. Sturdy gloves, a hook extractor, wire cutter or needlenose pliers can be used to keep to protect the hands from the spines. To mazimize dexterity cut off the gloves' thumb and forefinger

5.4. CHECKLIST FOR SAFE FISHING

- Hook extractor, wire cutter or needlenose pliers
- Nets
- Hat, sunscreen and sunglasses
- Personal flotation device
- Proper shoes or boots, especially if you're wading
- Leather gloves for handling nets
- Drinking water
- First-aid kit, including adhesive bandage strips and disinfectant
- Cellular phone for outgoing emergency calls
- Radio -- so you can monitor weather reports

TASKS/OPERATION/ LOCATIONS	ANTICIPATED HAZARDS	RECOMMENDED CONTROL MEASURES	HAZARD MONITORING	PERSONAL PROTECTIVE EQUIPMENT *(Items in italics are deemed optional as conditions or the FOL or SSO require.)*	DECONTAMINATION PROCEDURES
Mobilization/ Demobilization	***Physical Hazards:*** 1) Lifting (strain/muscle pulls) 2) Pinches and compressions 3) Slip, trips, and falls 4) Ambient temperature extremes (heat stress) NATURAL HAZARDS: 5) Insect/animal bites and stings	1) Use machinery or multiple personnel for heavy lifts. Use proper lifting techniques. 2) Avoid moving parts. Use tools or equipment where necessary to avoid contacting pinch points. 3) Preview work locations for unstable/uneven terrain. 4) Wear appropriate clothing for weather conditions. Provide acceptable shelter and liquids for field crews. Additional information regarding heat stress concerns is provided in TtNUS Health and Safety Guidance Manual. 5) Avoid nesting areas, use commerically available insect repellents. Report potential hazards to the SSO. Follow guidance presented in the Health and Safety Guidance Manual.	Air monitoring is not required given that volatile contaminants are not likely to be present during surveying activities.	Level D - (Minimum Requirements) - Standard field attire (Sleeved shirt; long pants) - Steel Toe Safety shoes - *Safety glasses* - *Hardhat (when overhead hazards exists, or identified as a operation requirement)* - *Reflective vest for high traffic areas* - *Hearing protection for high noise areas, or as directed on an operation by operation scenario.*	Not required
Multi-media sampling including surface water, sediment, fish, and aquatic vegetation	***Chemical hazards:*** 1) Generally low concentrations of volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides, metals (mercury and silver) and energetics (nitroguanidine, 1,1-dimethylhydrazine, and nitrocellulose) See Table 6-1 for more information on the chemicals of concern. 2) Transfer of contamination into clean areas ***Physical hazards:*** 3) Lifting (strain/muscle pulls) 4) Slip, trips, and falls 5) Ambient temperature extremes (heat stress) 6) Water hazards/drowning 7) Pinches and compressions ***Natural hazards:*** 8) Insect/animal bites and stings 9) Inclement weather	1) Visually monitor sampling procedures, Avoid contact with potientially contaminated media. 2) Decontaminate all equipment and supplies between sampling locations and prior to leaving the site. 3) Use machinery or multiple personnel for heavy lifts. Use proper lifting techniques. 4) Preview work locations for unstable/uneven terrain. 5) Wear appropriate clothing for weather conditions. Provide acceptable shelter and liquids for field crews. Additional information regarding heat stress concerns is provided in the TtNUS Health and Safety Guidance Manual. 6) While working in a boat, personnel shall wear U.S. Coast Guard-approved personal flotation devices (PFD). See Section 6 of this HASP for further information on types of PFD. The State of Maryland requires that motor boats carry a Class B (flammable liquid) fire extinguisher, a PDF for each person on board and sound producing device such as a portable air horn. When working on the shore, within 4 ft. of the water edge, lifelines, safety harnesses, and other personal safety devices may be used instead of a PFD. 7). The Posnar sampler uses a spring loaded mechanism which is triggered upon impact. Avoid its moving parts especially when it is in the "cocked" position. Use tools or equipment where necessary to avoid contacting pinch points. 8) Avoid nesting areas, use commerically available insect repellents. Report potential hazards to the SSO. Follow guidance presented in the Health and Safety Guidance Manual Report potential hazards to the SSO. 9) Suspend or terminate operations until directed otherwise by SSO	Air monitoring is not required given that volatile contaminants are not likely to be present during surveying activities.	Level D protection will be utilized for the initiation of all sampling activities. Level D - (Minimum Requirements) - Standard field attire (Sleeved shirt; long pants) - Safety glasses - Surgical style gloves (double-layered if necessary) - Type III Personal floation device at all times in boat. - *Hat to protect from UV rays from the sun.* - *PVC Rainsuits or PE or PVC coated Tyvek - Hearing protection for high noise areas, or as directed on an operation by operation scenario.* **Note:** The Safe Work Permit(s) for this task (see Attachment IV) will be issued at the beginning of each day to address the tasks planned for that day. As part of this task, additional PPE may be assigned to reflect site-specific conditions or special considerations or conditions associated with any identified task.	**Personnel Decontamination** will consist of a removal and disposal of non-reusable PPE (gloves, coveralls, etc., as applicable). The decon function will take place at an area adjacent to the site activities. This procedure will consist of: - Equipment drop - Outer coveralls, boot covers, and/or outer glove removal (as applicable) - Removal, segregation, and disposal of non-reusable PPE in bags/containers provided - Soap/water wash and rinse of reusable PPE (e.g., hardhat) if potentially contaminated - Wash hands and face, leave contamination reduction zone.
Decontamination of Sampling Equipment	***Chemical hazards:*** 1) Generally low concentrations of volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides, metals (mercury and silver) and energetics (nitroguanidine, 1,1-dimethylhydrazine, and nitrocellulose) See Table 6-1 for more information on the chemicals of concern. 2) Decontamination fluids - Liquinox (detergent), acetone or isopropanol ***Physical hazards:*** 3) Lifting (strain/muscle pulls) 4) Slips, trips, and falls ***Natural hazards:*** 5) Ambient temperature extremes (heat stress)	1) and 2) Employ protective equipment to minimize contact with site contaminants and hazardous decontamination fluids. Obtain manufacturer's MSDS for any decontamination solvents used onsite. Use appropriate PPE as identified on MSDS. All chemicals used must be listed on the Chemical Inventory for the site, and site activities must be consistent with the Hazard Communication section of the Health and Safety Guidance Manual (Section 5). 3) Use multiple persons where necessary for lifting and handling sampling equipment for decontamination purposes. 4) Preview work locations for unstable/uneven terrain. 5) Wear appropriate clothing for weather conditions. Provide acceptable shelter and liquids for field crews. Additional information regarding cold/heat stress concerns is provided in Section 4 of the TtNUS Health and Safety Guidance Manual.	Air monitoring is not required given that volatile contaminants are not likely to be present during surveying activities.	For sampling equipment (trowels, MacroCore Samplers, bailers, etc.), the following PPE is required Level D Minimum requirements - - Standard field attire (Long sleeve shirt; long pants) - Steel-toe safety shoes - Nitrile outer gloves - Safety glasses In the event of overspray of chemical decontamination fluids employ PVC Rainsuits or PE or PVC coated Tyvek as necessary.	**Personnel Decontamination** will consist of a soap/water wash and rinse for reusable outer protective equipment (boots, gloves, PVC splash suits, as applicable). The decon function will take place at an area adjacent to the site activities. This procedure will consist of: - Equipment drop - Soap/water wash and rinse of outer boots and gloves, as applicable - Soap/water wash and rinse of the outer splash suit, as applicable - Disposable PPE will be removed and bagged. Sampling equipment will be decontaminated as per the requirements in the Sampling and Analysis Plan and/or Work Plan. MSDS for any decon solutions (Alconox, isopropanol, etc.) will be obtained and used to determine proper handling / disposal methods and protective measures (PPE, first-aid, etc.).

TASKS/OPERATION/ LOCATIONS	ANTICIPATED HAZARDS	RECOMMENDED CONTROL MEASURES	HAZARD MONITORING	PERSONAL PROTECTIVE EQUIPMENT *(items in italics are deemed optional as conditions or the FOL or SSO require.)*	DECONTAMINATION PROCEDURES
Geographical Survey	***Chemical hazards:*** Significant exposure to site contaminants is anticipated to be unlikely given the nature of this task. ***Physical hazards:*** 1) Slips, trips, and falls 2) Ambient temperature extremes (heat stress) ***Natural hazards:*** 3) Inclement weather 4) Insect/animal bites or stings, poisonous plants, etc.	1) Preview work locations and site lines for uneven and unstable terrain. Clear necessary vegetation, establish temporary means for traversing hazardous terrain (i.e., rope ladders, etc.) 2) Wear appropriate clothing for weather conditions. Provide acceptable shelter and liquids for field crews. Additional information regarding cold/heat stress is provided in the Health and Safety Guidance Manual. 3) Suspend or terminate operations until directed otherwise by SSO 4) Avoid nesting areas, use repellents. Report potential hazards to the SSO. Follow guidance presented in the Health and Safety Guidance Manual.	Air monitoring is not required given that volatile contaminants are not likely to be present during surveying activities.	Surveying activities shall be performed in Level D protection Level D Protection consists of the following: - Standard field dress including sleeved shirt and long pants - Safety shoes (Steel toe/shank) - *Safety glasses, hard hats (if working near machinery)* - *Snake chaps for heavily wooded area where encounters are likely.* - *Tyvek coveralls may be worn to provide additional protection against poisonous plants and insects, particularly ticks. Work gloves may be worn if desired.* **Note:** The Safe Work Permit(s) for this task (see Attachment IV) will be issued at the beginning of each day to address the tasks planned for that day. As part of this task, additional PPE may be assigned to reflect site-specific conditions or special considerations or conditions associated with any identified task.	**Personnel Decontamination** - A structured decontamination is not required as the likelihood of encountering contaminated media is considered remote. However, survey parties should inspect themselves and one another for the presence of ticks when exiting wooded areas, grassy fields, etc. This action will be employed to stop the transfer of these insects into vehicles, homes, and offices.

6.0 HAZARD ASSESSMENT

This section provides information regarding the chemical and physical hazards associated with the Mattawoman Creek near the IHDIV-NSWC and the activities that are to be conducted as part of the scope of work. Table 6-1 provides various information related to the chemical hazards that may be present at the site. Specifically, toxicological information, exposure limits, symptoms of exposure, physical properties, and air monitoring and sampling data are also discussed in that table.

6.1 CHEMICAL HAZARDS

A wide range of chemicals of potential concern were identified, including inorganics, SVOCs [including polynuclear aromatic hydrocarbons (PAHs)], pesticides, polychlorinated biphenyls (PCBs), and energetics.

Limited surface water and sediment sampling, primarily sediment sampling, was conducted in Mattawoman Creek during the Site Inspection (SI). Generally low concentrations of volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs) , pesticides, and metals were detected. Nitroguanidine, 1,1-dimethylhydrazine, and nitrocellulose were also detected. In the Remedial Investigation surface water and sediment samples were collected. In general, concentrations of all analytes were low in surface water, and concentrations of VOCs, SVOCs, and pesticides were low in sediments. In contrast, concentrations of nitrocellulose and several metals, including mercury and silver, were elevated in sediments.

Information on the toxicological, chemical, and physical properties of other potential contaminants of concern is addressed in Table 6-1 of this HASP. It is anticipated that the greatest potential for exposure to site contaminants is during activities in which contact with potential contaminated media exists (soil boring, monitoring well installations, sampling activities, etc.).

6.2 PHYSICAL HAZARDS

In addition to the chemical hazards discussed above, the following physical hazards may be present during the performance of site activities.

6.2.1 Slip, Trip and Fall Hazards

Various potential slip, trip, and fall hazards may be encountered during the performance of planned site activities. These hazards are associated with working out doors where uneven or wet terrain may be encountered, or near the edge of bodies of water, as well as on boat decks and docks. To minimize the potential for worker injury from these hazards, the following requirements must be observed:

- Maintain proper housekeeping in all work areas.

- Preview and inspect work areas to identify and eliminate slip, trip, or fall hazards. In outdoor locations, pay particular attention to sink holes or other depressions that may be encountered.

- Any work that is to be done on structures that are more than 6-feet above floor or ground level will require fall protection training and the use of 100% fall protection equipment.

- Cover, guard, barricade, and/or place warning postings over/at holes or openings that personnel may fall or step into.

- For traversing steep, slippery, or sloped terrain establish rope ladders to control ascent and descent to sampling areas or use alternative pathways.

6.2.2 Strains/Muscle Pulls

Worker injuries resulting from improper manual material handling activities are easily prevented through observation of proper lifting and carrying methods and utilization of material handling equipment where necessary and suitable. These types of injuries are not limited to merely the factor of the weight of the load. Other considerations include how many lifts will be involved (i.e., repetitive lifting of even small loads), the size, shape, and/or configuration of the load to be lifted, and whether or not the load will need to be lifted to another height or carried to another location. All workers involved with these types of activities are to be instructed by the SSO in the following manner:

- First estimate the weight and configuration of the load (i.e., is it bulky or hard to safely grasp/lift/control). If it appears to be too heavy or bulky to safely handle alone, either use a mechanical lifting device or obtain help from another employee to lift the load (Note: The use of mechanical lifting devises is always preferable over manual lifting).

- Bend at the knees (not at the waist) when attempting a lift.

- Ensure that a firm hold is obtained, and keep the load as close to the body as possible.

- Lift the load using your legs, and not the back.

- Avoid turning or twisting while holding a load.

- If the load is to be moved, preview the path of travel first to identify and eliminate any tripping hazards.
- Do not attempt to carry loads that obstruct the line of sight.
- When setting a load down, again use the leg muscles and do not bend at the waist.
- Break loads into smaller amounts for travel to remote locations.
- In all cases, where possible use mechanical equipment to transport equipment and resources to the desired location.

6.3 NATURAL HAZARDS

As most of the work to be conducted will occur in areas that are not improved or maintained, natural hazards and inclement weather may exist. This hazard is anticipated during the following activities:

Insect/animal bites and stings, poisonous plants, and inclement weather are natural hazards that may be present given the location of activities to be conducted. In general, avoidance of areas of known infestation or growth will be the preferred exposure control for insects/animals and poisonous plants. Specific discussion on principle hazards of concern follows:

6.3.1 Insect Bites and Stings

Insect bites and stings are difficult to control given the climate and environmental setting of IHDIV-NSWC. However, in an effort to minimize this hazard the following control measures will be implemented where possible.

- Commercially available bug sprays and repellents will be used whenever possible – Pesticides analytical screening includes chlordane, endrin, lindane, methoxychlor, toxaphene and heptachlor. Commercially available repellants may be used providing they don't contain substances which appear on the analytical list for pesticide analysis. Products such as DEET should not be applied directly to the skin due to potential irritation. This product, when permitted for use, should be applied over clothing articles.
- Where possible, loose-fitting and light-colored clothing with long sleeves should be worn. This will also aid in insect control by providing a barrier between the field person and the insects and to provide easy recognition of crawling insects against the lighter background. Pant legs should be secured to the work-boots using duct tape to prevent access by ticks. Mosquito nets are also recommended for use when commercially available repellents are not permitted.

- Clothing/limited body checks for ticks and other crawling insects should be conducted upon exiting heavily vegetated areas. Workers should perform a more detailed check of themselves when showering in the evening. Ticks prefer moist areas of the body (arm-pits, genitals, etc.) and will migrate to those locations.

- The FOL/SSO will preview all access routes and work areas in an effort to identify physical hazards including nesting areas in and around the work sites. These areas will be flagged and communicated to all site personnel.

- The FOL/SSO must determine if site personnel (through completion of Medical Data Sheets), suffer allergic reactions to bee and other insect stings and bites. Field crew members who are allergic to bites should have their emergency kit containing antihistamine and a preloaded syringe of epinephrine readily available.

Any allergies (insect bites, bee stings, etc.) must be reported on the Medical Data Sheet and to the SSO.

Tick-Borne Disease

During warm months (spring through early fall), tick-borne lyme disease may pose a potential health hazard in maryland which is listed as an area for lyme disease. The longer a disease carrying tick remains attached to the body, the greater the potential for contracting the disease. Wearing long sleeved shirts and long pants (tucked into boots). As well as performing frequent body checks will prevent long term attachment. Site first aid kits should be equipped with medical forceps and rubbing alcohol to assist in tick removal. For information regarding tick removal procedures, and symptoms of exposure consult the health and safety guidance manual.

Mosquito-Borne Illness

The Maryland Department of Health is urging people to take precautions to avoid potentially dangerous mosquitoes. Mosquitoes in Maryland may carry diseases including St. Louis encephalitis, Eastern Equine encephalitis, La Crosse encephalitis and West Nile virus.

Although mosquito-borne viral illnesses are rare in humans, a Kill Devil Hills, N.C., woman recently died after she came down with eastern equine encephalitis from an infected mosquito. The Maryland Department of Health, along with a variety of agencies, routinely conducts testing in mosquitoes and birds to monitor for possible mosquito-borne viruses. No cases of people, mosquitoes or birds testing positive for any of the four viruses have been reported in Maryland this year.

Mosquitoes become infected after biting infected birds. The symptoms for mosquito-borne illnesses may include headache, moderate to high fever, stiff neck and confusion. In serious cases coma, seizures or paralysis can result. Symptoms usually appear between 5 to 15 days after exposure to infected mosquitoes. Mosquito-borne illnesses may be mild or serious and can lead to death.

West Nile Virus

Encephalitis is an inflammation of the brain and can be caused by bacteria and viruses. West Nile encephalitis is caused by a virus transmitted to humans by mosquitoes. West Nile virus is commonly found in Africa, West Asia, and the Middle East. It is closely related to St. Louis encephalitis virus found in the United States. The West Nile-like virus that has been found in United States is genetically related to West Nile virus, but because of genetic differences it may be a new subtype of West Nile virus.

The mosquito becomes infected by feeding on birds infected with the West Nile virus. Infected mosquitoes then transmit the West Nile virus to humans and animals when biting (or taking a blood-meal).

West Nile encephalitis is NOT transmitted from person-to-person. There is no evidence that a person can get the virus from handling live or dead infected birds. However, avoid bare-handed contact when handling any dead animals, including dead birds. Ticks have not been implicated as vectors of West Nile-like virus.

Mild infections are common and include fever, headache, and body aches, often with skin rash and swollen lymph glands. More severe infection is marked by headache, high fever, neck stiffness, stupor, disorientation, coma, tremors, occasional convulsions, paralysis and, rarely, and death (especially in the elderly and very young). The incubation period of West Nile encephalitis is usually 3 to 12 days. There is no specific therapy or vaccine against West Nile encephalitis.

No cases have previously been reported in the U.S. prior to September 1999 (in New York). To date seven deaths in New York have been attributed to West Nile Virus. Since September 2000 seven dead crows have tested positive with West Nile Virus.

Eastern Equine Encephalitis (EEE)

EEE is responsible for the recent deaths of at least five horses in Maryland. One horse was from Prince George County, and the others were from Suffolk and Chesapeake. Other horses had compatible symptoms for EEE, but confirmatory results were not possible. Testing is still underway on one more

horse. EEE also has been confirmed in one sentinel chicken and a pool of trapped mosquitoes in Chesapeake. No human cases of EEE have been reported in Maryland this year.

Eastern Equine Encephalitis is spread to horses and humans though the bite of an infected mosquito. The mosquito becomes infected after biting an infected bird. EEE can cause severe complications and even death. Symptoms for EEE in humans begin with high fever, chills, soar throat, nausea and vomiting. The illness can affect the central nervous system, cause sudden fever, severe headache, mental confusion, seizures and coma. Symptoms usually appear between 5 to 15 days after exposure to infected mosquitoes.

Although EEE has the highest fatality rate of the mosquito-borne illnesses, in Maryland humans rarely contract EEE. Only four human cases of EEE in Maryland have ever been reported. The last case was the death of a Portsmouth man in 1998. On average, only one or two horses each year have become infected with EEE in Maryland, but as many as six horses were infected in 1997. There is no cure for EEE in humans.

Precautions include:

- Limit outdoor activities during peak mosquito times – at dusk and dawn.
- Avoid standing water
- Wear long-sleeved shirts and long pants whenever you are outdoors.
- Apply insect repellent according to manufacturers instruction to exposed skin. An effective repellent will contain 20% to 30% DEET (N,N-diethyl-meta-toluamide). Avoid products containing more than 30% DEET.
- Spray clothing with repellents containing permethrin or DEET, mosquitoes may bite through thin clothing.

6.3.2 Snakes and Other Wild Animals

Indigenous animals including snakes (only two poisonous and approximately 27 non-poisonous varieties in Maryland), raccoons, and other animals native to the region may be present at the site. These animals may be encountered if work locations encroach on nesting or territories claimed by these animals.

There are two poisonous snakes indigenous to the State of Maryland, the Northern Copperhead and the Timber Rattlesnake. Only the Northern Copperhead is indigenous to this part of the state. It is important to remember that snakes are rarely aggressive towards humans. If you encounter a snake simply maintain a safe distance and move away from it, or allow it to move away.

Northern Copperhead (Agkistrodon contortrix mokasen)

This is one of the two venomous snake species in Maryland. The color is a rich, reddish, brown with a series of darker hourglass markings down its back. Its head is usually a bright copper color and its belly is pinkish. It seldom exceeds three feet in length. It has a single anal plate and keeled scales. This is the only Maryland snake that has dark dorsal markings which are narrow on the back and broad on the sides. Copperheads exist throughout the State in remote rocky, wooded areas where they feed on small rodents and other warm-blooded prey. Occasionally, they will feed on aquatic animals. Females give birth to approximately 12 live young which are 8-10 inches in length.

Prevention

To avoid the obvious hazards conveyed as part of a direct encounter, the following actions will be taken to minimize impact on the field crews and/or operations. The FOL/SSO will preview access routes and work locations for nesting areas or signs of animal activities (tracks, foraging areas, etc.). All identified suspect areas will be communicated to the field crews. Snake chaps will be required as a precaution.

Snake Bites

All initial efforts will be directed to avoid, where possible, nesting and territorial areas. However, should field personnel come in contact with these animals and receive a bite, the following actions are necessary.

- Obtain a detailed description of the snake. This and the bite mark will enable medical personnel administering medical aid to provide prompt and correct antidotes, as necessary.

- Immobilize the bite victim to the extent possible. Physical exertion will mobilize the toxins (if poisonous varieties) from the bite point systemically through the body.

- Apply a pressure wrap (for extremities), just above and over the bite area. With a couple wraps of the pressure wrap in place over the bite area, apply a splint, and continue the application of the pressure wrap. The purpose for the splint is to restrict the movement of the extremity, this along with the pressure wrap will aid in restricting the toxins from leaving the site of the bite.

- Seek medical attention immediately.

6.3.3 Poisonous Plants

Various plants which can cause allergic reactions may be encountered during field work. These include, poison ivy, poison oak, and poison sumac. Contact with these plants may occur when clearing vegetation for access to work areas, or as a result of movement through these plants. An irritating, allergic reaction can occur after direct contact with the plant or indirect contact through some piece of equipment or clothing article. Oils are transferred from the plant to exposed skin, clothing, or piece of equipment. The degree of the irritating, allergic reaction can vary significantly from one person to the next.

Protective measures to control and minimize the effects of this hazard may include, but not be limited to, the following:

- Identify plants for field personnel.
  - Poison Ivy - Characterized by climbing vines, three leaf configuration ovate to elliptical in shape, deep green leaves with a reddish tint, greenish flowers, and white berries.
  - Poison Sumac - Characterized as a tall bush of the sumac family bearing compound leaves (7-13 entire leaflets), branched from a central axis, drooping, with axillary clusters of white fruit: However, these white fruits and berries may exist only during pubescent stages.
  - Poison oak - Characterized as similar to poison ivy consisting of a shrub, stems erect, 0.3 to 2.0 meters tall, leaflets consist of broad thick lobes coarsely serrated configuration, denser at the base, less so than the top.
- Protective measures may include wearing disposable garments such as Tyvek when clearing brush. These may be carefully removed and disposed of along with any oils accumulated from the plants.
- Personal Hygiene - The oils obtained from the plants will only elicit an allergic response when the person's bare skin layer is contacted. This can be aggravated when skin pores are open (perspiring), or through breaks in the skin such as cuts, nicks, scratches, etc. This can also be accomplished when using excessively hot water for cleaning the skin, which also causes pores to open. Prior to break time, lunchtime, etc. personnel should wash with cool water and soap to remove as much of the oils as possible. In heavily vegetated areas of these plants, additional measures including barrier creams and blocks may be used to prevent the oils from accessing and penetrating the skin.

All of these plants present an airborne sensitization hazard when burned. This is not to occur as part of this scope of work and therefore will not be addressed.

6.3.4 Inclement Weather

Project tasks under this Scope of Work will be performed outdoors and near water. As a result, inclement weather may be encountered. In the event that adverse weather conditions arise (electrical storms, hurricanes, etc.), the FOL and/or the SSO will be responsible for temporarily suspending or terminating activities until hazardous conditions no longer exist.

6.4 WATER HAZARDS

Planned activities involve locations that are near bodies or on bodies of water. Sampling activities will be conducted from a motor boat. To avoid potential hazards associated with working near water (drowning), the field team shall employ lifelines (tie-off procedure), safety harnesses, when within 4 feet of the water edge. When working out of a canoe or other boat, U.S. Coast Guard (USCG) approved personal flotation devices (PFD) will be used. Due to the obvious hazards associated with working on or near water edge during inclement weather, all field activities may be temporarily suspended or terminated at the discretion and direction of the FOL or SSO.

6.4.1 U.S.C.G. Flotation Device Types

Use the following information to determine the proper type of U.S.C.G. PFD.

Off Shore Life Jacket (Type I, 22lbs buoyancy)

Type I life jacket is the best choice for rough or open waters. This type will float you the best and is favorable if rescue may be long in coming. This type will turn an unconscious person upright in the water. Though is bulky it does have a highly visible color for easier detection.

Near Shore Buoyant Vest (Type II, 15.5lbs buoyancy)

Type II is a good choice for calmer waters. It will turn most unconscious persons face-up in the water. Though it is less bulky than Type I, it is not intended for long hours in calm or rough water.

Flotation Aid (Type III, 15.5lbs buoyancy)

Type III is probably the most comfortable device offering more freedom of movement, such as water skiing or fishing, but is not intended for rough water. Also, an unconscious person may end up face-down in the water.

Throwable Devices (Type IV)

Throwable devices are intended for calm waters with heavy boat traffic where help is always close. It is not intended for unconscious persons or non-swimmers or long hours in the water. They are good backups for the other devices.

All personnel shall wear Type III personal flotation devices in the event someone falls overboard, boats sinks or capsizes. Type IIIs were selected as they offer the most flexibility for working while still meeting minimum requirements for bouyancy. In situations where personal flotation devices cannot be worn due to the task to be conducted, the flotation devices shall be immediately available/accessible. It is recommended that personal flotation devices be worn at all times during colder months due to the potential for hypothermia to restrict muscle movement and therefore, self rescue and maintaining buoyancy.

In addition, a single Type IV Throwable Flotation Device shall be maintained on board the boat with at least 90 feet of 3/8 polypropylene line.

When work activities take personnel within four feet of navigable waters edge personnel will have immediately accessible a lifeline with a throwing bag or Type IV flotation device facilitate extraction from the water. All personnel working on waters edge will do so using the buddy system to assist in rescue efforts, if needed.

6.4.2 U.S.C.G and State of Maryland Boat Regulations

Certain bodies of water in Maryland may have local restrictions as to type and size of watercraft or motor horsepower, restricted use areas, boat speed, and times for use. Check with the local authorities for these additional restrictions. The U.S.C.G. and State of Maryland require all boats to have the following equipment on board:

- One personal flotation device per person
- A sound producing device such as an air horn or whistle which can be heard one half mile.

Vessels Required to be Registered in Maryland

All vessels, whether commercial or recreational, must be registered in Maryland if it is equipped with any kind of primary or auxiliary mechanical propulsion; if it is not currently documented with the U. S. Coast Guard; and if it is being used principally in Maryland. An owner of a federally documented vessel, though

exempt from state numbering requirements, shall apply to the Maryland Department Of Natural Resources for documented use decals, and is subject to the state excise tax requirements.

Reckless and Negligent Operation

Negligent or grossly negligent operation of a vessel which endangers lives and/or property is prohibited by law. A civil penalty may be imposed by the Coast Guard for this offense under federal laws. An operator may be subjected to a fine of up to $5,000 and or imprisonment for up to one year, or both. The Maryland penalty is a fine of up to $500 for the first offense.

Some examples of actions that may constitute negligent or grossly negligent operation include but are not limited to:

- Operating in a swimming area
- Operating under the influence of alcohol or drugs.
- Excessive speed in the vicinity of other boats or in dangerous waters.
- Hazardous water skiing practices
- Bowriding, also riding on seatback, gunwale or transom.

Termination of Use

A Maryland Natural Resources Police Officer who observes a boat being operated in an unsafe condition and who determines that an especially hazardous condition exists may direct the operator to take immediate steps to correct the condition, including returning to port. Termination for unsafe use may be imposed for, but is not limited to:

- Insufficient number of USCG approved Personal Flotation Devices.
- Insufficient fire extinguishers.
- Overloading beyond manufacturer's recommended safe loading capacity.
- Improper navigation light display.
- Ventilation requirements for tank and engine spaces not met.
- Fuel leakage.
- Fuel in bilges.
- Improper backfire flame control.

Boating Accident Reports

The operator of any boat involved in an accident must stop, render assistance, and offer identification. An accident report must be made to the Department within 48 hours if:

- A person dies within 24 hours;
- A person loses consciousness or receives medical treatment beyond first aid or is disabled more than 24 hours;
- A person disappears from the vessel under circumstances that indicate death or injury.

Accidents must be reported within 10 days if damage to all vessels and other property totals more than $500.00 or an earlier report is not required. Running aground or hitting a fixed or floating object is considered a boating accident. Boating accident report forms (DNR-149) are obtainable from the Natural Resources Police. They must be submitted to the Natural Resources Police by the operator of the vessel or vessels involved. Accident reports are required by federal law and furnish information for use in accident prevention. Information from individual reports will not be publicly disclosed nor may the information be used in court.

Rendering Assistance

Federal law requires the operator of a vessel to provide assistance, that can be safely provided to any individual in danger on the water. Persons who fail to provide assistance may be subject to fine or imprisonment.

TABLE 6-1
CHEMICAL, PHYSICAL, AND TOXICOLOGICAL DATA
INDIAN HEAD DIVISION - NAVAL SURFACE WARFARE CENTER

Substance	CAS No.	Air Monitoring/Sampling Information		Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
General PAHs / Coal Tar *Pitch Volatiles / Creosote* / cresol (Fluoranthene, pyrene, benzo(a) anthracene, benzo(a) pyrene, benzo(f)fluoranthene, benzo(k)fluoranthene), etc.)	(CAS Numbers vary depending on specific compound)	PID: I.P. of 8.97 eV, relative response ratio unknown. FID: Response factor unknown but given the substances flammability, detection by FID can be anticipated.	Refer to NIOSH *methods for each* specfic compound for appropriate air sampilng protocols. Many PAHs can be sampled using NIOSH Method 5506 or 5515 - Teflon filter with *support ring* - High pressure liquid chromatography with UV detector. For cresol (a major constituent of creosote) by silica gel or xad-7 sorbent tube; Acetone desorption and analysis by gas chromatography - flame ionization detector or high-pressure liquid chromatography. (NIOSH Method #2001, or OSHA Method #32)	Most PAHs have no *established exposure* limits. Other Coal Tar Pitch Volatiles / PAHs such as chrysene and benzo(a)pyrene have an exposure limit of 0.2 mg/m^3 (OSHA and ACGIH). 0.1 mg/m^3 - (NIOSH) **Creosote / Cresol:** OSHA; ACGIH: 5 ppm NIOSH: 2.3 ppm IDLH: 80 mg/m^3	Adequate - use a full-face air-*purifying respirator with organic* vapor / dust/mist cartridge up to 250 ppm. Cresol has an Odor Threshold of 0.00005-0.0079 ppm. **Recommended gloves:** Viton >96.00 hrs; butyl rubber >90.00 hrs; neoprene >4.50 hrs	Properties of various PAHs/Coal Tar *Pitch Volatiles vary depending upon* the specific compound. *For Creosote/Cresol:* **Boiling Pt:** 376-397°F; 191-203°C **Melting Pt:** 52-96°F; 10.9-35.5°C **Solubility:** Insoluble **Flash Pt:** 178°F; 81°C **LEL/LFL:** Not available **UEL/UFL:** Not available **Vapor Density:** 3.72 **Vapor Pressure:** 1 mmHg @ 100-127°F; 38-53°C **Specific Gravity:** 1.030-1.038 **Incompatibilities:** Nitric acid, oleum, chlorosulfonic acid, oxidizers **Appearance and Odor:** Yellowish or colorless, flammable, oily liquid (often brownish because of impurities or oxidation)	Regulated based on effects on *respiratory tract and skin irritation* Other effects may include eye irritiation and central nervous system, distrubances. Acute exposures may result in difficulty breathing, respiratory failure and skin and eye irritation and burns. Chronic exposure may damage the liver, kidneys, lungs and skin and cause photosensitivity. IARC, NTP, NIOSH, ACGIH, and the EPA list some PAHs such as benzo(a)pyrene as a potential carcinogen (ARC 2A, NTP-2, ACGIH TLV-A2, NIOSH-X, EPA-B2).

Substance	CAS No.	Air Monitoring/Sampling Information		Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
Nitroguanidine (NQ) Synonyms: Nitroguanidine, containing less than 20% water; Nitroguandine dry; Pictrite	556-88-7	No information found	None established	None established	This material will be in the form of a particulate under ambient temperatures. As there is no suitable way to determine its presence through warning properties or monitoring instruments, a general approach will be to control all particulate emissions and hence control potential exposures to this compound. Not very sensitive to shock or impact. **Recommended Gloves:** Gloves suitable to prevent skin contact. Natural rubber or Nitrile rubber recommended for incidental contact.	**Boiling Pt:** Decomposes at 437°F; 225°C **Melting Pt:** 450°F; 232°C **Solubility:** Yes, in hot water **Specific Gravity:** Not available **Vapor Density:** 3.6 **Vapor Pressure:** Negligible **Flash Pt:** Not available **LEL:** Not available **UEL:** Not available **Incompatibles:** oxidizers **Appearance and Odor:** White, fiber-like crystals	**Routes of exposure:** inhalation, absorption, and ingestion. The following symptoms may be experienced resulting from exposure to Nitroguanidine or its intermediates. The severity of the effect will depend on the concentrations, duration, and frequency of exposure. Acute Toxicity: CNS depression Chronic Toxicity: Chronic exposure may cause poison by intraperitoneal route, mutagenic effects, anemia, moderate cyanosis, dizziness, headache, and insomnia. *-based on general amine exposure
Nitrocellulose (NC) Synonyms: Pyroxylin Plastics Cellulose Nitrate Cellulose Tetranitrate	9004-70-0	Particulate form - unable to be detected by the PID or FID.	None found	None established	Extremely flammable Burns rapidly with extreme heat Deteriorates rapidly in the presence of moisture. **Recommended gloves:** Impermeable work gloves (Note: Nitrile has been selected as the predominant glove of choice for the other tasks.)	**Boiling Pt:** Not available **Melting Pt:** Not available **Detonation Pt:** 446°F; 230°C **Solubility:** Insoluble **Specific Gravity:** Not available **TDP:** Toxic fumes of Nox **Vapor Density:** Negligible **Vapor Pressure:** Negligible **Flash Pt:** 55°F; 13°C **LEL:** Not available **UEL:** Not available **Incompatibles:** Not available **Appearance and odor:** White fibers	Excessive airborne concentrations may react similar to that of nuisance dust. This would include difficulty in breathing, coughing, sneezing, tightness in the chest, increased sputum production. No chronic effects known.

Substance	CAS No.	Air Monitoring/Sampling Information		Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
1,1-Dimethylhydrazine	57-14-7	PID: I.P. of 8.05 eV, relative response ratio unknown. FID: Response factor unknown but given the substances flammability, detection by FID can be anticipated	Sampling and analytical protocol shall proceed in accordance with NIOSH Method #3515	NIOSH REL: Ca C 0.06 ppm (0.15 mg/m^3) [2-hr] OSHA PEL: TWA 0.5 ppm (1 mg/m^3) [skin] ACGIH TLV: 0.01 ppm [skin] IDLH: 15 ppm	Flammable. This compound is hygroscopic. It is also sensitive to air. **Recommended gloves:** Impermeable work gloves (Note: Nitrile has been selected as the predominant glove of choice.)	**Boiling Pt:** 145.4°F; 63°C **Melting Pt:** -70.96°F; -57.2°C **Detonation Pt:** 446°F; 230°C **Solubility:** Miscible. Decomposes **Specific Gravity:** Not available **Vapor Density:** 0.7914 **Vapor Pressure:** 103mm **Flash Pt:** 5°F; 1°C **LEL:** 2% **UEL:** 95% **Incompatibles:** Oxidizers, halogens, metallic mercury, fuming nitric acid, hydrogen peroxide. May ignite SPONTANEOUSLY in contact with oxidizers **Appearance and odor:** Fuming, colorless liquid with an ammonia or fish-like odor.	This compound is highly corrosive to the eyes, skin and mucous membranes. It is harmful if swallowed or absorbed through the skin. Vapors can cause mild irritation to skin and eyes. It may also cause irritation to the nose and throat. When heated to decomposition it emits very toxic fumes of NOx. It is readily absorbed through the skin.
Aroclor-1260 (Polychlorinated Biphenyl, PCB) It should be noted that this substance is representative of the more common isomers Aroclor - 1242, 1254, which may be encountered.	11096-82-5 53469-21-9 (42%) 11097-69-1 (54%)	Substance is not volatile (VP=0.00006 mmHg), I.P. is unknown however is anticipated to be elevated, therefore, PID is not anticipated to detect this substance. Substance is non combustible and as a result will not be detected by FID.	Air sample using a particulate filter, Florisil sorbent tube with glass fiber filter; hexane desorption; gas chromatography-electron capture detector. Sampling and analytical protocol shall proceed in accordance with NIOSH Method #5503 (PCBs).	OSHA; ACGIH: 0.5 mg/m^3 (skin) NIOSH: 0.001 mg/m^3 IDLH: 5 mg/m^3	Inadequate - However due to the low volatility it is assumed unless agitated this substance does not present a volatile vapor or gas respiratory threat. For dusty conditions where this material may cling to particulates, use a HEPA filter. APRs are approved for escape only when concentrations exceed the exposure limits. Concentrations greater than the exposure limits require PAPR or supplied air respirators. **Recommended glove:** Butyl rubber >24 hrs; Neoprene rubber >24.00 hrs; Silver shield or Viton (for pure product).	**Boiling Pt:** distillation range 689- 734°F; 365-390°C **Melting Pt:** -2 to 50°F; -19 to 10°C **Solubility:** Insoluble **Flash Pt:** Not applicable **LEL/LFL:** Not applicable **UEL/UFL:** Not applicable Nonflammable liquid, however, exposure to fire results in black soot containing PCBs, dibenzofurans, & chlorinated dibenzo-p-dioxins **Vapor Density:** Not available **Vapor Pressure:** 0.00006 - 0.001 mmHg **Specific Gravity:** 1.566 @ 60°F; 15.5°C **Incompatibilities:** Strong oxidizers **Appearance and Odor:** Colorless to pale yellow, viscous liquid or solid (Aroclor 54 below 50°F) with a mild, hydrocarbon odor	This substance is irritating to the eyes and skin. Chronic effects of overexposure may include potential to cause liver damage, chloracne, and reproductive effects. Recognized as possessing carcinogenic properties by NIOSH, and NTP.

