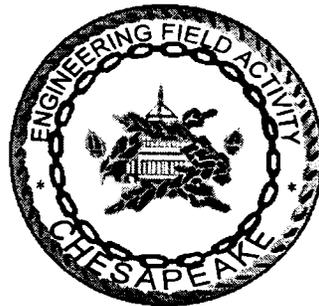


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MASTER PLANS FOR REMEDIAL INVESTIGATIONS NSWC INDIAN HEAD MD
4/1/1997
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Master Plans
for
Remedial Investigations
for
Indian Head Division
Naval Surface Warfare Center
Indian Head, Maryland



Engineering Field Activity Chesapeake
Naval Facilities Engineering Command

Contract Number N62472-90-D-1298

Contract Task Order 0245

April 1997



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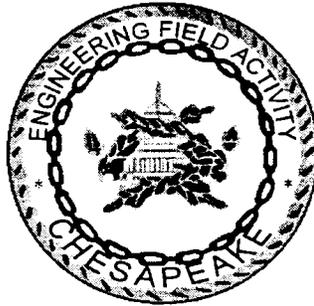
Master Work Plan

Master Field Sampling Plan

Master Quality Assurance Project Plan

Health and Safety Plan Guidance Document

Master Work Plan
for
Remedial Investigations
at
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 0245

April 1997

**MASTER WORK PLAN
for
REMEDIAL INVESTIGATIONS
at
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:
Brown & Root Environmental
993 Old Eagle School Road, Suite 415
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**CONTRACT NUMBER N62472-90-D-1298
CONTRACT TASK ORDER 0245**

APRIL 1997

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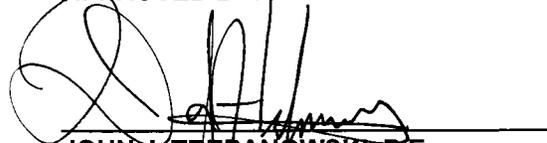

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EXECUTIVE SUMMARY

The Indian Head Division, Naval Surface Warfare Center (Station) in Indian Head, Maryland was placed on the National Priority List (NPL) of CERCLA in 1995. Ongoing and future environmental investigative work at the Station will be in accordance with CERCLA requirements as described in this Master Work Plan and the following associated master planning documents:

- Master Field Sampling Plan (Master FSP)/Standard Operating Procedures (SOPs)
- Master Quality Assurance Project Plan (Master QAPP)
- Health and Safety Plan Guidance Document (Master HASP)

The master planning documents combined with Project Specific Work Plans will describe the methods and procedures to perform environmental investigative work at the Station.

This Master Work Plan provides information pertaining to the Station and describes the general procedures for environmental investigations at the Station. Sites will be investigated to determine the nature and extent of contamination, and then the data will be evaluated in terms of human health and, if applicable, ecological risk.

1.0 INTRODUCTION

This Master Work Plan (Master WP) was prepared for the Indian Head Division, Naval Surface Warfare Center (Station) in Indian Head, Maryland, and the Engineering Field Activity Chesapeake (EFACHES), under the Comprehensive Long-term Environmental Action Navy (CLEAN), Contract Number N62467-90-D-1298, Contract Task Order (CTO) 0245. This Master WP presents general background and environmental information for the Station; describes development of this Master WP and its integration with project specific planning documents; summarizes overall scope and objectives of environmental investigations at the Station; outlines the procedures for implementation of environmental investigations; and describes how sites will be evaluated in terms of risk. Project-specific planning documents will be written as supplements to this Master WP.

1.1 SUMMARY OF PLANNING DOCUMENTS

This Master WP is part of a set of master planning documents. These master planning documents define the procedures and policies for performing environmental investigations at the main area of the Station. The other master planning documents are:

- Master Field Sampling Plan (Master FSP)/Standard Operating Procedures (SOPs)
- Master Quality Assurance Project Plan (Master QAPP)
- Health and Safety Plan Guidance Document (Master HASP).

Project-specific planning documents will be prepared for individual tasks. They will refer to the master planning documents where appropriate and provide site-specific information and reference the Station SOP for proposed sampling and analysis methods and procedures.

The procedures and policies in the master planning documents are for conducting environmental investigations at the Station as part of the Navy Installation Restoration (IR) Program. They were developed to comply with applicable tenants established in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as implemented through the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (March 1990). Additional guidance for conducting such activities is contained in the United States Environmental Protection Agency (US EPA) Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (1988) and the Navy/Marine

Corps Installation Restoration Manual (February 1992). Further discussion of the Navy IR Program is presented in Section 1.4.

1.2 LOCATION AND GENERAL DESCRIPTION

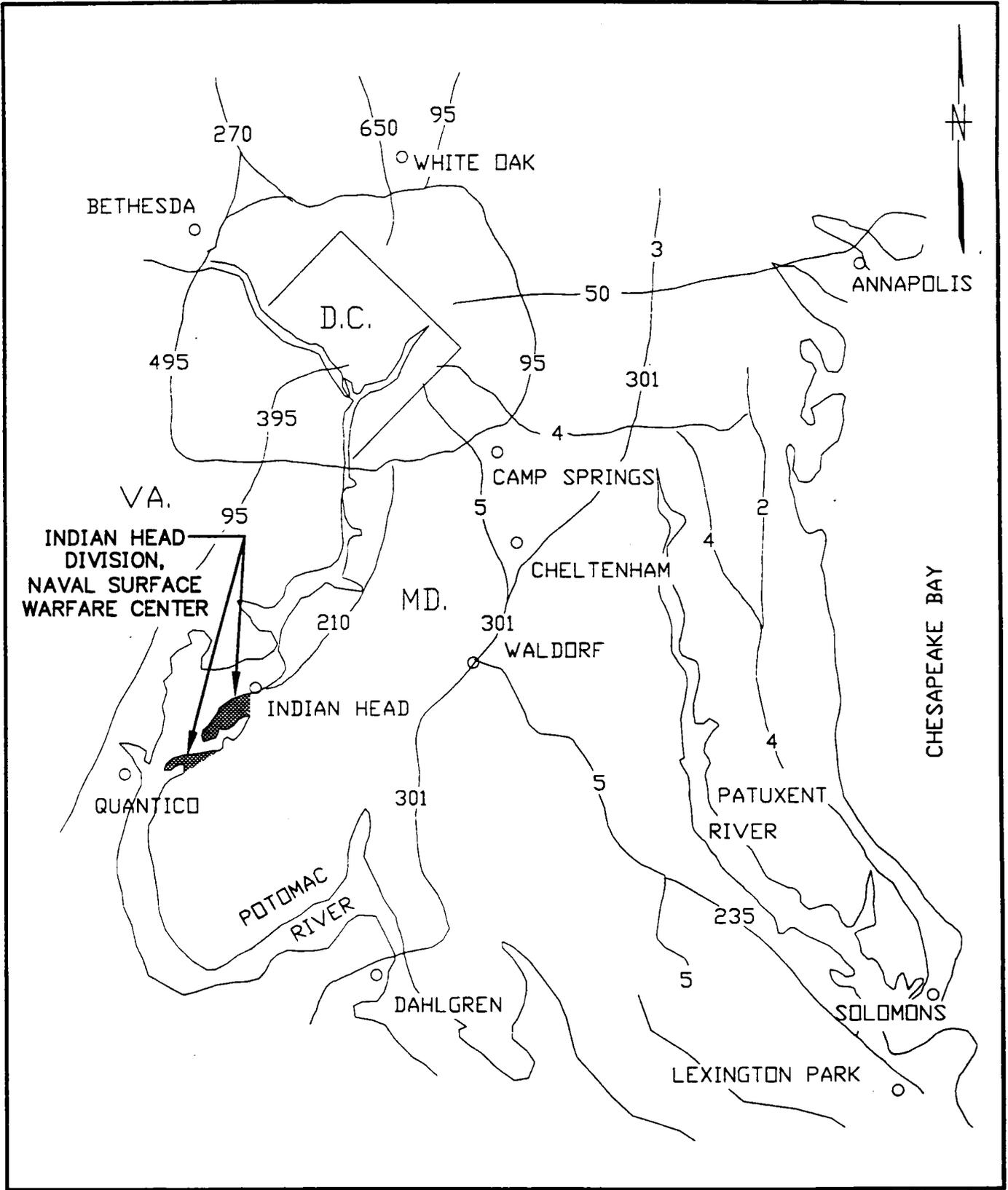
Indian Head Division, Naval Surface Warfare Center is located in the northwestern section of Charles County, Maryland, approximately 25 miles south of Washington D.C. The Station consists of two areas: the main area and Stump Neck Annex. The two areas are located on two separate peninsulas along the eastern shore of the Potomac River. The main area is on the Cornwallis Neck Peninsula, and the annex is on the Stump Neck Peninsula. Figure 1-1 illustrates the general location of the Station. The main area on Cornwallis Peninsula covers approximately 2,300 acres and is bounded by the Potomac River to the north and west, Mattawoman Creek to the south and east, and the Town of Indian Head to the east. The Stump Neck Annex covers approximately 1,100 acres and is bounded by the Potomac River to the north, Chicamuxen Creek to the south, and private residential property to the east.

The primary mission on the main area of the Station is to:

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

1.3 STATION HISTORY

The Station was established in 1890 as the Naval Proving Ground on the 659 acres of the Cornwallis Neck Peninsula. One year later, an adjacent tract of 222.75 acres, known as Mount Pleasant Farm, was acquired. Powder, fuses, and cartridge casings purchased by the Navy and naval guns manufactured at the Washington Navy Yard were tested for quality assurance and control at the Naval Proving Ground.



VICINITY MAP
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

FIGURE 1-1



Brown & Root Environmental

Projectiles were also field tested at the Naval Proving Ground. In 1900, the Station began producing smokeless powder to supply the entire U.S. naval fleet.

In 1901, the 1,084 acres of Mason's Enlargement, now known as Stump Neck, were purchased. This property was often shelled for gun testing. Between 1904 and 1907, the powder factory on the Cornwallis Neck Peninsula was expanded, and a powder re-working facility was constructed. In 1915 plants were added for the production of sulfuric and nitric acid because of the escalating costs of commercial acid. An ammonium picrate plant was built in the same year and operated for the next five years. Ammonium picrate (Explosive D) was combined with black powder for use in projectiles and valued for its insensitivity to shock and friction.

During World War I, the Naval Proving Ground established extensive propellant manufacturing, experimental, and test programs. It produced 10 million pounds of smokeless powder and reworked 800,000 pounds of smokeless powder over the course of the war. In 1918, the Station was enlarged by the purchase of 1,368 acres of adjacent land, and a 13.8-mile railroad spur was laid from the Naval Proving Ground to the Pennsylvania Railroad junction at White Plains, Maryland.

For a brief period in the early 1920's, Dr. Robert H. Goddard conducted research and development of rocket propellants at Indian Head.

The proofing of all Naval guns continued at the Naval Proving Ground until 1921 when this activity was relocated to an Indian Head-administered detachment at Dahlgren, Virginia. The activity was moved to Dahlgren because the safety limits for new shots and shrapnel exceeded the boundaries of the Station. In 1932, the Station was redesignated the Naval Powder Factory, and the facility at Dahlgren became the Naval Proving Ground.

With the onset of World War II, fundamental research was conducted in rocketry and rocket propellant grains for bombardment rockets, bazookas, and air-to-ground anti-tank weapons, beginning in 1940. A new Explosive D plant was completed in 1942, and an extrusion plant for the production of double-base propellants began operations in 1943. An ammonia oxidation plant came into operation in 1945 to improve nitric acid production. During World War II, the Naval Powder Factory produced an average of 48 tons of nitric acid a day and 4 million pounds of Explosive D a month.

As the war ended, the mission of the Station was expanded into propellant research and development. A pilot plant constructed in 1949 was responsible for the research and development of solid propellants for new rockets and guided missiles.

Beginning in 1950, the Naval Powder Factory returned to major production for the Korean War with an emphasis on double-base and high energy casting powders. Four additional manufacturing plants for nitroglycerin, cast propellants, cordite, and nitroguanidine were constructed. In 1958, the Station became known as the Naval Propellant Plant.

In support of the Polaris missile program, 23 new buildings were constructed in 1960 for base grain manufacturing. In the following year, a computer facility was completed for ballistic evaluation, and the first nitroplasticizers were produced for the program. In 1962, the Station had the capability of manufacturing space rocket propellant and developed a new liquid monopropellant for use in the Mark 46 and 48 torpedoes. It also had developed inert diluent and pneumatic mixing processes.

In 1966, the Station was redesignated to the Naval Ordnance Station (NOS). It subsequently approached maximum production during the Vietnam War. Land on Bullet's Neck (47 acres) and Rum Point (83 acres) was acquired in 1965 and 1966 to satisfy increased Quantity Distance Arc requirements. In the late 1960's, the Station began producing propellant and casting powder for the Poseidon missile, and the Inert Diluent Process Pilot Plant was erected.

In 1971, the Department of the Navy was designated as the single manager for explosive ordnance disposal, which is conducted at NAVEODTECHDIV on Stump Neck Annex. In 1976 NOS was assigned the task of production of Standard Anti-Radiation Missile (ARM) motors.

In recent years, the Station has been involved with the development of electronic missile simulators and air-crew escape propulsion systems. A resulting product line is the cartridge-actuated device (CAD)/propellant-actuated device (PAD) program. These devices provide the various energy sources to perform the many functions required to eject and parachute air crews to safe recovery. They also provide the energy for a myriad of other functions such as stores release, cable cutting, inflation, etc. The Station is the Department of Defense (DOD) manager for CADs and PADs. The CAD/PAD program is designed to eliminate duplication of effort within DOD.

In 1992, the Station became a division of the newly-formed Naval Surface Warfare Center. As a result of the BRAC 93 decision, the Indian Head Division was established as the Navy's single-site, full-spectrum energetics center with the transfer of the Navy's principal RDT&E capability for explosives, components,

and warheads technology from White Oak to Indian Head. Its role is to provide expertise in the field of energetics to the other members of the center and the other warfare centers established in the underwater and air warfare areas. The Indian Head Division is a facility able to synthesize propellants and explosives from design to full-scale production.

1.4 NAVY INSTALLATION RESTORATION (IR) PROGRAM/CERCLA HISTORY

Identification, investigation, and cleanup of hazardous waste sites at the Station are conducted under the auspices of the Department of the Navy IR Program. This program is designed to identify, assess, characterize, and clean up or control contamination from past hazardous waste disposal operations and hazardous materials spills at Navy and Marine Corps activities. The Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) and its implementing regulation, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), established a series of programs for the cleanup of hazardous waste disposal and spill sites nationwide. One of these programs, the Defense Environmental Restoration Program (DERP), is codified in the Superfund Amendments Reauthorization Act (SARA) Section 211 (10 USC 2701). The IR Program is a component of the DERP.

The IR Program provides a structured but flexible approach for identifying, evaluating, and cleaning up sites where hazardous substances have been released to the environment for which the Department of the Navy is responsible. Initial guidance for the Navy's IR Program was published in May 1988. The IR Manual was revised in 1992 to represent a compilation of DERP requirements, policy, and guidance for both the United States Navy and the United States Marine Corps. The IR Manual was revised and updated to incorporate the many changes that have occurred in the IR Program since 1988. The latest version of the manual is entitled *Navy/Marine Corps Installation Restoration Manual* (February 1992).

The IR Program is comprised of three distinct phases: Preliminary Assessment/Site Inspection (PA/SI), Remedial Investigation/Feasibility Study (RI/FS), and Remedial Design/Remedial Action (RD/RA).

- **PA/SI.** The PA is a basic record search and personnel interview process that locates sites on a base which may be candidates for inclusion in the IR Program. The SI is a more detailed investigation, which includes actual site inspection and sampling and laboratory analysis to determine if site contamination is present. Based on the results of the SI, a site may be included in the IR Program or removed from further consideration.
- **RI/FS.** The RI is a thorough, physical site investigation to determine the nature and extent of contamination at sites. This phase typically includes tasks for quantitative risk assessment. A risk

assessment can be performed on both human and ecological receptors. The FS is an assessment of the possible engineering solutions for site remediation and a cost and benefit analysis of each of the alternatives. The FS recommends a single course of action and leads to a Record of Decision (ROD), which is the formal approval of the plan by the agencies involved.

- **RD/RA.** The RD provides a detailed, comprehensive design for implementation of the action recommended by the FS. The RA is the implementation of the RD. The goal of the RD/RA is that no further action is necessary except continued monitoring. An RA may be initiated at any time during the remedial process for expedition of cleanup.

Cleanup goals are determined on an individual site basis. All Applicable or Relevant and Appropriate Requirements (ARARs) of Federal and State laws are considered in setting cleanup goals and selecting the methods for cleanup. Overall, CERCLA is, by regulation, risk driven, and requires the evaluation of human health and environmental risks.

1.5 GEOGRAPHIC INFORMATION SYSTEM

A Geographical Information System (GIS) is being developed for the Station. A GIS is a computer system designed to organize and present data and to provide support for the complex decision making processes involved with resource management. GIS provides this capability by associating graphic data with database information. Many sets of graphic data, called "layers", may be overlaid and integrated for analysis. These layers include such variables as vegetation, soils, wetlands, geology, topography, environmental parameters (contaminants and concentrations), and aquifer data. Some historical environmental data will be entered into the GIS, and future environmental data will be incorporated into the GIS. The GIS will be used as a tool for making future environmental decisions at the Station.

Spatial environmental data, such as soil boring and monitoring well locations, site boundaries, and topography, will be incorporated into the GIS system. Accurate spatial data (e.g., land survey and/or Global Positioning System (GPS)) will be collected during future environmental activities at the Station. Analytical environmental data, such as soil and water chemical analysis and geotechnical analysis of soils and sediments, will also be incorporated into the database of the GIS system to be integrated with the graphic data.

1.6 WORK PLAN ORGANIZATION

This Master Work Plan is organized into seven sections. Section 1 provides a brief discussion of the planning documents in the set of Master documents, a general description of the Station and its history,

and issues concerning the environment. Section 2 provides detailed physical description of the Station. Sections 3 and 4 describe how human health and ecological risk assessments will be performed for the Station. Section 5 describes the development of the Master Work and its integration with site-specific work plans and the process of development of data quality objectives. Section 6 outlines the regulatory requirements for the history of environmental study at the Station. Section 7 outlines the management and execution of various aspects of the environmental investigations and actions.

2.0 BACKGROUND INFORMATION

This section provides background information about the Station and surrounding region in the following areas:

- Landuse
- Water Sources and Usage
- Population
- Station Access
- Regional Geology
- Regional Hydrogeology
- Station Hydrology
- Station Ecology
- Meteorology

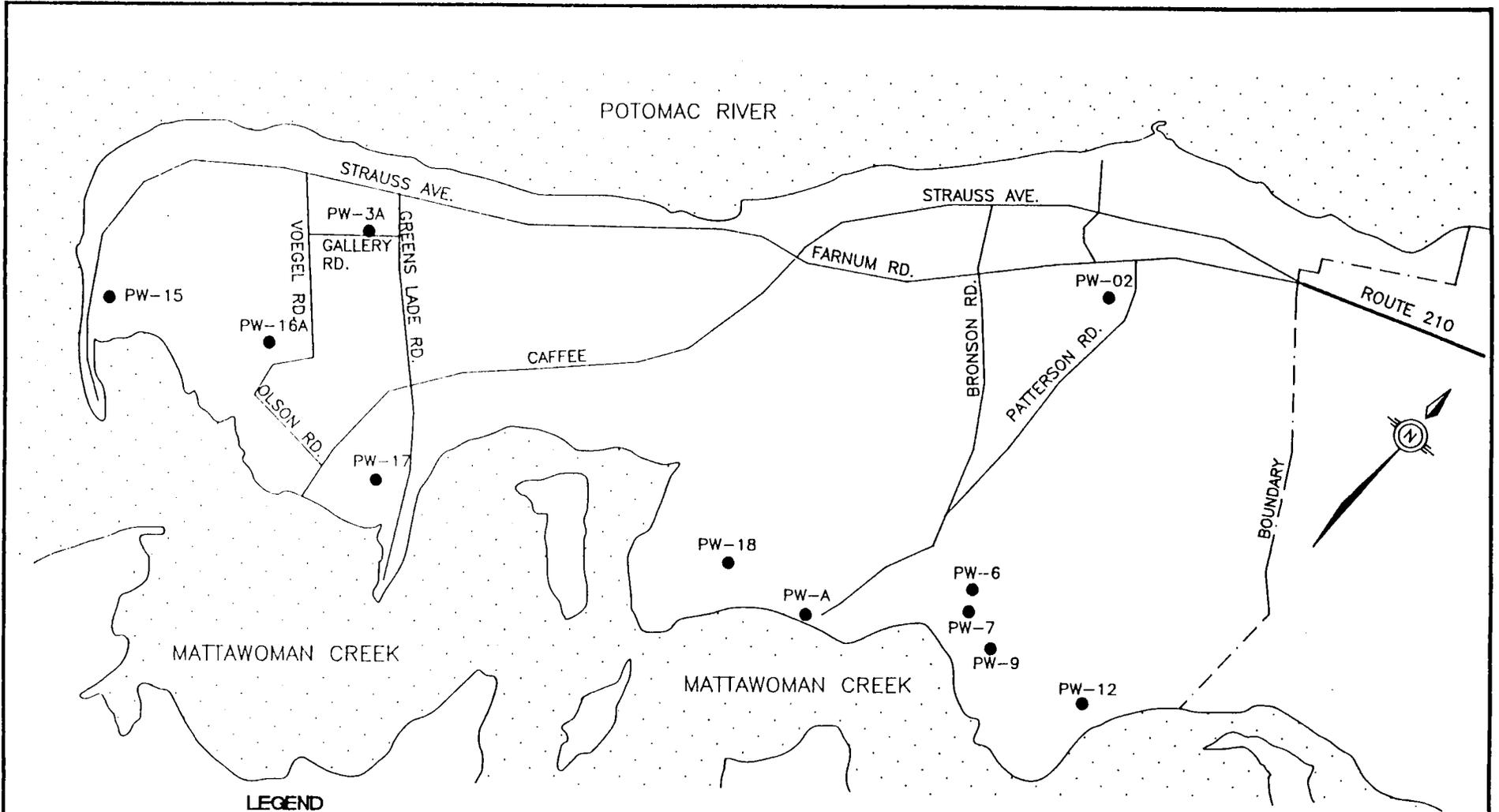
2.1 LAND USE

According to the IAS (Hart, 1983), Indian Head Division, Naval Surface Warfare Center covers approximately 2,034 acres on the Indian Head Peninsula in the Charles County. Of this area, explosive production and storage activities occupy 1,494 acres; Explosive Ordnance Disposal classrooms and field training areas occupy 60 acres; administrative operations occupy 280 acres; and, military housing and personnel support occupy 200 acres. There are 1,043 buildings on the Station. There are also over 29 miles of steam distribution lines, a power plant and a water and sewage treatment plant on the Station.

The area adjoining the Station to the northeast is residential and under the authority of the Town of Indian Head.

2.2 WATER SOURCES AND USAGE

The Station is the largest user of groundwater in the area with average daily withdrawals of approximately 1 to 2 million gallons per day (Hiortdahl, 1990). Drinking water and industrial process water are supplied by production wells screened in either the Patapsco Formation or the Arundel or Patuxent Formations, ranging in depth from 190 to 450 feet. Currently, 11 production wells are in use at the Station. The location of those wells is shown on Figure 2-1.



LEGEND

● - PRODUCTION WELL LOCATION

NOT TO SCALE



SITE INSPECTION
 INDIAN HEAD DIVISION,
 NAVAL SURFACE
 WARFARE CENTER

FIGURE Figure 2-1
 PRODUCTION WELL LOCATIONS

DATE: 02/24/94 DWG NAME: INDH0320

Two principal waterways bound the Indian Head Peninsula: the Potomac River and Mattawoman Creek. The Potomac River is the major waterway in the area and lies west of the Station. It is classified by the State of Maryland for Class I (Water Contact Recreation and Aquatic Life) use in the area of the Station and Class II (Shellfish Harvesting Waters) use downstream of the Station. The Station draws water from the Potomac River to charge the onsite fire protection system. According to the IAS (Hart, 1983), the Station withdraws up to 3 million gallons of water a day from the Potomac River. Mattawoman Creek is a tributary to the Potomac River and is east of the Station. It is classified for Class I use by the State of Maryland.

2.3 POPULATION

The population of the Station is approximately 3,300 (EnSafe/Allen & Hoshall, 1994). It includes 2,000 employees, 1,000 contracted employees, 100 Strauss Avenue residents, and 200 Bachelor Enlisted Quarters residents. The population of the Town of Indian Head is approximately 3,531. Based on the 1990 U.S. Census, the total population of Charles County is 101,154.

2.4 STATION ACCESS

The Station is accessible from Washington D.C. by Maryland State Route 210. Air service is from Washington National Airport, Baltimore-Washington D.C. International Airport, or Dulles International Airport. A railroad connected the Station to White Plains, Maryland, for shipment of products and bulk deliveries. There were rail connections from the main spur to all parts of the Station. The Station also had docking facilities along the Potomac River for river service. Both the railway and docking facilities are inactive.

2.5 REGIONAL GEOLOGY

2.5.1 Physiography and Topography

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

2.5.2 Geology

The regional geology consists of a sedimentary wedge of Cretaceous to Quaternary fluvial and marine deposits overlying crystalline Precambrian metamorphic and igneous bedrock. The sedimentary wedge dips and thickens eastward and ranges in thickness from 650 to 900 feet (Vroblesky, 1991). It lies unconformably on the crystalline basement rock surface, which dips to the east. In stratigraphically ascending order, the sedimentary units underlying Indian Head are the Cretaceous Potomac Group, the Tertiary Aquia and Park Hall Formations, and Quaternary fluvial and estuarine deposits.

The Potomac Group consists of three units (in descending stratigraphic order): the Patapsco Formation, the Arundel Formation, and the Patuxent Formation. The lithology of the Potomac Group is interbedded clay, silt, sand, and gravel, deposited in fluviodeltaic environments (Hiortdahl, 1990), and ranges in thickness from 650 to 750 feet (Vroblesky, 1991; Harsh, 1990). The upper 100 feet of the Patapsco Formation outcrops along the western bluffs of the peninsula along the Potomac River. The middle and lower units of the Patapsco subcrop below the Potomac River (Hiortdahl, 1990). The Arundel Formation and Patuxent Formation consist of clays with interbedded sand units.

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

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

2.5.3 Soils

The dominant soil series on the Indian Head Peninsula are the Beltsville, Keyport, and Elkton Silt Loams (Hart, 1983; USDA, 1974). The Beltsville Silt Loam is found primarily in the upland elevations of the northern end of the Station, roughly north of Bronson Road. The Beltsville series consists of silt and sand with moderate amounts of clay. They are nearly level to moderately sloping and slowly permeable but well drained (USDA, 1974). In addition to the Beltsville Silt Loam, areas of cut-and-fill soils are found in the northern end of the Station. Cut-and-fill lands are areas where the native soils have been removed and graded or filled with other material or soil. The Keyport and Elkton Silt Loams are found in the lower elevations of the southern end of the Station, roughly south of Bronson Road. They are both clayey silt

loam soils. Both series are slowly permeable; however, the Elkton series is less permeable than the Keyport series.

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

2.6 REGIONAL HYDROGEOLOGY

The Patapsco and Patuxent Formations of the Potomac Group are the main groundwater aquifers used in the area. The Patapsco Formation is the principal aquifer for Charles County. The three principal water-bearing zones within the formation are the Lower, Middle, and Upper Sands. They are under confined conditions. The Lower Sand outcrops in Virginia; the Middle Sand outcrops below the Potomac River and in Virginia; and, the Upper Sand outcrops beneath the Potomac River. The water-bearing zones of the Patuxent Formation are laterally discontinuous sand zones. Recharge of the Patuxent Formation occurs in Virginia, where it outcrops.

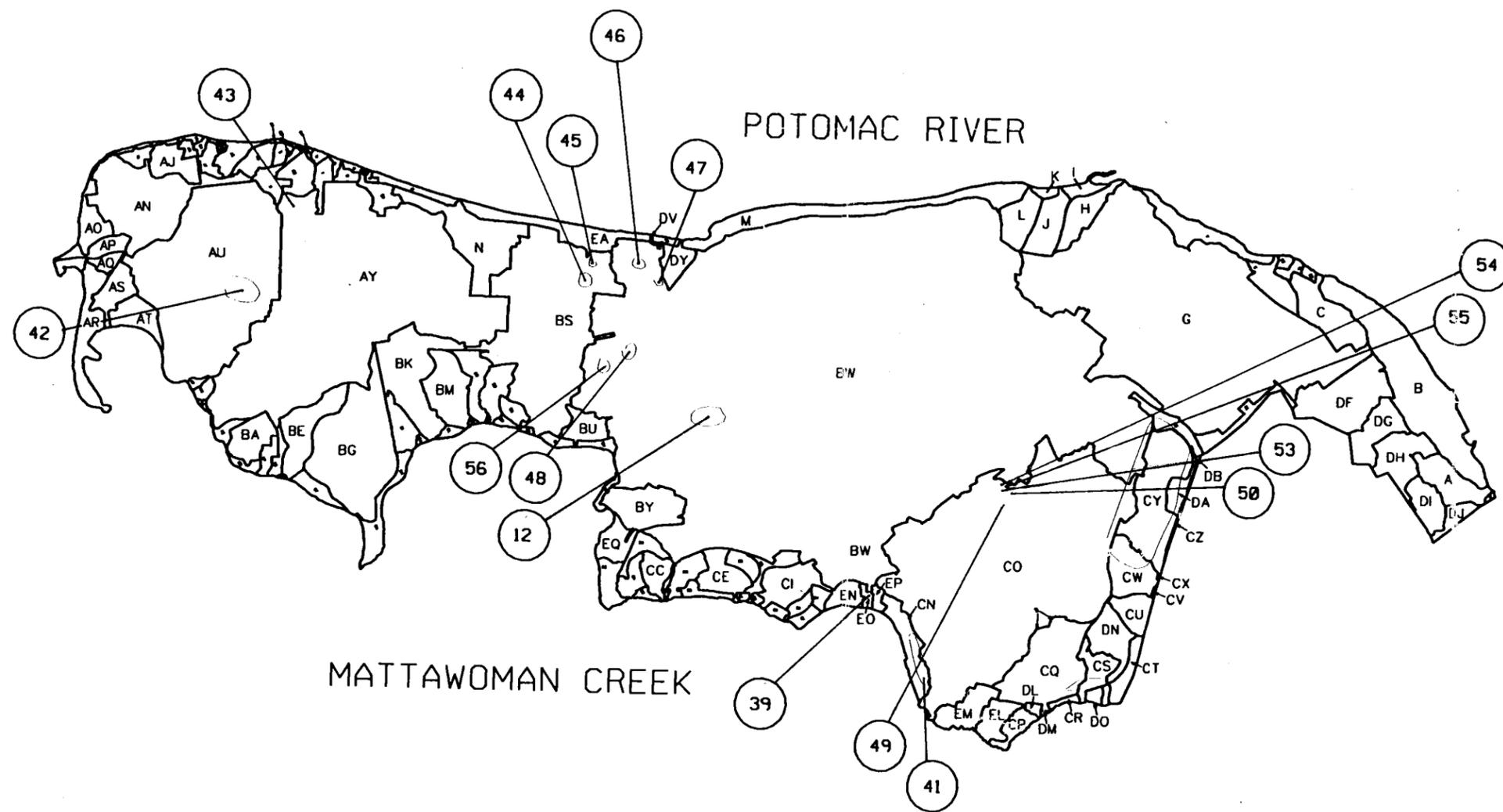
Groundwater elevations of the Potomac Group measured in 1990 indicate a cone of depression in the Indian Head Peninsula area (Hiortdahl, 1990). The area of influence extends for approximately six miles in the northeast and southwest direction and approximately 2-3 miles in the northwest and southeast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

2.7 STATION HYDROLOGY

The two principal waterways in the vicinity of the Station are the Potomac River and the Mattawoman Creek. The Potomac River is a tidally-influenced estuary and slightly brackish. Mattawoman Creek is a tributary to the Potomac River and also tidally influenced. Tidal marshes exist along the Mattawoman Creek. Major drainage areas on the Station are shown on Figure 2-2.

As shown on the Drainage area map, natural drainage from the Station is predominately to Mattawoman Creek with the remaining drainage flowing to the Potomac River. A drainage divide extends down the length of the peninsula and roughly parallels Route 210. Drainages east of the divide flow to Mattawoman Creek; drainages west of the divide flow into the Potomac River.

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NOT TO SCALE

WATER SHED MAP
INDIAN HEAD DIVISION NSW
INDIAN HEAD, MARYLAND

FIGURE 2--2



Brown & Root Environmental

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

Shallow, unconfined ground water at the Station occurs from near surface to approximately 20 feet. Typically, the shallow groundwater occurs in perched water-bearing zones and is recharged from infiltration (Hart, 1983; Slaughter and Otton, 1968). At some lowland areas at the edge of the surrounding bodies of water, surface water intrusion may be an additional source of recharge of the shallow aquifer. In lieu of comprehensive shallow ground water level data, it is assumed shallow ground water flow follows topography. Hence, shallow groundwater east of the drainage divide flows toward Mattawoman Creek, and shallow groundwater west of the divide flows toward the Potomac River.

2.8 STATION ECOLOGY

The information in the following section was taken from the Initial Assessment Study Report (Hart, 1983), except where noted.

2.8.1 FLORA

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

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

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

2.8.2 Wildlife

The ecosystem at the Station supports a variety of animal life. Deer are abundant on the Station. Other common mammals include possum, bats, squirrels, mice, raccoon, woodchuck, rabbits, and other

burrowing rodents, such as voles and shrews. The birds found within Charles County include grebes, herons, ducks, geese, hawks, kestrels, osprey, eagles, gulls, owls, gulls, and perching birds, such as robins, warblers, and jays. Common reptiles and amphibians of Charles County include lizards, skunks, snakes, turtles, salamanders, frogs, and toads.

2.8.3 Aquatic Life

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

2.8.4 Threatened and Endangered Species

Investigation efforts will include searches for state and Federally listed threatened and endangered species. The search will include contacting the U.S. Fish and Wildlife Service and appropriate state agencies to establish the most current list.

2.9 METEOROLOGY

The Indian Head Peninsula experiences a modified moist, humid continental climate with warm and wet summers and cool winters. The Appalachian and Blue Ridge mountain ranges to the west obstruct cold, continental air in the winter, while the Potomac River and Atlantic Ocean contribute to more moderate temperatures but higher humidity.

Temperatures range from 49°F to 66°F (1958-1987) with a mean of 58°F (NOAA, 1987). The warmest month is typically July with an average temperature of 79°F, while January is the coldest month with an average temperature of 35°F.

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

3.0 HUMAN HEALTH RISK ASSESSMENT METHODOLOGY

A Human Health Risk Assessment will be performed for those sites where contamination levels indicate that the site may pose a risk to human health. The evaluation process is described in this section of the Master Work Plan.

The objective of a human health risk assessment is to determine whether detected concentrations of chemicals pose a significant threat to potential human receptors under current and/or future land use. The potential risks to human health at sites under investigation at the Indian Head Division, Naval Surface Warfare Center (Station) will be estimated based on the assumption that no actions are taken to control contaminant releases.

This section of the Master Workplan contains the general methodologies which will be used to evaluate site-specific human health risks at the Station. Detailed site information will be provided in site-specific workplans. The use of the framework provided will ensure continuity between site-specific assessments and allow for the streamlined development of future risk assessments. The following current USEPA risk assessment guidance and Region III supplements were primarily used to develop the framework contained in this section of the Master Workplan:

- USEPA (U.S. Environmental Protection Agency), December 1989. Risk Assessment Guidance for Superfund: Volume I, Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response, Washington, D.C. EPA 540/1-89/002.
- USEPA (U.S. Environmental Protection Agency), May 1989. Exposure Factors Handbook. Office of Health and Environmental Assessment, Washington, D.C. EPA/600/8-89/043.
- USEPA (U.S. Environmental Protection Agency), March 25, 1991. Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. Washington, D.C. OSWER Directive 9285.6-03.
- USEPA (U.S. Environmental Protection Agency), January 1992. Dermal Exposure Assessment: Principles and Applications. Interim Report. Office of Research and Development, Washington, D.C. EPA/600/8-91/011B.

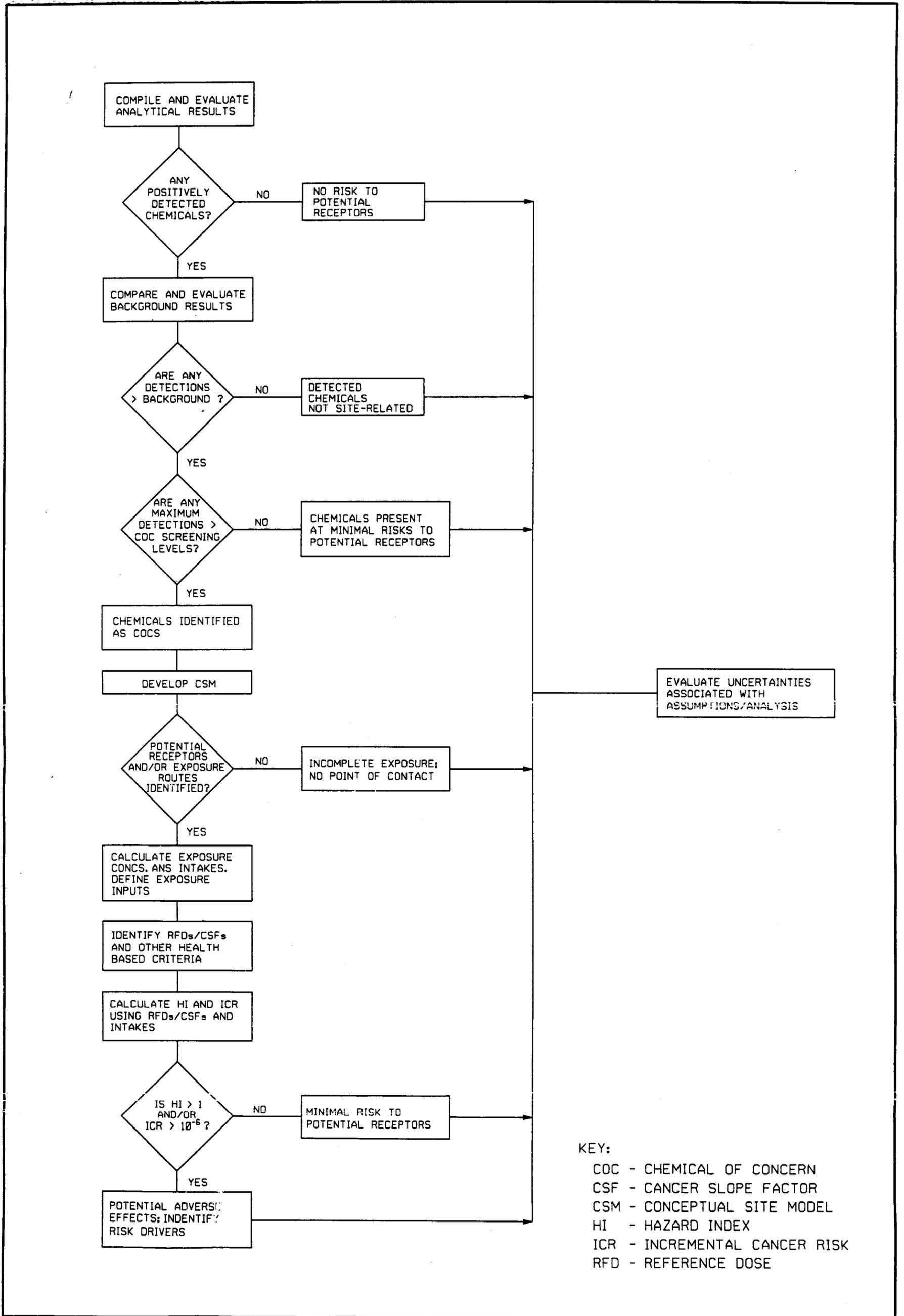
- USEPA (U.S. Environmental Protection Agency), May 1992. Supplemental Guidance to RAGS: Calculating the Concentration Term. OSWER Publication No. 9285.7-081.
- USEPA (U.S. Environmental Protection Agency) Region III, January 1993. Selecting Exposure Routes and Contaminants by Risk-Based Screening. Hazardous Waste Management Division, Philadelphia, PA. EPA/903/R-93-001.
- USEPA (U.S. Environmental Protection Agency) Region III, December 1995. Assessing Dermal Exposure from Soil. Hazardous Waste Management Division, Philadelphia, PA. EPA/903-K-95-003.

A human health risk assessment consists of five components: (1) Data Evaluation; (2) Exposure Assessment; (3) Toxicity Assessment; (4) Risk Characterization, and (5) Uncertainty Analysis. Sections 3.1 through 3.5 of the Master Workplan contain detailed discussions of the methodologies to be followed for each component of a human health risk assessment. A schematic diagram of the general risk assessment process is provided as Figure 3-1.

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

3.1 DATA EVALUATION

Data evaluation, the first component of a human health risk assessment, is a site-specific task involving the compilation and evaluation of analytical data. The main objective of data evaluation is to develop a media-specific list of chemicals of concern (COCs), which will be used to quantitatively determine potential human health risks.



SUMMARY OF HUMAN HEALTH RISK ASSESSMENT PROCESS
INDIAN HEAD, MARYLAND

FIGURE 3-1

3.1.1 Quantitative vs. Qualitative Use of Analytical Data

Current site data, as well as historical data, may be used to assess risks to potential human receptors at a site. All analytical data employed in the quantitative estimation of potential risks will be subjected to data validation. A discussion of data validation protocol to be followed for data generated for the Station is provided in the associated Master Quality Assurance Project Plan (QAPP).

Fixed-based analytical results from the targeted analyte lists only are generally used in the quantitative risk evaluation. Typically, unfiltered results for groundwater and surface water will be used to assess risks associated with these media. Field screening results, data regarded as unreliable (i.e., qualified as "R" during the data validation process), results of Tentatively Identified Compound (TIC) analyses, and filtered sample results will not be used. However, these data may be used to substantiate the conclusions of the quantitative risk analysis.

3.1.2 COC Selection

The selection of COCs is a qualitative screening process used to limit the number of chemicals and exposure routes quantitatively evaluated in a human health risk assessment to those site-related constituents that dominate overall potential risks. Screening by risk-based concentrations and background will be employed to focus the risk assessment on meaningful chemicals and exposure routes.

In general, a chemical will be selected as a COC and retained for further risk evaluation if: 1) the maximum detection in a sampled medium exceeds the risk-based concentration, referred to as the COC screening level, 2) the chemical is determined to be present at concentrations above background, and 3) if the chemical is infrequently detected (i.e., in less than 10 percent of the samples available for risk assessment). Frequency of detection will be used to exclude chemicals when data sets of 20 samples or greater are available. Chemicals eliminated from further evaluation at this time are assumed to present minimal risks to potential human receptors.

COC Screening Level Development

The risk-based concentration screen developed by USEPA Region III (USEPA Region III, January 1993), along with the most recent version of the Region's Risk-Based Concentration (RBC) Table, will be used to develop risk-based COC screening levels for a site. The risk-based COC screening levels will correspond to a systemic hazard quotient of 0.1 (for noncarcinogens) or a lifetime cancer risk of 1E-6 (for carcinogens). RBC Tables will be incorporated in the development of the screening levels to account for changes in toxicological information and default exposure parameters.

Risk-based COC screening levels for tap water ingestion, which are based on daily, residential exposure assumptions, will be used to select COCs for groundwater and surface water. As discussed in the recent RBC Table (USEPA Region III, May 10, 1996), direct ingestion and inhalation exposure routes will be considered for various volatile organic compounds. In general, the use of tap water screening levels is regarded as an extremely conservative approach to COC selection at the Indian Head Division, Naval Surface Warfare Center because shallow groundwater at the Station is not used as a potable drinking water source (i.e., drinking water supplies are obtained from relatively deep aquifers, approximately 190 to 240 feet below ground surface), and potential human exposure to surface water is expected to be limited to incidental exposures (such as recreational activities and trespassing).

Risk-based COC screening levels for soil ingestion and Soil Screening Levels (SSLs) for transfers from soil to air will be used to select COCs for soil. Depending on the current and projected future land use at a particular site, soil ingestion screening levels for residential or industrial/commercial land use will be employed. Industrial soil ingestion screening levels will be used at sites where a potential future residential scenario is highly unlikely. COCs for soil will also be identified using USEPA Region III SSLs, which have been developed using the Office of Solid Waste and Emergency Response's (OSWER) proposed SSL guidance (USEPA, December 1994). SSLs will be used to screen out chemicals detected at insignificant concentrations and to justify the elimination of the inhalation exposure pathway, which is comprised of the generation of fugitive dust and volatile emissions.

For sediment, COCs will be selected by comparing detected site concentrations to soil ingestion (residential or industrial/commercial) screening levels only. SSLs for transfers from soil to air are not considered to be appropriate for sediment screening because of high moisture content associated with sediment matrices. The use of soil ingestion screening levels for sediment COC identification is regarded as a conservative approach since anticipated exposure to sediment is less than anticipated exposure to soil.

