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R-49-7-92-6

FINAL
ABBREVIATED FIELD SAMPLING PLAN
SITE 8 - NITROGLYCERIN PLANT OFFICE
INDIAN HEAD, MARYLAND

PREPARED BY
HALLIBURTON NUS
ENVIRONMENTAL CORPORATION

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY
(CLEAN) PROGRAM

CONTRACT NUMBER N62472-90-D-1298
CONTRACT TASK ORDER NUMBER 0064

AUGUST 1992

HALLIBURTON NUS
Environmental Corporation

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ENVIRONMENTAL ACTION NAVY (CLEAN) PROGRAM

Submitted to:
Northern Division
Naval Facilities Engineering Command
10 Industrial Highway, MS #82
Lester, Pennsylvania 19113

and

Chesapeake Division
Environmental Engineering Branch, Code 18
Naval Facilities Engineering Command
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technologies and services for a cleaner and safer world

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1.0 INTRODUCTION AND PROJECT BACKGROUND

The Northern Division of the Naval Facilities Engineering Command has issued Contract Task Order Number 0064 (CTO 64) to HALLIBURTON NUS Environmental Corporation (HALLIBURTON NUS), under the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract No. N62472-90-D-1298. The activities under the CLEAN Contract are performed by a team of contractors comprised of HALLIBURTON NUS, the prime contractor, and SEC Donohue, Inc. and ENSR Consulting and Engineering, both team subcontractors. HALLIBURTON NUS is the lead technical firm for this project.

CTO 64 is for environmental work to support interim removal action at Site 8 - Nitroglycerin Plant Office (Site 8), at the Indian Head Division, Naval Surface Warfare Center, (IHDIVNAVSURFWARCEN or NSWC) in Indian Head, Maryland. IHDIVNAVSURFWARCEN is in the Chesapeake Division (CHESDIV) of the Naval Facilities Engineering Command. This Abbreviated Field Sampling Plan (AFSP) presents a plan to perform sampling and analysis work to define the extent of mercury contamination at Site 8.

1.1 PROJECT BACKGROUND

The NSWC contains approximately 3,423 acres and is located approximately 25 miles southwest of Washington, DC, in the northwestern section of Charles County, Maryland. It is located on a peninsula bounded by the Potomac River to the northwest and Mattawoman Creek to the south and southeast. As shown on Figure 1-1, Site 8 is located on the southeast side of the NSWC; water from Site 8 discharges into Mattawoman Creek.

Site 8 - Nitroglycerin Plant Office consists of the following: Building 766 - Former Nitroglycerin Plant Office laboratory, a 3-inch drain pipe from Building 766 to a manhole (Manhole A), a concrete pipe that conveys water from Manhole A under railroad tracks to a stream, approximately 1,300 feet of stream, and a tidal pond/swamp area. The tidal pond/swamp area is approximately 700 feet long and 200 feet wide; it includes both a marsh and open water area. The tidal pond outlets through a culvert under Noble Road and into Mattawoman Creek.

Building 766 was constructed in 1953. From 1953 to 1981, mercury used in laboratory tests in Building 766 was inadvertently disposed through drains and discharged into Site 8. Since 1981, the drains have been sealed and the practice discontinued. Environmental investigative work began at Site 8 after mercury contamination was discovered in 1981. In 1984, a contractor inadvertently broke

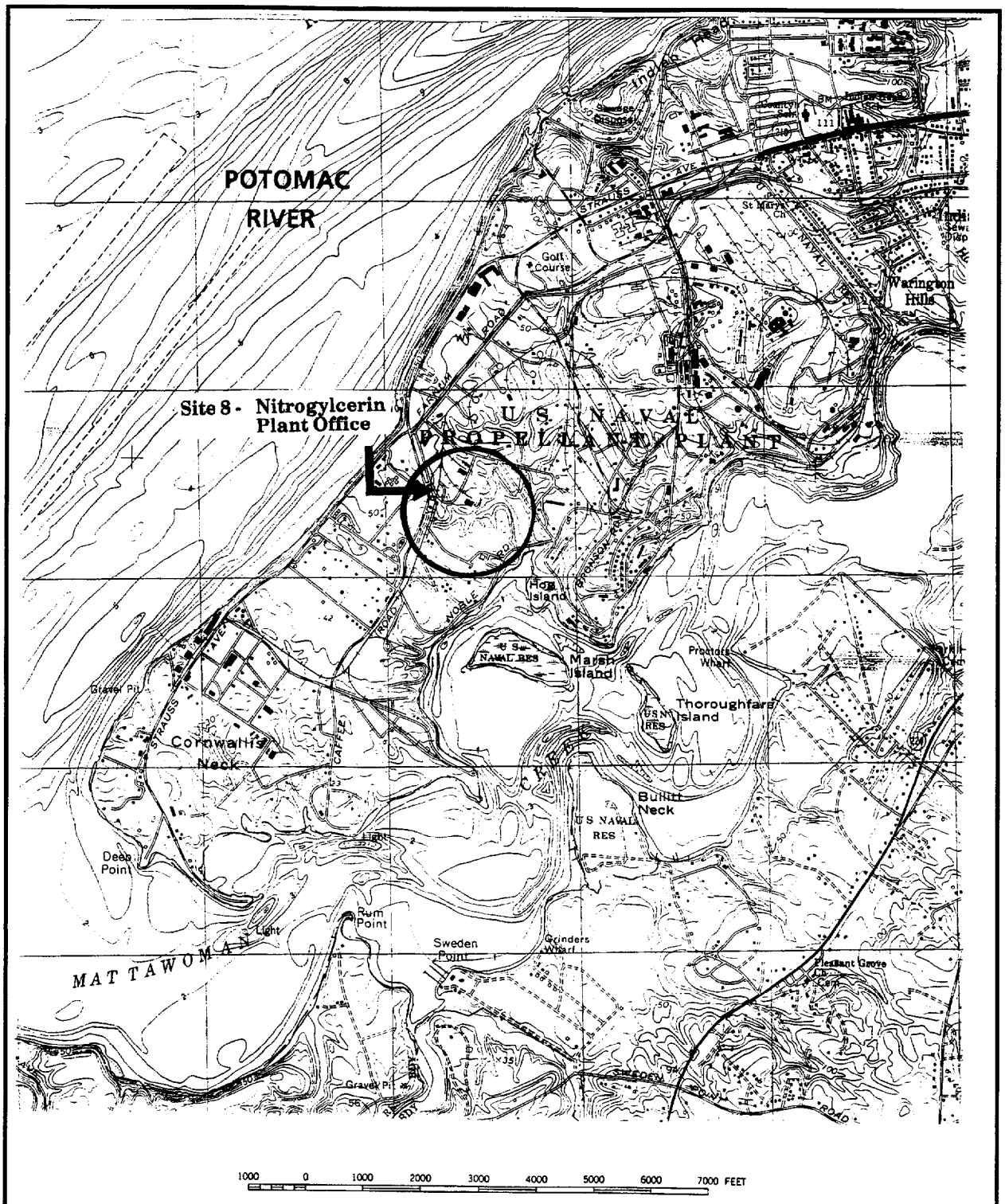

FIGURE 1-1

SITE LOCATION MAP
SITE 8 - NITROCLYCERIN PLANT OFFICE

HALLIBURTON NUS
Environmental Corporation

Source: 7.5 Minute USGS Quad Indian Head, MD-VA 1966 Photo Revised 1978

the drain pipe from Building 766 to Manhole A; mercury was observed leaking into the soil. The drain pipe, Manhole A, and approximately 200 drums (55-gallon capacity) of mercury contaminated soil were excavated and removed from the site. After the excavation was completed, the drain pipe, manhole, and soil were replaced; the removal and subsequent replacement action was performed with oversight from the enforcement staff of the state of Maryland. The previous environmental investigative work at Site 8 has indicated that sediments in the stream and tidal pond are contaminated with mercury; because of this contamination, interim removal action may be appropriate. However, before performing interim removal action, additional information is needed to determine the extent of mercury contamination.

1.2 OBJECTIVE AND SAMPLING STRATEGY

The objective of the work described in this Abbreviated Field Sampling Plan is to obtain sufficient data to define the extent of mercury contaminated sediment/soils and water at Site 8. The data will be used to either justify no further action or used to prepare an Interim Removal Action Plan.

A "phased" sampling and analysis strategy has been developed to achieve the project objective. During the initial phase (Phase I), samples will be collected throughout the site and analyzed to identify mercury contaminated areas. During Phase I, sampling will also be performed to determine background levels of mercury in the vicinity of Site 8. Based on the results of Phase I, additional sampling and analysis may subsequently be performed in Phase II to better define the extent of contamination, if necessary.