Substance	CAS No.	Air Monitoring/Sampling Information		Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
Mercury	7439-97-6	Jerome Mercury Vapor Analyzer This substance is unable to be detected by PID/FID.	Air sample using Hydrar® sorbent tube; acid desorption; AA cold detection. Sampling and analytical protocol shall proceed in accordance with NIOSH Method #6009.	OSHA; NIOSH; ACGIH: as alkyl compounds 0.01 mg/m³; STEL 0.03 mg/m³ IDLH: 10 mg/m³	No identifiable warning properties to indicate presence and thereby detection. **Recommended APR Cartridge:** Suitable for Metallic mercury with HEPA filter. Preferably, with an end-of-service life indicator. **Recommended gloves:** Rubber gloves	**Boiling Pt:** 674°F; 356.9°C **Melting Pt:** -38°F; -38.89°C **Solubility:** Insoluble **Flash Pt:** Not available **LEL/LFL:** Not available **UEL/UFL:** Not available **Vapor Density:** Not available **Vapor Pressure:** 0.0012 mmHg @ 77° F; 25°C **Specific Gravity:** 13.6 **Incompatibilities:** Acetylene, ammonia, chlorine dioxide, azides, calcium, sodium carbide, lithium, rubidium, and copper **Appearance and odor:** Silvery-white heavy mobile liquid, odorless	This substance is corrosive to all points of contact. Systemic symptoms include irritability, wakefulness, muscle weakness and tremors, increased reflexes, gingivitis, anorexia, headache, tinnitus, hypermobility, GI disturbances (nausea, vomiting), diarrhea (sometimes bloody), liver changes, dermatitis, and fever. Symptoms experienced via inhalation include to those above coughing, chest pain, dyspnea, bronchial pneumonitis, and excessive salivation.
Silver	7440-22-4	Particulate form - Unable to be detected by PID or FID.	Air sample using a mixed cellulose ester filter; acid desorption; Atomic absorption or plasma emission spectroscopy detection. Sampling and analytical protocol shall proceed in accordance with NIOSH Method #5(s182), or OSHA Method #ID121.	NIOSH; OSHA; ACGIH: 0.01 mg/m³	No identifiable warning properties to indicate presence and thereby detection. The use of a air purifying, full-face respirator with a high efficiency particulate air filter. **Recommended gloves:** This is in the particulate form. Therefore any glove suitable to prevent skin contact (Nitrile has been the one most widely used for the other substances).	**Boiling Pt:** 4014°F; 2212°C **Melting Pt:** 1764°F; 962°C **Solubility:** Insoluble **Flash Pt:** Not applicable (Airborne dust may burn or explode when exposed to heat, flame, or incompatible chemicals) **LEL/LFL:** Not applicable **UEL/UFL:** Not applicable **Vapor Density:** Not available **Vapor Pressure:** 0 mmHg **Specific Gravity:** 10.49 **Incompatibilities:** Acetylene, acetylene compounds, ammonia, peroxides, bromoazide, chlorine, trifluoride, ethylene imine, oxalic acid, nitric acid, and tartaric acid **Appearance and Odor:** Metal: white lustrous solid.	Overexposure to this substance may result in gastrointestinal, upper respiratory, and skin irritation. Discoloration of the eyes, skin and hair.

7.0 AIR MONITORING

Prior analyses have indicated that contaminants of concern in the sediment and surface water are non-volatile. Further, given the proposed activities and the fact that samples will be collected in a wet condition, it is not anticipated that any airborne particulates will be generated during site activities. As a result direct reading instruments will not be required to monitor worker exposures at the site. Should site conditions change to warrant air monitoring, as determined by the FOL and/or SSO, this HASP will be modified accordingly and personnel will be trained on the need for and use of direct reading instrument(s).

8.0 TRAINING/MEDICAL SURVEILLANCE REQUIREMENTS

8.1 INTRODUCTORY/REFRESHER/SUPERVISORY TRAINING

This section is included to specify health and safety training and medical surveillance requirements for both TtNUS and subcontractor personnel participating in site activities.

8.1.1 Requirements for TtNUS Personnel

All TtNUS personnel must complete 40 hours of introductory hazardous waste site training prior to performing work at the PNS facility. Additionally, TtNUS personnel who have had introductory training more than 12 months prior to site work must have completed 8 hours of refresher training in the past 12 months before being cleared for site work. In addition, 8-hour supervisory training in accordance with 29 CFR 1910.120 (e)(4) will be required for site supervisory personnel.

Documentation of TtNUS introductory, supervisory, and refresher training as well as site-specific training will be maintained at the project. Copies of certificates or other official documentation will be used to fulfill this requirement.

8.1.2 Requirements for Subcontractors

All TtNUS subcontractor personnel must have completed introductory hazardous waste site training or equivalent work experience as defined in OSHA Standard 29 CFR 1910.120 (e). Additionally, personnel who have had the introductory training more than 12 months ago, are required to have 8 hours of refresher training meeting the requirements of 29 CFR 1910.120 (e)(8) prior to performing field work at the PNS facility if required. TtNUS subcontractors must certify that each employee has had such training by sending TtNUS a letter, on company letterhead, containing the information in the example letter provided as in Figure 8-1 and by providing copies of certificates for all subcontractor personnel participating in site activities.

FIGURE 8-1

OSHA TRAINING CERTIFICATION

The following statements must be typed on company letterhead and signed by an officer of the company and accompanied by copies of personnel training certificates:

LOGO
XYZ CORPORATION
555 E. 5th Street
Nowheresville, Kansas 55555

Month, day, year

Mr. George J. Latulippe, P.E.
Tetra Tech NUS, Inc.
Project Manager
661 Andersen Drive
Pittsburgh, Pennsylvania 15220

Subject: HAZWOPER Training

Dear Mr. Latulippe:

As an officer of XYZ Corporation, I hereby state that I am aware of the potential hazardous nature of the subject project. I also understand that it is our responsibility to comply with all applicable occupational safety and health regulations, including those stipulated in Title 29 of the Code of Federal Regulations (CFR), Parts 1900 through 1910 and Part 1926.

I also understand that Title 29 CFR 1910.120, entitled "Hazardous Waste Operations and Emergency Response," requires appropriate level of training for certain employees engaged in hazardous waste operations. In this regard, I hereby state that the following employees have had 40 hours of introductory hazardous waste site training or equivalent work experience as requested by 29 CFR 1910.120(e) and have had 8 hours of refresher training as applicable and as required by 29 CFR 1910.120(e)(8) and that site supervisory personnel have had training in accordance with 29 CFR 1910.120(e)(4).

LIST FULL NAMES OF EMPLOYEES AND THEIR SOCIAL SECURITY NUMBERS HERE.

Should you have any questions, please contact me at (555) 555-5555

Sincerely,

(Name and Title of Company Officer)

Enclosed: Training Certificates

8.2 SITE-SPECIFIC TRAINING

TtNUS will provide site-specific training to all TtNUS employees and subcontractor personnel who will perform work on this project. Site-specific training will also be provided to all personnel (U.S. Department of Defense, EPA, etc.) who may enter the site to perform functions that may or may not be directly related to site operations. Site-Specific training will include:

- Names of designated personnel and alternates responsible for site safety and health
- Safety, health, and other hazards present on site
- Use of personal protective equipment
- Safe use of engineering controls and equipment
- Medical surveillance requirements
- Signs and symptoms of overexposure
- Contents of the Health and Safety Plan
- Emergency response procedures (evacuation and assembly points)
- Incipient response procedures
- Review of the contents of relevant Material Safety Data Sheets
- Review of the use of Safe Work Permits

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

8.3 MEDICAL SURVEILLANCE

8.3.1 Medical Surveillance Requirements for TtNUS Personnel

All TtNUS personnel participating in project field activities will have had a physical examination meeting the requirements of TtNUS's medical surveillance program and will be medically qualified to perform hazardous waste site work using respiratory protection.

Documentation for medical clearances will be maintained in the TtNUS Pittsburgh office and made available, as necessary.

FIGURE 8-2

SITE-SPECIFIC TRAINING DOCUMENTATION

My signature below indicates that I am aware of the potential hazardous nature of performing remedial investigation activities at Indian Head Division, Naval Surface Warfare Center and that I have received site-specific training which included the elements presented below:

- Names of designated personnel and alternates responsible for site safety and health
- Safety, health, and other hazards present on site
- Use of personal protective equipment
- Safe use of engineering controls and equipment
- Medical surveillance requirements
- Signs and symptoms of overexposure
- Contents of the Health and Safety Plan
- Emergency response procedures (evacuation and assembly points)
- Incipient response procedures
- Review of the contents of relevant Material Safety Data Sheets
- Review of the use of Safe Work Permits

I have been given the opportunity to ask questions and that all of my questions have been answered to my satisfaction, and that the dates of my training and medical surveillance indicated below are accurate.

Name (Printed and Signature)	Site-Specific Training (Date)	40-Hour Training (Date)	8-Hour Refresher Training (Date)	8-Hour Supervisory Training (Date)	Medical Exam (Date)

8.3.2 Medical Surveillance Requirements for Subcontractors

Subcontractors are required to obtain a certificate of their ability to perform hazardous waste site work and to wear respiratory protection. The "Subcontractor Medical Approval Form" provided in Figure 8-3 shall be used to satisfy this requirement, providing it is properly completed and signed by a licensed physician.

Subcontractors who have a company medical surveillance program meeting the requirements of paragraph (f) of OSHA 29 CFR 1910.120 can substitute "Subcontractor Medical Approval Form" (See Figure 8-3) with a letter, on company letterhead, containing all of the information in the example letter presented in Figure 8-4 of this HASP.

8.3.3 Requirements for All Field Personnel

Each field team member (including subcontractors) and visitors entering the Exclusion Zone(s) shall be required to complete and submit a copy of Medical Data Sheet found in the TtNUS Health and Safety Guidance Manual. This shall be provided to the SSO, prior to participating in site activities. The purpose of this document is to provide site personnel and emergency responders with additional information that may be necessary in order to administer medical attention.

8.4 SUBCONTRACTOR EXCEPTIONS

Subcontractors who will not enter the Exclusion Zone during intrusive operations, and whose activities involve no potential for exposure to site contaminants, will not be required to meet the requirements for training/medical surveillance other than those stated for site-specific training (See Section 8.2).

FIGURE 8-3

SUBCONTRACTOR MEDICAL APPROVAL FORM

For employees of _____
Company Name

Participant Name: _____ Date of Exam: _____

Part A

The above-named individual has:

1. Undergone a physical examination in accordance with OSHA Standard 29 CFR 1910.120, paragraph (f), and was found to be medically -

   ( ) qualified to perform work at the IHDIV-NSWC work site
   ( ) not qualified to perform work at the IHDIV-NSWC work site

   and,

2. Undergone a physical examination in accordance with OSHA 29 CFR 1910.134(b)(10) and was found to be medically -

   ( ) qualified to wear respiratory protection
   ( ) not qualified to wear respiratory protection

My evaluation has been based on the following information, as provided to me by the employer.

( ) A copy of OSHA Standard 29 CFR 1910.120 and appendices.
( ) A description of the employee's duties as they relate to the employee's exposures.
( ) A list of known/suspected contaminants and their concentrations (if known).
( ) A description of any personal protective equipment used or to be used.
( ) Information from previous medical examinations of the employee that is not readily available to the examining physician.

Part B

I, _____, have examined _____
Physician's Name (print) Participant's Name (print)

and have determined the following information:

FIGURE 8-3
SUBCONTRACTOR MEDICAL APPROVAL FORM
PAGE TWO

1. Results of the medical examination and tests (excluding finding or diagnoses unrelated to occupational exposure):

   _____
   _____
   _____

2. Any detected medical conditions which would place the employee at increased risk of material impairment of the employee's health:

   _____
   _____
   _____

3. Recommended limitations upon the employee's assigned work:

   _____
   _____
   _____

I have informed this participant of the results of this medical examination and any medical conditions which require further examination of treatment.

Based on the information provided to me, and in view of the activities and hazard potentials involved at the IHDIV-NSWC work site, this participant

( ) may
( ) may not

perform his/her assigned task.

Physician's Signature _____

Address _____

Phone Number _____

NOTE: Copies of test results are maintained and available at:

_____
Address

FIGURE 8-4

MEDICAL SURVEILLANCE LETTER

The following statements must be typed on company letterhead and signed by an officer of the company:

LOGO
XYZ CORPORATION
555 E. 5th Street
Nowheresville, Kansas 55555

Month, day, year

Mr. George Latulippe, P.E.
Project Manager
Tetra Tech NUS, Inc.
Foster Plaza 7, 661 Andersen Drive
Pittsburgh, Pennsylvania 15220

Subject: Medical Surveillance for Indian Head Division - Naval Surface Warfare Center

Dear Mr. Latulippe:

As an officer of XYZ Corporation, I hereby state that the persons listed below participate in a medical surveillance program meeting the requirements contained in paragraph (f) of Title 29 of the Code of Federal Regulations (CFR), Part 1910.120, entitled "Hazardous Waste Operations and Emergency Response: Final Rule." I further state that the persons listed below have had physical examinations under this program within the past 12 months and that they have been cleared, by a licensed physician, to perform hazardous waste site work and to wear positive- and negative- pressure respiratory protection. I also state that, to my knowledge, no person listed below has any medical restriction that would preclude him/her from working at the IHDIV-NSWC work site.

LIST FULL NAMES OF EMPLOYEES AND THEIR SOCIAL SECURITY NUMBERS HERE.

Should you have any questions, please contact me at (555) 555-5555.

Sincerely,

(Name and Title of Company Officer)

9.0 SITE CONTROL

This section outlines the means by which TtNUS will delineate work zones and use these work zones in conjunction with decontamination procedures to prevent the spread of contaminants into previously unaffected areas of the site. It is anticipated that a three zone approach will be used during work at this site; exclusion zone, contamination reduction zone, and support zone.

9.1 EXCLUSION ZONE

The exclusion zone will be considered those areas of the site of known or suspected contamination. In many cases, however, significant amounts of contamination will not be encountered in the proposed work areas of this site until/unless contaminants are brought to the surface by site activities (i.e., sediment, fish sampling). Furthermore, once such activities have been completed and contamination has been removed, the potential for exposure is again diminished and the area can then be reclassified as part of the contamination reduction zone. Therefore, the exclusion zones for this project will be limited to those areas where active work is being performed and/or anywhere there is believed to be the potential for encountering any of the potential hazards defined in this HASP.

9.2 CONTAMINATION REDUCTION ZONE

The contamination reduction zone (CRZ) will be a buffer area between the exclusion zone and any area of the site where contamination is not suspected. The personnel and equipment decontamination area established for this project will take place in the CRZ. This area will serve as a focal point in supporting exclusion zone activities. In addition, this area will serve as the access and control points to the exclusion zone.

9.3 SUPPORT ZONE

The support zone for this project will include a staging area where site vehicles will be parked, equipment will be unloaded, and where food and drink containers will be maintained. In all cases, the support zones will be established at areas of the site where exposure to site contaminants would not be expected during normal working conditions or foreseeable emergencies.

9.4 SAFE WORK PERMITS

All work conducted in support of this project will be performed using Safe Work Permits to guide and direct field crews on a task by task basis. An example of the Safe Work Permit to be used is illustrated in Figure 9-1. Partially completed Permits for the work to be performed are included in Attachment IV. The daily meetings conducted at the site will further support these work permits. This effort will ensure all site-specific considerations and changing conditions are incorporated into the planning effort. All permits will require the signature of the FOL and SSO. Use of these permits will provide the communication line for reviewing protective measures and hazards associated with each operation. This HASP will be used as the primary reference for selecting levels of protection and control measures. The work permit will take precedence over the HASP when more conservative measures are required based on specific site conditions.

9.5 SITE VISITORS

Site visitors for the purpose of this document are identified as representing the following groups of individuals:

- Personnel invited to observe or participate in operations by TtNUS
- Regulatory personnel (DOD, OSHA, EPA, MDE, etc.)
- Northern Division Navy Personnel
- Other authorized visitors

It is not anticipated that this operation will result in a large number of site visitors. However, as some visitors can reasonably be expected, the following requirements will be enforced:

- All site visitors will be routed to the FOL, who will sign them in to the field logbook. Information to be recorded in the logbook will include the individual's name (proper identification required), who they represent, and purpose for the visit.
- All site visitors will be required to produce the necessary information supporting clearance onto the site. This includes information attesting to applicable training (40-hours of HAZWOPER training required for all EFACHES personnel) and medical surveillance, as stipulated in Section 8 of this document. In addition, to enter the site's operational zones during planned activities, all visitors will be required to first go through site-specific training covering the topics stipulated in Section 8.2 of this document.

NOTE: All site visitors will be escorted at all times while at the site.

FIGURE 9-1

SAFE WORK PERMIT

Permit No. _____ Date: _____ Time: From _____ to _____

SECTION I: General Job Scope (To be filled in by person performing work)

I. Work limited to the following (description, area, equipment used): _____

II. Names: _____

III. Onsite Inspection conducted ☐ Yes ☐ No Initials of Inspector _____ _____
TtNUS

SECTION II: General Safety Requirements (To be filled in by permit issuer)

IV. Protective equipment required
Level D ☐ Level B ☐
Level C ☐ Level A ☐
Detailed on Reverse

Respiratory equipment required
Full face APR ☐ Escape Pack ☐
Half face APR ☐ SCBA ☐
SAR ☐ Bottle Trailer ☐
Skid Rig ☐ None ☐

Modifications/Exceptions: _____

V. Chemicals of Concern | Action Level(s) | Response Measures
_____ _____ _____
_____ _____ _____

VI. Additional Safety Equipment/Procedures

Hardhat	☐ Yes	☐ No	Hearing Protection (Plugs/Muffs)	☐ Yes	☐ No
Safety Glasses	☐ Yes	☐ No	Safety belt/harness	☐ Yes	☐ No
Chemical/splash goggles	☐ Yes	☐ No	Radio	☐ Yes	☐ No
Splash Shield	☐ Yes	☐ No	Barricades	☐ Yes	☐ No
Splash suits/coveralls	☐ Yes	☐ No	Gloves (Type)	☐ Yes	☐ No
Steel toe/shank Workboots	☐ Yes	☐ No	Work/rest regimen	☐ Yes	☐ No

Modifications/Exceptions: _____

VII. Procedure review with permit acceptors

	Yes	NA		Yes	NA
Safety shower/eyewash (Location & Use)	☐	☐	Emergency alarms	☐	☐
Procedure for safe job completion	☐	☐	Evacuation routes	☐	☐
Contractor tools/equipment inspected	☐	☐	Assembly points	☐	☐

VIII. Equipment Preparation

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☐
Equipment and Foot Traffic Routes Cleared and Established	☐	☐	☐
Physical Hazards Barricaded and Isolated	☐	☐	☐
Emergency Equipment Staged	☐	☐	☐

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

X. Special instructions, precautions: _____

Permit Issued by: _____ Permit Accepted by: _____
Job Completed by: _____ Date: _____

Following this, the site visitor will be permitted to enter the site and applicable operational areas. All visitors are required to observe the protective equipment and site restrictions in effect at the area of their visit. Any and all visitors not meeting the requirements as stipulated in this plan for site clearance will not be permitted to enter the site operational zones during planned activities. Any incidence of unauthorized site visitation will cause all onsite activities to be terminated until that visitor can be removed. Removal of unauthorized visitors will be accomplished with support from the IHDIV – NSWC contact, if necessary.

9.6 SITE SECURITY

Site security will be accomplished using TtNUS field personnel. TtNUS will retain complete control over active operational areas. Exclusion Zone barriers, and any existing barriers at the site will be used to restrict the general public. The second line of security will take place at the work site referring interested parties to the FOL or designee. The FOL will serve as a focal point for all non-project interested parties, and serve as the final line of security and the primary enforcement contact.

9.7 SITE MAP

Once the areas of contamination, access routes, topography, and dispersion routes are determined, a site map will be generated and adjusted as site conditions change. When possible, these maps will be posted to illustrate up-to-date collection of contaminants and adjustment of zones and access points.

9.8 BUDDY SYSTEM

Personnel engaged in on-site activities will practice the "buddy system" to ensure the safety of all personnel involved in this operation.

9.9 MATERIAL SAFETY DATA SHEET (MSDS) REQUIREMENTS

TtNUS and subcontractor personnel will provide MSDSs for all chemicals brought on site. The contents of these documents will be reviewed by the SSO with the user(s) of the chemical substances prior to any actual use or application of the substances on site. A chemical inventory of all chemicals used on site will be developed using the Health and Safety Guidance Manual. The MSDSs will then be maintained in a central location (i.e., temporary office) and will be available for anyone to review upon request.

9.10 COMMUNICATION

As personnel will be working in proximity to one another during field activities, a supported means of communication between field crews members will not be necessary. External communication will be

accomplished by using the telephones at predetermined and approved locations. External communication will primarily be used for the purpose of resource and emergency resource communications. Prior to the commencement of activities, the FOL will determine and arrange for telephone communications.

10.0 SPILL CONTAINMENT PROGRAM

10.1 SCOPE AND APPLICATION

It is not anticipated that bulk hazardous materials (over 55-gallons) will be handled at any given time, or that any cylinders or containers will be unearthed, as part of this scope of work. It is also not anticipated that such spillage of Investigative Derived Wastes (IDW) would constitute a danger to human health or the environment. However, as the job progresses, the potential may exist for accumulating (IDW) such as decontamination fluids, soil cuttings, and purge and well development waters, in a central staging area. Once these fluids and other materials have been characterized, they can be removed from this area and properly disposed.

10.2 POTENTIAL SPILL AREAS

Potential spill areas will be periodically monitored in an ongoing attempt to prevent and control further potential contamination of the environment. Currently, limited areas are vulnerable to this hazard including:

- Resource deployment
- Waste transfer
- Central staging

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

10.3 LEAK AND SPILL DETECTION

To establish an early detection of potential spills or leaks, a periodic walk-around by the personnel staging or disposing of drums or in the resource deployment area will be conducted during working hours to visually determine that storage vessels are not leaking. If a leak is detected, the contents will be transferred, using a hand pump, into a new vessel. The leak will be collected and contained using absorbents such as Oil-Dry, vermiculite, or sand, which are stored at the vulnerable areas in a conspicuously marked drum. This used material, too, will be containerized for disposal pending analysis. All inspections will be documented in the project logbook.

It is not anticipated that any cylinders or containers will be unearthed during site activities. Should a cylinder or container be uncovered, however, work will immediately be stopped and personnel will retreat to a safe area until directed by the FOL or SSO.

10.4 PERSONNEL TRAINING AND SPILL PREVENTION

All personnel will be instructed in the procedures for incipient spill prevention, containment, and collection of hazardous materials in the site-specific training. The FOL and the SSO will serve as the Spill Response Coordinators for this operation, should the need arise.

10.5 SPILL PREVENTION AND CONTAINMENT EQUIPMENT

The following represents the minimum equipment that may be maintained (depending on anticipated need) at the staging areas at all times for the purpose of supporting this Spill Prevention/Containment Program.

- Sand, clean fill, vermiculite, or other non combustible absorbent (Oil-dry)
- Drums (55-gallon U.S. DOT 17-E or 17-H)
- Shovels, rakes, and brooms

10.5.1 PPE for Spill Control

Minimal PPE for spill control will be employed as needed. These materials may include:

- Nitrile work and inner gloves
- Tyvek coveralls
- Hard Hat
- Steel toed shoes with neoprene boot covers

10.6 SPILL CONTROL PLAN

This section describes the procedures the TtNUS field crewmembers will use upon the detection of a spill or leak.

1. Notify the SSO or FOL immediately upon detection of a leak or spill. Activate emergency alerting procedures for that area to remove all non-essential personnel.

2. Use the personal protective equipment stored at the staging area. Take immediate actions to stop the leak or spill by plugging or patching the container or raising the leak to the highest point in the vessel. Spread the absorbent material in the area of the spill, covering it completely.

3. Transfer the material to a new vessel; collect and containerize the absorbent material. Label the new container appropriately. Await analyses for treatment and disposal options.

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

It is not anticipated that a spill will occur that the field crew cannot handle. Should this occur, notification of the appropriate Emergency Response agencies will be carried out by the FOL or SSO in accordance with the procedures discussed in Section 2.0 of this HASP.

11.0 CONFINED-SPACE ENTRY

Personnel under the provisions of this HASP are not allowed, under any circumstances, to enter confined spaces. A confined space is defined as an area that has one or more of the following characteristics:

- Is large enough and so configured that an employee can bodily enter and perform assigned work.
- Has limited or restricted means for entry or exit (for example, tanks, manholes, sewers, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry).
- Is not designed for continuous employee occupancy.

Additionally, a Permit-Required Confined Space may also have one or more of the following characteristics:

- Contains or has a potential to contain a hazardous atmosphere.
- Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly caving walls or by a floor that slopes downward and tapers to a smaller cross-section.
- Contains any other recognized, serious, safety or health hazard.

For further information on confined space operations, consult the Health and Safety Guidance Manual or call the HSM. Any activity that may be considered a confined-space entry shall require modifications of this HASP and shall result in the immediate notification of the Project Health and Safety Officer. This determination shall be made by the FOL and SSO.

12.0 MATERIALS AND DOCUMENTATION

The TtNUS FOL shall ensure the following materials/documents are taken to the project site and used when required.

- A complete copy of this HASP
- Health and Safety Guidance Manual
- Incident Reports
- Medical Data Sheets (multiple copies)
- Material Safety Data Sheets for all chemicals brought on site, including decon solutions, fuels, lime, sample preservatives, calibration gases, etc.
- A full-size OSHA Job Safety and Health Poster
- Training/Medical Surveillance Documentation Form (Blank) (multiple copies)
- Emergency Reference Information (Section 2.0, extra copy for posting)

12.1 MATERIALS TO BE POSTED OR MAINTAINED AT THE SITE

The following documentation is to be posted or maintained at the site for quick reference purposes. In situations where posting of these documents is not feasible (such as no office trailer), these documents should be filed in a transportable file container and immediately accessible. The file should remain in the FOL's possession.

Chemical Inventory Listing (posted) - This list represents all chemicals brought on site, including decontamination solutions, sample preservatives, fuel, calibration gases, etc.. This list should be posted in a central area.

Material Safety Data Sheets (MSDSs) (maintained) - The MSDSs should also be in a central area accessible to all site personnel. These documents should match all the listings on the chemical inventory

list for all substances employed on site. It is acceptable to have these documents within a central folder and the chemical inventory as the table of contents.

The OSHA Job Safety & Health Protection Poster (posted) - This poster, as directed by 29 CFR 1903.2 (a)(1), should be conspicuously posted in places where notices to employees are normally posted. Each FOL shall ensure that this poster is not defaced, altered, or covered by other material.

Site Clearance (maintained) - This is found within the training section of the HASP (See Figure 8-1). This list identifies all site personnel, dates of training (including site-specific training), and medical surveillance and indicates not only clearance but also status. If personnel do not meet these requirements, they do not enter the site while site personnel are engaged in activities.

Emergency Phone Numbers and Directions to the Hospital(s) (maintained) - This list of emergency numbers and hospital directions will be maintained at all phone communications points and in each site vehicle.

Medical Data Sheets/Cards (maintained) - Medical Data Sheets will be filled out by all onsite personnel and filed in a central location. The Medical Data Sheet will accompany any injury or illness requiring medical attention to the medical facility. A copy of this sheet or a wallet card will be given to all personnel to be carried on their person.

Investigative Derived Waste Inventory Log (maintained) – The FOL and/or the SSO shall log collected containers of IDW. An updated inventory will be submitted to the Base POC at the termination of each shift.

13.0 GLOSSARY

ACGIH	American Conference of Governmental Industrial Hygienists
CFR	Code of Federal Regulations
CIH	Certified Industrial Hygienist
CNS	Central Nervous System
CO	Carbon Monoxide
CRZ	Contamination Reduction Zone
CSE	Confined Space Entry
CSP	Certified Safety Professional
CTO	Contract Task Order
DCA	Dichloroethane
DOD	Department of Defense
DOT	Department of Transportation
EFACHES	Engineering Field Activities Chesapeake
EPA	Environmental Protection Agency
eV	electron Volts
FID	Flame Ionization Detector
FOL	Field Operations Leader
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
HEPA	High Efficiency Particulate Air
HSM	Health and Safety Manager
IDH – NSWC	Indian Head Division – Naval Surface Warfare Center
IDW	Investigative Derived Waste
LEL	Lower Explosive Limit
MDE	Maryland Department of Environment
MSDS	Material Safety Data Sheet
N/A	Not Available
NIOSH	National Institute Occupational Safety and Health
NO_2	Nitrogen Dioxide
O_2	Oxygen
OSHA	Occupational Safety and Health Administration (U.S. Department of Labor)
PE	Professional Engineer
PEL	Permissible Exposure Limit
PHSO	Project Health and Safety Officer
PID	Photo Ionization Detector

PM	Project Manager
PPE	Personal Protective Equipment
PVC	Poly Vinyl Chloride
SOP	Standard Operating Procedure
SSO	Site Safety Officer
STEL	Short Term Exposure Limit
TBD	To Be Determined
TCE	Trichloroethylene
TPH	Total Petroleum Hydrocarbons
TtNUS	Tetra Tech NUS, Inc.
TWA	Time Weighted Average
UEL	Upper Explosive Limit
UST	Underground Storage Tank
UV	Ultraviolet

ATTACHMENT I

INJURY/ILLNESS PROCEDURE AND REPORT FORM

case no. _____

TETRA TECH NUS, INC.
INJURY/ILLNESS PROCEDURE
WORKER'S COMPENSATION PROGRAM

WHAT YOU SHOULD DO IF YOU ARE INJURED OR DEVELOP AN ILLNESS AS A RESULT OF YOUR EMPLOYMENT:

- If injury is minor, obtain appropriate first aid treatment.
- If injury or illness is severe or life threatening, obtain professional medical treatment at the nearest hospital emergency room.
- If incident involves a chemical exposure on a project work site, follow instructions in the Health & Safety Plan.
- Immediately report any injury or illness to your supervisor or office manager. In addition, you must contact your Human Resources representative, Marilyn Diethorn at (412) 921-8475, and the Corporate Health and Safety Manager, Matt Soltis at (412) 921-8912 within 24 hours. You will be required to complete an Injury/Illness Report (attached). You may also be required to participate in a more detailed investigation from the Health Sciences Department.
- If further medical treatment is needed, The Hartford Network Referral Unit will furnish a list of network providers customized to the location of the injured employee. These providers are to be used for treatment of Worker's Compensation injuries subject to the laws of the state in which you work. Please call Marilyn Diethorn at (412) 921-8475 for the number of the Referral Unit.

ADDITIONAL QUESTIONS REGARDING WORKER'S COMPENSATION:

Contact your local human resources representative, corporate health and safety coordinator, or Corporate Administration in Pasadena, California, at (626) 351-4664.

Worker's compensation is a state-mandated program that provides medical and disability benefits to employees who become disabled due to job related injury or illness. Tetra Tech, Inc. and its subsidiaries (Tetra Tech or Company) pay premiums on behalf of their employees. The type of injuries or illnesses covered and the amount of benefits paid are regulated by the state worker's compensation boards and vary from state to state. Corporate Administration in Pasadena is responsible for administering the Company's worker's compensation program. The following is a general explanation of worker's compensation provided in the event that you become injured or develop an illness as a result of your employment with Tetra Tech or any of its subsidiaries. Please be aware that the term used for worker's compensation varies from state to state.

WHO IS COVERED:

All employees of Tetra Tech, whether they are on a full-time, part-time or temporary status, working in an office or in the field, are entitled to worker's compensation benefits. All employees must follow the above injury/illness reporting procedures. Consultants, independent contractors, and employees of subcontractors are <u>not</u> covered by Tetra Tech's Worker's Compensation plan.

WHAT IS COVERED:

If you are injured or develop an illness caused by your employment, worker's compensation benefits are available to you subject to the laws of the state you work in. Injuries do not have to be serious; even injuries treated by first aid practices are covered and must be reported. Please note that if you are working out-of-state and away from your home office, you are still eligible for worker's compensation benefits.

case no. _____

TETRA TECH NUS, INC.
INJURY/ILLNESS PROCEDURE
WORKER'S COMPENSATION PROGRAM

To: Corporate Health and Safety Manager
Human Resource Administrator

Project Name: _____ Position: _____

Project No. _____ Office: _____

Prepared by: _____ Telephone: _____

Information Regarding Injured or Ill Employee:

Name: _____ Office: _____

Home address: _____ Gender: M ☐ F ☐ No. of dependents: _____

_____ Marital status: _____

Home telephone: _____ Date of birth: _____

Occupation (regular job title): _____ Social Security No.: _____

Department: _____

Date of Accident: _____ **Time of Accident:** _____

Location of Accident Was place of accident or exposure on employer's premises Yes ☐ No ☐

Street address: _____

City, state, and zip code: _____

County: _____

Narrative Description of How Accident Occurred: (Be specific. Explain <u>what</u> the employee was doing and <u>how</u> the accident occurred.)

Did employee die? Yes ☐ No ☐

Was employee performing regular job duties? Yes ☐ No ☐

Was safety equipment provided? Yes ☐ No ☐

Was safety equipment used? Yes ☐ No ☐

Note: Attach any police reports or related diagrams to this accident report.

Witness(es):

Name:

Address:

Telephone:

TETRA TECH, INC.

INJURY/ILLNESS REPORT

Describe the Illness or Injury and Part of Body Affected:

Name the Object or Substance which Directly Injured the Employee:

Medical Treatment Required:

☐ No ☐ Yes ☐ First Aid Only

Physician's Name: _____

Address: _____

Hospital or Office Name: _____

Address: _____

_____

Telephone No.: _____

Lost Work Days:

☐ No. of Lost Work Days _____

Last Date Worked _____

Time Employee Left Work _____

Date Employee Returned to Work _____

☐ No. of Restricted Work Days _____

☐ None

Corrective Action(s) Taken by Unit Reporting the Accident:

Corrective Action Still to be Taken (by whom and when):

Name of Tetra Tech employee the injury or illness was first reported to: _____

Date of Report: _____ Time of Report: _____

	Printed Name	Signature	Telephone No.	Date
Project or Office Manager				
Site Safety Coordinator				
Injured Employee				

To be completed by Human Resources:

Date of hire: Hire date in current job:

Wage information: $_____ per _____ (hour, day, week, or month)

Position at time of hire:

Shift hours:

State in which employee was hired:

Status: ☐ Full-time ☐ Part-time_____ Hours per week: _____

Days per week: _____

Temporary job end date:

To be completed during report to workers' compensation insurance carrier:

Date reported: Reported by:

TeleClaim phone number:

TeleClaim account number:

Location code:

Confirmation number:

Name of contact:

Field office of claims adjuster:

ATTACHMENT II

ELECTROFISHING SAFETY CHECKLIST

ELECTROFISHING FIELD SAFETY CHECKLIST

Electrical Equipment

- ☐ Electrical connections secure and protected
- ☐ Gages and wiring in proper working condition
- ☐ "Deadman switch" in operating condition
- ☐ Anodes in good condition; attached to handles securely [wadeable streams]

Ancillary Equipment

- ☐ Fire extinguisher - fully charged
- ☐ First-aid kit present
- ☐ Dip net handles constructed of nonconductive material

Crew Members

- ☐ Trained in electrofishing operation
- ☐ Wearing rubber gloves (inspected for leaks)
- ☐ Wearing chest waders (inspected for leaks) with nonslip soles [wadeable streams]
- ☐ Wearing hip boots (inspected for leaks) [nonwadeable streams]

_____ _____

Signature Date

ATTACHMENT III

MEDICAL DATA SHEET

MEDICAL DATA SHEET

This Medical Data Sheet must be completed by all on-site personnel and kept in a central location during site operations. This sheet will accompany any personnel when medical assistance is needed or if transport to hospital facilities is required.

Project _____

Name _____ Home Telephone _____

Address _____

Age _____ Height _____ Weight _____

Name of Next Kin _____

Drug or other Allergies _____

Particular Sensitivities _____

Do You Wear Contacts? _____

Provide a Checklist of Previous Illnesses or Exposure to Hazardous Chemicals _____

_____

_____

What medications are you presently using? _____

_____

_____

Do you have any medical restrictions? _____

_____

_____

_____

Name, Address, and Phone Number of personal physician: _____

_____

_____ _____

Signature Date

ATTACHMENT IV

SAFE WORK PERMITS

SAFE WORK PERMIT FOR
MOBILIZATION/DEMOBILIZATION
MATTAWOMAN CREEK – INDIAN HEAD DIVIDION - NSWC

Permit No. _____ Date: _____ Time: From _____ to _____

SECTION I: **General Job Scope**

I. Work limited to the following (description, area, equipment used): Mobilization/Demobilization

II. Names: _____

III. Onsite Inspection conducted ☒ Yes ☐ No Initials of Inspector _____ _____
TtNUS

SECTION II: General Safety Requirements (To be filled in by permit issuer)

IV. Protective equipment required
Level D ☒ Level B ☐
Level C ☐ Level A ☐

Respiratory equipment required

Full face APR	☐	Escape Pack	☐
Half face APR	☐	SCBA	☐
SAR	☐	Bottle Trailer	☐
Skid Rig	☐	None	☒

Modifications/Exceptions: Sleeved shirts and long pants, safety footware.

V. Chemicals of Concern

Chemicals of Concern	Action Level(s)	Response Measures
None anticipated given the nature of activities and limited contact w/media	None	

VI. Additional Safety Equipment/Procedures

Hardhat	☐ Yes	☐ No	Hearing Protection (Plugs/Muffs)	☐ Yes	☐ No
Safety Glasses	☐ Yes	☐ No	Safety belt/harness	☐ Yes	☒ No
Chemical/splash goggles	☐ Yes	☒ No	Radio	☐ Yes	☒ No
Splash Shield	☐ Yes	☒ No	Barricades	☐ Yes	☒ No
Splash suit/coveralls (Type)	☐ Yes	☒ No	Gloves (leather/cotton)	☒ Yes	☐ No
Steel toe work boots	☒ Yes	☐ No	Work/rest regimen	☐ Yes	☒ No
Chemical Protective Over-boots	☐ Yes	☒ No			

Modifications/Exceptions: Safety glasses, hardhat, reflective vests, and hearing protection when required.

VII. Procedure review with permit acceptors

	Yes	NA		Yes	NA
Safety shower/eyewash (Location & Use)	☐	☒	Emergency alarms	☒	☐
Procedure for safe job completion	☐	☒	Evacuation routes	☒	☐
Contractor tools/equipment inspected	☐	☒	Assembly points	☒	☐

VII. Site Preparation

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☒
Vehicle and Foot Traffic Routes Cleared and Established	☐	☐	☒
Physical Hazards Barricaded and Isolated	☐	☐	☒
Emergency Equipment Staged	☐	☐	☒

VIII. Additional Permits required (Hot work, confined space entry, excavation, etc.). ☐Yes ☒No
If yes, See SSO for appropriate permit

IX. Special instructions, precautions: _____

Permit Issued by: _____ Permit Accepted by: _____

SAFE WORK PERMIT
DECONTAMINATION ACTIVITIES
MATTAWOMAN CREEK – INDIAN HEAD DIVISION - NSWC

Permit No. _____ Date: _____ Time: From _____ to _____

SECTION I: General Job Scope

I. Work limited to the following (description, area, equipment used): Decontamination of sampling equipment. Brushes and spray bottles will be used to decon small sampling equipment.

II. Required Monitoring Instrument(s): None required

III. Field Crew: _____

IV. On-site Inspection conducted ☒ Yes ☐ No Initials of Inspector _____ _____
TtNUS

SECTION II: General Safety Requirements (To be filled in by permit issuer)

IV. Protective equipment required

Level D ☒ Level B ☐
Level C ☐ Level A ☐
Detailed on Reverse

Respiratory equipment required

Full face APR	☐	Escape Pack	☐
Half face APR	☐	SCBA	☐
SAR	☐	Bottle Trailer	☐
Skid Rig	☐	None	☒

Modifications/Exceptions: Minimum requirement include sleeved shirt and long pants, safety glasses, and nitrile gloves.