If fish tissue and ambient air sample data are available for a site, COC screening levels will also be developed for these matrices based on input parameters presented in the current USEPA Region III RBC Table. Estimated fish tissue concentrations may also be calculated by multiplying measured surface water concentrations in mg/L by the Bioconcentration Factor (BCF) in L/kg, obtained from literature sources.

Lead as a COC

RBCs are not calculated for lead since the USEPA has not derived toxicity values for this chemical. However, recommended screening levels are available for lead in soil which are used to indicate the need for response activities. Guidance from both the Office of Prevention, Pesticides, and Toxic Substances (OPPTS) and the OSWER recommend 400 mg/kg as the lowest screening level for lead-contaminated soil in a residential setting where children are frequently present (USEPA, July 14, 1994a and July 14, 1994b). OPPTS identifies 2,000 to 5,000 mg/kg as an appropriate range for areas where contact with soil by children in a residential setting is less frequent.

At this time, no screening level is available for non-residential areas involving adult and adolescent exposure only. A value of 400 mg/kg will be used as a screening level for soil and sediment at sites where a future residential scenario is considered to be a likely potential land use. For those sites where industrial/commercial land use only is anticipated, a screening level of 2,000 mg/kg will be used to identify lead as a COC in soil and sediment. The Safe Drinking Water Act action level of 15 µg/L will be used as the screening level for lead in groundwater and surface water.

Essential Nutrients and Chemicals Without Toxicity Criteria

The essential nutrients calcium, magnesium, potassium, and sodium will not be identified as COCs at a site. 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 COC screening levels may not be calculable for some chemicals commonly detected at sites (i.e., hexanone, benzo(g,h,i)perylene, phenanthrene). These chemicals will not be selected as COCs as they can not be addressed during the quantitative risk assessment. However, they will be mentioned in the data evaluation section, after the identification of COCs, and qualitatively addressed in the uncertainty section of the risk assessment.

Determination of Site-Related Chemicals

Chemicals found at concentrations indicative of background levels are not considered to be site-related contaminants and will not be retained as COCs. The use of site-specific background data or literature background values will determine if detected chemicals are present at naturally occurring levels. Conventional statistical methods (e.g., Bartlett's T-test, etc.) will be employed to compare site concentrations to background concentrations if site-specific (or Base-wide) background data are available. In the event that site-specific data are not available, a direct comparison of maximum site concentrations to published literature values will be used.

The elimination of detected chemicals based on background data will be limited to inorganics only. Although some organic compounds (primarily PAHs, pesticides, and PCBs) can be a result of anthropogenic sources, organics are not considered to represent "true" background levels. All detected organic compounds will be regarded as site-related for purposes of COC selection. However, historical information for a site will be reviewed to determine if the presence of organics are attributable to site-related activities or anthropogenic sources.

3.1.3 COC Summary Screening Tables

Media-specific tables summarizing the selection of COCs will be included in the site-specific risk assessments. The summary tables will most likely be appended to the assessment since the length of these tables may be extensive. At a minimum, the following information will be included in the summary tables: 1) maximum concentration of all detected chemicals, 2) frequency of detection, 3) location of maximum, 4) COC screening level(s), and 5) results of COC screening process. An example format of a typical COC summary screening table is provided as Table 3-1.

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

OSWER SSLs for contamination transfer from soil to groundwater (USEPA, December 1994) will also be included in the COC summary tables to identify chemicals present in soil at concentrations which may impact water quality. The values will be provided for informational purposes only, but will not be used to identify COCs since they are not based on direct human exposure and merely indicate the potential ability of a chemical to migrate from soil to groundwater. Where data indicate the potential for contaminant migration from soil to groundwater, groundwater sampling may be necessary when insufficient groundwater data exists.

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

TABLE 3-1

**SUMMARY OF COC SELECTION
ENVIRONMENTAL MATRIX
INDIAN HEAD, MARYLAND**

Chemical	Frequency of Detection	Range of Detection	Location of Maximum Detection	Risk-Based COC Screening Level	Other Health-Based Criteria	Attributable to Background?	Selected as COC?	Rationale
All positively detected chemicals presented.	Presented as the number of positive detections divided by the total number of sample results. Sample results qualified as rejected during data validation are not included in the total sample count.	Positive results qualified as rejected during data validation are not presented.	The sampling date associated with the maximum detection may be appended if an extensive amount of historical data is available.	Direct exposure criteria developed using current USEPA Region III RBC guidance. Soil and tap water ingestion, SSLs for transfers from soil to air, and SSLs for transfers from soil to groundwater will be used.	State and Federal drinking water standards, and ambient water quality criteria for the protection of human health may also be presented.	Yes or No identification.	Yes or No identification.	Indicates decision process. Will typically be presented as blanketed numeric references, such as "1" maximum exceeds screening level, "2" maximum is less than screening level, etc.

and applicable exposure pathways, calculate concentrations of COCs to which receptors might be exposed, and estimate chemical intakes under the identified exposure scenarios.

Actual or potential exposures at the Indian Head Division, Naval Surface Warfare Center will be determined based on the most likely pathways of contaminant release and transport, as well as human activity patterns. A complete exposure pathway has three components: (1) a source of chemicals that can be released to the environment; (2) a route of contaminant transport through an environmental medium; and (3) an exposure or contact point for a human receptor.

3.2.1 Conceptual Site Model

The development of a Conceptual Site Model (CSM) is an essential component of the exposure assessment. The CSM will integrate 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 to be evaluated in the risk assessment. A well defined CSM will allow for a better understanding of the risks at a site and will aid the risk managers in the identification of the potential need for remediation.

Exposure Setting

The exposure setting will consist of a description of the physical characteristics (climate, meteorology, geology, groundwater hydrology, vegetation, and nearby surface water bodies) of a site, as well as the identification of potentially exposed populations at or near the site. Exposed populations will be identified with respect to both current and future land uses. Information on the population (or nearby population) at a site, the average tour of duty for military personnel, and identification of residential areas at the Station will be provided. Section 2.0 of the Master Workplan contains general Station-specific information which will be used to develop the exposure setting for a site.

Potential Exposure Pathways/Receptors

The course that a chemical takes from the source to the exposed individual is defined as the exposure pathway. Several factors regarding exposure (chemical sources, environmental release mechanisms, contact points, likely exposure routes, and potential receptors) will be considered during the development of applicable exposure pathways at a site. The characterization of these 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 five environmental media: air, soil, groundwater, surface water, and sediment. Potential exposure routes for these media include ingestion (swallowing), dermal contact (skin or eye), and/or inhalation (through breathing passages).

In general, the following exposure scenarios may be applicable under current and/or future land use for sites under investigation at the Station:

- **Maintenance workers and full-time employees** may be exposed to site media while performing maintenance activities (e.g., mowing, landscaping), site inspections, or daily duties. Typically, these two classes of receptors will be evaluated for exposure to surface soil only. Exposure to groundwater will not be evaluated for this receptor because shallow groundwater at the Station is not used as a potable water supply under current conditions and is not anticipated to be used for this purpose under potential projected future land use. Exposure to surface water and sediment is expected to be minimal for these receptors.
- Unless a site is physically restricted or located in a highly remote or secured area, individuals may trespass on the site and come in contact with site media. **Adolescent trespassers** from ages 6 to 16 years will be evaluated for infrequent exposure to surface soil, surface water, and sediment. Small children (6 years or younger) are not included in this receptor group because they are expected to be supervised by an adult.
- As discussed in Section 2.2, Potomac River and Mattawoman Creek, which bound the Station, are Maryland Class I and/or II waterways, indicating that they are protected resources for aquatic life, recreational activities involving water contact, and/or shellfish harvesting. **Adult recreational users** will be considered as potential receptors at a site, if applicable. This receptor group will be evaluated for exposure to surface water, sediment, and contaminated finfish/shellfish. Anticipated exposure to surface soil is assumed to be relatively insignificant for this receptor.
- For sites involving current or potential future construction or excavation activities, **construction workers** will be evaluated for exposure to surface and subsurface soil. Dermal exposure to shallow groundwater may also be likely for this receptor. The determination of whether this exposure will be evaluated in the quantitative risk assessment will be made on a site-by-site basis using information on the depth to groundwater and detected groundwater chemicals.

- If applicable, **onsite/offsite residents** will be evaluated as potential receptors. Future onsite residents will be assumed to be exposed to surface soil and groundwater on a daily basis. A future residential scenario will not be considered to be likely at sites located in secured production areas at the Station or at sites containing land use restrictions. Offsite residents may be exposed to site media indirectly through the generation of fugitive dust and/or volatile emissions and migration of groundwater.

A summary of the exposure routes that may be addressed quantitatively for a particular receptor is provided in Table 3-2.

The CSM for a site will be presented in an illustrative fashion in addition to a textual discussion. Figure 3-2 is an example format of an illustrative CSM.

3.2.2 CTE vs. RME

Traditionally, exposures evaluated in the human health risk assessment were based on the concept of a Reasonable Maximum Exposure (RME) only, which is defined as " the maximum exposure that is reasonably expected to occur at a site" (USEPA, December 1989). However, recent risk assessment guidance (USEPA, February 26, 1992) indicates the need to address an average case or Central Tendency Exposure (CTE).

In order to provide a full characterization of potential exposure, both RME and CTE will be evaluated in the site-specific risk assessments for the Indian Head Division, Naval Surface Warfare Center. It should be noted that the available guidance (USEPA, May 5, 1993) concerning the evaluation of CTE is limited and at times vague. Therefore, professional judgement may be exercised when defining CTE conditions for a particular receptor at a site.

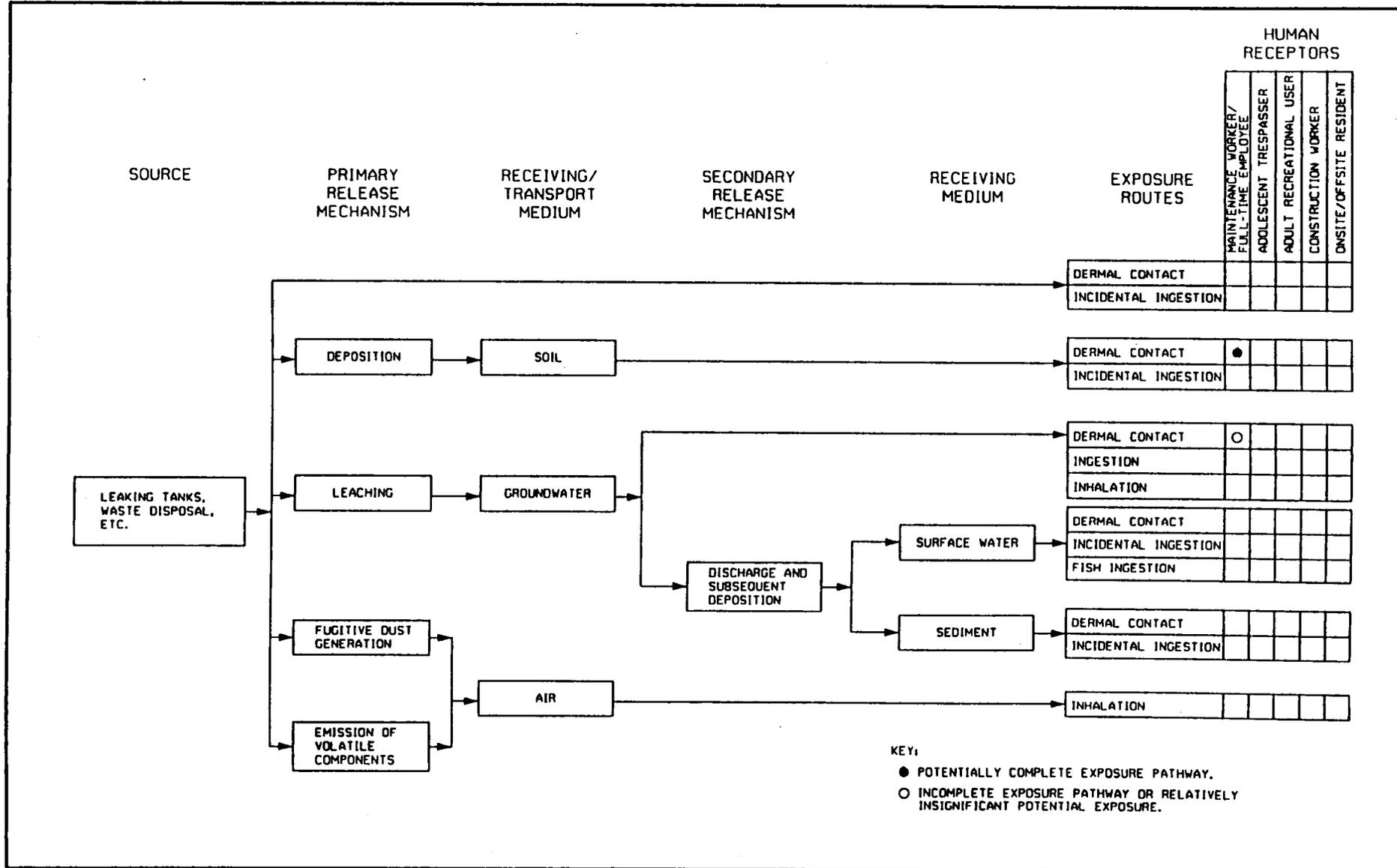
3.2.3 Exposure Concentrations

The exposure concentration, which is calculated for COCs 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 concentration for data sets with 10 or more samples (USEPA, May 1992). The 95 percent UCL will be used as the exposure concentration to assess RME and CTE risks (USEPA., May 5, 1993). For data sets with less than 10 samples, the UCL is considered to be

TABLE 3-2

**POTENTIALLY COMPLETE EXPOSURE ROUTES FOR QUANTITATIVE EVALUATION
INDIAN HEAD, MARYLAND**

Receptors	Exposure Routes
Maintenance Workers/Full-Time Employees	<ul style="list-style-type: none"> • Soil Dermal Contact (surface) • Soil Ingestion (surface) • Inhalation of Air/Dust/Emissions (surface)
Adolescent Trespassers	<ul style="list-style-type: none"> • Soil Dermal Contact (surface) • Soil Ingestion (surface) • Inhalation of Air/Dust/Emissions (surface) • Surface Water/Sediment Dermal Contact • Surface Water/Sediment Ingestion
Adult Recreational User (swimmers, water skiers, fishermen)	<ul style="list-style-type: none"> • Surface Water/Sediment Dermal Contact • Surface Water/Sediment Ingestion • Ingestion of Finfish/Shellfish
Construction Workers	<ul style="list-style-type: none"> • Soil Dermal Contact (surface and subsurface) • Soil Ingestion (surface and subsurface) • Inhalation of Air/Dust/Emissions (surface and subsurface) • Groundwater Dermal Contact (shallow groundwater)
Onsite Resident	<ul style="list-style-type: none"> • Soil Dermal Contact (surface) • Soil Ingestion (surface) • Inhalation of Air/Dust/Emissions (surface) • Direct Ingestion of Groundwater • Groundwater Dermal Contact (showering/bathing) • Inhalation of Volatiles in Groundwater (showering/bathing)
Offsite Resident	<ul style="list-style-type: none"> • Inhalation of Air/Dust/Emissions (surface) • Direct Ingestion of Groundwater • Groundwater Dermal Contact (showering/bathing) • Inhalation of Volatiles in Groundwater (showering/bathing)



EXAMPLE CONCEPTUAL SITE MODEL

SITE NAME
INDIAN HEAD, MARYLAND

FIGURE 3-2

a poor estimate of the mean, and the exposure concentration will be defined as the arithmetic mean or maximum detection, depending on the exposure scenario to be evaluated.

Conventional statistical methods will be used to determine the distribution and UCL of a particular data set (Gilbert, 1987 and USEPA, May 1992). Detailed sample calculations, as well as general methodology for the statistical evaluation, will be presented in the site-specific risk assessment. Sample and duplicate analytical results will be averaged for statistical use. Nondetected data points will be utilized; in general, one-half the sample-specific detection limit will be employed for these analytical results. If the calculated 95 percent UCL exceeds the maximum detected concentration, the maximum will be used as exposure concentration in place of the UCL.

3.2.4 Chemical Intake Estimation

The methodologies and techniques which will be used to estimate exposure intakes are presented in this section of the Master Workplan. Intakes for the identified potential receptor groups will be calculated using current USEPA risk assessment guidance (USEPA, December 1989 and January 1992) and presented in the risk assessment spreadsheets. Risk assessment spreadsheets will be appended to the site-specific assessment as support documentation.

Noncarcinogenic intakes will be estimated using the concept of an average annual exposure. Carcinogenic intakes will be calculated as an incremental lifetime exposure, which will assume a life expectancy of 70 years. Equations which will be used to calculate estimated intakes are provided below. Assumptions regarding exposure are presented at the end of this section.

Inhalation of Air and Fugitive Dust/Volatile Emissions

The amount of a chemical a receptor takes in as a result of respiration is determined using the concentration of the contaminant in air. Intakes of both particulates and vapors/gases will be calculated using the same equation, as follows (USEPA, December 1989):

$$Intake_{ai} = (C_{ai}) (IR_a) (ET) (EF) (ED) / (BW)(AT)$$

where: Intake_{ai} = intake of chemical "i" from air via inhalation (mg/kg/day)
 C_{ai} = concentration of chemical "i" in air (mg/m³)
 IR_a = inhalation rate (m³/hr)

ET	=	exposure time (hours/day)
EF	=	exposure frequency (days/yr)
ED	=	exposure duration (yr)
BW	=	body weight (kg)
AT	=	averaging time (days); for noncarcinogens, AT = ED x 365 days/yr; for carcinogens, AT = 70 yr x 365 days/yr

The concentration of a chemical in air will be developed using modeling techniques presented in current SSL guidance, measured soil concentrations, and additional site-specific information.

The total estimated intake for the inhalation pathway assumes that after the chemical is inhaled 1) a certain fraction of the chemical is deposited in the lungs (12.5 percent), 2) another portion of the chemical is subsequently ingested and accumulated in the gastrointestinal tract (62.5 percent), and 3) some amount of the chemical is exhaled (25 percent).

As mentioned previously in Section 3.1.2, the need for a quantitative evaluation of the inhalation pathway may not be warranted for all sites at the Station. A qualitative evaluation of exposure (i.e., comparison of maximum site soil data to SSLs for transfers from soil to air) will be used to identify whether a quantitative analysis of this exposure pathway is warranted.

Dermal contact with Soil/Sediment

Direct physical contact with soil (and sediment) may result in the dermal absorption of chemicals. Exposure associated with the dermal route are estimated in the following manner (USEPA, December 1989 and January 1992):

$$Intake_{si} = (C_{si}) (SA) (AF) (ABS) (CF) (EF) (ED) / (BW)(AT)$$

where:	Intake _{si}	=	amount of chemical "i" absorbed during contact with soil/sediment (mg/kg/day)
	C _{si}	=	concentration of chemical "i" in soil/sediment (mg/kg)
	SA	=	skin surface area available for contact (cm ² /day)
	AF	=	skin adherence factor (mg/cm ²)
	ABS	=	absorption factor (dimensionless)

- CF = conversion factor (1E-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

Exposed surface areas of 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 (USEPA, January 1992) were used to develop the following default assumptions concerning the amount of skin surface area available for contact for a receptor:

- For maintenance workers, full-time employees and construction workers, 20 percent of the total body surface area will be assumed to be available for soil contact.
- For adolescent trespassers and onsite residents, 30 percent of the total body surface area (20,000 cm²) will be assumed to be available for soil and/or sediment contact.
- For recreational users, 50 percent of the total body surface area will be assumed to be available for sediment contact.

The published range for the soil adherence factor is 0.2 to 1.0 mg/cm² (USEPA, January 1992). Soil adherence factors of 1.0 and 0.2 will be used to evaluate RME and CTE, respectively. Current USEPA Region III guidance (USEPA, December 1995) will be used to determine chemical-specific absorption factors.

Incidental Ingestion of Soil/Sediment

Incidental ingestion of soil (and sediment) by potential receptors coincides with dermal exposure:

$$Intake_{si} = (C_{si}) (IR_s) (FI) (EF) (ED) (CF) / (BW)(AT)$$

- where: Intake_{si} = intake of contaminant "i" from soil or sediment (mg/kg/day)
- C_{si} = concentration of contaminant "i" in soil or sediment (mg/kg)

IR _s	=	ingestion rate (mg/day)
FI	=	fraction ingested from contaminated source (dimensionless)
EF	=	exposure frequency (days/yr)
ED	=	exposure duration (yr)
CF	=	conversion factor (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

The same exposure frequencies and durations used in the estimation of dermal intakes will be used to estimate exposure via incidental ingestion. The fraction of soil ingested from the source is based on assumed human activity patterns and may be determined on a site-specific basis. Default values of 1.0 (RME) and 0.5 (CTE) will be used for this input parameter.

Dermal Contact with Groundwater/Surface Water

The same equation is used to estimate intakes for dermal contact with groundwater and surface water. Residential receptors are assumed to use groundwater for domestic purposes (i.e., bathing, showering, washing dishes) which can result in a dermal exposure. It is also possible under future land use conditions that deep excavations at the Station for activities such as utility maintenance and construction could result in a dermal exposure to the shallow groundwater). Dermal contact with surface water may also occur while receptors are involved in certain activities, such as fishing and trespassing. As discussed previously, the need for an evaluation of these exposure scenarios will be determined on a site-by-site basis.

The following equation will be used to assess exposures resulting from dermal contact with water (USEPA, January 1992):

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

where:	DAD _{wi}	=	dermally absorbed dose of chemical "i" from water (mg/kg/day)
	DA _{event}	=	absorbed dose per event (mg/cm ² -event)
	EV	=	event frequency (events/day)
	ED	=	exposure duration (yr)

EF	=	exposure frequency (days/yr)
A	=	skin surface area available for contact (cm ²)
BW	=	body weight (kg)
AT	=	averaging time (days); for noncarcinogens, AT = ED x 365 days/yr; for carcinogens, AT = 70 yr x 365 days/yr

Groundwater exposure for residential receptors will be assumed to occur on a daily basis, while exposure for other receptor groups will be limited to infrequent, site-specific exposure events. Dermal intakes for residents and select recreational users (i.e., water skiers, swimmers) will assume total body exposure. For other receptor groups, such as trespassers, fishermen, and construction workers, the exposed surface area of the body available for contact will be determined based on assumed activities and will be similar to the assumptions outlined for dermal contact with soil and sediment.

The absorbed dose per event (DA_{event}) will be estimated using a nonsteady-state approach for organic compounds and a traditional steady-state approach for inorganics. For organics, the following equations apply:

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

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

where:	t_{event}	=	duration of event (hr/event)
	t^*	=	time it takes to reach steady-state conditions (hr)
	K_p	=	permeability coefficient from water through skin (cm/hr)
	C_{wi}	=	concentration of chemical "i" in water (mg/L)
	T	=	lag time (hr)
	π	=	constant (dimensionless; equal to 3.141592654)
	CF	=	conversion factor (1E-3 L/cm ³)
	B	=	partitioning constant derived by Bunge Model (dimensionless)

Values for the chemical-specific parameters (t_{event} , t' , K_p , T , and B) will be obtained from the current dermal guidance (USEPA, January 1992, Table 5-8). If no published values are available for a particular compound, they will be calculated using equations provided in the cited guidance.

The following nonsteady-state equation will be used to estimate DA_{event} for inorganics:

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

In general, the recommended default value of 1E-3 will be used for the dermal permeability of inorganic constituents.

Incidental/Direct Ingestion of Groundwater/Surface Water

Residents may be exposed to groundwater via direct ingestion. Direct contact with surface waters while swimming or exploring could also result in the inadvertent ingestion of small amounts of water. Intakes associated with ingestion of water will be evaluated using the following equations (USEPA, December 1989):

$$Intake_{wi} = (C_{wi}) (IR_w) (EF) (ED) / (BW)(AT) \quad \text{for groundwater}$$

$$Intake_{wi} = (C_{wi}) (CR) (ET) (EF) (ED) / (BW)(AT) \quad \text{for surface water}$$

where:

$Intake_{wi}$	=	intake of chemical "i" from water (mg/kg/day)
C_{wi}	=	concentration of chemical "i" in water (mg/L)
IR_w	=	ingestion rate for groundwater (L/day)
CR	=	contact rate for surface water (L/hr)
ET	=	exposure time for surface water (hr/day)
EF	=	exposure frequency (days/yr)
ED	=	exposure duration (yr)
BW	=	body weight (kg)
AT	=	averaging time (days);
		for noncarcinogens, $AT = ED \times 365$ days/yr;
		for carcinogens, $AT = 70$ yr \times 365 days/yr

The same exposure times, frequencies, and durations used to assess dermal exposure to water will be used to estimate intakes for ingestion of water.

Inhalation of Volatiles in Groundwater

Groundwater exposure may also result in an inhalational exposure. This exposure route is typically evaluated for residential receptors only who may be exposed while showering, bathing, washing dishes, etc. For other receptors who may come in contact with groundwater, the inhalation pathway is assumed to be minimal and will not be evaluated. Inhalation exposures will be estimated using a mass transfer model, developed specifically for this exposure route, in combination with an air intake estimation model. The mass transfer model accounts for inhalation that occurs during a shower and after a shower while the receptor remains in the closed bathroom. The method which will be employed is as follows (USEPA, December 1989 and Foster and Chrostowski, 1987):

$$Intake_{si} = \frac{(S)(IR_{sh})(K)(EF)(ED)}{(BW)(AT)(R_a)(CF)} \left[\frac{\exp(-R_a \times D_t)}{R_a} - \frac{\exp(-R_a \times (D_s - D_t))}{R_a} \right]$$

where:	$Intake_{wi}$	=	intake of chemical "i" from water via inhalation (mg/kg/day)
	S	=	volatile chemical generation rate ($\mu\text{g}/\text{m}^3\text{-min}$ - shower)
	IR_{sh}	=	inhalation rate (L/min)
	EF	=	exposure frequency (showers/yr)
	ED	=	exposure duration (yrs)
	BW	=	body weight (kg)
	AT	=	averaging time or period of exposure (days)
	R_a	=	air exchange rate (min^{-1})
	K	=	mass transfer coefficient (min)
	D_s	=	shower duration (min)
	D_t	=	total time in bathroom (min)
	CF	=	conversion factor ($1\text{E}+6 \mu\text{g-L}/\text{mg-m}^3$)

The volatile chemical generation rate will be estimated using the Foster and Chrostowski mass transfer model, which is based on two-phase film theory. The model employs contaminant-specific mass transfer coefficients, Henry's Law constants, droplet diameter, drop time, viscosity, temperature, etc.

Ingestion of Finfish/Shellfish

Indirect chemical exposure may also occur via the ingestion of finfish or shellfish from the Potomac River or Mattawoman Creek. This exposure route will be evaluated under an adult recreational user exposure scenario using the following model (USEPA, December 1989):

$$Intake_{fi} = (C_{fi}) (IR_f) (EF) (ED) / (BW)(AT)$$

where: Intake_{fi} = intake of chemical "i" from shellfish/finfish (mg/kg/day)
 C_{fi} = concentration of chemical "i" in shellfish/finfish (mg/kg)
 IR_f = ingestion rate (kg/day)
 EF = exposure frequency (days/yr)
 ED = exposure duration (yr)
 BW = body weight (kg)
 AT = averaging time (days);
 for noncarcinogens, AT = ED x 365 days/yr;
 for carcinogens, AT = 70 yr x 365 days/yr

If actual fish tissue samples are available for a site, the tissue analytical data will be used to estimate intakes. If they are not available, finfish tissue concentrations will be estimated using surface water data and chemical-specific BCFs, as discussed in Section 3.1.2.

Summary of Exposure Parameters

In general, standard default parameters (USEPA, March 25, 1991), which combine mid-range and upper-end exposure factors, will be used to assess RME. CTE will be assessed primarily by the use of mid-range exposure factors presented in current risk assessment guidance (USEPA, May 1989 and May 5, 1993). Age-adjusted factors will be used to assess RME and CTE risks for residential receptors. General exposure input parameters for the identified potential receptor groups at the Station are presented in Table 3-3. These input parameters may be updated according to new risk assessment guidance, as it becomes available.

TABLE 3-3

**SUMMARY OF EXPOSURE ASSUMPTIONS
INDIAN HEAD, MARYLAND**

Receptor	Exposure Assumptions			Rationale/Reference
	Input Parameter	RME	CTE	
Maintenance Worker/ Full-Time Employee	EF (days/yr)	30 ⁽¹⁾ 150 ⁽²⁾	15 ⁽¹⁾ 150 ⁽²⁾	Professional judgement. Ground assumed to be frozen or snow covered for 22 weeks/yr. Infrequent exposure for maintenance workers; daily exposure for full-time employees.
	ED (yrs)	25	9	Convention for RME (USEPA, March 25, 1991); 50th percentile time at one residence for CTE (USEPA, May 1989).
	BW (kg)	70	70	USEPA, May 5, 1993.
	SA (cm ² /day)	4,000	4,000	20% of total body surface area (20,000 cm ²) assumed to be available for soil contact (USEPA, January 1992).
	IR _s (mg/day)	100	50	USEPA, May 5, 1993.
	IR _a (m ³ /hr)	2.5	2.5	Mean value for moderate activity (USEPA, May 1989).
	ET _a (hours/day)	8	4	Professional judgement.
Adolescent Trespasser (6-16 years)	EF (days/yr)	52	26	Professional judgement.
	ED (yrs)	10	10	Adolescents from age 7 to 16 evaluated.
	ET (hours/day) and t _{event} (hr/event)	4	2	Professional judgement.
	BW (kg)	43	43	Average age-specific value (USEPA, May 1989).
	SA (cm ² /day) and A (cm ²)	3,720	3,720	30% of total body surface area (12,400 cm ²) assumed available for contact (USEPA, January, 1992).
	IR _s (mg/day)	100	50	Assumed similar to adult exposure (USEPA, May 5, 1993).
	IR _a (m ³ /hr)	3.2	3.2	Moderate activity for a child, age 10 (USEPA, May 1989).
	EV (events/day)	1	1	Professional judgement.
	CR (L/hr)	0.05	0.05	USEPA, April 1988.
Adult Recreational User	EF (days/yr)	16 ⁽¹⁾ 48 ⁽²⁾	8 ⁽¹⁾ 48 ⁽²⁾	Professional judgement for skiing/swimming. Convention for fish ingestion (USEPA, December 1989).
	ED (yrs)	30	9	USEPA, May 5, 1993.
	ET (hours/day) and t _{event} (hr/event)	4	2	Professional judgement.
	BW (kg)	70	70	USEPA, May 5, 1993.
	SA (cm ² /day)	10,000	10,000	50% of total body surface area (20,000 cm ²) assumed to be available for sediment contact (USEPA, January 1992).
	A (cm ²)	20,000	20,000	Total body exposure for surface water contact.
IR _s (mg/day)	100	50	Based on USEPA, May 5, 1993.	

**TABLE 3-3
SUMMARY OF EXPOSURE ASSUMPTIONS
INDIAN HEAD, MARYLAND
PAGE 2**

Receptor	Exposure Assumptions			Rationale/Reference
	Input Parameter	RME	CTE	
Adult Recreational User (Continued)	EV (events/day)	1	1	Professional judgment.
	CR (L/hr)	0.05	0.05	USEPA, April 1988.
	IR _r (kg/day)	0.054	0.054	USEPA, Region III, May 10, 1996.
Construction Worker	EF (days/yr)	150	150	Professional judgement. Ground assumed to be frozen or snow covered for 22 weeks/yr.
	ED (yrs)	1	1	Estimated length of construction project (professional judgement).
	ET (hours/day) and t _{event} (hr/event)	2	1	Professional judgement.
	BW (kg)	70	70	USEPA, May 5, 1993.
	SA (cm ² /day) and A (cm ²)	4,000	4,000	20% of total body surface area (20,000 cm ²) assumed to be available for soil/groundwater contact (USEPA, January, 1992).
	IR _s (mg/day)	240	100	Professional judgement based on USEPA, March 25, 1991.
	IR _a (m ³ /hr)	4.8	4.8	Mean value for heavy activity (USEPA, May 1989).
	EV (events/day)	1	1	Professional judgement.
	Onsite/Offsite Resident ⁽³⁾	EF (days/yr or showers/yr)	150 ⁽⁴⁾ 350 ⁽⁵⁾	150 ⁽⁴⁾ 234 ⁽⁵⁾
ED (yrs)		24 ⁽⁶⁾ 6 ⁽⁷⁾	7 ⁽⁶⁾ 2 ⁽⁷⁾	USEPA, May 5, 1993.
ET (hours/day)		24	24	Constant exposure.
t _{event} (hr/event)		0.25	0.167	15 min/event for RME and 10 min/ev for CTE (USEPA, January 1992).
BW (kg)		70 ⁽⁶⁾ 15 ⁽⁷⁾	70 ⁽⁶⁾ 15 ⁽⁷⁾	USEPA, May 5, 1993.
SA (cm ² /day)		6,000 ⁽⁶⁾ 2,090 ⁽⁷⁾	6,000 ⁽⁶⁾ 2,090 ⁽⁷⁾	30% of total body surface area (20,000 and 6,970 cm ² for adult and child, respectively) assumed to be available for soil contact (USEPA, January 1992).
A (cm ²)		20,000 ⁽⁶⁾ 6,970 ⁽⁷⁾	20,000 ⁽⁶⁾ 6,970 ⁽⁷⁾	Total body exposure while showering/bathing.
IR _s (mg/day)		100 ⁽⁶⁾ 200 ⁽⁷⁾	50 ⁽⁶⁾ 100 ⁽⁷⁾	USEPA, May 5, 1993.
IR _a (m ³ /hr)		0.833 ⁽⁶⁾ 0.5 ⁽⁷⁾	0.833 ⁽⁶⁾ 0.5 ⁽⁷⁾	USEPA Region III, May 10, 1996.
IR _w (L/day)		2 ⁽⁶⁾ 1 ⁽⁷⁾	1.4 ⁽⁶⁾ 1 ⁽⁷⁾	USEPA, May 5, 1993 for adult exposure. USEPA Region III, May 10, 1996 for child exposure.

**TABLE 3-3
SUMMARY OF EXPOSURE ASSUMPTIONS
INDIAN HEAD, MARYLAND
PAGE 3**

Receptor	Exposure Assumptions			Rationale/Reference
	Input Parameter	RME	CTE	
Onsite/Offsite Resident (Continued)	EV (events/day)	1	1	Professional judgement.
	IR _{sh} (L/min)	10	10	USEPA, March 25, 1991.
	D _s (min)	15	10	USEPA, January 1992.
	D _s (min)	20	15	Professional judgement. An additional 5 minutes of time assumed to be spent in bathroom after shower.

- 1 Maintenance worker.
- 2 Full-time employee.
- 3 Swimming/water skiing.
- 4 Fish ingestion.
- 5 For dermal contact and inhalation while showering/bathing, onsite residential exposure based on adult exposure only.
- 6 Direct soil exposure.
- 7 Inhalation and groundwater exposures.
- 8 For adult; will be incorporated into an age-adjusted exposure factor.
- 9 For child; will be incorporated into an age-adjusted exposure factor.

3.2.5 Exposure to Lead

The equations and methodology presented in the previous section cannot be used to evaluate exposure to lead because of the absence of published dose-response parameters. Exposure to lead will be assessed using the latest version of the USEPA's Integrated Exposure Uptake Biokinetic (IEUBK) Model for lead (USEPA, February 1994). This model is designed to estimate blood levels of lead in children (under 7 years of age) based on either default or site-specific input values for air, drinking water, diet, dust, and soil exposure.

Studies indicate that infants and young children are extremely susceptible to adverse effects from exposure to lead. Considerable behavioral and developmental impairments have been noted in children with elevated blood lead levels. The threshold for toxic effects from this chemical is believed to be in the range of 10 µg/dL to 15 µg/dL. Blood lead levels greater than 10 µg/dL are considered to be a "concern".

For sites under investigation at the Station, the IEUBK Model for lead will be used to address exposure to lead in children when detected groundwater and surface water concentrations exceed the 15 µg/L Federal Action Level promulgated under the Safe Drinking Water Act and when detected soil and sediment concentrations exceed the OSWER soil screening level of 400 mg/kg for residential land use (USEPA, July 14, 1994a). Average chemical concentrations, as well as default parameters for some input parameters, will be employed. 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.

At this time, no mechanism is available to evaluate adult and adolescent exposure to lead. However, the results of the IEUBK Model for children will be used qualitatively to assess exposure to these receptor groups. Essentially, the qualitative discussion will cite that potential adverse effects from exposure to lead are expected to be of a lesser magnitude for adults and adolescents than for children.

3.3 TOXICITY ASSESSMENT

The objective of the toxicity assessment is to identify the potential health hazards and adverse 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 will be defined for the identified COCs. Quantitative toxicity values determined during this component of the risk assessment will be 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). Carcinogenic effects are quantified using the Cancer Slope Factor (CSF).

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 Station will be obtained from the following primary literature sources:

- Integrated Risk Information System (IRIS)
- Annual Health Effects Assessment Summary Tables (HEAST)
- NCEA Superfund Health Risk Technical Support Center

Although RfDs and CSFs can be found in several toxicological sources, USEPA's IRIS on-line data base is the preferred source of toxicity values. This data base is continuously up-dated and values presented have been verified by USEPA RfD and Carcinogenic Risk Assessment Verification Endeavor (CRAVE) work groups. The USEPA Region III RBC Tables will also be used as a source of toxicity criteria.

3.3.2 Toxicity Criteria for Dermal Exposure

RfDs and CSFs found in literature may be expressed as administered 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 this information is not always readily available, all oral dose-response parameters will be adjusted.

The adjustment to an absorbed dose will be made using chemical-specific absorption efficiencies published in available guidance (i.e., 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

If absorption efficiencies are not found in literature, default absorption efficiencies for volatiles (80 percent), semivolatiles/pesticides/PCBs (50 percent), and metals (5 percent) will be used.

3.3.3 Toxicity Criteria for Carcinogenic Effects of PAHs

Limited toxicity values are available to evaluate the carcinogenic effects from exposure to PAHs. The most extensively studied PAH is benzo(a)pyrene, which is classified by the USEPA as a known human carcinogen. Although CSFs are available for benzo(a)pyrene, insufficient data are available to calculate CSFs for other carcinogenic PAHs. Toxic effects for these chemicals will be evaluated using the concept of estimated orders of potential potency, as presented in current USEPA guidance (USEPA, July 1993). These parameters are based on the carcinogenicity of benzo(a)pyrene and are available for select carcinogenic PAHs. 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.

3.3.4 Toxicity Criteria for Carcinogenic Effects of Dioxins/Furans

Similar to the concept of estimated orders of potential potency for PAHs, chlorinated dibenzo-p-dioxins (CDDs) and -dibenzofurans (CDFs) will be evaluated using Toxicity Equivalence Factors (TEFs) relative to the toxicity of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) (USEPA, March 1989). Based on a variety of approaches that generate toxicities relative to 2,3,7,8-TCDD, the USEPA developed TEFs for other dioxins/furans from structure-activity relationships and the available toxicological information. The equivalent oral CSF for these chemicals is derived by multiplying the CSF for 2,3,7,8-TCDD by the TEF.

3.3.5 Toxicity Criteria for Chromium

Toxicity criteria are available for different forms of chromium, which is considered to be more toxic in the hexavalent state. Unless chromium speciation is performed at a site, risks associated with this chemical will be assessed by assuming that 10 percent of the reported total chromium result is attributable to hexavalent chromium, while 90 percent of the total chromium result is comprised of trivalent chromium. This assumption is based on published toxicological information (ATSDR, February 18, 1992).

3.3.6 Identification of Other Human Health-Based Criteria

Media-specific regulatory and human health-based criteria for COCs, other than dose-response parameters, will also be provided in the site-specific risk assessments. 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 (i.e., drinking water and ambient water quality criteria) are cleanup 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.

3.4 RISK CHARACTERIZATION

Potential risks (noncarcinogenic and carcinogenic) for human receptors resulting from the exposures outlined in the exposure assessment are quantitatively determined during the risk characterization component of the human health risk assessment.

A summary and interpretive discussion of the quantitative risk estimates will be provided in the text of the site-specific risk assessments. COCs which contribute significantly to elevated risks will be identified as "risk drivers" during the interpretive risk discussion. All of the numeric estimates of risk will be contained in the risk assessment spreadsheets, which will be appended to the assessment as support documentation.

3.4.1 Risk Estimation Methods

Quantitative estimates of risk will be calculated according to risk assessment methods outlined in current USEPA guidance (USEPA, December 1989). Lifetime cancer risks will be expressed in the form of dimensionless probabilities, referred to as Incremental cancer risks (ICRs), based on CSFs. Noncarcinogenic risk estimated will be presented in the form of Hazard Quotients (HQs) that are determined through a comparison of intakes with published RfDs.

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

$$ICR = (Estimated\ Exposure\ Intake) (CSF)$$

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

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

An ICR of 1E-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.

As mentioned previously, noncarcinogenic risks will be assessed using the concept of HQs and Hazard Indices (HIs). The HQ for a COC is the ratio of the estimated intake to the RfD, as follows:

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

An HI will be generated by summing the individual HQs for all of the COCs. 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.

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. Calculated ICRs will be interpreted using the USEPA's "target range" (1E-4 to 1E-6), while HIs will be evaluated using a value of 1.0.

The USEPA has defined the range of 1E-4 to 1E-6 as the ICR "target range" for most hazardous waste facilities addressed under CERCLA. Individual or cumulative ICRs greater than 1E-4 will not be considered as protective of human health, while ICRs below 1E-6 will be regarded as protective.

An HI exceeding unity (1.0) indicates that there may be potential noncarcinogenic health risks associated with exposure. If an HI exceeds unity, a segregation of target organs effects associated with exposure to COCs will be performed. Only those chemicals which impact the same target organ(s) or exhibit similar critical effect(s) will be regarded as truly additive.

3.5 UNCERTAINTY ANALYSIS

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

4.0 ECOLOGICAL RISK ASSESSMENT

An Ecological Risk Assessment will be performed for those sites where contamination levels indicate that the site may pose a risk to the ecology. The evaluation process is described in this section of the Work Plan.

In addition to characterizing the nature and extent of site contamination and assessing potential risks to human health, the RI process also requires an assessment of the potential adverse effects of site contamination on the environment. Specifically, ecological receptors may be at risk from environmental contamination associated with NSWC Indian Head. Accordingly, an Ecological Risk Assessment (ERA) will be performed to characterize the potential risks from NSWC Indian Head-related contaminants to ecological receptors that inhabit the installation area. This section provides an outline of the general approach for assessing the impacts of site contamination on aquatic, terrestrial biota and the habitats that support these organisms. This effort represents a "baseline" risk assessment, conducted to evaluate potential risks to ecological receptors under present site contamination conditions, assuming that no remediation is to occur. The assessment will generally follow a two-step process, as follows:

Step 1: Preliminary Problem Definition and Ecological Effects Characterization

- Preliminary Problem Definition - This is the first phase of an ERA, which will discuss the goals, breadth, and focus of the assessment. It includes general descriptions of NSWC Indian Head RI sites with emphasis on the habitats and ecological receptors present. This phase also involves characterization of contaminant sources and migration routes, evaluation of routes of contaminant exposure, and the selection of Contaminants of Potential Concern (COPCs). Assessment and measurement endpoints that will be evaluated are also selected. Finally, a conceptual model will be developed that describes how contaminants associated with the RI sites may come into contact with ecological receptors.
- Ecological Effects Characterization - In this component, media-specific ecotox threshold screening values (ETs) for each COPC (i.e., concentrations of each contaminant above which adverse effects to ecological receptors may occur) will be identified or derived. This step is undertaken concurrently with the exposure assessment described below.