1.3 PLAN FORMAT

Section 1.0 of this Abbreviated Field Sampling Plan contains an Introduction and Background Information. Sections 2.0 and 3.0 describe the Procedures and Methods that will be used to implement the field work. Section 4.0 contains the Site-specific Sampling Plan. The Project Management Plan is included in Section 5.0, and a Schedule in Section 6.0. Additional support information is included in the appendices.

2.0 FIELD OPERATIONS

The field investigation to be performed at Site 8 - Nitroglycerin Plant Office (Site 8) will consist of the sampling sediments/soils (to a depth of approximately 30 inches) and surface waters to characterize the level of residual mercury contamination within Site 8, and to determine if there is any mercury currently discharging to the site. A maximum of 200 sediment/soil and 10 surface water samples plus additional QA/QC samples will be obtained for laboratory analysis.

The sampling effort will be performed in two phases. During Phase I samples will be collected to determine the overall nature and extent of mercury contamination, identify areas with elevated levels of mercury, identify potential sources of mercury contamination and determine background levels of mercury. Phase II sampling will be performed to refine the Phase I results and to address data gaps prior to preparation of site characterization report and a subsequent engineering evaluation/cost analysis (EE/CA) for the site. The results of Phase I will dictate the Phase II sampling program; depending on the results of Phase I, the Phase II sampling may not be implemented. Phase I will consist of approximately 156 sediment/soil and 6 surface water samples . The number of samples to be obtained during Phase II will depend upon the results of Phase I, but the total number of samples for Phases I and II will not exceed the maximum number of samples discussed above. This section (Section 2.0) describes the field operation procedures that will be used to implement the sampling program. Details of the sampling procedures are presented in Section 3.0 and details of the site-specific environmental sampling approach are presented in Section 4.0.

2.1 MOBILIZATION/DEMOBILIZATION

Following approval of this AFSP, HALLIBURTON NUS will begin mobilization activities. All field team members will review this AFSP including the Health and Safety Plan (HASP) and Quality Assurance Project Plan (QAPP) contained in the appendices. 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 coordinate the mobilization activities upon arrival at IHDIVNAVSURFWARCEN. The FOL will also make any equipment purchases required to conduct the field investigation. The equipment required for the field activities will be loaded in Pittsburgh and driven to the site by the FOL and a geologist. After field activities are completed, the FOL will demobilize the equipment and drive back to Pittsburgh.

2.2 SEDIMENT/SOIL SAMPLING

During Phase I, 152 sediment/soil samples will be obtained from Site 8 for total mercury analysis. In addition, four sediment/soil samples will be collected in the vicinity, and upgradient, of Site 8 to obtain information on background mercury levels. Therefore, a total of 156 sediment/soil samples will be collected and analyzed for mercury during Phase I. Site-specific sampling locations are described in Section 4.0. The Phase I sampling locations were chosen, and Phase II sampling locations will be chosen (if necessary) to determine the horizontal and vertical extent of mercury contamination; generally, sediment/soil samples will be collected from throughout the site.

Sediment/soil samples will be collected from all drainageways on the site downstream from where mercury was known to have been released into the environment (from the outlet of the drain pipe into Manhole A, through the site and into Mattawoman Creek). Sediment/soil sampling will generally be performed downstream to upstream. Sediment/soil samples will be collected from the following areas (listed downstream to upstream):

- Area downstream of Noble Road (Mattawoman Creek)
- Tidal pond/swamp area
- Stream
- Outlet of pipe under railroad tracks
- Manhole A Area (downstream of known source).

In addition, in order to identify other potential sources of contamination, sediment/soil samples will be collected from the following:

- Tributaries and spring upstream of known mercury source and contamination area.
- Tributary from Town Gut Landfill area.
- Manhole A Area (upstream of known source)

The four background sediment/soil samples will be collected at random locations upgradient of Site 8.

As described in Sections 3.0 and 4.0, generally two sediment/soil samples will be collected from each sampling location--one shallow and one deep. The shallow samples will be collected from the surface sediments at an approximate depth of 0 to 6 inches. The shallow sample will represent the more recently deposited sediment within the stream channel and may provide data on the mercury contamination in recently transported sediments. The deeper sediment/soil samples will generally be collected at a depth of 6 to 12 inches. Within the stream channel the deeper sediment/soil samples

will be a more "organic" sample (relative to the shallow) and should provide more historical information on contamination.

In addition, seven samples will be collected from a depth of approximately 30 inches in the tidal pond/swamp area. Deeper residual mercury contamination may be present in this area.

As stated earlier, Phase II sampling will only will be implemented to supplement information and address Phase I data gaps. A total of 36 additional sediment/soil samples may be collected and analyzed for mercury during the Phase II investigation. In addition, four sediment/soil samples may be analyzed for Target Analyte List (TAL) metals plus cyanide and four sediment/soil samples for Toxicity Characteristics Leaching Procedure (TCLP) metals. Those samples will be obtained from the locations determined to have the highest concentrations of mercury. Section 3.1.1 details the sampling procedures for the sediments/soils.

During field sampling, a lithologic description will be made of each sample and a complete sample log of each location will be maintained by the FOL. At a minimum, the HALLIBURTON NUS sediment/soil field sample log will contain the following information:

- Sample number and depth
- Soil density or cohesiveness
- Soil color and moisture
- Apparent depositional history (recent vs. residual)
- Relative organic content
- Unified Soil Classification System (USCS) material description and symbol

2.3 SURFACE WATER SAMPLES

Surface water drainage from Site 8 discharges into the Mattawoman Creek then flows into the Potomac River. A total of six surface water samples will be obtained from the onsite drainages during Phase I. One sample will be obtained every other day during the first eight days of sampling (for a maximum of four samples) from the downstream end of the outfall pipe from the tidal pond under Noble Road. If the outfall at Noble Road is tidally influenced, sampling will occur during the outgoing tide. In addition, one sample will be collected from the downstream end of the pipe discharging from Manhole A during the first and fourth day of sampling. The sampling location at the Noble Road outfall was chosen to determine the potential for surface water contamination leaving the site . The samples to be obtained from Manhole A will confirm that no additional mercury input is occuring from the Nitroglycerin Plant Office or associated piping.

All surface water samples will be analyzed for total and dissolved mercury. Section 3.1.2 details the sampling procedures for the surface waters.

2.4 SURVEYING

HALLIBURTON NUS will utilize a surveying subcontractor to accurately determine all sampling locations. Sampling locations will either be directly surveyed in the field or measured from control points (and the control points will be directly surveyed). The sampling locations and control points will be tied to the coordinates of the traverse survey monuments provided by IHDIVNAVSURFWARCEN. The surveyed points will be measured to within 0.10 feet. Control points will be used in areas too swampy to survey directly; control points will be installed on both shores of the tidal pond/ swamp during the sampling effort to delineate each sampling transect (one on each end of each transect). HALLIBURTON NUS will then collect sediment/soil samples directly in line between the two control points of the transect and measure the distance from the sampling location to one of the control points. The survey subcontractor will then survey both control points and HALLIBURTON NUS will illustrate the sampling locations on a map. The survey will also locate the centerline of the stream and obtain vertical elevations of the surveyed sampling points.

2.5 DECONTAMINATION

The equipment involved in field sampling activities will be decontaminated prior to, during, and at completion of the sampling activities.

The following decontamination steps will be taken:

- Potable water rinse
- Alconox or liquinox detergent wash
- Potable water rinse
- Nitric acid rinse
- Analyte-free water rinse
- Air dry

Field analytical equipment such as pH, conductivity and temperature instrument probes will be rinsed first with analyte-free water, then with the sample liquid. All decontamination fluids will be discharged onto the ground at the site. Nitric acid rinsate will be collected and neutralized prior to discharge.

2.6 WASTE HANDLING

All disposable equipment, tyveks and other investigative derived waste (IDW) will be collected by HALLIBURTON NUS and placed in plastic garbage bags. All bagged IDW will be disposed of by the Navy.

2.7 FIELD MEASUREMENTS

Certain field measurements will be recorded during sampling activities including temperature, pH and specific conductance. All instruments used in the field will be calibrated according to the procedures described below.

2.7.1 Equipment Calibration

The following monitoring instruments may be used during field activities:

- Temperature probe
- Specific conductance meter
- pH meter
- Jerome 411 Gold Film Mercury Analyzer

All instruments will be calibrated daily or according to the manufacturer's operating manual. Calibration will be documented on an equipment calibration log. A sample calibration log is attached in 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. Additional information about the Jerome 411 Gold Film Mercury Analyzer is contained in Appendix C - Site-Specific Health and Safety Plan.

2.7.2 Equipment Maintenance

Measuring equipment used in environmental monitoring or analysis and test equipment used for calibration and maintenance shall be controlled by established procedures. Measuring equipment shall have an initial calibration and shall be recalibrated at scheduled intervals against certified standards.