V.

Chemicals of Concern	Action Level(s)	Response Measures
low concentrations of VOCs,	Avoid contact	
SVOCs, pesticides, metals,		
and entergetics		

VI. Additional Safety Equipment/Procedures

Hard-hat	☐ Yes	☐ No	Hearing Protection (Plugs/Muffs)	☐ Yes	☐ No
Safety Glasses	☒ Yes	☐ No	Safety belt/harness	☐ Yes	☒ No
Chemical/splash goggles	☐ Yes	☒ No	Radio	☐ Yes	☒ No
Splash Shield	☐ Yes	☒ No	Barricades	☐ Yes	☒ No
Splash suits/coveralls	☐ Yes	☐ No	Gloves (Type - Nitrile)	☒ Yes	☐ No
Steel toe Work shoes or boots	☐ Yes	☐ No	Work/rest regimen	☐ Yes	☒ No

Modifications/Exceptions: PVC rain suits or PE or PVC coated Tyvek for protection against splashes and overspray. Chemical resistant boot covers if excessive liquids are generated or protected footwear.

VII. Procedure review with permit acceptors

	Yes	NA		Yes	NA
Safety shower/eyewash (Location & Use)	☒	☐	Emergency alarms	☒	☐
Procedure for safe job completion	☐	☒	Evacuation routes	☒	☐
Contractor tools/equipment/PPE inspected	☐	☒	Assembly points	☒	☐

VIII. Site Preparation

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☒
Vehicle and Foot Traffic Routes Cleared and Established	☐	☐	☒
Physical Hazards Barricaded and Isolated	☐	☐	☒
Emergency Equipment Staged	☐	☐	☒

IX. Additional Permits required (Hot work, confined space entry, excavation etc.). ☐ Yes ☒ No
If yes, complete permit required or contact Health Sciences, Pittsburgh Office

X. Special instructions, precautions: Chemical hazards with decontamination because of use of fluids such as isopropyl alcohol, methanol, etc. To minimize the potential for exposure, site personnel will use PPE and prevent contact with potentially contaminated equipment. Refer to the manufacturer's MSDS regarding PPE, handling, storage, and first-aid measures related to decontamination fluids.

Permit Issued by: _____ Permit Accepted by: _____

SAFE WORK PERMIT FOR
MULTI-MEDIA SAMPLING
MATTAWOMAN CREEK - INDIAN HEAD DIVISION NSWC

Permit No. _____ Date: _____ Time: From _____ to _____

SECTION I: General Job Scope

I. Work limited to the following (description, area, equipment used): Multi-media sampling including surface water, sediment, fish, and aquatic vegitation

II. Required Monitoring Instrument(s): none required

III. Field Crew: _____

IV. On-site Inspection conducted ☒ Yes ☐ No Initials of Inspector _____ _____
TtNUS

SECTION II: General Safety Requirements (To be filled in by permit issuer)

IV. Protective equipment required

Level D ☒ Level B ☐
Level C ☐ Level A ☐
Detailed on Reverse

Respiratory equipment required

Full face APR	☐	Escape Pack	☐
Half face APR	☐	SCBA	☐
SAR	☐	Bottle Trailer	☐
Skid Rig	☐	None	☒

Modifications/Exceptions: Minimum requirement include sleeved shirt and long pants, safety shoes, surgical style gloves, and safety glasses. Hats will be worn to protect from uV rays when working in the boat. Type III PFD will be worn at all time in the boat and around water.

V.

Chemicals of Concern	Action Level(s)	Response Measures
low concentrations of VOCs, SVOCs, pesticides, metals, energetics	Avoid skin contact with all potentially contaminated media	

VI. Additional Safety Equipment/Procedures

Hard-hat	☐ Yes	☒ No	Hearing Protection (Plugs/Muffs)	☐ Yes	☒ No
Safety Glasses	☒ Yes	☐ No	Safety belt/harness	☐ Yes	☒ No
Chemical/splash goggles	☐ Yes	☒ No	Radio	☐ Yes	☒ No
Splash Shield	☐ Yes	☒ No	Barricades	☐ Yes	☒ No
Splash suits/coveralls	☐ Yes	☒ No	Gloves (Type – Surgical Style)	☒ Yes	☐ No
Steel toe Work shoes or boots	☐ Yes	☒ No	Work/rest regimen	☐ Yes	☒ No

Modifications/Exceptions: _____

VII. Procedure review with permit acceptors

	Yes	NA		Yes	NA
Safety shower/eyewash (Location & Use)	☐	☒	Emergency alarms	☒	☐
Procedure for safe job completion	☒	☐	Evacuation routes	☒	☐
Contractor tools/equipment/PPE inspected	☒	☐	Assembly points	☒	☐

VIII. Site Preparation

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☒
Vehicle and Foot Traffic Routes Cleared and Established	☐	☐	☒
Physical Hazards Barricaded and Isolated	☐	☐	☒
Emergency Equipment Staged	☒	☐	☐

IX. Additional Permits required (Hot work, confined space entry, excavation etc.). ☐ Yes ☒ No
If yes, complete permit required or contact Health Sciences, Pittsburgh Office

X. Special instructions, precautions: Minimize contact with potentially contaminated media (sediments, fish, etc. Use safe work practices disucssed in the HASP and Guidance Manual. Wash hands and face before performing any hand to mouth activities. Fire extinguisher and first aid kit to be in sampling boat at all times.

Permit Issued by: _____ Permit Accepted by: _____

APPENDIX C

QUALITY ASSURANCE PROJECT PLAN

Quality Assurance Project Plan for Mattawoman Creek

Indian Head Division
Naval Surface Warfare Center
Indian Head, Maryland

Engineering Field Activity Chesapeake
Naval Facilities Engineering Command
Contract Number N62472-90-D-1298
Contract Task Order 0320

July 2001

Rev. 0
07/10/01

QUALITY ASSURANCE PROJECT PLAN
FOR MATTAWOMAN CREEK
INDIAN HEAD DIVISION
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

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

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ACRONYMS AND ABBREVIATONS

%R	percent recovery
ASTM	American Society for Testing and Materials
AVS	acid volatile sulfide
AWQC	Ambient Water Quality Criteria
BTAG	Biological Technical Assistance Group
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action Navy
CLP	Contract Laboratory Program
COC	chemical of concern or chain of custody
COPC	chemical of potential concern
CTO	contract task order
DO	dissolved oxygen
DOD	Department of Defense
DQO	data quality objective
DUP	duplicate
EFACHES	Environmental Field Activity Chesapeake
EPA	Environmental Protection Agency
ERA	ecological risk assessment
ESM	Environmental Site Manager
FD	field duplicate
FOL	Field Operations Leader
FS	Feasibility Study
FTMR	Field Task Modification Request
GC	gas chromatograph or gas chromatography
GC/MS	gas chromatograph/mass spectrometer or gas chromatography/mass spectrometry
HASP	Health and Safety Plan
HHRA	human health risk assessment
HMX	octahydro-1,3,5,6-tetranitro-1,3,5,6-tetrazocine
HPLC	high performance liquid chromatograph (or chromatography)
HSM	Health and Safety Manager
ICP/AES	inductively coupled plasma/atomic emission spectrometer or inductively coupled plasma/atomic emission spectroscopy
IDL	instrument detection limit
IDW	investigation derived waste

IHDIV	Indian Head Division
IRP	Installation Restoration Program
kg	kilogram
L	liter
LCS	laboratory control sample
MDL	method detection limit
mg	milligram
MNA	Monitored Natural Attenuation
MS	matrix spike
MSD	matrix spike duplicate
NA	not applicable
NEESA	Naval Engineering and Environmental Support
NFESC	Naval Facilities Engineering Service Center
NIST	National Institute of Standards and Technology
NPDES	National Pollution Discharge Elimination System
NSWC	Naval Surface Warfare Center
NTU	nephelometric turbidity unit
NWSC	Naval Weapons Support Center
ORP	oxidation reduction potential
OSHA	Occupational Safety and Health Administration
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCA	1,1,2,2-tetrachloroethane
PCB	polychlorinated biphenyl
PDS	post-digestion spike
PE	performance evaluation
PM	preventive maintenance or Project Manager
POC	point of contact
PPE	personal protective equipment
PVC	polyvinyl chloride
QA	quality assurance
QAM	Quality Assurance Manager
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	quality control
RAGS	Risk Assessment Guidance for Superfund
RBC	risk-based concentration
RBSL	risk-based screening level

RBTL	risk-based target level
RCRA	Resource Conservation and Recovery Act
RDX	hexahydro-1,3,3-trinitro-1,3,3-triazine
RI	Remedial Investigation
RL	reporting limit
RPD	relative percent difference
RPM	Remedial Project Manager
SAP	Sampling and Analysis Plan
SAV	submerged aquatic vegetation
SD	sediment
SDG	sample delivery group
SED	sediment
SEM	simultaneously extracted metals
SOP	standard operating procedure
SOW	statement of work
SRM	Standard Reference Material
SSL	Soil Screening Level or Sediment Screening Level
SSO	Site Safety Officer
SVOC	semivolatile organic compound
SW	surface water
SWSL	Surface Water Screening Level
TAL	Target Analyte List
TBD	to be determined
TCE	trichloroethene
TCL	Target Compound List
TDS	total dissolved solids
TNT	trinitrotoluene
TOC	total organic carbon
TSS	total suspended solids
TtNUS	Tetra Tech NUS, Inc.
UCL	upper confidence limit
ug	microgram
uS	microSiemen
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VOC	volatile organic chemical
WQS	Water Quality Standard

WP	Work Plan
WWTP	Wastewater Treatment Plant

1.0 PROJECT DESCRIPTION

1.1 INTRODUCTION

This investigation is an environmental investigation of the Mattawoman Creek at the Indian Head Division, Naval Surface Warfare Center (IHDIV-NSWC), Indian Head, Maryland. NSWC Indian Head is a U.S. Navy installation located within U.S. Environmental Protection Agency (EPA) Region 3. This investigation is being undertaken to satisfy requirements of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA, 1980) as amended under the Superfund Amendments and Reauthorization Act (SARA) of 1986. It is also designed to satisfy the requirements of the U.S. Navy Installation Restoration Program (IRP), the U.S. EPA Region 3 and the state of Maryland.

1.2 PLANNING DOCUMENT PREPARATION

To govern this investigation, a group of documents was prepared. The quality assurance project plan (QAPP) was developed to present the project planning strategy and to address all aspects of the project not associated directly with field activities. Liberal reference is made in this QAPP to the attendant Work Plan (WP). The Work Plan includes a field sampling plan (FSP) and a health and safety plan (HASP). The FSP is devoted to governance of actual field operations related to environmental data collection. The HASP governs health and safety operations, primarily related to field operations.

Tetra Tech NUS, Inc. (TtNUS) has prepared this Quality Assurance Project Plan (QAPP) on behalf of the United States Navy Engineering Field Activity Chesapeake (EFACHES) Naval Facilities Engineering Command and the IHDIV-NSWC under the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract No. N62472-90-D-1298, Contract Task Order (CTO) 320. Project planning incorporated the most pertinent aspects of the U.S. EPA Data Quality Objectives (DQO) process (U.S. EPA, 1999b). That process requires explicit statements of the problem to be solved, the spatial and temporal boundaries related to the problem, the measurements to be made in solving the problem and, when applicable, quantitative specifications of the tolerances for making decision errors. It culminates in a specification of decision rules and in a sampling and analysis plan designed to solve the stated problem.

This QAPP was generated for and complies with applicable Maryland and United States Environmental Protection Agency (USEPA) Region 3 requirements, regulations, guidance and technical standards. Also followed closely for establishing the QA/QC requirements specified in this QAPP was the Naval Facilities Engineering Service Center (NFESC) guidance document entitled "Navy Installation Restoration

Laboratory Quality Assurance Guide" (NFESC, 1996). The NFESC guidance specifies criteria for acceptable laboratory performance and monitoring of that performance.

U.S. EPA human health and ecological risk-based screening levels (RBSLs) were considered in developing this QAPP, especially when selecting sampling and analytical methods to measure target analyte concentrations in the media of interest. All QA/QC procedures are structured in accordance with applicable U.S. EPA Region 3 requirements, regulations, guidance, and technical standards.

The subsections below are used to develop the project context, the site history, a statement of the problem being investigated, the decisions to be made to resolve the problem and the strategy for collecting data to make the decisions, all with a focus on the protection of human health and the environment. An effort has been made to insure that the flow of information from one section to another is logical. Project requirements are delineated in the QAPP body and are supplemented with detailed descriptions or collections of data in the appendix, including risk-based screening levels used in deriving decision-making criteria (Appendix A). The Table of Contents provides an overview of the document organization. Tables and figures are placed at the end of each section in which they are first referenced.

1.3 PROJECT STATUS AND PHASE

The United States Fish and Wildlife Service (USFWS) conducted a series of ecological studies in the Mattawoman Creek in the late 1980s and early 1990s. These studies consisted of a 5-year study of mercury accumulation in Mattawoman Creek fish and a study to gauge the effectiveness of the IHDIV-NSWC National Pollution Discharge Elimination System (NPDES) permit. The results of these studies near IHDIV-NSWC concluded that ecological receptors could be at potential risk from Base-related chemicals in Mattawoman Creek media. Table 1-1 summarizes these and other past investigations at the site.

The results of the remedial investigation (RI) conducted for Site 39, Organics Plant, and Site 41, Scrap Yard, indicated the presence of elevated concentrations of some metals and organic compounds in sediments of Mattawoman Creek adjacent to these sites (TtNUS, 1999b). The RI included a screening-level ecological risk assessment that concluded that potential risks were present for aquatic and semi-aquatic receptors in that portion of Mattawoman Creek. These studies also concluded that additional data were needed to more fully investigate the potential risks. Therefore, the Navy has initiated an ERA to further characterize impacts to Mattawoman Creek biota, with emphasis on the section of the creek near the Base, where impacts are thought to be most significant. For more information on the results of these studies, refer to Section 1.3 of the WP, Section 2.0, and Table 2-1 of the Mattawoman Creek ERA Problem Formulation (Appendix A of the WP).

1.4 PROBLEM STATEMENT

In August of 2000, project biologists visited Mattawoman Creek to ascertain what receptors could potentially be at risk from chemicals released to the creek. The biologists also identified potentially affected aquatic and semi-aquatic habitats, the locations of these habitats, the nature of Mattawoman Creek hydrology near IHDIV-NSWC and the sediment depositional areas in the creek. Locations of potential sources of chemicals near the Base were evaluated, including active and inactive outfalls, feeder creeks, and Installation Restoration Program (IRP) sites. These areas were identified from active and historical records of Base activities and recent IRP investigations.

The historical studies of the site were reviewed, along with available information regarding past and current waste management practices, to develop a list of proposed chemicals of potential concern (COPCs). With the exception of Sites 39 and 41, the presence or absence of these COPCs in sediments along other portions of Mattawoman Creek adjacent to the Base is generally unknown. In addition, several outfalls associated with the installation are located along Mattawoman Creek. At present these outfalls are under the NPDES permit. However, historical operations at the Base have resulted in introduction of Base-related chemicals to Mattawoman Creek from past waste management practices, documented spills and other discharges. Historical information describing the activities, waste management practices and specific chemicals relate to many of the outfalls on the Base is scarce. Furthermore, the hydrological conditions in Mattawoman Creek have changed over time, including movement of the main channel, sediment loading from on-Base and off-Base sources and dynamic movement of sediment depositional areas. The creek is also subject to tidal influences.

The degree of risk to a human or ecological receptor is determined based on the nature of contamination and the frequency, duration, and nature of exposure to contaminants. Consequently, it is important to understand where receptors could be exposed to the contaminants. This requires that the extent of contamination be established. In this context, extent of contamination will be established relative to numerical risk-based criteria. A risk evaluation will be conducted for human and ecological receptors in contaminated areas to determine whether risks posed by exposure of those receptors to site contaminants is unacceptable. Plausible land use scenarios were considered when identifying the receptors that could be at risk.

The purpose of the Mattawoman Creek Study is to determine the magnitude of impacts on Mattawoman Creek from Base-related activities and to assess the potential ecological and human health risks resulting from those impacts. The data generated from this investigation will be used to conduct an screening level Ecological Risk Assessment (ERA) and a baseline Human Health Risk Assessment (HHRA) to determine the most appropriate course of risk management for Mattawoman Creek.

1.5 PROJECT OBJECTIVES AND DECISION STATEMENTS

Past sampling at the site, although limited, identified the presence of select contaminants that have the potential to cause ecological and human health risks. Since the past sampling was limited, the extent to which these chemical releases have impacted the region has not been determined. This investigation is designed to further delineate the nature and extent of contamination in surface water, sediment and fish and vegetation tissue. It is also designed to implement a baseline HHRA and a screening level ERA. Because of these two general objectives, two decision statements have been developed for this project, each of which applies to multiple environmental media. The decision statements that will facilitate attainment of the project objectives are as follows:

From surface water, sediment, fish tissue and vegetation data, determine the nature and extent of chemical contaminant concentrations that exceed applicable screening levels in each environmental medium (sediment, surface water, fish tissue and vegetation).

Determine whether contamination associated with Mattawoman Creek poses an unacceptable risk to human or ecological receptors through the use of a baseline human health risk assessment and a screening level ecological risk assessment. If risks are unacceptable, consider implementing a Feasibility Study (FS) to reduce the risks to acceptable levels. If risks are acceptable, take no further action.

1.6 SITE FACILITY/FACILITY DESCRIPTION

This section is a presentation of background information, general site characteristics of the NSWC Indian Head facility and physical site characteristics specific to Mattawoman Creek. It discusses such topics as site location, facility size and borders, natural and manmade features, climatology, topography, local hydrology and hydrogeology, surrounding land use and ecological communities and habitats. A description of the site location, facility size and borders and surrounding land use is presented in Section 1.2 and Figure 1.1 of the Work Plan.

1.6.1 Hydrology and Hydrogeology

A discussion of the hydrology and hydrogeology of Mattawoman creek is presented in Section 1.2 of the Work Plan.

1.6.2 Ecological Communities and Habitat

Mattawoman Creek has a diverse and abundant aquatic and semi-aquatic ecology, with an abundance of wildlife and aquatic vegetation. Many species of fish inhabit Mattawoman Creek or adjacent areas, including many species of freshwater gamefish and some marine species that use the creek as a nursery.

Several species of waterfowl and piscivorous birds are found in and along the creek. In addition, an abundance of turtles and aquatic snakes are regularly observed. Extensive aquatic vegetation is found throughout Mattawoman Creek, including some wooded swamps, submerged aquatic vegetation (SAV) and several types of riparian vegetation. Several of these species of flora and fauna found in Mattawoman Creek are rare, threatened or endangered. Refer to Section 1.2.1 of the Work Plan (WP) for further information on these species.

1.7 FACILITY HISTORY AND BACKGROUND

This section provides an overview of the site operations, summarizes past environmental investigations at Mattawoman Creek and presents an evaluation of historical data gathered from the past investigations.

1.7.1 Facility Operational History

The primary mission of IHDIV-NSWC is as follows:

- Provide service in energetics for all warfare centers through engineering, fleet and operational support, manufacturing technology, limited production and industrial Base support.

- Provide research, development, testing and evaluation of energetic materials, ordnance devices and components and other related ordnance engineering standards, including chemicals, propellants, and their propulsion systems, explosives, pyrotechnics, warheads and simulators.

- Provide support to all warfare centers, military departments and the ordnance industry for special weapons, explosive safety and ordnance environmental issues.

From the 1960s to 1988, electrical transformers and lead batteries were stored at the northwestern end of the Scrap Yard (Site 41) prior to offsite disposal. The transformers were believed to have leaked and contaminated the soil in this area with polychlorinated biphenyls (PCBs). Additionally, lead may have been released from the batteries to the surface soil. Runoff from this site flows southwest into Mattawoman Creek. PCBs and lead are relatively immobile in soils under normal environmental conditions. However, some migration of these contaminants is anticipated to have occurred, especially via percolation into the soil.

1.7.2 Evaluation of Historical Data

Several studies were conducted in the Mattawoman Creek and areas surrounding the Base from the late 1980s to the early 1990s. These studies consisted of two separate studies by the United States Fish and

Wildlife Service and a remedial investigation (RI) conducted for Site 39, Organics Plant and Site 41, Scrap Yard. For more information about the details and results of these studies, refer to Section 1.3 of the Work Plan and/or Section 2.0 and Table 2-1 of the Mattawoman Creek ERA Problem Formulation (Appendix A of the WP).

1.8 INTENDED DATA USES

This section provides a detailed description of the project target parameters and intended data uses.

1.8.1 Project Target Parameters

Table 1-2 summarizes project target parameters for each medium (surface water, sediment, fish tissue and vegetation) and the associated intended data uses. The specified data uses are linked to the decision statements presented in Section 1.5. Decision rules that expand on these decision statements are found in Section 1.9.4. Data used to determine the nature and extent of contamination will also be used to evaluate human health and ecological risk.

All field and laboratory target parameter results greater than or equal to method detection limits (MDLs) will be reported. MDLs for field parameters are based on method or field test kit capabilities and specifications. Analytical results for analytes that are less than applicable MDLs will be reported with a "U" flag. The "U" flag signifies that the parameter was analyzed for but was not detected at a concentration greater than or equal to the MDL. Laboratory MDLs are based in part on best professional judgment and on statistical computations in accordance with 40 Code of Federal Regulations (CFR) Part 136, Appendix B. Sample-specific laboratory MDLs will be computed for each sample to account for variations in the MDL that are caused by factors such as sample moisture content, the size of the sample aliquot used in the analysis, and dilutions. MDLs will be available once the laboratory is selected.

1.8.1.1 Field Parameters

Several field measurements will be made for this investigation. As previously noted, Table 1-2 summarizes all project target parameters and the associated intended data uses. Table 1-3 also indicates which measurements will be made in the field and presents MDLs, as applicable, for the target parameters measured in the field. Field parameters are not typically used to establish the extent of contamination or to evaluate risks. They are generally used to establish that stable sampling conditions exist before samples are collected or to provide contextual information for interpreting the primary target parameters.

1.8.1.2 Laboratory Parameters

Laboratory analyses will be used to estimate target analyte concentrations in surface water, sediment, fish tissue and vegetation. Use of target analyte data for decision-making is described in Section 1.9.4.

The data use includes comparing the analytical data to risk-based target levels (RBTLs), which are derived from human health and ecological risk-based screening levels (RBSLs). The RBTL is the lowest (i.e., most conservative) RBSL. Following is a list of sources for the RBSLs applicable to this project:

Surface water RBSLs

- Federal Ambient Water Quality Criteria (AWQC) for Freshwater
- Federal Ambient Water Quality Criteria (AWQC) for Saltwater
- Federal Ambient Water Quality Criteria (AWQC) for the Protection of Human Health; Consumption of Water and Organisms
- Federal Ambient Water Quality Criteria (AWQC) for the Protection of Human Health; Consumption of Organisms Only
- EPA Region 3 Risk-Based Concentration (RBC) for Tap Water

Sediment RBSLs

- EPA Region 3 Risk-Based Concentration (RBC) for Residential Land Use Soils
- Ecological Screening Effects-Range Low Values

Fish Tissue RBSLs

- EPA Region 3 Risk-Based Concentration (RBC) for Fish

Tabular presentations of the RBSLs are provided in Appendix A. Table 1-4 lists the laboratory parameters, analytical methods, laboratory detection and reporting limits (RLs), and RBTLs for surface water, sediment and fish tissue. No RBSLs exist that would be appropriate to use for the vegetation matrix; therefore, this matrix is not included in Table 1-4. MDLs and RLs used for vegetation tissue analyses will be the same as those used for the sediment analyses.

MDLs are generally less than reporting limits. Measurement uncertainty is so great at concentrations less than the MDL that the presence of an analyte cannot be asserted with reasonable confidence in that concentration range. Thus, results less than the MDL represent analytes that are classified as "non-detects." As concentration increases, the *relative* measurement uncertainty typically decreases up to the RL. Analyte concentrations greater than RLs are generally reported with a relatively high degree of accuracy and precision (i.e., the reported value is within about 20 or 30 percent of the true value). The uncertainty varies from analyte to analyte and is not typically quantified for individual analytes. The uncertainty associated with results between the MDL and RL is comparatively high, but also varies from analyte to analyte. This can cause problems when interpreting data, especially when comparing two values. However, the decision to report to concentrations as little as MDLs was made to provide the greatest chance for achieving the RBTLs in Table 1-4. Despite this relatively aggressive reporting convention, several RBTLs may still be unattainable. Analytes for which the MDL is greater than the RBTL will be identified in Table 1-4 with an asterisk, once the MDLs are available.

1.8.2 Human Health Risk Assessment

A detailed discussion of the human health risk assessment methodologies to be used to evaluate potential site-specific human health risks at this site is presented in Section 2.3 of the attendant Work Plan. It includes the topics of data evaluation, exposure assessment, toxicity assessment, risk characterization and uncertainty analysis as they relate to the investigation at Mattawoman Creek.

1.8.3 Ecological Risk Assessment

Appendix A of the attendant Work Plan provides a detailed description of the species, exposure pathways, and other concerns that were considered when developing the Work Plan. Also provided in Appendix A of the work plan is a detailed description of the methodology that will be used to assess ecological risk at Mattawoman Creek.

1.8.4 Decision Rules

Based on site-specific factors and the DQO process outputs, this section describes how the data will be used for making decisions concerning the risk to human health and ecological receptors. Decision rules are designed to be technically defensible and practical to implement. Risk-based decision rules must also relate to the appropriate exposure units (EUs). EUs relate to project geographical boundaries as well as the behaviors of the receptor species potentially exposed to contaminants. The decision making process is summarized below and is supplemented with decision flow charts where appropriate.

For this project, the primary EU consists of the entire study area. If contamination extends beyond that boundary, the actual EU may be either reshaped or relocated to coincide with the contaminated area, or additional EUs may be established to encompass contamination extending beyond the study area. Any reshaping or relocation of the EU will not change the size of the EU materially, as the EU size is based on receptor behavior. For surface water, and sediment, the ability to collect samples will be affected by rain events. However, risk impacts associated with these media are expected to be relatively low, so sampling will not be specifically timed to coincide with rain events.

1.8.4.1 Definition

The decision rule is a statement that integrates DQO planning process outputs into a concise summary of how data will be interpreted when making decisions about the site being investigated. In this case, decision rules have been developed to address the multiple project objectives and media under investigation. The decision rules form a basis for establishing a sampling plan design that enables data of the correct type, quantity, and quality to be collected for attaining project objectives.

1.8.4.2 Background Concentrations

The decision rules for establishing background are presented in Section 2.3.1.2.4 of the attendant Work Plan.

1.8.4.3 Decision Rules for Establishing Chemicals of Potential Concern

The decision rule for establishing chemicals of potential concern is presented in Section 2.3.1.2 of the attendant Work Plan.

1.8.4.4 Decision Rules for Risk-Based Evaluation

A detailed risk evaluation strategy is presented in the attendant Work Plan, Section 2.3.2. This culminates in Section 2.3.4.2 of the attendant Work Plan with a description of how quantitative risk estimates will lead to decisions concerning the need to remediate the site or whether other actions would be appropriate.

1.9 SAMPLING LOCATIONS AND RATIONALES

1.9.1 Rationale for the Selected Number of Sediment Samples

Rationales for sediment sampling are presented in Section 3.3 of the attendant Work Plan.

1.9.2 Rationale for the Selected Number of Surface Water Samples

Rationales for surface water sampling are presented in Section 3.2 of the attendant Work Plan.

1.9.3 Rationale for the Selected Number of Fish Tissue Samples

Rationales for fish tissue sampling are presented in Section 3.4 of the attendant Work Plan.

1.9.4 Rationale for the Selected Number of Vegetation Samples

Rationales for vegetation sampling are presented in Section 3.5 of the attendant Work Plan.

1.10 PROJECT SCHEDULE

The project schedule is not presented in this QAPP.

TABLE 1-1

MATTAWOMAN CREEK
HISTORICAL INVESTIGATION SUMMARY
IHDIV-NSWC INDIAN HEAD, MARYLAND
PAGE 1 OF 2

Event	Summary/Conclusions
USFWS 5-year study of mercury accumulation in Mattawoman Creek fish-1987	• Total mercury concentrations in Mattawoman Creek fish in the vicinity of IHDIV-NSWC were not significantly different than those at the upgradient reference station. All Marsh Island fish had mercury concentrations below 1 mg/kg, which USFWS cited as a "contaminated threshold"
USFWS 5-year study of mercury accumulation in Mattawoman Creek fish-1988	• Total mercury concentrations in Mattawoman Creek fish in the vicinity of IHDIV-NSWC were not significantly different than those at the upgradient reference station. All Marsh Island fish had mercury concentrations below 1 mg/kg. Channel catfish were not available from the Marsh Island site. All data analyzed at that station were from largemouth bass and bluegill.
USFWS 5-year study of mercury accumulation in Mattawoman Creek fish-1989	• Total mercury concentrations in Mattawoman Creek fish in the vicinity of IHDIV-NSWC were not significantly different than those at the upgradient reference station. All Marsh Island fish had mercury concentrations below 1 mg/kg.
USFWS study of the IHDIV-NSWC NPDES permit-1989	• Marsh Island sediment samples contained higher concentrations of arsenic, chromium, lead, selenium, silver and zinc than upgradient samples. • Metals analyzed for in fish, clams and aquatic plants were not significantly different among sites, with the exception of elevated copper in aquatic plants near the Facility. • Bioassay tests showed no significant toxic effects of short-term exposure to ambient water near the Facility. • Fish histopathological results indicated that fish health may be negatively impacted near the Facility.
USFWS 5-year study of mercury accumulation in Mattawoman Creek fish-1990	• Total mercury concentrations in Mattawoman Creek largemouth bass and bluegill in the vicinity of IHDIV-NSWC were not significantly different than those at the upgradient reference station. Channel catfish concentrations were slightly higher than those of the upgradient station. All Marsh Island fish had mercury concentrations below 1 mg/kg.
USFWS 5-year study of mercury accumulation in Mattawoman Creek fish-1991	• An additional reference site in Nanjemoy Creek was added to the sampling scheme. Total mercury concentrations in channel catfish and bluegill in the vicinity of IHDIV-NSWC were not significantly different than those at the upgradient reference station. Largemouth bass concentrations were significantly higher than those of the upgradient station. All Marsh Island fish had mercury concentrations below 1 mg/kg, with the exception of one largemouth bass sample. Bluegills from the upgradient site had higher concentrations than those of the Marsh Island site and the Nanjemoy Creek reference site.
Site Investigation-1994	• Sediment samples collected near Site 39, the Organics Plant, and Site 41, the Scrap Yard, showed low concentrations of VOCs, SVOCs, pesticides and metals. In addition, nitroguanidine, 1,1-dimethyl hydrazine and nitrocellulose were detected in these samples.

TABLE 1-1

MATTAWOMAN CREEK
HISTORICAL INVESTIGATION SUMMARY
IHDIV-NSWC INDIAN HEAD, MARYLAND

Event	Summary/Conclusions
Remedial Investigation-1999	• Six surface water and eight sediment samples were collected near Sites 39 & 41. Concentrations of all analytes were low in surface water. Concentrations of VOCs, SVOCs and pesticides were low in sediments. Concentrations of nitrocellulose and several metals, including mercury and silver, were elevated in sediments. The major COPCs for these sites were determined to be: ➢ Surface Water-cadmium, chromium, copper, lead, mercury, silver, zinc and Arochlor 1260. ➢ Sediment-mercury, nickel, silver, 1,1-dimethylhydrazine, nitrocellulose and N-nitrosodiphenylamine. ➢ Aquatic Foodchain-chromium, lead, mercury, silver and zinc.

USFWS-United States Fish and Wildlife Service
NPDES-National Pollution Discharge Elimination System
VOC-Volatile Organic Compound
SVOC-Semi-volatile Organic Compound
COPC-Chemical of Potential Concern

TABLE 1-2

PROJECT TARGET PARAMETERS AND RATIONALES
IHDIV-NSWC INDIAN HEAD, MARYLAND
PAGE 1 OF 2

Parameter	Environmental Medium				Intended Data Use
	SW	SD	F	V	
Target Compound List (TCL) CLP SOWs OLC02.1 & OLM04.2 Pesticides/PCBs	X	X	X	X	To establish absence or presence and extent of contamination. Evaluate risks to potential receptors (human health and ecological) from potentially site-related contaminants.
Target Compound List (TCL) CLP SOWs OLC02.1 & OLM04.2 SVOCs	X	X	X		To establish absence or presence and extent of contamination. Evaluate risks to potential receptors (human health and ecological) from potentially site-related contaminants.
Target Compound List (TCL) CLP SOWs OLC02.1 & OLM04.2 VOCs plus Diethyl ether	X	X			To establish absence or presence and extent of contamination. Evaluate risks to potential receptors (human health and ecological) from potentially site-related contaminants.
Explosives (SW-846 8330 list)	X	X			To establish absence or presence and extent of contamination. Evaluate risks to potential receptors (human health and ecological) from potentially site-related contaminants.
Nitroglycerine	X	X			To establish absence or presence and extent of contamination. Evaluate risks to potential receptors (human health and ecological) from potentially site-related contaminants.
Nitrocellulose and Nitroguanidine	X	X			To establish absence or presence and extent of contamination. Evaluate risks to potential receptors (human health and ecological) from potentially site-related contaminants.
Target Analyte List (TAL) metals, total	X	X	X	X	To establish absence or presence and extent of contamination. Evaluate risks to potential receptors (human health and ecological) from potentially site-related contaminants.
Target Analyte List (TAL) metals, dissolved	X				To establish absence or presence and extent of contamination. Evaluate risks to potential receptors (human health and ecological) from potentially site-related contaminants.
Cyanide	X	X	X		To establish absence or presence and extent of contamination. Evaluate risks to potential receptors (human health and ecological) from potentially site-related contaminants.
Nitrate	X				Evaluate risks to potential human receptors from potentially site-related contaminants.
Nitrite	X				To evaluate fate and transport of contaminants as well as natural attenuation.
Total Organic Carbon (TOC)	X	X			To evaluate fate and transport of contaminants and to corroborate absence or presence of contamination. Indication of bioavailability of chemicals in sediment.

TABLE 1-2

PROJECT TARGET PARAMETERS AND RATIONALES
IHDIV-NSWC INDIAN HEAD, MARYLAND

Parameter	Environmental Medium				Intended Data Use
	SW	SD	F	V	
Acid Volatile Sulfides/Simultaneously Extracted Metals (AVS/SEM)		X			To evaluate the potential of metal bioavailability in sediment.
Dissolved Oxygen (f)	X				To evaluate natural attenuation and fate and transport.
Salinity (f)	X				Generally useful for data interpretation and potential future uses.
Grain Size		X			To evaluate fate and transport of contaminants.
Hardness	X				To evaluate water quality and to calculate water quality standards.
Perchlorate	X				To evaluate fate and transport of contaminants.
pH (f)	X				To obtain information on mobility of chemicals (especially metals). Generally useful for data interpretation and potential future uses.
Specific Conductance (f)	X				Generally useful for data interpretation and potential future uses.
Total Dissolved Solids (TDS)	X				To evaluate water quality and to determine if contaminant concentrations are reflective of dissolved solids concentrations.
Total Suspended Solids (TSS)	X				To evaluate water quality and to determine if contaminant concentrations are reflective of suspended solids concentrations.
Fluoride	X				To evaluate fate and transport of contaminants as well as natural attenuation.
Chloride	X				To evaluate fate and transport of contaminants as well as natural attenuation.
Sulfate	X				To evaluate fate and transport of contaminants as well as natural attenuation.
Turbidity (f)	X				Measured to estimate whether total contaminant concentrations are attributable to suspended solids.
Oxidation-Reduction Potential (ORP) (f)	X				To evaluate natural attenuation and fate and transport of contaminants. To evaluate water quality.
Temperature-Water and Air (f)	X				Generally useful for data interpretation and potential future uses. Measured to aid in interpretation of temperature sensitive parameters.