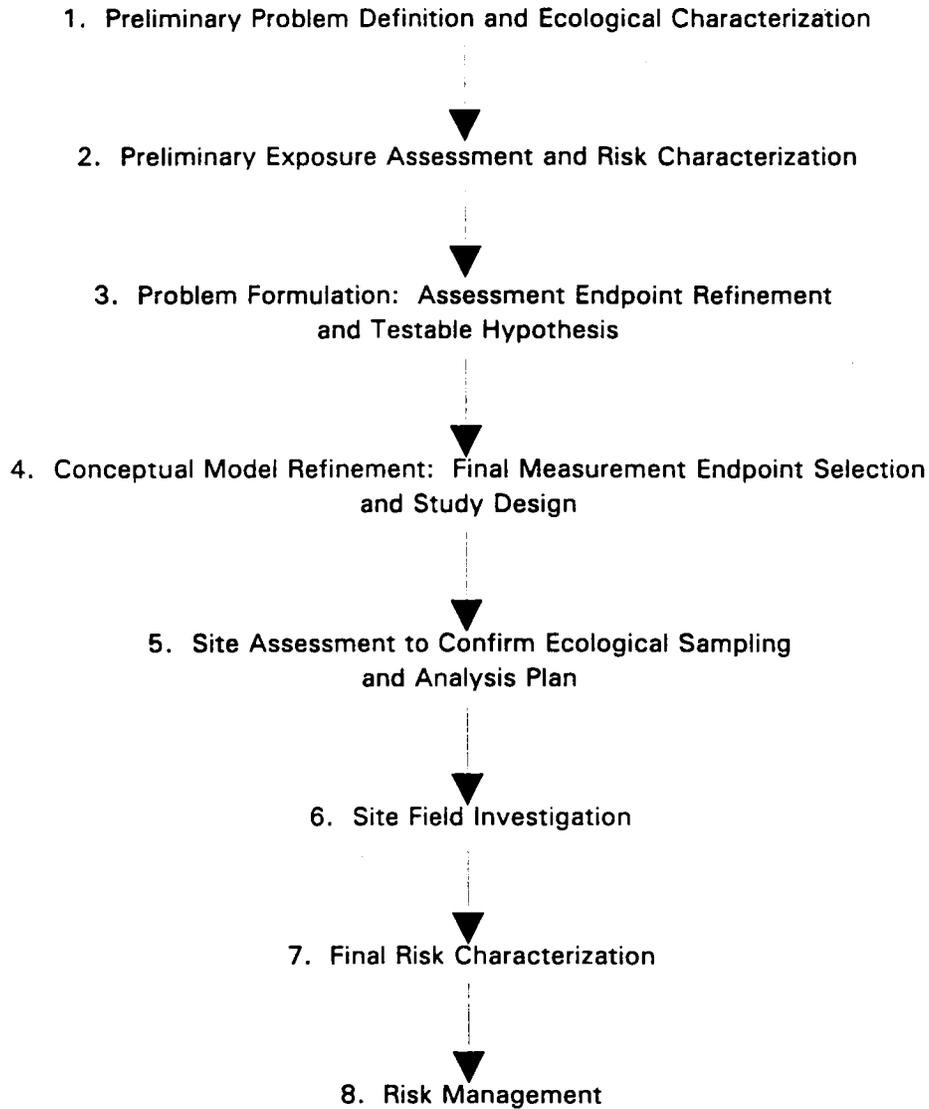
Step 2: Preliminary Exposure Assessment and Risk Characterization

- Preliminary Exposure Assessment - This portion of the ERA involves the identification of the data used to represent concentrations of contaminants to which ecological receptors may be exposed in various media, and the actual selection of exposure point concentrations from those data.
- Risk Characterization - In this step exposure concentrations will be compared to ETs in order to characterize risk to ecological receptors from potential contaminant exposure. COPCs found to pose potential risk after these comparisons will be placed on a list of Contaminants of Concern (COCs). Toxicity profiles describing the fate, transport, and toxicities of all COCs will also be developed. In addition, conclusions will be drawn during this step. The uncertainties associated with the assessment process will also be addressed.

The above process, described in further detail below, is the first two steps in an eight step approach outlined in USEPA guidance for performing ERAs at CERCLA sites (USEPA, 1994a; Figure 4-1), and is a summation of the ten-step ERA process recommended by USEPA Region III (USEPA, 1994b), which will serve as the basis of the ERA methodology. Furthermore, the ERA will be conducted in accordance with other available ERA guidance documents (USEPA, 1992; Wentzel et al., 1994), and recent publications (Suter, 1993; Calabrese and Baldwin, 1993).

These two steps are considered the first "tier" in a three-tiered ERA approach recommended by USEPA Region III (1994b). Due to the potential complexity of ERAs, they are often conducted using a tiered approach and punctuated with Scientific/Management Decision Points (SMDPs), which are meetings involving the risk assessors, regulatory contacts, risk managers, and client (Figure 4-1), to control costs, prevent unnecessary analyses, and ensure that the ERA is proceeding in an efficient, timely manner. Information analyzed in one tier is evaluated to determine whether the objectives of the study have been met, and then may be used to identify the data required for the next tier, if necessary. Tier 1, the focus of this Work Plan, can also be viewed as a "screening-level assessment," since the conclusions are based on a preliminary contaminant level screening in various media, and may warrant further ecological study in successive tiers on the effects of contaminants from NSWIC Indian Head activities on ecological receptors (USEPA, 1994b). Tiers 2 and 3, referred to as semi-quantitative and quantitative assessments, respectively, would be more focused studies that incorporate the initial screening but may also encompass more detailed laboratory and field studies, or extensive modeling (USEPA, 1994b).

FIGURE 4-1
STEPS IN THE ECOLOGICAL RISK ASSESSMENT PROCESS
(ADAPTED FROM USEPA, 1994a)
INDIAN HEAD, MARYLAND



4.1 PRELIMINARY PROBLEM DEFINITION AND ECOLOGICAL EFFECTS CHARACTERIZATION

As summarized above, the first step in the ERA process involves preliminary problem definition and ecological effects characterization. Section 4.1.1 describes the components associated with preliminary problem definition and Section 4.1.2 describes the components associated with ecological effects characterization.

4.1.1 Preliminary Problem Definition

4.1.1.1 Site Description and Physical Features

The first step in preliminary problem definition will be a general NSW Indian Head site description, or site characterization, discussing the overall ecology of the installation. This will also include geological, hydrogeological, and climatologic descriptions of the NSW Indian Head area as they relate to the ecological setting on the installation.

4.1.1.2 Habitat Types and Ecological Receptors

ERAs will be conducted on contaminated sites initially identified during previous environmental investigations at the base, including the Site Investigation (E/A&H, 1992; E/A&H, 1994), site-specific biomonitoring (HNUS, 1995), and initial reconnaissance performed by B&RE in 1996. As a result, RI site-specific descriptions of habitat types and ecological receptors will be composed. This will encompass aquatic habitats and receptors, terrestrial habitats and wildlife, and terrestrial vegetation. Additionally, searches will be conducted for state and federally listed rare, threatened and endangered species. An evaluation of sensitive habitats, such as wetlands, and threatened and endangered species on and around each RI site will also be provided, in accordance with all applicable or relevant and appropriate requirements (ARARs). A preliminary list of ARARs to be followed in this ERA is as follows:

- Executive Order 11988, Protection of Floodplains
- Executive Order 11990, Protection of Wetlands
- Clean Water Act (Section 404 40 CFR 230.10)
- Fish and Wildlife Coordination Act (16 USC 661 et seq.)/Endangered Species Act (16 USC 1531 et seq.)
- State Water Quality Standards and Federal Water Quality Criteria (described in Section 4.1.2.1)

4.1.1.3 Contaminant Sources, Release Mechanisms, and Migration Pathways

The nature of the RI sites at NSWC Indian Head results in several different contaminant sources, release mechanisms, and migration pathways. These items will be investigated on an RI site-specific basis. In general, release pathways that will be evaluated include volatilization, wind erosion, overland runoff/outfalls, and infiltration of contaminants. Constituents in the site soil may volatilize from surficial material or become airborne via resuspension. Fugitive dust may also be generated during ground-intrusive activities, such as construction or excavation. These chemicals are dispersed in the surrounding environment and transported to downwind locations where they may re-partition to surface soil, surface water, or sediment through gravitational settling, precipitation, and deposition.

Precipitation runoff and outfalls may carry constituents to nearby surface waters, sediments, and soils. Infiltrating precipitation may cause the contamination of surface water, subsurface soil, and groundwater. Chemicals with a stronger tendency to adsorb to organic matter in a soil are expected to migrate at a slower rate. Upon infiltrating the soil column and reaching the water table, a chemical may be carried with the flow of groundwater to downgradient locations. Groundwater from the site may eventually discharge to surface water; contaminants may be subsequently deposited in sediment or they may accumulate in the tissues of aquatic organisms.

4.1.1.4 Exposure Routes

The unique nature of the different RI sites also results in the presence of several possible contaminant exposure routes. A brief description of general exposure routes that will be investigated on an RI site-specific basis is provided below.

Terrestrial animal receptors associated with the base may be exposed to soil contaminants via incidental ingestion of soil and ingestion of contaminated food items. Terrestrial vegetation may be exposed to contaminants via root translocation from contaminated soils and direct aerial deposition onto leaves. Terrestrial receptors may also come into contact with contaminants present in surface water by using it as a source of drinking water, although exposure via this route is usually minuscule. In addition, terrestrial receptors such as piscivorous birds and riparian-associated mammals may be exposed to contaminants by incidental ingestion of surface water and sediments, and ingestion of contaminants in prey. Exposure to contaminants present in the surface soil via dermal contact may occur but is unlikely to represent a major exposure pathway because fur, feathers, and chitinous exoskeletons minimize transfer of contaminants across dermal tissue.

Although some volatile constituents may be present in soil and soil-bound contaminant resuspension may occur on some RI sites, inhalation will not represent a significant exposure pathway because air contaminant concentrations are assumed to be quite low at all RI sites and for all sources, even for burrowing wildlife. In addition the inhalation pathway is generally insignificant for ecological receptors and inhalation screening levels for chronic exposure are scarce. Hence, the air pathway will not be considered for ecological receptors.

Aquatic organisms inhabiting the installation area may be exposed to contaminants via direct contact with surface water and sediments, incidental ingestion of surface water and sediments, and consumption of contaminated prey. Furthermore, aquatic organisms may be exposed to constituents from contaminated groundwater that flows into surface water.

4.1.1.5 Selection of Preliminary Contaminants of Potential Concern

Preliminary COPCs will be all contaminants detected in RI sampling activities for each site of "ecological relevance." RI sites will be considered ecologically relevant if they meet one or more of the following criteria.

- The presence of viable ecological habitat (note that viable ecological habitat may be absent due to contaminants or habitat alteration, which will be considered).
- The presence of ecological receptor populations.
- The presence of contaminant migration pathways. Although a site may contain no or marginal ecological habitat, it will be assessed if site-related contaminants have the potential to migrate to areas containing more extensive or more viable habitat. A site of this nature may contribute to overall contamination in the watershed in which it exists.
- The existence of complete exposure routes.

Although individual RI sites will be assessed, the potential additive effects of their COPCs on the entire watershed in which they are located will be assessed. This is commonly referred to as a "watershed approach".

4.1.1.6 Assessment and Measurement Endpoints

As discussed in USEPA (1994a), and Wentsel et al. (1994) one of the major tasks in problem definition is the selection of assessment and measurement endpoints. An assessment endpoint is defined as "an explicit expression of actual environmental values that are to be protected" (USEPA, 1994a). Measurement endpoints are "measurable ecological characteristics that are related to the valued characteristic chosen as the assessment endpoint" (USEPA, 1994a). For this ERA, the most appropriate assessment endpoint will be the maintenance of receptor populations that inhabit NSW Indian Head. Therefore, the specific objectives of this assessment will be to determine if exposure to contaminants present in the surface water, sediment, and soil on and near the installation are likely to result in declines in ecological receptor populations. Declines in populations could result in a shift in community structure and possible elimination of resident species.

As indicated above, measurement endpoints are related to assessment endpoints, but these endpoints are more easily quantified or observed. In essence, measurement endpoints serve as surrogates for assessment endpoints. While declines in populations and shifts in community structure can be quantified, studies of this nature are generally time-consuming and difficult to interpret. However, measurement endpoints indicative of observed adverse effects on individuals are relatively easy to measure in toxicity studies and can be related to the assessment endpoint. For example, contaminant concentrations that lead to decreased reproductive success or increased mortality of individuals in toxicity tests could, if found in the environment, result in shifts in population structure, potentially altering the community composition associated with RI sites. Therefore, for this ERA, the highest contaminant concentrations unlikely to result in adverse effects on individuals will be tentatively selected as measurement endpoints.

4.1.1.7 Conceptual Site Model

The conceptual model is designed to diagrammatically present potentially exposed receptor populations and applicable exposure pathways, based on the physical nature of the sites and the potential contaminant source areas. Actual or potential exposures of ecological receptors associated with RI sites will be determined by identifying the most likely pathways of contaminant release and transport. A complete exposure pathway has three components: (1) a source of chemicals that can be released to the environment; (2) a route of contaminant transport through an environmental medium; and (3) an exposure or contact point for an ecological receptor. The ERA will provide a base-wide conceptual site model.

4.1.2 Ecological Effects Characterization

For this ERA, contaminant screening levels, referred to as "ecotox thresholds" (ETs; USEPA, 1996), which are concentrations of contaminants in various media protective of ecological receptors, will be selected to screen exposure point concentrations in surface water, sediment, and soil to determine if they qualify as COCs and pose potential ecological risk at NSWC Indian Head. Methods used for the selection of media-specific ETs are provided below. The completed ERA will contain tables listing ET values used for all media at all RI sites. ET values used will be reflective of the endpoints selected.

4.1.2.1 Selection of Surface Water ETs

Actual exposures of aquatic receptors to preliminary COPCs are assumed to be primarily chronic (long-term) exposures, usually at sublethal concentrations. For this ERA, benchmark values used to identify surface water COPCs will be chronic screening values preferentially obtained from USEPA Region III BTAG draft screening levels (USEPA, 1995). Most of these values are Federal Ambient Water Quality Criteria (AWQC; USEPA, 1991). State-specific Water Quality Standards (WQS) will also be used, if requested. Site-specific ET values may be derived if hardness data are available for RI sites, as per USEPA guidance (USEPA, 1996). The screening levels described above are protective of a wide variety of sensitive species and are, therefore, inherently conservative. USEPA Region III and Maryland Department of the Environment (MDE) will also be consulted during final surface water ET selection to ensure that all preferred ETs and all related ARARs are being followed.

4.1.2.2 Selection of Sediment ETs

Screening levels for assessing potential risks to benthic organisms from sediment contaminants will also be preferentially gathered from USEPA Region III BTAG screening levels (USEPA, 1995). However, these values are primarily Effects Range-Low (ER-L) values from Long and Morgan (1990) and Long et al. (1995), and Apparent Effects Thresholds (AETs) from various literature sources. ER-L values were derived from marine and estuarine systems, but surface waters on and near NSWC Indian Head are freshwater. These values are often used to assess freshwater systems, but only in the absence of appropriate freshwater screening levels. Certain AET values may have been derived from freshwater studies, but since the AET is the sediment contaminant concentration above which statistically significant biological effects always occur, they may be under-protective (Jones et al., 1996).

For these reasons, sediment ET values from other appropriate freshwater-based sources will also be presented, including Ontario Ministry of the Environment screening guidelines (OME, 1992), USEPA sediment quality criteria and benchmarks (USEPA, 1996), and those derived as part of ongoing Great

Lakes sediment research (Smith et al., 1996; Ingersoll et al., 1996). For this screening-level assessment, the most conservative values from the sources mentioned above will also be presented if the most conservative ET values are exceeded, to obtain a risk range.

4.1.2.3 Selection of Surface Soil ETs

Initial reconnaissance has indicated that surface soil may be a medium through which contaminants at the installation may migrate, but may not be an exposure medium, since the sites of main concern possess primarily aquatic exposure routes. Specifically, the sites that preliminarily appear to be ecologically relevant either contain limited terrestrial habitat or terrestrial habitats that are not contaminated. However, if subsequent RI investigations reveal that surface soil may be an exposure medium for terrestrial receptors, surface soil ETs will be used in the ERA. Widely accepted and comprehensive ET values for screening risk to terrestrial receptors from surface soil contaminants do not exist. While many sources have identified conservative, "safe" soil contaminant levels from a human health perspective, only a few have developed soil benchmark values with protection of ecological receptors as a goal. When possible, the ERA will preferentially select those soil benchmark values presented by USEPA Region III (USEPA, 1995). However, it should be noted that significant data gaps exist in BTAG tables as a result of the paucity of values in the primary literature. Some values may be available from Will and Suter (1994a). These data were derived for screening the potential effects of contaminants on soil litter invertebrates.

4.1.2.4 Selection of Terrestrial Plant ETs

Benchmarks for initial screening of risk from soil contaminants to terrestrial plants will be preferentially obtained from Will and Suter (1994b), if needed. If ETs are not available from Will and Suter, they will be obtained from various sources in the primary literature.

4.2 PRELIMINARY EXPOSURE ASSESSMENT AND RISK CHARACTERIZATION

The second step in the ERA process involves preliminary exposure assessment and risk characterization. Section 4.2.1 describes the components of preliminary exposure assessment and Section 4.2.2 describes the components of risk characterization.

4.2.1 Preliminary Exposure Assessment

4.2.1.1 Exposure Point Contaminant Concentrations

Data used to obtain contaminant concentrations in environmental media to be used as representative exposure point concentrations for this initial screening will be those generated from RI activities.

Representative exposure point concentrations in surface water, sediment, and surface soil will be 95% Upper Confidence Limits (UCLs) from RI data. For small sample sets, or if the 95% UCL is less than 80% of the maximum detected value, the maximum value will be used, as per USEPA Region III guidance (USEPA, 1994b). In addition, if the ETs used are below the detection limit, one-half of the sample quantitation limit will be used as the representative concentration. The 95% UCLs or maximum detected concentrations are used as conservative exposure point concentrations to minimize uncertainty in the screening-level assessment and assure that the most sensitive species will be protected. Background contaminant concentrations "presented for comparative purposes" will be gathered from base-wide, site-specific, or region-wide background data.

4.2.2 Risk Characterization

As identified by USEPA (1994a), the second step in the ecological risk assessment process compares the representative exposure point concentrations with contaminant concentrations that are protective of ecological receptors (ETs). Once this step is completed, the results of this study can be reviewed to determine whether a) little or no ecological risk is associated with RI sites or b) additional information must be generated to verify that ecological receptors are or are not at risk. The ratio of the exposure point concentration to the screening value (ET) is called the environmental effects quotient (EEQ), or hazard quotient (HQ), and is defined as follows:

$$EEQ_i = EPC_i/ET_i$$

where:

EEQ_i = Environmental Effects Quotient for chemical "i" (unitless)

EPC_i = Exposure Point Concentration for chemical "i" (mg/l or mg/kg)

ET_i = Ecotox Threshold Benchmark Value for chemical "i" (mg/l or mg/kg)

Potential risk will be considered possible when the ratio of the exposure concentration to its respective ET value exceeds 1.0. The EEQ value should not be construed as being probabilistic but rather as a numerical indicator of the extent to which an exposure concentration exceeds or is less than a screening value. When HQ values exceed 1.0, it is an indication that ecological receptors are potentially at risk; additional evaluation or data may be necessary to confirm with greater certainty whether these receptors are actually at risk. As stated earlier, most ET values to be used are derived using heavily conservative assumptions and calculations, which can result in relatively high risk numbers that are not truly indicative of potential risk, i.e., again, an EEQ greater than one may be misleading or actually be indicative of low

potential risk. USEPA Region III has suggested that values higher than 10 are indicative of moderately high potential risk, and values greater than 100 are indicative of high potential risk (USEPA, 1994b).

The comparisons described above will be presented in site-specific screening tables to select COCs. COPCs will be retained as COCs if the most conservative ET values are exceeded, but a less conservative ET (e.g., an ER-M for sediment) will be provided for comparison, if available. Hence the table would contain two ETs and EEQs for a given contaminant. When only one ET is available, only one EEQ will be presented. Screening tables will also present representative background contaminant concentrations. Representative background contaminant concentrations will be obtained from base-wide, region-wide, or site-specific background data. Qualitative comparisons of representative concentrations of inorganics to background concentrations are recommended by USEPA (1996) since concentrations of inorganics can be naturally high and not indicative of installation-related contaminant releases. These comparisons need to be taken into account when making risk management decisions.

The use of EEQs is probably the most common method used for risk characterization in ERAs. Advantages of this method, according to Barnthouse et al. (1986), include the following:

- The EEQ method is relatively easy to implement, is generally accepted, and can be applied to any data.
- This method is useful when a large number of contaminants must be screened.

However, this method of risk characterization has some inherent limitations. One primary limitation is that it is a "yes/maybe" method for relating toxicity to exposure. That is, it uses single values for exposure concentrations and screening levels and does not account for the variability in both these parameters, nor for incremental or cumulative toxicity.

Some inorganics, such as calcium, iron, magnesium, potassium, and sodium may be initially excluded as COPCs since they are essential nutrients and are only toxic at extremely high concentrations. Also, if no suitable ET is available for any contaminant in any medium, it will be conservatively retained as a COC and qualitatively assessed. Toxicity profiles describing the fate, transport, and toxicities of all COCs in all media will also be developed. Surface water physical parameters, such as temperature, dissolved oxygen, hardness, and pH, and sediment physical parameters, such as TOC, % solids, and grain size may also be measured as part of the RI, where applicable. These parameters will also be presented and discussed in the ERA.

Once the risk assessment is complete, the results will be reviewed and evaluated to identify the type and magnitude of uncertainty involved. Reliance on results from a risk assessment can be misleading without consideration of uncertainties, limitations, and assumptions inherent in the process.

4.3 SUMMARY

The screening-level ERA will conclude with a summary of results for each RI site of ecological relevance. As stated in this Work Plan, the 95% UCL or maximum exposure point concentrations for contaminants in surface water, sediment, and surface soil will be compared to screening values (ETs) that are protective of ecological receptors to assess potential risk to aquatic and terrestrial organisms. The relative potential risks that COPCs might pose to ecological receptors inhabiting the NSWC Indian Head area will be evaluated in the form of environmental effects quotients (EEQs). Also, data and results of previous biological studies at and around the base will be incorporated in the assessment. The results of this initial screening and results of previous studies will be used to ascertain whether COCs from NSWC Indian Head activities are present in surface water, sediment, and surface soil in concentrations that may pose little or no risk to ecological receptors, or that risk is potentially present and remediation or further ecological study may be warranted.

5.0 WORK PLAN DEVELOPMENT

The Navy has the responsibility of ensuring that site investigation and restoration projects are performed efficiently in the most cost-effective and timely manner, considering pertinent constraints, such as the need to protect human health and the environment, site closure requirements, regulatory compliance, and funding limitations. For these reasons, clearly focused site investigations are required to help improve the efficiency of the investigation and restoration process. Therefore, the Navy has developed and will implement an approach to improve the efficiency of the site investigation and restoration process through the appropriate use of guidance from USEPA, previous environmental work at the Station and other facilities, use of innovative technologies when warranted (e.g., direct penetration technology, onsite analyses), and new tools and methods for data analysis and presentation (e.g., geographic information systems - GIS). Together, this approach should provide for a more clearly focused, cost-effective site investigation.

This Master Work Plan and other master planning documents present general procedures and methods to perform consistent environmental investigations at the Indian Head Division, Naval Surface Warfare Center. A project specific work plan will be prepared to address specific sites.

5.1 INVESTIGATION OBJECTIVE

The overall objective of the environmental investigation work at the Station is to efficiently characterize environmental contamination to determine whether there is a risk to human health and the environment. Data will be collected to: (1) determine if the sites have caused contamination to enter the environment, (2) define the nature and extent of contamination, (3) determine whether additional investigation and characterization is needed, and/or (4) determine whether further action is required. The data will be used to develop and design appropriate remedial actions or justify No Further Action. Specific objectives for each site shall be presented in project specific work plans.

5.2 PROJECT SPECIFIC WORK PLANS

Prior to investigation, a project specific work plan will be prepared. In order to perform focused, cost effective sampling and analysis, the project specific work plan will summarize the investigative process in a logical manner. The investigation process will begin in the work plan stage and will include:

- Preliminary risk evaluation
 - Human health
 - Ecological
- Establishment of predetermined decision rules

The above components have been integrated into a process that meet the objectives of the EPA Data Quality Objective (DQO) process. For each site, a specific section in the Project Specific Work Plan will be prepared that presents the following information:

- Background Information and Site Description
- Previous Environmental Investigation
- Investigative Scoping
- Work Plan

Background Information and Site Description. This section will present background information and describe the site. It will include a brief history and describe the general location of the site.

Previous Environmental Investigations. Previous environmental investigative work will be summarized including analytical results and biomonitoring activities (if any).

Investigative Scoping. Known environmental information will be compared to what data is necessary to assess the site and determine what action is appropriate. This section will include the pertinent information and include the following:

- Contaminated Media and Exposure Pathways
- Identified and/or Suspected Contaminants
- Preliminary Site Risk Evaluation
- Data Gaps
- Decision Rule
- Potential Remedial Action

Potential human health and ecological risks will be evaluated and used as a basis to perform investigations. The investigative scoping process will be summarized on tables as shown on Table 5-1.

Work Plan. A site specific investigative work plan will be prepared for each site. Proposed investigative activities will be summarized in a table as shown on Table 5-2.

TABLE 5-1

**INVESTIGATION SCOPING TABLE
INDIAN HEAD, MARYLAND**

Contaminant Media/Exposure Pathway	Identified/ Suspected Contaminants	Screening Criteria	Preliminary Risk Evaluation	Data Gaps/ Investigative Objective	Decision Rule	Potential Remedial Action
Identify what media may be contaminated and possible exposure pathway and receptors.	Based on existing knowledge, identify what contaminants have the potential to be found at the site.	Identify relevant screening/ decision levels. (Primarily USEPA Region III RBC Screening Levels)	Identify potential receptors and possible impacts.	Identify and summarize what additional information is necessary to characterize and assess the site.	Identify the decisions that will be made based on the information collected.	Identify potential remedial methods and technologies.

TABLE 5-2
SITE SPECIFIC WORK PLAN TABLE
INDIAN HEAD, MARYLAND

Media/Data Needs	Investigative Techniques	Location	Number of Samples	Analysis
Identify what media will be sampled.	Describe what type of sampling will be performed.	Describe sampling locations.	Number of samples to be collected.	Describe the type of analysis that will be performed and analytical method.

5.3 DATA QUALITY OBJECTIVES

The Project Specific Work Plans will generally comply with the objectives of the DQO process. The DQO process consists of seven steps. The seven step DQO process and where they will be addressed in the planning documents is presented on Table 5-3.

TABLE 5-3

**INTEGRATION OF DQO PROCESS INTO SITE-SPECIFIC WORK PLAN
INDIAN HEAD, MARYLAND**

DQO Step ^(Source: EPA, 1994)	Location in Site-Specific Work Plan Document
1. State the Problem	Section 1.0, Background Section 2.0, Previous Investigations Table 3-1, Investigative Scoping Columns: <ul style="list-style-type: none"> • Contaminant Media/Exposure Pathway • Identified Suspected Contamination • Preliminary Risk Evaluation
2. Identify the Decision	Section 3.1, Objectives Table 3-1, Investigative Scoping Columns: <ul style="list-style-type: none"> • Data Gaps/Investigative Objective • Decision Rule • Potential Remedial Action
3. Identify the Inputs to the Decision	Table 3-1, Investigative Scoping Column: <ul style="list-style-type: none"> • Screening Criteria
4. Define the Boundaries of the Study	Section 1.0, Background Table 3-1, Investigative Scoping Column: <ul style="list-style-type: none"> • Data Gaps/Investigative Objective
5. Develop a Decision Rule	Table 3-1, Investigative Scoping Columns <ul style="list-style-type: none"> • Decision Rule • Potential Remedial Actions
6. Specify Tolerable Limits on Decision Efforts	Master QAPP
7. Optimize the Design for Obtaining Data	Section 4.0, Site Specific Work Plan Table 3-2, Investigation Matrix

6.0 REGULATORY BACKGROUND

This section describes how the site is being regulated, its current status under CERCLA, and a summary of Applicant or Relevant and Appropriate Requirements (ARARs).

6.1 REGULATORY OVERVIEW

The Indian Head Division, Naval Surface Warfare Center was placed on the NPL in 1995. The lead regulatory agency for the project is the USEPA. The MDE also provides input into the regulatory process. In addition, there are other regulatory programs that affect the Station including the Chesapeake Bay Agreement and the National Pollution Discharge Elimination System (NPDES).

6.1.1 Chesapeake Bay Agreement

Due to increased industry, agriculture and residential population demands, the Chesapeake Bay water quality has declined over the years. The U.S. Environmental Protection Agency (USEPA), representing the Federal government, the District of Columbia, Maryland, Pennsylvania and Virginia have signed the Chesapeake Bay Agreement. This agreement establishes a policy to halt and reverse this decline and provides a framework for continued cooperative efforts to restore and protect the Chesapeake Bay. The Department of Defense (DOD) and the USEPA have entered into a Cooperative Agreement to provide an active, coordinated program of pollution prevention and cleanup at installations in the Chesapeake Bay watershed. The Navy has designated the Commander of Naval Base Norfolk as the Chesapeake Bay Initiative Program Coordinator for all DOD installations in the Chesapeake Bay area. The Station is within the Chesapeake Bay watershed and has provided a point of contact to the Navy Program Coordinator.

There are no regulations unique to the Chesapeake Bay Agreement which require DOD compliance. The DOD is, however, voluntarily complying with the Chesapeake Bay Preservation Act. Additionally, installations must comply with all NPDES permits and consent agreement requirements as such compliance provides for improvement in the Chesapeake Bay watershed.

6.1.2 National Pollution Discharge Elimination System

The Station participates in the National Pollutant Discharge Elimination System (NPDES) Permit process in compliance with the Clean Water Act (CWA). The NPDES permit process identifies national goals to

eliminate the introduction or discharge of pollutants and toxic substances into waters of the United States, thus, restoring and maintaining biological and chemical integrity.

To attain goals established by the CWA, the USEPA identifies different types of pollutants and the degrees of technology that must be applied to remove pollutants from point sources of wastewater. Point source means any discernible, confined and discrete conveyance, including, but not limited to, any pipe, ditch, channel, tunnel, conduit, well, or landfill leachate collection system. All discharges of pollutants to waters of the United States from point sources must have a NPDES permit. Point source discharge requirements are implemented through the NPDES, a nationwide permit program that is administered by the USEPA or USEPA-approved state programs. This program issues, modifies, revokes and reissues, terminates, monitors and enforces permits. The CWA also authorizes the USEPA to promulgate pretreatment standards for industrial sources discharging effluents to publicly-owned treatment works (POTWs).

6.2 STATION CERCLA STATUS

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) in 1986, was promulgated to identify contamination resulting from past operations at closed or abandoned facilities (where operations ceased prior to November 1980) and to institute corrective measures as appropriate. In addition to requiring investigation and cleanup of sites, CERCLA also mandates reporting releases or threatened releases of hazardous substances from both current and past operations.

In addition, the USEPA has published regulations for responding to oil and hazardous spills in the National Oil and Hazardous Substances Pollution Contingency Plan (referred to as the National Contingency Plan (NCP)). The NCP established a phase approach to address potential emergency responses or removal situations. The response process consists of the preparation of a Preliminary Assessment (PA) and Site Inspection (SI). When the PA and SI are completed, the site is scored using the Hazard Ranking System (HRS). A site with an HRS score of 28.50 or greater becomes eligible for the National Priorities List (NPL).

Sites placed on the NPL are subject to a further, more detailed, remedial investigation. The objective of the remedial phase is to eliminate, reduce, or control risks to human health and the environment. Following the final listing of a Federal facility on the NPL, the negotiation of a Federal Facility Agreement (FFA) is required. The FFA is a legal document between the USEPA, the State, and the facility. Those geographical areas listed in the FFA as posing a potential risk to human health or the environment are

designated as Site Screening Areas (SSAs). SSAs may be RCRA SWMUs, Areas of Concern (AOCs), or current CERCLA sites.

Once designated, each SSA is preliminary investigated to confirm that it does or does not pose a potential risk to human health or the environment. Each SSA is ranked such that the worst sites, defined either qualitatively and/or quantitatively, are investigated first. The investigation process is referred to as the Site Screening Process (SSP). The SSP investigation and resulting SSP report determines the fate of each SSA. The SSP report makes recommendations as to whether the site should be further investigated under CERCLA, or whether the site does not pose a risk to human health or the environment, and therefore should be removed from the CERCLA program.

The remaining investigative/remedial steps of the CERCLA process include the Remedial Investigation/Feasibility Study (RI/FS), Record of Decision (ROD), and Remedial Design/Remedial Action (RD/RA). Throughout the SSP, each site is continuously reviewed to determine if site conditions are appropriate for a Removal Action, or an Interim Remedial Action. A Removal Action is undertaken in order to mitigate or minimize adverse impacts to human health or the environment. Interim Remedial Actions are implemented prior to a full-scale FS in order to temporarily mitigate risks until the final remedial action can be selected.

This Master Work Plan and corresponding Master Planning Documents provide standard procedures and guidance to perform RI projects at the Station.

6.3 SITE MANAGEMENT PLAN SUMMARY

A Site Management Plan (SMP) was prepared for the Station in 1995 (Halliburton NUS, 1995). The SMP summarized the status of 48 sites on Station and their various studies of investigation.

6.4 SUMMARY OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The assessment of Applicable or Relevant and Appropriate Requirements (ARARs) is an integral part of the remediation process mandated under the Comprehensive Environmental Response, Compensation, and Liability Act and the Superfund Amendments and Reauthorization Act (42 USC § 9601-9675) (1991). As the preamble of CERCLA states, the purpose of the law is "to provide for liability, compensation, cleanup, and emergency response for hazardous substances released into the environment and the cleanup of inactive hazardous waste disposal sites." In addressing hazardous substances and sites, CERCLA provides that onsite remedial actions must meet the standards and criteria that are otherwise

legally applicable to the substance, pollutant, or contaminant or that are relevant and appropriate under the circumstances (42 USC § 9621 [d][2][a]).

Guidance for assessing and selecting ARARs is provided in the U.S. EPA (U.S. EPA) manual "CERCLA Compliance With Other Laws" (USEPA, August 1988) and "CERCLA Compliance with Other Laws Manual: Part II, Clean Air Act and Other Environmental Statutes and State Requirements" (U.S. EPA, August 1989). These guidance documents were used to identify potential federal ARARs.

CERCLA remedial actions may trigger several different types of requirements or ARARs. These are organized into three categories: chemical-specific, action-specific, and location-specific. However, these categories are not always mutually exclusive. Chemical-specific ARARs are numeric requirements typically derived from health- or risk-based values for various chemical substances (U.S. EPA, August 1988). Action-specific ARARs are usually technology- or activity-based requirements or limitations (U.S. EPA, August 1988). Location-specific ARARs are requirements or limitations based on the physical setting of the site.

To be classified as an ARAR, a requirement must be **applicable** or **relevant and appropriate**. As defined in the NCP, **applicable requirements** are "those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site" (40 CFR §300.5).

Relevant and appropriate requirements are "those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site" (40 CFR § 300.5).

In either case, an applicable or a relevant and appropriate requirement for onsite remedial action must be substantive. Compliance with administrative requirements is not mandated for onsite actions (U.S. EPA, August 1988). Administrative requirements are those procedures "that facilitate the implementation of the substantive requirements of a statute or regulation" (U.S. EPA, August 1988). For example, CERCLA specifically exempts onsite actions from federal, state, and local permitting requirements (42 USC § 9621 [e][1]) (1991). Furthermore, only those state requirements that are more stringent than federal requirements are ARARs (40 CFR § 300.5) (1991). "More stringent" would also necessarily include those

state laws or programs that have no federal counterpart as, "they add to the federal law requirements that are specific to the environmental conditions in the State" (U.S. EPA, August 1989).

Finally, there is a category of requirements titled "To Be Considered" (TBC) guidance. These are guidelines or advisories which are issued by the federal or state government, but which are neither legally binding nor promulgated (U.S. EPA, August 1988). However, these guidelines may be used when they are necessary to ensure protection of public health and the environment and when they have not been superseded (U.S. EPA, August 1988). If no ARARs address a particular circumstance at a CERCLA site (such as soil standards), then TBCs can be used to establish remedial guidelines or targets. Even when TBCs are used, the other requirements imposed on the remedy, including cost-effectiveness, still apply.

The project specific field investigations for the Indian Head Division, Naval Surface Warfare Center have not been initiated. Therefore, COCs and remedial alternatives have not yet been identified. However, COCs, remedial alternatives, and the resulting ARARs will be determined during implementation of future investigative activities at the Station.

EPA Region III Screening Levels

U.S. EPA Region III has developed tables which provide screening levels for human health risk and ecological risk. The human health screening tables are presented in the Risk-Based Concentration (RBC) Tables provided by USEPA office of RCRA Technical and Programs Support branch. This table corresponds to a systemic hazard quotient of 0.1 or a lifetime cancer risk of 10^{-6} , which provide a method for screening out contaminants prior to conducting a risk assessment.

Screening levels developed by the USEPA Region III Biological Technical Advisory Group (BTAG) can be used to screen out contaminants prior to an ecological risk assessment. This table is presented in the Revised Region III BTAG Screening Levels from the USEPA Technical Support System.

Maximum Contaminant Levels (MCLs)

MCLs are enforceable standards promulgated under the Safe Drinking Water Act (40 CFR 141.11 through 141.16, and 40 CFR 141.50 through 141.51) and are designed for the protection of human health. MCLs are based on laboratory or epidemiologic studies and apply to drinking water supplies consumed by a minimum of 25 persons. They are designed for prevention of human health effects associated with lifetime exposure (70 years) of an average adult (weighing 70 kg) who consumes 2 liters of water per day, but they also reflect the technical feasibility of removing the contaminant from the water. These

enforceable standards also reflect the fraction of toxicant expected to be absorbed by the gastrointestinal tract.

Maximum Contaminant Level Goals (MCLGs)

MCLGs are generally specified as zero for carcinogenic chemicals, based on the assumption of nonthreshold toxicity, and do not consider either the technical or economic feasibility of achieving these goals. MCLGs are nonenforceable guidelines based entirely on health effects. The MCLs are set as close to the MCLGs as is considered technically and economically feasible.

Health Advisories

Health Advisories are guidelines developed by the EPA Office of Drinking Water for nonregulated contaminants in drinking water. These guidelines are designed to consider both acute and chronic toxic effects in children (with an assumed body weight of 10 kg) who consume 1 liter of water per day, or in adults (with an assumed body weight of 70 kg) who consume 2 liters of water per day. Health Advisories are generally available for acute (1-day), subchronic (10-day), and chronic (longer-term or lifetime) exposure scenarios. These guidelines are designed to consider only threshold effects and, as such, are not used to set acceptable levels of known or probable human carcinogens.

Tables 6-1 and 6-2 present the potential action-specific and location-specific ARARs for the Indian Head Division, Naval Surface Warfare Center.

Remedial alternatives have not been defined at this time. Therefore, action-specific ARARs are based on generic remedial alternatives. These remedial alternatives include the following:

- Soil vapor extraction (SVE) (i.e., in-place treatment).
- Thermal desorption of soil and replacement in the excavation (i.e., onsite treatment and clean closure).
- Incineration conducted either on or off site.

These remedial alternatives are listed in Table 6-1 with their respective action-specific ARARs identified. National Ambient Air Quality Standards (NAAQSs) are relevant and appropriate for air emissions resulting from the CERCLA remedial actions. USEPA Guidance (U.S. EPA, August 1989) interprets CERCLA activities as non-major sources of air emissions; therefore, the NAAQSs may not be applicable.

TABLE 6-1

**SUMMARY OF POTENTIAL ACTION-SPECIFIC ARARS
INDIAN HEAD, MARYLAND**

Remedial Alternative	Requirement	Prerequisite(s)	Citation	Comments
Soil Vapor Extraction (i.e., in-place treatment)	Air emissions must achieve compliance with air quality standards.	Major stationary source as defined in 40 CFR Section 52.21 (b)(1)(i)(a).	National Ambient Air Quality Standards (NAAQS) 40 CFR 52 and 40 CFR 61	Relevant and appropriate for criteria pollutants related to the site. Attainment of NAAQS is only required for "major sources." In general, emissions from CERCLA activities are not expected to qualify as "major sources."
Thermal Desorption of Soil and Replacement in the Excavation (i.e., onsite treatment and clean closure)	Air emissions must achieve compliance with air quality standards.	Major stationary source as defined in 40 CFR Section 52.21 (b)(1)(i)(a).	National Ambient Air Quality Standards (NAAQS) 40 CFR 52 and 40 CFR 61	Relevant and appropriate for criteria pollutants related to the site. Attainment of NAAQS is only required for "major sources." In general, emissions from CERCLA activities are not expected to qualify as "major sources."
Thermal Desorption of Soil and Replacement in the Excavation (Continued)	Thermal desorption must comply with RCRA removal, storage, and treatment requirements.	Excavated soil is determined to be a RCRA hazardous waste.	40 CFR 264	Applicable if excavated soil is determined to be a RCRA hazardous waste.
	Best management practices (i.e., sediment and erosion controls) for surface water control measures must be used during soil excavation.	Construction activities disturb greater than 5 acres of total land area.	40 CFR 122	Applicable if the total area of soil excavation is greater than 5 acres. Relevant and appropriate if less than 5 acres are disturbed.
Incineration Conducted Either On- or Off Site	Air emissions must achieve compliance with air quality standards.	Major stationary source as defined in 40 CFR Section 52.21 (b)(1)(i)(a).	National Ambient Air Quality Standards (NAAQS) 40 CFR 52 and 40 CFR 61	Relevant and appropriate for criteria pollutants related to the site. Attainment of NAAQS is only required for "major sources." In general, emissions from CERCLA activities are not expected to qualify as "major sources."

TABLE 6-1 (Continued)
SUMMARY OF POTENTIAL ACTION-SPECIFIC ARARS
INDIAN HEAD, MARYLAND

Remedial Alternative	Requirement	Prerequisite(s)	Citation	Comments
Incineration Conducted Either On- or Off Site (Continued)	Incineration must comply with RCRA removal, treatment, transportation requirements (if conducted off site), and land disposal regulations (if a RCRA hazardous waste).	Excavated soil is determined to be a RCRA hazardous waste.	40 CFR 264.271 and 264.60	Applicable if excavated soil is determined to be a RCRA hazardous waste.
	Incineration must meet RCRA performance standards and monitoring requirements.	Excavated soil is determined to be a RCRA hazardous waste.	40 CFR 264.340 through 40 CFR 264.345	Applicable if excavated soil is determined to be a RCRA hazardous waste.
	Best management practices (i.e., sediment and erosion controls) for surface water control measures must be used during soil excavation.	Construction activities disturb greater than 5 acres of total land area.	40 CFR 122	Applicable if the total area of soil excavation is greater than 5 acres. Relevant and appropriate if less than 5 acres are disturbed.

TABLE 6-2
SUMMARY OF POTENTIAL LOCATION-SPECIFIC ARARS
INDIAN HEAD, MARYLAND

Site Setting	Requirement	Prerequisite(s)	Citation	Comments
Within 100-year flood plain	Facility to be designed, constructed, operated, and maintained to avoid washout during flooding.	Remediation activities that involve treatment, storage, or disposal of RCRA hazardous waste.	40 CFR 264.18(b)	Applicable if the excavated soil is determined to be a RCRA hazardous waste and the material is treated, stored, or disposed within the 100-year flood plain.
Within flood plain	Avoid adverse effects, minimize potential impacts, and preserve natural beneficial value of flood plain.	Action that will affect a flood plain.	Protection of flood plains, 40 CFR 6, Appendix A	Applicable if a flood plain area exists at or near the site that will be affected by the remediation.
Within area affecting national wild, scenic, or recreational river	Avoid taking or assisting in action that will have direct adverse effect on wild, scenic, or recreational river.	Action that will affect or may affect any of the rivers specified in Section 1276(a).	Scenic Rivers Act (16 USC 1271 <u>et seq.</u> Section 7(a); 40 CFR 6.302	Applicable if national wild, scenic, or recreational rivers are located at or near the site that will be affected by the remediation.
Non-tidal wetland of special state concern	Avoid taking or assisting in action that will have direct adverse effect on wild, scenic, or recreational river.	Mattawoman Creek is identified as a non-tidal wetlands of special state concern located in the critical area.	COMAR 08.05.04.27	Mattawoman Creek will require special consideration when identifying potential remedial action.

Ex-situ treatment of the soil through thermal desorption or incineration must comply with RCRA removal, storage, and treatment requirements if the excavated soil is determined to be characteristically hazardous, or exhibit the presence of listed hazardous waste constituents. In addition, offsite transportation of the untreated hazardous soil must also comply with appropriate RCRA requirements. Once the soil is treated, the Maryland Department of the Environment requires that the treated soil be administratively delisted by the EPA prior to its placement on the site.

Best management practices for the control of surface water would also be applicable for the soil excavation that would be required for land filling thermal desorption and incineration alternatives.

Location-Specific ARARs

As presented in Table 6-2, the potential location-specific ARARs identified include the protection of flood plains and national wild, scenic, or recreational rivers. The following conditions must be met for these location-specific ARARs to be applicable:

- Flood-plain or national wild, scenic, or recreational river environments exist at or near the site.
- The remedial action could adversely affect these environments.

Appropriate agencies will be contacted to determine whether flood-plain areas or national wild, scenic, or recreational river environments will be affected by remedial activities undertaken at the Station.

Remedial actions that involve the treatment, storage, or disposal of RCRA hazardous waste (e.g., excavated soil determined to be hazardous) and that are conducted within the 100-year flood plain must also be designed and maintained to avoid washout during flooding.

7.0 PROJECT MANAGEMENT

This section discusses generic project management tasks such as Station support, project personnel, and contingency plans. Project personnel will be identified in project specific work plans. Responsibilities and authorities of management and support personnel are further detailed in the Master QAPP.

7.1 NAVY SUPPORT

The Navy Remedial Project Manager (RPM) will be provided from EFACHES. The RPM will provide overall management and co-ordination of the investigation project.

A Point of Contact (POC) will be identified by the Station. The POC will co-ordinate activities at the station and be the liaison between the Contractor and the Station.