HALLIBURTON NUS maintains a large inventory of sampling and measurement equipment. In the event that failed equipment cannot be repaired, replacement equipment will be shipped to the site by overnight express carrier to minimize downtime.

2.8 RECORD KEEPING

In addition to chain-of-custody records, certain standard forms will be completed for sample description and documentation. These shall include sample log sheets (for soil, surface water, and sediment), and logbooks. These forms are contained in Appendix A.

A bound/weatherproof field notebook shall be maintained by each sampling event leader. All information related to sampling or field activities will be recorded in the field notebook. This information will include, but is not limited to, sampling time, weather conditions, unusual events, field measurements, descriptions of photographs, etc.

A bound/weatherproof site logbook shall be maintained by the FOL. The requirements of the site logbook are outlined in HALLIBURTON NUS SOP SA-6.3. This book will contain a summary of the day's activities and will reference the field notebooks when applicable.

At the completion of field activities, the FOL shall submit all field records, data, field notebooks, chain-of-custody receipts, sample log sheet, drilling logs, daily logs, etc. to the Project Manager.

2.9 HEALTH AND SAFETY

All field activities will be performed in accordance with the Site-Specific Health and Safety Plan contained in Appendix C of this AFSP.

3.0 SAMPLING PROCEDURES

This section describes the procedures for environmental sampling at Site 8 and sample handling requirements. Both sediment/soil and surface water samples shall be collected at Site 8.

3.1 SAMPLING METHODS

This section details the site-specific methodology to be used to obtain the environmental samples.

3.1.1 Sediment Sampling

Sediment/soil samples will be collected from throughout the site but primarily in the stream channel and tidal pond/swamp area. Generally, two samples will be collected from each sampling location--one shallow (0 to 6 inches deep) and one deep (6 to 12 inches). However, at some locations a third deeper (30 inches) will be collected, and at some locations only a shallow sample will be collected. In addition, some solid (sediment/soil) samples will be collected from Manhole A and pipes near Building 766. The sampling locations and the number of samples to be collected at each location are described in Section 4.0 of this AFSP.

Sediment/soil samples will be collected from the existing stream channel and the tidal pond/swamp area. Additional samples will be collected from the overbank deposits, abandoned stream channels (now inactive), tributary streams, and the area below Noble Road where the tidal pond discharges to Mattawoman Creek. Sediment/soil samples will be collected from a depth of 0 to 6 inches below the ground surface using either stainless steel or disposable plastic trowels and will be homogenized prior to filling the required sample containers. As discussed earlier, the intention of the sampling surface sediments in the stream bed is to sample the sediments that were most recently in transit; analysis of the surface samples will provide information on recent (compared to the deeper samples) contamination. These samples will typically be more coarse grained and will contain less organic matter than the deeper samples collected at depth of 6 to 12 inches. Sediment samples will be analyzed only for total mercury during Phase I. Additional sediment samples may be collected during Phase II depending upon the Phase I results. If stainless steel trowels are utilized during sampling, the trowels must be decontaminated between samples as described in Section 2.5. Sample handling and chain-of-custody requirements are addressed in Sections 3.2 and 3.3 respectively. All pertinent field data will be recorded using the appropriate sample log sheet (see HALLIBURTON NUS Standard Operating Procedure [SOP] GH-1.3 in Appendix B of this AFSP) and the field log book.

The sampling locations in the tidal pond/swamp area where sediment/soil samples are to be collected at a depth of 30 inches will be collected by pushing a section of hollow 2-inch ID PVC pipe into the bottom of the swamp approximately 36 inches. The pipe will be left in place for several minutes, rotated two to three turns with a pipe wrench, capped with an air tight lid, and slowly pulled out of the swamp bottom. The cap will be removed from the pipe and the sample recovery will be measured from the top. The sample will then be driven out of the pipe into a stainless steel bowl. Discrete increments of the sample (such as 30 inches to 36 inches) will be segregated and homogenized prior to filling the required sample containers. If it is not physically possible to push the PVC pipe 36 inches into the sediment, a metal cap and sledge hammer, steel pipe or other device may be used to collect the deeper sample or the sample may be collected from a shallower depth.

Sediment/soil samples in tidal pond areas that are not accessible by foot will be collected by HALLIBURTON NUS in a boat provided by the Navy. The HALLIBURTON NUS field sampling team will use the 2-inch ID PVC pipe to collect samples in water up to 30 inches deep. Boards (approximately 18 inches x 48 inches) or plastic snow fencing may be used to provide access to sampling locations to collect samples from muddy/swampy areas that are not accessible by boat or by walking normally.

Where practical, sediment/soil sampling locations will be marked in the field by a wooden stake or flagging. Within the tidal pond/swamp area and area downstream of Noble Road the sampling locations will be measured from control points. The sampling locations and control points will later be surveyed and located in accordance with the coordinate system shown on the site map contained in Section 4.0. All sampling locations will be subsequently illustrated on a site sampling map.

Sediment/soil samples from the lining of the pipes will be collected by scraping the lining/accumulated material from the bottom of the pipe with a stainless steel trowel and collecting it in a sample jar. The sample to be collected at 10 feet from one end of the pipe will be collected with a sampling/scraping device at the end of a long pole. A sample of the material at the bottom of the manhole will be collected with a stainless steel trowel, stainless steel bucket, or other device at the end of a long pole.

3.1.2 Surface Water Sampling

During Phase I surface water samples will be obtained from two locations within Site 8. One location is the outfall of the tidal pond/swamp area into Mattawoman Creek (located on the downstream side of Noble Road). The second location is at the outfall of Manhole A. Samples will be obtained by using the direct fill method of sample acquisition. The sample bottle (unpreserved) will be placed in the direct flow of water with the sample bottle mouth pointed directly up stream. If there is not enough water

flowing to allow this method, or for pre-preserved sample bottles, a stainless steel sampling pail will be used. The pail will be decontaminated between sample locations as described in Section 2.5. Surface water sampling will be conducted in accordance with HALLIBURTON NUS SOP SA-1.2.

In addition, field measurements will be obtained on the surface water samples during sample collection. These field measurements are:

- pH
- Specific conductance
- Temperature

Color and turbidity shall also be noted on the sample log form for each surface water sample. Procedures for obtaining these field measurements will be in accordance with HALLIBURTON NUS SOP SF-1.1.

All surface water samples will be analyzed for total (unfiltered) and dissolved (filtered) mercury. Dissolved mercury analysis requires the samples to be field filtered through a 0.45 filter immediately after sampling. Surface water samples will be poured directly from the stainless steel sampling pail into the appropriate sample bottles for analysis. For those samples requiring filtering, the initial sample bottle will be unpreserved. Once filtered, and for those samples undergoing analysis for total mercury, the surface water samples will then be preserved with HNO_3 to a pH <2, as specified in Section 4.0.

3.2 SAMPLE HANDLING

Sample handling includes the field-related considerations concerning the selection of sample containers, preservatives, allowable holding times and analysis requested. In addition, sample identification, packaging and shipping will be addressed.

The EPA User's Guide to the Contract Laboratory Program (EPA, December 1986), and the Federal Register (EPA, October 26, 1984) address the topics of containers and sample preservations. A summary of the site-specific sample handling requirements are contained in Section 4.0.

3.2.1 Sampling Identification System

Each sample collected will be assigned a unique sample tracking number. The sample tracking number will consist of a three-segment, alpha-numeric code that identifies the sample medium and location,

sample depth or sampling round, and QA designation, if required. Other pertinent information regarding sample identification will be recorded in the field log books.

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

(AANN)	--	(NN/NN) or (NN)	--	(A)
Medium & Location		Sample Depth (Sediment/Soil) or Sampling Round (Surface Water)		QA Designation

Character Type:

A = Alpha
N = Numeric

Medium:

SW = Surface water
SS = Soil/sediment

Sample Location:

Sample location number

Sample Depth or Sampling Round:

For sediment/soil samples = Top of sample depth/bottom of sample depth (inches).
For surface water samples = Round of sampling (Example: first sample from a location is 01, second round is 02...etc.)

QA Sample Designation:

D = Duplicate
E = Equipment rinsate blank
F = Field blank

For example, a sediment sample collected from location 24 at a depth of 6 to 12 inches would be designated as:

SS24-06/12

A rinsate blank for that location would be:

SS24-E

The third surface water sample and its duplicate collected from location 02 would be:

SW02-03 and SW02-03-D

Information regarding sample labels and tags to be attached before shipment to a laboratory is contained in of the HALLIBURTON NUS SOP SA-6.1.

3.2.2 Sample Packaging and Shipping

Samples will be packaged and shipped in accordance with HALLIBURTON NUS SOP SA-6.2. The FOL will be responsible for completion of the following forms:

- Sample Labels
- Chain-of-Custody Forms
- Appropriate labels applied to shipping coolers
- Chain-of-Custody Labels

It is anticipated that the laboratory to be used for the analytical work will provide delivery of sample bottles and pickup of samples on a daily basis.