(f) Field analysis

SW surface water
F fish tissue
SD sediment
V vegetation

TABLE 1-3

AQUEOUS FIELD TARGET PARAMETERS AND METHOD DETECTION LIMITS IHDIV-NSWC INDIAN HEAD, MARYLAND

Parameter	Reporting Limit (mg/L, unless otherwise noted)
Air Temperature	NA (°C)
Dissolved Oxygen	0.1 mg/L
Oxidation Reduction Potential (ORP)	NA
pH	NA
Salinity	NA
Specific Conductance	0.02 uS/cm
Turbidity	1 NTU
Water Temperature	NA (°C)

NA – Not applicable
mg/L = milligrams per liter
uS/cm = microSiemens per centimeter
NTU = nephelometric turbidity unit
°C = degrees Celsius

TABLE 1-4

LABORATORY ANALYTICAL PARAMETERS, DETECTION AND REPORTING LIMITS, AND RISK-BASED TARGET LEVELS
MATTAWOMAN CREEK ECOLOGICAL RISK ASSESSMENT
IHDIV-NSWC INDIAN HEAD, MARYLAND

Parameter	Surface Water Matrix			Sediment and Fish Tissue Matrices			
	Laboratory MDL[1]	Method RL	Risk-Based Target Level[2]	Laboratory MDL[1]	Method RL	Risk-Based Sediment Target Level[2]	Risk-Based Fish Tissue Target Level[2]
	(µg/L)	(µg/L)	(µg/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
EXPLOSIVES (SW-846 METHOD 8330)							
1,3,5-Trinitrobenzene		7.3[5]	1100		0.25	2300	ANR[4]
1,3-Dinitrobenzene		0.11[3]	3.7		0.25	7.8	ANR[4]
2,4,6-Trinitrotoluene (TNT)		0.11[3]	2.2		0.25	21	ANR[4]
2,4-Dinitrotoluene		0.02[3]	0.11		0.25	160	ANR[4]
2,6-Dinitrotoluene		9.4[5]	37		0.26	78	ANR[4]
2-Amino-4,6-dinitrotoluene		0.35[3]	2.2		NA[6]	4.7	ANR[4]
2-Nitrotoluene		12.0[5]	61		0.25	780	ANR[4]
3-Nitrotoluene		7.9[5]	120		0.25	1600	ANR[4]
4-Amino-2,6-dinitrotoluene		0.060[3]	NA[6]		NA[6]	NA[6]	ANR[4]
4-Nitrotoluene		8.5[5]	61		0.25	780	ANR[4]
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)		0.84[3]	0.61		1	5.8	ANR[4]
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)		4.0[5]	370		0.65	780	ANR[4]
Nitrobenzene		6.4[5]	3.5		0.26	39	ANR[4]
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)		13.0[5]	68		2.2	3900	ANR[4]
EXPLOSIVES (SW-846 METHOD 8332)							
Nitroglycerine		NA[6]	4.8		NA[6]	46	ANR[4]
EXPLOSIVES (USATHAMA METHOD)							
Nitrocellulose		NA[6]	NA[6]		NA[6]	NA[6]	ANR[4]

TABLE 1-4

LABORATORY ANALYTICAL PARAMETERS, DETECTION AND REPORTING LIMITS, AND RISK-BASED TARGET LEVELS
MATTAWOMAN CREEK ECOLOGICAL RISK ASSESSMENT
IHDIV-NSWC INDIAN HEAD, MARYLAND

Parameter	Surface Water Matrix			Sediment and Fish Tissue Matrices			
	Laboratory MDL[1]	Method RL	Risk-Based Target Level[2]	Laboratory MDL[1]	Method RL	Risk-Based Sediment Target Level[2]	Risk-Based Fish Tissue Target Level[2]
	(µg/L)	(µg/L)	(µg/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Nitroguanidine		NA[6]	NA[6]		NA[6]	NA[6]	ANR[4]
TAL METALS AND CYANIDE (CLP SOW ILM04.1)							
Aluminum		200	87		40	7800	1400
Antimony		60	14		12	31	0.54
Arsenic		10	0.018		2	0.43	0.0021
Barium		200	1000		40	5500	95
Beryllium		5	73		1	160	2.7
Cadmium		5	2.2		1	1.2	1.4
Calcium		5000	NA[6]		1000	NA[6]	NA[6]
Chromium (total)		10	11		2	81	4.1
Cobalt		50	2200		10	4700	81
Copper		25	3.1		5	34	54
Cyanide		10	1		2.5	1600	27
Iron		100	300		20	23000	410
Lead		3	2.5		0.6	47	NA[6]
Magnesium		5000	NA[6]		1000	NA[6]	NA[6]
Manganese		15	50		3	1600	27
Mercury		0.2	0.05		0.1	0.15	0.41
Nickel		40	8.2		8	21	27
Potassium		5000	NA[6]		1000	NA[6]	NA[6]

TABLE 1-4

LABORATORY ANALYTICAL PARAMETERS, DETECTION AND REPORTING LIMITS, AND RISK-BASED TARGET LEVELS
MATTAWOMAN CREEK ECOLOGICAL RISK ASSESSMENT
IHDIV-NSWC INDIAN HEAD, MARYLAND

Parameter	Surface Water Matrix			Sediment and Fish Tissue Matrices			
	Laboratory MDL[1]	Method RL	Risk-Based Target Level[2]	Laboratory MDL[1]	Method RL	Risk-Based Sediment Target Level[2]	Risk-Based Fish Tissue Target Level[2]
	(µg/L)	(µg/L)	(µg/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Selenium		5	5		1	390	6.8
Silver		10	180		2	390	6.8
Sodium		5000	NA[6]		1000	NA[6]	NA[6]
Thallium		10	1.7		2	5.5	0.095
Vanadium		50	260		10	550	9.5
Zinc		20	81		4	150	410
TCL VOLATILE ORGANIC COMPOUNDS (CLP SOW OLC02.1 AND CLP SOW OLM04.2)							
1,1,1-Trichloroethane		1	3200		0.01	22000	ANR[4]
1,1,2,2-Tetrachloroethane		1	0.053		0.01	3.2	ANR[4]
1,1,2-Trichloroethane		1	0.19		0.01	11	ANR[4]
1,1,2-Trichloro-1,2,2-Trifluoroethane	ANR[4]	ANR[4]	ANR[4]		0.01	2300000	ANR[4]
1,1-Dichloroethane		1	800		0.01	7800	ANR[4]
1,1-Dichloroethene		1	0.044		0.01	1.1	ANR[4]
1,2,4-Trichlorobenzene		1	190		0.01	780	ANR[4]
1,2-Dibromo-3-Chloropropane		1	0.047		0.01	0.46	ANR[4]
1,2-Dibromoethane		1	0.00075		0.01	0.0075	ANR[4]
1,2-Dichlorobenzene		1	550		0.01	7000	ANR[4]
1,2-Dichloroethane		1	0.12		0.01	7	ANR[4]
1,2-Dichloropropane		1	0.16		0.01	9.4	ANR[4]
1,3-Dichlorobenzene		1	5.5		0.01	70	ANR[4]

TABLE 1-4

LABORATORY ANALYTICAL PARAMETERS, DETECTION AND REPORTING LIMITS, AND RISK-BASED TARGET LEVELS
MATTAWOMAN CREEK ECOLOGICAL RISK ASSESSMENT
IHDIV-NSWC INDIAN HEAD, MARYLAND

Parameter	Surface Water Matrix			Sediment and Fish Tissue Matrices			
	Laboratory MDL[1]	Method RL	Risk-Based Target Level[2]	Laboratory MDL[1]	Method RL	Risk-Based Sediment Target Level[2]	Risk-Based Fish Tissue Target Level[2]
	(µg/L)	(µg/L)	(µg/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
1,4-Dichlorobenzene		1	0.47		0.01	27	ANR[4]
2-Butanone		5	1900		0.01	47000	ANR[4]
2-Hexanone		5	1500		0.01	3100	ANR[4]
4-Methyl-2-Pentanone		5	140		0.01	6300	ANR[4]
Acetone		5	610		0.01	7800	ANR[4]
Benzene		1	0.32		0.01	12	ANR[4]
Bromochloromethane		1	NA[6]	ANR[4]	ANR[4]	ANR[4]	ANR[4]
Bromodichloromethane		1	0.17		0.01	10	ANR[4]
Bromoform		1	4.3		0.01	81	ANR[4]
Bromomethane		1	8.5		0.01	110	ANR[4]
Carbon Disulfide		1	1000		0.01	7800	ANR[4]
Carbon Tetrachloride		1	0.16		0.01	4.9	ANR[4]
Chlorobenzene		1	20		0.01	1600	ANR[4]
Chloroethane		1	3.6		0.01	220	ANR[4]
Chloroform		1	0.15		0.01	100	ANR[4]
Chloromethane		1	2.1		0.01	49	ANR[4]
Cis-1,2-Dichloroethene		1	61		0.01	780	ANR[4]
Cis-1,3-Dichloropropene		1	0.44		0.01	6.4	ANR[4]
Cyclohexane	ANR[4]	ANR[4]	ANR[4]		0.01	NA[6]	ANR[4]
Dibromochloromethane		1	0.13		0.01	7.6	ANR[4]

TABLE 1-4

LABORATORY ANALYTICAL PARAMETERS, DETECTION AND REPORTING LIMITS, AND RISK-BASED TARGET LEVELS
MATTAWOMAN CREEK ECOLOGICAL RISK ASSESSMENT
IHDIV-NSWC INDIAN HEAD, MARYLAND

Parameter	Surface Water Matrix			Sediment and Fish Tissue Matrices			
	Laboratory MDL[1]	Method RL	Risk-Based Target Level[2]	Laboratory MDL[1]	Method RL	Risk-Based Sediment Target Level[2]	Risk-Based Fish Tissue Target Level[2]
	(µg/L)	(µg/L)	(µg/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Dibromodichloromethane		1	NA[6]		0.01	NA[6]	ANR[4]
Dichlorodifluoromethane	ANR[4]	ANR[4]	ANR[4]		0.01	16000	ANR[4]
Diethyl Ether		1	1200		0.005	16000	ANR[4]
Ethylbenzene		1	1300		0.01	7800	ANR[4]
Isopropylbenzene	ANR[4]	ANR[4]	ANR[4]		0.01	7800	ANR[4]
Methyl Acetate	ANR[4]	ANR[4]	ANR[4]		0.01	78000	ANR[4]
Methyl Cyclohexane	ANR[4]	ANR[4]	ANR[4]		0.01	NA[6]	ANR[4]
Methyl Tert-Butyl Ether	ANR[4]	ANR[4]	ANR[4]		0.01	NA[6]	ANR[4]
Methylene Chloride		2	NA[6]		0.01	85	ANR[4]
Styrene		1	1600		0.01	16000	ANR[4]
Tetrachloroethene		1	0.8		0.01	12	ANR[4]
Toluene		1	750		0.01	16000	ANR[4]
Total Xylenes		1	12000		0.01	160000	ANR[4]
Trans-1,2-Dichloroethene		1	120		0.01	1600	ANR[4]
Trans-1,3-Dichloropropene		1	0.44		0.01	6.4	ANR[4]
Trichloroethene		1	1.6		0.01	58	ANR[4]
Trichlorofluoromethane	ANR[4]	ANR[4]	ANR[4]		0.01	NA[6]	ANR[4]
Vinyl Chloride		1	0.04		0.01	0.43	ANR[4]
TCL SEMIVOLATILE ORGANIC COMPOUNDS (CLP SOW OLC02.1 AND CLP SOW OLM04.2)							
1,1-Biphenyl	ANR[4]	ANR[4]	ANR[4]		0.33	3900	68

TABLE 1-4

LABORATORY ANALYTICAL PARAMETERS, DETECTION AND REPORTING LIMITS, AND RISK-BASED TARGET LEVELS
MATTAWOMAN CREEK ECOLOGICAL RISK ASSESSMENT
IHDIV-NSWC INDIAN HEAD, MARYLAND

Parameter	Surface Water Matrix			Sediment and Fish Tissue Matrices			
	Laboratory MDL[1]	Method RL	Risk-Based Target Level[2]	Laboratory MDL[1]	Method RL	Risk-Based Sediment Target Level[2]	Risk-Based Fish Tissue Target Level[2]
	(µg/L)	(µg/L)	(µg/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
2,2'-Oxybis(1-Chloropropane)		5	0.26		0.33	9.1	0.045
2,4,5-Trichlorophenol		20	1		0.83	7800	140
2,4,6-Trichlorophenol		5	2		0.33	58	0.29
2,4-Dichlorophenol		5	0.3		0.33	230	4.1
2,4-Dimethylphenol		5	400		0.33	1600	27
2,4-Dinitrophenol		20	70		0.83	160	2.7
2,4-Dinitrotoluene		5	0.11		0.33	160	2.7
2,6-Dinitrotoluene		5	37		0.33	78	1.4
2-Chloronaphthalene		5	490		0.33	6300	110
2-Chlorophenol		5	0.1		0.33	390	6.8
2-Methylnaphthalene		5	120		0.33	1600	27
2-Methylphenol		5	1800		0.33	3900	68
2-Nitroaniline		20	NA[6]		0.83	NA[6]	NA[6]
2-Nitrophenol		5	290		0.33	630	11
3,3'-Dichlorobenzidine		5	0.04		0.33	1.4	0.007
3-Nitroaniline		20	NA[6]		0.83	NA[6]	NA[6]
4,6-Dinitro-2-Methylphenol		20	3.7		0.83	7.8	0.14
4-Bromophenyl Phenyl Ether		5	NA[6]		0.33	NA[6]	NA[6]
4-Chloro-3-Methylphenol		5	3000		0.33	NA[6]	NA[6]
4-Chloroaniline		5	150		0.33	310	5.4

TABLE 1-4

LABORATORY ANALYTICAL PARAMETERS, DETECTION AND REPORTING LIMITS, AND RISK-BASED TARGET LEVELS
MATTAWOMAN CREEK ECOLOGICAL RISK ASSESSMENT
IHDIV-NSWC INDIAN HEAD, MARYLAND

Parameter	Surface Water Matrix			Sediment and Fish Tissue Matrices			
	Laboratory MDL[1]	Method RL	Risk-Based Target Level[2]	Laboratory MDL[1]	Method RL	Risk-Based Sediment Target Level[2]	Risk-Based Fish Tissue Target Level[2]
	(µg/L)	(µg/L)	(µg/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
4-Chlorophenyl Phenyl Ether		5	NA[6]		0.33	NA[6]	NA[6]
4-Methylphenol		5	180		0.33	390	6.8
4-Nitroaniline		20	NA[6]		0.83	NA[6]	NA[6]
4-Nitrophenol		20	290		0.83	630	11
Acenaphthene		5	370		0.33	0.016	81
Acenaphthylene		5	20		0.33	4700	81
Acetophenone	ANR[4]	ANR[4]	ANR[4]		0.33	7800	140
Anthracene		5	1800		0.33	23000	410
Atrazine	ANR[4]	ANR[4]	ANR[4]		0.33	2.9	0.014
Benzaldehyde	ANR[4]	ANR[4]	ANR[4]		0.33	7800	140
Benzo(A)Anthracene		5	0.0044		0.33	0.87	0.0043
Benzo(A)Pyrene		5	0.0044		0.33	0.087	0.00043
Benzo(B)Fluoranthene		5	0.0044		0.33	0.87	0.0043
Benzo(G,H,I)Perylene		5	6.5		0.33	1600	27
Benzo(K)Fluoranthene		5	0.0044		0.33	8.7	0.043
Bis(2-Chloroethoxy)Methane		5	NA[6]		0.33	NA[6]	NA[6]
Bis(2-Chloroethyl)Ether		5	0.0096		0.33	0.58	0.0029
Bis(2-Ethylhexyl)Phthalate		5	1.8		0.33	46	0.23
Butyl Benzyl Phthalate		5	3000		0.33	16000	270
Caprolactam	ANR[4]	ANR[4]	ANR[4]		0.33	39000	680

TABLE 1-4

LABORATORY ANALYTICAL PARAMETERS, DETECTION AND REPORTING LIMITS, AND RISK-BASED TARGET LEVELS
MATTAWOMAN CREEK ECOLOGICAL RISK ASSESSMENT
IHDIV-NSWC INDIAN HEAD, MARYLAND

Parameter	Surface Water Matrix			Sediment and Fish Tissue Matrices			
	Laboratory MDL[1]	Method RL	Risk-Based Target Level[2]	Laboratory MDL[1]	Method RL	Risk-Based Sediment Target Level[2]	Risk-Based Fish Tissue Target Level[2]
	(µg/L)	(µg/L)	(µg/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Carbazole	ANR[4]	ANR[4]	ANR[4]		0.33	32	0.16
Chrysene		5	0.0044		0.33	87	0.43
Dibenzo(A,H)Anthracene		5	0.0044		0.33	0.087	0.00043
Dibenzofuran		5	24		0.33	310	5.4
Diethyl Phthalate		5	23000		0.33	63000	1100
Dimethyl Phthalate		5	313000		0.33	780000	14000
Di-N-Butyl Phthalate		5	2700		0.33	7800	140
Di-N-Octyl Phthalate		5	730		0.33	1600	27
Fluoranthene		5	300		0.33	0.6	54
Fluorene		5	240		0.33	3100	54
Hexachlorobenzene		5	0.00075		0.33	0.4	0.002
Hexachlorobutadiene		5	0.44		0.33	8.2	0.04
Hexachlorocyclopentadiene		5	1		0.33	550	9.5
Hexachloroethane		5	1.9		0.33	46	0.23
Indeno(1,2,3-Cd)Pyrene		5	0.0044		0.33	0.87	0.0043
Isophorone		5	36		0.33	670	3.3
Naphthalene		5	6.5		0.33	0.16	27
Nitrobenzene		5	3.5		0.33	39	0.68
N-Nitroso-Di-N-Propylamine		5	0.005		0.33	0.091	0.00045
N-Nitrosodiphenylamine		5	5		0.33	130	0.64

TABLE 1-4

LABORATORY ANALYTICAL PARAMETERS, DETECTION AND REPORTING LIMITS, AND RISK-BASED TARGET LEVELS
MATTAWOMAN CREEK ECOLOGICAL RISK ASSESSMENT
IHDIV-NSWC INDIAN HEAD, MARYLAND

Parameter	Surface Water Matrix			Sediment and Fish Tissue Matrices			
	Laboratory MDL[1]	Method RL	Risk-Based Target Level[2]	Laboratory MDL[1]	Method RL	Risk-Based Sediment Target Level[2]	Risk-Based Fish Tissue Target Level[2]
	(µg/L)	(µg/L)	(µg/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Pentachlorophenol		20	0.28		0.83	5.3	0.026
Phenanthrene		5	6.5		0.33	0.24	27
Phenol		5	300		0.33	47000	810
Pyrene		5	180		0.33	0.66	41
TCL PESTICIDES AND PCB'S (CLP SOW OLC02.1 AND CLP SOW OLM04.2)							
4,4'-DDD		0.02	0.00083		0.0033	2.7	0.013
4,4'-DDE		0.02	0.00059		0.0033	1.9	0.0093
4,4'-DDT		0.02	0.00059		0.0033	0.0016	0.0093
Aldrin		0.01	0.00013		0.0017	0.038	0.00019
Alpha-BHC		0.01	0.00319		0.0017	0.1	0.0005
Alpha-chlordane		0.01	0.0021		0.0017	1.8	0.009
Aroclor-1016		0.2	0.00017		0.033	0.023	0.045
Aroclor-1221		0.4	0.00017		0.067	0.023	0.0016
Aroclor-1232		0.2	0.00017		0.033	0.023	0.0016
Aroclor-1242		0.2	0.00017		0.033	0.023	0.0016
Aroclor-1248		0.2	0.00017		0.033	0.023	0.0016
Aroclor-1254		0.2	0.00017		0.033	0.023	0.0016
Aroclor-1260		0.2	0.00017		0.033	0.023	0.0016
Beta-BHC		0.01	0.014		0.0017	0.35	0.0018
Delta-BHC		0.01	0.011		0.0017	0.1	0.0005

TABLE 1-4

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MATTAWOMAN CREEK ECOLOGICAL RISK ASSESSMENT
IHDIV-NSWC INDIAN HEAD, MARYLAND

Parameter	Surface Water Matrix			Sediment and Fish Tissue Matrices			
	Laboratory MDL[1]	Method RL	Risk-Based Target Level[2]	Laboratory MDL[1]	Method RL	Risk-Based Sediment Target Level[2]	Risk-Based Fish Tissue Target Level[2]
	(µg/L)	(µg/L)	(µg/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Dieldrin		0.02	0.00014		0.0033	0.04	0.0002
Endosulfan I		0.01	0.0087		0.0017	470	8.1
Endosulfan II		0.02	0.0087		0.0033	470	8.1
Endosulfan sulfate		0.02	110		0.0033	470	8.1
Endrin		0.02	0.0023		0.0033	23	0.41
Endrin aldehyde		0.02	0.76		0.0033	23	0.41
Endrin ketone		0.02	11		0.0033	23	0.41
Gamma-BHC (Lindane)		0.01	0.019		0.0017	0.49	0.0024
Gamma-chlordane		0.01	NA[6]		0.0017	NA[6]	NA[6]
Heptachlor		0.01	0.00021		0.0017	0.14	0.0007
Heptachlor epoxide		0.01	0.0001		0.0017	0.07	0.00035
Methoxychlor		0.1	0.03		0.017	390	6.8
Toxaphene		1.0	0.0002		0.17	0.58	0.0029
MISCELLANEOUS PARAMETERS							
Chloride (EPA 300.0)		1000	NA[6]	ANR[4]	ANR[4]	ANR[4]	ANR[4]
Fluoride (EPA 300.0)		100	NA[6]	ANR[4]	ANR[4]	ANR[4]	ANR[4]
Hardness (EPA 130.2)		5000	NA[6]	ANR[4]	ANR[4]	ANR[4]	ANR[4]
Nitrate (EPA 300.0)		50	NA[6]	ANR[4]	ANR[4]	ANR[4]	ANR[4]
Nitrite (EPA 300.0)		50	NA[6]	ANR[4]	ANR[4]	ANR[4]	ANR[4]
Perchlorate (EPA 314.0)		4	NA[6]	ANR[4]	ANR[4]	ANR[4]	ANR[4]

TABLE 1-4

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IHDIV-NSWC INDIAN HEAD, MARYLAND

Parameter	Surface Water Matrix			Sediment and Fish Tissue Matrices			
	Laboratory MDL[1]	Method RL	Risk-Based Target Level[2]	Laboratory MDL[1]	Method RL	Risk-Based Sediment Target Level[2]	Risk-Based Fish Tissue Target Level[2]
	(µg/L)	(µg/L)	(µg/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Sulfate (EPA 300.0)		1000	NA[6]	ANR[4]	ANR[4]	ANR[4]	ANR[4]
Total Dissolved Solids (TDS) (EPA 160.1)		10000	NA[6]	ANR[4]	ANR[4]	ANR[4]	ANR[4]
Total Organic Carbon (TOC) (EPA 415.1 and)		1000	NA[6]		100	NA[6]	NA[6]
Total Suspended Solids (TSS) (EPA 160.2)		5000	NA[6]	ANR[4]	ANR[4]	ANR[4]	ANR[4]
ACID VOLATILE SULFIDES/SIMULTANEOUSLY EXTRACTED METALS (AVS/SEM) (EPA DRAFT METHOD)							
Acid Volatile Sulfide	ANR[4]	ANR[4]	ANR[4]			NA[6]	ANR[4]
SIMULTANEOUSLY EXTRACTED METALS	ANR[4]	ANR[4]	ANR[4]			NA[6]	ANR[4]
Cadmium	ANR[4]	ANR[4]	ANR[4]			NA[6]	ANR[4]
Copper	ANR[4]	ANR[4]	ANR[4]			NA[6]	ANR[4]
Nickel	ANR[4]	ANR[4]	ANR[4]			NA[6]	ANR[4]
Lead	ANR[4]	ANR[4]	ANR[4]			NA[6]	ANR[4]
Zinc	ANR[4]	ANR[4]	ANR[4]			NA[6]	ANR[4]

MDL method detection limit
RL reporting limit
µg/L micrograms per liter.
mg/kg milligrams per kilogram.
mg/L milligrams per liter.
1 To be determined once a laboratory is selected.
2 Value is based on the lowest human health or ecological risk-based criteria as presented in Appendix A.
3 Low Level.
4 Analysis not required.
5 High Level.
6 Not applicable.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

This section presents the project management and organization for this Remedial Investigation (RI) QAPP for the Mattawoman Creek at IHDIV-NSWC. Discussed in the following subsections are the staffing and coordination requirements.

2.1 MANAGEMENT

TtNUS, on behalf of the U.S. Navy, is responsible for the overall management, implementation of contract field activities, and preparation of the Mattawoman Creek ERA Report QAPP. Personnel from the Navy will be actively involved and will coordinate with TtNUS personnel in a number of areas. The authorities and organizational relationships of key personnel are depicted on Figure 1-3 of the Work Plan. Responsibilities for program management, project management, field operations, and laboratory operations are discussed in the following sections. It is intended that the individuals in the designated functional positions will perform the designated responsibilities to the extent that the specific person is available to perform the stated activities.

2.1.1 Navy Project Manager

The Navy remedial Project Manager (RPM) acts as the focal representative for the U.S. Navy, providing management, technical direction, and oversight for all NSWC Indian Head project activities performed by contractors (i.e., TtNUS) and their subcontractors. For matters such as facilitation of site access, and oversight, etc., the IHDIV-NSWC point of contact (POC) is Shawn Jorgensen.

2.1.2 U.S. EPA Project Manager

The U.S. EPA Project Manager (PM) will oversee the implementation of the Mattawoman Creek ERA at IHDIV-NSWC. The U.S. EPA PM represents the Agency's interests and will provide input from this perspective, in addition to providing general historical and technical assistance to NSWC Indian Head field activities.

2.1.3 Maryland Department of the Environment

The MDE representative will oversee the implementation of the ERA investigation. He or she represents MDE's interests and will provide input from this perspective.

2.1.4 Tetra Tech NUS, Inc. (TtNUS) Project Management

Program Manager

The TtNUS Navy Comprehensive Long-Term Environmental Action Navy (CLEAN) Program Manager provides operations, technical, and administrative leadership, and oversees and supports quality policies. The Program Manager assigns project Project Managers (PMs) and oversees their performance. The Program Manager also ensures the availability of technical and support resources for program operations, and maintains consistency in procedures and projects among CTO assignments. In these matters, the Program Manager is assisted by the PM.

Project Manager

The TtNUS PM has overall responsibility for ensuring that the project meets U.S. Navy objectives and quality standards. The PM is responsible for the preparation and distribution of the QAPP at the direction of the Navy RPM to all parties connected with the project, including any subcontractors. The PM will report to the Navy RPM and is responsible for technical QC and project oversight.

Project Chemist

The TtNUS Project Chemist has the overall responsibility for ensuring that the project meets objectives from the standpoint of laboratory performance. The Project Chemist is responsible for the technical preparation of laboratory statements of work (SOWs) and work releases. All subcontractor Laboratory Project Managers will report to the Project Chemist. The Project Chemist will report to the PM.

Health and Safety Manager

The TtNUS Health and Safety Manager (HSM) is responsible for overseeing all Health and Safety aspects of the project as stated in the Health and Safety Plan (HASP). The HSM is also responsible for providing technical advice to the PM or the Site Safety Officer (SSO) on matters related to Health and Safety and preparing any necessary Health and Safety reports.

2.2 QUALITY ASSURANCE

This section identifies the QA responsibilities for this Mattawoman Creek RI. Responsibilities of U.S. EPA Region 3, TtNUS, and the analytical laboratories are discussed.

2.2.1 U.S. EPA Region 3 Quality Assurance Coordinator

The U.S. EPA Region 3 CERCLA Quality Assurance Coordinator has the responsibility to review and approve the QAPP and to provide overall QA support and review.

2.2.2 TtNUS QA Manager

The TtNUS Quality Assurance Manager (QAM) is responsible for overall QA for the project, and reports directly to the TtNUS Program Manager. He acts on behalf of the U.S. Navy for project quality assurance.

2.2.3 TtNUS Project QA Chemist

The TtNUS Project Chemist supports the PM in preparing and reviewing the QAPP, coordinating work performed by office technical staff, and resolving matters concerning project chemistry. The Project Chemist also supports the Project QA Advisor on matters of QA/QC.

2.2.4 TtNUS Project QA Advisor

The TtNUS Project QA Advisor supports the PM in preparing and reviewing the QAPP, and conducting data assessments. The Project QA Advisor communicates directly with the QAM on matters of QA/QC.

2.2.5 Laboratory Responsibilities

Samples collected as part of this investigation will be analyzed for CERCLA chemical analyses. A laboratory has not yet been selected to perform these services.

The subcontracted laboratory is responsible for analyzing all samples in accordance with the analytical methods and additional requirements specified in this QAPP. The analytical laboratory will also be responsible for properly disposing of unused sample aliquots in accordance with applicable regulations. Responsibilities of key laboratory personnel for each contracted laboratory are outlined in the following paragraphs.

Laboratory Project Manager

The Laboratory Project Manager will report directly to the TtNUS Project Chemist and will be responsible for monitoring analytical and project QA requirements and ensuring that project-specific requirements are properly communicated and understood by laboratory personnel. It is also the Laboratory Project Manager's responsibility to review data for completeness and compliance with project requirements while ensuring timeliness of deliverables as specified in contract documents. The Laboratory Project Manager

communicates to the TtNUS PM project status and any sample receipt or analytical problems and informs laboratory personnel of any potential hazards associated with samples submitted as part of this ERA.

Laboratory Quality Assurance Officer

The laboratory QA Officer (QAO) has the overall responsibility for ensuring that data quality standards are achieved throughout the analytical process. The laboratory QAO will be independent of the laboratory production operations, but will communicate data issues through the Laboratory Project Manager. QA will be provided by the Laboratory Project Manager and QAO prior to release of data to TtNUS.

Laboratory Technical Staff

The laboratory technical staff will be responsible for sample analyses and identification of corrective actions associated with chemical analyses. They will also be responsible for handling samples in accordance with the potential health and safety hazards that these samples may pose to themselves and other laboratory personnel. The project analytical staff will have accountability to the laboratory Project Manager.

2.3 FIELD INVESTIGATION

TtNUS will be responsible for all field activities related to this ERA. The TtNUS field team will be organized according to the activities planned. Field team members will be selected based on the type and extent of effort required. All team members will be appropriately skilled and trained for the tasks they are assigned to perform. The team will consist of a combination of the following personnel:

- Field Operations Leader (FOL)
- Site QA/QC Advisor
- Site Safety Officer
- Field Technical Staff

2.3.1 Field Operations Leader

The FOL is responsible for coordinating all on-site personnel and for providing technical assistance, when required. The FOL, or designee, will coordinate and lead all sampling activities and will ensure the availability and maintenance of all sampling materials and equipment. The FOL is responsible for completing all sampling, field and chain-of-custody documentation, will assume custody of all samples, and will ensure the proper handling and shipping of samples.

2.3.2 Site QA/QC Advisor

The FOL (or his designee) will act as the site QA/QC Advisor, and will be responsible for ensuring adherence to all QA/QC requirements as defined in the QAPP. Strict adherence to these procedures is critical to the collection of acceptable and representative samples and data.

2.3.3 Site Safety Officer

The FOL (or his designee) will act as the SSO during the field investigation. The duties of the SSO are detailed in the HASP. The SSO has stop-work authority, which can be executed upon the determination of an imminent safety hazard.

2.3.4 Field Technical Staff

The field technical staff for this project will be drawn from TtNUS's pool of qualified personnel. All of the designated field team members will be experienced professionals who possess the degree of specialization and technical competence required to effectively and efficiently perform the required work.

Field staff are responsible for complying with field-related requirements as presented in the QAPP and the HASP.

2.4 SPECIAL TRAINING REQUIREMENTS AND CERTIFICATIONS

All field personnel will have appropriate training to conduct the field activities to which they are assigned. Additionally, each site worker will be required to have completed a 40-hour course (and 8-hour refresher, if applicable) in Health and Safety Training as described under Occupational Safety and Health Administration (OSHA) 29 CFR 1910.120(b)(4).

The laboratory selected to perform the chemical analyses for this project will be required to successfully complete the laboratory evaluation process required as part of the NFESC QA Program and described in the "Navy Installation Restoration Laboratory Quality Assurance Guide" (NFESC, 1996).

3.0 SAMPLING AND ANALYSIS PLAN

3.1 GENERAL APPROACH

Prior to sampling, the PM will ensure that all field personnel read and understand the QAPP and HASP, the FOL will ensure that all required field equipment for non-health and safety operations is available and operational, and the SSO will ensure that all health and safety-related equipment is available and operational.

3.2 SAMPLE IDENTIFICATION SYSTEM

The sample identification system is presented in Section 5.2 of the attendant Work Plan.

3.3 SAMPLING LOCATIONS, ANALYSES, AND RATIONALES

This section presents sampling locations, QA samples to be collected, analyses to be performed, and rationale for the sampling and analytical program. Details regarding the equipment and procedures for collecting, preserving, packaging, and shipping the samples are included in Section 3.6.

Sampling locations for this investigation will consist of five general areas, three additional areas selected to fill spatial data gaps between these five and two reference sites. Sample types will consist of sediments, surface waters, fish and vegetation tissues. The rationale for sampling area and sampling location selection is presented in Section 2.4 of the WP. Figures 3-1, 3-2, 3-3, and 3-4 of the WP illustrate the locations of individual sediment, surface water, fish and vegetation samples to be collected.

3.3.1 Sampling Areas

Figure 2-3 of the Work Plan includes additional rationale for selecting the five sampling areas, three data gap areas and the two reference sites as well as the number and types of samples to be collected at each site.

3.3.2 Sediments

Rationales for sediment sampling are presented in Section 3.2 of the Work Plan.

3.3.3 Surface Water

Rationales for surface water sampling are presented in Section 3.1 of the Work Plan.

3.3.4 Fish Tissue

Rationales for fish tissue sampling are presented in Section 3.3 of the Work Plan.

3.3.5 Vegetation

Rationales for vegetation sampling are presented in Section 3.4 of the Work Plan.

3.4 QUALITY CONTROL SAMPLES

Section 3.6 of the Work Plan discusses the field QC samples relevant to this investigation. Field QC samples include field duplicates, source water blanks, equipment rinsate blanks, and trip blanks. While not field QC samples, additional sample must be collected in the field for matrix spike and matrix spike duplicate analyses. Work Plan Table 3-1 presents the types and numbers of required field QC samples to be collected for surface water, sediment, fish and vegetation sampling activities. Section 7.1 in this document provides definitions and details for these and all other QC checks to be used during this investigation.

3.5 SAMPLE HANDLING, PACKAGING AND SHIPPING

Refer to Section 5.2.3 of the Work Plan for specific instructions on sample packaging and shipping for the various environmental media involved in this sampling event.

3.5.1 Sample Preservation

Preservation requirements for each of the chemicals of interest are provided in Table 3-1 of the Work Plan. All sediment samples require only to be cooled to 4°C ± 2°C; no chemical preservatives are necessary. Additional information on sample preservation is provided in Section 5.2.3 of the Work Plan.

3.5.2 Sample Labeling

Information relevant to sample labeling is presented in Section 5.2.1 of the Work Plan.

3.5.3 Sample Packaging

Instructions for sample packaging are provided in Section 5.2.3 of the Work Plan.

3.5.4 Sample Shipping

Instructions for sample shipping are provided in Sections 5.2.3 and 5.3 of the Work Plan.

3.5.5 Sample Custody

Custody of samples must be maintained and documented at all times, beginning with the collection of samples in the field. Sample custody procedures are addressed in Section 4.0.

3.6 RECORD KEEPING

Standard forms, field notebooks, and a field log book will be used to record all sample collection activities, field measurements, observations concerning site conditions, and other project-related information. These records include sample log sheets, daily activity records, field logbooks and field instrument calibration log sheets, among others.

3.6.1 Field Log Books

Bound, weatherproof field notebooks shall be maintained by sampling personnel. All information related to sampling and other field activities will be recorded in field notebooks. This information will include, but is not limited to, sampling time, weather conditions, unusual events, field measurements, and descriptions of photographs.

A bound, weatherproof logbook shall be maintained by the FOL. This book will contain a summary of each day's activities and will reference the field notebooks when applicable.

3.6.2 Equipment Calibration Logs

An equipment calibration log sheet will be used to record each time an instrument is calibrated or recalibrated, or calibration is checked against a standard or background. The procedures and standards to be used for instrument calibration are discussed in Section 5.1.

3.6.3 Sample Collection Logs

One sample collection log sheet will be completed for every environmental sample, every duplicate sample, and every field blank sample collected during the field activities. Only the MS and MSD samples do not require their own individual sample collection log sheet.

3.6.4 Chain-of-Custody Forms

A chain-of-custody form will be completed for every cooler that contains samples being shipped to an off-site laboratory for analyses. These forms are a record of the people having custody of the samples from

the time the samples are collected to the time they are analyzed and disposed of. The completed field chain-of-custody document will be signed, placed in a sealed plastic envelope, and taped to the top inside cover of the shipping container before it is shipped. A copy of the document will be retained by the FOL.

3.6.5 Shipping Forms/Airbills

Copies of all forms and/or airbills related to the shipment of coolers will be retained by the FOL in order to trace the shipment, if necessary, and to communicate with the receiving laboratory.

3.6.6 Permanent Record File

At completion of the field activities, the FOL shall submit to the PM all field records, data, field notebooks, logbooks, COC records, sample log sheets, daily activity logs, and other records concerning the project, including all of the forms and log sheets listed above. The FOL will check these records for legibility and completeness prior to submitting them to the PM. These forms, data, and field notes will become part of the permanent project record.

3.7 SURVEYING

Refer to Section 4.4 of the Work Plan.

3.8 EQUIPMENT DECONTAMINATION

Refer to Section 4.2 of the Work Plan for information on equipment decontamination.

3.9 MANAGEMENT OF INVESTIGATION-DERIVED WASTE (IDW)

Refer to Section 4.3 of the Work Plan.

3.10 SAFETY

Health and safety issues and concerns are critically important during any field investigation involving hazardous wastes. Sampling team members working at the site must be fully aware of the potential dangers involved with sampling activities, must be trained and prepared to deal with problems or health-related issues as they arise, and should minimize to the greatest possible extent the potential for exposure to harmful chemicals or accidents. To ensure that field activities are performed at a high level of safety, the following are included in the health and safety activities related to the sampling program.

3.10.1 Health and Safety Plan

A separate HASP has been prepared describing specific health and safety requirements, concerns, and information related to the site activities. This document must be read and understood by each person working at the site. Each worker or visitor to the site must sign an acknowledgment that he or she has read and understands the HASP.

3.10.2 Health and Safety Training

All workers involved with the site investigations shall have successfully completed the OSHA-mandated, 40-hour health and safety training, and follow-up annual 8-hour refresher courses when appropriate.

3.10.3 Personal Protective Clothing and Equipment

Workers at the site must be part of a medical monitoring program and be medically approved to perform their duties without physical limitations. Protective clothing and equipment, as specified in the HASP, will be worn while performing site activities.

3.10.3 Safety Meetings

Safety meetings will be held among on-site workers whenever the SSO feels it is appropriate. The SSO will discuss safety issues related to activities being performed, and will make site workers aware of any new conditions that could potentially affect health or safety.

3.11 ORGANIZATION AND LOGISTICS OF FIELD INVESTIGATIONS

3.11.1 Personnel

The duties, responsibilities, and line of command for each person working on the project are described in Section 2.0 and displayed on Figure 1-3 of the WP. Persons working on the project should be intimately familiar with their roles and responsibilities. In addition, they should be familiar with the mechanisms and procedures for coordinating tasks, improving communications, and reporting incidences or irregularities. The FOL is responsible for coordinating all on-site personnel and activities (Section 2.3.1). The SSO is responsible for health and safety monitoring and ensures that the HASP is adhered to during all field activities (Section 2.3.3). The SSO has the authority to stop work if an imminent safety hazard is encountered (Section 2.3).

3.11.2 Mobilization and Demobilization

Mobilization and demobilization activities are covered in Section 4.1 of the Work Plan.

TABLE 3-1

NON-CALIBRATION QC SAMPLE USAGE FREQUENCIES, ACCEPTANCE LIMITS AND CORRECTIVE ACTIONS IHDIV-NSWC INDIAN HEAD, MARYLAND

QC Sample Type	Collection Frequency	Acceptance Limits	Corrective Action
Field Duplicate	1 per 10 investigative samples collected.	Aqueous = 30% RPD Sediment, Fish and Vegetation = 50% RPD	Qualify data according to data validation requirements.
Equipment Rinsate Blank	1 per 10 investigative samples collected, with a minimum of 1 per day of sampling, per non-disposable sampling device/instrument. For pre-cleaned, dedicated, and/or disposable equipment (i.e., disposable plastic trowels, etc.), one rinsate blank will be collected and analyzed at a frequency of 1 per lot or "batch blank" for a specific equipment type.	< RL (soil and water)	Identify source of contamination, if possible. Qualify data according to validation criteria. Qualify use of data if contamination appears to have adversely affected its usability.
Source Water Blank	1 per individual contiguous area of sampling.	< RL (soil and water)	Identify source of contamination, if possible. Qualify data according to validation criteria. Qualify use of data if contamination appears to have adversely affected its usability.
Trip Blanks	1 per cooler of VOC samples.	< RL (soil and water)	Identify source of volatiles contamination, if possible. Qualify data according to validation criteria. Qualify use of data if contamination appears to have adversely affected its usability.
Internal Standard	At least one internal standard per sample for GC/MS analyses.	Retention times stable to ±30 seconds and area counts stable to within a factor of 2.	Laboratory action taken per applicable analytical SOP. TtNUS action taken per validation protocols and Section 11.10.
Laboratory Control Sample	1 per 20 environmental samples per matrix	See Tables 11-2, 11-4, 11-6, 11-8, 11-10 and 11-12.	Laboratory action taken per applicable analytical SOP. TtNUS action taken per validation protocols and Section 11.10.
Laboratory Duplicate	1 per 20 environmental samples analyzed for inorganic target analytes.	See Tables 11-7 and 11-9	Laboratory action taken per applicable analytical SOP. TtNUS action taken per validation protocols and Section 11.10.

TABLE 3-1

NON-CALIBRATION QC SAMPLE USAGE FREQUENCIES, ACCEPTANCE LIMITS AND CORRECTIVE ACTIONS IHDIV-NSWC INDIAN HEAD, MARYLAND

QC Sample Type	Collection Frequency	Acceptance Limits	Corrective Action
Laboratory Method Blank	1 per 20 environmental samples or per preparation batch, whichever is more frequent.	< RL (soil and water)	Laboratory action taken per applicable analytical SOP. TtNUS action taken per validation protocols and Section 11.10.
Matrix Spike*	1 per 20 environmental samples.	See Tables 11-1, 11-3, 11-5, 11-7, 11-9 and 11-11.	Laboratory action taken per applicable analytical SOP. TtNUS action taken per validation protocols and Section 11.10.
Matrix Spike Duplicate*	1 per 20 environmental samples analyzed for organic target analytes	See Tables 11-1, 11-3, 11-5, 11-7, 11-9 and 11-11.	Laboratory action taken per applicable analytical SOP. TtNUS action taken per validation protocols and Section 11.10.
Post-digestion Spike	Only if out-of-control matrix spike exists (metals only).	100 ± 20%	Laboratory action taken per applicable analytical SOP. TtNUS action taken per validation protocols and Section 11.10.
Surrogate	At least 1 per sample for organic chromatographic analyses (GC, GC/MS, and HPLC).	See Table 11-3.	Laboratory action taken per applicable analytical SOP. TtNUS action taken per validation 11.10.
Temperature Blank	1 blank per sample cooler.	4 ± 2 °C	Laboratory action taken per applicable analytical SOP. TtNUS action taken per validation protocols and Section 11-10.