Throughout the duration of the site characterization activities, the following support functions will be provided by Station personnel:

- Assistance with the location of utilities and furnish up-to-date drawings and/or a Public Works point of contact. The Contractor will secure clearance for intrusive activities at each location with the point of contact before intrusion and will employ a magnetometer as an additional measure of clearing utilities in suspect areas.
- Personnel from the Station will sign disposal manifests for investigation-derived wastes, including any drill cuttings, well development fluids, or decontamination fluids suspected to be hazardous and requiring proper disposal according to applicable state and/or Federal regulations. (Drums are provided by the Contractor and/or it's subcontractors.)

In addition, Station personnel will aid in arranging the following:

- Coordinate field activities within the facility so that the ongoing mission of the Station will not be adversely affected.
- Secure staging areas for decontamination operations and for storing equipment and supplies. More than one area may be required.

- Provide a supply (e.g., fire hydrant, stand pipe, etc.) of large quantities of potable water and electricity for equipment cleaning, etc.
- A suitable area for setup of an operations field trailer near electric and phone service (Contractor will be responsible for arranging for utility connections).

7.2 PROJECT PERSONNEL

The Contractor should identify a project manager (at a minimum) and a Field Operations Leader (FOL). Support staff including geology, chemistry, engineering, health and safety, and drafting personnel. Key personnel will be identified in the project specific work plan.

7.3 CONTINGENCY PLAN

In the event problems are encountered during site investigation activities, the Contractor Project Manager, the Navy RPM and the Station Point of Contact will be notified immediately. The Project Manager will determine a course of action so as to minimize adverse impacts to the project schedule or budget. All contingency plans will be approved through the Navy RPM before enacted.

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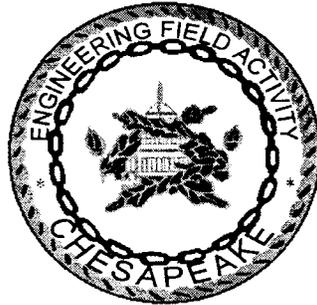
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Master Field Sampling Plan
for
Remedial Investigation
at
Indian Head Division
Naval Surface Warfare Center
Indian Head, Maryland



Engineering Field Activity Chesapeake
Naval Facilities Engineering Command

Contract Number N62472-90-D-1298

Contract Task Order 0245

April 1997

**MASTER FIELD SAMPLING PLAN
FOR
REMEDIAL INVESTIGATIONS
AT
INDIANA HEAD DIVISION
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND**

**COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT**

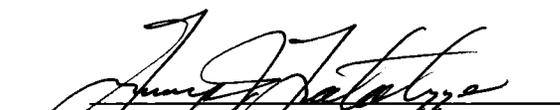
**Submitted to:
Engineering Field Activity Chesapeake
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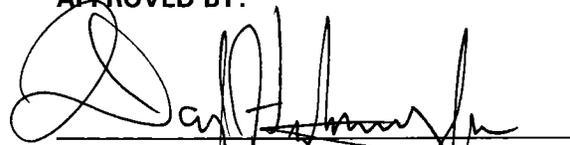

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ACRONYMS

AOC	Area of Concern
ARARs	Applicable or Relevant and Appropriate Requirements
ATV	All Terrain Vehicle
B&R Environmental	Brown and Root Environmental
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	Chain-of-Custody
CWA	Clean Water Act
DE	Disposable Sampling Equipment
DPD	Direct Push Drilling
ECD	Electron Capture Detector
EDM	Electronic Distance Measure
EM	Electromagnetic
EM31	Geonics EM31 Terrain Conductivity Meter
EM34	Geonics EM34-3 Terrain Conductivity Meter
EM38	Geonics EM38 Terrain Conductivity Meter
EM61	Geonics EM61 High Sensitivity Metal Detection
FDEM	Frequency Domain Electromagnetic Device
FID	Flame Ionization Detector
FOL	Field Operations Leader
Project FSP	Project Field Sampling Plan
FTMR	Field Task Modification Record
GC	Gas Chromatograph
GPR	Ground Penetrating Radar
GPS	Global Positioning System
HASP	Health and Safety Plan
HERO	Hazards of Electromagnetic Radiation due to Ordnance
HSA	Hollow Stem Auger
ID	Internal Diameter
IDW	Investigation-Derived Waste
IRP	Installation Restoration Program
LDRs	Land Disposal Restrictions
NCP	National Contingency Plan

NSF	National Sanitation Foundation
NSWCDL	Naval Surface Warfare Center Dahlgren Laboratory
Master FSP	Master Field Sampling Plan
OD	Outside Diameter
OVA	Organic Vapor Analyzer
PCB	Polychlorinated Biphenyl
PID	Photo Ionization Detector
PPE	Personal Protective Equipment
PVC	Polyvinyl Chloride
QAPP	Quality Assurance Project Plan
QA	Quality Assurance
QAM	Quality Assurance Manager
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
RPM	Remedial Project Manager
SOP	Standard Operating Procedure
SVOC	Semi-Volatile Organic Compound
TDEM	Time Domain Electromagnetic
TSCA	Toxic Substances Control Act
USCS	Unified Soil Classification System
USEPA	U.S. Environmental Protection Agency
UXO	Unexploded Ordnance
VDEQ	Virginia Department of Environmental Quality
VLF	Very Low Frequency
VOC	Volatile Organic Compound

1.0 INTRODUCTION

1.1 SCOPE AND OBJECTIVES

The purpose of this Master Field Sampling Plan (Master FSP) is to define the standardized sampling procedures to be used for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and certain specific Resource Conservation and Recovery Act (RCRA) investigations at the Indian Head Division, Naval Surface Warfare Center (Station) in Indian Head, Maryland. The plan specifies requirements for all field work and serves as a guide for use in the field by all members of the field investigation team. Investigations will comply with applicable Maryland and U.S. Environmental Protection Agency (USEPA) regulations. Either Federal laws and regulations, or Maryland laws and regulations whichever are more stringent than Federal laws and regulations, will be Applicable or Relevant and Appropriate Requirements for actions taken at this National Priorities List (NPL) facility.

This Master FSP is intended to be used in conjunction with a Project-Specific Work Plan and the other Master documents identified in the Master Project Plans.

This Master FSP consists of three sections. Section 1.0 presents this introduction and the overall project scope and objectives. Section 2.0 details the field operation tasks, including soil boring and well installation procedures, as well as decontamination and waste handling procedures. Section 3.0 details all aspects of the environmental sampling procedures. Field Forms and Standard Operating Procedures (SOPs) for these activities are included in Appendices A and B, respectively.

2.0 FIELD OPERATIONS

2.1 GENERAL FIELD OPERATIONS

This section discusses the general sampling operations, procedures, and proper documentation for the field operations to be performed at the Station. All field operations must be in compliance with the control measures detailed in the Master Health and Safety Plan (HASP) and corresponding Project-Specific HASP. Details of environmental sampling operations are discussed in Section 3.0. Standard Forms related to field activities are included in Appendix A.

2.1.1 Mobilization/Demobilization

Following approval of the project-specific Field Sampling Plan (Project FSP), Mobilization activities will begin. All field team members will review this Project FSP as well as the project specific Work Plan, Quality Assurance Project Plan (QAPP), and Health and Safety Plan (HASP). In addition, a field team orientation meeting will be held to familiarize personnel with the scope of the field activities.

The Field Operations Leader (FOL) will be designated as the lead in coordinating all day-to-day site activities during the investigation. The FOL will be responsible for ensuring that all field team members are familiar with the applicable plans. Additionally, the FOL will be responsible for all sampling operations, quality assurance (QA)/quality control (QC), field documentation requirements, and field change orders. The FOL will also regularly report to the Project Manager regarding the status of field work and any problems which may occur.

The FOL will coordinate the mobilization activities upon arrival at the facility. Prior to the initiation of field work, the FOL will arrive at the site to begin onsite mobilization activities. These activities will include clearing the drilling locations with utility personnel, coordinating with base personnel, purchasing expendable equipment, marking sample locations, preparing sample bottles, and preparing the field trailer. After field activities are completed, the FOL will demobilize the equipment.

All site preparation will be coordinated through Station personnel. When necessary, temporary barriers will be installed and traffic control provided at work locations as a safety precaution.

2.1.2 Site Restoration

All site restoration activities will be performed by B&R Environmental and its subcontractors. Site restoration may include, but will not be limited to, regrading areas where drilling activities were performed, general clean-up of investigation-related materials, and asphalt and concrete replacement where necessary. Site restoration shall be conducted to as close to pre-activity condition as feasible.

2.2 SUBSURFACE INVESTIGATIONS

Soil borings will be drilled to characterize subsurface lithology and soil contamination in accordance with Station SOP GH-04, contained in Appendix B. Some of the soil borings may be converted into groundwater monitoring wells. Unexploded ordnance (UXO) need to be evaluated on a site by site basis, however UXO is not considered to be a concern.

2.2.1 Soil Borings

2.2.1.1 Hand Auger Method

Soil borings may be conducted using a hand auger method. A stainless steel auger head, constructed for sand or clay retention, and stainless steel rods (typically 3 feet in length) will be used. The auger is advanced by turning the "T" handle in a clockwise motion. Samples are extracted using a stainless steel spoon or trowel. Further details are included in Station SOP GH-04. Borings advanced with a hand auger will be backfilled with the soil cuttings.

2.2.1.2 Hollow-Stem Auger Method

Soil samples will typically be collected continuously from the ground surface to the top of the water table, as referenced in specification ASTM-2686-84. Soil samples will also be collected in accordance with Station SOP GH-03, contained in Appendix B. Boreholes will be advanced using 4.25-inch internal diameter (ID) hollow-stem augers. The split-spoon samplers will have a minimum ID of 2 inches and will be at least 2 feet long. Three-inch ID split spoons may be required to fulfill sample volume requirements for chemical analysis. The split-spoon sampler will be driven to the required depth by means of a drill rig mounted hammer weighing 140 pounds for a 30-inch fall.

All samples obtained from the boreholes will be monitored with an organic vapor analyzer (OVA) or Photoionization Detector (PID) in particular a HNu as specified in the HASP. Each split-spoon sampler will be screened with the OVA or HNu immediately upon opening. These readings will be recorded on the boring logs. Additionally, some samples may be field screened for head-space analysis. Head-space analysis

involves obtaining a small amount of soil from the split-spoon sampler and placing it into a sealed container. The container is warmed for 15 minutes and then the OVA or HNu is used to detect possible volatile vapors in the sample. As required, chemical analyses samples will be obtained in accordance with the procedures outlined in Section 3.0. In addition to analytical samples, lithologic samples will be collected at all sampling intervals.

A lithologic description of each split-spoon sample and a complete log of each boring will be maintained by the geologist in accordance with Station SOP GH-05, contained in Appendix B. At a minimum, the boring log will contain the following information:

- Boring or Well Identification
- Name of Drilling Contractor
- Sample Numbers and Types
- Sample Depths
- Standard Penetration Test Data
- Sample Recovery/Sample Interval
- Soil Density or Cohesiveness
- Soil Color
- Unified Soil Classification System (USCS) Material Description
- Location of Boring
- Drilling and well construction problems/deviations from FSP and Installation Restoration Program (IRP) Handbook

In addition, depths of changes in lithology, sample moisture observations, depth to water, vapor readings, drilling methods, and total depth of each borehole will be included on each log, as well as any other pertinent observations. An example of the boring log form is attached in Appendix A.

After the borings are drilled to the desired depth, they will be grouted to the ground surface with a cement-bentonite slurry (approximately 94 pounds cement, not more than 4 pounds of bentonite powder and not more than 6.5 gallons of potable water). The slurry will be placed within the boring using a tremie pipe.

Due to the remote location of some of the sites, an all terrain vehicle (ATV) drilling rig may be required for the field work.

2.2.2 Test Pit Operations

Test pits may be excavated in areas identified during geophysical surveys. Soil grab samples will be collected from each test pit based upon visual observations, OVA or HNu readings, or immunoassay testing conducted by the site geologist. Samples will be collected directly from the backhoe bucket. Under no circumstances will personnel be permitted to enter the test pit. If drums or the unknown contents thereof are encountered during test pit excavations, the test pit excavation will cease, and the removed soils will be immediately replaced. Test pits will be backfilled before completion of each day's work activities. A description of each test pit will be completed by the field geologist.

Test pit sampling and excavation will be performed in accordance with Station SOP SA-10 attached in Appendix B.

2.2.3 Direct Push Drilling

B&R Environmental does not currently own direct push drilling (DPD) equipment (e.g., Geoprobe® and Hydropunch®). However, B&R Environmental has rented and operated DPD equipment and has routinely subcontracted DPD services. All subcontracted DPD operations are supervised by B&R Environmental personnel. Any direct push equipment utilized to explore for groundwater must be operated by a driller licensed in the State of Maryland as per Code of Maryland Regulations (COMAR) 26.04.04.03 and 26.05.01.

Geoprobe® type equipment is commonly mounted in cargo vans or on the bed of a pickup truck and includes a hydraulic-powered probe for driving and removal of hardened steel sample rods. These rigs are equipped with an additional air percussion option for penetrating dense material and an electric hammer for drilling through asphalt and concrete. A wide variety of sample rods can be utilized by the Geoprobe® for soil, soil gas, and groundwater sampling. Groundwater samples are typically obtained using peristaltic pumps, vacuum-lift pumps, or miniature bailers. Hydropunch® or similar systems use a drill rig to advance hollow stem augers (HSAs) to a desired depth. The Hydropunch® is then hammered ahead of the augers and a discrete groundwater sample is collected using a boiler or a pump. Some DPD subcontractors may also provide field gas chromatographs (GC) equipped with flame ionization detectors (FID), photo ionization detectors (PID), and electron capture detectors (ECD), for real-time analysis of environmental samples. Station SOP SA-06 describes the method for ground penetrating sampling techniques.

Advantages of DPD include the ability to obtain a vertical profile of contaminant concentrations, almost complete elimination of drill cuttings production, sampling in tight-access locations, reduced overhead clearance requirements, and real-time laboratory analyses. Disadvantages include a maximum penetration depth of approximately 15 to 40 feet in dense soils, inability to access uneven or wooded sites, reduced

capability of obtaining accurate water level measurements, and inability to install permanent groundwater monitoring wells.

2.3 MONITORING WELL CONSTRUCTION AND INSTALLATION

2.3.1 Monitoring Well Installation (Hollow Stem Auger Method)

Soil borings advanced only into the watertable aquifer may be converted to 4-inch ID Polyvinyl Chloride (PVC) monitoring wells. All monitoring wells will be constructed of 4-inch ID PVC flush-joint riser pipe and flush-joint factory slotted well screen. Each section of casing and screen will be National Sanitation Foundation (NSF)-approved. The monitoring well pilot hole will be drilled using 4.25-inch ID augers. The pilot borings will then be reamed using 8.25-inch ID augers. The diameter of the borehole will be recorded for each installation.

Unless otherwise specified, the top of the screened interval will be positioned approximately 2 feet above the stabilized water level. Typical screen lengths will be 10 feet and will have a screen slot size of 0.010 inch. After the borings are drilled to the desired depth, the well will be installed through the 8.25-inch ID augers. A silica sand pack will be installed into the boring annulus around the well screen. The sandpack will be medium to coarse grained, well graded, silica sand. The sand pack will be installed from the bottom of the hole to approximately 2 feet above the top of the well screen. The sandpack will be installed by pouring sand into the annular space between the riser pipe and hollow-stem augers. The hollow-stem augers act as a tremie pipe and are withdrawn from the boring as the sand is emplaced. The sand should always be kept within the augers during withdrawal in order to ensure an adequate sandpack.

A weighted tape measure will be used during the installation to ensure that no bridging occurs and to maintain no more than 1 foot of sand above the bottom of the augers. In some of the shallower monitoring wells it may be necessary to bring the sand pack up to only 1 foot above the top of the screen to allow enough room for a sufficient bentonite and grout seal. A 100 percent sodium bentonite pellet seal, no less than 2 feet thick, will be installed above the sand pack and allowed to hydrate using non-treated water. The depths of all backfill materials will be constantly monitored during the well installation process by means of a weighted stainless steel or plastic tape. A 20:1 cement:bentonite grout seal will be placed, with a tremie pipe, to extend from the top of the bentonite seal to the land surface. Station SOP GH-03 and GH-12 (attached in Appendix B) provides guidance for different types of well constructions such as confining layer monitoring wells, bedrock monitoring wells, and drive points.

An "at grade" protective steel casing equipped with a sealing, locking cap will be installed around all wells in high-traffic areas. At grade covers will be installed in accordance with state requirements. For all other wells,

a 4-inch diameter protective steel casing equipped with a locking steel cap will be installed. All protective casings will be grouted a minimum of 3 feet into the ground and will have at least one drain hole positioned approximately 0.5 foot above the ground surface. In addition, a concrete apron measuring 3 feet by 3 feet by 6 inches thick will be constructed equally portioned around the casing of each well. For stick-up casings in traffic areas, a minimum of three marker posts (3-inch nominal diameter, 5-foot-long steel pipe filled with cement) will be embedded 2 feet into the ground and set in concrete, separate from the concrete apron around the well base. The marker posts will be positioned equidistant from one another. All locks supplied for the wells will be keyed alike. After installation, the top of the riser pipe, the top of the protective casing, and the ground surface elevation at the well location will be surveyed to within 0.01-foot vertical accuracy. In addition, the well will be surveyed to a 0.1-foot horizontal accuracy.

A monitoring well construction diagram will be completed for each well installed. A sample of the monitoring well construction form is provided in Appendix A.

2.3.2 Monitoring Well Installation (Portable Solid Stem Auger Method)

In areas with extreme access difficulties, a portable solid stem auger system may be utilized to install 2-inch-diameter wells. The method for solid stem auger drilling is described in Station SOP GH-03 and GH-12 (Section 5.2.2: Continuous-Flight Solid Stem Auger Drilling), found in Appendix B. The soil boring will be advanced with the hydraulic drill using 4-inch outside diameter (OD) auger flights attached to the drive head of the drill. The borehole will then be reamed with 6-inch OD auger flights to allow for sufficient annular space to construct the groundwater monitoring well. After the desired depth has been reached, the auger flights will be removed from the borehole and a 4-inch ID temporary decontaminated PVC casing will be advanced to control borehole collapse. The 2-inch ID well screen and riser pipe will be installed inside the casing. Split spoon samples cannot be collected using the solid stem method, and therefore samples for chemical analysis will be collected using a 4-inch-diameter stainless steel hand auger.

Following completion of the above task, the groundwater monitoring well will be completed as detailed in Section 2.3.1. A deviation from Station SOP GH-03 will be the use of a factory-built, 2-inch ID, prepacked slotted screen (dual wall pipe with gravel pack between the inner and outer walls). The prepacked screen will be used in place of a standard 2-inch PVC screen section. Construction of the groundwater monitoring well will follow applicable procedures outlined in Station SOP GH-03 (Appendix B).

2.3.3 Monitoring Well Development

Following installation, each groundwater monitoring well will be developed in accordance with the Station SOP GH-12 (Appendix B) in order to remove any mud pack, drill cuttings, or formation fines from the well screen. Based upon field conditions (i.e. a well goes dry), the site geologist may modify these protocols. The groundwater monitoring wells will be developed by the driller no sooner than 48 hours nor longer than 7 calendar days after well installation, and this will be accomplished by surging, bailing, and/or pumping, as determined by the Field Geologist. Prior to development, a hydrocarbon interface probe will be used to determine the potential presence of both light and dense free product in the well. Groundwater monitoring wells with free product will not be developed.

A minimum of 5 times the standing water volume in the well casing plus 5 times the water volume in the saturated gravel pack (assume 30% porosity) will be removed. Turbidity will be measured during well development. An attempt will be made to develop the well to a turbidity of 10 NTU. The wells will be developed until the discharge water is visibly clear, and temperature, pH and specific conductivity have stabilized to within 10% variance for three consecutive measures, or as determined by the Field Geologist. All water quality measurements and the volumes removed will be recorded for each well on the well development form, attached in Appendix A.

2.3.4 Evaluation of Existing Wells

Existing groundwater monitoring wells may be evaluated in accordance with Station SOP SA-01. If required, the well may be redeveloped in accordance with Section 2.3.3 of this Master FSP.

2.4 WATER LEVEL MEASUREMENT

Synoptic water-level measurements will be taken from all newly installed monitoring wells at the base. All measurements will be taken within a 24-hour period of consistent weather conditions to minimize atmospheric/precipitation effects on groundwater levels. The sequence of measuring water levels will be determined in the field by the site geologist.

Measurements will be taken using an electronic water level meter capable of 0.01 foot resolution. The top of the well casing will be used as the reference point for determining depths to water in accordance with Station SOP GH-10, contained in Appendix B. A notch, cut prior to well installation, will be used at the top of the PVC to ensure that measurements are taken consistently between measuring events. Water-level measurements will be recorded to the nearest 0.01 foot in the appropriate field log book and on a groundwater level measurement form, attached in Appendix A.

2.5 FIELD MEASUREMENTS

Field measurements will be taken during field and sampling operations according to the Station SOPs located in Appendix B. Field measurements will include ambient air quality (Station SOP SA-04) and water quality (Station SOP SA-01; including pH, specific conductance, temperature, dissolved oxygen, oxidation-reduction potential, and turbidity). Measurements will be recorded either in the site logbook or Sample Log Form. Instruments used in the field to record this data will be calibrated to the procedures described below.

2.5.1 Equipment Calibration

One or more of the following monitoring instruments may be used during field activities:

- OVA flame ionization detector
- HNu or microtip photoionization detector
- Temperature probe
- Specific conductance meter
- Dissolved Oxygen meter
- pH meter
- Turbidity meter
- Electronic water-level indicator
- Radiation survey meter

Field instruments will be calibrated according to the manufacturer's procedures, the Station SOPs indicated above, and per the following:

- The pH meters will be calibrated daily. At least two buffer solutions that bracket the expected sample pH will be used (e.g., 4.0 and 7.0) to calibrate pH meters.
- Specific conductance meters will be calibrated prior to each day's use.
- The dissolved oxygen meter will be calibrated daily.
- Thermometers will be calibrated monthly. The expected range of sample temperatures will be bracketed. This will be performed at the B&R Environmental equipment warehouse.

- Turbidity meters will be calibrated at least daily using a standard within the expected range of sample turbidities.
- Duplicate measurements of pH, specific conductance, temperature, dissolved oxygen, oxidation-reduction potential, and turbidity will be taken at a frequency of one in 10 samples and used to estimate the precision of the field analytical measurements.
- HNUs or OVAs will be calibrated prior to each day's use.

Calibration will be documented on an Equipment Calibration Log (see Appendix A). 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.

2.6 GEOPHYSICAL INVESTIGATIONS

The following subsections describe the basic procedures and requirements to be implemented during various geophysical investigations at the Station. All geophysical investigations shall be in accordance with Station SOPs GH-13, GH-14, and GH-15, contained in Appendix B.

2.6.1 Geophysical Reference Grid

A geophysical reference grid will be installed at the site such that data can be accurately collected and reported. The grid will be staked at a constant interval in units of feet using a transit, electronic distance measure (EDM) or tape measure. Stakes will consist of pin flags or other semipermanent markings that will be labeled with the grid coordinates in units of feet.

The reference grid will be tied into an existing site grid system, if present, and also to any permanent site features such as monitoring wells or buildings. This will facilitate ease of reoccupation for subsequent subsurface investigations. Pin flags or other semipermanent markings will be left in place at the completion of the survey to also assist in the reoccupation of the grid for future investigations, if necessary. Data will be collected along parallel survey lines at a station spacing of 15 to 20 feet. Closer spacings may be used to increase resolution for specific targets.

2.6.2 Electromagnetics

Electromagnetic survey equipment will be approved on a site-specific basis by the Station's safety office. Electromagnetic surveying will be conducted in general accordance with Station SOP GH-13.

2.6.2.1 High Resolution Geonics EM31 Terrain Conductivity Survey

A Geonics EM31 Terrain Conductivity meter (EM31) and digital data logger will be used at this site to assist in the shallow (less than 15 feet deep) characterization of subsurface materials. The EM31 is a one-man-operated frequency domain electromagnetic (FDEM) device that utilizes the principle of electromagnetic (EM) induction to measure the apparent conductivity and magnetic susceptibility of surface and subsurface materials and their pore fluids. The instrument is equipped with very low frequency (VLF) radio transmitter and receiver coil. These coils are separated by a distance of 12 feet and are located at the ends of a ridged, non-metallic pole.

Quadrature and in-phase component data will be simultaneously collected at this site through the use of a digital data logger. Quadrature component data are a measure of the apparent electrical conductivity of the subsurface materials and their pore fluids. Quadrature component data are also commonly referred to as terrain conductivity or bulk conductivity data. A map of quadrature component data will assist in delineating areas of fill materials, contaminated soils, shallow contaminated ground water, changes in soil types, changes in soil moisture content relative to undisturbed soils, and the presence of most buried ferrous and non-ferrous metals. Quadrature component data are presented in units of conductivity, millimhos/meter (mmhos/m) or milliSiemens per meter (mS/m).

The EM31 device also records the in-phase component of the EM field. The in-phase component data are a measure of the presence of highly conductive material and are often referred to as the metal detection component. Buried metal within 15 feet of surface such as steel drums or metallic pipes can be mapped in this mode. In-phase data are presented in units of parts per thousand (ppt).

During investigations, data will be collected with the instrument at waist height, held parallel to ground surface and with the coils vertically oriented. Data will be collected along parallel survey lines. Digital data will be downloaded daily through the use of a laptop computer and the manufacturer's software DAT31.

2.6.2.2 High Resolution Geonics EM38 Terrain Conductivity Survey

A Geonics EM38 Terrain Conductivity meter (EM38) and digital data logger may be used at the Station to assist in the characterization of the shallow (less than 5 feet deep) subsurface materials. This procedure will be considered only where no UXO hazard is present. The EM38 is a one-man-operated FDEM device that utilizes the principle of EM induction to measure the apparent conductivity and magnetic susceptibility of surface and subsurface materials and their pore fluids. The instrument is equipped with a fixed frequency VLF radio transmitter and receiver coil. These coils are separated by a distance of approximately 3.3 feet and are located at the ends of the devices ridged non-metallic frame.

Quadrature and in-phase data are collected separately through the use of a digital data logger. Quadrature data collected with this device are used to map subtle soil moisture content changes often associated with disturbed soils or fill materials, shallow soil stratigraphic changes, the presence of shallow metallic objects and metallic pipes/utilities. The in-phase data are often used to further identify and confirm the presence of buried metallic objects, pipes and utilities.

During this investigation, data will be collected with the instrument at ground surface, oriented parallel to the survey line and with the coils vertically oriented. This will result in a depth of investigation of approximately 5 feet. Data will be collected along parallel survey lines. Data will be collected at a station spacing of 1 to 2 feet through the use of a digital data logger. Digital data will be downloaded daily through the use of a laptop computer and the manufacturer's software DAT38.

2.6.2.3 Geonics EM34-3 Terrain Conductivity Survey

A Geonics EM34-3 Terrain Conductivity meter (EM34) and digital data logger may be used at the Station to assist in the characterization of the subsurface materials to depths of approximately 25 to 200 feet below surface. The EM34 is a two-man-operated FDEM device that utilizes the principle of EM induction to measure the apparent conductivity of surface and subsurface materials and their pore fluids. The instrument is equipped with a variable frequency VLF radio transmitter and receiver coil that are separated by a flexible reference cable. The EM34 has a variable coil separation of 32, 66 and 131 feet.

Data are often collected with the coil dipoles oriented horizontally, then vertically. Data are collected by adjusting the coil separation distance while maintaining the coils in the same geometric plane until an optimum instrument response is observed. Data collected when the coil dipoles are oriented vertically (vertical dipole mode) are extremely sensitive to errors as a result of coil alignment. Therefore, vertical dipole data collection can be difficult in areas of steep topography or dense brush. Data are recorded through the use of a digital data logger and by hand in the field notebook.

The depth of investigation of the EM34 is dependent upon the coil separation and the orientation of the coil dipole. The depth of investigation increases as the coil separation increases. The approximate depth of investigation with the coil dipoles oriented horizontally is 0.75 times the coil separation. The depth of investigation with the coil dipole oriented vertically is 1.5 times the coil separation.

The EM34 is often used to map stratigraphic changes such as the presence of buried sand channels, clay lenses or the presence of contaminated groundwater. Data are generally collected at two or three coil separations at each station location and in the horizontal and vertical dipole mode. However, the instrument is very sensitive to the presence of anthropogenic features and extremely electrically resistive soils when collecting data in the vertical dipole mode. Vertical dipole mode data collection are occasionally omitted in areas of potentially high cultural interference and where extremely resistive soils are present.

2.6.2.4 High Sensitivity EM61 Metal Detection Survey

A Geonics EM61 high-sensitivity metal detection (EM61) and digital data logger may be used at Station to map the presence of buried metals, metallic pipes and metallic utilities. These buried metals often may represent sources of contamination or may represent buried ordnance hazardous to future subsurface investigations. This device is a time domain electromagnetic (TDEM) instrument that utilizes the principles of electromagnetic induction to measure the presence of highly conductive ferrous and non-ferrous materials in the subsurface. The device is equipped with a portable 3.3-foot-square transmitter, a main receiver located coincident to the transmitter and a focused receiver coil located 1.3 feet above the transmitter and main receiver coils. The transmitter and receiver coils are mounted onto a cart with plastic bicycle wheels and an electronic distance encoder. The power supply and electrical components are contained in a plastic backpack that is worn by the operator.

TDEM equipment operates by rapidly extinguishing a transmitted signal and measuring the induced secondary signal in the ground either at a specific point in time or as it decays with time. The EM61 transmitter coil generates a pulsed EM signal at a rate of 150 times per second. The two receiver coils measure the induced secondary EM field at a calibrated time in between the transmitted signal pulses. The secondary EM signal induced from the presence of natural earthen materials rapidly decays before the receiver coils measure the response. The secondary EM signal induced from the presence of metals has a much longer decay time such that it is still present when the receiver coils begin to collect data. This results in the EM61 being non-responsive to the presence of changing soil conditions that can sometimes obscure buried metallic targets. This device has a depth of investigation that is dependent upon the surface area of metal that is present.

The EM61 utilizes a digital data logger to record the secondary EM signals received by the main and focused receiver coils. Data are recorded and presented in units of millivolts (mV). The data from the main and focused receiver coils are stored in channels 2 and 1 of the data logger, respectively. Channel 1 data are a measurement of the presence of surface and very near surface metals. Channel 2 data is a measure of surface and deep metals. The effects of near surface metals are minimized by subtracting channel 2's response from channel 1's response. This is referred to as the differential response and is very useful in mapping buried metals at noisy sites.

During this investigation, data will be collected along parallel survey lines and at a station spacing of approximately one foot. Data will be collected using a digital data logger and downloaded daily onto a laptop computer using the manufacturer's software DAT61.

2.6.2.5 EM Data Reduction and Presentation

The downloaded data will be preliminarily processed onsite using the equipment manufacturer's software to help ensure that project objectives are achieved and that data coverage is sufficient. Digital data will be edited and viewed in profile format to assist the onsite geophysicist in making preliminary data interpretations prior to demobilization. Final data presentation will consist of a profile format, or, for larger data sets, map view contours may be constructed to visually depict anomalous areas.

2.6.3 Ground Penetrating Radar (GPR)

A Mala Geoscience Ramac/GPR unit or similar device may be used to collect site data in areas where no UXO hazard is present. Use of this equipment must be approved on a site-specific basis by the Station safety office. The Ramac/GPR instrument is a digital GPR device that will be equipped with a 200 megaHertz (MHz) transducer. GPR surveys will be conducted in general accordance with Station SOP GH-3.4.

GPR techniques are based upon the repetitive transmission of EM signals (pulses) via a transducer into the subsurface. The EM signal travels through the subsurface and is reflected at stratigraphic interfaces where contrast in the dielectric permittivity of the media are present. The reflected portion of the transmitted signal is received by the device's transducer. The two-way travel time and amplitude of the reflected signals versus the horizontal distance that the transducers traveled are digitally recorded.

The time it takes a signal to travel from the transducer, reflect off of a target and return to the transducer is called the two-way reflection time. Two-way reflection times are recorded in units of nano-seconds and vary

dependent upon the electrical properties of the subsurface materials. As the subsurface materials permittivity increases, the two-way travel time increases and the velocity of the GPR signal decreases. Areas of clayey soils, shales or saline groundwater have high permittivities, relatively long two-way reflection times and slow velocities. GPR signals in these materials also attenuate rapidly, resulting in depths of investigation that may be limited to a few feet or less. Conversely, dry sandy soils have low permittivities that result in relatively short two-way reflection times and fast velocities. The depth of investigation is often much greater in dry sandy soils relative to clayey soils.

Two-way reflection travel times can be converted into units of depth where signal propagation velocities are known or can be estimated. Signal propagation velocities can be estimated by collecting data over targets of known depths, performing a common midpoint sounding, or estimating soil permittivities based upon known or published values.

Data will be digitally recorded using a laptop computer and preliminary processed while on-site using the manufacturer's software. Observed anomalous responses will be annotated on-site using pin flagging or other semipermanent markings. The location of the anomalous response will be recorded into the field book and plotted onto the base map upon return to the office. GPR data will be presented in profile format.

2.6.4 Pipe and Cable Survey

A Schonstedt MAC51B or similar device may be used to assist in the identification of buried metallic pipes and utilities. This instrument works by inductively or actively coupling an electromagnetic transmitter coil to a known pipe location and tracing the feature with the device's receiver coil. Data for this instrument are not recorded digitally; rather a qualitative audio output that is proportional to the magnetic gradient field intensity is observed. The subsurface anomalies identified with this instrument will be annotated onsite with semipermanent markings and anomaly locations will be recorded in the field book for subsequent reporting.

2.6.5 TDEM Survey

TDEM soundings can be utilized to qualitatively assess stratigraphy, salt water intrusion or the presence of conductive groundwater that may be associated with a contaminant plume. This method non-invasively maps the subsurface and is used to measure the lateral and vertical resistivity distributions (geo-electric section) of the subsurface to depths of 15 to 500+ feet. Electrical resistivity (the inverse of conductivity) is dependent on the physical properties of the soils and/or rock. This includes the electrical conductance of the groundwater, and the soil and/or rock type. Clays and shales are naturally conductive (less resistive), whereas sands and limestones are poorly conductive (naturally resistive) to electricity.

TDEM surveys, if appropriate, would be conducted at the site using a Geonics PROTEM47D TDEM device. The PROTEM47D system consists of a transmitter loop and a receiver coil. The transmitter is a square loop of single-turn insulated wire which is laid on the ground surface forming a square or rectangle. The depth of penetration is dependent on the size of the transmitter and the electrical resistivity of the subsurface. The larger the size of the transmitter loop, the greater the depth of penetration. Transmitter sizes commonly used are 20 by 20 or 40 by 40 meters.

The receiver is a small vertical magnetic dipole that is placed either in the center of the square transmitter loop or directly adjacent to it. A half-duty cycle current wave form is driven through the transmitter, where a steady current is quickly terminated. The time-varying primary EM field of the transmitter induces eddy currents in the subsurface. The receiver measures the electromotive force (emf) due to the secondary magnetic field of these eddy currents during transmitter off-time.

Data are presented as a geo-electric section of the subsurface as a function of depth (feet or meters) and apparent resistivity (ohm meters). Vertical resolution is defined by the resistivity contrast between the hydrostratigraphic units. The TDEM data should be collected between borehole locations and tied into the geologic and geophysical logging results.

The digital TDEM data are downloaded from the instrument's data logger using the manufacturer's software DATEM. The raw data are then imported into TEMIX software and plotted as time verses instrument response (in units of millivolts) curves. The response curves are then digitally forward modeled based upon existing geophysical logging and geologic information, generally producing a model to observed data fit error of less than 20 percent. Forward modeling allows the user to input the observed geo-electric conditions from nearby boreholes or monitoring wells and compare them to the observed TDEM data. The data are then inverse-modeled until a fit error of generally less than 5 percent is achieved. The final results are presented as geo-electric sections showing depth versus apparent resistivity. The geo-electric sections are often plotted as geo-electric profiles incorporating geologic well log information where available.

2.6.6 Magnetic Survey

Magnetic surveys will be conducted using a portable gradiometer, such as an EG&G Geometrics model G-856AG, to define anomalous zones which may contain buried ferrous metals. The gradiometer uses two sensors to sample, stores readings from each in quick succession, and uses the difference between readings (i.e., the gradient) to more precisely locate shallow objects. Gradient information is useful for shallow search and survey applications because it can quickly define the depth and location of objects without the need for a

base station. Gradiometer data help to resolve composite or complex anomalies into their individual constituents. The data will be recorded automatically in the field and will later be downloaded into a computer-based software, such as MAG-PAC, used to correct the magnetic data for diurnal drift. General procedures, calibration, and data acquisition and interpretation are described in the manufacturer's manual and Station SOP GH-14 (Appendix B).

2.7 **AQUIFER TESTING**

2.7.1 **Slug Tests**

Slug tests can be performed to determine the hydraulic characteristics in the immediate vicinity of the well screen/open borehole. General procedures, data acquisition, and data analysis methods are described in Station SOP GH-09 (Appendix B). Although they typically require data logging equipment for rapidly recharging aquifers, they do not require pumping and are therefore applicable in low yield aquifers or at locations where contaminated water disposal would be prohibitively expensive.

Prior to performing the slug test, the static water level must be recorded as well as the well construction details. Both rising head and falling head tests can be performed either by inserting a solid slug into the well to raise water levels, then measuring the rate of decline in water level, or by removing a slug of water and measuring the rate of rise in the water level back to equilibrium. The change in water level should be induced as quickly as possible, as the analysis assumes an instantaneous change in head. Falling head tests cannot be performed where the water level is within the screened interval. In addition, as slug tests are very sensitive to borehole skin effects, the well must be developed properly in order to get accurate data.

Slug test data will be collected using an electronic data logger with pressure transducer and/or electronic water level indicator. To facilitate data graphing, the loggers will be programmed to record measurements on a logarithmic time scale. It is ideal to record water level data to at least 90 percent recovery in the well before terminating the test. The resulting plot of time (t)/head ratio (h/h₀) on semilog paper should approximate a straight line. The test should be rerun if data scatter is excessive or if the straight-line approximation is not obtained.

Raw data from the loggers or field records are used to calculate values of hydraulic conductivity in the immediate vicinity of the well screen or open borehole. The data will be analyzed using one or more of the following three methods:

- Hvorslev Method - rapid straight-line method for partially penetrating well screens

- Bouwer and Rice Method - rigorous straight-line method for complex well geometries
- Cooper et al, Method - type-curve method for low permeability aquifers

The above methods can be analyzed relatively simply by hand. However, the Bouwer and Rice method as well as the Cooper et al method may also be analyzed using the AQTESOLV Computer Program (Geraghty & Miller, Inc.).

2.7.2 Pumping Tests

Pumping tests can be performed to determine more complex and aerially extensive hydraulic properties of the aquifer. General procedures, data acquisition, and data analysis methods are described in Station SOP GH-08 (Appendix B). Although they require data logging equipment and pumping, they are more applicable to high yield aquifers or at locations where water disposal does not create severe management issues.

Prior to the pumping test, the static water level in all surrounding observation wells must be recorded. Several wells can be pumped at different times to determine both the lateral and vertical response of the aquifer to the pumping of the wells. For each individual test, the duration of pumping will be determined in the field based on the aquifer response to pumping, with a minimum duration of 4 hours and a maximum duration of 72 hours. It is ideal to stress the aquifer as much as possible near the pumping well without drawing the cone of depression below either the measuring device (in unconfined aquifers) or the confining layer (in confined aquifers). It is also important to maintain a consistent discharge rate from the pumping well.

Water levels will be periodically measured in the pumping well and in the observation wells throughout the duration of each pumping test (including water level recovery after pumping is halted). To facilitate data graphing, the loggers for nearby observation wells will be programmed to record measurements on a logarithmic time scale. It is ideal to record water level data to at least 90 percent recovery in the observation wells before terminating the test. The data gathered will be evaluated using techniques developed for pumping tests specific to the aquifer. Aquifer parameters determined during pumping tests include hydraulic conductivity, transmissivity and storativity. Due to the limitless number of analytical techniques possible for each specific aquifer, the exact method will be determined upon completion of the test. Some analytical methods include:

- Cooper-Jacob Method - rapid straight-line method for simple aquifer geometries
- Theis Method - type-curve method for complex aquifer geometries
- Theis Recovery Method - method used for analyzing well recovery data

- Theim Method - method for analyzing pumping test that have reached equilibrium conditions

In addition, the AQTESOLV Computer Program (Geraghty & Miller, Inc.) can also be employed to assist in the technical analysis of pumping test data.

2.7.3 Specific Capacity Testing

Specific capacity tests are used to determine a well's potential yield and to estimate hydraulic conductivity. General procedures, data acquisition, and data analysis methods are described in Station SOP GH-08 (Appendix B). These tests involve pumping a well at a constant rate and measuring the drawdown when the water level stabilizes. Specific capacity tests are advantageous because they can be conducted while wells are being developed or purged for sampling and automatic data logging equipment is not necessary.

During specific capacity tests, water level measurements are collected using an electronic water-level indicator. An electronic submersible or peristaltic pump is used to pump the well. Aquifer parameters will be calculated from the specific capacity test data using applicable computer software.

Drawdown data from the well is entered into the computer program along with required variables that characterize the aquifer (storage and well-loss coefficients), the pumping rate, and well dimensions. The program output will estimate specific capacity, transmissivity, and hydraulic conductivity.

2.8 SOIL GAS SURVEYING

Two types of soil gas surveys may be conducted; a contaminant-specific survey using a portable GC unit or a reconnaissance-type survey using an OVA. Grid patterns will be established within the areas to be covered by the soil gas survey using pin flags in unpaved areas and tape in paved areas. The grid patterns will be tied into local permanent features such as building corners and roadway boundaries. Grid spacing will be determined on a site-specific basis.

In paved areas, a small pilot hole will be drilled through the asphalt using a power drill with 1/2 - 1-inch-diameter drill bit. The soil gas boring will be completed by driving a 1/2-inch-diameter steel rod into the subsurface. The steel rod will be advanced to the desired depth, extracted, and a teflon tube will then be lowered into the boring. A surface seal of inert material will be used to seal the borehole annulus from the ambient atmosphere. The tube will then be attached to the analytical instrument. The tube will be purged of residual gas prior to sample collection at each sample location. The results will be recorded in the field on site maps, and the survey modified based upon incoming data, with grid spacing adjusted accordingly.

2.9 SURVEYING

All new groundwater wells and select soil boring locations will be surveyed. Existing survey monuments within the Station will be utilized as reference points. Horizontal locations will be surveyed to Virginia State Plane coordinates. Monitoring well and soil boring horizontal locations will be surveyed to the nearest 1.0 foot. All surveying will be conducted by a registered land surveyor licensed to practice in the State of Virginia.

Vertical elevations will be referenced to 1929 North American Datum. For each groundwater well, the elevation will be surveyed to the nearest 0.01 foot at the measuring point where the uncapped well riser is notched, and at the top of the protective casing. For all locations, ground surface elevations will be surveyed to the nearest 0.1 foot.

Global Positioning System (GPS) may be utilized to locate sampling points and map surface features. A hand-held GPS receiver processes signals from satellites and generates position solutions. Alternately, a tape and compass may be used for nonpermanent sampling locations.

2.10 DECONTAMINATION

The equipment involved in field sampling activities will be decontaminated prior to and during drilling and sampling activities. This equipment includes drilling rigs, downhole tools, augers, well casing and screens, and soil and water sampling equipment.

2.10.1 Major Equipment

All downhole purging equipment and drilling equipment, including downhole drilling tools, will be cleaned with high-pressure hot water from a non-treated, Navy-approved source prior to beginning work, between boreholes, any time the drilling rig leaves the drill site prior to completing a boring, and at the conclusion of the drilling program. Well casing and screens will be supplied in certified clean packaging.

These decontamination operations will consist of washing equipment using a high-pressure steam wash from a potable water supply. All decontamination activities will take place at a predetermined area within the Station. Additional requirements for drilling equipment decontamination can be found in Station SOP SA-13, attached in Appendix B.

2.10.2 Sampling Equipment

All equipment used for collecting samples will be decontaminated both prior to beginning field sampling and between samples in accordance with Station SOP SA-13, contained in Appendix B. The following decontamination steps will be taken:

- Potable water rinse
- Alconox or liquinox detergent wash
- Potable water rinse
- Steam distilled deionized water rinse
- Isopropyl alcohol or hexane rinse¹
- Dilute nitric acid rinse²
- Air dry
- Wrap in aluminum foil

Field analytical equipment such as turbidity, pH, conductivity and temperature instrument probes will be rinsed with steam distilled deionized water first and then with the sample liquid.

2.11 **HANDLING AND DISPOSAL OF INVESTIGATION-DERIVED WASTE**

Investigation Derived Waste (IDW) may consist of personnel protective equipment, decontamination fluids, monitoring well purge and development water, drill cuttings, and groundwater, surface water, soil and sediment that accumulates during sample collection. Unless described otherwise in a site-specific work plan to account for site-specific conditions, IDW for environmental investigations will be handled as follows:

1. Personnel protective equipment will be double bagged in plastic trash bags and disposed in an on-station dumpster.
2. All other IDW will be handled as follows:

Segregate solids and liquids and containerize them on-site in DOT-approved drums.