3.3 SAMPLE CUSTODY

Custody of samples must be maintained and documented at all times. Chain-of-custody begins with the collection of the samples in the field. HALLIBURTON NUS SOP SA-6.1 provides a description of the chain-of-custody procedures to be followed. A sample chain-of-custody form is contained in Appendix A.

3.4 QUALITY CONTROL SAMPLES

In addition to regular calibration of field equipment and appropriate documentation, field Quality Control (QC) samples will be collected or generated during environmental sampling activities. QC samples include field duplicates, field blanks, and equipment rinsate blanks. Site-specific information on the type and number of required QC samples is presented in Section 4.0 of this AFSP. Each type of field QC sample is defined as follows:

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

- Equipment Rinsate Blanks - Equipment rinsate blanks are obtained under representative field conditions by running analyte-free water through sample collection equipment (trowel, shover, pail, etc.) after decontamination and placing it in the appropriate sample containers for analysis. Equipment blanks will be used to assess the effectiveness of decontamination procedures. Equipment blanks will be collected for each type of non-dedicated sampling equipment used and will be submitted at a frequency of one per day per media. Equipment blanks however will only be analyzed every other day. Those not analyzed will be retained by the laboratory until completion of field activities. It will be the responsibility of the FOL to communicate to the laboratory whether an equipment blank is, or is not, to be analyzed as stated above. Equipment blanks for a solid matrix (soils and sediments) will be analyzed for total mercury only. Equipment blanks for surface water samples will be analyzed for total and dissolved mercury.

- Field Blanks - Field blanks are obtained by sampling the potable and analyte-free water used for decontamination during the field investigation. Field blanks will be used to confirm the effectiveness of decontamination procedures, and to determine if the analyte-free water may be contributing to sample contamination. Field blanks will be collected and submitted at a frequency of one per sampling event per media.

4.0 ENVIRONMENTAL SAMPLING

A maximum of 210 environmental samples (200 sediment/soil and 10 water) plus QA/QC samples may to be collected during field sampling activities; field sampling will be performed in a phased manner. One hundred fifty-six (156) sediment/soil samples and six (6) surface water samples are proposed to be collected in Phase I and analyzed for mercury. Based on the results of the Phase I analysis, additional samples may subsequently be collected in Phase II to further define the nature and extent of contamination, if necessary. The site-specific sampling plan is described in the following sections.

4.1 INITIAL PHASE I SAMPLING

All samples collected during Phase I will be sent to an offsite laboratory for rapid turnaround mercury analysis. Sediment/soil samples will be analyzed for total mercury on a dry weight basis and surface water samples will be analyzed for both total and dissolved mercury. The actual moisture content of each sediment/soil sample will also be determined and provided with the analytical results. Verbal results will be provided within 24 or 48 hours (as specified) after they are received at the laboratory.

4.1.1 Sediment/Soil Sampling

The project area and initial Phase I sampling locations are shown on Figure 4-1. The proposed Phase I sediment/soil sampling is summarized in Table 4-1. As shown in Table 4-1, sediment/soil samples will be collected from 10 different areas of Site 8. In addition, background sediment/soil samples will be collected in the vicinity of Site 8. The sampling plan for each of the different areas is summarized as follows:

- Downstream of Noble Road (8 samples) - Sediment samples will be collected from four different sampling locations downstream of the tidal pond outlet pipe in Mattawoman Creek. Sampling locations will be spaced approximately 100 feet apart beginning near the downstream end of the outlet pipe under Noble Road. Two sediment samples will be collected at each sampling location - one from surface sediments and one from a depth of approximately 6 inches to 12 inches.

- Tidal Pond/Swamp Area (49 samples) - Sediment samples will be collected from seven transects located throughout the tidal pond/swamp area. The first transect will be approximately 10 feet from downstream edge of the pond and parallel to Noble Road. The

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0060I01X
Box 3
FIG. 4-1

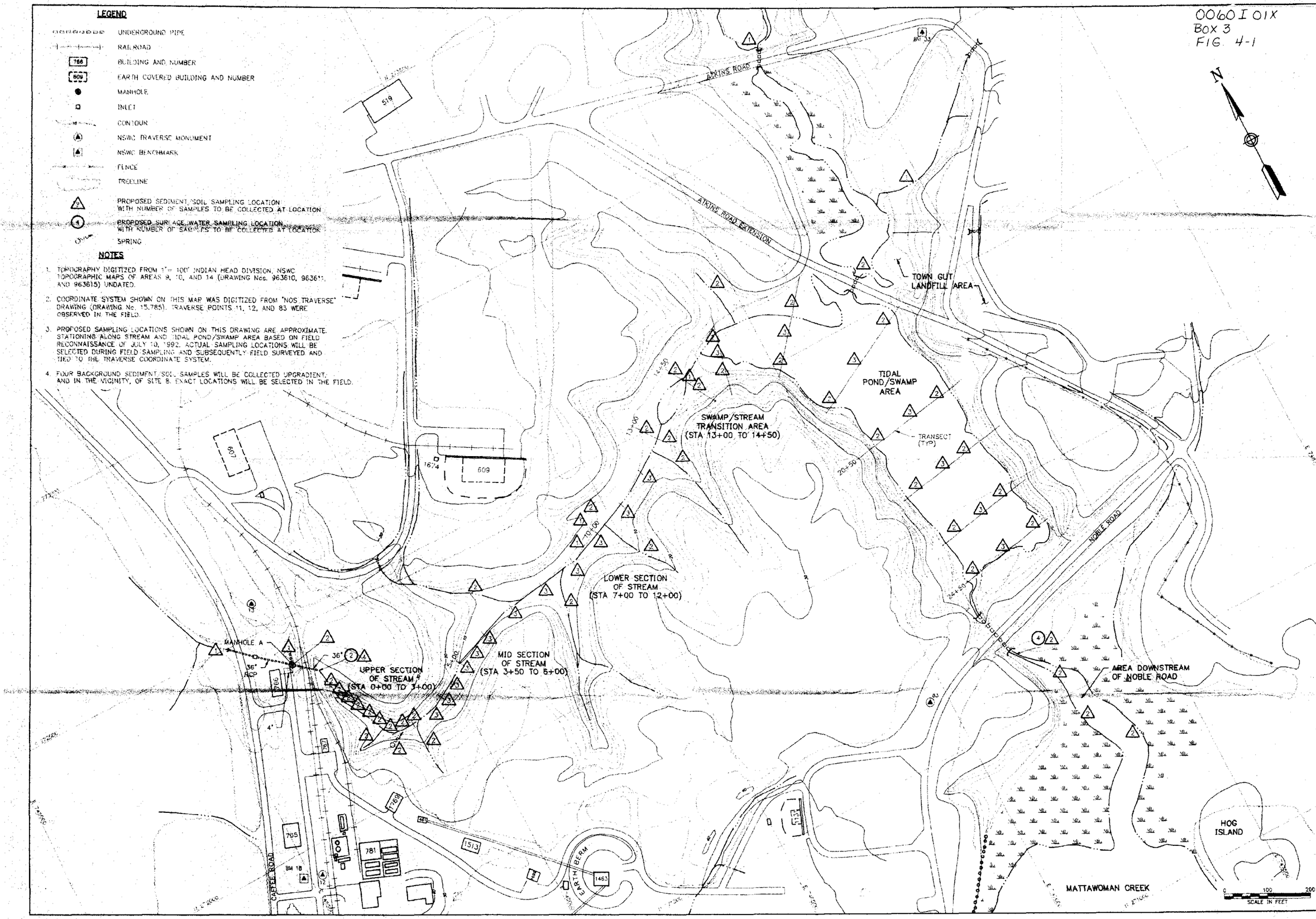


TABLE 4-1

PHASE I SEDIMENT/SOIL SAMPLING

Area	Sampling Summary	Sampling Area Preliminary Stationing(1)	Approximate Length of Area (Ft)	Number of Sediment/Soil Samples
Downstream of Noble Road	Collect sediment samples downstream of tidal pond in Mattawoman Creek	None	300	8
Tidal Pond/Swamp Area	Collect sediment samples from transects throughout tidal pond/swamp area	16 + 00 to 24 + 50	950	49
Swamp/Stream Transition Area	Collect sediment samples at area where stream outlets into swamp	13 + 00 to 14 + 50	275	9
Lower Section of Stream	Collect three sediment samples at 100 feet intervals along current stream channel. Collect two additional in old stream channel	7 + 00 to 12 + 00	700	20
Mid Section of Stream	Collect three sediment samples at 50 feet intervals along stream channel	3 + 57 to 6 + 00	375	18
Upper Section of Stream	Collect two sediment samples at 33 feet intervals along stream channel	0 + 28 to 2 + 98	325	18
Tributaries and Spring	Collect two samples from each of eight stream tributaries and one from the spring near the stream	None	NA	18
Tributary from Town Gut Landfill Area	Collect two sediment samples from back of Tidal Pond/ Swamp Area above Atkins Road Extension and one from each major tributary.	None	NA	4
Outlet of Pipe Under Railroad Tracks	Collect two sediment samples from pool area immediately downstream of pipe outlet. Collect two samples of sludge lining downstream end of pipe	None	NA	4
Manhole A Area	Collect sediment sample from bottom of Manhole A, collect sample from 3-inch pipe discharging from Building 766, and collect sediment samples from inlet areas of the two pipes that discharge into Manhole A	None	NA	4
Background	Collect four sediment/soil samples from areas in the vicinity, and upgradient of Site 8 to determine background mercury levels.	None	NA	4
	TOTAL	---	---	**156**