* Matrix spikes and matrix spike duplicates are not analyzed in the field, but additional sample material must be collected in the field to ensure that the laboratory has enough material for spiking and duplicate analysis. See Table 4-3 for details regarding the extra volume required.

FOL = Filed operations leader
VOC = volatile organic chemical
RL = reporting limit
RPD = relative percent difference
GC/MS = gas chromatography/mass spectrometry
HPLC = high performance liquid chromatography
°C = degrees Celsius

TABLE 3-2

SUMMARY OF SURFACE WATER ANALYSES AND QUALITY CONTROL SAMPLES MATTAWOMAN CREEK IHDIV-NSWC INDIAN HEAD, MARYLAND

Parameter	Samples	Field Duplicates[1]	Trip Blanks[2]	Source Water Blanks[3]	Matrix Spikes/ Matrix Spike Duplicates[4]	Total
Target Compound List (TCL) CLP SOW OLC02.1 Pesticides/Polychlorinated Biphenyls	32	4	NA	10	2	48
Target Compound List (TCL) CLP SOW OLC02.1 Semivolatile Organic Compounds	32	4	NA	10	2	48
Target Compound List (TCL) CLP SOW OLC02.1 Volatile Organic Compounds plus Diethyl ether	32	4	1	10	2	49
Explosives (SW-846 Method 8330 list) plus nitroglycerine, nitrocellulose and nitroguanidine	32	4	NA	10	2	48
Target Analyte List (TAL) CLP SOW ILM04.1 Metals (total)	32	4	NA	10	2	48
Target Analyte List (TAL) CLP SOW ILM04.1 Metals (dissolved)	32	4	NA	10	2	48
Cyanide CLPSOW ILM04.1	32	4	NA	10	2	48
Hardness ($CaCO_3$) EPA Method 130.2	32	4	NA	10	NA	46
Total Dissolved Solids (TDS) EPA Method 160.2	32	4	NA	10	NA	46
Total Suspended Solids (TSS) EPA Method 160.1	32	4	NA	10	NA	46
Nitrate, Nitrite, Chloride, Sulfate, Fluoride EPA method 300.0	32	4	NA	10	2	48
Perchlorate EPA Method 314.0	32	4	NA	10	2	48
Total Organic Carbon (TOC) SW-846 method 9060	32	4	NA	10	NA	46
Field Parameters[5]	32	NA	NA	10	NA	42

NA Not Applicable
1 Field duplicates will be collected at a frequency of 1 per every 10 samples. Field duplicates are not applicable for field parameters.
2 Trip blanks will be submitted for analysis at a frequency of one per cooler containing samples for VOC analysis.
3 Source water blanks will be collected at a frequency of 1 per individual contiguous area of sampling.
4 Matrix spike (MS) and matrix spike duplicate (MSD) samples will be collected at a frequency of 1 per every 20 samples. MS/MSDs are not applicable for field parameters.
5 Field parameters measured includes pH, specific conductance, turbidity, temperature, dissolved oxygen (DO), salinity and oxidation-reduction potential (ORP).

TABLE 3-3

SUMMARY OF SEDIMENT ANALYSES AND QUALITY CONTROL SAMPLES
MATTAWOMAN CREEK
IHDIV-NSWC INDIAN HEAD, MARYLAND

Parameter	Samples	Field Duplicates[1]	Trip Blanks[2]	Rinsate Blanks[3]	Matrix Spikes/ Matrix Spike Duplicates[4]	Total[3]
Target Compound List (TCL) CLP SOW OLM04.2 Pesticides/PCBs	32	4	NA	TBD	2	38
Target Compound List (TCL) CLP SOW OLM04.2 SVOCs	32	4	NA	TBD	2	38
Target Compound List (TCL) CLP SOW OLM04.2 VOCs plus Diethyl ether	32	4	1	TBD	2	39
Explosives (SW-846 Method 8330 list) plus nitroglycerine, nitrocellulose and nitroguanidine	32	4	NA	TBD	2	38
TAL Metals plus Cyanide CLP SOW ILM04.1	32	4	NA	TBD	2	38
Total Organic Carbon (TOC) Lloyd Kahn, Walkley-Black or modified SW-846 9060	32	4	NA	TBD	NA	36
Acid Volatile Sulfide / Simultaneously Extracted Metals (AVS/SEM) EPA Draft Method	32	4	NA	TBD	NA	36
Benthic Macroinvertebrate Community Analysis	24	3	NA	TBD	NA	27
10-day *Hyalella azteca* Toxicity Tests	24	3	NA	TBD	NA	27
Grain Size Distribution	24	3	NA	TBD	NA	27

1 Field duplicates will be collected at a frequency of 1 per every 10 samples. Field duplicates are not applicable (NA) for field measurements.
2 Trip blanks will be submitted for analysis at a frequency of one per cooler containing samples for volatile organics analysis. Because the number of sample coolers shipped may vary, the number of trip blanks is estimated to be four.
3 The number of rinsate blanks collected depends on how many sampling days are needed, with a minimum of 1 per day per non-disposable sampling device/instrument. The total number of samples will depend on the number of rinsate blanks collected.
4 Matrix spike (MS) and matrix spike duplicate (MSD) samples will be collected at a frequency of 1 per every 20 samples. MS/MSDs are not applicable (NA) for field analysis.

NA Not Applicable
PCBs = polychlorinated biphenyls
SVOCs = semivolatile organic compounds
TAL = Target Analyte List
VOCs = volatile organic compounds
TBD = to be determined

TABLE 3-4

SUMMARY OF FISH TISSUE ANALYSES AND QUALITY CONTROL SAMPLES
MATTAWOMAN CREEK
IHDIV-NSWC INDIAN HEAD, MARYLAND

Parameter	Samples -Whole Body	Field Duplicates (1)	Trip Blanks	Rinsate Blanks	Matrix Spikes/ Matrix Spike Duplicates(2)	Total
TCL CLP SOW OLM04.2 Pesticides/PCBs	27	3	NA	NA	2	32
TCL CLP SWO OLM04.2 SVOCs	27	3	NA	NA	2	32
TAL CLP SOW ILM04.1 Metals plus cyanide (total)	27	3	NA	NA	2	32

Parameter	Samples -Fillets	Field Duplicates(1)	Trip Blanks	Rinsate Blanks	Matrix Spikes/ Matrix Spike Duplicates(2)	Total
TCL CLP SOW OLM04.2 Pesticides/PCBs	27	3	NA	NA	2	32
TCL CLP SOW OLM04.2 SVOCs	27	3	NA	NA	2	32
TAL CLP SOW ILM04.1 Metals plus cyanide (total)	27	3	NA	NA	2	32

NA Not Applicable
1 Field duplicates will be collected at a frequency of 1 per every 10 samples. Field duplicates are not applicable (NA) for field measurements.
2 Matrix spike (MS) and matrix spike duplicate (MSD) samples will be collected at a frequency of 1 per every 20 samples. MS/MSDs are not applicable (NA) for field analyses.

TABLE 3-5

SUMMARY OF VEGETATION TISSUE ANALYSES AND QUALITY CONTROL SAMPLES MATTAWOMAN CREEK IHDIV-NSWC INDIAN HEAD, MARYLAND

Parameter	Samples	Field Duplicates(1)	Trip Blanks	Rinsate Blanks	Matrix Spike/ Matrix Spike Duplicates(2)	Total
TCL CLP SOW OLM04.2 Pesticides/PCBs	9	1	NA	NA	1	11
TAL CLP SOW ILM04.1 Metals	9	1	NA	NA	1	11

NA Not Applicable
1 Field duplicates will be collected at a frequency of 1 per every 10 samples. Field duplicates are not applicable for field parameters.
2 Matrix spike (MS) and matrix spike duplicate (MSD) samples will be collected at a frequency of 1 per every 20 samples. MS/MSDs are not applicable for field parameters.

4.0 CUSTODY PROCEDURES

Documented sample custody is one of several factors necessary for the admissibility of environmental data as evidence in a court of law. Custody procedures help to satisfy the two major requirements for admissibility: relevance and authenticity. Sample custody is addressed in three parts: field sample collection, laboratory analysis, and final evidence files. Final evidence files, including all original laboratory reports and purge files, are maintained under document control in a secure area. A sample or evidence file is under custody when any one of the following conditions is satisfied:

- The item is in the actual physical possession of an authorized person.
- The item is in view of the person after being in his or her possession.
- The item was placed in a secure area to prevent tampering.
- The item is in a designated and identified secure area with access restricted to authorized personnel only.

The chain of custody (COC) form is a multi-part, standardized form used to summarize and document pertinent sample information, such as sample identification and type, sample matrix, date and time of collection, preservation, and requested analyses. Furthermore, through the sequential signatures of various sample custodians (e.g., sampler, airbill number, laboratory sample custodian), the COC form documents sample custody and tracking. Laboratory custody procedures will ensure that sample integrity is not compromised from the time of receipt at the laboratory until final data are reported to TtNUS. This requires that the laboratory control all sample handling and storage conditions and circumstances. Custody procedures apply to all environmental and associated field QC samples obtained as part of the data collection system.

4.1 FIELD CUSTODY PROCEDURES

The FOL (or designee) is responsible for the care and custody of the samples collected until they are relinquished to the laboratory or entrusted to a commercial courier. Together, field logbooks and sample documentation including COC forms provide a record that should allow a technically qualified individual to reconstruct significant field activities without resorting to memory. COC forms are completed to the fullest extent possible for each sample cooler used for shipment. The forms are legibly completed with waterproof ink, and are signed and dated by the sampler. COC forms will include the following information: project name, sample number, time collected, matrix, designated analyses, type of sample, preservative, and name of sampler. Pertinent notes or comments, such as positive results during sample screening, are also indicated on the COC form.

Information similar to that contained on the COC form is provided on the sample label, which is securely attached to the sample bottle. Sample labels will include, at a minimum, the following information: sample number, date and time of collection, analysis required for the sample aliquot in the associated sample container and a space for the laboratory sample number. The procedures for sample numbering are listed in Section 5.2.2 of the Work Plan.

Site conditions during sampling and the care with which samples are handled may factor into the degree to which samples represent the media from which they are collected. This, in turn, could affect the ability of decision-makers to make accurate and timely decisions concerning the contamination status of the site. As appropriate, logbooks are assigned to, and maintained by, key field team personnel. The logbooks are used to record daily conditions and activities such as weather conditions, dates and times of significant events, level of PPE used, boring activities, actual sample collection locations, photographs taken, problems encountered during field activities, chemical screening results, and corrective actions taken to overcome problems. In addition, the names of site visitors and the purposes of their visits shall be recorded. Field logbook assignments shall be recorded in the site logbook or other central file whose location is known by the FOL and PM. During field activities the FOL is responsible for the maintenance and security of all field records. At the completion of field activities, the FOL will forward all field records to the TtNUS PM. All field sample records will eventually be docketed into the final evidence file.

Section 5.2.3 of the Work Plan describes procedures for sample packaging and shipment. A temperature blank shall be included in each cooler containing samples for use by the laboratory upon receipt. Each cooler that contains samples to be analyzed for VOCs shall also include a trip blank. Each cooler shall be taped shut with strapping tape in at least two places to prevent tampering. Custody seals shall be attached so that the seals must be broken to open the cooler. Shipment will be made by a public courier at the next scheduled pickup following completion of sample collection.

The following procedures will be used when transferring custody of samples. As previously noted, individual custody records will accompany each sample cooler. The methods of shipment, courier name, and other pertinent information will be entered in the remarks section of the custody record. When transferring samples, the individuals relinquishing and receiving the samples will sign, date, and note the time on the COC record. The original record (top copy of the multi-part form) will accompany the shipments and the field sampler will retain a copy. This record documents the sample custody transfer from the sampler to the laboratory, often through another person or agency (common courier). After COC records have been placed within sealed shipping coolers, the signed courier airbills will serve to document COC. When samples arrive at the laboratory, internal laboratory sample custody procedures will be followed (see Section 4.2).

4.2 LABORATORY CUSTODY PROCEDURES

When the analytical laboratory receives a shipment of samples, the laboratory's sample custodian will verify that the correct number of coolers has been received. The custodian will examine each cooler's custody seals to verify that they are intact and that the integrity of the environmental samples has been maintained. The custodian will then open each cooler and measure its internal temperature by measuring the temperature of the temperature blank. The temperature reading will be documented. The sample custodian will then sign the COC form and examine the contents of the cooler. Identification of broken sample containers or discrepancies between the COC form and sample labels will be recorded. The laboratory will retain the original field COC forms, providing copies of the forms with the final data package deliverable. All problems or discrepancies noted during sample receipt will be promptly reported to the TtNUS PM. Samples will be logged into the laboratory information management system.

5.0 CALIBRATION PROCEDURES AND FREQUENCY

All instrumentation used to perform chemical measurements must be properly calibrated prior to use in order to obtain valid and usable results. Instruments used in the field and in the laboratory will be calibrated in accordance with the procedures governing the use of the instruments. For this investigation, field instrument calibration is described in Section 5.1, and laboratory instrument calibration is outlined in Section 5.2.

5.1 FIELD INSTRUMENT CALIBRATION

Various instruments will be required for field measurements during this investigation.

Instruments used in the field will be calibrated in accordance with the procedures outlined in specific SOPs and the manufacturer's calibration procedures. Calibration of each instrument will be documented on a separate Equipment Calibration Log Form. During calibration, an appropriate maintenance check will be performed on each piece of equipment. If damaged or defective parts are identified during the maintenance check and it is determined that the damage could have an impact on the instrument's performance, the instrument will be removed from service until the defective parts are repaired or replaced. If the instrument cannot be repaired, a replacement will be procured from the supplier.

5.2 LABORATORY INSTRUMENT CALIBRATION

Calibration procedures for metals analyses by ICP/AES begin with a periodic establishment of the useful linear response range, followed by routine daily calibrations. The daily calibrations consist of at least one blank and one calibration standard, an initial calibration verification, and continuing calibration verification standards/blanks, with each batch of samples analyzed. In all cases, an independently prepared standard (i.e., from a second source or a different lot number from the primary source) will be used as a calibration verification solution or as the MS spiking mix.

Organic chemical analyses begin with an initial calibration of the gas chromatograph (GC), high performance liquid chromatograph (HPLC), or gas chromatograph/mass spectrometer (GC/MS) system with an initial calibration curve that establishes the instrument responses as functions of analyte concentration. The initial calibration curves incorporate a calibration blank and a series of calibration standards for the target analytes and any applicable internal standards or surrogate compounds. On a routine basis, a continuing calibration is performed in which the validity of the calibration curve is checked with a known chemical standard from a source independent of the initial calibration standards. This continuing calibration standard contains the target analytes of interest and any applicable internal

standards and surrogate compounds. The internal standards compensate for variations in analytical response that may occur in individual chromatographic analyses. The surrogate compounds provide a means to assess the efficiency of analyte extraction and analysis for each sample.

All standards used to calibrate analytical instruments must be obtained from the National Institute of Standards and Technology (NIST) or through a reliable commercial supplier with a proven record for quality standards. All commercially supplied standards will be traceable to NIST reference standards, where possible, and appropriate pedigree documentation will be obtained from the supplier. In cases where documentation is not available, the laboratory will analyze the standard and compare the results to a U.S. EPA-known or previous NIST-traceable standard.

Calibrations and associated documentation are required for all laboratory instruments. The documentation for calibrations performed in-house shall identify the person performing the calibration, the instrument being calibrated, the standards used for calibration and their concentration values or other pertinent calibration values, the source of the calibration standards, and the date of calibration. Certain instruments (e.g., balances) may be calibrated by a third party. In those cases, the details of calibration as described above and a certification of acceptable performance shall be obtained from the third party. The period during which the calibration is valid may appear in the calibration record or may be governed by the SOP.

6.0 ANALYTICAL AND MEASUREMENT PROCEDURES

Field measurements and laboratory analytical procedures are discussed in this section.

6.1 FIELD MEASUREMENT PROCEDURES

Chemical and physical parameters to be measured using field instrumentation include pH, specific conductance, turbidity, dissolved oxygen, salinity, oxidation-reduction potential, water and air temperatures. The field target parameters and the rationales for including them in the analysis scheme are presented in Table 1-2. Measurement of field parameters is described in Section 3.0. Calibration of field instruments is discussed in Section 5.0.

6.2 LABORATORY ANALYTICAL AND MEASUREMENT PROCEDURES

Table 6-1 summarizes of the laboratory analytical methods to be used during this investigation.

6.2.1 List of Project Target Analytes and Detection Limits

A list of the laboratory target analytes, project-specific risk-based target levels and laboratory-specific MDLs is provided in Table 1-4. The MDLs will be added to this table once a laboratory is selected to perform the analyses. Tables 6-2, 6-3, 6-4, 6-5 and 6-6 list the method required RLs for the target analytes. All environmental data will be reported to the analyte's laboratory-specific MDL. MDLs will be adjusted on a sample-by-sample basis, as necessary, based on dilutions, sample volume and, for soil samples, percent moisture.

6.2.2 List of Associated Quality Control Samples

Field and laboratory QC samples to be analyzed in support of this project are identified in Section 7.0. Details on QC sample usage are provided in Section 7.0.

TABLE 6-1

SUMMARY OF ORGANIC, INORGANIC, AND MISCELLANEOUS ANALYTICAL PROCEDURES SOLID AND AQUEOUS SAMPLES IHDIV-NSWC INDIAN HEAD, MARYLAND

Analytical Parameter	Preparation Method	Analytical Method
Explosives	SW-846 8330	SW-846 8330
Nitroglycerine	SW-846 8332	SW-846 8332
Nitrocellulose and Nitroguanidine	USATHAMA	USATHAMA
TAL Metals plus cyanide	CLP SOW ILM04.1	CLP SOW ILM04.1
TCL Volatile Organic Compounds plus Diethyl ether	Aqueous CLP SOW OLC02.1 Solid CLP SOW OLM04.2	Aqueous CLP SOW OLC02.1 Solid CLP SOW OLM04.2
TCL Semivolatile Organic Compounds	Aqueous CLP SOW OLC02.1 Solid CLP SOW OLM04.2	Aqueous CLP SOW OLC02.1 Solid CLP SOW OLM04.2
TCL Pesticides/PCBs	Aqueous CLP SOW OLC02.1 Solid CLP SOW OLM04.2	Aqueous CLP SOW OLC02.1 Solid CLP SOW OLM04.2
Chloride, Fluoride, Nitrate, Nitrite and Sulfate (aqueous only)	EPA Method 300.0	EPA Method 300.0
Hardness (aqueous only)	EPA Method 130.2	EPA Method 130.2
Total Organic Carbon	Aqueous SW-846 9060 Solid Lloyd Kahn, Walkley-Black or modified SW-846 9060	Aqueous SW-846 9060 Solid Lloyd Kahn, Walkley-Black or modified SW-846 9060
Total Dissolved Solids (aqueous only)	EPA 160.2	EPA 160.2
Total Suspended Solids (aqueous only)	EPA 160.1	EPA 160.1
Perchlorate (aqueous only)	EPA Method 314.0	EPA Method 314.0
Acid Volatile Sulfides/Simultaneously Extracted Metals (AVS/SEM) (sediments only)	EPA Draft Method	EPA Draft Method

Note: Solid samples consist of sediment, fish tissue and aquatic vegetation tissue samples. Aqueous samples consist of surface water samples.

TBD = To be determined.

TABLE 6-2

ANALYTICAL QUANTITATION LIMITS - TCL LOW-CONCENTRATION ORGANICS
MATTAWOMAN CREEK
NSWC INDIAN HEAD, MARYLAND

Parameter	CRQL [1] Surface Water Samples (µg/L)
Volatile Organic Compounds	
1,1,1-Trichloroethane	1
1,1,2,2-Tetrachloroethane	1
1,1,2-Trichloroethane	1
1,1-Dichloroethane	1
1,1-Dichloroethene	1
1,2,4-Tricholorobenzene	1
1,2-Dibromo-3-chloropropane	1
1,2-Dibromoethane	1
1,2-Dichlorobenzene	1
1,2-Dichloroethane	1
1,2-Dichloropropane	1
1,3-Dichlorobenzene	1
1,4-Dichlorobenzene	1
2-Butanone	5
2-Hexanone	5
4-Methyl-2-pentanone	5
Acetone	5
Benzene	1
Bromochloromethane	1
Bromodichloromethane	1
Bromoform	1
Bromomethane	1
Carbon disulfide	1
Carbon tetrachloride	1
Chlorobenzene	1
Chloroethane	1
Chloroform	1
Chloromethane	1
cis-1,2-Dichloroethene	1
cis-1,3-Dichloropropene	1
Dibromochloromethane	1
Diethyl ether	1
Ethylbenzene	1

TABLE 6-2

ANALYTICAL QUANTITATION LIMITS - TCL LOW-CONCENTRATION ORGANICS
MATTAWOMAN CREEK
NSWC INDIAN HEAD, MARYLAND

Parameter	CRQL [1] Surface Water Samples (µg/L)
Methylene chloride	2
Styrene	1
Tetrachloroethene	1
Toluene	1
trans-1,2-Dichloroethene	1
trans-1,3-Dichloropropene	1
Trichloroethene	1
Vinyl chloride	1
Xylenes (total)	1
Semivolatile Organic Compounds	
2,2'-Oxybis(1-chloropropane)	5
2,4,5-Trichlorophenol	5
2,4,6-Trichlorophenol	20
2,4-Dichlorophenol	5
2,4-Dimethylphenol	5
2,4-Dinitrophenol	20
2,4-Dinitrotoluene	5
2,6-Dinitrotoluene	5
2-Chloronaphthalene	5
2-Chlorophenol	5
2-Methylnaphthalene	5
2-Methylphenol	5
2-Nitroaniline	20
2-Nitrophenol	5
3,3'-Dichlorobenzidine	5
3-Nitroaniline	20
4,6-Dinitro-2-methylphenol	20
4-Bromophenyl-phenylether	5
4-Chloro-3-methylphenol	5
4-Chloroaniline	5
4-Chlorophenyl-phenylether	5
4-Methylphenol	5
4-Nitroaniline	20
4-Nitrophenol	20

TABLE 6-2

ANALYTICAL QUANTITATION LIMITS - TCL LOW-CONCENTRATION ORGANICS
MATTAWOMAN CREEK
NSWC INDIAN HEAD, MARYLAND

Parameter	CRQL [1] Surface Water Samples (µg/L)
Acenaphthene	5
Acenaphthylene	5
Anthracene	5
Benzo(a)anthracene	5
Benzo(a)pyrene	5
Benzo(b)fluoranthene	5
Benzo(g,h,i)perylene	5
Benzo(k)fluoranthene	5
Bis(2-chloroethoxy)methane	5
Bis(2-chloroethyl)ether	5
Bis(2-ethylhexyl)phthalate	5
Butylbenzylphthalate	5
Chrysene	5
Dibenz(a,h)anthracene	5
Dibenzofuran	5
Diethylphthalate	5
Dimethylphthalate	5
Di-n-butylphthalate	5
Di-n-octylphthalate	5
Fluoranthene	5
Fluorene	5
Hexachlorobenzene	5
Hexachlorobutadiene	5
Hexachlorocyclopentadiene	5
Hexachloroethane	5
Indeno(1,2,3-cd)pyrene	5
Isophorone	5
Naphthalene	5
Nitrobenzene	5
N-nitroso-di-n-propylamine	5
N-nitrosodiphenylamine	5
Pentachlorophenol	20
Phenanthrene	5
Phenol	5

TABLE 6-2

ANALYTICAL QUANTITATION LIMITS - TCL LOW-CONCENTRATION ORGANICS
MATTAWOMAN CREEK
NSWC INDIAN HEAD, MARYLAND

Parameter	CRQL [1] Surface Water Samples (µg/L)
Pyrene	5
Pesticides/PCBs	
4,4'-DDD	0.02
4,4'-DDE	0.02
4,4'-DDT	0.02
Aldrin	0.01
alpha-BHC	0.01
alpha-Chlordane	0.01
Aroclor-1016	0.2
Aroclor-1221	0.4
Aroclor-1232	0.2
Aroclor-1242	0.2
Aroclor-1248	0.2
Aroclor-1254	0.2
Aroclor-1260	0.2
beta-BHC	0.01
delta-BHC	0.01
Dieldrin	0.02
Endosulfan I	0.01
Endosulfan II	0.02
Endosulfan sulfate	0.02
Endrin	0.02
Endrin aldehyde	0.02
Endrin ketone	0.02
gamma-BHC (Lindane)	0.01
gamma-Chlordane	0.01
Heptachlor	0.01
Heptachlor epoxide	0.01
Methoxychlor	0.1
Toxaphene	1.0

1 CRQL Contract Required Quantitation Limit; as specified in the CLP SOW OLC02.1.

TABLE 6-3

ANALYTICAL QUANTITATION LIMITS - TCL ORGANICS
MATTAWOMAN CREEK
NSWC INDIAN HEAD, MARYLAND

Parameter	CRQL Sediment Samples (µg/kg)
Volatile Organic Compounds	
1,1,1-Trichloroethane	10
1,1,2,2-Tetrachloroethane	10
1,1,2-Trichloro-1,2,2-trifluoroethane	10
1,1,2-Trichloroethane	10
1,1-Dichloroethane	10
1,1-Dichloroethene	10
1,2,4-Trichlorbenzene	10
1,2-Dibromo-3-chloropropane	10
1,2-Dibromoethane	10
1,2-Dichlorobenzene	10
1,2-Dichloroethane	10
1,2-Dichloropropane	10
1,3-Dichlorobenzene	10
1,4-Dichlorobenzene	10
2-Butanone	10
2-Hexanone	10
4-Methyl-2-pentanone	10
Acetone	10
Benzene	10
Bromodichloromethane	10
Bromoform	10
Bromomethane	10
Carbon disulfide	10
Carbon tetrachloride	10
Chlorobenzene	10
Chloroethane	10
Chloroform	10
Chloromethane	10
Cis-1,2-Dichlorethene	10
cis-1,3-Dichloropropene	10
Cyclohexane	10
Dibromochloromethane	10
Dichlorodifluoromethane	10

TABLE 6-3

ANALYTICAL QUANTITATION LIMITS - TCL ORGANICS
MATTAWOMAN CREEK
NSWC INDIAN HEAD, MARYLAND

Parameter	CRQL Sediment Samples (µg/kg)
Diethyl ether	10
Ethylbenzene	10
Isopropylbenzene	10
Volatile Organic Compounds	
Methyl acetate	10
Methyl tert-butyl ether	10
Methylcyclohexane	10
Methylene chloride	10
Styrene	10
Tetrachloroethene	10
Toluene	10
Trans-1,2-Dichloroethene	10
trans-1,3-Dichloropropene	10
Trichloroethene	10
Trichlorofluoromethane	10
Vinyl chloride	10
Xylenes (total)	10
Semivolatile Organic Compounds	
1,1'-Biphenyl	330
2,2'-Oxybis(1-chloropropane)	330
2,4,5-Trichlorophenol	830
2,4,6-Trichlorophenol	330
2,4-Dichlorophenol	330
2,4-Dimethylphenol	330
2,4-Dinitrophenol	830
2,4-Dinitrotoluene	330
2,6-Dinitrotoluene	330
2-Chloronaphthalene	330
2-Chlorophenol	330
2-Methylnaphthalene	330
2-Methylphenol	330
2-Nitroaniline	830
2-Nitrophenol	330
3,3'-Dichlorobenzidine	330

TABLE 6-3

ANALYTICAL QUANTITATION LIMITS - TCL ORGANICS
MATTAWOMAN CREEK
NSWC INDIAN HEAD, MARYLAND

Parameter	CRQL Sediment Samples (µg/kg)
3-Nitroaniline	830
4,6-Dinitro-2-methylphenol	830
4-Bromophenyl-phenylether	330
4-Chloro-3-methylphenol	330
4-Chloroaniline	330
4-Chlorophenyl-phenylether	330
4-Methylphenol	330
4-Nitroaniline	830
4-Nitrophenol	830
Acenaphthene	330
Acenaphthylene	330
Acetophenone	330
Anthracene	330
Atrazine	330
Benzaldehyde	330
Benzo(a)anthracene	330
Benzo(a)pyrene	330
Benzo(b)fluoranthene	330
Benzo(g,h,i)perylene	330
Benzo(k)fluoranthene	330
Bis(2-chloroethoxy)methane	330
Bis(2-chloroethyl)ether	330
Bis(2-ethylhexyl)phthalate	330
Butylbenzylphthalate	330
Caprolactam	330
Carbazole	330
Chrysene	330
Dibenz(a,h)anthracene	330
Dibenzofuran	330
Diethylphthalate	330
Dimethylphthalate	330
Di-n-butylphthalate	330
Di-n-octylphthalate	330

TABLE 6-3

ANALYTICAL QUANTITATION LIMITS - TCL ORGANICS
MATTAWOMAN CREEK
NSWC INDIAN HEAD, MARYLAND

Parameter	CRQL Sediment Samples (µg/kg)
Fluoranthene	330
Fluorene	330
Hexachlorobenzene	330
Hexachlorobutadiene	330
Hexachlorocyclopentadiene	330
Hexachloroethane	330
Indeno(1,2,3-cd)pyrene	330
Isophorone	330
Naphthalene	330
Nitrobenzene	330
N-nitroso-di-n-propylamine	330
N-nitrosodiphenylamine	330
Pentachlorophenol	830
Phenanthrene	330
Phenol	330
Pyrene	330
Pesticides/PCBs	
4,4'-DDD	3.3
4,4'-DDE	3.3
4,4'-DDT	3.3
Aldrin	1.7
alpha-BHC	1.7
alpha-Chlordane	1.7
Aroclor-1016	33
Aroclor-1221	67
Aroclor-1232	33
Aroclor-1242	33
Aroclor-1248	33
Aroclor-1254	33
Aroclor-1260	33
beta-BHC	1.7
delta-BHC	1.7
Dieldrin	3.3
Endosulfan I	1.7

TABLE 6-3

ANALYTICAL QUANTITATION LIMITS - TCL ORGANICS
MATTAWOMAN CREEK
NSWC INDIAN HEAD, MARYLAND

Parameter	CRQL Sediment Samples
	(µg/kg)
Endosulfan II	3.3
Endosulfan sulfate	3.3
Endrin	3.3
Endrin aldehyde	3.3
Endrin ketone	3.3
gamma-BHC (Lindane)	1.7
gamma-Chlordane	1.7
Heptachlor	1.7
Heptachlor epoxide	1.7
Methoxychlor	17
Toxaphene	170

1 CRQL Contract Required Quantitation Limit; as specified in the CLP SOW OLM04.2.

TABLE 6-4

ANALYTICAL QUANTITATION LIMITS - TAL INORGANICS
MATTAWOMAN CREEK
NSWC INDIAN HEAD, MARYLAND

Parameter	CRDL[1]	
	Surface Water Samples	Sediment, Vegetation, and Fish Samples
	(µg/L)	(mg/kg)
Aluminum	200	40
Antimony	60	12
Arsenic	10	2
Barium	200	40
Beryllium	5	1
Cadmium	5	1
Calcium	5000	1000
Chromium (total)	10	2
Cobalt	50	10
Copper	25	5
Cyanide	10	2.5
Iron	100	20
Lead	3	0.6
Magnesium	5000	1000
Manganese	15	3
Mercury	0.2	0.1
Nickel	40	8
Potassium	5000	1000
Selenium	5	1
Silver	10	2
Sodium	5000	1000
Thallium	10	2
Vanadium	50	10
Zinc	20	4

1 CRDL Contract Required Detection Limit; as specified in the CLP SOW ILM04.1. Results are reported down to the Instrument Detection Limit (IDL) as specified in method ILM04.1.

TABLE 6-5

ANALYTICAL QUANTITATION LIMITS – MISCELLANEOUS PARAMETERS
MATTAWOMAN CREEK
NSWC INDIAN HEAD, MARYLAND

Parameter	RL[1]	
	Surface Water Samples (mg/L, unless otherwise noted)	Sediment Samples (mg/kg)
Acid Volatile Sufides/Simultaneously Extracted Metals (AVS/SEM)	NR[2]	
Chloride	1	NR[2]
Fluoride	0.1	NR[2]
Grain Size Distribution	NR[2]	NA[3]
Hardness (as $CaCO_3$)	5	NR[2]
Nitrate	0.05	NR[2]
Nitrite	0.05	NR[2]
Perchlorate	0.004	NR[2]
pH	NA[3]	NR[2]
Salinity	NA[3]	NR[2]
Sulfate	1	NR[2]
Total Dissolved Solids (TDS)	10	NR[2]
Total Organic Carbon (TOC)	1	100
Total Suspended Solids (TSS)	5	NR[2]
Turbidity	1 NTU[4]	NR[2]

1 RL is the typical reporting limit; actual RL may vary based on the laboratory.
2 Analysis not required.
3 Not Applicable.
4 Nephelometric turbidity units.

TABLE 6-6

ANALYTICAL QUANTITATION LIMITS – EXPLOSIVES[1]
MATTAWOMAN CREEK
NSWC INDIAN HEAD, MARYLAND

Parameter	EQL[1]	
	Surface Water Samples (mg/L)	Sediment Samples (mg/kg)
1,3,5-Trinitrobenzene (1,3,5-TNB)	0.26	0.25
1,3-Dinitrobenzene (1,3-DNB)	0.11	0.25
2,4,6-Trinitrotoluene (2,4,6-TNT)	0.11	0.25
2,4-Dinitrotoluene (2,4-DNT)	0.31	0.26
2,6-Dinitrotoluene (2,6-DNT)	0.02	0.25
2-Amino-4,6-dinitrotoluene (2-Am-DNT)	0.035	NA[3]
2-Nitrotoluene (2-NT)	12.0	0.25
3-Nitrotoluene (3-NT)	8.5	0.25
4-Amino-2,6-dinitrotoluene (4-Am-DNT)	0.06	NA[3]
4-Nitrotoluene (4-NT)	7.9	0.25
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	0.84	1.0
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	4.0	0.65
Nitrobenzene (NB)	6.4	0.26
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	13.0	2.2
Nitroglycerine[3]	NA[3]	NA[3]
Nitrocellulose[5]	NA[3]	NA[3]
Nitroguanidine[5]	NA[3]	NA[3]

1 All explosives by SW 846 method 8330 except for nitroglycerin, nitrocellulose and nitroguanidine.
2 EQL is the estimated quantitation limit as published in the analytical method.
3 Not applicable.
4 Nitroglycerin by SW 846 method 8332.
5 Nitrocellulose and nitroguanidine by the USATHAMA method.

7.0 INTERNAL QUALITY CONTROL CHECKS

Field and laboratory QC samples will be analyzed routinely to evaluate overall data quality. This section provides information regarding those internal QC checks. Laboratory QC samples are addressed in Sections 3.5, 6.2, and 8.3.2, and Table 3-1 of this QAPP. Section 11.6 addresses field and laboratory QC sample types and required level of effort; Section 5.2 addresses instrument calibrations; Section 7.0 addresses non-calibration analytical QC of the laboratories. Table 3-1 summarizes analysis frequencies and associated corrective actions for the routine field and laboratory non-calibration QC samples. Tables 3-2, 3-3, 3-4 and 3-5 of Section 3.0 present the numbers of QC samples that are anticipated to be collected in the field.

7.1 FIELD QUALITY CONTROL CHECKS

TtNUS has established a QC program designed to monitor and assess the quality of field work performed during environmental investigations. That program includes the use of various types of QC samples as indicated in Table 3-1. Some of the samples are identified in Tables 3-2, 3-3, 3-4 and 3-5 as requiring additional sample material to be collected in the field even though the actual field QC check is performed in the laboratory.

The field QC samples consist of field duplicates, trip blanks, equipment rinsate blanks, source water blanks and temperature blanks. Temperature blanks will be included in each cooler submitted to the laboratory to monitor sample storage conditions prior to arrival at the laboratory. With the exception of temperature blanks, each type of field QC sample undergoes the same preservation, analysis, and reporting procedures as the related environmental samples. The types of field QC samples to be used for this project are described in detail in Sections 7.1.1 through 7.1.6. Target precision and accuracy values, as applicable, for field QC samples are presented in Table 3-1.

7.1.1 Source Water Blanks

Source water blanks will be obtained by sampling each water source (e.g., potable water and distilled water) used for decontamination activities during the field investigation. Source water blanks will be used to determine if the water or the laboratory bottles are contributing to sample contamination. Source water blanks will be collected for each type of water used for decontamination and will be submitted at a frequency of one per sampling event. Source water blanks, as applicable, will be analyzed for the entire suite of parameters under investigation.

7.1.2 Field Duplicates

Field duplicates will be collected and analyzed for chemical constituents to measure the cumulative uncertainty (i.e., precision) of the sample collection, splitting, handling, storage, preparation, and analysis operations, as well as natural sample heterogeneity that is not eliminated through simple mixing in the field. Field duplicates are two samples prepared by mixing a volume of sample and splitting it into two separate sample containers that are labeled as individual field samples. For ground water and surface water sampling, field duplicates may be generated by collecting individual water samples from the same well or water source in rapid succession rather than splitting a given volume of water. Field duplicates are labeled as individual environmental samples and are not identified to the laboratory as duplicate samples.

7.1.3 Rinsate Blanks

Equipment rinsate blanks or rinsate blanks are obtained under representative field conditions by collecting the rinse water generated by running analyte-free water through sample collection equipment after sampling and decontamination and prior to use. These blanks will be collected to indicate the potential for sample cross-contamination through the use of improperly cleaned sampling equipment.

7.1.4 Trip Blanks

Trip blanks are samples of deionized water that are analyzed for VOCs. These blanks are used to indicate the potential for cross contamination of the samples by VOCs during sample shipment.

7.1.5 Temperature Blanks

Temperature blanks are vials of water inserted into each sample cooler prior to being shipped from the field. The temperature of the temperature blank is measured prior to shipping and upon receipt at the laboratory to assess whether samples were properly cooled during transit.

7.2 LABORATORY QUALITY CONTROL CHECKS

The laboratory's QA plans describe the policies, organization, objectives, QC activities, and specific QA functions used by each laboratory. All analytical procedures are documented as SOPs. Each analytical SOP specifies minimum QC requirements for the procedure. In addition, the laboratory should maintain SOPs regarding general laboratory QA operations.

Internal laboratory analytical QC requirements beyond those used for instrument calibration QC are highlighted in the remainder of this section. Additional QC requirements, specific to the NFESC QA

Program, are also specified, as applicable, for each of the QC checks. Target precision and accuracy values (control limits) are presented in Tables 11-1 through 11-12.

7.2.1 Laboratory Control Samples

LCSs provide a means to monitor the overall performance of each step during the analysis, including the sample preparation. These are solid samples (soil analyses) or blank spikes (water analyses) that contain concentrations of analytes that are known with a specified degree of certainty.

Based on the requirements of the NFESC QA program, LCSs for metals analyses must contain all analytes of interest, whereas LCSs for multiple-analyte organic methods must contain at least two targeted analytes from each major class of compounds subject to analysis. Target analytes for LCSs are listed in Tables 11-2, 11-4, 11-6, 11-8, 11-10 and 11-12.

Based on NFESC QA program requirements, if recovery of an LCS falls outside the control limits (see Tables 11-2, 11-4, 11-6, 11-8, 11-10 and 11-12), the laboratory will reject the data for the analytical batch and take corrective action. The associated samples, extracts, or digestates may be reanalyzed a single time, and if the LCS recoveries meet acceptance criteria, the data will be reported. If LCS analyte recovery is still outside the acceptance limits, the associated samples in the preparation batch will be reprocessed, if sufficient sample is available and holding times have not lapsed. If re-preparation or reanalysis is not possible, the data will be flagged and the sample delivery group (SDG) narrative will include details of the failed LCS.