¹Hexane will be used following sampling in areas with polychlorinated biphenols (PCBs) or oily waste.

²Only when sampling for metals.

Record in field log books and on drum labels which samples or sampling locations (e.g., decontamination fluids) have contributed to the contents of each drum.

Review the analytical results for the environmental samples.

If analytical results do not exceed screening concentrations for the samples associated with the environmental media placed in a drum, dispose of the drum's contents on the site. The screening concentrations for soil will consist of the Region III Industrial scenario soil ingestion RBC's and the soil SSL's, whichever is the lowest concentration. The screening concentrations for liquids will be the State of Maryland MCL's, or if no value is published for an analyte, the National Primary Drinking Water Standard MCL's.

If analytical results exceed screening concentrations for the samples associated with the environmental media placed in a drum, collect a composite sample of the drum's contents for TCLP analysis and RCRA characterization.

If the TCLP analysis of the RCRA characterization produce positive results (i.e., exceed the screening concentrations), dispose of the material at a permitted hazardous waste disposal facility.

If the TCLP analysis and the RCRA characterization produce negative results, dispose of the material at a permitted solid waste disposal facility.

2.12 ECOLOGICAL ASSESSMENT

Ecological assessments may be conducted on Station to characterize the interaction between site-related contaminants and the environment at each study area. An Ecological Assessment will be performed as part of a Remedial Investigation, unless otherwise agreed to by the Remedial Project Managers. Evaluation of ecological screening values, as well as other site specific conditions, will be evaluated by the Remedial Project Managers in determining when an ecological assessment is critical. Independent Ecological Assessments may be performed to support various environmental investigations and engineering studies for remedial actions, as warranted by the Remedial Project Managers. In conjunction with other investigative and analytical data, the ecological assessments will provide information to fully understand the presence and potential effect of contaminants.

Field activities associated with these assessments may include floral and faunal surveys, timberstand mapping, wetlands delineation, survey of threatened or endangered species, identification of exposure pathways, toxicity testing, and biota sampling. The information provided in the sections that follow represents the minimum sampling protocols to be followed, project-specific needs may require additional protocols.

2.12.1 Aquatic Habitat Characterization

The Aquatic Habitat Characterization may be comprised of two parts: the Macroinvertebrate Inventory and the Fish Characterization.

2.12.1.1 Macroinvertebrate Inventory

Although aquatic habitats typically include several types of organisms (including plankton, macroinvertebrates, amphibians, and fish), macroinvertebrates are the best choice for an inventory because they can be readily collected without specialized equipment, because their general lack of mobility results in an increased chance of exposure to contaminants, and because fish populations largely depend upon macroinvertebrates for food.

Local/state officials will be contacted to determine if state-specific biotic indices have been established so that the relative "health" of impacted and unimpacted study areas might be evaluated.

Methods outlined in Rapid Bioassessment Protocols for Use in Stream and Rivers (EPA/444/4-89-001), Protocol III, will be used to generate a number of matrices, such as taxa richness, species diversity, abundance and percent contribution by dominant taxa. Following taxonomic identification of each macroinvertebrate sample, the data will be summarized and indices estimated using formulae cited in the Rapid Bioassessment protocol. However, these matrices will not be compared to matrices generated for freshwater streams and rivers. Macroinvertebrate sampling will be conducted in conformance with the Station SOP: "Aquatic Ecological Inventory and Sampling" (SA-09).

Samples will be shipped to a laboratory specializing in aquatic invertebrate taxonomy for identification of macroinvertebrate samples.

2.12.1.2 Fish Characterization

Fish characterization will be performed to characterize (in general terms) the fish species and to determine their utility in documenting potential bioaccumulation. Fish will be sampled by means of seine netting,

electroshocking, or gill netting in conformance with Station SOP SA-09. Fish samples will be submitted to a laboratory that specializes in such fish characterization analyses.

Additional studies (e.g., tissue analyses) may be necessary to determine if contaminants are adversely affecting aquatic communities and/or predators that feed on organisms comprising these communities.

2.12.2 Terrestrial Habitat Characterization

The Terrestrial Habitat Characterization may be comprised of two parts: the Vegetation Inventory and the Terrestrial Wildlife Inventory. The inventories outlined below do not constitute surveys for threatened and endangered species. Because the remedial action must be in compliance with the Endangered Species Act (an ARAR), the following agencies will be contacted to request a review of their respective databases for recorded sightings of threatened and endangered species at the Station: the U.S. Fish and Wildlife Service; the Virginia Natural Heritage Program; the Virginia Department of Game and Inland Fisheries; The National Marine Fisheries Service; and the Virginia Department of Agriculture. If one or more of these reviews indicates that any federally listed threatened or endangered species could occur in the vicinity of one or more of the investigation sites, a survey for those species might be required.

2.12.2.1 Vegetation Inventory

Vegetation inventories will typically include trees (canopy), saplings, shrubs, herbaceous ground cover, woody vines, and bryophytes. The inventory will generate a list of vegetation for each investigation site. Each species will be listed by common and scientific name. The species will be classified according to wetland indicator status obtained from Region I listings (Reed, 1988) and by habitat type. Dominance of plant species will be judged subjectively. The absence of vegetation within the vicinity of an investigation site will also be documented.

The field data collected from the vegetation inventory will also be used to prepare detailed descriptions of each vegetative stratum in each habitat type. Although the inventory will provide detailed descriptive information for each habitat type, it is not designed to generate a comprehensive plant species list for investigation sites. Although most trees and shrubs can be identified any time of the year, many herbaceous plants are only seasonally present or can be identified only at specific times of the year when they are in flower or fruit.

Additionally, a canvas of each area will be conducted for stressed or dying vegetation. If any such vegetation is observed, its location will be noted on the habitat maps. Typical sources of stress (such as disease, insects, or physical injury) for the affected species will be investigated to assess whether they offer an

explanation for the observed effects. Any area of absent or sparse vegetation that cannot be attributed to known causes will also be noted.

2.12.2.2 Terrestrial Wildlife Inventory

At a minimum, investigation site areas and areas potentially affected by each study site will be inspected for the presence of terrestrial mammals, birds, reptiles, amphibians, and other wildlife. Observations will include not only direct sightings but also sound (call) and sightings of signs such as tracks, nests, burrows, skins, and scat.

The terrestrial wildlife inventory will generate a list for each site. Each species will be listed by scientific and common name, followed by a column indicating those habitat types in which the species was observed. Any visually apparent stress experienced by the wildlife will be noted.

2.12.3 Wetland Delineation

Wetlands potentially affected by each site will be delineated. Wetlands are defined by the USEPA as areas that are saturated or inundated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, plant life adapted to saturated soil conditions (COE, 1987; FICWD, 1989). Wetlands perform a number of ecologically valuable functions, including (but not limited to) providing habitat for a number of threatened or endangered plant and animal species, providing habitat for many lower food-chain organisms upon which fish and wildlife depend, improving water quality, and stabilizing shoreline soils.

The wetland delineation will follow the three parameter approach based on vegetation, soils, and hydrology developed in the Corps of Engineers Wetlands Delineation Manual (COE, 1987) and supplementary guidance (COE, 1992).

Specifically, wetland delineations will follow the procedures for routine determinations using an onsite inspection as outlined in Part IV, Section D, Subsection 2 of the Corps of Engineers Wetlands Delineation Manual. For small sites of under 5 acres, or for larger areas where the wetland/nonwetland boundaries are abrupt and distinct, the procedures developed for areas less than 5 acres in size (Steps 4 - 17) will be employed. Representative observation points for collecting vegetation, soil, and hydrology data will be established subjectively in each occurrence (stand) of each plant community on the site. For larger sites where the wetland/nonwetland boundaries are gradual or indistinct, the procedures developed for areas greater than 5 acres in size (Steps 18 -22) will be employed. Representative observation points will be established on transects perpendicular to the hydrological gradient.

Each observation point will be flagged (or staked) and labeled in the field and mapped on the wetland delineation drawings generated in the report. If the delineation will be used to support permit applications or notifications under Section 404 of the Clean Water Act, the delineated wetland boundaries will also be staked in the field for subsequent land survey and plotting on construction drawings. Each habitat mapping unit meeting the technical criteria for a wetland will be identified on the habitat map. Each wetland will be classified on the map using the classification system developed by the U.S. Fish and Wildlife Service in Classification of Wetlands and Deepwater Habitats of the United States (Cowardin et al., 1979).

Vegetation, soil, and hydrology data will be collected at each data collection point and presented on the Data Form shown in Appendix A. Each data collection point will be examined for field indicators which will include hydrophytic vegetation, hydric soils, and wetland hydrology, respectively. Each dominant plant species identified at each data collection point will be assigned one of the wetland indicator statuses using Region 1 data in the National List of Plant Species that Occur in Wetlands (Reed, 1988).

Soil pits will be hand augered at each data collection point to a minimum depth of 18 inches or to the depth necessary to adequately investigate for the presence of field indicators of hydric soils and wetland hydrology. For each soil horizon encountered, the color will be read using a Munsell soil color chart, and the texture will be estimated by feel (gloves worn to comply with the Health and Safety Plan will partially limit the accuracy of the texture estimates). If the water table or its capillary fringe is encountered, the depth below the ground surface will be recorded.

3.0 GENERAL SAMPLING OPERATIONS

3.1 GENERAL SAMPLING OPERATIONS

This section discusses the sampling methodology for all groundwater, surface water, soil, and sediment sampling activities to be performed at the NSWC, Indian Head. All sampling operations must be in compliance with the control measures detailed in the HASP.

3.1.1 Groundwater Sampling

The objective of this section is to provide guidance for the proper sampling equipment and techniques for groundwater sample collection. All groundwater sampling will be conducted in accordance with the requirements of the project specific Work Plan and in accordance with Station SOP SA-01, contained in Appendix B. Groundwater sampling will occur after a minimum of 14 days following well development.

Prior to obtaining a groundwater sample, water level in the monitoring well will be measured to within 0.01-foot accuracy from the marked location on the top of the well riser pipe. If volatile organic contamination is suspected, a head-space reading will be obtained in the well's riser pipe using an organic vapor monitor. Monitoring wells will typically be purged prior to sample collection. If, however, non-aqueous phase liquids (dense or light) are suspected and/or detected in the well, a site-specific decision needs to be made on whether to collect samples of the free phase liquids and/or dissolved phase.

Purging will be accomplished by removing groundwater from the well using a stainless steel bailer or a submersible, low flow rate pump with a new, clean length of polyethylene tubing. Temperature, pH, turbidity, and conductivity measurements will be taken and recorded before, during (at least twice), and after purging the well in accordance with the discussion in Section 2.5. Purging will continue until field measurements collected by in-line instrumentation or standard sample collection methods for groundwater, have stabilized within 10% over at least two measurements, or until 3 well volumes are removed. The volume removed will be determined by the time and measured pump rate, or by direct measurement of the purged volume. These data will be recorded in the sampling log book along with instrument calibration data. In the event that the aquifer recharge does not allow sustained pumping or does not return to 80% of original static water level after 2 hours, a decision (subject to Navy approval) may be made to sample the well prior to removal of 3 calculated well volumes.

Following the purging process, samples will be collected with a clean, bottom discharge, disposable Polyethylene bailer. To avoid excessive oxidation, adsorption on the PVC well casing, or loss of volatiles

from the well, samples will be collected as soon as sufficient water returns to the groundwater monitoring well.

Normally well sampling will progress from the well expected to be least contaminated to that expected to be most contaminated, to minimize the potential for cross-contamination of samples that may result from inadequate decontamination of sampling equipment. The samples will be collected and containerized according to the volatility of the target analytes. At the subject sites, the collection order will be as follows:

- (1) Volatile Organic Compounds (VOCs)
- (2) Semi-Volatile Organic Compounds (SVOCs);
- (3) Filtered and Unfiltered Metals and Cyanides and
- (4) Nitrate/Nitrite, Pesticides/PCBs, and Explosives

All well purge and sampling equipment will be thoroughly decontaminated between sampling sites as detailed in Section 2.10. Wells with PID readings or a distinctive odor will require that the polyethylene tubing used at that well be discarded before proceeding to the next well.

All pertinent field data will be recorded on a well sample form (Attached in Appendix A) and in the field log book.

3.1.2 Surface Water Sampling

Surface water samples will be collected as grab samples from surface water drainages, discharge ponds, and low wet areas in accordance with Station SOP SA-02, contained in Appendix B.

Immediately prior to sampling, the temperature, pH, and conductivity of the water will be measured and recorded on the sample log form (attached in Appendix A) in accordance with Section 2.5. During sampling, the sample bottle will be submerged just below the water surface and allowed to fill. After the sample bottle has been filled, preservatives will be added (if required) and the sample bottle will be capped. Samples to be analyzed for volatile constituents will be collected first and immediately sealed in a container so that no head space exists. Sampling will be conducted initially from the location farthest downstream and will proceed progressively upstream.

If there is an insufficient depth of water to use the direct fill method of sample collection, a stainless steel beaker will be used to fill the sample bottles. Sample beakers will be decontaminated between samples as described in Section 2.10.2 of this Master FSP.

All pertinent field data will be recorded using a sample log form (attached in Appendix A) and in the field log book.

3.1.3 Surface Soil Sampling

Surface soil samples will be collected from the ground surface to a depth not exceeding 6 inches in accordance with Station SOP SA-03, contained in Appendix B. A stainless-steel trowel or hand auger will be used to collect the surface soil sample. All samples obtained will be monitored with an organic vapor monitor and then collected for lithologic and/or chemical analysis. Upon sample retrieval, the samples to be analyzed for volatile constituents will be taken first and immediately sealed. Samplers will be decontaminated between samples as described in this FSP. All pertinent field data will be recorded using a sample log form (attached in Appendix A) and the field log book.

3.1.4 Subsurface Soil Sampling

Subsurface soil samples will be collected from soil borings drilled in accordance with Section 2.2.1 of this document and Station SOP GH-03, contained in Appendix B. All samples obtained from the borehole will be monitored with an organic vapor monitor and then collected for lithologic and/or chemical analysis. Upon sample retrieval, the samples to be analyzed for volatile constituents will be taken first and immediately sealed. Samplers will be decontaminated between samples as described in Section 2.10.2. All pertinent field data will be recorded using a sample log form (attached in Appendix A) and the field log book.

3.1.5 Sediment Sampling

Sediment samples will be collected as grab samples from both the pond perimeters and interiors as well as from stream/drainage bottoms in accordance with Station SOP SA-02, contained in Appendix B. A stainless-steel Ekman or Ponar dredge will be used to collect the sediment sample. The sediment samples will be collected from the top 4 to 6 inches in depositional or low lying areas where fines comprise at least 50% of the sample. Upon sample retrieval, a sufficient volume will be obtained for volatile organics analysis and sealed with no head space. The remaining material will be homogenized and distributed to the remaining sample containers. Sample equipment will be decontaminated between samples as described in Section 2.10.2.

All pertinent field data will be recorded using a sample log form (attached in Appendix A) and the field log book.

3.1.6 Head-Space Soil Sampling

If required, head-space soil analysis will be performed. Upon split-spoon sample retrieval, a small quantity of the soil will be removed from the sampler and immediately placed in a sealed container. The container will then be warmed for 15 minutes in order to volatilize the potential contaminants in the soil sample. After 15 minutes, the tip of the OVA is pushed into or through the container or its lid, and a direct reading is obtained from the OVA. All head-space readings will be noted on the appropriate boring log and/or sample form.

3.1.7 Air Sampling

During routine field activities, air monitoring can aid in the selection of sample locations and screening of samples for a rapid qualitative determination of volatile contamination. The purpose of this section is to provide a general guide for the determination of volatile airborne contamination. All air sampling will be performed in accordance with Station SOP SA-04 provided in Appendix B.

Continuous air monitoring is performed by drawing air samples from a fixed sampling point (e.g., screening of split-barrel samplers to select samples for laboratory analysis). Typical qualitative air monitoring equipment includes FID, PID, and calorimetric sorbent media (e.g., Draeger® tubes). It is important to choose the proper detector for the anticipated site contaminants and to account for air travel time required to move the contaminant from the source to the detector. It is sometimes advantageous to draw an air sample into a non-reactive sample bag (such as Mylar) for confirmatory, fixed-base analysis or for field analysis at a location away from potential site contaminants and temperature extremes.

Most air monitoring equipment is battery powered (requiring daily charging), lightweight, and water resistant. Some newer air monitors allow for chemical-specific calibration and data logging capabilities. Advantages of qualitative air monitoring include immediate qualitative sample screening, the ability to obtain a general vertical profile of contaminant concentrations during drilling operations, and inexpensive screening of many samples in order to reduce expensive, fixed-base laboratory analyses. Disadvantages include a limited concentration range (both high and low), inability to detect some particular contaminants, sensitivity to site environmental conditions such as temperature and humidity, and limited battery life.

3.1.8 Drum Sampling

Drum sampling is only anticipated to be conducted for IDW waste generated during field investigative activities. Preliminary classification will be possible based on available data to minimize safety hazards associated with drum opening.

3.1.9 Tank Sampling

Tank sampling may be conducted for IDW liquid waste stored in above-ground tanks or upon discovery of an underground storage tank in an investigation area.

3.1.10 Ultra-Clean Mercury Sampling

Standard handling procedures may contribute to unsatisfactory detection limits for Mercury analysis. As a result ultra-clean sampling and handling procedures have been adopted. These procedures are summarized below and a more complete discussion is included in Summary of Ultra-Clean Sampling Protocols (Bloom, 1994).

Samples will be collected into rigorously cleaned Teflon bottles or borosilicate glass bottles with Teflon caps. The bottles must have tightly sealing caps to prevent diffusion of atmospheric Mercury through the threads. Clean bottles filled with high purity 0.4% (V/V) HCl are dried, capped, and double bagged in new zipsealed bags and stored in wooden or plastic boxes until use.

Sampling crews require two people acting in concert. The first crew member opens the outer zipsealed bag while avoiding touching the inside of the bag. The second crew member reaches in, opens the inner bag, and pulls out the sample bottle. This bottle is opened with a plastic shrouded wrench and the acidified water is containerized for disposal along with decontamination fluids generated during cleaning of field sampling equipment (Section 2.11.4). The sample is then collected and the lid is replaced using the wrench. The bottle is then resealed in the zipsealed bags in the opposite order as it was removed. The sample is then handled as other environmental samples.

3.1.11 Field Test Kits

Field test kits may be used for screening purposes or for determining gross contamination levels at various sites. These kits will be used in accordance with manufactures specifications. USEPA-approved kits will be used, when available.

3.2 SAMPLE HANDLING

Sample handling includes the field-related considerations concerning the selection of sample containers, preservatives, allowable holding times and analyses requested. Sample identification, packaging, and shipping are addressed in Station SOP SA-11, contained in Appendix B. Preservation requirements and

procedures are summarized below. The project-specific QAPP discusses details concerning sample containers, volume requirements, preservatives, allowable holding times and analyses requested.

3.2.1 Field Documentation

Sample documentation consists of the completion of chain-of-custody (COC) reports and matrix-specific sample logsheets. COC reports are detailed in Section 7.0 of the Master QAPP. Completion of sample logsheets are discussed along with the matrix-specific sampling procedures presented in Section 2.0 of the Master FSP.

In addition, various hardcover, bound, record books are maintained for each field activity. The Site Logbook (Station SOP SA-12, Appendix B) serves as the overall record of field activities. Information included daily in the master Site Logbook includes weather conditions, identity and arrival and departure times of personnel, management issues, etc. Various field notebooks are also maintained. For example, each geologist supervising drilling operations at a specific sampling location will maintain a field notebook.

The FOL is responsible for the maintenance and security of all field records. Eventually, all field records (COCs, sample logsheets, logbooks, and notebooks), are docketed and incorporated in the project central file.

One other type of standardized field documentation exists. Field Task Modification Records (FTMRs) are specific forms initiated when a change to or deviation from procedures provided for in the project planning documents occurs. The procedure for requesting and recording field changes follows:

- The FOL notifies the Project Manager (PM) of the need for the change.
- If necessary, the PM discusses the change with the pertinent individuals (e.g., the Navy Remedial Project Manager (RPM), B&R Environmental QA Manager (QAM)). Verbal approval or denial of the proposed change is given at this time.
- The FOL then documents the change on an FTMR and forwards the form to the PM at the earliest convenient time (e.g., end of the workweek).
- The PM signs the form and distributes copies to the Navy RPM, B&R Environmental QAM, the PM, FOL, and project file.

- A copy of the completed FTMR is attached to the field copy of the affected document.

3.2.2 Sample Nomenclature

Each sample collected at the Station will be assigned a unique tracking number. The sample designation includes the sample or well location number, site number, and an indication of the sample matrix (e.g., soil, groundwater, surface water, or sediment). The designations indicate--from left to right--matrix/sample type, site number, sample location number, and sample depth, as needed. The sample locations identified in the Project Work Plan incorporate the sample matrix/type, site, and sample location numbers.

The standard sample type codes are summarized below.

Water Samples

GW - Groundwater
SE - Seepage
SW - Surface Water
OF - Outfall

Soil Samples

SB - Subsurface Soil
SD - Sediment
SS - Surface Soil
TP - Test Pit Sample

OTHER CODES

AS - Air Sample
BO - Bulk Sample
CO - Concrete Sample
DS - Drum Sample
DU - Duplicate Sample
ER - Equipment Rinsate Sample
FB - Field Blank
ID - Investigation-Derived Wash Sample

MW - Monitoring Well
QC - Quality Control
RS - Rinsate Sample
SG - Soil Gas Sample
TB - Trip Blank
WO - Wipe Sample
WP - Well Point (temporary)

The QC sample code is usually used for drilling water and sand pack samples. Drilling water samples will be collected. Samples of the sand pack are not necessary, as analysis should be available from the manufacturer. Duplicates will be numbered sequentially using the 100 series in place of the sample location number. Trip blanks and field blanks will be labeled sequentially followed by the date (i.e., TB-01-013194). Rinsate samples will be numbered by site. Background locations will use 00 in place of a site number. Samples to be used for matrix spikes and matrix spike duplicates will be labeled MS/MSD, as required in the laboratory QA Plan.

3.2.3 Preservation

The existence of some chemical constituents in some environmental matrices is unstable. Therefore, these types of samples must be "stabilized" using preservatives and/or special handling procedures (such as maintaining the sample on ice at 4°C or using amber glass bottles to prevent photodegradation). These preservation techniques prevent (or forestall) degradation of the sample to ensure that the sample is representative of actual site conditions.

Common chemical preservatives (fixatives) include the following:

- hydrochloric acid (HCl)
- sulfuric acid (H₂SO₄)
- nitric acid (HNO₃)
- sodium hydroxide (NaOH)

General procedures for adding these preservatives are discussed below. Tables 3-1 and 3-2 show general sample container and preservation requirements; these Tables also show maximum technical holding time allowances. The standards presented in these tables are current and are subject to change as guidelines are periodically revised or updated by the regulatory agencies. Prior to including in a specific project plan, the standards should be reviewed to ensure that the most recent values are used.

All acids/bases used for preservation will be analytical reagent (AR) grade (or purer) and will be diluted to the required concentration before field sampling commences. To avoid uncontrolled reactions, be sure to ADD the ACID to the water, not vice versa. A dilution guide is provided below:

Acid/Base	Dilution	Concentration
HCl	1 part concentrated HCl : 1 part double-distilled, deionized water	6N
H ₂ SO ₄	1 part concentrated H ₂ SO ₄ : 1 part double-distilled, deionized water	18N
HNO ₃	undiluted concentrated HNO ₃	16N
NaOH	400 grams solid NaOH dissolved in 870 mL double-distilled, deionized water; yields 1 liter of solution	10N

Another general guide, showing the amount of prepared preservative necessary to achieve the desired level of sample preservation, follows:

TABLE 3-1

**GENERAL SAMPLE CONTAINER AND PRESERVATION REQUIREMENTS
FOR CERCLA/RCRA SAMPLES
INDIAN HEAD, MARYLAND**

Sample Type and Concentration	Container ⁽¹⁾	Sample Size	Preservation ⁽²⁾	Holding Time ⁽²⁾	
WATER					
Organics (GC&GC/MS)	VOA Low	Borosilicate glass	3 x 40 mL	Cool to 4°C HCl to ≤ 2	14 days ⁽⁹⁾
	Extractables Low Medium	Amber glass	2x1 L	Cool to 4°C None	7 days to extraction; 40 days after extraction
Inorganics	Metals Low Medium	High-density polyethylene	1 L	HNO ₃ to pH ≤ 2	6 months (Hg-28 days)
	Cyanide Low Medium	High-density polyethylene	1 L	NaOH to pH > 12 Cool to 4°C	14 days
Organic/Inorganic	High Hazard	8-oz. wide-mouth glass	6 oz.	None	14 days
COD	Low	High-density polyethylene	0.5 L	H ₂ SO ₄ to pH < 2 Cool to 4°C	28 days
TOC	Low	High-density polyethylene	0.5 L	HCl to pH < 2 Cool to 4°C	28 days
Oil & Grease	Low	Glass	1.0 L	H ₂ SO ₄ to pH < 2 Cool to 4°C	28 days
Phenols	Low	High-density polyethylene	1.0 L	H ₂ SO ₄ to pH < 2 Cool to 4°C	28 days
General Chemistry	—	High-density polyethylene	1.0 L	Cool to 4°C	—
SOIL					
Organics (GC&GC/MS)	VOA	2 x 60 mL	120 mL	Cool to 4°C	14 days
	Extractables Low Medium	8-oz. glass	6 oz.	Cool to 4°C	7 days to extraction; 40 days after extraction
Inorganics	Low/Medium	8-oz. glass	6 oz.	Cool to 4°C	6 months (Hg - 28 days) Cyanide (14 days)
Organic/Inorganic	High Hazard	8-oz. (120 mL) wide-mouth glass	6 oz.	None	NA
Dioxin	All	4-oz. (120 mL) wide-mouth glass (Protect from light)	4 oz.	None	7 days until extraction; 28 days after extraction
EP Toxicity	All	250 mL high-density polyethylene	200 grams	None	NA
AIR					
Volatile Organics	Low Medium	Charcoal tube – 7 cm long, 6 mm OD, 4 mm ID	100 L air	Cool to 4°C	NA

(1) All glass containers should have Teflon cap liners or septa.

(2) Preservation and maximum holding time allowances per 40 CFR 136.

TABLE 3-2

**REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES
INDIAN HEAD, MARYLAND**

Parameter Number/Name	Container ⁽¹⁾	Preservation ⁽²⁾⁽³⁾	Maximum Holding Time ⁽⁴⁾
INORGANIC TESTS:			
Acidity	P, G	Cool, 4°C	14 days
Alkalinity	P, G	Cool, 4°C	14 days
Ammonia	P, G	Cool, 4°C; H ₂ SO ₄ to pH 2	28 days
Biochemical Oxygen Demand	P, G	Cool, 4°C	48 hours
Bromide	P, G	None required	28 days
Biochemical Oxygen Demand, Carbonaceous	P, G	Cool, 4°C	48 hours
Chemical Oxygen Demand	P, G	Cool, 4°C; H ₂ SO ₄ to pH 2	28 days
Chloride	P, G	None required	28 days
Chlorine, Total Residual	P, G	None required	Analyze immediately
Color	P, G	Cool, 4°C	48 hours
Cyanide, Total and Amenable to Chlorination	P, G	Cool, 4°C; NaOH to pH 12; 0.6 g ascorbic acid ⁽⁵⁾	14 days ⁽⁶⁾
Fluoride	P	None required	28 days
Hardness	P, G	HNO ₃ to pH 2; H ₂ SO ₄ to pH 2	6 months
Hydrogen Ion (pH)	P, G	None required	Analyze immediately
Kjeldahl and Organic Nitrogen	P, G	Cool, 4°C; H ₂ SO ₄ to pH 2	28 days
Nitrate	P, G	None required	48 hours
Nitrate-Nitrite	P, G	Cool, 4°C; H ₂ SO ₄ to pH 2	28 days
Nitrite	P, G	Cool, 4°C	48 hours
Oil & Grease	G	Cool, 4°C; H ₂ SO ₄ to pH 2	28 days
Organic Carbon	P, G	Cool, 4°C; HCl or H ₂ SO ₄ to pH 2	28 days
Orthophosphate	P, G	Filter immediately; Cool, 4°C	48 hours
Oxygen, Dissolved-Probe	G Bottle & top	None required	Analyze immediately
Oxygen, Dissolved-Winkler	G Bottle & top	Fix on site and store in dark	8 hours
Phenols	G	Cool, 4°C; H ₂ SO ₄ to pH 2	28 days
Phosphorus (elemental)	G	Cool, 4°C	48 hours
Phosphorus, Total	P, G	Cool, 4°C; H ₂ SO ₄ to pH 2	28 days
Residue, Total	P, G	Cool, 4°C	7 days
Residue, Filterable	P, G	Cool, 4°C	7 days
Residue, Nonfilterable (TSS)	P, G	Cool, 4°C	7 days
Residue, Settleable	P, G	Cool, 4°C	48 hours
Residue, Volatile	P, G	Cool, 4°C	7 days
Silica	P	Cool, 4°C	28 days
Specific Conductance	P, G	Cool, 4°C	28 days
Sulfate	P, G	Cool, 4°C	28 days
Sulfide	P, G	Cool, 4°C; add zinc acetate plus sodium hydroxide to pH 9	7 days
Sulfite	P, G	None required	Analyze immediately
Surfactants	P, G	Cool, 4°C	48 hours
Temperature	P, G	None required	Analyze immediately
Turbidity	P, G	Cool, 4°C	48 hours

**TABLE 3-2
REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES
INDIAN HEAD, MARYLAND
PAGE 2 OF 3**

Parameter Number/Name	Container ⁽¹⁾	Preservation ^{(2),(3)}	Maximum Holding Time ⁽⁴⁾
METALS:⁽⁷⁾			
Chromium VI	P, G	Cool, 4°C	24 hours
Mercury	P, G	HNO ₃ to pH 2	28 days
Metals, except Chromium VI and Mercury	P, G	HNO ₃ to pH 2	6 months
ORGANIC TESTS:⁽⁸⁾			
Purgeable Halocarbons	G, Teflon-lined septum	Cool, 4°C; 0.008% Na ₂ S ₂ O ₃ ⁽⁵⁾	14 days
Purgeable Aromatic Hydrocarbons	G, Teflon-lined septum	Cool, 4°C; 0.008% Na ₂ S ₂ O ₃ ⁽⁵⁾ HCl to pH 2 ⁽⁹⁾	14 days
Acrolein and Acrylonitrile	G, Teflon-lined septum	Cool, 4°C; 0.008% Na ₂ S ₂ O ₃ ⁽⁵⁾ adjust pH to 4-5 ⁽¹⁰⁾	14 days
Phenols ⁽¹¹⁾	G, Teflon-lined cap	Cool, 4°C; 0.008% Na ₂ S ₂ O ₃ ⁽⁵⁾	7 days until extraction; 40 days after extraction
Benzidines ^{(11), (12)}	G, Teflon-lined cap	Cool, 4°C; 0.008% Na ₂ S ₂ O ₃ ⁽⁵⁾	7 days until extraction ⁽¹³⁾
Phthalate esters ⁽¹¹⁾	G, Teflon-lined cap	Cool, 4°C	7 days until extraction; 40 days after extraction
Nitrosamines ^{(11), (14)}	G, Teflon-lined cap	Cool, 4°C; store in dark; 0.008% Na ₂ S ₂ O ₃ ⁽⁵⁾	7 days until extraction; 40 days after extraction
PCBs ⁽¹¹⁾ Acrylonitrile	G, Teflon-lined cap	Cool, 4°C	7 days until extraction; 40 days after extraction
Nitroaromatics & Isophorone ⁽¹¹⁾	G, Teflon-lined cap	Cool, 4°C; 0.008% Na ₂ S ₂ O ₃ ⁽⁵⁾ ; store in dark	7 days until extraction; 40 days after extraction
Polynuclear Aromatic Hydrocarbons ^{(11), (14)}	G, Teflon-lined cap	Cool, 4°C; 0.008% Na ₂ S ₂ O ₃ ⁽⁵⁾ ; store in dark	7 days until extraction; 40 days after extraction
Haloethers ⁽¹¹⁾	G, Teflon-lined cap	Cool, 4°C; 0.008% Na ₂ S ₂ O ₃ ⁽⁵⁾	7 days until extraction; 40 days after extraction
Chlorinated Hydrocarbons ⁽¹¹⁾	G, Teflon-lined cap	Cool, 4°C	7 days until extraction; 40 days after extraction
TCDD/TCDF ⁽¹¹⁾	G, Teflon-lined cap	Cool, 4°C; 0.008% Na ₂ S ₂ O ₃ ⁽⁵⁾	7 days until extraction; 40 days after extraction
PESTICIDES TESTS:			
Pesticides ⁽¹¹⁾	G, Teflon-lined cap	Cool, 4°C; pH 5-9 ⁽¹⁵⁾	7 days until extraction; 40 days after extraction
RADIOLOGICAL TESTS:			
1-5 Alpha, beta and radium	P, G	HNO ₃ to pH 2	6 months

- (1) Polyethylene (P) or Glass (G)
- (2) Sample preservation should be performed immediately upon sample collection. For composite chemical samples each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining at 4°C until compositing and sample splitting is completed.
- (3) When any sample is to be shipped by common carrier or sent through the United States mails, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172).
- (4) Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid. Samples may be held for longer periods only if the permittee, or monitoring laboratory, has data on file to show that the specific types of samples under study are stable for the longer periods, and has received a variance from the Regional Administrator.
- (5) Should only be used in the presence of residual chlorine.

**TABLE 3-2
REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES
INDIAN HEAD, MARYLAND
PAGE 3 OF 3**

- (6) Maximum holding time is 24 hours when sulfide is present. Optionally, all samples may be tested with lead acetate paper before pH adjustments are made to determine if sulfide is present. If sulfide is present, it can be removed by the addition of cadmium nitrate powder until a negative spot test is obtained. The sample is filtered and then NaOH is added to pH 12.
- (7) Samples should be filtered immediately on site before adding preservative for dissolved metals.
- (8) Guidance applies to samples to be analyzed by GC, LC, or GC/MS for specific compounds.
- (9) Sample receiving no pH adjustment must be analyzed within 7 days of sampling.
- (10) The pH adjustment is not required if acrolein will not be measured. Samples for acrolein receiving no pH adjustment must be analyzed within 3 days of sampling.
- (11) When the extractable analytes of concern fall within a single chemical category, the specified preservative and maximum holding times should be observed for optimum safeguard of sample integrity. When the analytes of concern fall within two or more chemical categories, the sample may be preserved by cooling to 4°C, reducing residual chlorine with 0.008% sodium thiosulfate, storing in the dark, and adjusting the pH to 6-9; samples preserved in this manner may be held for 7 days before extraction and for 40 days after extraction. Exceptions to this optional preservation and holding time procedure are noted in footnote 5 (re: the requirement for thiosulfate reduction of residual chlorine) and footnotes 12, 13 (re: the analysis of benzidine).
- (12) If 1,2-diphenylhydrazine is likely to be present, adjust the pH of the sample to 4.0 ± 0.2 to prevent rearrangement to benzidine.
- (13) Extracts may be stored up to 7 days before analysis if storage is conducted under an inert (oxidant-free) atmosphere.
- (14) For the analysis of diphenylnitrosamine, add 0.008% $\text{Na}_2\text{S}_2\text{O}_3$ and adjust pH to 7-10 with NaOH within 24 hours of sampling.
- (15) The pH adjustment may be performed upon receipt at the laboratory and may be omitted if the samples are extracted within 72 hours of collection. For the analysis of aldrin, add 0.008% $\text{Na}_2\text{S}_2\text{O}_3$.

Acid/Base	Amount Required for Preservation
HCl	5-10 mL
H ₂ SO ₄	2 - 5 mL
HNO ₃	2 - 5 mL
NaOH	2 mL

The amounts required for preservation shown in the above table assumes proper preparation of the preservative and addition of the preservative to one liter of aqueous sample (assuming that the sample is initially at pH 7, is poorly buffered, and does not contain particulate matter; as these conditions vary, more preservative may be required.) The final sample pH must be checked using narrow-range pH paper, as described in the generalized procedure detailed below

- Pour off 5-10 mL of sample into a dedicated, clean container. Use some of this sample to check the initial sample pH using wide range (0-14) pH paper. Never dip the pH paper into the sample; always apply a drop of sample to the pH paper using a clean stirring rod or pipette.
- Add about one-half of the estimated preservative required to the original sample bottle. Cap and invert gently several times to mix. Check pH (as described above) using medium range pH paper (pH 0-6 or pH 7.5-14, as applicable).
- If proper preservation was not achieved, continue to add preservative drop-wise and repeat mixing and checking, using narrow range (pH 0-2.5 or pH 11-13) pH paper. When desired pH is reached, fill original sample container to the top using the sample initially poured off; recheck pH.
- Cap sample bottle and seal securely.

Additional considerations are discussed below:

- To test if ascorbic acid must be used to remove oxidizing agents present in the sample before it can be properly preserved, place a drop of sample on KI-starch paper. A blue color indicates the need for ascorbic acid addition.

If required, add a few crystals of ascorbic acid to the sample and retest with the KI-starch paper. Repeat until a drop of sample produces no color on the KI-starch paper. Then add an additional 0.6 grams of ascorbic acid per each liter of sample volume.

Continue with proper base preservation of the sample as described, generally, above.

- Samples for sulfide analysis must be treated by the addition of 4 drops (0.2 mL) of 2N zinc acetate solution per 100 mL of sample.

The 2N zinc acetate solution is made by dissolving 220 grams of zinc acetate in 870 mL of double-distilled, deionized water to make 1 liter of solution.

The sample pH is then raised to 9 using the NaOH preservative.

- To test of sodium thiosulfate must be added to remove residual chlorine from a sample, test the sample for residual chlorine using a field test kit especially made for this purpose.

If residual chlorine is present, add 0.08 grams of sodium thiosulfate per liter of sample to remove the residual chlorine.

Continue with proper acidification of the sample as described, generally, above.

At times, field-filtration may be required to provide for the analysis of dissolved chemical constituents. Field-filtration must be performed prior to the preservation of samples as described above. General procedures for field filtration are described below:

- The sample shall be filtered through a non-metallic, 0.45-micron membrane filter, immediately after collection. The filtration system shall consist of a dedicated filter canister, dedicated silicon tubing, and a peristaltic pump with pressure or vacuum pumping squeeze action (since the sample is filtered by mechanical peristalsis, the sample travels only through the tubing).
- To perform filtration, thread the silicon tubing through the peristaltic pump head. Attach the filter canister to the discharge end of the silicon tubing (note flow direction arrow); attach the aqueous sample container to the intake end of the silicon tubing. Turn the peristaltic pump on and perform filtration.
- Continue by preserving the filtrate, as applicable and generally described above.

3.2.4 Documentation, Sample Packaging and Shipping

Samples will be packaged and shipped in accordance with Station SOP SA-6.2 contained in Appendix B. Updated material classification information, which supercedes the information in Attachments A and B of Station SOP SA-6.2, is provided in Table 3-3 and Table 3-4. The standards presented in these tables are current and are subject to change as guidelines are periodically revised or updated by the regulatory agencies. Prior to including in a specific project plan, the standards should be reviewed to ensure that the most recent values are used. A general guide for hazardous materials shippers is provided in Appendix C. In addition, to further assist the field crew, the following hazardous materials shipping checklist is provided:

- PACKAGING

1. Check DOT 173.24 for appropriate type of package for hazardous substance.
2. Check for container integrity, especially the closure.
3. Check for sufficient absorbent material in package.
4. Check for sample tags and log sheets for each sample and for chain-of-custody record.

- SHIPPING PAPERS

1. Check that entries contain only approved DOT abbreviations.
2. Check that entries are in English.
3. Check that hazardous material entries are specially marked to differentiate them from any nonhazardous materials being sent using same shipping paper.
4. Be careful that all hazardous classes are shown for multiclass materials.
5. Check total amounts by weight, quantity, or other measures used.

TABLE 3-3
DOT HAZARDOUS MATERIAL CLASSIFICATION
(49 CFR 173.2a)
INDIAN HEAD, MARYLAND

- | | |
|-----|--|
| 1. | Radioactive material (except a limited quantity) |
| 2. | Division 2.3, Poisonous Gases |
| 3. | Division 2.1, Flammable Gas |
| 4. | Division 2.2, Nonflammable gas |
| 5. | Division 6.1, Poisonous Liquids, Packing Group 1 (poison by inhalation only) |
| 6. | Division 4.2, Pyrophoric Material |
| 7. | Division 4.1, Self-Reactive Material |
| 8. | Class 3, Flammable Liquids* |
| 9. | Class 8, Corrosive Material |
| 10. | Division 4.1, Flammable Solid* |
| 11. | Division 4.2, Spontaneously Combustible Materials* |
| 12. | Division 4.3, Dangerous When Wet Materials* |
| 13. | Division 5.1, Oxidizers* |
| 14. | Division 6.1, Poisonous Liquids or Solids (other than Packing Group 1)* |
| 15. | Combustible liquid |
| 16. | Class 9, Miscellaneous Hazardous Materials |

* If a material has or meets the criteria for more than one hazard class, use the precedence of hazardous table on the following page for Classes 3 and 8 and Divisions 4.1, 4.2, 4.3, 5.1, and 6.1. The following table ranks those materials that meet the definition of Classes 3 and 8 and Divisions 4.1, 4.2, 4.3, 5.1, and 6.1.

TABLE 3-4

**PRECEDENCE OF HAZARD TABLE
(Hazard Class and Packing Group)
INDIAN HEAD, MARYLAND**

Class	Packing Group	4.2	4.3	5.1 I ^(a)	5.1 II ^(a)	5.1 III ^(a)	6.1 I (Dermal)	6.1 I (Oral)	6.1 II	6.1 III	8 I (Liquid)	8 I (Solid)	8 II (Liquid)	8 II (Solid)	8 III (Liquid)	8 III (Solid)
3	I						3	3	3	3	3	^(c)	3	^(c)	3	^(c)
3	II						3	3	3	3	8	^(c)	3	^(c)	3	^(c)
3	III						6.1	6.1	6.1	3 ^(d)	8	^(c)	8	^(c)	3	^(c)
4.1	II ^b	4.2	4.3	5.1	4.1	4.1	6.1	6.1	4.1	4.1	^(c)	8	^(c)	4.1	^(c)	4.1
4.1	III ^b	4.2	4.3	5.1	4.1	4.1	6.1	6.1	6.1	4.1	^(c)	8	^(c)	8	^(c)	4.1
4.2	II		4.3	5.1	4.2	4.2	6.1	6.1	4.2	4.2	^(c)	8	^(c)	4.2	^(c)	4.2
4.2	III		4.3	5.1	4.2	4.2	6.1	6.1	6.1	4.2	^(c)	8	^(c)	8	^(c)	4.2
4.3	I			5.1	4.3	4.3	6.1	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
4.3	II			5.1	4.3	4.3	6.1	4.3	4.3	4.3	8	8	8	4.3	4.3	4.3
4.3	III			5.1	4.3	4.3	6.1	6.1	6.1	4.3	8	8	8	8	4.3	4.3
5.1	I ^a						5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1
5.1	II ^a						6.1	5.1	5.1	5.1	8	8	8	5.1	5.1	5.1
5.1	III ^a						6.1	6.1	6.1	5.1	8	8	8	8	5.1	5.1
6.1	I, Dermal										8	6.1	6.1	6.1	6.1	6.1
6.1	I, Oral										8	6.1	6.1	6.1	6.1	6.1
6.1	II, Inhalation										8	6.1	6.1	6.1	6.1	6.1
6.1	II, Dermal										8	6.1	8	6.1	6.1	6.1
6.1	II, Oral										8	8	8	6.1	6.1	6.1
6.1	III										8	8	8	8	8	8

- (a) There are at present no established criteria for determining Packing Groups for liquids in Division 5.1. At present, the degree of hazard is to be assessed by analogy with listed substances, allocating the substances to Packing Group I, Great; Group II, Medium; or Group III, Minor Danger.
- (b) Substances of Division 4.1 other than self-reactive substances.
- (c) Denotes an impossible combination.
- (d) For pesticides only, where a material has the hazards of Class 3, Packing Group III, and Division 6.1, Packing Group III, the primary hazard is Division 6.1, Packing Group III.

6. Check that any limited-quantity exemptions are so designated on the shipping paper.
 7. Check that certification is signed by shipper.
 8. Make certain driver signs for shipment.
- RCRA MANIFEST
 1. Check that approved state/federal manifests are prepared.
 2. Check that transporter has the following: valid EPA identification number, valid driver's license, valid vehicle registration, insurance protection, and proper DOT labels for materials being shipped.
 3. Check that destination address is correct.
 4. Check that driver knows where shipment is going.
 5. Check that the driver is aware of emergency procedures for spills and accidents.
 6. Make certain driver signs for shipment.
 7. Make certain one copy of executed manifest and shipping document is retained by shipper.