(1) Sampling area preliminary stationing delineated during field reconnaissance on July 10, 1992 and shown on Figure 4-1. Actual location of sampling points will be selected during field sampling activities and subsequently located by field surveying.

second transect will be approximately 100 feet from the first. Each succeeding transect will be approximately 150 feet apart. The pond/swamp area will be visually divided into thirds at each transect, and one sampling location will be selected in each third (west, central, and east). Two sediment samples will be collected from each west and east sampling location - one from the surface and one from a depth of approximately 12 inches. Three sediment samples will be collected from each central sampling location - one at the surface, one at a depth of approximately 12 inches, and one at a depth of approximately 30 inches. Seven sediment samples will be collected from each transect.

- Swamp/Stream Transition Area (9 samples) - Sediment samples will be collected from two different transects (identified on Figure 4-1 as Station 13 + 00 and 14 + 50) in the swamp area at the back of the tidal pond where the stream transitions into the swamp. At Station 14 + 50, one sample will be collected from the surface sediments in the defined stream channel and two sediment samples - one at the surface and one from a depth of 6 inches to 12 inches - will be collected on each over bank (at approximately 35 feet on either side of defined channel). At Station 13 + 00, two sampling locations will be selected in the swamp area approximately 40 feet apart. Two sediment samples will be collected from each sampling location - one from the surface and one at a depth of 6 inches to 12 inches.

- Lower Section of Stream (20 samples) - Sediment samples will be collected from six sampling stations located approximately 100 feet apart. Generally, three samples will be collected from each location. Two samples will be collected from the stream sediments - one from the surface and one from the more organic sediments located at a depth of 6 inches to 12 inches. A third sample will be collected from the flood plain over bank sediments at each sampling station approximately 10 to 20 feet from the stream channel. In addition, at approximately Stations 9 + 50 and 10 + 00, two sediment samples (one from each location) will be collected from the abandoned stream channel located north of the existing channel.

- Mid Section of Stream (18 samples) - Sediment samples will be collected from six sampling stations located approximately 50 feet apart. Three samples will be collected from each station - one from the surface sediments of the stream channel, one from the more organic sediments of the stream channel (approximately 6 inches to 12 inches deep), and one from the flood plain over bank deposits approximately 8 to 15 feet from the stream channel. The actual sampling locations will be identified in the field at sediment deposit areas.

- Upper Section of Stream (18 samples) - Sediment samples will be collected from nine sampling locations approximately 33 feet apart within the stream channel. Two samples will be collected from each location - one from the surface sediments within the stream channel and one from the more organic sediments located approximately 6 inches to 12 inches deep also within the stream channel.

- Tributaries and Spring (18 samples) - Two sediment samples will be collected from each tributary and major valley discharging into the main stream. As shown on Figure 4-1, there are three tributaries on the west side of the stream and five tributaries on the east. An additional sampling location will be at the spring adjacent to the stream near Station 2 + 50. Two sediment samples will be collected at each sampling location - one from the surface sediments and one from the more organic sediments located at an approximate depth of 6 inches to 12 inches.

- Tributary from Town Gut Landfill Area - (4 samples) - Two sediment samples will be collected from the Tidal Pond/Swamp Area in the main tributary from Town Gut Landfill Area above Atkins Road Extension - one will be collected from surface sediments and one from a depth of approximately 6 inches to 12 inches. Additional samples will be collected from each of the two major subtributaries. A composite sample will be collected from a depth of 0 inches to 6 inches at each location.

- Outlet of Pipe Under Railroad Tracks (4 samples) - Two sediment samples will be collected from the pool area immediately downstream of the pipe that carries flow from Manhole A under the railroad tracks to the upper section of the stream. Two additional samples will be collected from the sludge that lines the bottom of the downstream end of the pipe - one sample will be collected from the last 24 inches of the pipe and one sample will be collected approximately 10 feet from the downstream of the pipe.

- Manhole A Area (4 samples) - Two samples will be collected from within Manhole A - one from the sediments at the bottom of the manhole and one from the lining of the 3-inch pipe that discharges into the manhole from Building 766. If no sample can be collected from the 3-inch pipe, an alternate sample will be collected from the sludge at the bottom of the upstream end of the concrete pipe that discharges under the railroad tracks or a second sediment sample from the bottom of the manhole. One sample will be collected from the sediments at the upstream end of the 12-inch concrete pipe that discharges into Manhole A from the north and one sediment sample will be collected from the stream on the west side

of Caffee Road that discharges into the pipe that carries the flow under the road and into Manhole A.

- Background Samples (4 samples) - Sediment/soil samples will be collected from four different locations in the vicinity, and upgradient, of Site 8. One sample will be collected from each location. The exact locations will be selected in the field and are anticipated to include near surface soil and sediment samples from areas within one-half mile of Site 8.

4.1.2 Surface Water Sampling

During Phase I, surface water samples will be collected from the two sampling locations shown on Figure 4-1 in accordance with the procedures summarized in Table 4-2. As shown in Table 4-2, surface water samples will be collected from both the tidal pond and the Manhole A outlet pipe. A water sample will be collected from the tidal pond outlet pipe every other day during the first eight days of sampling (4 samples), and a surface water sample will be collected from the Manhole A outlet pipe during the first and fourth day of sampling. Each surface water sample collected will be divided into two samples in the field. One sample will be filtered in the field and subsequently analyzed for dissolved mercury in the laboratory; the other sample will not be filtered and will be analyzed for total mercury.

4.2 SUBSEQUENT SAMPLING FOR MERCURY

It is anticipated that the Phase I sampling for mercury will be performed over a 6- to 7-day time period. Verbal analytical results of the samples collected during the first few days will be received as the Phase I sampling is completed. Based on the results of the Phase I analysis additional sampling (Phase II) may be performed to further define the extent of mercury contamination.

A Phase II sampling plan (if necessary) will be based on the results of Phase I. Additional samples may be collected from areas where elevated levels of mercury are detected. The actual elevated levels will be determined based on the results of Phase I; however, at this time, it is assumed that the elevated levels will be in range of 2.0 to 5.0 mg/kg (ppm) for sediment/soil samples and 10 ug/L (ppb) for water samples. Additional samples may be collected from these areas to define the extent of contamination above the elevated levels. "Elevated levels" of mercury as described in this AFSP are the proposed minimum levels of mercury contamination proposed to be defined by the field sampling activities. They are not action and/or cleanup levels.

If elevated levels of mercury are detected in the sediment/soil samples, additional samples may be collected to determine the horizontal and vertical extent of the contamination in the sediment/soils,

TABLE 4-2

PHASE I SURFACE WATER SAMPLING

Location	Location Description	Sampling Summary	No. of Samples	No. of Analysis(1)
Tidal Pond Outfall	Downstream end of pipe under Noble Road	Collect 1 water sample every other day (prior to upstream sediment sampling) during first 8 days of sampling. If Outfall is actually tidally influenced, sampling will occur during outgoing tide.	4	8
Manhole A Outlet	Downstream end of pipe from Manhole A under railroad tracks	Collect 1 water sample during the first and fourth day of field sampling	2	4
		TOTAL	6	12

(1) Each surface water sample will be analyzed for both total and dissolved mercury.

and/or a water sample collected to determine if water is being impacted. If an elevated level of mercury is identified in a Phase I stream sampling location, Phase II samples may be collected as follows:

- Sediment/soil samples upstream and downstream of the "Hot" spot location (to further define the extent of contamination).
- Soil samples from over bank areas on each side of the stream (to determine width of contamination).
- Deeper sediment/soil samples (to determine depth of contamination).
- Surface water sample (to determine if surface water is being impacted.)

If a surface water sample contains elevated levels of mercury, additional water samples may be collected to identify a source area.