7.2.2 Laboratory Duplicates

Laboratory duplicates will be analyzed for metals, and miscellaneous parameters to measure the cumulative uncertainty (i.e., precision) of the sample handling, subsampling, preparation, laboratory storage, and analysis operations within the laboratory, as well as sample heterogeneity that is not eliminated through simple mixing in the laboratory. Laboratory duplicates are two subsamples obtained by the laboratory analyst after mixing the sample. If chemical analysis RPD values exceed QC limits for laboratory duplicates (Tables 3-1, 11-7 and 11-9), the analytical process will be investigated to assess whether the observed RPD value is an indication of a deficient analytical system or of excess sample heterogeneity.

7.2.3 Internal Standards

Internal standards are added to each sample analyzed by GC/MS to ensure that the analysis sensitivity and response are stable during every analytical run. Internal standard area counts for samples and

blanks must not vary by more than a factor of two (- 50% to + 100%) from the associated 12-hour calibration standard.

7.2.4 Laboratory Method Blanks

Laboratory method blanks or preparation blanks are an analyte-free matrix prepared and analyzed in accordance with the analytical method employed to determine whether contaminants originating from laboratory sources have been introduced and have affected environmental sample analyses. Analyte-free water is used as a blank for water analyses. A method blank for organic soil sample analysis consists of an aliquot of sand (or in some cases sodium sulfate or Teflon® beads) that is subjected to the same preparation and analysis as the environmental samples. The solid method blank results are presented on a dry-weight basis assuming 100 percent solids. Native soils devoid of acid leachable metals do not exist. Therefore, a method blank for inorganic soil sample analysis consists of an aliquot of analyte-free water that is subjected to the same preparation and analysis procedures as the environmental samples undergoing analysis. The aqueous results are normalized to a fictitious soil sample and presented on a dry-weight basis assuming 100 percent solids.

Under no circumstances should laboratory method blank contaminant values be subtracted from environmental sample analytical results.

7.2.5 Matrix Spikes

MSs are environmental samples to which known quantities of analytes are added prior to sample preparation (digestion or extraction). These samples provide information about the heterogeneity of the samples as well as the effect of the sample matrix on the sample digestion and measurement methodology.

Matrix spikes, to conform to NFESC requirements, will contain as many representative analytes as practicable.

If the MS recovery is not within applicable control limits (Tables 11-1, 11-3, 11-5, 11-7, 11-9 and 11-11), the laboratory will assess the batch to determine whether the spike results are attributable to a matrix effect or are the result of other problems in the analytical process. Based on NFESC requirements, if all the batch QC elements that are not affected by the sample matrix are in control (e.g., method blank, LCS, calibration checks) and if there is no evidence that spiking was not properly performed, the poor spike recovery may be attributed to matrix effects. In this case, the associated data will be flagged, but repreparation and reanalysis will not be required. If any of the batch QC elements which are not affected by the sample matrix are out of control, or if there is any evidence that spiking may have been improperly

performed, the MS sample will be reprocessed through the entire analytical sequence. If insufficient sample is available, or if holding times have passed, the laboratory will flag the associated data. Details of noncompliant matrix spikes and laboratory duplicate results will be included in the SDG narrative.

7.2.6 Matrix Spike Duplicates

MSDs are duplicates of matrix spikes and are used for estimating the precision of organic target analyte analyses. They are used in lieu of simple duplicate samples because native environmental samples frequently do not exhibit detectable levels of organic target analytes, which otherwise prevents the calculation of RPD values. Precision criteria for MSDs are presented in Tables 11-1, 11-3, 11-5, 11-7, 11-9 and 11-11.

7.2.7 Post Digestion Spikes

PDSs are similar to MSs except that the sample digestate, rather than the original soil sample, is spiked. These spikes are analyzed only for metal target analytes if the matrix spike recovery falls outside control limits. Comparing %Rs for PDSs and MSs helps to identify where in the analytical process accuracy problems are occurring. PDSs will contain all target analytes of interest and will be used to assist in determining whether unacceptable MS recoveries are a result of matrix effects.

7.2.8 Surrogates

Surrogates are organic compounds (typically brominated, fluorinated, or isotopically labeled) that are similar in nature to the compounds of concern and are not likely to be present in environmental media. They are spiked into each sample, standard, and method blank before analysis, and are used in organic chromatographic analytical procedures as a check of method effectiveness. Corrective actions for noncompliant surrogate recoveries are implemented in accordance with the applicable SOP. Details of noncompliant surrogate recoveries will be included in the SDG narrative. Accuracy criteria for surrogates are included in Tables 11-1, 11-3 and 11-5.

7.2.9 Additional Laboratory QC Checks

Additional internal laboratory QC checks include mass tuning for GC/MS analysis, second-column confirmation for GC and HPLC analyses, etc. The laboratory is required to follow requirements specified in the analytical methods.

8.0 DATA REDUCTION, VALIDATION, AND REPORTING

This section describes the procedures to be used for data reduction, validation, and reporting. Data generated during the course of the field investigations will be maintained in hard copy form in the Administrative Record at NSWC Indian Head.

8.1 DATA REDUCTION

8.1.1 Field Data Reduction Procedures

All field logs containing observations will be inspected and approved by the FOL. All field observations will be recorded in the logs immediately after observations are made. Limited data reduction will be required in the field.

Concentration measurements will be reported in the units indicated in Tables 6-2, 6-3, 6-4, 6-5 and 6-6.

If errors are made in recording or transcribing observations, erroneous observations will be legibly crossed out using a single line, initialed, dated by the field member, and corrected in a space adjacent to the crossed-out entry. The FOL is responsible for assuring that errors are identified and assessed relative to the intent of the QAPP.

Errors judged to affect the use of the sample results within the context of this investigation shall be brought to the immediate attention of the PM.

8.1.2 Laboratory Data Reduction Procedures

Data reduction will be completed by the analytical laboratory. In addition, data are reviewed in accordance with the laboratory QA plans.

Laboratory analytical data will be reported using standard concentration units to ensure comparability with previous analytical results. Surface water sample results will be reported in units of micrograms per liter (µg/L); sediment, fish tissue and vegetation sample results will be reported on a dry-weight basis in units of micrograms per kilogram (µg/kg) for organic parameters and milligrams per kilogram (mg/kg) for inorganic parameters.

8.2 DATA VALIDATION

Validation of field measurements and laboratory analytical data are presented in this section.

8.2.1 Procedures Used to Validate Field Data

Field measurements will not be subjected to a formal data validation process. Validation of field data will be limited to real time inspection by the FOL of observations relative to actual site conditions and activities. In addition, field technicians will ensure that the equipment used for sample collection is performing adequately via compliance with the applicable SOPs.

8.2.2 Procedures Used to Validate Laboratory Data

One hundred percent of the laboratory analytical data will be subjected to data validation to ensure that the data are of evidentiary quality. Validation of analytical data will be completed by the TtNUS Environmental Chemistry/Toxicology Department located in the TtNUS Pittsburgh office. Final review and approval of validation deliverables will be completed by the department's Data Validation Manager.

Prior to statistical analyses, analytical results will be validated *versus* the applicable analytical methods and the requirements of this QAPP. Validation of these data will conform to the U.S. EPA Region 3 Standard Operating Procedures for Validation of CLP Inorganic and Organic Data (U.S. EPA, September 1994) and the National Functional Guidelines for Inorganic and Organic Data Review (U.S. EPA, April 1993) to the greatest extent practicable. Data validators will review the chemical analytical data packages submitted by the laboratory. The data validators will check that the data were obtained using approved methodology, that the appropriate level of QC and reporting was conducted, and that the results are in conformance with QC criteria.

On the basis of the data validation results, the data validator will generate a report describing data limitations. The report will be reviewed internally by the Data Validation Manager prior to submittal to the PM. Data review will be extended beyond this routine validation by involving the project chemist, statistician, and risk assessor, as appropriate, to examine the data for anomalies (See Section 11). This additional review may result in more detailed inspections of the data to determine the cause of, and to rectify, individual anomalies. The impact of data qualifiers on data usability will also be assessed, and any qualifications that are indicated during use of the data shall be documented in the ERA report.

The data validation process will provide an estimate of the number of usable data points. This completeness check will be effected by computing the number of data points that are rejected relative to the total number of data points for a given analyte in a given environmental medium. Completeness is addressed in Section 11.3.

8.3 DATA REPORTING

8.3.1 Field Data Reporting

Field data will be transcribed from the site logbook or sample logsheets to the electronic database and will be reviewed for accuracy by an independent reviewer.

All records regarding field measurements (i.e., field logbooks, sampling logbooks, and sample logsheets) will be placed in the TtNUS central files upon completion of the field effort. Entry of these results in the database will require temporary removal of these records from the files. Outcards (date, person, subject matter) will be used to document the removal of any such documentation from the files. After database entry is complete, all original records will be placed in the project file for subsequent shipment to the Navy upon project closeout.

8.3.2 Laboratory Data Reporting

To achieve the investigation objectives, a confirmational level of analytical quality is needed. This provides the highest level of data quality necessary to address potential risks. These analyses require full documentation of the chosen analytical methods and sample preparation steps, data packages, and data validation sufficient to provide defensible data. QC must be sufficient to define the overall precision and accuracy of these procedures. Therefore, data reported by the analytical laboratory for all analytical fractions will be in a CLP-like reporting format. Hard copy data deliverables shall be generated at the time of analysis. All pertinent QC data (including raw data and summary forms for blanks, standards analysis, calibration information, etc.), will be provided for all analyses. Case narratives will be provided for each sample delivery group (SDG).

Validation will be completed using the hard copy data. After validation, the Data Validation Manager will review the validated data. The validation qualifiers will be entered into the electronic database, and will be subjected to independent review for accuracy. During this review process, the electronic database printout also will be compared with the hard copy data to ensure that the hard copy data and electronic data are consistent.

8.4 DATA ACQUISITION REQUIREMENTS AND DATA MANAGEMENT

Data acquisition and management will begin with the identification and collection of past data and newly acquired project samples. The samples will be received at the laboratory and analyzed, the analytical results will be reported by the analyst along with QC check data, and the data will be reviewed within the laboratory. Data will then be transmitted from the laboratory in both hardcopy and electronic formats. The data deliverable requirements are specified in TtNUS's basic ordering agreements with analytical

laboratories. This agreement requires the analytical laboratory to provide data in both hardcopy and electronic form. Upon receipt by TtNUS, the data will be validated, analyzed, assessed, and ultimately archived.

The electronic database will include pertinent sampling information such as sample number, sampling date, and sampling point location, as well as analytical information. Sample-specific method detection limits (MDLs) will be reported for nondetected analytes. Units will be clearly summarized in the database and will conform to those identified in Section 8.1.2. The original electronic diskettes and data validation reports for this investigation will be maintained in the project file for subsequent forwarding to the Navy upon project closeout.

9.0 PERFORMANCE AND SYSTEM AUDITS

Performance and system audits will be conducted periodically to ensure that work is being implemented in accordance with the approved QAPP and in an overall satisfactory manner. Some examples of pertinent audits are as follows:

- The FOL will supervise and check daily that the field observations are made accurately, equipment is thoroughly decontaminated, samples are collected and handled properly, and fieldwork is documented accurately and neatly.

- The PM will maintain contact with the FOL and Data Validation Manager to ensure that management of the acquired data proceeds in an organized and expeditious manner.

Details regarding additional audit responsibilities, frequency, and procedures are provided in the remainder of this section. Field performance and system audits are addressed in Section 9.1. Laboratory performance and system audits are addressed in Section 9.2.

9.1 FIELD PERFORMANCE AND SYSTEM AUDITS

This section presents the responsibilities, frequencies, and procedures associated with internal and external field performance and system audits.

9.1.1 Internal Field Audits

9.1.1.1 Internal Field Audit Responsibilities

In addition to the daily checks performed by the FOL, the TtNUS QAM or designee may conduct an independent performance and system audit of field activities. Such audits are scheduled with individual projects being selected for audit by the QAM without the involvement of the PM. If a formal field audit is conducted for this study, the QAM (or designee) will be responsible for ensuring that sample collection, handling, and shipping protocols, as well as equipment decontamination and field documentation procedures, are being performed in accordance with the approved QAPP and SOPs.

9.1.1.2 Internal Field Audit Frequency

As explained in Section 9.1.1.1, internal field audits may be scheduled as part of the Mattawoman Creek ERA. Individual projects are selected for audit by the QAM without the involvement of the PM.

9.1.1.3 Internal Field Audit Procedure

Internal field audits will be conducted in accordance with the following procedure:

- Prior to an audit, the auditor will prepare a detailed checklist to be used as an auditing guide.
- Upon arrival at the audit location, the auditor shall conduct a pre-audit meeting with the responsible management of the organization or project to be reviewed.
- Field audits will include a review of required project documentation (logbooks, sample log sheets, etc.) and field operations (sample COC, sample handling, etc.) to evaluate completeness and compliance with applicable SOPs.
- The audit checklist will be used to record observations including any noted nonconformances.
- A formal post-audit debriefing will be conducted, and potential immediate corrective actions will be discussed.
- The auditor will generate a formal audit report that will address corrective actions. The auditor will provide this report to the PM.
- The PM will ensure that all corrective actions are addressed and will provide written verification of corrective action implementation to the auditor.
- The auditor will manage corrective action verification and audit closure.
- The following audit records will be maintained by the QAM:
  - Audit checklists
  - Audit reports
  - Response evaluations
  - Verification of corrective actions
  - Follow-up checklists and audit reports

9.1.2 External Field Audits

9.1.2.1 External Field Audit Responsibilities

MDE, U.S. EPA Region 3, or both may conduct external field audits.

9.1.2.2 External Field Audit Frequency

External field audits may be conducted at any time during field activities at the discretion of MDE and U.S. EPA Region 3. If an audit is to be conducted, scheduling should be coordinated through the TtNUS QAM to ensure that personnel and equipment are available as necessary. Personnel being audited may or may not be informed of the impending audit at the discretion and request of the auditing body.

9.1.2.3 Overview of the External Field Audit Process

External audit procedures are at the discretion of U.S. EPA Region 3 and MDE.

9.2 LABORATORY PERFORMANCE AND SYSTEMS AUDITS

This section presents the responsibilities, frequencies, and procedures associated with internal and external laboratory performance and system audits.

9.2.1 Internal Laboratory Audits

9.2.1.1 Internal Laboratory Audit Responsibilities

The QAO or appropriate designee of the subcontracted laboratory performs routine internal audits of the laboratory. The U.S. Navy, through the NFESC, also conducts internal laboratory audits. TtNUS holds no responsibility for such audits. Performance and system audits of laboratories are coordinated through the NFESC by an independent QA contractor. It is the responsibility of the NFESC and its contractor to ensure that the subcontracted laboratories comply with good laboratory practices and the general requirements of all analytical services provided by the laboratories.

9.2.1.2 Internal Laboratory Audit Frequency

The U.S. Navy completes internal laboratory performance and system audits for all contracted laboratories on an 18-month schedule.

9.2.1.3 Internal Laboratory Audit Procedures

Internal systems audits are conducted to detect any problems in sample flow, analytical procedures, or documentation and to ensure adherence to laboratory SOPs.

Internal U.S. Navy laboratory audit procedures, as performed by a Navy contractor, include a pre-screening process that requires review of the laboratory's QA plan, analysis of performance evaluation samples, generation of data deliverables for those samples, an on-site technical systems audit of the laboratory, and satisfactory resolution of all deficiencies and findings.

9.2.2 External Laboratory Audits

9.2.2.1 External Laboratory Audit Responsibilities

MDE and U.S. EPA Region 3 may perform external laboratory audits at their discretion.

9.2.2.2 External Laboratory Audit Frequency

U.S. EPA Region 3 or MDE may conduct an external laboratory audit prior to or during sampling and analysis activities.

9.2.2.3 Overview of the External Laboratory Audit Process

External audit procedures are at the discretion of U.S. EPA Region 3 and MDE. External laboratory audits may include (but are not limited to) review of laboratory analytical procedures, laboratory on-site audits, and submission of performance evaluation (PE) samples to the laboratory for analysis.

10.0 PREVENTIVE MAINTENANCE PROCEDURES

Equipment used to collect samples will be maintained in accordance with the manufacturers' operation and maintenance manuals. Equipment and instruments will be calibrated in accordance with the procedures and at the frequencies presented in Section 5.0. Preventive maintenance for field and laboratory equipment is addressed in the remainder of this section.

10.1 FIELD EQUIPMENT PREVENTIVE MAINTENANCE

The TtNUS equipment manager and the equipment operator will be responsible for ensuring that equipment is operating properly prior to use and that routine maintenance is performed and documented. Field measurements of dissolved oxygen, oxidation-reduction potential, pH, salinity, specific conductance, temperature and turbidity in surface water will be measured using an electronic instrument. Any problems encountered while operating the instrument will be recorded in the field logbook, including a description of the symptoms and corrective actions taken. If problems with the equipment are detected and service is required, the equipment will be logged, tagged, and segregated from equipment in proper working order. Use of the equipment will not resume until the problem is corrected.

10.2 LABORATORY INSTRUMENT PREVENTIVE MAINTENANCE

Proper maintenance of laboratory instruments and equipment is essential. Depending on manufacturers' recommendations, maintenance intervals are established for each instrument. All instruments will be labeled with a model number and serial number, and a maintenance logbook will be maintained for each instrument. Personnel will be alert to the maintenance status of the equipment they are using at all times.

The use of manufacturer-recommended grades or better of supporting supplies and reagents is also a form of preventive maintenance. For example, gases used in the ICP instruments are of sufficient grade to minimize fouling of the instrument. The routine use of other supporting supplies from reputable manufacturers will assist in averting unnecessary periods of instrument downtime. An inventory of critical spare parts will also be maintained by the laboratory to minimize instrument downtime. Table 10-1 includes recommended preventative maintenance schedules for some common pieces of laboratory equipment.

10.3 INSPECTION/ACCEPTANCE REQUIREMENTS FOR SUPPLIES AND CONSUMABLES

All field equipment shall be inspected prior to use to ensure that necessary parts are available. Most equipment planned for use in this project is simple, with few to no moving parts. Therefore, a visual

inspection prior to use shall be sufficient to ensure that the equipment is suitable for use. This visual inspection shall occur during mobilization and during each use by the person using the equipment.

Laboratory inspection and acceptance requirements are provided in the laboratory Quality Assurance Plans. The plans present the following specifications for inspection and acceptance of supplies and consumables:

- Requirements to follow individual SOP specifications for grades of chemicals necessary to achieve acceptable analytical performance. SOPs are required to detail the necessary grade of chemicals, including compressed gases.

- Requirements to obtain primary chemical standards from reliable sources that use calibrated glassware in the preparation of the standards and to maintain all certificates supplied with the standards. Emphasis is on obtaining NIST-traceable standards where possible.

- Storage of chemical standards in accordance with applicable SOPs and in a manner that preserves their integrity.

- Routine monitoring of deionized water and other solvents to ensure that analytical systems, samples, and standards are not contaminated.

- Requirements to record the date received and the date opened on each container of chemical used for analysis.

TABLE 10-1

RECOMMENDED PREVENTIVE MAINTENANCE FOR LABORATORY ANALYTICAL AND SUPPORT INSTRUMENTS[1]
IHDIV-NSWC INDIAN HEAD, MARYLAND

Instrument	Preventive Maintenance	Maintenance Frequency
HPLC	Change frit in mixer. Change column pre-filter, change pump seals.	As needed ((when pressure builds up)
	Rinse water pump with methanol, filter water, sonicate water intake filter frit.	Approximately weekly
GC/MS	Change pump oil.	Every 6 months
	Change septum. Clean injection port, replace liner, bake oven, check carrier gas, clean the ion source.	As needed
	Clean source and rods, check power supplies in QEM box, clean inside and outside of printer, general cleaning of instrument.	As needed
	Service in accordance with manufacturer specifications under the contractor maintenance agreement.	As needed
	Replace solvent washes and clean syringe.	Daily
GC	Change carrier and make-up gas filters.	As needed
	Change trap, clean flame ionization detector (FID) jet, trim column, clean injection port, replace liner and bake oven.	As needed
	Replace solvent washes and clean syringe.	Daily
ICP/AES	Service Intercooler.	Annually
	Rinse and clean nebulizer cap and spray chamber.	Monthly or as needed
	Clean torch, vacuum filters.	Bi-monthly
	Profile instrument, examine autosampler tubing and replace as needed.	Daily
	Empty rinse container, fill rinse water reservoir.	As needed
	Manual profile and automatic profile optics.	As needed
Mercury Analyzer	Check and replace pump tubing, check and replace membrane, check and clean windows.	As needed
Spectro-photometer	Clean sample compartment.	Semi-annually
	Check wavelength calibration.	Annually

TABLE 10-1

RECOMMENDED PREVENTIVE MAINTENANCE FOR LABORATORY ANALYTICAL AND SUPPORT INSTRUMENTS[1]
IHDIV-NSWC INDIAN HEAD, MARYLAND

Instrument	Preventive Maintenance	Maintenance Frequency
Ion Chromato-graph	Replace pump seals.	Annually
	Lubricate analytical pump motor.	Semi-annually
	Check chromatography module and all gas lines for leaks.	Every run
	Clean conductivity detector cell electrodes, check cell calibration.	Monthly
	Replace bed supports, clean columns, clean membrane supressor, replace autosampler pipette tip.	As needed
Ion Analyzer	Clean RAS sampler and sample trays	Daily
	Flush manifold	Daily
	Clean proportioning pump rollers	Weekly
	Replace flared tubing	Monthly
	Check / Replace O-Rings	Monthly / As Needed
TOC Analyzer	Replace pump tubing.	Each run
	Change other tubing, change furnace tubes, change LiOH tube, change tin trap, adjust optical balance, change septum, change permeation dryer tubing	As needed
	Change IR filter screen, change gas tubing	Check monthly
Refrigerators	Monitor temperature	Daily
Ovens	Monitor temperature	Daily
Balances	Certify Class S weights Routine service by outside party	Annually Annually
	Certify and/or service in accordance with the Test, Measurement and Evaluation Division of the Army Calibration System.	Annually
Thermometers	Calibrate against NIST thermometer Recertify NIST Thermometer	Annually Annually
Micropipets	Check gravimetrically Clean o-rings	Monthly As needed

1 These procedures are recommended and may vary slightly from laboratory to laboratory.

11.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA AND SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY AND COMPLETENESS

The overall QA objective for this project is to develop and implement procedures for field sampling, chain-of-custody, laboratory analysis, data management, and reporting that will yield results sufficient to support the attainment of the project objectives specified in Section 1.0. Intended data uses, including the list of project target parameters, are described in Section 1.4.1 of this QAPP. How decisionmaking will be based on data comparisons is described in the decision rules of Section 1.4.4 and in Section 11.10. The overall QC level of effort is described in Section 11.6.

The PARCC parameters (precision, accuracy, representativeness, comparability, and completeness) are qualitative and quantitative statements regarding the quality characteristics of the data used to support the attainment of project objectives and ultimately, environmental decisions. These parameters are presented in the remainder of this section. QC samples used to evaluate performance and their frequencies of use are described in Section 7.1 (field QC samples) and Section 7.2 (laboratory QC samples). Equations used to compute accuracy, precision, and completeness values are provided in Sections 11.7 through 11.9.

11.1 PRECISION

11.1.1 Definition

Precision is a measure of the degree to which two or more measurements are in agreement and describes the reproducibility of measurements of the same parameter for samples analyzed under similar conditions. A fundamental tenet of using precision measurements for QC is that precision will be bounded by known limits. Results outside these predetermined limits trigger corrective actions.

By definition, chemical solutions are uniform in composition. Therefore, ignoring any imprecision caused by the sample matrix, the variability of analytical results for water samples should be relatively low unless suspended material or sample handling and storage introduce additional imprecision. Precision acceptance criteria for aqueous duplicate samples have been assigned accordingly in Tables 11-1, 11-3, 11-5, 11-7, 11-9 and 11-11.

Because of the inherent and unknown heterogeneity of sediment samples, the precision of sediment field duplicate samples will not be used for QC, but will be compared to laboratory precision estimates to gain perspective on the natural heterogeneity of the sediment. Although precision for sediment samples will

not be used for QC purposes, acceptance criteria have been incorporated into Tables 11-1, 11-3, 11-5, 11-7, 11-9 and 11-11 as a means of warning data users when the measures of precision are becoming relatively large.

11.1.2 Field Precision Objectives

Field precision is assessed by collecting and measuring field duplicates at a rate of 1 duplicate per 10 environmental samples. Acceptance limits for field duplicate precision are provided in Table 3-1. This precision estimate encompasses the combined uncertainty associated with sample collection, homogenization, splitting, handling, laboratory and field storage (as applicable), preparation for analysis, and analysis. In contrast, precision estimates obtained from analyzing duplicate laboratory samples incorporate only homogenization, subsampling, preparation for analysis, laboratory storage (if applicable), and analysis uncertainties. Consequently, the field precision estimates [i.e., relative percent difference (RPD) values] should equal or exceed the laboratory precision estimates, on average, for each analyte. If field duplicate precision is significantly different from laboratory duplicate precision, the underlying cause will be investigated to determine whether the observed difference could be artifacts of sampling and analysis. Considerations given to this effort include the following:

- The scale of subsampling for laboratory precision estimates relative to the scale of field duplicate sample size
- Analytical measurement precision
- Precision for repeat analysis of the same solid laboratory control sample (LCS)
- Estimated environmental sample grain size relative to LCS grain size
- Potential natural sample heterogeneity
- Concentration level of the analyte

11.1.3 Laboratory Precision Objectives

Laboratory precision QC samples [i.e., laboratory duplicates for inorganic chemicals and matrix spike duplicates (MSDs) for organic chemicals] will be analyzed with a minimum frequency of 5 percent (i.e., 1 QC sample per 20 environmental samples). Laboratory precision is measured by comparing RPD values to precision control limits specified in Table 11-1, 11-3, 11-5, 11-7, 11-9 and 11-11.

11.2 ACCURACY

11.2.1 Definition

Accuracy is the degree of agreement between an observed value and an accepted reference value. This parameter is assessed by measuring spiked samples [e.g., surrogate spikes or matrix spikes (MSs)] or well-characterized samples of certified analyte concentrations (e.g., LCSs) and by measuring blanks. Accuracy measurements are designed to detect biases resulting from sample handling and analysis. Equations for determining accuracy of an individual MS and a surrogate spike or LCS for this project are provided in Section 11.7. The equations in Section 11.7 do not apply to blank samples, however, because division by zero (the expected amount or added amount) causes the calculated value to be infinite. Instead, laboratory blank acceptance criteria are designed to limit the tolerable amount of contamination while recognizing that non-zero results for blanks are likely, if only because of random error in the measurement process. The bias computations for individual MSs, LCSs, and method blanks will be used to control the analysis process by triggering corrective actions as specified in Table 3-1.

11.2.2 Field Accuracy Objectives

Accuracy requirements for field measurements are typically ensured through control over the sample collection and handling and through routine instrument calibration. In addition, after field measurements are completed, check standards are commonly analyzed to verify continued acceptable calibrations.

Accuracy is also typically monitored through the use of blanks to detect cross-contamination and by monitoring adherence to procedures that prevent sample contamination or degradation. The frequencies for collecting blanks are presented in Table 3-1. Equipment rinsate blanks shall be collected for this investigation to assess cross-contamination via sample collection equipment. Source water blanks will be collected to determine whether water used to decontaminate sampling equipment is leading to sample contamination. Trip blanks, used to gauge whether cross-contamination is occurring during sample storage and transport, will be placed into each cooler containing samples to be analyzed for VOCs. Accuracy shall also be assured qualitatively through adherence to all sample handling, preservation, and holding time requirements.

11.2.3 Laboratory Accuracy Objectives

Accuracy in the laboratory is measured through the comparison of a spiked sample or LCS result to a known or calculated value and is expressed as a percent recovery (%R). It is also assessed by monitoring the analytical recovery of select surrogate compounds added to samples that are analyzed by organic chromatographic methods. MS and surrogate compound analyses measure the combined accuracy effects of the sample matrix, sample preparation, and sample measurement. LCSs are used to

assess the accuracy of laboratory operations with minimal sample matrix effects. Post-digestion spikes (PDSs) are used to assess the accuracy of the analytical measurement on the sample extract or digestate. Each spike sample shall be spiked with representative project target analytes for the analysis being performed to ensure that accuracy measures are obtained for each target analyte. Spiking concentrations shall equal or approximate the default concentrations detailed in the applicable sample preparation or analysis SOPs. LCS and MS analyses are performed at a frequency no less than 1 per 20 associated samples of like matrix. Laboratory accuracy is assessed by comparing calculated %R values to accuracy control limits specified in Tables 11-1 through 11-12.

11.3 COMPLETENESS

11.3.1 Definition

Completeness is a measure of the amount of usable, valid analytical data obtained compared to the amount expected to be obtained. Completeness is expressed as a percentage.

11.3.2 Field Completeness Objectives

Field completeness is a measure of the amount of valid field measurements obtained from all the field measurements taken in the project. Documentation of sample location and depth is planned for each groundwater sample. Documentation of grain size and sample location is also planned for each sediment sample. A completeness criterion of 100 percent applies to these measurements. However, the 100 percent completeness criterion for grain size may be reduced, depending on whether these factors are significant for background comparisons. Failure to obtain 100 percent of these measurements for field samples may indicate a need for corrective actions designed to recover the missing information. Failure to recover the information will constitute a need to resample, unless the missing data are judged not to adversely affect attainment of project objectives.

Turbidity in groundwater is a critical parameter that must be determined prior to sampling to establish attainment of equilibrium, and its completeness criterion is 100 percent. There are no completeness criteria for the other field measurements. These are noncritical parameters that are generally determined to verify that appropriate sampling conditions exist prior to sampling, or to provide data to evaluate the potential efficacy of monitored natural attenuation (MNA) as a remedial option.

11.3.3 Laboratory Completeness Objectives

Laboratory completeness is a measure of the amount of usable, valid laboratory measurements per matrix obtained for each target analyte. Usable, valid results are those that are judged, after data

assessment, to represent the sampling populations and to have not been disqualified for use through data validation or data assessment.

Laboratory completeness objectives are 90 percent for each critical target analyte per sample matrix (sediment, surface water, fish tissue and vegetation tissue). The impact of missing data cannot be quantified in advance of sampling because the impact will depend on which data are missing. The impact of the loss of any other particular datum on attainment of project objectives will be evaluated during data assessment.

11.4 REPRESENTATIVENESS

11.4.1 Definition

Representativeness is an expression of the degree to which the data accurately and precisely represent a characteristic of a population or environmental condition existing at the site. Adherence to the sampling and analysis plan (SAP) in Section 3.0 and use of standardized sampling, handling, preparation, analysis, and reporting procedures ensures that the final data accurately represent the desired populations. Representativeness will be evaluated during data assessment to determine whether each datum belongs to the observed data distribution through outlier testing and qualitative evaluation of sampling conditions that existed at the time of sampling. The statistical tests to be used are described in Section 11.10. Any anomalies will be investigated to assess their impact on statistical computations.

11.4.2 Measures to Ensure Representativeness of Field Data

Representativeness depends on the proper design of the sampling program and will be satisfied by ensuring that the SAP (Section 3.0) is followed and that proper sampling techniques are used.

11.4.3 Measures to Ensure Representativeness of Lab Data

Representativeness in the laboratory is ensured or evaluated by using the proper analytical procedures, meeting prescribed sample holding times, and analyzing and evaluating field duplicate samples relative to laboratory duplicates. During development of this QAPP, measures to ensure representativeness of the data generated included considering past operations, aerial photographs, existing analytical data, physical setting, sediment depositional environments, spatial coverage of the proposed sampling locations, accessibility to sampling locations, and constraints inherent to the CERCLA program. The rationale of the sampling network is presented in detail in Section 3.0.

11.5 COMPARABILITY

11.5.1 Definition

Comparability is defined as the confidence with which one data set can be compared to another (e.g., between sampling points and between sampling events). Comparability is achieved by using standardized sampling and analysis methods and data reporting formats (including use of consistent units of measure), and by ensuring that reporting and detection limits are sufficiently low to satisfy project detection and quantitation criteria for the duration of the project. The RLs and detection limits anticipated for this project are presented in Tables 1-3, 1-4, 6-2, 6-3, 6-4, 6-5 and 6-6.

11.5.2 Measures to Ensure Comparability of Field Data

Comparability depends on the proper design of the sampling program and will be satisfied by ensuring that Section 3.0 of this QAPP is followed and that proper sampling techniques are used. The rationale behind the SAP design is found in Section 3.0.

11.5.3 Measures to Ensure Comparability of Laboratory Data

Planned analytical data will be comparable when similar sampling and analytical methods are used and documented for each sampling round. The use of sediment sampling and analysis methods in this investigation should limit the need to consider biases when making sediment data set comparisons for metals. Results will be reported in units that ensure comparability with previous data. The units used for the laboratory measurements are further explained in Section 8.1.2 of this QAPP.

11.6 LEVEL OF QUALITY CONTROL EFFORT

Several QC samples will be analyzed for this project to provide a means to assess field and laboratory performance. Field QC samples consist of field duplicates, equipment rinsate blanks, field blanks, temperature blanks and trip blanks (VOC analyses only). These QC checks are described in Section 7.1. Each type of field QC sample undergoes the same preservation, analysis, and reporting procedures as the related environmental samples. Frequencies of field QC sample collection and analysis are presented in Table 3-1. The types and numbers of QC samples to be collected in the field are presented in Tables 3-2, 3-3, 3-4 and 3-5.

Laboratory QC encompasses a host of other checks performed during sample preparation and analysis, as described in Section 7.2. Frequencies for laboratory QC checks are provided in Table 3-1.

Compliance with quantitative QC objectives for laboratory accuracy and precision as outlined in Tables 11-1 through 11-12 will be evaluated during data validation (Section 8.0). Compliance with completeness objectives for field and laboratory data will be computed. Sections 11.7 and 11.8 present equations to be used for computing accuracy and precision values, respectively. Section 11.9 describes the means and presents the equation for determining completeness. Section 11.10 addresses the overall data assessment process.

In general, data validation requires that data be evaluated batch by batch based on the results of quality indicators for the respective batches. Section 11.10 presents additional data quality considerations to be evaluated after data validation. These considerations are designed to incorporate data quality factors that extend beyond evaluation of the simple quantitative estimators for precision, accuracy, and completeness.

11.7 ACCURACY ASSESSMENT

Sample collection accuracy cannot be evaluated because there is no standard by which to judge such accuracy. Instead of a quantitative evaluation of sample collection accuracy, compliance with field SOPs will be the metric. Background comparisons of data generated by similar sampling and analysis methods incorporate similar biases and are expected to be directly comparable without any adjustments or compensations.

The accuracy of chemical analyses will be assessed through the use of surrogate spikes, MSs, PDSs, LCSs, calibration check standards, internal standards, and blanks. Blanks will be used to infer the potential for positive biases because of contamination. To assure the accuracy of the analytical procedures, at least 1 of every 20 environmental samples will be spiked with known amounts of target analytes (i.e., MSs) prior to preparation for analysis. The spiked samples will be analyzed and the concentrations of each target analyte observed in the spiked sample will be compared to the reported value of the analyte in the unspiked sample to determine the %R of the analyte. Control charts are plotted by the laboratory for each target analyte and are kept on matrix- and analyte-specific bases. The %R for a spiked sample is calculated by using the following formula:

$$\%R = \frac{\text{Amount in Spiked Sample} - \text{Amount in Sample}}{\text{Known Amount Added}} \times 100\%$$

As discussed in Section 11.2.3, LCSs and surrogate spikes are also analyzed to assess accuracy. The %R calculation for LCSs and surrogate spikes is as follows:

$$\%R = \frac{\text{Experimental Concentration}}{\text{Certified or Known Concentration}} \text{ X } 100\,\%$$

11.8 PRECISION ASSESSMENT

As presented in Section 11.1.3, laboratory duplicate samples (for inorganic analyses) and MSD samples (for organic analyses) will be prepared and analyzed at a minimum frequency of 1 per every 20 environmental samples per matrix. As described in Section 11.1.2, field duplicate samples also will be collected and analyzed at a minimum frequency of 1 per 10 environmental samples per matrix. The RPD between a sample or MS (Sample 1) and its duplicate or MSD (Sample 2) is calculated for chemical analyses using to the following formula:

$$RPD = \frac{|\text{Amount in Sample 1} - \text{Amount in Sample 2}|}{0.5\,(\text{Amount in Sample 1} + \text{Amount in Sample 2})} \text{ X } 100\,\%$$

11.9 COMPLETENESS ASSESSMENT

Completeness for this project will be determined based on the number of sample results for each target analyte and each sample type that are usable as determined through data validation and data assessment. Data values rejected during data validation (indicated by an "R" or "UR" flag) will be considered unusable unless additional review and documentation by one or more technical team members demonstrates that the rejection was erroneous. To monitor completeness, the number of usable, valid results for each matrix type and analyte will be counted and compared to the completeness objectives in Sections 11.3.2 and 11.3.3.

Percent completeness will be calculated using the following equation:

$$\%\,\text{Completeness} = \frac{(\text{number of valid measurements})}{(\text{number of measurements planned})} \text{ x } 100\%$$

Because the many parameters to be measured for this project are interrelated in many different ways, a single overall completeness criterion cannot be established for the project. Instead, the ability to attain project objectives will be evaluated at the end of each sampling round by how effectively the necessary decisions and data evaluations can be made.

11.10 DATA ASSESSMENT

The assessment of data obtained from this investigation is a critical part of determining the next step in data collection and decision making. It must be determined whether the data are of appropriate type, quality, quantity, and representativeness to support the project objectives. The effect of the loss of data deemed unacceptable for use, for whatever reason, will be evaluated.

11.10.1 Reconciliation with Data Quality Objectives

Field data will be examined immediately after generation for errors. Laboratory data will be examined upon receipt from the laboratory in a series of evaluations. The first step will be a data verification and validation as described in Section 8.0.

After data validation, the data will be reconciled with DQOs to determine whether sufficient data of acceptable quality are available for decision-making. In addition to the evaluations described in Sections 11.7 through 11.9, a series of inspections and statistical analyses will be performed to estimate several of the data set characteristics. The statistical evaluations will include simple summary statistics for target analytes, such as the maximum concentration, minimum concentration, number of samples exhibiting no detectable analyte, the number of samples exhibiting detectable analytes, and the proportion of samples with detectable and undetectable analytes. Where appropriate, the data will be presented in a tabular format. These inspections and statistical analyses will be designed to:

- Identify deviations, if any, from the field sampling SOPs (inspection).
- Identify deviations, if any, from the laboratory analytical SOPs (inspection).
- Identify deviations, if any, from the QAPP (inspection).
- Identify deviations, if any, from the data validation process (inspection).
- Identify and explain the impacts of elevated MDLs and IDLs (inspection).
- Identify unusable data (i.e., data qualified as "R") (inspection).
- Evaluate project assumptions (inspection).
- Characterize data set distributions (e.g., Shapiro-Wilk W test) if enough data are available (statistics).

- Identify unanticipated data set characteristics such as a laboratory variance greater than the sampling variance (i.e., ANOVA, *t*-test) if enough data are available (statistics).

- Identify and evaluate potential data outliers (95% confidence goodness-of-fit test on probability plot data). The plotted data will be transformed, if necessary, depending on the observed distribution (statistics).

- Evaluate adherence to investigation objectives and decision rules (inspection and statistics, as applicable).

- Ensure completion of corrective actions (inspection).

- Evaluate effects of deviations from planned procedures and processes on the interpretation and utility of the data (inspection and statistics, as applicable).

- Identify the existence of remaining data gaps (inspection/statistics).

For statistical comparisons and mathematical manipulations, analytes that are not detected at the applicable sample-specific MDL will be represented by a concentration equal to one-half the sample-specific MDL.

Duplicate results will not be averaged to represent analyte concentrations at sampling locations. Instead, the "original" sample of the duplicate pair will represent the analyte concentrations. The "duplicate" sample will be used for QC purposes only.