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

- Sample Labels
- COC Forms
- Appropriate labels applied to shipping coolers
- COC Labels
- Federal Express Airbills

3.3 SAMPLE CUSTODY

Custody of samples must be maintained and documented at all times. COC begins with the collection of the samples in the field. The Master QAPP and Station SOP-6.1 further details the COC procedures. An example of the COC record is included in Appendix A.

3.4 QUALITY CONTROL SAMPLES

In addition to periodic calibration of field equipment and appropriate documentation, QC samples will be collected or generated during environmental sampling activities. QC samples include field blanks, rinsate duplicates, trip blanks, and background samples. Each type of field QC sample is defined in the Master QAPP.

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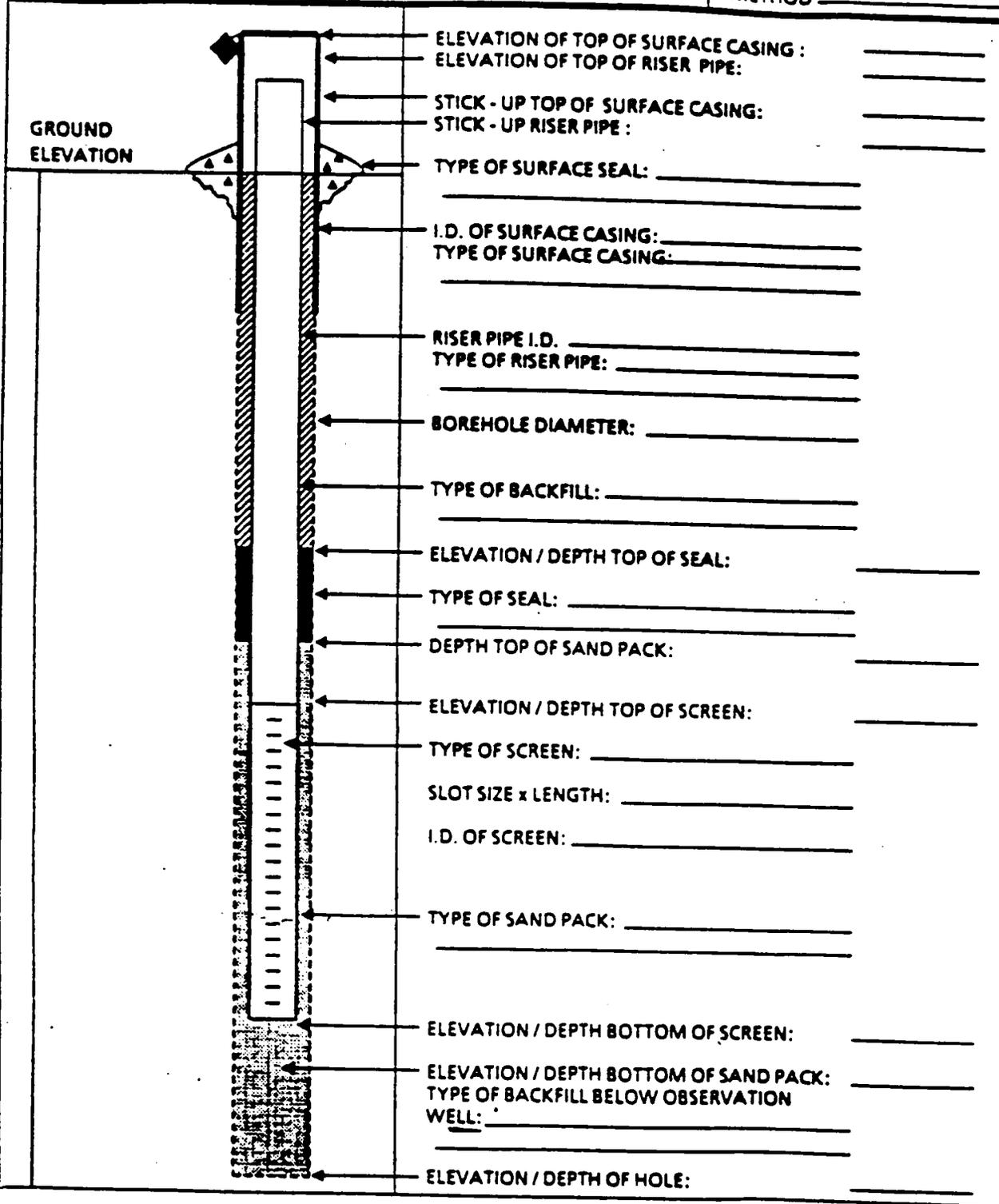
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APPENDIX A
STANDARD FORMS

OVERBURDEN MONITORING WELL SHEET

PROJECT _____ LOCATION _____
 PROJECT NO. _____ BORING _____
 ELEVATION _____ DATE _____
 FIELD GEOLOGIST _____

DRILLER _____
 DRILLING METHOD _____
 DEVELOPMENT METHOD _____



MONITORING WELL DEVELOPMENT DATA FORM

Project Name: _____ Well No.: _____
 Project No: _____ Location: _____
 Project Hydrogeologist: _____ Date: _____

VOLUME CALCULATION

Bottom of well _____(toc) Depth to water - _____(toc) Water column _____ Well volume factor x _____	Bottom of Well _____ Top of saturated sand pack _____ Saturated sand pack thickness (≤ water column) _____ Sand pack 30% volume factor x _____(gal/ft)	Steel Casing _____ Slick up _____ Down to T.O.C) _____ Recharge Rate (ft/t) _____
Gallons in water column _____ + Gallons in sand pack _____		
One-Well volume = _____ Gallons		

PURGE DATA

INITIAL WATER LEVEL T.O.C.=				PID BACKGROUND			ppm	PID IN WELL		ppm
DATE:	TIME:	Volume Gallons	TEMP.	pH	S.C.	N.T.U.	Remarks			

SUBSEQUENT VISITS

DATE:	TIME:	WATER LEVEL T.O.C.	PID BACKGROUND	PID IN WELL	Remarks

Total gallons purged _____

COMMENTS



NUS CORPORATION

910 CLOPPER ROAD
GAITHERSBURG, MARYLAND 20878-1399
301-258-6000

- Monitoring Well Data
- Domestic Well Data
- Other _____

Case # _____

By _____

Project Site Name _____ Project Site Number _____

NUS Source No. _____ Source Location _____

Total Well Depth:	Purge Data				
	Volume	pH	S.C.	Temp. (-C)	Color & Turbidity
Well Casing Size & Depth:					
Static Water Level:					
One Casing Volume:					
Start Purge (hrs.):					
End Purge (hrs.):					
Total Purge Time (min.):					
Total Amount Purged (gal.):					
Purge Method:					
Sample Method:					
Sample Date & Time:	Sample Data				
	pH	S.C.	Temp. (-C)	Color & Turbidity	
Sampled By:					
Signature(s):	Observations/Notes:				
Type of Sample					
<input type="checkbox"/> Low Concentration <input type="checkbox"/> High Concentration <input type="checkbox"/> Grab <input type="checkbox"/> Composite <input type="checkbox"/> Grab - Composite					
Analysis:			Organic	Inorganic	
	Date Shipped				
	Time Shipped				
	Lab				
	Volume				



SAMPLE LOG SHEET

- Surface Soil
- Subsurface Soil
- Sediment
- Lagoon / Pond
- Other _____

Page _____ of _____

Case # _____

By _____

Project Site Name _____

Project Site Number _____

NUS Source No. _____

Source Location _____

Sample Method:	Composite Sample Data		
	Sample	Time	Color / Description
Depth Sampled:			
Sample Date & Time:			
Sampled By:			
Signatures:			
Type of Sample <input type="checkbox"/> Low Concentration <input type="checkbox"/> High Concentration <input type="checkbox"/> Grab <input type="checkbox"/> Composite <input type="checkbox"/> Grab - Composite	Sample Data		
	Color	Description: (Sand, Clay, Dry, Moist, Wet, etc.)	
Analysis:			
	Organic	Inorganic	
	Traffic Report #		
	Tag #		
	AB #		
	Date Shipped		
	Time Shipped		
	Lab		
Volume			

**DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)**

Project/Site: _____ Applicant/Owner: _____ Investigator: _____	Date: _____ County: _____ State: _____
Do Normal Circumstances exist on the site? Yes No Is the site significantly disturbed (Atypical Situation)? Yes No Is the area a potential Problem Area? Yes No (If needed, explain on reverse.)	Community ID: _____ Transect ID: _____ Plot ID: _____

VEGETATION

Dominant Plant Species Stratum Indicator	Dominant Plant Species Stratum Indicator
1. _____	9. _____
2. _____	10. _____
3. _____	11. _____
4. _____	12. _____
5. _____	13. _____
6. _____	14. _____
7. _____	15. _____
8. _____	16. _____

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC): _____

Remarks: _____

HYDROLOGY

<input type="checkbox"/> Recorded Data (Describe in Remarks): <input type="checkbox"/> Stream, Lake, or Tide Gauge <input type="checkbox"/> Aerial Photographs <input type="checkbox"/> Other <input type="checkbox"/> No Recorded Data Available	Wetland Hydrology Indicators: Primary Indicators: <input type="checkbox"/> Inundated <input type="checkbox"/> Saturated in Upper 12 inches <input type="checkbox"/> Water Marks <input type="checkbox"/> Drift Lines <input type="checkbox"/> Sediment Deposits <input type="checkbox"/> Drainage Patterns in Wetlands Secondary Indicators (2 or more required): <input type="checkbox"/> Oxidized Root Channels in Upper 12 inches <input type="checkbox"/> Water-Stained Leaves <input type="checkbox"/> Local Soil Survey Data <input type="checkbox"/> FAC-Neutral Test <input type="checkbox"/> Other (Explain in Remarks)
Field Observations: Depth of Surface Water: _____ (in.) Depth of Free Water in Pft: _____ (in.) Depth to Saturated Soil: _____ (in.)	
Remarks: _____	

SOILS

Map Unit Name (Series and Phase): _____		Drainage Class: _____			
Taxonomy (Subgroup): _____		Field Observations Confirm Mapped Type? Yes No			
Profile Description:					
Depth (Inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)		
_____	_____	_____	_____		
_____	_____	_____	_____		
_____	_____	_____	_____		
_____	_____	_____	_____		
_____	_____	_____	_____		
_____	_____	_____	_____		
_____	_____	_____	_____		
Hydric Soil Indicators: <table style="width: 100%; margin-left: 20px;"> <tr> <td style="width: 50%; vertical-align: top;"> <input type="checkbox"/> Histosol <input type="checkbox"/> Histic Epipedon <input type="checkbox"/> Sulfidic Odor <input type="checkbox"/> Aquic Moisture Regime <input type="checkbox"/> Reducing Conditions <input type="checkbox"/> Gleyed or Low-Chroma Colors </td> <td style="width: 50%; vertical-align: top;"> <input type="checkbox"/> Concretions <input type="checkbox"/> High Organic Content in Surface Layer in Sandy Soils <input type="checkbox"/> Organic Streaking in Sandy Soils <input type="checkbox"/> Listed on Local Hydric Soils List <input type="checkbox"/> Listed on National Hydric Soils List <input type="checkbox"/> Other (Explain in Remarks) </td> </tr> </table>				<input type="checkbox"/> Histosol <input type="checkbox"/> Histic Epipedon <input type="checkbox"/> Sulfidic Odor <input type="checkbox"/> Aquic Moisture Regime <input type="checkbox"/> Reducing Conditions <input type="checkbox"/> Gleyed or Low-Chroma Colors	<input type="checkbox"/> Concretions <input type="checkbox"/> High Organic Content in Surface Layer in Sandy Soils <input type="checkbox"/> Organic Streaking in Sandy Soils <input type="checkbox"/> Listed on Local Hydric Soils List <input type="checkbox"/> Listed on National Hydric Soils List <input type="checkbox"/> Other (Explain in Remarks)
<input type="checkbox"/> Histosol <input type="checkbox"/> Histic Epipedon <input type="checkbox"/> Sulfidic Odor <input type="checkbox"/> Aquic Moisture Regime <input type="checkbox"/> Reducing Conditions <input type="checkbox"/> Gleyed or Low-Chroma Colors	<input type="checkbox"/> Concretions <input type="checkbox"/> High Organic Content in Surface Layer in Sandy Soils <input type="checkbox"/> Organic Streaking in Sandy Soils <input type="checkbox"/> Listed on Local Hydric Soils List <input type="checkbox"/> Listed on National Hydric Soils List <input type="checkbox"/> Other (Explain in Remarks)				
Remarks:					

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	Yes	No (Circle)	
Wetland Hydrology Present?	Yes	No	(Circle)
Hydric Soils Present?	Yes	No	
			Is this Sampling Point Within a Wetland? Yes No
Remarks:			

HALLIBURTON NUS Environmental Corporation and Subsidiaries

CHAIN OF CUSTODY RECORD

PROJECT NO.:				SITE NAME:				NO. OF CON- TAINERS	REMARKS				
SAMPLERS (SIGNATURE):													
STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION								
RELINQUISHED BY (SIGNATURE):			DATE / TIME:		RECEIVED BY(SIGNATURE):			RELINQUISHED BY (SIGNATURE):		DATE / TIME:		RECEIVED BY(SIGNATURE):	
RELINQUISHED BY (SIGNATURE):			DATE / TIME:		RECEIVED BY (SIGNATURE):			RELINQUISHED BY (SIGNATURE):		DATE / TIME:		RECEIVED BY(SIGNATURE):	
RELINQUISHED BY (SIGNATURE):			DATE / TIME:		RECEIVED FOR LABORATORY BY (SIGNATURE):			DATE / TIME:		REMARKS:			

APPENDIX B
STANDARD OPERATING PROCEDURES

The Station Standard Operating Procedures (SOPs) are provided in a separate 3-ring binder as a separate submittal.

APPENDIX C

GUIDE FOR HAZARDOUS MATERIAL SHIPPERS

APPENDIX C

GUIDE FOR HAZARDOUS MATERIALS SHIPPERS

USE OF GUIDE - This guide is presented as an aid to shippers of hazardous materials. It does not contain or refer to all of the DOT requirements for shipping hazardous materials. For specific details, refer to all of the DOT requirements for shipping hazardous materials, as provided in the Code of Federal Regulations (CFR), Title 49, Transportation, Parts 100-199.

The following is offered as a step-by-step procedure to aid in compliance with the applicable DOT regulations.

STEP 1 - DETERMINE THE PROPER SHIPPING NAME. The shipper must determine the proper shipping name of the materials as listed in the Hazardous Materials Table, 49 CFR 172.101, Column (2).

STEP 2 - DETERMINE THE HAZARD CLASS OR CLASSES.

- a. Refer to the Table, 49 CFR 172.101, Column (3), and locate the hazard class of the material.
- b. If more than one class is shown for the proper shipping name, determine the proper class by definition.
- c. If the materials have more than one hazard, classify the material based on the order of hazards in 49 CFR 173.2.

STEP 3 - SELECT THE PROPER IDENTIFICATION NUMBERS.

- a. Refer to the Table, 49 CFR 172.101, Column (3a), and select the Identification Number (ID) that corresponds to the proper shipping name and hazard class.

- b. Enter the ID number(s) on the shipping papers and display them, as required, on packagings, placards and/or orange panels.

STEP 4 - DETERMINE THE MODE(S) OF TRANSPORT TO ULTIMATE DESTINATION.

- a. As a shipper, you must assure yourself that the shipment complies with various modal requirements.
- b. The modal requirements may affect the following: (1) Packaging; (2) Quantity per Package; (3) Marking; (4) Labeling; (5) Shipping Papers; and (6) Certification.

STEP 5 - SELECT THE PROPER LABEL(S) AND APPLY AS REQUIRED.

- a. Refer to the Table, 49 CFR 172.101, Column (4) for required labels.
- b. For details on labeling refer to (1) Additional Labels, 49 CFR 172.402; (2) Placement of Labels, 49 CFR 172.406; (3) Packagings (Mixed or Consolidated), 49 CFR 172.404(a) and (h); (4) Packages Containing Samples, 49 CFR 172.402(h); (5) Radioactive Materials, 49 CFR 172.403; and (6) Authorized Label Modifications, 49 CFR 172.405.

STEP 6 - DETERMINE AND SELECT THE PROPER PACKAGES.

- a. Refer to the Table, 49 CFR 172.101, Column (5a) for exceptions and Column (5b) for specification packagings. Consider the following when selecting an authorized package: Quantity per Package; Cushioning Material, if required; Proper Closure and Reinforcement; Proper Pressure; Outage; etc., as required.
- b. If packaged by a prior shipper, make sure the packaging is correct and in proper condition for transportation.

STEP 7 - MARK THE PACKAGING (INCLUDING OVERPACKS).

- a. Apply the required markings (49 CFR 172.300); Proper shipping name and ID number, when required (49 CFR 172.301); Name and address of Consignee or Consignor (49 CFR 172.306).
- b. For details and other required markings, see 49 CFR 172.300 through 172.338.

STEP 8 - PREPARE THE SHIPPING PAPERS.

- a. The basic requirements for preparing shipping papers include Proper Shipping Name; Hazard Class; ID Number; Total Quantity; Shipper's Certification; and Emergency Response Telephone Number.
- b. Make all entries on the shipping papers using the information required and in proper sequence (49 CFR 172.202).

STEP 9 - CERTIFICATION.

- a. Each shipper must certify by printing (manually or mechanically) on the shipping papers that the materials being offered for shipment are properly classified, described, packaged, marked and labeled, and in proper condition for transportation according to the applicable DOT Regulations (49 CFR 172.202).

STEP 10 - LOADING, BLOCKING, AND BRACING. When hazardous materials are loaded into the transport vehicle or freight container, each package must be loaded, blocked, and braced in accordance with the requirements for mode of transport.

- a. If the shipper loads the freight container or transport vehicle, the shipper is responsible for the proper loading, blocking, and bracing of the materials.
- b. If the carrier does the loading, the carrier is responsible.

STEP 11 - DETERMINE THE PROPER PLACARD(S). Each person who offers hazardous materials for transportation must determine that the placarding requirements have been met.

- a. For Highway, unless the vehicle is already correctly placarded, the shipper must provide the required placard(s) and required ID number(s) (49 CFR 172.506).
- b. For Rail, if loaded by the shipper, the shipper must placard the rail car if placards are required (49 CFR 172.508).
- c. For Air and Water shipments, the shipper has the responsibility to apply the proper placards.

STEP 12 - HAZARDOUS WASTE/HAZARDOUS SUBSTANCE.

- a. If the material is classed as a hazardous waste or hazardous substance, most of the above steps will be applicable.
- b. Pertinent Environmental Protection Agency regulations are found in the Code of Federal Regulations, Title 40, Part 262.

As a final check and before offering the shipment for transportation, visually inspect your shipment. The shipper should ensure that emergency response information is on the vehicle for transportation of hazardous materials.

Master Quality Assurance Project Plan
for
Remedial Investigations
at
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 0245

April 1997

**MASTER QUALITY ASSURANCE PROJECT PLAN
FOR
REMEDIAL INVESTIGATIONS
AT
INDIAN HEAD DIVISION
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND**

**COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT**

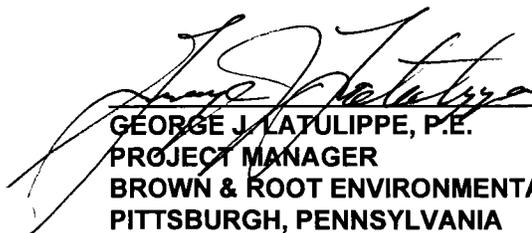
**Submitted to:
Engineering Field Activity Chesapeake
Environmental Branch Code 18
Naval Facilities Engineering Command
Washington Navy Yard, Building 212
Washington, D.C. 20374-2121**

**Submitted by:
Brown & Root Environmental
993 Old Eagle School Road, Suite 415
Wayne, Pennsylvania 19087-1710**

**CONTRACT NUMBER N62472-90-D-1298
CONTRACT TASK ORDER 0245**

APRIL 1997

PREPARED BY:


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PITTSBURGH, PENNSYLVANIA

APPROVED BY:

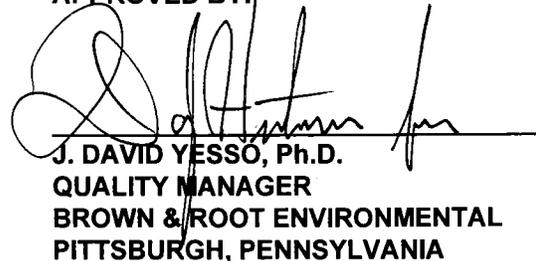

J. DAVID YESSO, Ph.D.
QUALITY MANAGER
BROWN & ROOT ENVIRONMENTAL
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ACRONYMS/ABBREVIATIONS

AA	Atomic Absorption
B&R Environmental	Brown & Root Environmental
BFB	Bromofluorobenzene
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEAN	Comprehensive Long-Term Environmental Action, Navy
CLP	Contract Laboratory Program
COC	Chain of Custody
CRDL	Contract Required Detection Limit
CRQL	Contract Required Quantitation Limit
CVAA	Cold Vapor Atomic Absorption
DFTPP	Decafluorotriphenyl phosphine
DQO	Data Quality Objective
EC	Electron Capture
FOL	Field Operations Leader
FS	Feasibility Study
FSP	Field Sampling Plan
FTMR	Field Task Modification Request
GC	Gas Chromatograph
GFAA	Graphite Furnace Atomic Absorption
ICP	Inductively Coupled Plasma
LCS	Laboratory Control Sample
MCL	Maximum Contaminant Level
MDE	Maryland Department of the Environment
MS	Mass Spectrophotometer
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NFESC	Naval Facilities Engineering Service Center
NIST	National Institute of Science and Technology
NSWC	Naval Surface Warfare Center
NTU	Nephelometric Turbidity Units
PARCC	Precision, Accuracy, Representativeness, Comparability, Completeness
PCB	Polychlorinated Biphenyl
QA	Quality Assurance
QAM	Quality Assurance Manager
QAPP	Quality Assurance Project Plan
QC	Quality Control
QN	Quality Notice
RA	Risk Assessment
RAS	Routine Analytical Services
RI	Remedial Investigation
RPD	Relative Percent Difference
SDG	Sampling Delivery Group
SOP	Standard Operating Procedure
SOW	Statement of Work
SRM	Standard Reference Materials
TAL	Target Analyte List
TCL	Target Compound List
TSS	Total Suspended Solids
UCL	Upper Ninety-Five Percent Confidence Limit
U.S. EPA	United States Environmental Protection Agency

VOC
%R

Volatile Organic Compound
Percent Recovery

1.0 PROJECT DESCRIPTION

1.1 INTRODUCTION

This Master Quality Assurance Project Plan (QAPP) has been prepared by Brown & Root Environmental on behalf of the United States Navy Engineering Field Activity Chesapeake Naval Facilities Engineering Command and the Indian Head Division Naval Surface Warfare Center (the Station). The Master QAPP has been prepared under Comprehensive Long-Term Environmental Action Navy Contract N62472-90-D-1298, Contract Task Order 0245.

1.1.1 Overall Project Objectives

This Master QAPP is intended to outline general Quality Assurance (QA) guidelines that will be common to multiple site investigations to be conducted at the Station. This Master QAPP outlines QA issues for what are expected to be the most common types of field efforts and analyses during the Remedial Investigation efforts. Specific project objectives will be identified in subsequent Project-Specific Work Plans. Additional Quality Assurance issues will be addressed in Addenda to this Master QAPP as necessary. Such addenda are to be provided as appendices to Project-Specific Work Plans.

Important companion documents to this Master QAPP include the Indian Head Master Standard Operating Procedures and a Master Work Plan.

1.1.2 QAPP Preparation Guidelines

This Master QAPP has been prepared in accordance with the general requirements outlined in Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans dated December 29, 1980 (QAMS-005/80).

1.2 FACILITY DESCRIPTION

A facility description, including the location and general description, station history, land use, water sources and usage, population, physiography and topography, geology, soils, hydrogeology, hydrology, ecology, and meteorology is provided in the Master Work Plan.

1.3 PROJECT TARGET PARAMETERS AND INTENDED DATA USES

This section discusses typical field and laboratory analytical information to be generated during the course of the Remedial Investigation efforts at the Station. Field parameters and intended data uses are discussed in Section 1.3.1. Laboratory parameters and intended data uses are discussed in Section 1.3.2.

1.3.1 Field Parameters

Field parameters will typically include those associated with the completion of soil borings, installation and development of monitoring wells, and groundwater sampling and analysis. Field measurements will include only those completed using simple field instrumentation.

Field measurements of total volatile organics will be completed using a Photoionization Detector. These measurements will be used to determine appropriate subsurface sample horizons to be submitted for laboratory analysis.

Field parameters including pH, specific conductance, turbidity, dissolved oxygen, and temperature will be completed for all aqueous phase samples. These measurements will typically be used to support monitoring well development and purging of stagnant water from well casings. Specific conductance and pH will also be used as general indicators of water quality.

1.3.2 Laboratory Parameters

Laboratory parameters will generally include Target Compound List (TCL) volatile and semivolatile organics and pesticides/polychlorinated biphenyls as well as Target Analyte List (TAL) metals. Tables 1-1 and 1-2 provide a summary of all target laboratory analytes and associated Contract Required Quantitation Limits (organics) and Contract Required Detection Limits (inorganics). Any additional analyses required on a project-specific basis shall be provided in Addenda to this Master QAPP (Project-Specific Work Plan appendix).

1.4 DATA QUALITY OBJECTIVES

Data quality objectives will be discussed in Project-Specific Work Plans to be provided as the investigative efforts progress.

TABLE 1-1

**ANALYTICAL DETECTION LIMITS - ORGANICS
NSWC INDIAN HEAD, MARYLAND
PAGE 1 OF 5**

Parameter	CRQL ⁽¹⁾	
	Aqueous ⁽²⁾	Solid ⁽³⁾
Volatile Organic Compounds	µg/L	µg/kg
Acetone	10	10
Benzene	10	10
Bromodichloromethane	10	10
Bromoform	10	10
Bromomethane	10	10
2-Butanone	10	10
Carbon disulfide	10	10
Carbon tetrachloride	10	10
Chlorobenzene	10	10
Chloroethane	10	10
Chloroform	10	10
Chloromethane	10	10
Dibromochloromethane	10	10
1,1-Dichloroethane	10	10
1,2-Dichloroethane	10	10
1,1-Dichloroethene	10	10
1,2-Dichloroethene (total)	10	10
1,2-Dichloropropane	10	10
cis-1,3-Dichloropropene	10	10
trans-1,3-Dichloropropene	10	10
Ethylbenzene	10	10
2-Hexanone	10	10
4-Methyl-2-pentanone	10	10
Methylene chloride	10	10
Styrene	10	10
1,1,2,2-Tetrachloroethane	10	10
1,1,1-Trichloroethane	10	10
1,1,2-Trichloroethane	10	10
Trichloroethene	10	10
Tetrachloroethene	10	10
Toluene	10	10
Vinyl chloride	10	10
Xylenes (total)	10	10

TABLE 1-1
ANALYTICAL DETECTION LIMITS - ORGANICS
NSWC INDIAN HEAD, MARYLAND
PAGE 2 OF 5

Parameter	CRQL ⁽¹⁾	
	Aqueous ⁽²⁾	Solid ⁽³⁾
Semivolatile Organic Compounds	µg/L	µg/kg
Acenaphthene	10	330
Acenaphthylene	10	330
Anthracene	10	330
Benzo(a)anthracene	10	330
Benzo(a)pyrene	10	330
Benzo(b)fluoranthene	10	330
Benzo(g,h,i)perylene	10	330
Benzo(k)fluoranthene	10	330
Bis(2-chloroethoxy)methane	10	330
Bis(2-chloroethyl)ether	10	330
Bis(2-ethylhexyl)phthalate	10	330
4-Bromophenyl-phenylether	10	330
Butylbenzylphthalate	10	330
Carbazole	10	330
4-Chloro-3-methylphenol	10	330
4-Chloroaniline	10	330
2-Chloronaphthalene	10	330
2-Chlorophenol	10	330
4-Chlorophenyl-phenylether	10	330
Chrysene	10	330
Dibenz(a,h)anthracene	10	330
Dibenzofuran	10	330
3,3'-Dichlorobenzidine	10	330
Diethylphthalate	10	330
Di-n-butylphthalate	10	330
Di-n-octylphthalate	10	330
4,6-Dinitro-2-methylphenol	25	830
2,4-Dinitrophenol	25	830
2,4-Dinitrotoluene	10	330
1,2-Dichlorobenzene	10	330
1,3-Dichlorobenzene	10	330
1,4-Dichlorobenzene	10	330
2,4-Dichlorophenol	10	330

TABLE 1-1
ANALYTICAL DETECTION LIMITS - ORGANICS
NSWC INDIAN HEAD, MARYLAND
PAGE 3 OF 5

Parameter	CRQL ⁽¹⁾	
	Aqueous ⁽²⁾	Solid ⁽³⁾
Semivolatile Organic Compounds	µg/L	µg/kg
Dimethylphthalate	10	330
2,4-Dimethylphenol	10	330
2,6-Dinitrotoluene	10	330
Fluoranthene	10	330
Fluorene	10	330
Hexachlorobenzene	10	330
Hexachlorobutadiene	10	330
Hexachlorocyclopentadiene	10	330
Hexachloroethane	10	330
Indeno(1,2,3-cd)pyrene	10	330
Isophorone	10	330
2-Methylnaphthalene	10	330
2-Methylphenol	10	330
4-Methylphenol	10	330
Naphthalene	10	330
2-Nitroaniline	25	830
3-Nitroaniline	25	830
4-Nitroaniline	25	830
Nitrobenzene	10	330
2-Nitrophenol	10	330
4-Nitrophenol	25	830
N-nitroso-di-n-propylamine	10	330
N-nitrosodiphenylamine	10	330
2,2'-Oxybis(1-chloropropane)	10	330
Pentachlorophenol	25	830
Phenanthrene	10	330
Phenol	10	330
Pyrene	10	330
1,2,4-Trichlorobenzene	10	330
2,4,5-Trichlorophenol	25	830
2,4,6-Trichlorophenol	10	330

TABLE 1-1

**ANALYTICAL DETECTION LIMITS - ORGANICS
NSWC INDIAN HEAD, MARYLAND
PAGE 4 OF 5**

Parameter	CRQL ⁽¹⁾	
	Aqueous ⁽²⁾	Solid ⁽³⁾
Pesticides	µg/L	µg/kg
alpha-BHC	0.050	1.7
beta-BHC	0.050	1.7
delta-BHC	0.050	1.7
gamma-BHC (lindane)	0.050	1.7
Heptachlor	0.050	1.7
Aldrin	0.050	1.7
Heptachlor epoxide	0.050	1.7
Endosulfan I	0.050	1.7
Dieldrin	0.10	3.3
4,4'-DDE	0.10	3.3
Endrin	0.10	3.3
Endosulfan II	0.10	3.3
4,4'-DDD	0.10	3.3
Endosulfan sulfate	0.10	3.3
4,4'-DDT	0.10	3.3
Methoxychlor	0.50	17
Endrin ketone	0.10	3.3
Endrin aldehyde	0.10	3.3
alpha-Chlordane	0.050	1.7
gamma-Chlordane	0.050	1.7
Toxaphene	5.0	170
Polychlorinated biphenyls	µg/L	µg/kg
Aroclor-1016	1.0	33
Aroclor-1221	2.0	67
Aroclor-1232	1.0	33
Aroclor-1242	1.0	33
Aroclor-1248	1.0	33
Aroclor-1254	1.0	33
Aroclor-1260	1.0	33

TABLE 1-1

**ANALYTICAL DETECTION LIMITS - ORGANICS
NSWC INDIAN HEAD, MARYLAND
PAGE 5 OF 5**

Explosive Organic Compounds	EDL ⁽⁴⁾ Aqueous (µg/L)	EDL Soil (mg/kg)
HMX	-	2.2
RDX	0.84	1.0
1,3,5-TNB	0.26	0.25
1,3-DNB	0.11	0.25
Tetryl	-	0.65
NB	-	0.26
2,4,6-TNT	0.11	0.25
4-Am-DNT	0.060	-
2-Am-DNT	0.035	-
2,6-DNT	0.31	0.26
2,4-DNT	0.020	0.25
2-NT	-	0.25
4-NT	-	0.25
3-NT	-	0.25

- 1 CRQL - Contract Required Quantitation Limit; as specified in OLM03.1.
- 2 Groundwater and surface water.
- 3 Soil and sediment.
- 4 EDL - Estimated Detection Limit

TABLE 1-2

**ANALYTICAL DETECTION LIMITS - INORGANICS
NSWC INDIAN HEAD, MARYLAND**

Parameter	CRDL ⁽¹⁾	
	Aqueous ⁽²⁾	Solid ⁽³⁾
Target Analyte List Metals	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	10	2
Cobalt	50	10
Copper	25	5
Cyanide	10	10
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 ILM04.0.
- 2 Groundwater and surface water
- 3 Soil and sediment.

1.5 SAMPLE NETWORK DESIGN AND RATIONALE

Sample network design and rationale will be provided in Project-Specific Work Plans.

1.6 PROJECT SCHEDULE

Project schedules will be provided in Project-Specific Work Plans.

2.0 PROJECT ORGANIZATION

The project organization for the Remedial Investigation/Feasibility Study activities will be project-specific. Therefore, the project organization will be provided in project-specific Work Plans (typically in Section 1.3). Personnel expected to be involved with the RI/FS activities at a programmatic level for the foreseeable future include the Navy Remedial Project Manager, the facility point of contact, and the current contractor's Program Manager and Quality Manager, as follows:

Mr. Brent Meridith
Department of the Navy
Engineering Field Activity Chesapeake
Naval Facilities Engineering Command
901 M Street SW, Building 212
Washington, DC 20374-5018
(202) 685-3274
(202) 433-7018 (FAX)

Mr. Shawn Jorgensen, Code 0952C
Indian Head Division
Naval Surface Warfare Center
Building D-327, 101 Strauss Avenue
Indian Head, MD 20640-5035
(301) 743-6745
(301) 743-4180 (FAX)

Mr. John Trepanowski
Program Manager
Brown & Root Environmental
993 Old Eagle School Road, Suite 415
Wayne, PA 19087-1710

Mr. J. David Yesso
Quality Manager
Brown & Root Environmental
661 Andersen Drive
Pittsburgh, PA 15275
(412) 921-8984
(412) 921-4040 (FAX)

Additional key project personnel shall be identified in Project-Specific Work Plans.

3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

The overall Quality Assurance (QA) objective for this project is to develop and implement procedures for field sampling, chain-of-custody, laboratory analysis, and reporting that will provide results which are legally defensible in a court of law. Specific procedures for sampling, chain-of-custody, laboratory instrument calibration, laboratory analysis, reporting of data, internal quality control, audits, preventive maintenance of field equipment, and corrective action are described in other sections of this Master QAPP.

The PARCC parameters (precision, accuracy, representativeness, comparability, and completeness) are qualitative and/or quantitative statements regarding the quality characteristics of the data used to support project objectives and ultimately, environmental decisions. These parameters are discussed in the remainder of this section. Specific routine procedures used to assess the quantitative parameters (precision, accuracy, and completeness) are provided in Section 12.0.

3.1 PRECISION

3.1.1 Definition

Precision is a measure of the amount of variability and bias inherent in a data set. Precision describes the reproducibility of measurements of the same parameter for samples under similar conditions. The equation for determining precision is provided in Section 12.2.

3.1.2 Field Precision Objectives

Field duplicate precision monitors the consistency with which environmental samples were obtained and analyzed. Field duplicate results for solid matrix samples are considered to be precise if the relative percent difference (RPD) is less than or equal to 50 percent. Field duplicate results for aqueous matrix samples are considered to be precise if the RPD is less than or equal to 30 percent. Field precision is assessed through the collection and measurement of field duplicates at a rate of 1 duplicate per 10 environmental samples or one duplicate per sampling day per matrix, whichever is greater.

3.1.3 Laboratory Precision Objectives

Laboratory precision Quality Control samples are analyzed at a frequency of 5 percent (i.e., one quality control sample per 20 environmental samples). Laboratory precision is measured via comparison of

calculated Relative Percent Difference (RPD) values and Precision Control Limits specified in the analytical method or by the laboratory's QA/QC Program.

Three distinct types of analyses will typically be completed for environmental samples collected during the RI activities at NSWC Indian Head, as follows:

- Target Compound List (TCL) organic analyses via OLM03.1
- Target Analyte List (TAL) inorganic/cyanide analysis via ILM04.0
- Explosives analysis via SW-846 Method 8330

Precision for TCL organic analysis will be measured via the RPDs for matrix spike/matrix spike duplicate samples. Precision for TAL inorganic analysis will be measured via RPDs for laboratory duplicates. Tables 3-1 and 3-2 present RPD Precision Control Limits for the major categories of analysis. Precision requirements for explosives analysis will be measured via the RPDs for matrix spike/matrix spike duplicate which should be statistically derived at the analytical laboratory. These limits will be provided in each analytical data package. In the event that project-specific requirements dictate the use of additional (or alternate) analytical methods, specific precision objectives will be provided in Addenda to this Master QAPP (Project-Specific Work Plan appendix).

3.2 ACCURACY

3.2.1 Definition

Accuracy is the degree of agreement between an observed value and an accepted reference value. The equation for determining accuracy is provided in Section 12.1.

3.2.2 Field Accuracy Objectives

Accuracy in the field is assessed through the use of field, equipment, and trip blanks and is ensured through the adherence to all sample handling, preservation and holding times. Accuracy and precision requirements for field measurements (e.g., pH) are ensured through calibration as discussed in Section 6.0.

3.2.3 Laboratory Accuracy Objectives

Accuracy in the laboratory is measured through the comparison of a spiked sample result against a known or calculated value expressed as a percent recovery (%R). Percent recoveries are derived from the

TABLE 3-1

**PRECISION CONTROL LIMITS (RPDS)⁽¹⁾
MATRIX SPIKE/MATRIX SPIKE DUPLICATE SAMPLES
ORGANIC ANALYSIS VIA OLM03.1⁽²⁾
NSWC INDIAN HEAD, MARYLAND**

Chemical	Aqueous Samples	Solid Samples
VOLATILE ORGANICS		
1,1-Dichloroethene	14	22
Trichloroethene	14	24
Benzene	11	21
Toluene	13	21
Chlorobenzene	13	21
SEMIVOLATILE ORGANICS		
Phenol	42	35
2-Chlorophenol	40	50
1,4-Dichlorobenzene	28	27
N-Nitroso-di-n-propylamine	38	38
1,2,4-Trichlorobenzene	28	23
4-Chloro-3-methylphenol	42	33
Acenaphthene	31	19
4-Nitrophenol	50	50
2,4-Dinitrotoluene	38	47
Pentachlorophenol	50	47
Pyrene	31	36
PESTICIDES/PCBS		
gamma-BHC (Lindane)	15	50
Heptachlor	20	31
Aldrin	22	43
Dieldrin	18	38
Endrin	21	45
4,4'-DDT	27	50

1 RPD - Relative Percent Difference as described in Section 12.0.

2 U.S. EPA (U.S. Environmental Protection Agency) CLP, 1994. Statement of Work for Organics Analysis, Multi-Media, Multi-Concentration, OLM03.1.

TABLE 3-2

**PRECISION CONTROL LIMITS (RPDS)⁽¹⁾
LABORATORY DUPLICATE SAMPLES
INORGANIC ANALYSIS VIA ILM04.0⁽²⁾
NSWC INDIAN HEAD, MARYLAND**

Chemical	Aqueous Samples	Solid Samples
INORGANICS		
Aluminum	20	35
Antimony	20	35
Arsenic	20	35
Barium	20	35
Beryllium	20	35
Cadmium	20	35
Calcium	20	35
Chromium	20	35
Cobalt	20	35
Copper	20	35
Iron	20	35
Lead	20	35
Magnesium	20	35
Manganese	20	35
Mercury	20	35
Nickel	20	35
Potassium	20	35
Selenium	20	35
Silver	20	35
Sodium	20	35
Thallium	20	35
Vanadium	20	35
Zinc	20	35
Cyanide	20	35

- 1 RPD - Relative Percent Difference as described in Section 12.0.
- 2 U.S. EPA (U.S. Environmental Protection Agency) CLP, 1995. Statement of Work for Inorganics Analysis, Multi-Media, Multi-Concentration, ILM04.0.

analysis of known amounts of compounds spiked into deionized water (i.e., laboratory control sample analysis), or into actual samples (i.e., surrogate or matrix spike analysis). These analyses measure the accuracy of laboratory operations as affected by matrix. Laboratory control sample and/or matrix spike analyses are performed with a frequency of one per twenty associated samples of like matrix. Surrogate spike analysis is performed for all organic analyses. Laboratory accuracy is assessed via comparison of calculated percent recovery (%R) values with Accuracy Control Limits specified in the analytical method or by the contracted laboratory's QA/QC Program.

Two distinct types of analyses will be completed for environmental samples collected during the RI activities at NSWC Indian Head, as follows:

- Target Compound List (TCL) organic analyses via OLM03.1
- Target Analyte List (TAL) inorganic/cyanide analysis via ILM04.0
- Explosives analysis via SW-846 Method 8330

Accuracy for Target Compound List organic and explosives analyses will be measured via the percent recoveries for surrogate spikes and matrix spike/matrix spike duplicates. Accuracy for Target Analyte List Inorganic analysis will be measured via percent recoveries for matrix spikes and laboratory control samples. Tables 3-3 and 3-4 present control limits for matrix and surrogate spike recoveries, respectively, for TCL organics. Tables 3-5 and 3-6 present control limits for matrix spike and laboratory control samples, respectively, for TAL inorganics. Quality control limits for matrix and surrogate spike recoveries in explosives analyses are statistically derived by the analytical laboratory and will be provided in each analytical data package. In the event that additional (or alternate) analytical methods are required on a project-specific basis, specific accuracy objectives will be provided in Addenda to this Master QAPP (Project-Specific Work Plan appendix).

3.3 COMPLETENESS

3.3.1 Definition

Completeness is a measure of the amount of usable, valid, analytical data obtained, compared to the amount expected to be obtained. Completeness is typically expressed as a percentage.

The ideal objective for completeness is 100 percent (i.e., every sample planned to be collected is collected; every sample submitted for analysis yields valid data). However, samples can be rendered unusable during shipping or preparation (e.g., bottles broken or extracts accidentally destroyed); errors can be introduced during analysis (e.g., loss of instrument sensitivity, introduction of ambient laboratory

TABLE 3-3

ACCURACY CONTROL LIMITS (%R)⁽¹⁾
MATRIX SPIKE/MATRIX SPIKE DUPLICATE SAMPLES
ORGANIC ANALYSIS VIA OLM03.1⁽²⁾
NSWC INDIAN HEAD, MARYLAND

Chemical	Aqueous Samples	Solid Samples
VOLATILE ORGANICS		
1,1-Dichloroethene	61-145	59-172
Trichloroethene	71-120	62-137
Benzene	76-127	66-142
Toluene	76-125	59-139
Chlorobenzene	75-130	60-133
SEMIVOLATILE ORGANICS		
Phenol	12-110	26-90
2-Chlorophenol	27-123	25-102
1,4-Dichlorobenzene	36-97	28-104
N-Nitroso-di-n-propylamine	41-116	41-126
1,2,4-Trichlorobenzene	39-98	38-107
4-Chloro-3-methylphenol	23-97	26-103
Acenaphthene	46-118	31-137
4-Nitrophenol	10-80	11-114
2,4-Dinitrotoluene	24-96	28-89
Pentachlorophenol	9-103	17-109
Pyrene	26-127	35-142
PESTICIDES/PCBS		
gamma-BHC (Lindane)	56-123	46-127
Heptachlor	40-131	35-130
Aldrin	40-120	34-132
Dieldrin	52-126	31-134
Endrin	56-121	42-139
4,4'-DDT	38-121	23-134

1 %R - Percent Recovery as described in Section 12.0.

2 U.S. EPA (U.S. Environmental Protection Agency) CLP, 1994. Statement of Work for Organics Analysis, Multi-Media, Multi-Concentration, OLM03.1.

TABLE 3-4

**ACCURACY CONTROL LIMITS (%R)⁽¹⁾
SURROGATE SPIKES
ORGANIC ANALYSIS VIA OLM03.1⁽²⁾
NSWC INDIAN HEAD, MARYLAND**

Chemical	Aqueous Samples	Solid Samples
VOLATILE ORGANICS		
Toluene-d8	88-110	84-138
Bromoflourobenzene	86-115	59-113
1,2-Dichloroethane-d4	76-114	70-121
SEMIVOLATILE ORGANICS		
Nitrobenzene-d5	35-114	23-120
2-Fluorobiphenyl	43-116	30-115
Terphenyl-d14	33-141	18-137
Phenol-d5	10-110	24-113
2-Fluorophenol	21-110	25-121
2,4,6-Tribromophenol	10-123	19-122
2-Chlorophenol-d4	33-110 ⁽³⁾	20-130 ⁽³⁾
1,2-Dichlorobenzene-d4	16-110 ⁽³⁾	20-130 ⁽³⁾
PESTICIDES/PCBS		
Tetrachloro-m-xylene	30-150	30-150
Decachlorobiphenyl	30-150	30-150

1 %R - Percent Recovery as described in Section 12.0.