4.3 TAL/TCLP METAL ANALYSIS

Sediment/soil that has relatively high concentrations of mercury may require removal and offsite disposal. Offsite disposal of sediment/soil will require additional analysis to classify the sediment/soil and to verify that there are not other contaminants in the material. Therefore, during Phase II, some environmental samples that contain high concentrations of mercury (and may be subsequently excavated and disposed offsite) may be analyzed for Target Analyte List (TAL) metals plus cyanide (23 metals) and Toxic Characteristic Leaching Procedure (TCLP) metals (eight metals including mercury). These analyses may be performed on up to four samples; and will aid in the classification of the waste. However, additional analysis may be required prior to actual offsite disposal of the material.

4.4 ANALYTICAL SUMMARY

Samples collected at the site will be submitted for the laboratory analyses presented in Tables 4-3 and 4-4. These tables indicate the analytical parameters, preservation methods, holding times, bottle requirements, and analytical methods for each sample.

TABLE 4-3

ANALYTICAL PROGRAM SUMMARY

Parameter	Method	Detection Limit	Sample Matrix	Estimated No. Samples	Equipment Rinsate Blanks(1)	Field Blanks(2)	Duplicates(3)	Total Samples
Mercury (dry weight basis)	SW 846/7471	0.1 mg/kg (ppm)(4)	Sediment/Soil	192	5	2	20	219
Mercury(5) (Total)	SW 846/7470	0.2 µg/L (ppb)	Surface Water	10	2	1	1	14
Mercury(6) (Dissolved)	SW 846/7470	0.2 µg/L (ppb)	Surface Water	10	2	0	1	13
TAL Metals(7) plus cyanide	6010/7000 CLP/SOW 3/90	NA	Sediment/Soil	4	0	0	1	5
TCLP Metals(8)	1311 6010/7000	NA	Sediment/Soil	4	0	0	0	4
			TOTALS	220	9	3	23	255

(1) Equipment Rinsate Blank - Samples obtained by pouring analyte-free water over sample collection equipment after decontamination. Assesses the effectiveness of field decontamination procedure. Obtained at a frequency of 1/day/media/analysis but analyzed every other day unless positive detection are recorded. Number of samples reflects the number of actual laboratory analyses performed.
(2) Field Blank - Samples consisting of the source water used in decontamination. Obtained at a frequency of 1/event/media.
(3) Duplicates - A single sample split into two portions during a signal act of sampling. Assess the overall precision of the sampling and analysis program. Obtained at a frequency of 10 percent of the number of samples.
(4) Detection Limit for Sediment/Soil samples on a wet weight basis.
(5) Total - For the determination of total mercury the sample is not filtered before acidification.
(6) Dissolved - For the determination of dissolved mercury the sample will be field filtered through a 0.45 micron filter before acidification.
(7) TAL Metals - Target analyte list of 23 metals.
(8) TCLP Metals - Toxicity Characteristics Leaching Procedure of 8 metals (including mercury).

TABLE 4-4

SUMMARY OF ANALYSIS,BOTTLE REQUIREMENTS, PRESERVATION REQUIREMENTS AND HOLDING TIMES

Media	Analysis	Number of Samples	Number of Containers per Sample	Container Type	Preservation Requirements	Holding Times
Sediment/Soil	Mercury (Total Recoverable)	212	1	4 oz. wide mouth glass jar	Cool to 4°C	28 days
Surface Water(1)	Mercury (Total Recoverable)	11	1	500 ml polyethylene bottle	HNO_3 to pH<2; Cool to 4°C	28 days
	Mercury (Dissolved)	11	1	500 ml polyethylene bottle	Field Filtered; HNO_3 to pH<2; Cool to 4°C	28 days
Sediment/Soil	TCL Metals plus Cyanide	5	1	8 oz. wide mouth glass jar	Cool to 4°C	6 months
Sediment/Soil	TCLP Metals	4	1	8 oz. wide mouth glass jar	Cool to 4°C	6 months
Equipment Rinsate and Field Blanks	Mercury (Total Recoverable)	10	1	500 ml polyethylene bottle	HNO_3 to pH<2; Cool to 4°C	28 days
	Mercury (Dissolved)	2	1	500 ml polyethylene bottle	Field Filtered; HNO_3 to pH<2; Cool to 4°C	28 days
	TOTAL	255	-	-	-	-

(1) All duplicate water samples will be collected in four bottles - one will be the actual sample, one will be the duplicate (field QC), one will be used for matrix spike analysis (Lab QC), and one will be used for matrix spike duplicate analysis (Lab QC).

5.0 PROJECT MANAGEMENT PLAN

HALLIBURTON NUS will perform this project with support from the Navy. This section of the Abbreviated Field Sampling Plan describes the project organization, Navy contacts and support, and a project contingency plan.

5.1 PROJECT ORGANIZATION

The proposed project organization is shown on Figure 5-1. The project will be staffed with personnel from the Pittsburgh office of HALLIBURTON NUS. Support personnel from other offices may be utilized on an as-needed basis.

Mr. Anthony P. Klimek, P.E. will be the project manager for CTO 64 and will be the primary point of contact. He will manage the day-to-day aspects of this project and will be responsible for cost and schedule control as well as technical performance. Mr. Klimek is a registered professional engineer in the state of Maryland and has more than 11 years of experience on civil and environmental engineering projects.

Mr. Andrew Kendrick will be the project geologist. He will provide technical continuity through development of the field sampling plan, field work, and preparation of the site characterization report. Mr. Terry Rojahn will be the Field Operations Leader (FOL).

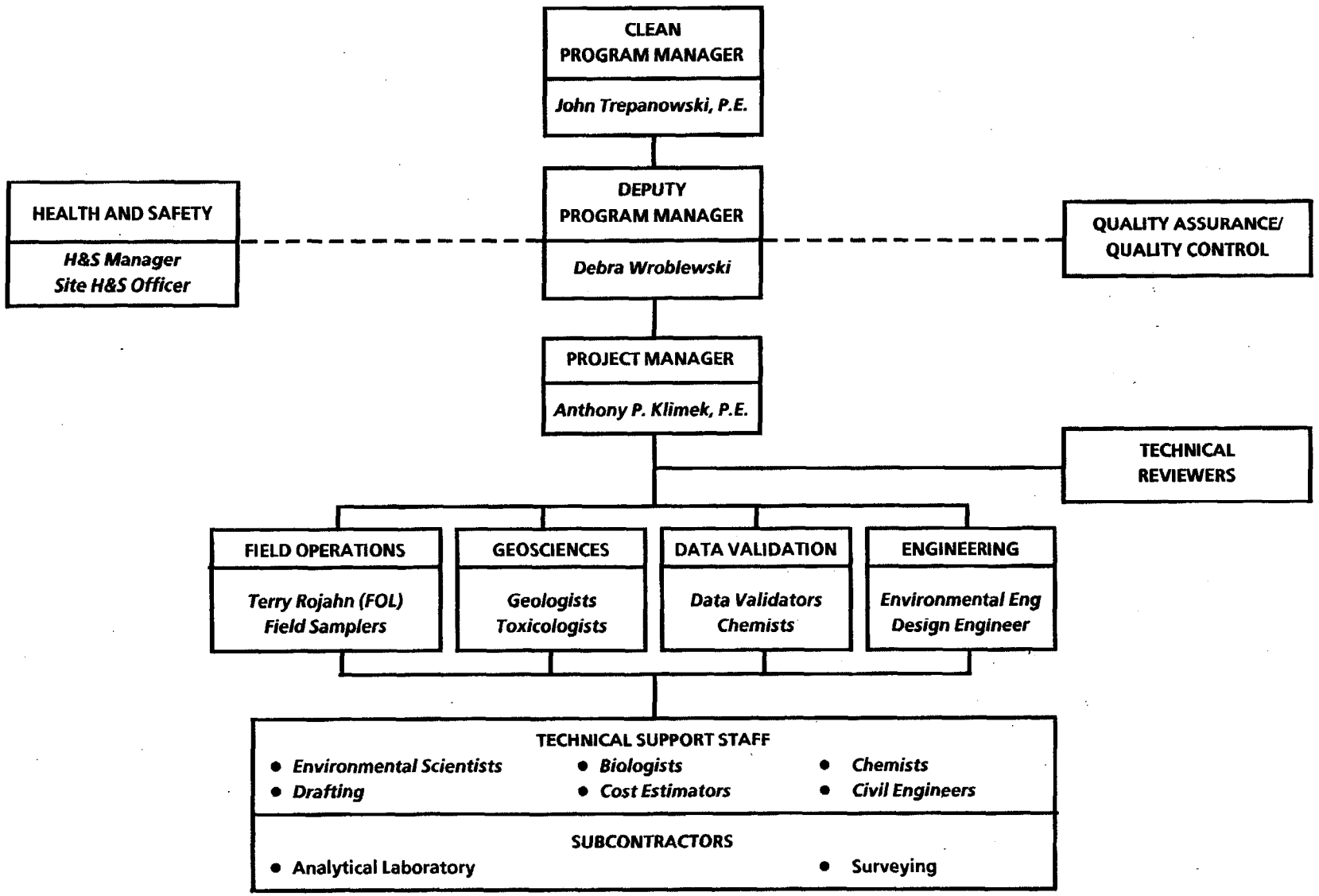
As shown on Figure 5-1, other technical expertise will be provided as required by the project. Two subcontractors - an analytical laboratory, and a surveyor will be used to implement this project.