Statistical tests for outlier validity will be based on "Procedural Guidance for Statistically Analyzing Environmental Background Data" (NFEC, 1998). Potential outliers will be removed if a review of field and laboratory documents indicates that the results are true outliers. If no identifiable reason for the outlier can be identified, the datum will not be removed from the data set.

If necessary, investigation objectives may be revised in anticipation of additional data collection.

The suitability of any given statistical test will be assessed based on the completeness of the data sets and the conditions observed at the site. For example, when a single data value is available for sediment or water samples at a given sampling location, statistical tests cannot be conducted for that individual sampling location. However, pooling of data across sampling locations may be possible and, if logical to do so, may be implemented at the discretion of the PM. For example, when evaluating COPCs, multiple

sediment sample results of a given depth may be pooled for statistical comparison to the background data set from sediment of the same depth and grain size. Statistical testing will generally be conducted at the 5% significance level. Statistical testing at other significance levels may also be warranted to provide perspective on the results of testing a 5% significance. If other significance levels are used, they will be supported with rationales for their use.

TABLE 11-1

QUALITY CONTROL LIMITS
MATRIX SPIKE AND MATRIX SPIKE DUPLICATE SAMPLES
VOLATILE ORGANIC COMPOUND ANALYSES
IHDIV-NSWC INDIAN HEAD, MARYLAND

Chemical	Sediment Matrix[1]		Aqueous Matrix[2]	
	Accuracy (%R)	Precision (RPD)	Accuracy (%R)	Precision (RPD)
TCL VOLATILE ORGANIC COMPOUNDS BY CLP SOWs OLM04.2 AND OLC02.1				
1,1,1-Trichloroethane	NA	NA	NA	NA
1,1,2,2-Tetrachloroethane	NA	NA	NA	NA
1,1,2-Trichloro-1,2,2-Trifluoroethane	NA	NA	NA	NA
1,1,2-Trichloroethane	NA	NA	NA	NA
1,1-Dichloroethane	NA	NA	NA	NA
1,1-Dichloroethene	NA	NA	61-145	22
1,2,4-Trichlorobenzene	NA	NA	NA	NA
1,2-Dibromo-3-Chloropropane	NA	NA	NA	NA
1,2-Dibromoethane	NA	NA	NA	NA
1,2-Dichlorobenzene	NA	NA	NA	NA
1,2-Dichloroethane	NA	NA	NA	NA
1,2-Dichloropropane	NA	NA	NA	NA
1,3-Dichlorobenzene	NA	NA	NA	NA
1,4-Dichlorobenzene	NA	NA	NA	NA
2-Butanone	NA	NA	NA	NA
2-Hexanone	NA	NA	NA	NA
4-Methyl-2-Pentanone	NA	NA	NA	NA
Acetone	NA	NA	NA	NA
Benzene	NA	NA	66-142	21
Bromochloromethane	NA	NA	NA	NA
Bromodichloromethane	NA	NA	NA	NA
Bromoform	NA	NA	NA	NA
Bromomethane	NA	NA	NA	NA
Carbon Disulfide	NA	NA	NA	NA
Carbon Tetrachloride	NA	NA	NA	NA
Chlorobenzene	NA	NA	60-133	21
Chloroethane	NA	NA	NA	NA
Chloroform	NA	NA	NA	NA
Chloromethane	NA	NA	NA	NA
Cis-1,2-Dichloroethene	NA	NA	NA	NA
Cis-1,3-Dichloropropene	NA	NA	NA	NA
Cyclohexane	NA	NA	NA	NA

TABLE 11-1

QUALITY CONTROL LIMITS
MATRIX SPIKE AND MATRIX SPIKE DUPLICATE SAMPLES
VOLATILE ORGANIC COMPOUND ANALYSES
IHDIV-NSWC INDIAN HEAD, MARYLAND

Chemical	Sediment Matrix(1)		Aqueous Matrix(2)	
	Accuracy (%R)	Precision (RPD)	Accuracy (%R)	Precision (RPD)
Dibromochloromethane	NA	NA	NA	NA
Dibromodichloromethane	NA	NA	NA	NA
Dichlorodifluoromethane	NA	NA	NA	NA
Diethyl Ether	NA	NA	NA	NA
Ethylbenzene	NA	NA	NA	NA
Isopropylbenzene	NA	NA	NA	NA
Methyl Acetate	NA	NA	NA	NA
Methyl Cyclohexane	NA	NA	NA	NA
Methyl Tert-Butyl Ether	NA	NA	NA	NA
Methylene Chloride	NA	NA	NA	NA
Styrene	NA	NA	NA	NA
Tetrachloroethene	NA	NA	NA	NA
Toluene	NA	NA	59-139	21
Total Xylenes	NA	NA	NA	NA
Trans-1,2-Dichloroethene	NA	NA	NA	NA
Trans-1,3-Dichloropropene	NA	NA	NA	NA
Trichloroethene	NA	NA	62-137	24
Trichlorofluoromethane	NA	NA	NA	NA
Vinyl Chloride	NA	NA	NA	NA

1 Solid samples by CLP SOW OLM04.2
2 Aqueous samples by CLP SOW OLC02.1
%R = Percent recovery
RPD = Relative percent difference
NA = Not applicable (Not specified in the applicable analytical method)

TABLE 11-2

QUALITY CONTROL LIMITS
LABORATORY CONTROL SAMPLES
VOLATILE ORGANIC COMPOUND ANALYSES
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Chemical	Solid Matrix	Aqueous Matrix
	Accuracy (%R)	Accuracy (%R)
TCL VOLATILE ORGANIC COMPOUNDS BY CLP SOW OLM04.2 & OLC02.1		
1,1,1-Trichloroethane	NA	NA
1,1,2,2-Tetrachloroethane	NA	NA
1,1,2-Trichloro-1,2,2-Trifluoroethane	NA	NA
1,1,2-Trichloroethane	NA	NA
1,1-Dichloroethane	NA	NA
1,1-Dichloroethene	NA	NA
1,2,4-Trichlorobenzene	NA	NA
1,2-Dibromo-3-Chloropropane	NA	NA
1,2-Dibromoethane	NA	NA
1,2-Dichlorobenzene	NA	NA
1,2-Dichloroethane	NA	NA
1,2-Dichloropropane	NA	NA
1,3-Dichlorobenzene	NA	NA
1,4-Dichlorobenzene	NA	NA
2-Butanone	NA	NA
2-Hexanone	NA	NA
4-Methyl-2-Pentanone	NA	NA
Acetone	NA	NA
Benzene	NA	NA
Bromochloromethane	NA	NA
Bromodichloromethane	NA	NA
Bromoform	NA	NA
Bromomethane	NA	NA
Carbon Disulfide	NA	NA
Carbon Tetrachloride	NA	NA
Chlorobenzene	NA	NA
Chloroethane	NA	NA
Chloroform	NA	NA
Chloromethane	NA	NA
Cis-1,2-Dichloroethene	NA	NA
Cis-1,3-Dichloropropene	NA	NA
Cyclohexane	NA	NA
Dibromochloromethane	NA	NA

TABLE 11-2

QUALITY CONTROL LIMITS
LABORATORY CONTROL SAMPLES
VOLATILE ORGANIC COMPOUND ANALYSES
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Chemical	Solid Matrix	Aqueous Matrix
	Accuracy (%R)	Accuracy (%R)
Dibromodichloromethane	NA	NA
Dichlorodifluoromethane	NA	NA
Diethyl Ether	NA	NA
Ethylbenzene	NA	NA
Isopropylbenzene	NA	NA
Methyl Acetate	NA	NA
Methyl Cyclohexane	NA	NA
Methyl Tert-Butyl Ether	NA	NA
Methylene Chloride	NA	NA
Styrene	NA	NA
Tetrachloroethene	NA	NA
Toluene	NA	NA
Total Xylenes	NA	NA
Trans-1,2-Dichloroethene	NA	NA
Trans-1,3-Dichloropropene	NA	NA
Trichloroethene	NA	NA
Trichlorofluoromethane	NA	NA
Vinyl Chloride	NA	NA

NA = Not applicable (Not specified in the applicable analytical method)
%R = Percent recovery

TABLE 11-3

QUALITY CONTROL LIMITS
MATRIX SPIKE/MATRIX SPIKE DUPLICATE SAMPLES AND SURROGATE SPIKES
SEMIVOLATILE ORGANIC COMPOUND ANALYSES
IHDIV-NSWC INDIAN HEAD, MARYLAND

Chemical	Solid Matrix		Aqueous Matrix	
	Accuracy (%R)	Precision (RPD)	Accuracy (%R)	Precision (RPD)
TCL SEMIVOLATILE ORGANIC COMPOUNDS BY CLP SOW OLM04.2 & OLC02.1				
1,1-Biphenyl	NA	NA	NA	NA
1,2-Dichlorobenzene-d4[(1)]	20-130	NA	NA	NA
2,2'-Oxybis(1-Chloropropane)	NA	NA	NA	NA
2,4,6-Tribromophenol[(1)]	19-122	NA	15-130	NA
2,4,5-Trichlorophenol	NA	NA	NA	NA
2,4,6-Trichlorophenol	NA	NA	NA	NA
2,4-Dichlorophenol	NA	NA	NA	NA
2,4-Dimethylphenol	NA	NA	NA	NA
2,4-Dinitrophenol	NA	NA	NA	NA
2,4-Dinitrotoluene	28-89	47	NA	NA
2,6-Dinitrotoluene	NA	NA	NA	NA
2-Chloronaphthalene	NA	NA	NA	NA
2-Chlorophenol	25-102	50	NA	NA
2-Chlorophenol-d4[(1)]	20-130[(2)]	NA	NA	NA
2-Fluorobiphenyl[(1)]	30-115	NA	30-115	NA
2-Fluorophenol[(1)]	25-121	NA	15-121	NA
2-Methylnaphthalene	NA	NA	NA	NA
2-Methylphenol	NA	NA	NA	NA
2-Nitroaniline	NA	NA	NA	NA
2-Nitrophenol	NA	NA	NA	NA
3,3'-Dichlorobenzidine	NA	NA	NA	NA
3-Nitroaniline	NA	NA	NA	NA
4,6-Dinitro-2-Methylphenol	NA	NA	NA	NA
4-Bromophenyl Phenyl Ether	NA	NA	NA	NA
4-Chloro-3-Methylphenol	26-103	33	NA	NA
4-Chloroaniline	NA	NA	NA	NA
4-Chlorophenyl Phenyl Ether	NA	NA	NA	NA
4-Methylphenol	NA	NA	NA	NA
4-Nitroaniline	NA	NA	NA	NA
4-Nitrophenol	11-114	50	NA	NA
Acenaphthene	31-137	19	NA	NA
Acenaphthylene	NA	NA	NA	NA
Acetophenone	NA	NA	NA	NA

TABLE 11-3

QUALITY CONTROL LIMITS
MATRIX SPIKE/MATRIX SPIKE DUPLICATE SAMPLES AND SURROGATE SPIKES
SEMIVOLATILE ORGANIC COMPOUND ANALYSES
IHDIV-NSWC INDIAN HEAD, MARYLAND

Chemical	Solid Matrix		Aqueous Matrix	
	Accuracy (%R)	Precision (RPD)	Accuracy (%R)	Precision (RPD)
Anthracene	NA	NA	NA	NA
Atrazine	NA	NA	NA	NA
Benzaldehyde	NA	NA	NA	NA
Benzo(A)Anthracene	NA	NA	NA	NA
Benzo(A)Pyrene	NA	NA	NA	NA
Benzo(B)Fluoranthene	NA	NA	NA	NA
Benzo(G,H,I)Perylene	NA	NA	NA	NA
Benzo(K)Fluoranthene	NA	NA	NA	NA
Bis(2-Chloroethoxy)Methane	NA	NA	NA	NA
Bis(2-Chloroethyl)Ether	NA	NA	NA	NA
Bis(2-Ethylhexyl)Phthalate	NA	NA	NA	NA
Butyl Benzyl Phthalate	NA	NA	NA	NA
Caprolactam	NA	NA	NA	NA
Carbazole	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA
Dibenzo(A,H)Anthracene	NA	NA	NA	NA
Dibenzofuran	NA	NA	NA	NA
Diethyl Phthalate	NA	NA	NA	NA
Dimethyl Phthalate	NA	NA	NA	NA
Di-N-Butyl Phthalate	NA	NA	NA	NA
Di-N-Octyl Phthalate	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA
Fluorene	NA	NA	NA	NA
Hexachlorobenzene	NA	NA	NA	NA
Hexachlorobutadiene	NA	NA	NA	NA
Hexachlorocyclopentadiene	NA	NA	NA	NA
Hexachloroethane	NA	NA	NA	NA
Indeno(1,2,3-Cd)Pyrene	NA	NA	NA	NA
Isophorone	NA	NA	NA	NA
Naphthalene	NA	NA	NA	NA
Nitrobenzene	NA	NA	NA	NA
Nitrobenzene-d5[1]	23-120	NA	23-120	NA
N-Nitroso-Di-N-Propylamine	41-126	38	NA	NA
N-Nitrosodiphenylamine	NA	NA	NA	NA

TABLE 11-3

QUALITY CONTROL LIMITS
MATRIX SPIKE/MATRIX SPIKE DUPLICATE SAMPLES AND SURROGATE SPIKES
SEMIVOLATILE ORGANIC COMPOUND ANALYSES
IHDIV-NSWC INDIAN HEAD, MARYLAND

Chemical	Solid Matrix		Aqueous Matrix	
	Accuracy (%R)	Precision (RPD)	Accuracy (%R)	Precision (RPD)
Pentachlorophenol	17-109	47	NA	NA
Phenanthrene	NA	NA	NA	NA
Phenol	26-90	35	NA	NA
Phenol-d5[1]	24-113	35	15-115	NA
Pyrene	35-142	36	NA	NA
Terphenyl-d14[1]	18-137	NA	18-140	NA

1 Surrogate Compound
2 Advisory limits from CLP SOW OLM04.2
NA = Not applicable (Not specified in the applicable analytical method)
%R = Percent recovery
RPD = Relative percent difference

TABLE 11-4

QUALITY CONTROL LIMITS
LABORATORY CONTROL SAMPLES
SEMIVOLATILE ORGANIC COMPOUND ANALYSES
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Chemical	Solid Matrix Accuracy (%R)	Aqueous Matrix Accuracy (%R)
TCL SEMIVOLATILE ORGANIC COMPOUNDS BY CLP SOW OLM04.2 & OLC02.1		
1,1-Biphenyl	NA	NA
2,2'-Oxybis(1-Chloropropane)	NA	NA
2,4,5-Trichlorophenol	NA	NA
2,4,6-Trichlorophenol	NA	40-120
2,4-Dichlorophenol	NA	NA
2,4-Dimethylphenol	NA	NA
2,4-Dinitrophenol	NA	NA
2,4-Dinitrotoluene	NA	30-120
2,6-Dinitrotoluene	NA	NA
2-Chloronaphthalene	NA	NA
2-Chlorophenol	NA	50-110
2-Methylnaphthalene	NA	NA
2-Methylphenol	NA	NA
2-Nitroaniline	NA	NA
2-Nitrophenol	NA	NA
3,3'-Dichlorobenzidine	NA	NA
3-Nitroaniline	NA	NA
4,6-Dinitro-2-Methylphenol	NA	NA
4-Bromophenyl Phenyl Ether	NA	NA
4-Chloro-3-Methylphenol	NA	NA
4-Chloroaniline	NA	10-120
4-Chlorophenyl Phenyl Ether	NA	NA
4-Methylphenol	NA	NA
4-Nitroaniline	NA	NA
4-Nitrophenol	NA	NA
Acenaphthene	NA	NA
Acenaphthylene	NA	NA
Acetophenone	NA	NA
Anthracene	NA	NA
Atrazine	NA	NA
Benzaldehyde	NA	NA
Benzo(A)Anthracene	NA	NA
Benzo(A)Pyrene	NA	50-120
Benzo(B)Fluoranthene	NA	NA

TABLE 11-4

QUALITY CONTROL LIMITS
LABORATORY CONTROL SAMPLES
SEMIVOLATILE ORGANIC COMPOUND ANALYSES
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Chemical	Solid Matrix Accuracy (%R)	Aqueous Matrix Accuracy (%R)
Benzo(G,H,I)Perylene	NA	NA
Benzo(K)Fluoranthene	NA	NA
Bis(2-Chloroethoxy)Methane	NA	NA
Bis(2-Chloroethyl)Ether	NA	50-110
Bis(2-Ethylhexyl)Phthalate	NA	NA
Butyl Benzyl Phthalate	NA	NA
Caprolactam	NA	NA
Carbazole	NA	NA
Chrysene	NA	NA
Dibenzo(A,H)Anthracene	NA	NA
Dibenzofuran	NA	NA
Diethyl Phthalate	NA	50-120
Dimethyl Phthalate	NA	NA
Di-N-Butyl Phthalate	NA	NA
Di-N-Octyl Phthalate	NA	NA
Fluoranthene	NA	NA
Fluorene	NA	NA
Hexachlorobenzene	NA	40-120
Hexachlorobutadiene	NA	NA
Hexachlorocyclopentadiene	NA	NA
Hexachloroethane	NA	20-110
Indeno(1,2,3-Cd)Pyrene	NA	NA
Isophorone	NA	50-110
Naphthalene	NA	30-110
Nitrobenzene	NA	NA
N-Nitroso-Di-N-Propylamine	NA	30-110
N-Nitrosodiphenylamine	NA	30-110
Pentachlorophenol	NA	NA
Phenanthrene	NA	NA
Phenol	NA	40-120
Pyrene	NA	NA

NA = Not applicable (Not specified in the applicable analytical method)
%R = Percent recovery
RPD = Relative percent difference

TABLE 11-5

QUALITY CONTROL LIMITS
MATRIX SPIKE AND /MATRIX SPIKE DUPLICATE SAMPLES
PESTICIDE/PCB ANALYSES
IHDIV-NSWC IDIAN HEAD, MARYLAND

Chemical	Solid Matrix		Aqueous Matrix	
	Accuracy (%R)	Precision (RPD)	Accuracy (%R)	Precision (RPD)
TCL PESTICIDE/PCB COMPOUNDS BY CLP SOWs OLM04.2 AND OLC02.1				
4,4'-DDD	NA	NA	NA	NA
4,4'-DDE	NA	NA	NA	NA
4,4'-DDT	23-134	50	NA	NA
Aldrin	34-123	43	NA	NA
Alpha-BHC	NA	NA	NA	NA
Alpha-Chlordane	NA	NA	NA	NA
Aroclor-1016	NA	NA	NA	NA
Aroclor-1221	NA	NA	NA	NA
Aroclor-1232	NA	NA	NA	NA
Aroclor-1242	NA	NA	NA	NA
Aroclor-1248	NA	NA	NA	NA
Aroclor-1254	NA	NA	NA	NA
Aroclor-1260	NA	NA	NA	NA
Beta-BHC	NA	NA	NA	NA
Delta-BHC	NA	NA	NA	NA
Dieldrin	31-134	38	NA	NA
Endosulfan I	NA	NA	NA	NA
Endosulfan II	NA	NA	NA	NA
Endosulfan Sulfate	NA	NA	NA	NA
Endrin	42-139	45	NA	NA
Endrin Aldehyde	NA	NA	NA	NA
Endrin Ketone	NA	NA	NA	NA
Gamma-BHC (Lindane)	46-127	50	NA	NA
Gamma-Chlordane	NA	NA	NA	NA
Heptachlor	35-130	31	NA	NA
Heptachlor Epoxide	NA	NA	NA	NA
Methoxychlor	NA	NA	NA	NA
Toxaphene	NA	NA	NA	NA

NA = Not applicable (Not specified in the applicable analytical method)
%R = Percent recovery
RPD = Relative percent difference

TABLE 11-6

QUALITY CONTROL LIMITS
LABORATORY CONTROL SAMPLES
PESTICIDE/PCB COMPOUND ANALYSES
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Chemical	Solid Matrix Accuracy (%R)	Aqueous Matrix Accuracy (%R)
TCL PESTICIDE/PCB COMPOUNDS BY CLP SOW OLM04.2 & OLC02.1		
4,4'-DDD	NA	NA
4,4'-DDE	NA	50-150
4,4'-DDT	NA	NA
Aldrin	NA	NA
Alpha-BHC	NA	NA
Alpha-Chlordane	NA	NA
Aroclor-1016	NA	NA
Aroclor-1221	NA	NA
Aroclor-1232	NA	NA
Aroclor-1242	NA	NA
Aroclor-1248	NA	NA
Aroclor-1254	NA	NA
Aroclor-1260	NA	NA
Beta-BHC	NA	NA
Delta-BHC	NA	NA
Dieldrin	NA	30-130
Endosulfan I	NA	NA
Endosulfan II	NA	NA
Endosulfan Sulfate	NA	50-120
Endrin	NA	50-120
Endrin Aldehyde	NA	NA
Endrin Ketone	NA	NA
Gamma-BHC (Lindane)	NA	50-120
Gamma-Chlordane	NA	30-130
Heptachlor	NA	NA
Heptachlor Epoxide	NA	50-150
Methoxychlor	NA	NA
Toxaphene	NA	NA

NA = Not applicable (Not specified in the applicable analytical method)
%R = Percent recovery
RPD = Relative percent difference

TABLE 11-7

QUALITY CONTROL LIMITS
MATRIX SPIKE AND DUPLICATE SAMPLES
METALS ANALYSES
IHDIV-NSWC IDIAN HEAD, MARYLAND

Analyte	Solid Matrix		Aqueous Matrix	
	Accuracy (%R)	Precision (RPD)	Accuracy (%R)	Precision (RPD)
TAL METALS AND CYANIDE BY CLP SOW ILM04.1				
Aluminum	NA	20	75-125	20
Antimony	75-125	20	75-125	20
Arsenic	75-125	20	75-125	20
Barium	75-125	20	75-125	20
Beryllium	75-125	20	75-125	20
Cadmium	75-125	20	75-125	20
Calcium	NA	20	NA	20
Chromium	75-125	20	75-125	20
Cobalt	75-125	20	75-125	20
Copper	75-125	20	75-125	20
Cyanide	75-125	20	75-125	20
Iron	NA	20	75-125	20
Lead	75-125	20	75-125	20
Magnesium	NA	20	NA	20
Manganese	75-125	20	75-125	20
Mercury	75-125	20	75-125	20
Nickel	75-125	20	75-125	20
Potassium	NA	20	NA	20
Selenium	75-125	20	75-125	20
Silver	75-125	20	75-125	20
Sodium	NA	20	NA	20
Thallium	75-125	20	75-125	20
Vanadium	75-125	20	75-125	20
Zinc	75-125	20	75-125	20

NA = Not applicable (Not specified in the applicable analytical method)
%R = Percent recovery
RPD = Relative percent difference

TABLE 11-8

QUALITY CONTROL LIMITS
LABORATORY CONTROL SAMPLES
MISCELLANEOUS PARAMETERS
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Analyte	Solid Matrix Accuracy (%R)	Aqueous Matrix Accuracy (%R)
Acid Volatile Sulfide/Simultaneously Extracted Metals (AVS/SEM) (EPA Draft Method)	NA	NR
Chloride (EPA 300.3)	NR	NA
Fluoride (EPA 300.0)	NR	NA
Grain Size (ASTM 422)	NA	NR
Hardness (EPA 130.2)	NR	NA
Nitrate (EPA 300.0)	NR	NA
Nitrite (EPA 300.0)	NR	NA
Perchlorate (EPA 314.0)	NR	NA
Sulfate (EPA 300.0)	NR	NA
Total Dissolved Solids (TDS) (EPA 160.2)	NR	NA
Total Organic Carbon (TOC) (EPA 415.1)	NA	NA
Total Suspended Solids (TSS) (EPA 160.1)	NR	NA

NA = Not applicable (Not specified in the applicable analytical method)
NR = Analysis not Required
%R = Percent recovery

TABLE 11-9

QUALITY CONTROL LIMITS
MATRIX SPIKE, MATRIX SPIKE DUPLICATE AND SAMPLE DUPLICATES
MISCELLANEOUS PARAMETERS
IHDIV-NSWC IDIAN HEAD, MARYLAND

Analyte	Solid Matrix		Aqueous Matrix	
	Accuracy (%R)	Precision (RPD)	Accuracy (%R)	Precision (RPD)
Acid Volatile Sulfide/Simultaneously Extracted Metals (AVS/SEM) (EPA Draft Method)	NA	NA	NR	NR
Chloride (EPA 300.3)	NR	NR	NA	NA
Fluoride (EPA 300.0)	NR	NR	NA	NA
Grain Size (ASTM 422)	NA	NA	NR	NR
Hardness (EPA 130.2)	NR	NR	NA	NA
Nitrate (EPA 300.0)	NR	NR	NA	NA
Nitrite (EPA 300.0)	NR	NR	NA	NA
Perchlorate (EPA 314.0)	NR	NR	NA	NA
Sulfate (EPA 300.0)	NR	NR	NA	NA
Total Dissolved Solids (TDS) (EPA 160.2)	NR	NR	NA	NA
Total Organic Carbon (TOC) (EPA 415.1)	NA	NA	NA	NA
Total Suspended Solids (TSS) (EPA 160.1)	NR	NR	NA	NA

NA = Not applicable (Not specified in the applicable analytical method)
NR = Analyte not required
%R = Percent recovery
RPD = Relative percent difference

TABLE 11-10

QUALITY CONTROL LIMITS
LABORATORY CONTROL SAMPLES
METALS
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Analyte	Solid Matrix Accuracy (%R)	Aqueous Matrix Accuracy (%R)
Aluminum	NA	80-120
Antimony	NA	NA
Arsenic	NA	80-120
Barium	NA	80-120
Beryllium	NA	80-120
Cadmium	NA	80-120
Calcium	NA	80-120
Chromium	NA	80-120
Cobalt	NA	80-120
Copper	NA	80-120
Cyanide	NA	80-120
Iron	NA	80-120
Lead	NA	80-120
Magnesium	NA	80-120
Manganese	NA	80-120
Mercury	NA	80-120
Nickel	NA	80-120
Potassium	NA	80-120
Selenium	NA	80-120
Silver	NA	NA
Sodium	NA	80-120
Thallium	NA	80-120
Vanadium	NA	80-120
Zinc	NA	80-120

NA = Not applicable (Not specified in the applicable analytical method)
%R = Percent recovery

TABLE 11-11

QUALITY CONTROL LIMITS
MATRIX SPIKES AND MATRIX SPIKE DUPLICATES
EXPLOSIVES ANALYSES
IHDIV-NSWC IDIAN HEAD, MARYLAND

Analyte	Solid Matrix		Aqueous Matrix	
	Accuracy (%R)	Precision (RPD)	Accuracy (%R)	Precision (RPD)
EXPLOSIVES BY SW-846 METHOD 8330				
1,3,5-Trinitrobenzene	NA	NA	NA	NA
1,3-Dinitrobenzene	NA	NA	NA	NA
2,4,6-Trinitrotoluene (TNT)	NA	NA	NA	NA
2,4-Dinitrotoluene	NA	NA	NA	NA
2,6-Dinitrotoluene	NA	NA	NA	NA
2-Amino-4,6-Dinitrotoluene	NA	NA	NA	NA
2-Nitrotoluene	NA	NA	NA	NA
3-Nitrotoluene	NA	NA	NA	NA
4-Amino-2,6-Dinitrotoluene	NA	NA	NA	NA
4-Nitrotoluene	NA	NA	NA	NA
Hexahydro-1,3,5-Trinitro-1,3,5-Triazine (RDX)	NA	NA	NA	NA
Methyl-2,4,6-Trinitrophenylnitramine (Tertyl)	NA	NA	NA	NA
Nitrobenzene	NA	NA	NA	NA
Octahydro-1,3,5,7-Tetranitro-1,3,5,7-Tetrazocine (HMX)	NA	NA	NA	NA
EXPLOSIVES BY SW-846 METHOD 8332				
Nitroglycerine	NA	NA	NA	NA
EXPLOSIVES BY THE USATHMA METHOD				
Nitrocellulose	NA	NA	NA	NA
Nitroguanidine	NA	NA	NA	NA

NA = Not applicable (Not specified in the applicable analytical method)
%R = Percent recovery
RPD = Relative percent difference

TABLE 11-12

QUALITY CONTROL LIMITS
LABORATORY CONTROL SAMPLES
EXPLOSIVES ANALYSES
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Chemical	Solid Matrix Accuracy (%R)	Aqueous Matrix Accuracy (%R)
EXPLOSIVES BY SW-846 METHOD 8330		
1,3,5-Trinitrobenzene	NA	NA
1,3-Dinitrobenzene	NA	NA
2,4,6-Trinitrotoluene (TNT)	NA	NA
2,4-Dinitrotoluene	NA	NA
2,6-Dinitrotoluene	NA	NA
2-Amino-4,6-Dinitrotoluene	NA	NA
2-Nitrotoluene	NA	NA
3-Nitrotoluene	NA	NA
4-Amino-2,6-Dinitrotoluene	NA	NA
4-Nitrotoluene	NA	NA
Hexahydro-1,3,5-Trinitro-1,3,5-Triazine (RDX)	NA	NA
Methyl-2,4,6-Trinitrophenylnitramine (Tertyl)	NA	NA
Nitrobenzene	NA	NA
Octahydro-1,3,5,7-Tetranitro-1,3,5,7-Tetrazocine (HMX)	NA	NA
EXPLOSIVES BY SW-846 METHOD 8332		
Nitroglycerine	NA	NA
EXPLOSIVES BY THE USATHMA METHOD		
Nitrocellulose	NA	NA
Nitroguanidine	NA	NA

NA = Not applicable (Not specified in the applicable analytical method)
%R = Percent recovery

12.0 CORRECTIVE ACTION

The TtNUS QA/QC program requires that any and all personnel noting conditions adverse to quality should report these conditions immediately to the PM and QAM. These parties, in turn, are charged with implementing appropriate corrective action in a timely manner. It is ultimately the responsibility of the QAM to document all findings and corrective actions taken and to monitor the effectiveness of the corrective measures performed. A brief summary of corrective actions for some specific field and laboratory QC check samples is presented in Section 3.0, Table 3-1.

12.1 FIELD CORRECTIVE ACTION

Field nonconformances or conditions adverse to quality must be identified and corrected as quickly as possible so that work integrity or product quality is not compromised. The need for corrective action may arise based on deviations from project plans and procedures, adverse field conditions, or other unforeseen circumstances. Corrective action needs may become apparent during the performance of daily work tasks or as a consequence of internal or external field audits.

Corrective action may include resampling and may involve amending previously approved field procedures. Minor modifications to field activities, such as the collection of additional samples, will be initiated at the discretion of the FOL. Major modifications, such as the elimination of a sampling point or other situations that affect compliance with or achievement of DQOs, must be approved and documented via a Field Task Modification Request (FTMR). The FOL is responsible for initiating FTMRs. An FTMR will be prepared for all deviations from the project plan documents, as applicable. Copies of all FTMRs will be maintained with the on-site project planning documents and will be placed in the final evidence file.

12.2 LABORATORY CORRECTIVE ACTION

In general, laboratory corrective actions are warranted whenever an out-of-control event or potential out-of-control event is noted. The specific corrective action taken depends on the specific analysis and the nature of the event. Generally, the following occurrences alert laboratory personnel that corrective action may be necessary:

- QC data are outside established warning or control limits
- Method blank analyses yield concentrations of target analytes above acceptable levels
- Undesirable trends are detected in spike %Rs or in duplicate RPDs
- There is an unexplained change in compound detection capability
- Inquiries concerning data quality are received

- Deficiencies are detected by laboratory QA staff during audits or from PE sample test results

Any corrective action taken above the analyst level that cannot be performed immediately at the instrument will be documented. Corrective actions typically are documented for out-of-control situations in accordance with laboratory procedures.

Laboratory corrective actions must be documented and included as part of the final evidence file. The TtNUS PM will be informed of all major corrective actions that do not bring DQO-related nonconformances into conformance with project DQOs. The TtNUS PM will advise all levels of project management in accordance with Section 13.0 of this QAPP.

12.3 CORRECTIVE ACTION DURING DATA VALIDATION AND DATA ASSESSMENT

The need for corrective action may become apparent during data validation, interpretation, or presentation activities. Rework (i.e., resampling or reanalysis), a change in work procedures, or additional or refresher training are possible corrective actions relevant to data evaluation activities. The PM will be responsible for approving the implementation of a corrective action and ensuring that it is documented appropriately. Analytical data may be qualified during data validation to alert data users of the potential that particular analytical results are potentially deficient relative to expected performance standards. Such validation practices are described in Section 8.2. When conducting data assessment for project decisionmaking, a number of situation-dependent qualifications of data or decisions are possible. The number of possible situations or conditions precludes enumeration of all possible corrective actions; however the approach used to identify and impose such qualifications is described in Section 11.10.

13.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

QA reports to management will be provided in four primary formats during the course of this investigation: data validation reports, reports summarizing accomplishments and QA/QC issues during the field investigation, project-wide progress reports, and laboratory QA reports. The report frequencies, content, preparers, and recipients are summarized in Table 13-1.

Data validation reports will address all major and minor laboratory noncompliances as well as noted sample matrix effects. In the event that major problems occur with the analytical laboratory (e.g., repeated or extreme holding time exceedances or calibration noncompliances, etc.), the Data Validation Manager will notify the PM, QAM, Program Manager, Technical Coordinator, and Laboratory Services Coordinator. Such notifications (if necessary) are typically provided via internal memoranda and are placed in the project file. These reports contain a summary of the noncompliance, a synopsis of the impact on individual projects, and recommendations regarding corrective action and compensation adjustments. Corrective actions for major noncompliances are initiated at the program level.

The FOL will provide the PM with daily verbal field progress reports during the course of the sampling event. These reports will explain accomplishments, deviations from the QAPP, upcoming activities, and a QA summary. The PM provides a monthly progress report to the Navy which addresses the project budget, schedule, accomplishments, planned activities, and QA/QC issues and intended corrective actions.

The analytical laboratory will provide a QA report to TtNUS if QC limits are updated or if other significant plan deviations resulted from unanticipated circumstances. Because MDLs will be included in the analytical data packages for NSWC Indian Head samples, it is not necessary for the laboratories to include updated MDLs in their QA reports unless the updates result in MDLs which exceed RBTLs.