2 U.S. EPA (U.S. Environmental Protection Agency) CLP, 1994. Statement of Work for Organics Analysis, Multi-Media, Multi-Concentration, OLM03.1.

3 Advisory limits only.

TABLE 3-5
ACCURACY CONTROL LIMITS (%R)⁽¹⁾
MATRIX SPIKE SAMPLES
INORGANIC ANALYSIS VIA ILM04.0⁽²⁾
NSWC INDIAN HEAD, MARYLAND

Chemical	Aqueous Samples	Solid Samples
INORGANICS		
Aluminum	75-125	NS ⁽³⁾
Antimony	75-125	75-125
Arsenic	75-125	75-125
Barium	75-125	75-125
Beryllium	75-125	75-125
Cadmium	75-125	75-125
Calcium	NS ⁽³⁾	NS ⁽³⁾
Chromium	75-125	75-125
Cobalt	75-125	75-125
Copper	75-125	75-125
Iron	75-125	75-125
Lead	75-125	75-125
Magnesium	NS ⁽³⁾	NS ⁽³⁾
Manganese	75-125	75-125
Mercury	75-125	75-125
Nickel	75-125	75-125
Potassium	NS ⁽³⁾	NS ⁽³⁾
Selenium	75-125	75-125
Silver	75-125	75-125
Sodium	NS ⁽³⁾	NS ⁽³⁾
Thallium	75-125	75-125
Vanadium	75-125	75-125
Zinc	75-125	75-125
Cyanide	75-125	75-125

1 %R - Percent Recovery as described in Section 12.0.

2 U.S. EPA (U.S. Environmental Protection Agency) CLP, 1995. Statement of work for Inorganics Analysis, Multi-Media, Multi-Concentration, ILM04.0.

3 No spike required.

TABLE 3-6

**ACCURACY CONTROL LIMITS (%R)⁽¹⁾
LABORATORY CONTROL SAMPLES
INORGANIC ANALYSIS VIA ILM04.0⁽²⁾
NSWC INDIAN HEAD, MARYLAND**

Chemical	Aqueous Samples	Solid Samples
INORGANICS		
Aluminum	80-120	TBD ⁽³⁾
Antimony	80-120 ⁽⁴⁾	TBD
Arsenic	80-120	TBD
Barium	80-120	TBD
Beryllium	80-120	TBD
Cadmium	80-120	TBD
Calcium	80-120	TBD
Chromium	80-120	TBD
Cobalt	80-120	TBD
Copper	80-120	TBD
Iron	80-120	TBD
Lead	80-120	TBD
Magnesium	80-120	TBD
Manganese	80-120	TBD
Mercury	NA ⁽⁵⁾	TBD
Nickel	80-120	TBD
Potassium	80-120	TBD
Selenium	80-120	TBD
Silver	80-120 ⁽⁴⁾	TBD
Sodium	80-120	TBD
Thallium	80-120	TBD
Vanadium	80-120	TBD
Zinc	80-120	TBD
Cyanide	NA	TBD

1 %R - Percent Recovery as described in Section 12.0.

2 U.S. EPA (U.S. Environmental Protection Agency) CLP, 1995. Statement of Work for Inorganic Analysis, Multi-Media, Multi-Concentration, ILM04.0.

3 TBD - To Be Determined at time of analysis based on EPA LCS lot number.

4 Advisory limits only.

5 NA - Not Applicable.

contamination), or strong matrix effects can become apparent (e.g., extremely low matrix spike recovery). These instances result in data that do not meet QC criteria. Based on these considerations, 95 percent is considered an acceptable target for the data completeness objective. If critical data points are lost, resampling and/or reanalysis may be required.

One hundred percent of the CLP data for the RI activities shall be validated in accordance with the U.S. EPA National Functional Guidelines for Organic and Inorganic Data Review unless dictated otherwise by Project-Specific Data Quality Objectives (DQOs). If additional non-CLP (e.g., explosives) analyses are required, one hundred percent of non-CLP data will be validated (pursuant to DQOs) in accordance with analytical method-specific requirements and the National Functional Guidelines (to the extent practicable). Data rejected as a result of the validation process will be treated as incomplete data.

3.3.2 Field Completeness Objectives

Field completeness is a measure of the amount of valid field measurements obtained from all the field measurements taken in the project. The equation for completeness is presented in Section 12.3. Field data completeness for the NSWC Indian head RI activities is expected to be 100 percent.

3.3.3 Laboratory Completeness Objectives

Laboratory completeness is a measure of the amount of valid laboratory measurements obtained from all the laboratory measurements made in support of a given project. The equation for completeness is presented in Section 12.3. Laboratory completeness for the NSWC Indian Head RI activities is expected to be at least 95 percent.

3.4 REPRESENTATIVENESS

3.4.1 Definition

Representativeness is an expression of the degree to which the data accurately and precisely depict the actual characteristics of a population or environmental condition existing at an individual sampling point. Use of standardized sampling, handling, analytical, and reporting procedures ensures that the final data accurately represent actual site conditions.

3.4.2 Measures to Ensure Representativeness of Field Data

Representativeness is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the Project-Specific Work Plans are followed and that proper sampling techniques are used.

3.4.3 Measures to Ensure Representativeness of Laboratory Data

Representativeness in the laboratory is ensured by using the proper analytical procedures, meeting sample holding times, and analysis of field duplicate samples.

3.5 COMPARABILITY

3.5.1 Definition

Comparability is defined as the confidence with which one data set can be compared to another (e.g., between sampling points; between sampling events). Comparability is achieved by using standardized sampling and analysis methods, and data reporting formats (including use of consistent units of measure and reporting of solid matrix sample results on a dry-weight basis). Additionally, consideration is given to seasonal conditions and other environmental variations that could exist to influence data results.

3.5.2 Measures to Ensure Comparability of Field Data

Comparability is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the Project-Specific Work Plans are followed and that proper sampling techniques are used. It is also dependent on recording field measurements using the correct units. Field measurements for the NSWC Indian Head RI activities may include pH, specific conductance, temperature, turbidity, and dissolved oxygen. The units used for these field measurements are as follows:

- pH is measured to the nearest 0.1 standard pH unit.
- Specific conductance is measured in μmhos (the inverse of the ohm).
- Temperature is measured in degrees Celsius.
- Turbidity is measured in nephelometric turbidity units (NTU).
- Dissolved oxygen is measured in mg/L.

3.5.3 Measures to Ensure Comparability of Laboratory Data

Analytical data will be comparable when similar sampling and analytical methods are used and documented. Results will be reported in units that ensure comparability with previous data and with current state and federal standards and guidelines. Organic chemicals will be reported in $\mu\text{g/L}$ for aqueous samples and $\mu\text{g/kg}$ for solid samples. Metals and cyanide will be reported as $\mu\text{g/L}$ for aqueous

samples and mg/kg for solid samples. Detection/reporting limits are discussed in Sections 7.2.1 and 1.3.2 of this Master QAPP.

3.6 LEVEL OF QUALITY CONTROL EFFORT

Trip blank, equipment blank, field blank, method blank, duplicate, standard reference materials (SRM), and matrix spike samples will be analyzed to assess the quality of the data resulting from the field sampling and analytical programs. In addition, duplicate field measurements will be completed for temperature, dissolved oxygen, pH, specific conductance, and turbidity, as applicable.

External QC samples (i.e., field quality control samples) consist of field duplicates, field blanks, trip blanks, and equipment (rinsate) blanks. Each of these types of field quality control samples undergo the same preservation, analysis, and reporting procedures as the related environmental samples. Each type of field quality control sample is discussed below.

Field duplicates are either two samples collected independently at a sampling location (e.g., surface water), or a single sample homogenized and split into two portions. Where volatile organic compounds (VOCs) are to be analyzed, the VOC sample aliquots are containerized first to avoid loss of constituents, then the remaining sample matrix is homogenized. Field duplicates are collected and analyzed for chemical constituents to measure the precision of the sampling and analysis methods employed. The general level of the QC effort will be one field duplicate for every 10 or fewer investigative samples or one duplicate per matrix per sampling day, whichever is greater.

Trip blanks and field blanks (ambient condition blanks), consisting of distilled water, will be submitted to the laboratories to provide the means to assess the quality of the data resulting from the field sampling program. Field blank samples are analyzed to check for background contamination at the facility (e.g., vapors or exhaust fumes) which may cause sample contamination. Field blanks will be collected based on conditions at the time of sampling at the discretion of the Field Operations Leader (FOL), with a minimum of one field blank being collected per individual contiguous area of potential concern. Trip blanks pertain to volatile organic compounds (VOCs) only. Trip blanks are used to assess the potential for contamination of VOCs resulting from contaminant migration into sample bottles/jars during sample shipment and storage. Trip blanks are prepared by the laboratory prior to the sampling event, shipped to the site with the sample containers, and kept with the investigative samples throughout the sampling event. They are then packaged for shipment with other VOC samples and sent for analysis. There should be one trip blank included in each sample shipping container that contains VOCs. At no time after trip blank preparation are the trip blank sample containers opened before they reach the laboratory.

Equipment (rinsate) blanks are obtained under representative field conditions by collecting the rinse water generated by running analyte-free water through sample collection equipment after decontamination and prior to use. One rinsate blank will be collected per each type of sampling equipment used (i.e., bailer, split-spoon sampler, hand tools, etc.) per day that sampling is conducted at a minimum frequency of 10 percent. A sampling event is matrix specific, therefore an equipment blank must be collected for each matrix sampled. If pre-cleaned, dedicated, or disposable sampling equipment is used, one rinsate blank must be collected as a "batch blank." Rinsate blanks are analyzed for the same chemical constituents as the associated environmental samples.

Method blank samples are generated within the laboratory and used to assess contamination resulting from laboratory procedures. Laboratory duplicate samples are analyzed for inorganic parameters to check for sampling and analytical reproducibility. Matrix spikes provide information about the effect of the sample matrix on the digestion and measurement methodology. All matrix spikes for organic analyses are performed in duplicate and are hereinafter referred to as MS/MSD samples. One matrix spike/matrix spike duplicate will be analyzed for every 20 or fewer investigative samples.

MS/MSD samples are investigative samples. Soil MS/MSD samples require no extra volume for VOCs or extractable organics. However, aqueous MS/MSD samples must be collected at triple the volume for VOCs and double the volume for extractable organics. One MS/MSD sample will be collected/designated for every 20 or fewer investigative samples per sample matrix (i.e. groundwater, soil).

The level of QC effort provided by the contracted laboratories will be equivalent to the level of QC effort specified under the CLP program for the Routine Analytical Services (RAS) parameters to be tested. The level of QC effort for testing of Target Compound List (TCL) organics (volatiles and semivolatiles) will conform to the Statement of Work (SOW/OLM03.1). The level of QC effort for testing of inorganics (metals and cyanide) will conform to the Statement of Work (SOW/ILM04.0). The level of QC effort for testing of explosive compounds will conform to those listed in the analytical method (i.e., SW-846 Method 8330).

4.0 SAMPLING PROCEDURES

Field sampling procedures for NSW Indian Head Remedial Investigation activities are discussed in detail in the Master Standard Operating Procedures (SOPs) deliverable. Specific sampling information contained in the Master SOP Deliverable and to be provided in Project-Specific Work Plans is as follows:

- Field sampling by matrix
- Field quality control sample collection/preparation procedures
- Sample containers, preservatives, and volume requirements
- Decontamination procedures
- Sample packaging and shipping procedures
- Mobilization/demobilization
- Monitoring well installation
- Monitoring well development
- Groundwater sampling
- Water level measurements
- Soil sampling procedures
- Surveying
- Aquifer testing
- Waste handling
- Quality control sample procedures
- Field measurements/screening
- Preventive maintenance procedures/schedule
- Sample disposal

5.0 CUSTODY PROCEDURES

Custody is one of several factors which is necessary for the admissibility of environmental data as evidence in a court of law. Custody procedures help to satisfy the two major requirements for admissibility: relevance and authenticity. Sample custody is addressed in three parts: field sample collection, laboratory analysis, and final evidence files. Final evidence files, including all originals of laboratory reports and purge files, are maintained under document control in a secure area. A sample or evidence file is under custody if:

- the item is in the actual physical possession of an authorized person, or;
- the item is in view of the person after being in his or her possession, or;
- the item was placed in a secure area to prevent tampering; or
- the item is in a designated and identified secure area with access restricted to authorized personnel only.

The chain-of-custody (COC) report is a multi-part, standardized form used to summarize and document pertinent sample information, such as sample identification and type, matrix, date and time of collection, preservation, and requested analyses. Furthermore, through the sequential signatures of various sample custodians (e.g., sampler, airbill number, laboratory sample custodian), the COC report documents sample custody and tracking. Custody procedures apply to all environmental and associated field quality control samples obtained as part of the data collection system.

5.1 FIELD CUSTODY PROCEDURES

The FOL (or designee) is responsible for the care and custody of the samples collected until they are relinquished to the analyzing laboratory or entrusted to a commercial overnight courier. COC reports are completed for each sample shipment. The reports are filled out in a legible manner, using waterproof ink, and are signed (and dated) by the sampler. Pertinent notes, such as whether the sample was field filtered, or whether the sample is suspected to be high in contaminant concentration, are also indicated on the COC report. Information similar to that contained in the COC report is also provided on the sample label, which is securely attached to the sample bottle. COC report forms and sample labels are generally supplied by the laboratory subcontractor. In accordance with NFESC guidelines protocols, samples for chemical constituent analysis must be sent (for next-day receipt) to the laboratory within 24-hours of collection.

Full details regarding sample chain-of-custody (including use of custody seals and sample shipment protocols) are contained in Indian Head Master SOP SA-11. Indian Head Master SOP SA-12 discusses maintenance of site logbooks, site notebooks, and other field records. Additionally, each of the various types of sampling are discussed in the Master SOPs, including relevant sample documentation (i.e., completion of sample logsheets, etc.). All sample records are to be docketed into the contractors project central file.

5.2 LABORATORY CUSTODY PROCEDURES

When samples are received by the laboratory subcontractor, the laboratory's sample custodian examines each cooler's custody seals to verify that they are intact and that the integrity of the environmental samples has been maintained. The custodian then opens the cooler and measures its internal temperature. The temperature reading is noted on the accompanying COC report. The sample custodian then signs the COC report and examines the contents of the cooler. Sample container breakages or discrepancies between the COC report and sample label documentation are recorded. The pH of chemically preserved samples is checked using Hydrion paper and recorded. All problems or discrepancies noted during this process are to be promptly reported to the Project Manager.

5.3 FINAL EVIDENCE FILES

The contractors central file will be the repository for all documents which constitute evidence relevant to sampling and analysis activities as described in this QAPP. The contractor is the custodian of the evidence file and maintains the contents of these files for the RI, including all relevant records, reports, logs, field notebooks, photographs, subcontractor reports and data reviews in a secure, limited access location and under custody of the facility manager. The control file will include at a minimum:

- field logbooks
- field data and data deliverables
- photographs
- drawings
- soil boring logs
- laboratory data deliverables
- data validation reports
- data assessment reports
- progress reports, QA reports, interim project reports, etc.
- all custody documentation (tags, forms, airbills, etc.)

Upon completion of the contract, all pertinent files will be relinquished to the custody of the United States Navy.

6.0 CALIBRATION PROCEDURES AND FREQUENCY

All instrumentation used to perform chemical measurements must be properly calibrated prior to use in order to obtain valid and usable results. The requirement to properly calibrate instruments prior to use applies equally to field instruments as it does to fixed laboratory instruments. Field instrument calibration is discussed in Section 6.1. Laboratory instrument calibration is discussed in Section 6.2.

6.1 FIELD INSTRUMENT CALIBRATION

Field instrument calibration is discussed in the Indian Head Master SOPs.

6.2 LABORATORY INSTRUMENT CALIBRATION

Calibration of laboratory balances, thermometers, ovens, and incubators is addressed in specific laboratory SOPs. Method- and instrument-specific calibration and tuning criteria for particular analyses are described briefly below. The frequency of calibration will be performed according to the requirements of the specific methods.

6.2.1 Volatile Organic Compound Analyses

For volatile organic compounds, the GC/MS system will be tuned and calibrated in accordance with the Contract Laboratory Program Statement of Work (OLM03.1). A bromofluorobenzene (BFB) instrument performance check (tuning check) must be run prior to the initial and each continuing calibration and must meet all method-specified criteria before analyses may continue. Initial calibration is required before any samples are analyzed and must include a blank and a minimum of five different concentrations as specified in the method. A continuing calibration check, including the mid-range standard and a blank, must be performed at the beginning of each 12-hour shift during which analyses are performed.

As long as all the continuing calibration criteria listed in Table 6-1 are met, the initial calibration is valid and shall remain. If all the criteria listed in Table 6-1 are not met, the laboratory must run a new initial calibration.

TABLE 6-1

**VOLATILE ORGANIC CONTINUING CALIBRATION ACCEPTANCE CRITERIA
NSWC INDIAN HEAD, MARYLAND**

Chemical	Minimum RRF	Maximum %RSD	Maximum %Diff
VOLATILE COMPOUNDS			
Chloromethane	0.010	None	None
Bromomethane	0.100	20.5	±25.0
Vinyl Chloride	0.100	20.5	±25.0
Chloroethane	0.010	None	None
Methylene Chloride	0.010	None	None
Acetone	0.010	None	None
Carbon Disulfide	0.010	None	None
1,1-Dichloroethene	0.100	20.5	±25.0
1,1-Dichloroethane	0.200	20.5	±25.0
1,2-Dichloroethene (total)	0.010	None	None
Chloroform	0.200	20.0	±25.0
1,2-Dichloroethane	0.100	20.5	±25.0
2-Butanone	0.010	None	None
1,1,1-Trichloroethane	0.100	20.5	±25.0
Carbon Tetrachloride	0.100	20.5	±25.0
Bromodichloromethane	0.200	20.5	±25.0
1,2-Dichloropropane	0.010	None	None
cis-1,3-Dichloropropene	0.200	20.5	±25.0
Trichloroethene	0.300	20.5	±25.0
Dibromochloromethane	0.100	20.5	±25.0
1,1,2-Trichloroethane	0.100	20.5	±25.0
Benzene	0.500	20.5	±25.0
trans-1,3-Dichloropropene	0.100	20.5	±25.0
Bromoform	0.100	20.5	±25.0
4-Methyl-2-pentanone	0.010	None	None
2-Hexanone	0.010	None	None
Tetrachloroethene	0.200	20.5	±25.0
1,1,2,2-Tetrachloroethane	0.300	20.5	±25.0
Toluene	0.400	20.5	±25.0
Chlorobenzene	0.500	20.5	±25.0
Ethylbenzene	0.100	20.5	±25.0
Styrene	0.300	20.5	±25.0
Xylenes (total)	0.300	20.5	±25.0
SYSTEM MONITORING COMPOUNDS			
Bromofluorobenzene	0.200	20.5	±25.0
Toluene-d ₈	0.010	None	None
1,2-Dichloroethane-d ₄	0.010	None	None

6.2.2 Semivolatile Organic Compound Analyses

For semivolatile organic compounds, the GC/MS system will be calibrated in accordance with the CLP SOW (OLM03.1). A decafluorotriphenyl phosphine (DFTPP) instrument performance check (tuning check) must be run prior to the initial and each continuing calibration and must meet all method-specified criteria before analyses may continue. Initial calibration is required before any samples are analyzed and must include a blank plus five different concentrations as specified in the method. A continuing calibration check, including the mid-range standard and a blank, must be performed at the beginning of each 12-hour shift during which analyses are performed.

The same initial calibration for an instrument is valid as long as all continuing calibration acceptance criteria are met. Continuing calibration acceptance criteria are listed in Table 6-2. Additionally, up to four semivolatile target compounds may fail to meet the minimum RRF or maximum percent difference criteria listed in Table 6-2, but the RRFs for those four compounds must be greater than or equal to 0.010, and the percent difference must be within the inclusive range of ± 40.0 percent.

6.2.3 Pesticide/PCB Analyses

For Pesticide/PCB analyses, the GC system will be calibrated in accordance with the CLP SOW (OLM03.1). Initial calibration is required before any samples are analyzed. An 18-point initial calibration sequence is analyzed using dual column injection. The calibration sequence consists of an instrument blank to show system cleanliness, a resolution check to prove analyte separation, a performance evaluation mixture (PEM) to show endrin and 4,4'-DDT degradation, a single point of each Aroclor, and a 3-point calibration of the individual pesticides to prove linearity. A second instrument blank and PEM sample are then analyzed.

If all initial calibration criteria are met, samples may be analyzed for a period of 12 hours after the injection of the second instrument blank. At the end of the 12-hour period, a third instrument blank followed by continuing calibration standard mixtures must be analyzed. If continuing calibration criteria are met, sample analysis may continue for an additional 12 hours. At this point, an instrument blank followed by a PEM is analyzed. The 12-hour clock continues, alternating between the continuing calibration standard mixtures and the PEM, until failure to meet method-specified criteria requires a new initial calibration.

TABLE 6-2

**RELATIVE RESPONSE FACTOR CRITERIA FOR INITIAL AND CONTINUING CALIBRATION
OF SEMIVOLATILE TARGET COMPOUNDS AND SURROGATES
NSWC INDIAN HEAD, MARYLAND
PAGE 1 OF 3**

Chemical	Minimum RRF	Maximum %RSD	Maximum %Diff
SEMIVOLATILE COMPOUNDS			
Anthracene	0.700	20.5	±25.0
Carbazole	0.010	None	None
Di-n-butylphthalate	0.010	None	None
Fluoranthene	0.600	20.5	±25.0
Pyrene	0.600	20.5	±25.0
Butylbenzylphthalate	0.010	None	None
3,3'-Dichlorobenzidine	0.010	None	None
Benzo(a)anthracene	0.800	20.5	±25.0
bis(2-Ethylhexyl)phthalate	0.010	None	None
Chrysene	0.700	20.5	±25.0
Di-n-octylphthalate	0.010	None	None
Benzo(b)fluoranthene	0.700	20.5	±25.0
Benzo(k)fluoranthene	0.700	20.5	±25.0
Benzo(a)pyrene	0.700	20.5	±25.0
Indeno(1,2,3-cd)pyrene	0.500	20.5	±25.0
Dibenzo(a,h)anthracene	0.400	20.5	±25.0
Benzo(g,h,i)perylene	0.500	20.5	±25.0
SURROGATES			
Nitrobenzene-d5	0.200	20.5	±25.0
2-Fluorobiphenyl	0.700	20.5	±25.0
Terphenyl-d14	0.500	20.5	±25.0
Phenol-d5	0.800	20.5	±25.0
2-Fluorophenol	0.600	20.5	±25.0
2,4,6-Tribromophenol	0.010	None	None
2-Chlorophenol-d4	0.800	20.5	±25.0
1,2-Dichlorobenzene-d4	0.400	20.5	±25.0

TABLE 6-2

**RELATIVE RESPONSE FACTOR CRITERIA FOR INITIAL AND CONTINUING CALIBRATION
OF SEMIVOLATILE TARGET COMPOUNDS AND SURROGATES
NSWC INDIAN HEAD, MARYLAND
PAGE 2 OF 3**

Chemical	Minimum RRF	Maximum %RSD	Maximum %Diff
SEMIVOLATILE COMPOUNDS			
Phenol	0.800	20.5	±25.0
bis(2-Chloroethyl)ether	0.700	20.5	±25.0
2-Chlorophenol	0.800	20.5	±25.0
1,3-Dichlorobenzene	0.600	20.5	±25.0
1,4-Dichlorobenzene	0.500	20.5	±25.0
1,2-Dichlorobenzene	0.400	20.5	±25.0
2-Methylphenol	0.700	20.5	±25.0
2,2'-Oxybis (1-Chloropropane)	0.010	None	None
4-Methylphenol	0.600	20.5	±25.0
N-Nitroso-di-n-propylamine	0.500	20.5	±25.0
Hexachloroethane	0.300	20.5	±25.0
Nitrobenzene	0.200	20.5	±25.0
Isophorone	0.400	20.5	±25.0
2-Nitrophenol	0.100	20.5	±25.0
2,4-Dimethylphenol	0.200	20.5	±25.0
bis(2-chloroethoxy)methane	0.300	20.5	±25.0
2,4-Dichlorophenol	0.200	20.5	±25.0
1,2,4-Trichlorobenzene	0.200	20.5	±25.0
Naphthalene	0.700	20.5	±25.0
4-Chloroaniline	0.010	None	None
Hexachlorobutadiene	0.010	None	None
4-Chloro-3-methylphenol	0.200	20.5	±25.0
2-Methylnaphthalene	0.400	20.5	±25.0
Hexachlorocyclopentadiene	0.010	None	None
2,4,6-Trichlorophenol	0.200	20.5	±25.0
2,4,5-Trichlorophenol	0.200	20.5	±25.0
2-Chloronaphthalene	0.800	20.5	±25.0
2-Nitroaniline	0.010	None	None
Dimethylphthalate	0.010	None	None
Acenaphthylene	0.900	20.5	±25.0

TABLE 6-2

**RELATIVE RESPONSE FACTOR CRITERIA FOR INITIAL AND CONTINUING CALIBRATION
OF SEMIVOLATILE TARGET COMPOUNDS AND SURROGATES
NSWC INDIAN HEAD, MARYLAND
PAGE 3 OF 3**

Chemical	Minimum RRF	Maximum %RSD	Maximum %Diff
SEMIVOLATILE COMPOUNDS (Continued)			
3-Nitroaniline	0.010	None	None
2,6-Dinitrotoluene	0.200	20.5	±25.0
Acenaphthene	0.900	20.5	±25.0
2,4-Dinitrophenol	0.010	None	None
4-Nitrophenol	0.010	None	None
Dibenzofuran	0.800	20.5	±25.0
2,4-Dinitrotoluene	0.200	20.5	±25.0
Diethylphthalate	0.010	None	None
4-Chlorophenyl-phenylether	0.400	20.5	±25.0
Fluorene	0.900	20.5	±25.0
4-Nitroaniline	0.010	None	None
4,6-Dinitro-2-methylphenol	0.010	None	None
N-Nitrosodiphenylamine	0.010	None	None
4-Bromophenyl-phenylether	0.100	20.5	±25.0
Hexachlorobenzene	0.100	20.5	±25.0
Pentachlorophenol	0.050	20.5	±25.0
Phenanthrene	0.700	20.5	±25.0

6.2.4 Explosive Compound Analyses

For explosive organic compounds, the High Performance Liquid Chromatography (HPLC) will be calibrated in accordance with the method-specific requirements set forth in SW-846 Method 8330. Once a level baseline reading at the instrument detector's greatest sensitivity level is achieved an initial calibration is performed. Initial calibration is required before any samples are analyzed and should include five different concentrations. A daily calibration should include a mid-range calibration standard that is analyzed at the beginning, middle, and end of a sample group (assuming a sample group of 10 or less samples).

The daily calibration must agree with the initial calibration within ± 15 percent. The same criteria is required for subsequent standard responses compared to the mean response. If this criterion is not met, a new initial calibration must be obtained.

6.2.5 Calibration Troubleshooting

The following are some troubleshooting tips outlined in the CLP SOW.

- Minor corrective actions may not require performing a new initial calibration, provided that a new analysis of the standard (PEM or Individual Standard Mixture) that originally failed the criteria and an associated instrument blank immediately after the corrective action do meet all the acceptance criteria.
- If a PEM or Individual Standard Mixture does not meet technical acceptance criteria listed above, it must be reinjected immediately. If the second injection of the PEM or Individual Standard Mixture meets the criteria, sample analysis may continue. If the second injection does not meet the criteria, all data collection must be stopped. Appropriate corrective action must be taken, and a new initial calibration sequence must be run before more sample data are collected.
- If an instrument blank does not meet the technical acceptance criteria listed in Section 12.1.4.4, all data collection must be stopped. Appropriate corrective action must be taken to clean out the system, and an acceptable instrument blank must be analyzed before more sample data are collected.
- Late eluting peaks may carry over from one injection to the next if highly complex samples are analyzed or if the GC conditions are unstable. Such carryover is unacceptable. Therefore, it may be necessary to run instrument blanks and standards more often to avoid discarding data.

6.2.6 Metals Analyses

6.2.6.1 Inductively Coupled Argon Plasma (ICP) Analyses

Inductively coupled plasma spectrometry (ICP) systems will be calibrated in accordance with the EPA CLP protocols outlined in ILM04.0. Initial calibration is required each day before any samples are analyzed and consists of a calibration blank and at least one standard. The standard must be within the demonstrated linear range of the instrument. The linear range is verified quarterly. Following initial calibration, an initial calibration verification sample (obtained from a different source than the solutions used for calibration), an initial calibration blank, and interference check samples are analyzed. A continuing calibration verification sample and a continuing calibration blank are run every 2 hours or every 10 samples, whichever occurs first. A continuing calibration verification sample, a continuing calibration blank, and interference check samples are also run after analysis of the last sample. The initial calibration verification standard, continuing calibration verification standard, and interference check sample each contain analytes of interest at different concentrations. In addition, a standard prepared at a concentration of two times the quantitation limit is analyzed at the beginning and end of each sample analysis run or a minimum of twice per 8-hour period. Linearity spanning the range of analysis is verified using this combination of standards. All calibration standards contain acids at the same concentrations as the sample digestates

If any of the continuing calibration samples fail to yield a response within 10% of the true value, initial calibration will be repeated, and all field samples analyzed since the last in-control calibration standard will be reanalyzed.

6.2.6.2 Atomic Absorption Analyses

Graphite furnace and cold vapor atomic absorption analyses will be calibrated in accordance with the EPA CLP protocols outlined in ILM04.0. Initial calibration is required each day before any samples are analyzed and consists of a calibration blank and at least three calibration standards (at least four standards for mercury) covering the range of concentrations of interest. The correlation coefficient of the regression of concentration versus response should be 0.995 or greater. Immediately following initial calibration, an initial calibration verification sample (obtained from a different source than the solutions used for calibration) and an initial calibration blank are analyzed. A continuing calibration verification sample and a continuing calibration blank are run every two hours or every ten samples, whichever occurs first. A continuing calibration verification sample and a continuing calibration blank are also run after analyses of the last sample.

If any of the continuing calibration samples fail to yield a response within 10% of the true value, initial calibration will be repeated, and all field samples analyzed since the last in-control calibration standard will be reanalyzed.

6.2.7 Cyanide

The CLP SOW allows for the analysis for cyanide by either a titrimetric or colorimetric procedure. The colorimetric procedure requires instrument calibration. If the colorimetric procedure is used, calibration for cyanide analyses will be performed as specified in the CLP SOW ILM04.0. Initial calibration is required each day before any samples are analyzed and consists of a calibration blank and at least three calibration standards covering the range of concentrations of interest. The correlation coefficient of the regression of concentration versus response should be 0.995 or greater. Immediately following initial calibration, an initial calibration verification sample (obtained from a different source than the solutions used for calibration) and an initial calibration blank are analyzed. The initial calibration verification must be distilled as are the associated field samples. A continuing calibration verification sample and a continuing calibration blank are run every two hours or every ten samples, whichever occurs first. A continuing calibration verification sample and a continuing calibration blank are also run after analysis of the last sample

If any of the continuing calibration samples fail to yield a response within 15 percent of the true value, initial calibration will be repeated, and all field samples analyzed since the last in-control calibration standard will be reanalyzed.

7.0 ANALYTICAL AND MEASUREMENT PROCEDURES

Typically samples be subjected to field parameter measurement and will be analyzed for Target Compound List (TCL) volatiles, semivolatiles, and pesticides/polychlorinated biphenyls (PCBs), Target Analyte List (TAL) inorganics and cyanide, and explosive compounds. Selected laboratories will typically be participants in the Contract Laboratory Program and hence will be fully capable of completing the CLP and explosives analyses. In the event that additional, non-CLP methods are required on a project-specific basis, the non-CLP methods will be provided in addenda to this Master QAPP.

7.1 FIELD MEASUREMENT PROCEDURES

Field measurements to be completed during the field investigations will be discussed in Project-Specific Work Plans and may include those completed in support of health and safety considerations, well development and purging, general chemical and physical characterization of groundwater, and selection of soil samples for laboratory analysis. Chemical/physical parameters to be measured using field instrumentation may include volatile organics as methane equivalents (breathing zone air and soil vapors), temperature, specific conductance, hydronium ion concentration (pH), dissolved oxygen, and turbidity (groundwater samples). Measurement of field parameters is discussed in the Indian Head Master SOPs. Calibration of field instruments is discussed in Section 6.0 of this Master Quality Assurance Project Plan.

7.2 LABORATORY ANALYTICAL AND MEASUREMENT PROCEDURES

All samples for TCL volatile and semivolatile organics and pesticides/PCBs and TAL metals and cyanide will be analyzed in accordance with the CLP analytical procedures set forth in the U.S. EPA Statement of Work for organics analysis (OLM03.1) and inorganic analysis (ILM04.0), respectively. All samples analyzed for explosive compounds will be analyzed in accordance with SW-846 Method 8330.

7.2.1 List of Project Target Compounds and Detection Limits

Table 7-1 provides a summary of the analytical methods for the anticipated activities. A complete list of the target compounds/analytes and Contract Required Quantitation and Detection Limits is provided in Section 1.3 of this Master QAPP. Data generated through use of CLP protocols will be reported to the Contract Required Quantitation Limit (CRQL) for organics analysis and the Contract Required Detection Limit (CRDL) for inorganics analysis. All solid sample results will be reported on a dry-weight basis. Quantitation and detection limits will also be adjusted, as necessary, based on dilutions and sample

TABLE 7-1

**SUMMARY OF ORGANIC AND INORGANIC ANALYTICAL PROCEDURES
SOLID AND AQUEOUS MATRICES
NSWC INDIAN HEAD, MARYLAND**

Analytical Parameter	Analytical Method
TCL Volatile Organics	OLM03.1 ⁽¹⁾
TCL Semivolatile Organics	OLM03.1
TCL Polychlorinated Biphenyls	OLM03.1
TAL Metals and Cyanide	ILM04.0 ⁽²⁾
Explosives	SW-846 8330 ⁽³⁾

- 1 U.S. EPA (U.S. Environmental Protection Agency) CLP, 1994. Statement of Work for Organics Analysis, Multi-Media, Multi-Concentration, OLM03.1.
- 2 U.S. EPA (U.S. Environmental Protection Agency) CLP, 1995. Statement of Work for Inorganics Analysis, Multi-Media, Multi-Concentration, ILM04.0.
- 3 U.S. EPA (U.S. Environmental Protection Agency), 1994. Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW-846). Third Edition, Final Update IIA.

volume. Explosives data generated will be reported at Estimated Quantitation Limits (EQLs). These EQLs are also provided in Section 1.3 of this Master QAPP.

7.2.2 List of Associated Quality Control Samples

In addition to the field quality control samples (duplicates, trip blanks, rinsate blanks, etc.) discussed in Section 3.0 of this Master Quality Assurance Project Plan, laboratory quality control samples including matrix spike/matrix spike duplicate samples, method blanks, preparation blanks, etc. will be analyzed as required by the CLP and SW-846 methods. Laboratory Quality Control samples are discussed in additional detail in Section 8.0 of this Master QAPP.

8.0 INTERNAL QUALITY CONTROL CHECKS

Field-related Quality Control checks were discussed in Section 3.0 of this Master Quality Assurance Project Plan and in the Master Work Plan. This section provides additional information regarding internal quality control checks for the field and the laboratory.

8.1 FIELD QUALITY CONTROL CHECKS

Quality Control procedures for pH, specific conductance, temperature, and turbidity will include calibrating the instruments as described in Section 6.0 of this Master QAPP and in the Indian Head Master Standard Operating Procedures. Assessment of field sampling precision and bias will be made by collection of field duplicates and equipment blanks for laboratory analysis. Collection of the Field Quality Control samples will be in accordance with the procedures provided in the Master Work Plan at the frequency discussed in Section 3.0 of this Master QAPP.

8.2 LABORATORY QUALITY CONTROL CHECKS

Subcontract laboratories will have a Quality Control program that ensures the reliability and validity of the analyses performed at the laboratory. All analytical procedures are typically documented in writing as SOPs. Laboratory SOPs for any and all non-CLP analyses will be provided in either Addenda to this Master QAPP or under separate cover contingent upon the logistics of the laboratory procurement process.

Internal quality control procedures for CLP analyses (volatile and semivolatile organics, pesticides/PCBs, metals, and cyanide) are specified in the Statements of Work (SOWs) for organics (OLM03.1) and inorganics (ILM04.0). All quality control measures for explosives analysis are discussed in SW-846 Methods 8000 and 8330. Several internal laboratory Quality Control checks are briefly discussed in the remainder of this section.

Laboratory method blanks are prepared and analyzed in accordance with the analytical method employed to determine whether contaminants originating from laboratory sources have been introduced and have affected environmental sample analyses. A method blank generally consists of an aliquot of analyte-free water (or purified sodium sulfate for soil/sediment samples) that is subjected to the same preparation and analysis procedures as the environmental samples undergoing analysis. With the exception of recognized VOC common laboratory contaminants (e.g., methylene chloride, acetone, 2-butanone, and phthalate esters), method blanks must not contain levels of target analytes above the

reported detection limits (above 2.5X the CRQL for methylene chloride and above 5X the CRQL for acetone, 2-butanone, and phthalate esters). If method blank contamination is found to exist above allowable limits, corrective actions indicated in the CLP SOWs or laboratory SOPs must be followed. Under no circumstances are laboratory method blank contaminant values subtracted from environmental sample analysis results.

Instrument blank analysis is performed during PCB analysis to demonstrate that PCBs are not detected at greater than 0.5 times the CRQL and that the surrogate retention times are within the retention time windows. If analytes are detected at greater than half the CRQL, or the surrogate retention times are outside the retention time windows, all data collection must be stopped and corrective action must be taken. An acceptable instrument blank must be run before additional data is collected. One instrument blank every 12 hours is the minimum contract requirement.

Matrix spike analysis for organic fraction analyses is performed in duplicate as a measure of laboratory precision. For inorganic analyses, one **laboratory duplicate** analysis is likewise performed for every 20 environmental sample analyses of like matrix. With the exception of VOC MSD analyses, laboratory duplicates are prepared by thoroughly mixing and splitting a sample aliquot into two portions and analyzing each portion following the same analytical procedures that are used for the environmental sample analyses. For VOC MSD analyses, a second sample aliquot is used for analysis in order to avoid VOC constituent loss through the homogenization process. The field crew provides extra volumes of sample matrices designated for laboratory quality control analyses, as required. Control limits for laboratory duplicate analyses are specified in the SOWs for CLP analyses are established statistically by the laboratory in accordance with method-specific procedures and general protocols outlined in the laboratory SOPs for non-CLP analyses. The laboratory SOPs and CLP SOWs define under what circumstances corrective actions are warranted and how they must be performed when required.

Surrogates are organic compounds (typically brominated, fluorinated, or isotopically labeled), which are similar in nature to the compounds of concern, and which are not likely to be present in environmental media. Surrogates are spiked into each sample, standard, and method blank prior to analysis, and are used only in organic chromatographic analysis procedures as a check of method effectiveness. Surrogate recoveries are evaluated against control limits specified in the CLP SOW, where applicable, or laboratory-derived statistical control limits.

Laboratory control samples (LCS) serve to monitor the overall performance of each step during the analysis, including the sample preparation. Laboratory control sample analysis will be performed for metals, DRO, GRO, and engineering parameter analyses. Aqueous LCS results must fall within the

control limits specified in the CLP SOW, where applicable, or statistically established by the laboratory. Solid LCS results must fall within the control limits established by EPA-EMSL/LV, where applicable, or the supplier of the LCS standard. Aqueous and solid Laboratory Control Samples shall be analyzed utilizing the same sample preparations, analytical methods and QA/QC procedures as employed for the samples.

Internal standard performance criteria ensure that GC/MS analysis sensitivity and response are stable during every analytical run. Internal standard area counts for samples and blanks must not vary by more than a factor of two (- 50% to + 100%) from the associated 12-hour calibration standard. The retention time of the internal standards in samples and blanks must not vary by more than ± 30 seconds from the retention time of the associated 12-hour calibration standard.

Additional internal laboratory Quality Control checks include mass tuning for GC/MS analysis and second column confirmation for GC/EC analysis.

9.0 DATA REDUCTION, VALIDATION, AND REPORTING

This section describes the procedures to be used for data reduction, validation, and reporting for the NSWC Indian Head Remedial Investigation (RI) activities. All data generated during the course of the activities will be maintained in hardcopy form by the contractor in the contractor's central files.

In addition to the central files, photocopies of all hardcopy data (as well as electronic data) will be maintained in the database records files. Indian Head Master Standard Operating Procedure (SOP CT-03) governs Database Management and Quality Assurance. Upon completion of the contract, all files will be relinquished to the United States Navy.

9.1 DATA REDUCTION

Data reduction will be completed for both field measurements and laboratory-generated analytical data. Field data reduction will be relatively limited versus the degree of laboratory data reduction required for the project. Reduction of both field data and laboratory data are discussed in the remainder of this section.

9.1.1 Field Data Reduction

Field data may be generated as a result of real time measurement of organic vapor concentrations via a Photoionization Detectors (for health and safety monitoring and to support selection of soil samples for shipment to the analytical laboratory) and through onsite water quality testing for general indicator parameters including hydronium ion concentration (pH), specific conductance, turbidity, and temperature.

Field measurements of organic vapor concentrations (parts per million on a volume/volume basis relative to methane or benzene) will be recorded in the site logbook but will not be used once the field effort is completed. Hence, no further reduction of field PID data will be completed. General water quality indicator parameters will be recorded in the site logbook and on sample logsheets immediately after the measurements are taken and later encoded in the RI data base for presentation in the RI Report. If an error is made in the logbook, the error will be legibly crossed out (single-line strikeout), initialed and dated by the field member, and corrected in a space adjacent to the original (erroneous) entry. No calculations will be necessary to reduce these data for inclusion in the RI Report. Field data will be entered in the electronic data base manually and the entries will be verified by an independent reviewer to make sure that no "transcription" errors occurred. General groundwater quality data will be recorded and reported in the following units:

- Hydronium ion concentration (standard pH units)
- Temperature (degrees Celsius)
- Specific Conductance (micromhos)
- Turbidity (Nephelometric turbidity units)
- Dissolved oxygen (mg/L)

Standard pH units as specified above is the negative logarithm (base 10) of the hydronium ion concentration in moles/liter. Additional aspects of field data handling are provided in Sections 9.2 and 9.3 of this Master QAPP.

9.1.2 Laboratory Data Reduction

The majority of the laboratory analytical data for the NSWC Indian Head RI activities is expected to be generated via the U.S. EPA's Contract Laboratory Program analytical methods, quality assurance requirements, and reporting procedures. Therefore, data reduction for volatile organics, semivolatile organics, polychlorinated biphenyls, metals, and cyanide will be completed in accordance with the most current Statements of Work for Organic and Inorganic Analysis as identified in previous sections of this Master Quality Assurance Project Plan.

Laboratory analytical data will be reported using standard concentration units to ensure comparability with regulatory standards/guidelines and previous analytical results. Reporting units for solid and aqueous matrices for the various classes of chemicals under consideration are as follows.

- Explosives in groundwater - $\mu\text{g/L}$
- Explosives in soil - mg/kg
- TCL volatiles in soil - $\mu\text{g/kg}$
- TCL semivolatiles in soil - $\mu\text{g/kg}$
- TCL pesticides/polychlorinated biphenyls in soil - $\mu\text{g/kg}$
- TAL metals in soil - mg/kg
- Cyanide in soil - mg/kg
- TCL volatiles in groundwater - $\mu\text{g/L}$
- TCL semivolatiles in groundwater - $\mu\text{g/L}$
- TCL pesticides/polychlorinated biphenyls in groundwater - $\mu\text{g/L}$
- TAL metals in groundwater - $\mu\text{g/L}$
- Cyanide in groundwater - mg/L

No manipulation of these results for reporting purposes will be necessary once the results are received by the laboratory (with the possible exception of the elimination of false positives as a result of data validation as discussed in Section 9.2). However, data may be manipulated in support of risk assessment calculations. Three general calculations are involved with respect to data reduction for risk assessment, as follows:

- Determination of average concentrations for duplicate samples
- Determination of upper 95% confidence limits on the arithmetic mean
- Determination of upper 95% confidence limits on the geometric mean

Determination of average concentrations for duplicate samples will be necessary because duplicate samples will be collected as a Quality Control measure. Arithmetic means will be determined for duplicate samples for reporting purposes in summary tables in RI Reports. The original duplicate sample results will be presented in an appendix to the RI Report as discussed in Section 9.3. Averages for duplicates will be determined using distinct equations which are contingent upon the analytical results for the duplicate samples. The equations to be used are as follows:

Positive result for both the original and duplicate sample:

$$\text{Average} = (\text{Original Result} + \text{Duplicate Result})/2$$

Nondetect for both the original and duplicate sample:

$$\begin{aligned} \text{Average} &= (\text{Original Detection Limit}/2 + \text{Duplicate Detection Limit}/2)/2 \\ &= (\text{Original Detection Limit} + \text{Duplicate Detection Limit})/4 \end{aligned}$$

Nondetect for one sample and positive result for the other (detection limit/2 < result):

$$\text{Average} = (\text{Detection Limit}/2 + \text{Positive Result})/2$$

Nondetect for one sample and positive result for the other (detection limit/2 ≥ result):

$$\text{Average} = \text{Positive Result}$$

Note that the preceding treatment of average results includes the handling of nondetects quantitatively as values equal to one-half the detection limit. This is a typical procedure for the handling of nondetects.