5.2 NAVY SUPPORT

Mr. Paul Berkman will be the CHESDIV Remedial Project Manager (RPM). He will be the primary Navy point of contact for the project. All project activities, including reporting and field activities, will be coordinated through Mr. Berkman. Any changes in scope will be approved through Mr. Berkman prior to implementation.

FIGURE 5-1

PROJECT ORGANIZATION



Mr. Berkman may be contacted at the following address:

Mr. Paul Berkman, Code 1812
Chesapeake Division
Naval Facilities Engineering Command
Washington Naval Yard, Building 212
Washington, DC 20374-2121
(202) 433-3760

Mr. Shawn Jorgensen will be the primary point of contact at IHDIVNAVSURFWARCEN. All field work will be coordinated through Mr. Jorgensen; he will notify appropriate NSWC personnel (security, etc.) and make arrangements for equipment (boat and support equipment) that will be provided by the Navy. Mr. Jorgensen may be contacted at the following address:

Mr. Shawn Jorgensen, Code 0965
Indian Head Division
Naval Surface Warfare Center
Building D28
Indian Head, MD 20640-5000
(301) 743-6745

Throughout this project, Navy will provide the following support:

- Confirm the absence of underground utilities in the areas to be sampled and/or identify and flag underground utilities prior to the commencement of sampling activities. NOTE: This AFSP is based on the assumption that no digging and/or sampling permits will be required to implement the field sampling activities and no underground utilities will be impacted by the field sampling.

- Take custody of all investigative derived waste (IDW) and dispose of it according to applicable state and/or Federal regulations.

- Make available existing engineering plans, drawings, diagrams, aerial photographs, digitized map files, etc., to facilitate evaluation of the site.

- Make available all historical data, background geological and hydrogeological information, and previous investigation documents.

In addition, IHDIVNAVSURFWARCEN personnel will arrange to provide the following:

- A supply (e.g., garden hose) of potable water for equipment cleaning, etc.

- A temporary office area, equipped with a telephone for local and long distance telephone calls. HALLIBURTON NUS will pay for any long distance telephone calls from this phone.

- A row boat, two life preservers, and other associated equipment to obtain samples from the water-covered areas to be sampled.

5.3 CONTINGENCY PLAN

In the event major problems are encountered during field activities, the HALLIBURTON NUS Project Manager will be notified immediately, followed by the HALLIBURTON NUS Point of Contact and the CHESDIV RPM. HALLIBURTON NUS will then develop an alternate course of action and discuss it with the Navy. All alternate courses of action that impact the project and schedule and budget will be approved through the NSWC Point of Contact and the CHESDIV RPM before being enacted.

6.0 SCHEDULE

The proposed project schedule is shown on Figure 6-1. This schedule is contingent on the project proceeding as planned, with no changes in scope, no unforeseen difficulties encountered in the field or laboratory analysis of samples, or no increased review and/or approval times.

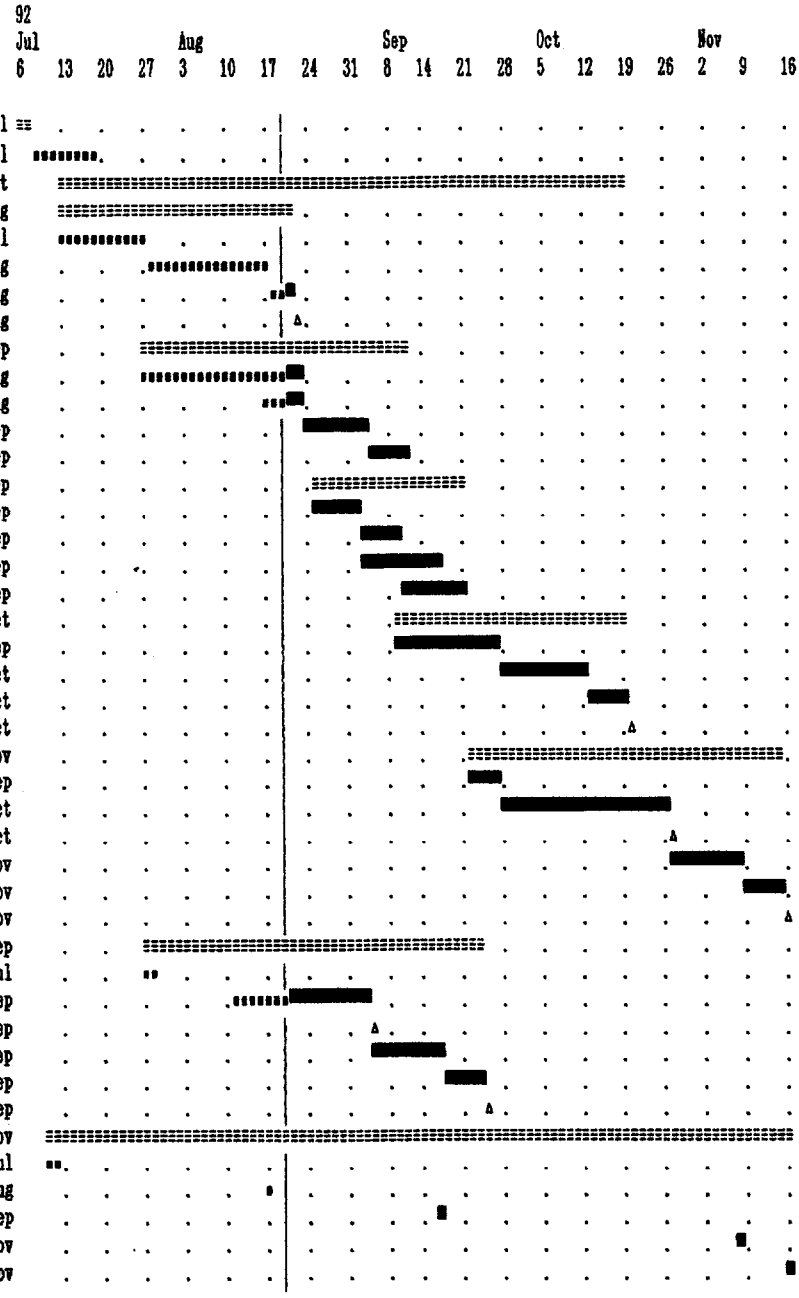
Figure 6-1 includes all aspects of work that HALLIBURTON NUS has been authorized to perform at Site 8 - Nitroglycerin Plant Office. As shown in Figure 6-1, the information collected during the field work will be used to prepare a Site Characterization Report. The Site Characterization report will subsequently be the basis to prepare an engineering evaluation/cost analysis (EE/CA). HALLIBURTON NUS will also prepare a Biomonitoring Plan for Site 8.

As shown in Figure 6-1, two (2) weeks of review time have been allotted for Navy review of Draft deliverables, and 1 week has been allotted for HALLIBURTON NUS to revise the deliverables and submit final versions of the reports. HALLIBURTON NUS will work closely with the Navy during development of the Draft documents and does not anticipate major comments from the Navy to finalize the documents. Increased (greater than 2 weeks) review times by the Navy and/or major comments on the Draft document will increase the project schedule.