TABLE 13-1

SUMMARY OF REPORTS
IHDIV-NSWC INDIAN HEAD, MARYLAND

Report	Content	Preparer	Frequency of Submittal	Recipient(s)
Data Validation Report	All major and minor laboratory noncompliances as well as noted sample matrix effects.	Data Validation Manager or designee	Per SDG	PM, project file
Major Analysis Problem Identification Report (internal memorandum)	Notification of persistent or major problems with analytical laboratory performance. Summary of the noncompliances, a synopsis of the impact on the project, and recommendations regarding corrective action and compensation adjustments.	Data Validation Manager or designee	When persistent analysis problems are detected	PM, QAM, Program Manager, Technical Coordinator, Laboratory Services Coordinator, project file
Project Monthly Progress Report	Summary of the project budget, schedule, accomplishments, planned activities, and QA/QC issues and intended corrective actions.	PM	Monthly for duration of project	Navy, project file
Field Progress Reports	Accomplishments, deviations from the SAP, upcoming activities, and a QA summary.	FOL	Daily, verbal, during the course of sampling	PM
Laboratory QA Report	Summary of updated QC limits or significant deviations from planned activities/performance.	Analytical laboratory	When QC limits are updated or when other significant plan deviations result from unanticipated circumstances	TtNUS, project file; U.S. EPA Region 3, if changes in MDLs cause them to exceed RBTLs or if QAPP deviations impact DQOs

SDG = Sample Delivery Group
PM = Project Manager
QAM = Quality Assurance Manager
MDL = Method Detection Limit
FOL = Field Operations Leader
SAP = Sampling and Analysis Plan

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APPENDIX A

TABULAR PRESENTATION OF RBSLs

TABULAR PRESENTATION OF RBSL'S FOR SURFACE WATER, SEDIMENT AND FISH TISSUE FOR RBTL SELECTION
IHDIV-NSWC INDIAN HEAD, MARYLAND

PARAMETER	CAS	EPA REGION 3 RBC'S FOR RESIDENTIAL LAND USE (mg/kg)	Footnote	BASIS FOR CRITERIA	ECOLOGICAL SCREENING EFFECTS RANGE LOW VALUES (mg/kg)[1]	Footnote	EPA REGION 3 RBC'S FOR FISH (mg/kg)	Footnote	BASIS FOR CRITERIA	EPA REGION 3 RBC'S FOR TAP WATER (ug/L)	Footnote	BASIS FOR CRITERIA	FEDERAL AWQ CRITERIA FOR PROTECTION OF HUMAN HEALTH-CONSUMPTION OF WATER AND ORGANISMS (ug/L)	Footnote	FEDERAL AWQ CRITERIA FOR PROTECTION OF HUMAN HEALTH-CONSUMPTION OF ORGANISMS (ug/L)	Footnote	FEDERAL AWQ CRITERIA - FRESHWATER-CHRONIC EFFECTS (ug/L)	Footnote	FEDERAL AWQ CRITERIA - SALTWATER-CHRONIC EFFECTS (ug/L)	Footnote	MINIMUM CRITERIA VALUE-SEDIMENT (mg/kg)	Footnote	MINIMUM CRITERIA VALUE-FISH (mg/kg)	Footnote	MINIMUM CRITERIA VALUE-SURFACE WATER (ug/L)	Footnote	MINIMUM CRITERIA VALUE-VEGETATION (mg/kg)	Footnote
EXPLOSIVES (SW-846 METHOD 8330)																												
1,3,5-TRINITROBENZENE	99-35-4	2300		N			41		N	1100		N									2300		NR		1100		NR	
1,3-DINITROBENZENE	99-65-0	7.8		N			0.14		N	3.7		N									7.8		NR		3.7		NR	
2,4,6-TRINITROTOLUENE (TNT)	118-96-7	21		C			0.11		C	2.2		C									21		NR		2.2		NR	
2,4-DINITROTOLUENE	121-14-2	160		N			2.7		N	73		N	0.11		9.1						160		NR		0.11		NR	
2,6-DINITROTOLUENE	606-20-2	78		N			1.4		N	37		N									78		NR		37		NR	
2-AMINO-4,6-DINITROTOLUENE	35572-78-2	4.7		N			0.081		N	2.2		N									4.7		NR		2.2		NR	
2-NITROTOLUENE	88-72-2	780		N			14		N	61		N									780		NR		61		NR	
3-NITROTOLUENE	99-08-1	1600		N			27		N	120		N									1600		NR		120		NR	
4-AMINO-2,6-DINITROTOLUENE	19406-51-0																				NA		NR		NA		NR	
4-NITROTOLUENE	99-99-0	780		N			14		N	61		N									780		NR		61		NR	
HEXAHYDRO-1,3,5-TRINITRO-1,3,5-TRIAZINE (RDX)	121-82-4	5.8		N			0.029		N	0.61		N									5.8		NR		0.61		NR	
METHYL-2,4,6-TRINITROPHENYLNITRAMINE (TERTYL)	479-45-8	780		N			14		N	370		N									780		NR		370		NR	
NITROBENZENE	98-95-3	39		C			0.68		C	3.5		C	17	2	1900						39		NR		3.5		NR	
OCTAHYDRO-1,3,5,7-TETRANITRO-1,3,5,7-TETRAZOCINE (HMX)	2691-41-0	3900		N			68		N	1800		N									3900		NR		68		NR	
EXPLOSIVES (SW-846 METHOD 8332)																												
NITROGLYCERINE	55-63-0	46		C			0.23		C	4.8		C									46		NR		4.8		NR	
EXPLOSIVES (USATHAMA METHOD)																												
NITROCELLULOSE	9004-70-0																				NA		NR		NA		NR	
NITROGUANIDINE	556-88-7																				NA		NR		NA		NR	
TAL INORGANICS (CLP SOW ILM04.1)																												
ALUMINUM	7429-90-5	78000		N			1400		N	37000		N					87				78000		1400		87		NA	
ANTIMONY	7440-36-0	31		N			0.54		N	15		N	14		4300						31		0.54		14		NA	
ARSENIC	7440-38-2	0.43		C	8.2	3	0.0021		C	0.045		C	0.018		0.14		150		36		0.43		0.0021		0.018		NA	
BARIUM	7440-39-3	5500		N			95		N	2600		N	1000								5500		95		1000		NA	
BERYLLIUM	7740-41-7	160		N			2.7		N	73		N									160		2.7		73		NA	
CADMIUM	7440-43-9	78	4	N	1.2		1.4	5	N	18	6	N					2.2	7	9.3	7	1.2		1.4		2.2		NA	
CALCIUM	7440-70-2																				NA		NA		NA		NA	
CHROMIUM	7440-47-3	230	8	N	81	3	4.1	9	N	110	10	N					11	11	50	11	81		4.1		11		NA	
COBALT	7440-48-4	4700		N			81		N	2200		N									4700		81		2200		NA	
COPPER	7440-50-8	3100		N	34		54		N	1500		N	1000	65,66			9	7	3.1		34		54		3.1		NA	
CYANIDE	57-12-5	1600		N			27		N	730		N	700		220000		5.2		1		1600		27		1		NR	
IRON	7439-89-6	23000		N			410		N	11000		N	300				1000				23000		410		300		NA	
LEAD	7439-92-1	400	12		47					15	13						2.5	7	8.1		47		NA		2.5		NA	
MAGNESIUM	7439-95-4																				NA		NA		NA		NA	
MANGANESE	7439-96-5	1600	14	N			27	15	N	730	16	N	50		100						1600		27		50		NA	
MERCURY	7439-97-6	23	17	N	0.15	3	0.41	17	N	11	17	N	0.05		0.051		0.77		0.94		0.15		0.41		0.05		NA	
NICKEL	7440-02-0	1600		N	21		27		N	730		N	610		4600		52	7	8.2		21		27		8.2		NA	
POTASSIUM	7440-09-7																				NA		NA		NA		NA	
SELENIUM	7782-49-2	390		N			6.8		N	180		N	170		11000		5		71		390		6.8		5		NA	
SILVER	7440-22-4	390		N			6.8		N	180		N									390		6.8		180		NA	
SODIUM	7440-23-5																				NA		NA		NA		NA	
THALLIUM	7440-28-0	5.5		N			0.095		N	2.6		N	1.7		6.3						5.5		0.095		1.7		NA	
VANADIUM	7440-62-2	550		N			9.5		N	260		N									550		9.5		260		NA	
ZINC	7440-66-6	23000		N	150		410		N	11000		N	5000	18,19	69000		120	7	81		150		410		81		NA	
MISCELLANEOUS PARAMETERS																												
ACID VOLATILE SULFIDE/SIMULTANEOUSLY EXTRACTED METALS (AVS/SEM) (EPA DRAFT METHOD)																					NA		NR		NR		NR	
CHLORIDE (EPA 300.3)	16887-00-6																230000				NR		NR		230000		NR	
FLUORIDE (EPA 300.0)	16984-48-8																				NR		NR		NA		NR	
GRAIN SIZE (ASTM 422)	NA																				NA		NR		NR		NR	
HARDNESS (EPA 130.2)	NA																				NR		NR		NA		NR	
NITRATE (EPA 300.0)	14797-55-8	130000		N			2200		N	58000		N	10000								130000		NR		10000		NR	
NITRITE (EPA 300.0)	14797-65-0	7800		N			140		N	3700		N									7800		NR		3700		NR	
PERCHLORATE (EPA 314.0)	14797-73-0									18	20	C									NR		NR		18		NR	
SULFATE (EPA 300.0)	14808-79-8																				NR		NR		NA		NR	
TOTAL DISSOLVED SOLIDS (TDS)	NA												250000								NR		NR		250000		NR	
TOTAL ORGANIC CARBON (TOC) (EPA 415.1)	NA																				NA		NR		NA		NR	
TOTAL SUSPENDED SOLIDS (TSS)	NA																				NR		NR		NA		NR	
TCL SEMIVOLATILE ORGANIC COMPOUNDS (CLP SOWs OLM04.2 AND OLC02.1)																												
1,1-BIPHENYL	92-52-4	3900		N			68		N	300		N									3900		68		NR		NR	

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TABULAR PRESENTATION OF RBSL'S FOR SURFACE WATER, SEDIMENT AND FISH TISSUE FOR RBTL SELECTION
IHDIV-NSWC INDIAN HEAD, MARYLAND

PARAMETER	CAS	EPA REGION 3 RBC'S FOR RESIDENTIAL LAND USE (mg/kg)	Footnote	BASIS FOR CRITERIA	ECOLOGICAL SCREENING EFFECTS RANGE LOW VALUES (mg/kg)(1)	Footnote	EPA REGION 3 RBC'S FOR FISH (mg/kg)	Footnote	BASIS FOR CRITERIA	EPA REGION 3 RBC'S FOR TAP WATER (ug/L)	Footnote	BASIS FOR CRITERIA	FEDERAL AWQ CRITERIA FOR PROTECTION OF HUMAN HEALTH-CONSUMPTION OF WATER AND ORGANISMS (ug/L)	Footnote	FEDERAL AWQ CRITERIA FOR PROTECTION OF HUMAN HEALTH-CONSUMPTION OF ORGANISMS (ug/L)	Footnote	FEDERAL AWQ CRITERIA - FRESHWATER-CHRONIC EFFECTS (ug/L)	Footnote	FEDERAL AWQ CRITERIA - SALTWATER-CHRONIC EFFECTS (ug/L)	Footnote	MINIMUM CRITERIA VALUE-SEDIMENT (mg/kg)	Footnote	MINIMUM CRITERIA VALUE-FISH (mg/kg)	Footnote	MINIMUM CRITERIA VALUE-SURFACE WATER (ug/L)	Footnote	MINIMUM CRITERIA VALUE-VEGETATION (mg/kg)	Footnote
2,2'-OXYBIS(1-CHLOROPROPANE)	108-60-1	9.1		C			0.045		C	0.26		C	1400		170000						9.1		0.045		0.26		NR	
2,4,5-TRICHLOROPHENOL	95-95-4	7800		N			140		N	3700		N	1	18,21	9800						7800		140		1		NR	
2,4,6-TRICHLOROPHENOL	88-06-2	58		C			0.29		C	6.1		C	2	18,22	6.5						58		0.29		2		NR	
2,4-DICHLOROPHENOL	120-83-2	230		N			4.1		N	110		N	0.3	18,23	790						230		4.1		0.3		NR	
2,4-DIMETHYLPHENOL	105-67-9	1600		N			27		N	730		N	400	18,24	2300						1600		27		400		NR	
2,4-DINITROPHENOL	51-28-5	160		N			2.7		N	73		N	70		14000						160		2.7		70		NR	
2,4-DINITROTOLUENE	121-14-2	160		N			2.7		N	73		N	0.11		9.1						160		2.7		0.11		NR	
2,6-DINITROTOLUENE	606-20-2	78		N			1.4		N	37		N									78		1.4		37		NR	
2-CHLORONAPHTHALENE	91-58-7	6300		N			110		N	490		N	1700		4300						6300		110		490		NR	
2-CHLOROPHENOL	95-57-8	390		N			6.8		N	30		N	0.1	18,25	400						390		6.8		0.1		NR	
2-METHYLNAPHTHALENE	91-57-6	1600		N			27		N	120		N									1600		27		120		NR	
2-METHYLPHENOL	95-48-7	3900		N			68		N	1800		N									3900		68		1800		NR	
2-NITROANILINE	88-74-4																				NA		NA		NA		NR	
2-NITROPHENOL	88-75-5	630	26	N			11	26	N	290	26	N									630		11		290		NR	
3,3'-DICHLOROBENZIDINE	91-94-1	1.4		C			0.007		C	0.15		C	0.04		0.077						1.4		0.007		0.04		NR	
3-NITROANILINE	99-09-2																				NA		NA		NA		NR	
4,6-DINITRO-2-METHYLPHENOL	534-52-1	7.8		N			0.14		N	3.7		N	13.4		765						7.8		0.14		3.7		NR	
4-BROMOPHENYL PHENYL ETHER	101-55-3																				NA		NA		NA		NR	
4-CHLORO-3-METHYLPHENOL	59-50-7												3000	18							NA		NA		3000		NR	
4-CHLOROANILINE	106-47-8	310		N			5.4		N	150		N									310		5.4		150		NR	
4-CHLOROPHENYL PHENYL ETHER	7005-72-3																				NA		NA		NA		NR	
4-METHYLPHENOL	106-44-5	390		N			6.8		N	180		N									390		6.8		180		NR	
4-NITROANILINE	100-01-6																				NA		NA		NA		NR	
4-NITROPHENOL	100-02-7	630		N			11		N	290		N									630		11		290		NR	
ACENAPHTHENE	83-32-9	4700		N	0.016		81		N	370		N	1200		2700						0.016		81		370		NR	
ACENAPHTHYLENE	208-96-8	4700	27	N			81	27	N	370	27	N	20	18							4700		81		20		NR	
ACETOPHENONE	98-86-2	7800		N			140		N	0.042		N									7800		140		NR		NR	
ANTHRACENE	120-12-7	23000		N			410		N	1800		N	9600		110000						23000		410		1800		NR	
ATRAZINE	1912-24-9	2.9		C			0.014		C	0.3		C									2.9		0.014		NR		NR	
BENZALDEHYDE	100-52-7	7800		N			140		N	3700		N									7800		140		NR		NR	
BENZO(A)ANTHRACENE	56-55-3	0.87		C			0.0043		C	0.092		C	0.0044		0.049						0.87		0.0043		0.0044		NR	
BENZO(A)PYRENE	50-32-8	0.087		C	0.43		0.00043		C	0.0092		C	0.0044		0.049						0.087		0.00043		0.0044		NR	
BENZO(B)FLUORANTHENE	205-99-2	0.87		C			0.0043		C	0.092		C	0.0044		0.049						0.87		0.0043		0.0044		NR	
BENZO(G,H,I)PERYLENE	191-24-2	1600	28	N			27	28	N	6.5	28	N									1600		27		6.5		NR	
BENZO(K)FLUORANTHENE	207-08-9	8.7		C			0.043		C	0.92		C	0.0044		0.049						8.7		0.043		0.0044		NR	
BIS(2-CHLOROETHOXY)METHANE	111-91-1																				NA		NA		NA		NR	
BIS(2-CHLOROETHYL)ETHER	111-44-4	0.58		C			0.0029		C	0.0096		C	0.031		1.4						0.58		0.0029		0.0096		NR	
BIS(2-ETHYLHEXYL)PHTHALATE	117-81-7	46		C			0.23		C	4.8		C	1.8		5.9						46		0.23		1.8		NR	
BUTYL BENZYL PHTHALATE	85-68-7	16000		N			270		N	7300		N	3000		5200						16000		270		3000		NR	
CAPROLACTAM	105-60-2	39000		N			680		N	18000		N									39000		680		NR		NR	
CARBAZOLE	86-74-8	32		C			0.16		C	3.3		C									32		0.16		NR		NR	
CHRYSENE	218-01-9	87		C			0.43		C	9.2		C	0.0044		0.049						87		0.43		0.0044		NR	
DIBENZO(A,H)ANTHRACENE	53-70-3	0.087		C			0.00043		C	0.0092		C	0.0044		0.049						0.087		0.00043		0.0044		NR	
DIBENZOFURAN	132-64-9	310		N			5.4		N	24		N									310		5.4		24		NR	
DIETHYL PHTHALATE	84-66-2	63000		N			1100		N	29000		N	23000		120000						63000		1100		23000		NR	
DIMETHYL PHTHALATE	131-11-3	780000		N			14000		N	370000		N	313000		2900000						780000		14000		313000		NR	
DI-N-BUTYL PHTHALATE	84-74-2	7800		N			140		N	3700		N	2700		12000						7800		140		2700		NR	
DI-N-OCTYL PHTHALATE	117-84-0	1600		N			27		N	730		N									1600		27		730		NR	
FLUORANTHENE	206-44-0	3100		N	0.60		54		N	1500		N	300		370						0.6		54		300		NR	
FLUORENE	86-73-7	3100		N			54		N	240		N	1300		14000						3100		54		240		NR	
HEXACHLOROBENZENE	118-74-1	0.4		C			0.002		C	0.042		C	0.00075		0.00077						0.4		0.002		0.00075		NR	
HEXACHLOROBUTADIENE	87-68-3	8.2		C			0.04		C	0.86		C	0.44		50						8.2		0.04		0.44		NR	
HEXACHLOROCYCLOPENTADIENE	77-47-4	550		N			9.5		N	260		N	1	18,29	17000						550		9.5		1		NR	
HEXACHLOROETHANE	67-72-1	46		C			0.23		C	4.8		C	1.9		8.9						46		0.23		1.9		NR	
INDENO(1,2,3-CD)PYRENE	193-39-5	0.87		C			0.0043		C	0.092		C	0.0044		0.049						0.87		0.0043		0.0044		NR	
ISOPHORONE	78-59-1	670		C			3.3		C	70		C	36		2600						670		3.3		36		NR	
NAPHTHALENE	91-20-3	1600		N	0.16		27		N	6.5		N									0.16		27		6.5		NR	
NITROBENZENE	98-95-3	39		N			0.68		N	3.5		N	17	2	1900						39		0.68		3.5		NR	
N-NITROSO-DI-N-PROPYLAMINE	621-64-7	0.091		C			0.00045		C	0.0096		C	0.005		1.4						0.091		0.00045		0.005		NR	
N-NITROSODIPHENYLAMINE	86-30-6	130		C			0.64		C	14		C	5		16						130		0.64		5		NR	
PENTACHLOROPHENOL	87-86-5	5.3		C			0.026		C	0.56		C	0.28	2	8.2		15		7.9		5.3		0.026		0.28		NR	
PHENANTHRENE	85-01-8	1600	28	N	0.24		27	28	N	6.5	28	N									0.24		27		6.5		NR	
PHENOL	108-95-2	47000		N			810		N	22000		N	300	18,30	4600000						47000		810		300		NR	

TABULAR PRESENTATION OF RBSL'S FOR SURFACE WATER, SEDIMENT AND FISH TISSUE FOR RBTL SELECTION
IHDIV-NSWC INDIAN HEAD, MARYLAND

PARAMETER	CAS	EPA REGION 3 RBC'S FOR RESIDENTIAL LAND USE (mg/kg)	Footnote	BASIS FOR CRITERIA	ECOLOGICAL SCREENING EFFECTS RANGE LOW VALUES (mg/kg)(1)	Footnote	EPA REGION 3 RBC'S FOR FISH (mg/kg)	Footnote	BASIS FOR CRITERIA	EPA REGION 3 RBC'S FOR TAP WATER (ug/L)	Footnote	BASIS FOR CRITERIA	FEDERAL AWQ CRITERIA FOR PROTECTION OF HUMAN HEALTH-CONSUMPTION OF WATER AND ORGANISMS (ug/L)	Footnote	FEDERAL AWQ CRITERIA FOR PROTECTION OF HUMAN HEALTH-CONSUMPTION OF ORGANISMS (ug/L)	Footnote	FEDERAL AWQ CRITERIA - FRESHWATER-CHRONIC EFFECTS (ug/L)	Footnote	FEDERAL AWQ CRITERIA - SALTWATER-CHRONIC EFFECTS (ug/L)	Footnote	MINIMUM CRITERIA VALUE-SEDIMENT (mg/kg)	Footnote	MINIMUM CRITERIA VALUE-FISH (mg/kg)	Footnote	MINIMUM CRITERIA VALUE-SURFACE WATER (ug/L)	Footnote	MINIMUM CRITERIA VALUE-VEGETATION (mg/kg)	Footnote
PYRENE	129-00-0	2300		N	0.66		41		N	180		N	960		11000						0.66		41		180		NR	
TCL VOLATILE ORGANIC COMPOUNDS (CLP SOWs OLM04.2 AND OLC02.1)																												
1,1,1-TRICHLOROETHANE	71-55-6	22000		N			380		N	3200		N									22000		NR		3200		NR	
1,1,2,2-TETRACHLOROETHANE	79-34-5	3.2		C			0.016		C	0.053		C	0.17		11						3.2		NR		0.053		NR	
1,1,2-TRICHLOROETHANE	79-00-5	11		C			0.055		C	0.19		C	0.6		42						11		NR		0.19		NR	
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	76-13-1	2300000		N			41000		N	59000		N									2300000		NR		NR		NR	
1,1-DICHLOROETHANE	75-34-3	7800		N			140		N	800		N									7800		NR		800		NR	
1,1-DICHLOROETHENE	75-35-4	1.1		C			0.0053		C	0.044		C	0.057		3.2						1.1		NR		0.044		NR	
1,2,4-TRICHLOROBENZENE	120-82-1	780		N			14		N	190		N	260		940						780		NR		190		NR	
1,2-DIBROMO-3-CHLOROPROPANE	96-12-8	0.46		C			0.0023		C	0.047		C									0.46		NR		0.047		NR	
1,2-DIBROMOETHANE	106-93-4	0.0075		C			0.000037		C	0.00075		C									0.0075		NR		0.00075		NR	
1,2-DICHLOROBENZENE	95-50-1	7000		N			120		N	550		N	2700		17000						7000		NR		550		NR	
1,2-DICHLOROETHANE	107-06-2	7		C			0.035		C	0.12		C	0.38		99						7		NR		0.12		NR	
1,2-DICHLOROPROPANE	78-87-5	9.4		C			0.046		C	0.16		C	0.52		39						9.4		NR		0.16		NR	
1,3-DICHLOROBENZENE	541-73-1	70		N			1.2		N	5.5		N	400		2600						70		NR		5.5		NR	
1,4-DICHLOROBENZENE	106-46-7	27		C			0.13		C	0.47		C	400		2600						27		NR		0.47		NR	
2-BUTANONE	78-93-3	47000		N			810		N	1900		N									47000		NR		1900		NR	
2-HEXANONE	591-78-6	3100		N			54		N	1500		N									3100		NR		1500		NR	
4-METHYL-2-PENTANONE	108-10-1	6300		N			110		N	140		N									6300		NR		140		NR	
ACETONE	67-64-1	7800		N			140		N	610		N									7800		NR		610		NR	
BENZENE	71-43-2	12		C			0.057		C	0.32		C	1.2		71						12		NR		0.32		NR	
BROMOCHLOROMETHANE	74-97-5																				NR		NR		NA		NR	
BROMODICHLOROMETHANE	75-27-4	10		C			0.051		C	0.17		C	0.56		46						10		NR		0.17		NR	
BROMOFORM	75-25-2	81		C			0.4		C	8.5		C	4.3		360						81		NR		4.3		NR	
BROMOMETHANE	74-83-9	110		N			1.9		N	8.5		N	48		4000						110		NR		8.5		NR	
CARBON DISULFIDE	75-15-0	7800		N			140		N	1000		N									7800		NR		1000		NR	
CARBON TETRACHLORIDE	56-23-5	4.9		C			0.024		C	0.16		C	0.25		4.4						4.9		NR		0.16		NR	
CHLOROBENZENE	108-90-7	1600		N			27		N	110		N	20	18,31	21000						1600		NR		20		NR	
CHLOROETHANE	75-00-3	220		C			1.1		C	3.6		C									220		NR		3.6		NR	
CHLOROFORM	67-66-3	100		C			0.52		C	0.15		C	5.7		470						100		NR		0.15		NR	
CHLOROMETHANE	74-87-3	49		C			0.24		C	2.1		C									49		NR		2.1		NR	
CIS-1,2-DICHLOROETHENE	156-59-2	780		N			14		N	61		N									780		NR		61		NR	
CIS-1,3-DICHLOROPROPENE	10061-01-5	6.4	32	C			0.032	32	C	0.44	32	C	10	32	1700						6.4		NR		0.44		NR	
CYCLOHEXANE	110-82-7																				NA		NR		NR		NR	
DIBROMOCHLOROMETHANE	124-48-1	7.6		C			0.038		C	0.13		C	0.41		34						7.6		NR		0.13		NR	
DIBROMODICHLOROMETHANE	594-18-3																				NA		NR		NA		NR	
DICHLORODIFLUOROMETHANE	75-71-8	16000		N			270		N	350		N									16000		NR		NR		NR	
DIETHYL ETHER	60-29-7	16000		N			270		N	1200		N									16000		NR		1200		NR	
ETHYLBENZENE	100-41-4	7800		N			140		N	1300		N	3100		29000						7800		NR		1300		NR	
ISOPROPYLBENZENE	98-82-8	7800		N			140		N	660		N									7800		NR		NR		NR	
METHYL ACETATE	79-20-9	78000		N			1400		N	6100		N									78000		NR		NR		NR	
METHYL CYCLOHEXANE	108-87-2									6300		N									NA		NR		NR		NR	
METHYL TERT-BUTYL ETHER	1634-04-4									6300		N									NA		NR		NR		NR	
METHYLENE CHLORIDE	75-09-2	85		C			0.42		C	4.1		C	4.7		1600						85		NR		4.1		NR	
STYRENE	100-42-5	16000		N			270		N	1600		N									16000		NR		1600		NR	
TETRACHLOROETHENE	127-18-4	12		C			0.061		C	1.1		C	0.8		8.85						12		NR		0.8		NR	
TOLUENE	108-88-3	16000		N			270		N	750		N	6800		200000						16000		NR		750		NR	
TOTAL XYLENES	1330-20-7	160000		N			2700		N	12000		N									160000		NR		12000		NR	
TRANS-1,2-DICHLOROETHENE	156-60-5	1600		N			27		N	120		N	700		1400000						1600		NR		120		NR	
TRANS-1,3-DICHLOROPROPENE	10061-02-6	6.4	32	C			0.032	32	C	0.44	32	C	10	32	1700						6.4		NR		0.44		NR	
TRICHLOROETHENE	79-01-6	58		C			0.29		C	1.6		C	2.7		81						58		NR		1.6		NR	
TRICHLOROFLUOROMETHANE	75-69-4	23000		N			410		N	1300		N									NR		NR		NR		NR	
VINYL CHLORIDE	75-01-4	0.43	33	C			0.0021		C	0.04	33	C	2		525						0.43		NR		0.04		NR	
TCL PESTICIDES/PCBs (CLP SOWs OLM04.2 AND OLC02.1)																												
4,4'-DDD	72-54-8	2.7		C			0.013		C	0.28		C	0.00083		0.00084						2.7		0.013		0.00083		NA	
4,4'-DDE	72-55-9	1.9		C			0.0093		C	0.2		C	0.00059		0.00059						1.9		0.0093		0.00059		NA	
4,4'-DDT	50-29-3	1.9		C	0.0016		0.0093		C	0.2		C	0.00059		0.00059		0.001		0.001		0.0016		0.0093		0.00059		NA	
ALDRIN	309-00-2	0.038		C			0.00019		C	0.0039		C	0.00013		0.00014						0.038		0.00019		0.00013		NA	
ALPHA-BHC	319-84-6	0.1		C			0.0005		C	0.011		C	0.0039		0.013						0.1		0.0005		0.0039		NA	
ALPHA-CHLORDANE	5103-71-9	1.8	34	C			0.009	34	C	0.19	34	C	0.0021	34	0.0022		0.0043	34	0.004	34	1.8		0.009		0.0021		NA	
AROCLOR-1016	12674-11-2	5.5	35,36	N	0.023	35	0.045	35,37	C	0.96	38	C	0.00017	35	0.00017		0.014	35	0.03	35	0.023		0.045		0.00017		NA	
AROCLOR-1221	11104-28-2	0.32	35	C	0.023	35	0.0016	35	C	0.033	35	C	0.00017	35	0.00017		0.014	35	0.03	35	0.023		0.0016		0.00017		NA	
AROCLOR-1232	11141-16-5	0.32	35	C	0.023	35	0.0016	35	C	0.033	35	C	0.00017	35	0.00017		0.014	35	0.03	35	0.023		0.0016		0.00017		NA	

TABULAR PRESENTATION OF RBSL'S FOR SURFACE WATER, SEDIMENT AND FISH TISSUE FOR RBTL SELECTION
II DIV-NSWC INDIAN HEAD, MARYLAND

PARAMETER	CAS	EPA REGION 3 RBC'S FOR RESIDENTIAL LAND USE (mg/kg)	Footnote	BASIS FOR CRITERIA	ECOLOGICAL SCREENING EFFECTS RANGE LOW VALUES (mg/kg)(1)	Footnote	EPA REGION 3 RBC'S FOR FISH (mg/kg)	Footnote	BASIS FOR CRITERIA	EPA REGION 3 RBC'S FOR TAP WATER (ug/L)	Footnote	BASIS FOR CRITERIA	FEDERAL AWQ CRITERIA FOR PROTECTION OF HUMAN HEALTH-CONSUMPTION OF WATER AND ORGANISMS (ug/L)	Footnote	FEDERAL AWQ CRITERIA FOR PROTECTION OF HUMAN HEALTH-CONSUMPTION OF ORGANISMS (ug/L)	Footnote	FEDERAL AWQ CRITERIA - FRESHWATER-CHRONIC EFFECTS (ug/L)	Footnote	FEDERAL AWQ CRITERIA - SALTWATER-CHRONIC EFFECTS (ug/L)	Footnote	MINIMUM CRITERIA VALUE-SEDIMENT (mg/kg)	Footnote	MINIMUM CRITERIA VALUE-FISH (mg/kg)	Footnote	MINIMUM CRITERIA VALUE-SURFACE WATER (ug/L)	Footnote	MINIMUM CRITERIA VALUE-VEGETATION (mg/kg)	Footnote
AROCLOR-1242	53469-21-9	0.32	35	C	0.023	35	0.0016	35	C	0.033	35	C	0.00017	35	0.00017		0.014	35	0.03	35	0.023		0.0016		0.00017		NA	
AROCLOR-1248	12672-29-6	0.32	35	C	0.023	35	0.0016	35	C	0.033	35	C	0.00017	35	0.00017		0.014	35	0.03	35	0.023		0.0016		0.00017		NA	
AROCLOR-1254	11097-69-1	0.32	35	C	0.023	35	0.0016	35	C	0.033	35	C	0.00017	35	0.00017		0.014	35	0.03	35	0.023		0.0016		0.00017		NA	
AROCLOR-1260	11096-82-5	0.32	35	C	0.023	35	0.0016	35	C	0.033	35	C	0.00017	35	0.00017		0.014	35	0.03	35	0.023		0.0016		0.00017		NA	
BETA-BHC	319-85-7	0.35		C			0.0018		C	0.037		C	0.014		0.046						0.35		0.0018		0.014		NA	
DELTA-BHC	319-86-8	0.1	39	C			0.0005	39	C	0.011	39	C									0.1		0.0005		0.011		NA	
DIELDRIN	60-57-1	0.04		C			0.0002		C	0.0042		C	0.00014		0.00014		0.056		0.0019		0.04		0.0002		0.00014		NA	
ENDOSULFAN I	959-98-8	470	40	N			8.1	40	N	220	40	N	110		240		0.056		0.0087		470		8.1		0.0087		NA	
ENDOSULFAN II	33213-65-9	470	40	N			8.1	40	N	220	40	N	110		240		0.056		0.0087		470		8.1		0.0087		NA	
ENDOSULFAN SULFATE	1031-07-8	470	40	N			8.1	40	N	220	40	N	110		240						470		8.1		110		NA	
ENDRIN	72-20-8	23		N			0.41		N	11		N	0.76		0.81		0.036		0.0023		23		0.41		0.0023		NA	
ENDRIN ALDEHYDE	7421-93-4	23	41	N			0.41	41	N	11	41	N	0.76		0.81						23		0.41		0.76		NA	
ENDRIN KETONE	53494-70-5	23	41	N			0.41	41	N	11	41	N									23		0.41		11		NA	
GAMMA-BHC (LINDANE)	58-89-9	0.49		C			0.0024		C	0.052		C	0.019		0.063						0.49		0.0024		0.019		NA	
GAMMA-CHLORDANE	5103-74-2																				NA		NA		NA		NA	
HEPTACHLOR	76-44-8	0.14		C			0.0007		C	0.015		C	0.00021		0.00021		0.0038		0.0036		0.14		0.0007		0.00021		NA	
HEPTACHLOR EPOXIDE	1024-57-3	0.07		C			0.00035		C	0.0074		C	0.0001		0.00011		0.0038		0.0036		0.07		0.00035		0.0001		NA	
METHOXYCHLOR	72-43-5	390		N			6.8		N	180		N	100				0.03		0.03		390		6.8		0.03		NA	
TOXAPHENE	8001-35-2	0.58		C			0.0029		C	0.061		C	0.00073		0.00075		0.0002		0.0002		0.58		0.0029		0.0002		NA	

NA-Not applicable.
NR-Not required.

1- Long, Edward R., Donald D. MacDonald, Sherri L. Smith, and Fred D. Calder. 1995. Incidence of Adverse Biological effects within Ranges of Chemical Concentrations in Marine and Estuarine Sediments. Environmental Management 19 (1): 81-97.
2- Value for organoleptic effects is 30 ug/L.
3- Value is for total of all chemical forms.
4- The RBC for residential land use calculated using the RfDo for food is presented. The RBC for residential land use calculated using the RfDo for water is 39 mg/kg.
5- The RBC for fish calculated using the RfDo for food is presented. The RBC for fish calculated using the RfDo for water is 0.68 mg/kg.
6- The RBC for tapwater calculated using the RfDo for water is presented. The RBC for tapwater calculated using the RfDo for food is 37 ug/L.
7- Criteria are hardness dependent.
8- The RBC for residential land use for hexavalent chromium is presented. The RBC for residential land use for trivalent chromium is 120,000 mg/kg.
9- The RBC for fish for hexavalent chromium is presented. The RBC for fish for trivalent chromium is 2,000 mg/kg.
10- The RBC for tapwater for hexavalent chromium is presented. The RBC for tapwater for trivalent chromium is 55,000 ug/L.
11- Hexavalent chromium.
12- OSWER soil screening level for residential land use (USEPA, July 1994). Value was developed using the USEPA Integrated Exposure Uptake Biokinetic Model (IEUBK) (USEPA, February 1994).
13- No RBC is available. The Action Level promulgated under the Safe Drinking Water Actis typically usewd for screening purposes.
14- The RBC for residential land use calculated using the RfDo for nonfood is presented. The RBC for residential land use calculated using the RfDo for food is 11,000 mg/kg.
15- The RBC for fish calculated using the RfDo for nonfood is presented. The RBC for fish calculated using the RfDo for food is 190 mg/kg.
16- The RBC for tapwater calculated using the RfDo for nonfood is presented. The RBC for tapwater using the RfDo for food is 5,100 ug/L.
17- Mercuric chloride.
18- Value presented is based on organoleptic effects (i.e. which would make water and edible aquatic life unpalatable but not toxic to humans).
19- AWQC for the protection of human health, water and organisms is 9,100 ug/L.
20- Value presented is from Region 9 PRG table.
21- AWQC for the protection of human health, water and organisms is 2,600 ug/L.
22- AWQC for the protection of human health, water and organisms is 2.1 ug/L.
23- AWQC for the protection of human health, water and organisms is 93 ug/L.
24- AWQC for the protection of human health, water and organisms is 540 ug/L.
25- AWQC for the protection of human health, water and organisms is 120 ug/L.
26- 4-Nitrophenol.
27- Acenaphthene.
28- Naphthalene.
29- AWQC for the protection of human health, water and organisms is 240 ug/L.
30- AWQC for the protection of human health, water and organisms is 21,000 ug/L.
31- AWQC for the protection of human health, water and organisms is 680 ug/L.
32- 1,3-Dichloropropene.
33- Need Region 3 footnote for vinyl chloride
34- The standard/criteria/screening value for chlordane is presented.
35- Total for all PCB congeners (Aroclors) is presented.
36- Criteria is applicable if Aroclor-1016 only is present. If other Aroclors are present, a RBC for residential land use of 0.32 mg/kg applies to the mixture.
37- Criteria is applicable if Aroclor-1016 only is present. If other Aroclors are present, a RBC for fish of 0.0016 mg/kg applies to the mixture.
38- Criteria is applicable if Aroclor-1016 only is present. If other Aroclors are present, a RBC for tapwater of 0.033 ug/L applies to the mixture.
39- Alpha-BHC.
40- Endosulfan.
41- Endrin.

APPENDIX D

FIELD SAMPLING FORMS

Tetra Tech NUS, Inc.

DAILY ACTIVITIES RECORD

PROJECT NAME: _____ **PROJECT NUMBER:** _____

CLIENT: _____ **LOCATION:** _____

DATE: _____ **ARRIVAL TIME:** _____

Tt NUS PERSONNEL: _____ **DEPARTURE TIME:** _____

CONTRACTOR: _____ **DRILLER:** _____

ITEM	QUANTITY ESTIMATE	QUANTITY TODAY	PREVIOUS TOTAL QUANTITY	CUMULATIVE QUANTITY TO DATE

COMMENTS: _____

APPROVED BY:

_____ _____

Tt NUS REPRESENTATIVE DRILLER

DATE: _____

Tetra Tech NUS, Inc.

SOIL & SEDIMENT SAMPLE LOG SHEET

Page___ of ___

Project Site Name: _____
Project No.: _____

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

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

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

GRAB SAMPLE DATA:

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

COMPOSITE SAMPLE DATA:

Date:	Time	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings				
(Range in ppm):				

SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other

OBSERVATIONS / NOTES:

MAP:

Circle if Applicable:

MS/MSD	Duplicate ID No.:

Signature(s):

Tetra Tech NUS, Inc.

SOIL & SEDIMENT SAMPLE LOG SHEET

Page___ of ___

Project Site Name: _____
Project No.: _____

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

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

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

GRAB SAMPLE DATA:

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

COMPOSITE SAMPLE DATA:

Date:	Time	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings				
(Range in ppm):				

SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other

OBSERVATIONS / NOTES:

MAP:

Circle if Applicable:

MS/MSD	Duplicate ID No.:

Signature(s):

Tetra Tech NUS, Inc.

SURFACE WATER SAMPLE LOG SHEET

Page___ of ___

Project Site Name: _____
Project No.: _____

[] Stream
[] Spring
[] Pond
[] Lake
[] Other: _____
[] QA Sample Type: _____

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

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

SAMPLING DATA:

Date: / Time: / Depth: / Method:	Color (Visual)	pH (S.U.)	S.C. (mS/cm)	Temp. (°C)	Turbidity (NTU)	DO (mg/l)	Salinity (%)	Other

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected

OBSERVATIONS / NOTES:

MAP:

Circle if Applicable:

MS/MSD	Duplicate ID No.:

Signature(s):

TETRA TECH NUS
FIELD TASK MODIFICATION REQUEST FORM

Project/Installation Name _____ CTO & Project Number _____ Task Mod. Number _____

Modification To (e.g. Work Plan) _____ Site/Sample Location _____ Date _____

Activity Description: _____

Reason for Change: _____

Recommended Disposition: _____

Field Operations Leader (Signature) _____ Date _____

Approved Disposition:

Project/Task Order Manager (Signature) _____ Date _____

Distribution:

Program/Project File –
Project/Task Order Manager –
Field Operations Leader –

Other: _____

Fish Collection Log
NSWC Indian Head, Virginia

	Water Body		Project Number:	
	Station Number:			
	Species:			
	Samplers:			
Date	Time	Sample Number	Length (cm)	Weight (grams)

Comments:

Fish Composite Summary for Laboratory Analysis
Indian Head Investigation
NSWC Indian Head, Virginia

Water Body					**Project Number:**
Station Number:					
Species:					
Duplicate Analyses?			**If Yes, Which Composite?**		
Samplers:					
Date	**Time**	**Length (cm)**	**Weight (grams)**	**Individual Fish Sample Number**	**Composite Fish Sample Number**

Sample Analyses: *******NEED TO CORRECT*********

Metals: Arsenic, cadmium, chromium, copper, mercury, manganese, nickel, lead, silver, and zinc

Pesticides: Aldrin, alpha-BHC, gamma-BHC, alpha-chlordane, gamma-chlordane, DDD, DDE, DDT (op&pp), dieldrin, endosulfan I and II, endosulfan sulfate, endrin, heptachlor, heptachlor epoxide, hexachlorobenzene, methoxychlor-pp, trans-nonachlor, mirex, technical chlordane and PAHs.

Percent Lipids

Comments: Only use left fillet for composite of "regular samples." Use right fillet for duplicate samples (if any).
Freeze the remaining portion of the fish. Call the Project Manager immediately if there is inadequate sample
volume in left fillets for analysis.

Fish Composite Summary for Laboratory Analysis
Indian Head Investigation
NSWC Indian Head, Virginia

Water Body					**Project Number:**
Station Number:					
Species:					
Duplicate Analyses?			**If Yes, Which Composite?**		
Samplers:					
Date	**Time**	**Length (cm)**	**Weight (grams)**	**Individual Fish Sample Number**	**Composite Fish Sample Number**

Sample Analyses: *******NEED TO CORRECT*******

Metals: Arsenic, cadmium, chromium, copper, mercury, manganese, nickel, lead, silver, and zinc

Pesticides: Aldrin, alpha-BHC, gamma-BHC, alpha-chlordane, gamma-chlordane, DDD, DDE, DDT (op&pp), dieldrin, endosulfan I and II, endosulfan sulfate, endrin, heptachlor, heptachlor epoxide, hexachlorobenzene, methoxychlor-pp, trans-nonachlor, mirex, technical chlordane and PAHs.

Percent Lipids

Comments: Only use left fillet for composite of "regular samples." Use right fillet for duplicate samples (if any).
Freeze the remaining portion of the fish. Call the Project Manager immediately if there is inadequate sample
volume in left fillets for analysis.

Fish Collection Matrix
NSWC Indian Head Investigation
NSWC, Indian Head, Virginia

Station	Largemouth Bass	Channel Catfish	Bluegill
Nanjemoy Creek			
1	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
2	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
3	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
4	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
5	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
6	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Fish Collection Matrix
NSWC Indian Head Investigation
NSWC, Indian Head, Virginia

Station	Largemouth Bass	Channel Catfish	Bluegill
Mattawomen Creek			
1	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
2	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
3	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
4	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
5	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
6	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Fish Collection Matrix
NSWC Indian Head Investigation
NSWC, Indian Head, Virginia

Station	Largemouth Bass	Channel Catfish	Bluegill
Highway 225 Bridge			
1	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
2	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
3	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
4	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
5	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
6	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Station Characterization Form
NSWC Indian Head Investigation
Indian Head, Virginia

Water Body:							**Project Number:**	
Station Number:								
Samplers:								
Station Depth:								
Station Width:								
Date	**Time**	**Depth (feet)**	**pH (S.U.)**	**Temperature (°C)**	**Dissolved Oxygen (mg/L)**	**Turbidity (NTU)**	**Salinity (ppt)**	**Conductivity (umhos/cm)**

Station Description/Comments:

Photographic Log
Station Characterization Form
NSWC Indian Head Investigation, Indian Head, Virginia

Project Number:			Roll Number:
Samplers:			
Photo Number	Date	Direction	Description
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			

FISH COLLECTION SUMMARY
NSWC INDIAN HEAD

Fish Species		Nanjemoy Creek	Mattawoman Creek	Highway 225 Bridge	
				#1	#2
Channel Catfish	# of Fish				
	length (cm)				
	# of Fish				
	length (cm)				
	# of Fish				
	length (cm)				
Largemouth Bass	# of Fish				
	length (cm)				
	# of Fish				
	length (cm)				
	# of Fish				
	length (cm)				
Bluegill	# of Fish				
	length (cm)				
	# of Fish				
	length (cm)				
	# of Fish				
	length (cm)				

FISHING LOG SHEET
NSWC INDIAN HEAD, VIRGINIA

Station							
Nanjemoy Creek							
Mattawoman Creek							
Highway 225 Bridge #1							
Highway 225 Bridge #2							