In the event that manipulation of the analytical data for risk assessment purposes is necessary, calculations to determine representative concentrations for the exposure assessment will be performed. Such procedures will only be necessary in the event that the results for various sampling locations are pooled to generate representative concentrations for an exposure unit. Based on the anticipated distance between sampling points, it is considered unlikely that data will be pooled (i.e., each individual sampling point will be treated separately for risk assessment purposes). However, in the event that pooling of data is completed, representative concentrations will be determined using the following equations:

Normally distributed data

$$UCL = X_m + t(s / \sqrt{n})$$

Where: UCL = the upper 95% confidence limit
 X_m = the arithmetic mean concentration
 t = the Student's t statistic
 s = the sample standard deviation
 n = the number of samples

Log-normally distributed data

$$UCL = \exp(X_m + 0.5s^2 + sH / \sqrt{n-1})$$

Where: UCL = the upper 95% confidence limit
 X_m = the arithmetic mean concentration
 s = the sample standard deviation
 H = H statistic
 n = the number of samples
 \exp = the exponential function (e)

Note that distributional assumption testing will be completed prior to use of the preceding equations. Either the Shapiro-Wilk W-Test or the Komolgorov-Smirnov test will be used to test for normality or log-normality.

Field Quality Control sample results will be included in the data base for the NSWC Indian Head RI activities. Specifically, the analytical results for trip blanks, equipment blanks, and field blanks will be provided. The results for field Quality Control samples will be considered during the course of data validation (in concert with laboratory method blanks) to eliminate false positive results according to the 5- and 10-times rules specified in the National Functional Guidelines for Organic and Inorganic Data Review. The results for laboratory Quality Control samples such as method blanks will not be included in the data base. In addition, only the original (unspiked) sample results for Matrix Spike/Matrix Spike Duplicate samples will be provided in the data base.

Additional aspects of laboratory data handling are provided in Sections 9.2 and 9.3. Treatment of both hardcopy and electronic data deliverables are discussed.

9.2 DATA VALIDATION

Validation of field measurements and laboratory analytical data are discussed in this section. Validation of field data will be limited to real time "reality" checks whereas laboratory analytical data will be validated in accordance with current U.S. EPA guidance. Validation of field measurements is discussed in Section 9.2.1. Validation of laboratory analytical data is discussed in Section 9.2.2.

9.2.1 Field Measurement Data Validation

Field measurements will not be subjected to a formal data validation process. However, field technicians will ensure that the equipment used for field measurement is performing accurately via compliance with the Standard Operating Procedures discussed in Section 6.0 of this Master Quality Assurance Project Plan. As described in Section 9.1.1, all field data entered into the electronic database will be independently reviewed for transcription errors.

9.2.2 Laboratory Data Validation

All CLP laboratory analytical data will be subjected to validation in accordance with the National Functional Guidelines for Organic and Inorganic Data Review. Data validation will be completed to ensure that the data are of evidentiary quality. Particular emphasis will be placed on holding time compliance, equipment calibration, spike recoveries, and blank results, although all required elements of the validation process will be considered.

Validation of analytical data shall be completed by the contractor or subcontractor. The analytical results for non-CLP parameters (e.g., explosives) will be validated versus the methods and laboratory SOPs.

Validation of these data shall conform to the National Functional Guidelines to the greatest extent practicable. The contractor shall complete the validation process in accordance with the additional requirements outlined in Indian Head Master Standard Operating Procedure CT-01.

9.3 DATA REPORTING

This section discusses data reporting requirements for field and laboratory analytical data. Section 9.3.1 discusses field measurement data handling and reporting. Section 9.3.2 discusses laboratory data handling and reporting.

9.3.1 Field Measurement Data Reporting

Field data will be reported in the units discussed in Section 9.1.1. RI Reports will include a comprehensive data base including all field measurements (specifically pH, specific conductance, temperature, and turbidity). Field Measurements will be transferred from the site logbook or sample logsheets to the electronic data base manually and will be reviewed for accuracy by an independent reviewer. Transcription of field measurements to the electronic data base will be completed shortly after completion of the field investigation and prior to receipt of laboratory analytical data.

All records regarding field measurements (i.e., field logbooks, sampling logbooks, and sample logsheets) will be placed in the central files upon completion of the field effort. Entry of these results in the data base will require removal of these results from the files. Outcards will be used to document the removal of any such documentation from the files (date, person, subject matter). Field measurement data will be reported in an appendix of RI Reports at a minimum and may also be reported in summary fashion if they are indicative of the presence of contamination (e.g., high specific conductance readings).

9.3.2 Laboratory Data Reporting

Data reported by the laboratory for all analytical fractions will be in accordance with CLP reporting format, including all non-CLP data (to the extent practicable). All pertinent quality control data including raw data and summary forms for blanks, standards analysis, calibration information, etc., will be provided for any non-CLP analyses. Case narratives will be provided for each Sample Delivery Group.

Environmental and field Quality Control sample results (trip blanks, duplicates, equipment blanks, field blanks) will be included in RI Reports as appendices. The data base will include pertinent sampling information such as sample number, sampling date, general location, depth, and survey coordinates (if

applicable). Sample-specific detection limits will be reported for nondetected analytes. Units will be clearly summarized in the data base and will conform to those identified in Section 9.1.2.

The analytical data will also be reported in summary fashion within the body of RI Reports in tabular and graphic fashion. Tabular summaries will report the frequency of detection, mean concentrations, representative concentrations (if applicable), standard deviations, etc. in accordance with the data reporting requirements outlined in Risk Assessment Guidance for Superfund - Human Health Evaluation Manual (Part A). The tabular summaries will include only those analytes that are detected in at least one sample. In the event that graphical portrayals of data are informative, isoconcentration contours or "tag maps" including the location and concentration of specific Chemicals of Potential Concern will be provided in the RI Reports.

Data will be handled electronically pursuant to the electronic deliverable requirements outlined in specifications to the analytical laboratories. Analytical laboratories are required to provide data in both hardcopy and electronic form (DBF files). The original electronic diskettes and the original hardcopy analytical data are maintained in the central files as received. All other pertinent information, including field logbooks, sampling notebooks, chain-of-custody forms, etc. are also maintained in the central files. Various aspects of field documentation are addressed in detail in the Indian Head Master SOPs and shall also be addressed in Project-Specific Work Plans. Indian Head Master Standard Operating Procedure CT-03 discusses data base management and Quality Assurance.

Validation will be completed using the hard copy data. Upon completion of validation of a Sample Delivery Group and review, the validation qualifiers will be entered in the electronic data base and will be subjected to independent review for accuracy. During this review process, the electronic data base printout will also be contrasted with the hard copy data (Form Is) to ensure that the hard copy data and electronic data are consistent. A summary of the validation results (actions taken and completeness, precision, and accuracy) will be provided in the RI Reports.

10.0 PERFORMANCE AND SYSTEM AUDITS

Performance and system audits will be performed periodically to ensure that work is being implemented in accordance with the approved Project Plans and in an overall satisfactory manner. Such audits will be performed by various personnel and will include evaluation of field, laboratory, data validation, and data reporting processes. Examples of pertinent audits are as follows:

- The Field Operations Leader (FOL) will supervise and check daily that any field measurements are made accurately, equipment is thoroughly decontaminated, samples are collected and handled properly, and fieldwork is documented accurately and neatly.
- Performance and system audits for the laboratory will be performed regularly, in accordance with the requirements of the Contract Laboratory Program (external), by a U.S. Navy Contractor (internal), and in accordance with Laboratory Quality Assurance Plans (internal).
- Data validators will review (on a timely basis) the chemical analytical data packages submitted by the laboratory. The data validators will check that the data were obtained through use of the approved methodology, that the appropriate level of QC effort and reporting was conducted, and whether or not the results are in conformance with QC criteria. On the basis of these factors, the data validator will generate a report describing data limitations, which will be reviewed internally by the Data Validation Coordinator prior to submittal to the Project Manager.
- The Project Manager will maintain contact with the FOL and Data Validation Coordinator to ensure that management of the acquired data proceeds in an organized and expeditious manner. Similarly, the Project Manager will interface with the Risk Assessment and Modeling Coordinators, as applicable.

Details regarding audit responsibilities, frequency, and procedures are discussed in the remainder of this section. Field performance and system audits are discussed in Section 10.2. Laboratory performance and system audits are discussed in Section 10.3.

10.1 FIELD PERFORMANCE AND SYSTEM AUDITS

This section discusses internal and external field performance and system audits.

10.1.1 Internal Field Audits

10.1.1.1 Internal Field Audit Responsibilities

An independent performance and system audit of field activities will be conducted by the Quality Manager or designee. When the formal field audit is conducted, the Quality Manager (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 Project Plans and SOPs. An internal audit of office procedures will also be conducted by the Quality Manager (or designee) to ensure compliance with SOPs regarding review of deliverables, verification of calculations, data handling and transcription, and recordkeeping.

10.1.1.2 Internal Field Audit Frequency

Internal field and office audits are conducted once per annum unless the complexity of the project dictates a greater audit frequency. One audit per annum is considered appropriate for the NSWC Indian Head RI/FS activities. Based on uncertainties regarding project plan approval, mobilization cannot be pinpointed at this time. However, the field and office audits will be completed in accordance with the following milestone schedule: (1) field audit - within one month of mobilization; (2) office audit - within three months of receipt of the final analytical data package from the subcontract laboratory.

10.1.1.3 Internal Field Audit Procedures

The field and office audits will be conducted by the Quality Manager (or designee) in accordance with the following procedures:

- Prior to the 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.) for completeness and agreement; and field operations (well installation, sample collection, sample handling and preservation, etc.) to determine compliance with the Work Plans and QAPP, as well as applicable SOPs. The field audit checklist will be used to record observations of these reviews including any noted nonconformances.

- File audits will consist of reviewing required project records for completeness, organization and ease of retrieval, and compliance with applicable docketing protocols. These observations and any related nonconformances will also be recorded on the audit checklist.
- Office audits will focus on compliance with Standard Operating Procedures governing deliverable review, verification of calculations, recordkeeping procedures, and data handling, transcription, and reporting.
- A formal post-audit debriefing will be conducted; potential immediate corrective actions will be discussed.
- The auditor will generate a formal audit report which will document observations and address corrective actions. This report will be provided by the auditor to the Project Manager.
- The Project Manager will ensure that all corrective actions are addressed and will provide written verification of corrective action implementation by the auditor.
- The auditor will manage corrective action verification and audit closure providing all documentation to the Quality Manager.
- The following audit records will be maintained by the Quality Manager.
 - Original monitoring schedules and revisions
 - Audit checklists
 - Audit reports
 - Response evaluations
 - Verification of corrective actions
 - Follow-up checklists and audit reports

The results of the audit will be considered acceptable if all Standard Operating Procedures and project planning document requirements are followed to the letter. If problems are identified, corrective action is initiated in accordance with the procedures outlined in Section 13.0.

10.1.2 External Field Audits

External field audits may be conducted by the Maryland Department of the Environment (MDE), the U.S. EPA Region III, or both. Details regarding the responsibilities of these agencies, frequency, and procedures are left to the discretion of the agencies.

10.1.2.1 External Field Audit Responsibilities

At the discretion of the MDE and U.S. EPA Region III.

10.1.2.2 External Field Audit Frequency

At the discretion of the MDE and U.S. EPA Region III.

10.1.2.3 Overview of External Field Audit Process

At the discretion of the MDE and U.S. EPA Region III.

10.2 LABORATORY PERFORMANCE AND SYSTEMS AUDITS

Internal and external laboratory performance and systems audits are discussed in this section.

10.2.1 Internal Laboratory Audits

Internal laboratory audit responsibilities, frequencies, and procedures are discussed in this section.

10.2.1.1 Internal Laboratory Audit Responsibilities

Subcontract laboratories QA/QC Officers perform routine internal audits of the laboratories. Internal laboratory audits are also conducted by the U.S. Navy. The contractor holds no responsibility for such audits. Performance and system audits of laboratories are coordinated through the NFESC by an independent Quality Assurance contractor. It is the responsibility of the NFESC and their Quality Assurance contractor to ensure that the contracted laboratories comply with good laboratory practices and the general requirements of all analytical services provided by the laboratory.

10.2.1.2 Internal Laboratory Audit Frequency

Subcontract laboratories typically conduct internal system audits on a quarterly basis. Internal laboratory performance and system audits are completed by the U.S. Navy for each contracted laboratory on an 18-month schedule.

10.2.1.3 Internal Laboratory Audit Procedures

Procedures used by the subcontract laboratories for internal audits will be provided in project-specific addenda to this Master QAPP. Internal U.S. Navy laboratory audit procedures fall under the domain of the NFESC and its contractor. Procedures will be provided to the MDE and U.S. EPA upon request.

10.2.2 External Laboratory Audits

This section discusses external laboratory audit responsibilities, frequencies, and procedures.

10.2.2.1 External Laboratory Audit Responsibilities

It is the responsibility of the U.S. EPA's Contract Laboratory Program to complete audits of contracted laboratories to ensure compliance with the requirements of the CLP and the most recent organic and inorganic Statements of Work. It is the responsibility of the MDE and U.S. EPA Region III to conduct laboratory audits at their discretion.

10.2.2.2 External Laboratory Audit Frequency

External laboratory audits by the U.S. EPA are conducted during qualification as a contract laboratory. CLP laboratory audits are completed on an as-needed basis thereafter. An external laboratory audit may be conducted by U.S. EPA Region III or MDE prior to the initiation of the sampling and analysis activities.

10.2.2.3 External Audit Procedures

External audit procedures are at the discretion of the CLP, U.S. EPA Region III, and the MDE. External laboratory audits may include (but are not limited to) review of laboratory analytical procedures, laboratory onsite audits, and/or submission of performance evaluation samples to the laboratory for analysis.

11.0 PREVENTIVE MAINTENANCE PROCEDURES

Measuring equipment used in environmental monitoring or analysis for the NSW Indian Head RI activities shall be maintained in accordance with the manufacturer's operation and maintenance manuals. Equipment and instruments shall be calibrated in accordance with the procedures, and at the frequency, discussed in Section 6.0 (Calibration Procedures and Frequency). Preventive maintenance for field and laboratory equipment are discussed in the remainder of this section.

11.1 FIELD EQUIPMENT PREVENTIVE MAINTENANCE

Preventive maintenance of field equipment is described in the Indian Head Master SOPs. The contractors Equipment Manager and the instrument operator will be responsible for ensuring that equipment is operating properly prior to use and that routine maintenance is performed and documented. Any problems encountered while operating the instrument will be recorded in the field log book including a description of the symptoms and corrective actions taken. If problem equipment is detected or should require service, the equipment should be logged, tagged, and segregated from equipment in proper working order. Use of the instrument will not be resumed until the problem is resolved.

11.2 LABORATORY INSTRUMENT PREVENTIVE MAINTENANCE

Proper maintenance of laboratory instruments and equipment is essential to ensuring their readiness when needed. Dependent on manufacturer's recommendations, maintenance intervals are established for each instrument. All instruments must be labeled with a model number and serial number, and a maintenance logbook must be maintained for each instrument. Personnel must be alert to the maintenance status of the equipment they are using at all times.

11.2.1 Major Instruments

Table 11-1 provides a summary of preventive maintenance procedures typically performed by environmental laboratories for key analytical instruments.

Maintenance of key instruments may also be covered under service contracts with external firms. Such contracts provide for periodic routine maintenance to help guard against unexpected instrument downtime. These contracts also typically provide for quick response for unscheduled service calls when malfunctions are observed by the operator.

TABLE 11-1

**PREVENTIVE MAINTENANCE FOR ANALYTICAL INSTRUMENTS
NSWC INDIAN HEAD, MARYLAND**

Instrument	Preventive Maintenance	Maintenance Frequency
GC/MS	Volatiles: Bake oven, replace septum, check carrier gas. Semivolatiles: Replace the septum, clean injection port, replace liner, bake oven, check carrier gas, clean the source, monitor/change pump oil. Replace solvent washes and clean syringe.	As required. As required. Daily.
GC	Replace solvent washes and clean syringe. Clip column, clean injection port, replace liner, and bake oven.	Daily. As required.
ICP	Change sample introduction tubing, clean nebulizer, clean spray chamber, clean torch, manual profile, and automatic profile optics.	As required.
GFAA	Clean contact cylinders, replace/clean tube, check lamp alignment.	As required.
CVAA	Change sample introduction tubing, change drying cell, re-zero detector.	As required.
HPLC	Monitor/change pump oil. Change filter in mixer. Change column pre-filter. Rinse water pump with methanol. Change pump seals.	As required. As required (when pressure builds). As required (approximately 2 to 3 months). Weekly. As required.

The use of manufacturer recommended grades or better of supporting supplies and reagents is also a form of preventive maintenance. For example, gases used in the various gas chromatographs and metals instruments are of sufficient grade to minimize fouling of the instrument. The routine use of septa, chromatographic columns, ferrules, AA furnace tubes, and other supporting supplies from reputable manufacturers will assist in averting unnecessary periods of instrument downtime.

11.2.2 Refrigerators/Ovens

The temperatures of refrigerators used for sample storage will be monitored once daily. The acceptable range for refrigerator temperatures is $4^{\circ}\text{C} \pm 2^{\circ}\text{C}$. The temperatures will be recorded in the refrigerator temperature log. Maintenance of the log will be the responsibility of the sample custodian or designee. The log will contain the following information:

- Date
- Temperature
- Initials of person performing the check

Assignment of responsibilities for temperature monitoring to specific personnel does not preclude the participation of other laboratory personnel. If unusual temperature fluctuations are noted, it is the responsibility of the observer to immediately notify the person in charge of the discrepancy before the condition of the samples is compromised.

Unstable or fluctuating temperatures may be indicative of malfunctions in the cooling system. On the other hand, the instability may be due to frequent opening of the door. Regardless of the cause, such an observation must be investigated, and modifications must be made to access procedures or repairs to equipment must be made to prevent jeopardizing the integrity of the samples.

12.0 SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

Compliance with the Quality Control objectives outlined in Section 3.0 will be monitored via two separate mechanisms. Precision and accuracy will be assessed through data validation in accordance with the National Functional Guidelines (to the extent practicable for non-CLP analyses if conducted). Compliance with the completeness objectives for field and laboratory data/measurement will be calculated by hand (field measurements) and electronically via a database subroutine (laboratory data). Information necessary to complete the precision and accuracy calculations will be provided in electronic and hardcopy form by the subcontract laboratory. Equations to be used for the precision, accuracy, and completeness assessment are outlined in the remainder of this section.

12.1 ACCURACY ASSESSMENT

To assure the accuracy of the analytical procedures, a minimum of 1 of every 20 samples is spiked with a known amount of the analyte or analytes to be evaluated. The spiked sample is then analyzed. The increase in concentration of the analyte observed in the spiked sample, because of the addition of a known quantity of the analyte, compared to the reported value of the same analyte in the unspiked sample determines the percent recovery. Daily control charts are plotted for each commonly analyzed compound and kept on matrix-specific and analyte-specific bases. The percent recovery for a spiked sample is calculated according to the following formula:

$$\%R = \frac{\text{Amount in Spiked Sample} - \text{Amount in Sample}}{\text{Known Amount Added}} \times 100\%$$

12.2 PRECISION ASSESSMENT

Duplicate samples (for inorganic analyses) and matrix spike duplicate samples (for organic analyses) are prepared and analyzed at a minimum frequency of 1 per every 20 environmental samples. Duplicate samples are prepared by dividing an environmental sample into equal aliquots.

Matrix spike duplicate samples are prepared by dividing an environmental sample into equal aliquots and then spiking each of the aliquots with a known amount of analyte. The duplicate samples are then included in the analytical sample set. The splitting of the sample allows the analyst to determine the precision of the preparation and analytical techniques associated with the duplicate samples. The relative percent difference (RPD) between the sample (or spike) and duplicate (or duplicate spike) is calculated and plotted. The RPD is calculated according to the following formula:

$$\text{RPD} = \frac{\text{Amount in Sample} - \text{Amount in Duplicate}}{0.5 (\text{Amount in Sample} + \text{Amount in Duplicate})} \times 100\%$$

12.3 COMPLETENESS ASSESSMENT

Completeness is the ratio of the number of valid sample results to the total number of samples analyzed with a specific matrix and/or analysis. Following the completion of the analytical testing, the percent completeness will be calculated by the following equation:

$$\text{Completeness} = \frac{(\text{number of valid measurements})}{(\text{number of measurements planned})} \times 100\%$$

The results of the data validation process and the completeness assessment will be summarized in Section 4.0 of the RI Reports (Nature and Extent of Contamination).

13.0 CORRECTIVE ACTION

It is required that any and all personnel noting conditions adverse to quality report these conditions immediately to the Project Manager and Quality Manager. These parties, in turn, are charged with performing root-cause analyses and implementing appropriate corrective action in a timely manner. It is ultimately the responsibility of the Quality Manager to document all findings and corrective actions taken and to monitor the effectiveness of the corrective measures performed.

13.1 FIELD CORRECTIVE ACTION

Field nonconformances or conditions adverse to quality must be identified and corrected as quickly as possible so that work integrity or quality of product is not compromised. The need for corrective action may arise based on deviations from Project Plans and procedures, adverse field conditions, or other unforeseen circumstances. Corrective action needs may become apparent during the performance of daily work tasks or as a consequence of internal or external field audits.

Corrective action may include resampling and may involve amending previously approved field procedures. If warranted by the severity of the problem (e.g., if a change in the approved Project Plan documents or SOPs is required), the Navy will be notified in writing via a Field Task Modification Request (FTMR), and Navy (in conjunction with U.S. EPA Region III) approvals will be obtained. The Field Operations Leader (FOL) is responsible for initiating FTMRs; an FTMR will be initiated for all deviations from the Project Plan documents, as applicable. An example of an FTMR is provided as Figure 13-1. Copies of all FTMRs will be maintained with the onsite project planning documents and will be placed in the final evidence file.

Minor modifications to field activities such as a slight offset of a boring location will be initiated at the discretion of the FOL, subject to onsite approval by NSWC personnel. Approval for major modifications (e.g., elimination of a sampling point) must be obtained via an FTMR.

FIGURE 13-1

FIELD TASK MODIFICATION REQUEST FORM

Client Identification _____ Project Number _____ TMR Number _____

To _____ Location _____ Date _____

Description:

Reason for Change:

Recommended Disposition:

Field Operations Leader (Signature, if applicable) _____ Date _____

Disposition:

Project Manager (Signature, if required) _____ Date _____

Distribution:

Program Manager
Quality Assurance Officer
Project Manager
Field Operations Leader

Others as required _____

13.2 LABORATORY CORRECTIVE ACTION

In general, laboratory corrective actions are warranted whenever an out-of-control event or potential out-of-control event is noted. The specific corrective action taken depends on the specific analysis and the nature of the event. Generally, the following occurrences alert laboratory personnel that corrective action may be necessary:

- QC data are outside established warning or control limits;
- method blank analyses yield concentrations of target analytes above acceptable levels;
- undesirable trends are detected in spike recoveries or in duplicate RPDs;
- there is an unexplained change in compound detection capability;
- inquiries concerning data quality are received;
- deficiencies are detected by laboratory QA staff audits or from performance evaluation sample test results.

Corrective actions are documented for non-routine out-of-control situations on a Corrective Action Form. Figure 13-2 provides an example of a typical Corrective Action Form. A routine out-of-control situation is defined as one that is noted in the corrective action section of the method-specific SOP. Each SOP defines the routine out-of-control situations and the appropriate corrective action procedures for these situations. All out-of-control situations that are not addressed in the SOP must be treated as non-routine and documented in the corrective action logbook.

Using the Corrective Action Form, any employee may notify the QA/QC Officer of a problem. The QA/QC Officer initiates the corrective action by relating the problem to the appropriate Laboratory Manager and/or Internal Coordinator, who then investigates or assigns responsibility for investigating the problem and its cause. Once determined, an appropriate corrective action is approved by the QA/QC Officer. Its implementation is verified and documented on the Corrective Action Form and is further documented through audits.

Information contained on corrective action forms is kept confidential within the laboratories and is generally limited to the individuals involved. Severe problems and difficulties may warrant special reports to the laboratory President, who will ensure that the appropriate corrective actions are taken.

FIGURE 13-2

ANALYTICAL LABORATORY
CORRECTIVE ACTION FORM

Name: _____

Date: _____

Problem:

Samples Affected:

Action Taken:

Name _____

Date: _____

Action Taken:

Name _____

Date: _____

Proof of Return to Control:

Supervisor: _____

QA/QC Officer: _____

Date: _____

Date: _____

13.3 CORRECTIVE ACTION DURING DATA VALIDATION AND DATA ASSESSMENT

As a means of oversight, the Quality Manager will audit a percentage of the data validation, assessment, and evaluation deliverables generated/performed. Oversight audits may also be conducted directly by U.S. Navy personnel, or by an independent data validation firm under contract to the U.S. Navy.

The need for corrective action may become apparent during data validation, interpretation, or presentation activities, or problems may be identified as a result of oversight findings. The performance of rework, instituting a change in work procedures, or providing additional/refreshers training are possible corrective actions relevant to data evaluation activities. The Project Manager will be responsible for approving the implementation of corrective action.

13.4 CORRECTIVE ACTION FOR ADMINISTRATIVE ACTIVITIES

Findings identified by the conduct of office procedures and file audits may also necessitate the performance of corrective actions. Corrective actions involving file management and office procedures usually consist of correction of an isolated nonconformance or the performance of activities necessary to conform with clarified guidance.

14.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

Quality Assurance reports to management will be provided in five primary formats during the course of the NSWC Indian Head Remedial Investigation activities. Data validation letters will be prepared on a Sample Delivery Group-specific basis and will summarize Quality Assurance issues for the subcontract laboratory data. Internal audit reports regarding compliance with Standard Operating Procedures (specifically those regarding recordkeeping and review of deliverables) and compliance with the Field Sampling Plan and Health and Safety Plan are also prepared. In addition, written weekly reports summarizing accomplishments and Quality Control/Quality Assurance issues during the field investigation will be provided by the Field Operations Leader. Finally, monthly progress reports are provided to the U.S. Navy Task Order Manager.

14.1 CONTENTS OF PROJECT QUALITY ASSURANCE REPORTS

The contents of the specific Quality Assurance reports are as follows. The data validation reports address all major and minor laboratory noncompliances as well as noted sample matrix effects. In the event that major problems occur with the analytical laboratory (e.g., holding time exceedances or calibration noncompliances, etc.) the Data Validation Task Manager notifies the Project Manager, the Technical Program Manager, and the Laboratory Services Task Manager. Such notifications (if necessary) are typically provided via internal memoranda and are placed in the project file. Such reports contain a summary of the noncompliance, a synopsis of the impact on individual projects, and recommendations regarding corrective action and compensational adjustments. Corrective actions are initiated at the program level.

Internal field and office audits are conducted on an annual basis for each active project. The Quality Manager (or designee) conducts the audits to ensure that projects are completed in accordance with applicable Standard Operating Procedures and project planning documents. The primary emphasis of internal office audits is to ensure that all calculations are checked, that recordkeeping is conducted in accordance with Standard Operating Procedure, and that all deliverables are subjected to peer review by experienced senior staff members. Field audits are conducted to ensure that sampling, sample shipment, recordkeeping, etc. are completed in accordance with the Project-Specific Work Plan and relevant Standard Operating Procedures. At the completion of such audits, the Project Manager is provided a Quality Assurance report that outlines the scope of the audit, any findings regarding nonconformance, recommendations for corrective action, and a proposed schedule for completion of corrective action and post-corrective action monitoring.

The Field Operations leader will provide the Project Manager with weekly reports regarding accomplishments, deviations from the Field Sampling Plan, upcoming activities, and a Quality Assurance summary during the course of the field investigation. In addition, monthly project review meetings are held for all active Navy CLEAN projects. Issues discussed at the project review meeting include all aspects of budget and schedule compliance, and Quality Assurance/Quality Control problems. The Project Manager provides a monthly progress report to the Navy CLEAN Task Order Manager which addresses the project budget, schedule, accomplishments, planned activities, and Quality Assurance/Quality Control issues and intended corrective action.

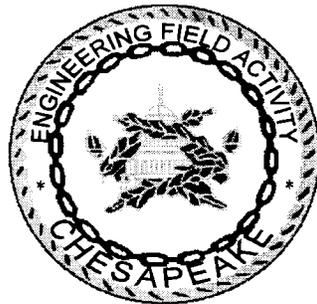
14.2 FREQUENCY OF QUALITY ASSURANCE REPORTS

As discussed in the preceding section, Quality Assurance reports are generated either frequently or infrequently contingent upon the type of Quality Assurance report generated. The following frequencies will apply for the RI activities: (1) Data validation QA Reports - Contingent upon SDG delivery date; (2) Internal Office Audit QA Reports - Once per annum; (3) Internal Field Audit Reports - once per annum; (4) Weekly field progress reports - weekly during the course of the field investigation; (5) Monthly Progress Reports - monthly.

14.3 INDIVIDUALS RECEIVING/REVIEWING QUALITY ASSURANCE REPORTS

Data validation Quality Assurance Reports are provided to the Project Manager for inclusion in the project files. In the event that major problems are observed for a given laboratory, the Program Manager, Deputy Program Manager, Quality Assurance Manager, Project Manager, and Laboratory Services Coordinator are provided copies of the QA report. Copies of internal field and office audit QA Reports are provided to the Program Manager, Deputy Program Manager, and Project Manager. Weekly field progress reports are provided to the Project Manager. Monthly progress reports are provided to the Navy CLEAN Task Order Manager, the Program Manager, and the Navy CLEAN Contracting Officers Technical Representative.

**Health and Safety Plan
Guidance Document**
for
**Installation Restoration Program
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 0245

April 1997

**HEALTH AND SAFETY PLAN
GUIDANCE DOCUMENT
FOR
INSTALLATION RESTORATION PROGRAM
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 181
Naval Facilities Engineering Command
Washington Navy Yard, Building 212
Washington, D.C. 20374-2121**

**Submitted by:
Brown & Root Environmental
993 Old Eagle School Road, Suite 415
Wayne, Pennsylvania 19087-1710**

**NORTHERN DIVISION CONTRACT NO. N62472-90-D-1298
CONTRACT TASK ORDER 0245**

APRIL 1997

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**BROWN & ROOT ENVIRONMENTAL
APPROACH
TO
INDIAN HEAD
CTO 245
SITE SPECIFIC SAFETY AND HEALTH PLANNING**

INTRODUCTION

This document presents an overview of the Brown & Root Environmental approach to providing for health and safety of personnel participating in onsite activities as part of the remedial investigation/remedial resolution efforts at the Naval Surface Warfare Center, Indian Head(NSWC), Maryland. Brown & Root Environmental is committed to providing a safe and healthful workplace for personnel performing work at Naval facilities under this CLEAN contract.

The foundation of effective health and safety practices is the development, implementation, and maintenance of site specific Health and Safety Plans (HASPs). These documents are developed and implemented to satisfy regulatory and internal requirements, and to ensure that appropriate considerations are taken to protect personnel for each task and operation performed at the NSWC Indian Head. This approach has been effectively used at various sites nationwide, and satisfies requirements outlined in OSHA 1910.120 Hazardous Waste Operations and Emergency Response standard.

The intent of this document is to summarize the procedures that will be used to develop Site-Specific Health and Safety Plans for this CTO. The following information will provide the reader with an overview of this process.

SECTION 1.0 INTRODUCTION

The introductory section of the Indian Head Site Health and Safety Plan describes a brief overview of the plan, listing the basic objectives of the project work plan, the overall organization and purpose of the plan, and an outline of the information found in the Health and Safety Plan. This section also defines the personnel organization for the specific project being undertaken at Indian Head.

SECTION 2.0 EMERGENCY ACTION PLAN

A site Emergency Action Plan (EAP) will be developed and presented as the second section of the HASP, and implemented prior to commencement of any onsite operations. The procedures implemented as part of the EAP will be designed to provide for incipient stage response until the incident is declared an emergency. At Indian Head personnel are to evacuate the site in the event of an emergency. Therefore, the EAP will be prepared to meet the requirements in OSHA regulations 29 CFR 1910.38(a) and 29 CFR 1910.120* (as reflected below).

Emergency Action Plan for Site Evacuation

- Emergency escape procedures and escape route assignments will be designated.
- Procedures will be specified for personnel who must remain on site to operate any critical operations before they evacuate, (if appropriate).
- Procedures to account for all personnel following an evacuation.
- Procedure to activate Indian Head fire, rescue, hazardous materials, and medical units.
- Emergency reporting procedures.
- Names or job titles of persons or departments at Indian Head who are to be contacted for additional information or explanation of duties under the EAP.
- Provisions for a site emergency alarm system.
- Training (and re-training) of site personnel in the contents of the EAP.

* *Emergency response or responding to emergencies means a response effort by employees from outside the immediate release area or by other designated responders (i.e., mutual-aid groups, local fire departments, etc.) to an occurrence which results, or is likely to result, in an uncontrolled release of a hazardous substance. Responses to an incidental releases of hazardous substances where the substance can be absorbed, neutralized, or otherwise controlled at the time of release by employees in the immediate release area, or by maintenance personnel are not considered to be emergency responses within the scope of this standard. Responses to releases of hazardous substances where there is no potential safety or health hazard (i.e., fire, explosion, or chemical exposure) are not considered to be emergency responses.*

The Emergency Action Plan will also address:

- Emergency Recognition and Prevention of emergencies at Indian Head.
- Safe Distances and Places of Refuge located within the Indian Head complex.
- Decontamination Procedures
- Personal Protective Equipment
- Emergency route to Physicians Memorial Hospital or Southern Maryland Hospital.

SECTION 3.0 SITE BACKGROUND

Background information will be provided to familiarize field team members with Indian Head's history, current mission, and physical features. A description of the facility, the principal disposal methods for hazardous materials, available results of past monitoring (readings obtained via using photo ionization detector, organic vapor analyzer, radiation meter, etc.) and/or sampling data (ground water, soil, air, etc.). Other information found in this section will include identifying the characteristics of potentially hazardous materials found at areas of investigation at Indian Head.

SECTION 4.0 SCOPE OF WORK

The Scope of Work section will summarize the work tasks to be performed at Indian Head covered by the HASP. These tasks will correspond to those specified in the project Work Plan.

SECTION 5.0 TASKS/HAZARDS/ASSOCIATED CONTROL MEASURES SUMMARIZATION

This section will identify the specific tasks that are to be performed at Indian Head. This will include information on:

- Anticipated site hazards
- Appropriate control measures
- Air monitoring requirements

The above information will be presented in two logic charts specifically customized for the conditions and anticipated or foreseeable hazards and specific control measures as they relate to the tasks and possibly site conditions found at the Indian Head site.

SECTION 6.0 HAZARD ASSESSMENT

This section will address the chemical and physical hazards expected to be found at the Indian Head site. This information will be incorporated into the tables used in Section 5. Organizing the information in this manner will enable the field team to readily locate pertinent information.

SECTION 7.0 AIR MONITORING

This section of the Indian Head Site-Specific HASP will identify the equipment and procedures to be used for personal and area monitoring and sampling procedures. Through the use of monitoring equipment, some potential health and safety hazards may be identified and quantified by site personnel. Monitoring the atmosphere in the work area will assist site personnel in the proper selection of engineering controls, safe work practices, and personal protective equipment. This section will also specify situations when air monitoring must be performed. Such as:

- When work begins on a different portion of the site.
- When contaminants not previously identified are encountered.
- When a different type of operation is initiated (e.g., drum opening as opposed to exploratory well drilling).
- When employees are handling leaking drums or containers or working in areas with obvious contamination (e.g., a spill or lagoon).

SECTION 8.0 TRAINING/MEDICAL SURVEILLANCE REQUIREMENTS

This section will identify employee training requirements necessary to ensure that personnel working at Indian Head safely perform their job duties and comply with regulatory requirements. Employees will be permitted to participate in (or supervise) field activities only when they have been adequately trained to the level required by their job function and responsibility. Although training requirements may vary, the following requirements are applicable to personnel performing work at Indian Head.

- Initial training (40 hours in duration).
- Site supervision (for site managers and/or supervisors only, 8 hours in duration).
- Annual refresher training (8 hours in duration).
- Actual field experience (for new personnel only, 3 days in duration)

Documentation of the dates that each participant attended the training courses will be indicated in the site-specific Indian Head HASP, along with the method for documentation of that training. The requirements for maintaining documentation onsite is included. Additional training requirements applicable to the specific project will also be addressed in this section of the HASP. Training required by the Occupational Safety and Health Administration [OSHA] for

(respiratory protection, powered industrial truck operation, asbestos-related work, etc.) would be indicated, as appropriate. It also may be necessary due to unique or non-routine projects to specify training such as: (i.e., confined-space entry, hot work operations), or other topics (cardiopulmonary resuscitation [CPR] or first aid).

Safety briefings procedures are identified and specified in the plan when the following situations occur:

- Routine or daily basis to delineate safety problems
- New operations are conducted
- Site or environmental conditions change
- When safety practices are not being followed

Medical Surveillance

In this section, medical surveillance requirements will be identified to provide adequate health monitoring of project participants. Medical Data Sheet will be collected for all site personnel, and will specify the date of the employee's most recent physical examination and other pertinent information, such as any known allergies, medical conditions, physical restrictions, etc. Additionally, restrictions or work limitations procedures will be specified in these employee data sheets.

SECTION 9.0 SITE CONTROL MEASURES

This section will identify appropriate site control procedures for projects conducted at Indian Head Naval Warfare Center. Information supplied in this section will include:

- Existing site perimeter and/or zone controls including specifications for delineating the needed zones.
- Requirements for use of the "buddy system."
- Applicable site-specific standard operating procedures to be followed.
- A map of the site.
- Material Safety Data Sheet procedures
- Communications Procedures
- Site Visitors access procedures
- Site Security

SECTION 10.0 SPILL CONTAINMENT PROGRAM

In this section the procedures and equipment to be used in isolating and containing spills will be specified. This information includes: training, spill prevention and containment, and spill equipment. A spill containment program for the specific site listing notification and response procedures will also be included in this section.

SECTION 11.0 CONFINED SPACE ENTRY

This section will define what a confined space is and the requirements for entry into a space. It will also define the notification procedure that must be followed and the procedure for augmenting the HASP to include confined space entry.

SECTION 12.0 MATERIALS AND DOCUMENTATION

This section will list the materials that the on-site supervisor is required to keep onsite and how these documents are to be used. This section will also address documents that must be posted at the site.

SECTION 13.0 GLOSSARY

This section of the Indian Head Plan will list important acronyms, and site-specific terms relevant to the HASP contents.

CONCLUSION

The Indian Head Site Specific Health and Safety Plan is of vital importance to site personnel in order to maintain a healthful and safe working environment. For this reason Brown & Root Environmental takes great care in creating and reviewing this document. We consider this to be a living and constantly changing document which is updated as the need presents itself.

ATTACHMENT 1

**STANDARD OPERATING PROCEDURE (SOP)
FOR
SITE SPECIFIC HEALTH AND SAFETY PLAN**

SECTION SOP-1

SITE SPECIFIC HEALTH AND SAFETY PLAN

1.0 PURPOSE

This section sets out a general outline to be followed in the preparation of a site-specific health and safety plan. Operations conducted in accordance with 29 CFR 1910.120, Hazardous Waste Operations and Emergency Response, are required to have a site-specific Health and Safety Plan (HASP). This outline is a minimum and may be modified or expanded to meet project needs.

2.0 SCOPE

This section applies to plans prepared for all Brown & Root Environmental projects.

3.0 GLOSSARY

◀See Appendix A to this Manual▶

4.0 RESPONSIBILITY

Project Management is responsible for securing the preparation of all site-specific health and safety plans by professional industrial hygiene/safety personnel. Written approval of the final plan by a Certified Industrial Hygienist is required.

Corporate Health and Safety Staff will review plans prepared by consultants, other BRE personnel, teaming partners, or subcontractors. The staff will prepare plans or provide guidance to others in the preparation of an acceptable plan upon request by a BRE Project Manager. The staff will conduct site assessments to determine compliance with the HASP.

5.0 GENERAL OUTLINE

This general outline is to be followed for BRE projects. The order of the outline may be changed to meet client or project requirements, however, the major elements must be included and discussed. Elements which are not part of the scope of the project should be

covered as "not applicable to this project". Contents of certain elements may be obtained from the Corporate staff. Additional elements may be added per project requirements.

SITE-SPECIFIC HEALTH AND SAFETY PLAN GENERAL OUTLINE

Table of Contents

Sections

1. Project Information

Project Name

Project Number

Date Prepared

Location

Prepared By

Approved By

Revision Number and Date

2. Site Description and Background

3. Entry Objectives or Work Plan

List and description of tasks to be performed

4. Emergency Information

Telephone Numbers of nearest hospital, ambulance service, fire department, police, utilities, poison control center

Written directions to nearest hospital

Map to nearest hospital

5. Site Control

State security measures to be taken, ie., three-zone system, fencing, signs, ID badges, daily sign in/out logs, etc.

6. Site Organization and Standard Operating Procedures

Titles and responsibilities of project management including an organizational chart

Health and Safety Standard Operating Procedures

Identification of Site Supervisor, Site Safety Officer, and Radiation Safety Officer

Emergency Medical Data Sheets

HASP Review

HASP Auditing

Posting the OSHA Posters

Stop Work Authority -

The SSO will exercise his or her authority and responsibility to stop any activity if the safety or health of site personnel is being compromised. Resumption of activities will occur only when the unsafe condition has been corrected.

Project Discipline

Any person found to be disregarding any provisions of this document will be subject to immediate removal from further site work by the Brown & Root Environmental Project Manager or his designee, using Brown & Root Environmental Safety Violation procedures included in ADM - 18.

Hazard Communication

General Procedures

General Safety Rules

Chemical Hazards

Fire Hazards

Inclement Weather Procedures

Safety and Emergency Equipment Location

First Aid Equipment

First Aid and CPR Trained Personnel

Accident Investigation and Reporting

Heat and Cold Stress

Excavations

Hot Work

Confined Space Entry

Spill Control

Manual Lifting
Illumination
Noise
Sanitation and Drinking Water
Site Appearance

7. Communications

8. Hazard Evaluation

Chemical Hazards with approximate contamination concentration or airborne levels, (if known), exposure limits, symptoms of exposure, and target organs

Physical Hazards

Biological Hazards

Radiological Hazards

Activity Hazard Analysis (based on tasks to be performed)

9. Personal Protective Equipment

Descriptions of equipment to be used for each level of PPE

PPE Selection Criteria

List of major tasks with initial PPE assignments

10. Decontamination Procedures

Personnel

Sampling equipment

Heavy equipment

11. Health and Safety Monitoring

Environmental monitoring plan

Personal monitoring plan

Radiological monitoring and personal dosimetry

12. Action Levels

List or table of real-time monitoring levels and response actions

13. Emergency Response Plan

Priority of actions in the event of site emergencies

- 14. Accident Prevention
 - Health and Safety Policy
 - Subcontractor Supervision
 - Fire Prevention and Protection
 - Mechanical Equipment Inspection
 - Safety Inspections
 - Accident Prevention Measures
 - Drill Rig Safety

15. Training Requirements

16. Medical Requirements

Appendix Contents

- A. Material Safety Data Sheets
- B. Emergency Medical Data Sheets*
 - Medical Qualifications
 - Subcontractor Medical Approval Form*
- C. Training Certificates
 - Site Specific Training Form
 - Safety Training Forms*
- D. Heat and Cold Stress *
- E. OSHA Posters
 - OSHA 200 Log*
 - Brown & Root Supervisors Accident Report Form 39062 (09-92)
 - First Report of Injury Form (varies by state) in Texas 39070 (08-91)
 - Safety Violation Procedures and Form*
 - Radiological Work Permit
- F. Alcohol & Drug Abuse Policy
- G. Monitoring Instrument Calibration and Data Logs*
 - Industrial Hygiene Monitoring Data Forms*
- H. Safety Inspection Forms*
 - Daily Excavation Inspection Report*
 - Heavy Equipment Inspection Forms*
 - Hot Work and Confined Space Entry Procedures *
 - Hot Work Permits 39061 (03-88)

Confined Space Permits 39036 (04-93)

- I. Weekly HASP Audit Forms*
- J. Decontamination Logs*
- K. Crane Operations*
- L. Drum Handling Procedures*

5.1 Appendix

Appendix contents marked with an asterisk (*) may be obtained from Corporate staff. Forms available from Brown & Root, Inc., (713) 676-3116, have the form order number listed beside them.

6.0 REFERENCES

NIOSH/OSHA/USCG/EPA Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities. 1985.

7.0 ATTACHMENTS

None