FIGURE 6-1

PROJECT SCHEDULE

Task Name	Start Date	Duratn (Days)	End Date
+ 1.0 PROJECT IMPLEMENT. PLAN	11-May	40	7-Jul
2.0 DOCUMENT REVIEW	6-Jul	8	17-Jul
3.0 SITE CHARACTER. STUDY	13-Jul	70	19-Oct
3.1 WORK PLAN	13-Jul	29	20-Aug
3.1.1 DRAFT WP	13-Jul	11	27-Jul
3.1.2 NAVY REVIEW	28-Jul	15	17-Aug
3.1.3 FINALIZE WP	18-Aug	3	20-Aug
3.1.4 FINAL WP TO NAVY	21-Aug	0	21-Aug
3.2 FIELD INVESTIGATION	27-Jul	33	10-Sep
3.2.1 PROCURE SUBS	27-Jul	20	21-Aug
3.2.2 MOBILIZE	17-Aug	5	21-Aug
3.2.3 FIELD WORK	24-Aug	8	2-Sep
3.2.4 SURVEY SMP PTS	3-Sep	5	10-Sep
3.3 LAB ANAL & DV	25-Aug	19	21-Sep
3.3.1 QUICK Hg ANAL.	25-Aug	6	1-Sep
3.3.2 7-DAY HARD COPY	2-Sep	5	9-Sep
3.3.3 TCL & TCLP	2-Sep	10	16-Sep
3.3.4 DATA VALID	10-Sep	8	21-Sep
3.4 SITE CHAR. REPORT	9-Sep	29	19-Oct
3.4.1 DRAFT REPORT	9-Sep	13	25-Sep
3.4.2 NAVY REVIEW	28-Sep	11	12-Oct
3.4.3 FINALIZE RPT	13-Oct	5	19-Oct
3.4.4 FINAL SC TO NAVY	20-Oct	0	20-Oct
4.0 RE/CA	22-Sep	39	13-Nov
4.1 REVIEW PREV RE/CA	22-Sep	4	25-Sep
4.2 PREPARE DRAFT RE/CA	28-Sep	21	26-Oct
4.3 SUBMIT DRAFT RE/CA	27-Oct	0	27-Oct
4.4 NAVY REVIEW	27-Oct	9	6-Nov
4.5 FINALIZE RE/CA	9-Nov	5	13-Nov
4.6 SUBMIT FINAL RE/CA	16-Nov	0	16-Nov
5.0 BIOMONITORING PLAN	27-Jul	42	23-Sep
5.1 PRELIM SURVEY	27-Jul	2	28-Jul
5.2 PREPARE DRAFT	11-Aug	17	2-Sep
5.3 SUBMIT DRAFT	3-Sep	0	3-Sep
5.4 NAVY REVIEW	3-Sep	9	16-Sep
5.5 FINALIZE BIO PLAN	17-Sep	5	23-Sep
5.6 SUBMIT FIN. BIO PLN	24-Sep	0	24-Sep
6.0 MEETINGS	9-Jul	92	16-Nov
6.1 WP FIELD REVIEW MTG	9-Jul	2	10-Jul
6.2 TRC MEETING	17-Aug	1	17-Aug
6.3 BIO PLN REV MTG	16-Sep	1	16-Sep
6.4 RE/CA REVIEW MTG	6-Nov	1	6-Nov
6.5 TRC MEETING	16-Nov	1	16-Nov



Detail Task ===== Summary Task ***** Baseline
(Progress) ==== (Progress) >>> Conflict
(Slack) ===— (Slack) ..■ Resource delay
Progress shows Percent Achieved on Actual ▲ Milestone
---------- Scale: 8 hours per character ----------

REFERENCES

Initial Assessment Study, May 1983.

NACIP Confirmation Study, September 1985

NIRP Feasibility Study and Remedial Design, Task 2, Supplemental Site Characterization Report, December 1987.

NIRP Feasibility Study and Remedial Design, Task 3, Remedial Alternatives Evaluation Report, February 1988.

Draft Data Evaluation Report, November 1989.

Draft Mercury Speciation Study Report, July 1990.

Technical Memoranda, Draft Final, May 1991.

Interim Remedial Action, Final Bid Specification Document, June 1991.

Biomonitoring Work Plan, Draft Final, January 1992.

Engineering Evaluation and Cost Analysis Report, March 1992.

APPENDIX A

FORMS FOR FIELD ACTIVITIES

HALLIBURTON NUS
Environmental Corporation

SAMPLE LOG SHEET

☐ Spring
☐ Lake
☐ Stream
☐ Other _____

Page _____ of _____

Case # _____

By _____

Project Site Name _____ Project Site Number _____

NUS Source No. _____ Source Location _____

Sample Method:	Sample Data			
	pH	S.C.	Temp. (°C)	Color & Turbidity
Depth Sampled:				
Sample Date & Time:				
Sampled By:				
Signatures:				

Type of Sample

☐ Low Concentration
☐ High Concentration
☐ Grab
☐ Composite
☐ Grab - Composite

Analysis:	Preservative

	Organic	Inorganic
Traffic Report #		
Tag #		
AB #		
Date Shipped		
Time Shipped		
Lab		
Volume		

SAMPLE LOG SHEET

HALLIBURTON NUS
Environmental Corporation

- ☐ 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:			
Signature(s):			
Type of Sample			
☐ Low Concentration			
☐ High Concentration			
☐ Grab			
☐ Composite			
☐ Grab - Composite			

Sample Data	
Color	Description: (Sand, Clay, Dry, Moist, Wet, etc.)

Analysis:	PRESERV. :

Observations / Notes

	Organic	Inorganic
Traffic Report #		
Tag #		
AB #		
Date Shipped		
Time Shipped		
Lab		
Volume		

HALLIBURTON NUS
Environmental Corporation

EQUIPMENT CALIBRATION LOG

Instrument (Name/Model No./Serial No.): _____

Manufacturer _____ Date Purchased _____

Calibration Date	Initial Settings	Standard/Gas Used	Procedure	Adjustments Made	Final Settings	Signature	Comments

HALLIBURTON NUS

CHAIN OF CUSTODY RECORD

PROJECT NO.:

SITE NAME:

SAMPLERS (SIGNATURE):

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

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

NUS 440 34 0484

APPENDIX B

HALLIBURTON NUS STANDARD OPERATING PROCEDURES

APPENDIX B

HALLIBURTON NUS STANDARD OPERATING PROCEDURES (SOP's)

SA-1.2, Surface Water and Sediment Sampling

SA-6.1, Sample Identification and Chain-of-Custody

SA-6.2, Sampling Packaging and Shipping

SA-6.3, Site Logbook

SF-1.1, On-Site Water Quality Testing

SF-1.2, Sample Preservation

SF-2.3, Deconntamination of Chemical Sampling and Field Analytical Equipment

NUS CORPORATION ENVIRONMENTAL MANAGEMENT GROUP	STANDARD OPERATING PROCEDURES	Number SA-1.2	Page 1 of 10
		Effective Date 05/04/90	Revision 2
		Applicability EMG	
		Prepared Earth Sciences	
Subject SURFACE WATER AND SEDIMENT SAMPLING		Approved D. Senovich	

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1.0 PURPOSE

This procedure describes methods and equipment commonly-used for collecting environmental samples of surface water and aquatic sediment for either on-site examination and chemical testing or for laboratory analysis.

2.0 SCOPE

The information presented in this guideline is generally applicable to all environmental sampling of surface waters (Section 5.3) and aquatic sediments (Section 5.4), except where the analyte(s) may interact with the sampling equipment. The collection of concentrated sludges or hazardous waste samples from disposal or process lagoons often requires methods, precautions and equipment different from those described herein.

3.0 GLOSSARY

Environmental Sample - low concentration sample typically collected offsite and not requiring DOT hazardous waste labeling or CLP handling as a high concentration sample.

Hazardous Waste Sample - medium to high concentration sample (e.g., source material, sludge, leachate) requiring DOT labeling and CLP handling as a high concentration sample.

4.0 RESPONSIBILITIES

Field Operations Leader - has overall responsibility for the correct implementation of surface water and sediment sampling activities, including review of the sampling plan with, and any necessary training of, the sampling technician(s). The actual collection, packaging, documentation (sample label and log sheet, chain-of-custody record, CLP traffic reports, etc.) and initial custody of samples will be the responsibility of the sampling technician(s).

5.0 PROCEDURES

5.1 INTRODUCTION

Collecting a representative sample from surface water or sediments is difficult because of water movement, stratification or patchiness. To collect representative samples, one must standardize sampling bias related to site selection; sampling frequency; sample collection; sampling devices; and sample handling, preservation, and identification.

Representativeness is a qualitative description of the degree to which an individual sample accurately reflects population characteristics or parameter variations at a sampling point. It is therefore an important quality not only of assessment and quantification of environmental threats posed by the site, but also for providing information for engineering design and construction. Proper sample location selection and proper sample collection methods are important to ensure that a truly representative sample has been taken. Regardless of scrutiny and quality control applied during laboratory analyses, reported data are not better than the confidence that can be placed in the representativeness of the samples.

5.2 DEFINING THE SAMPLING PROGRAM

Many factors must be considered in developing a sampling program for surface water or sediments including study objectives; accessibility; site topography; flow, mixing and other physical characteristics of the water body; point and diffuse sources of contamination; and personnel and equipment available to conduct the study. For waterborne constituents, dispersion depends on the vertical and lateral mixing within the body of water. For sediments, dispersion depends on bottom current or flow characteristics, sediment characteristics (density, size) and geochemical properties (which affect an adsorption/desorption). The hydrologist developing the sampling plan must therefore, know not only the mixing characteristics of streams and lakes, but also must understand the role of fluvial-sediment transport, deposition, and chemical sorption.

5.2.1 Sampling Program Objectives

The objective of surface water sampling is to determine the surface water quality entering, leaving or remaining within the site. The scope of the sampling program must consider the sources and potential pathways for transport of contamination to or in a surface water body. Sources may include point sources (leaky tanks, outfalls, etc.) or nonpoint sources (e.g., spills). The major pathways for surface water contamination (not including airborne deposition are: (a) overland runoff; (b) leachate influx to the waterbody; (c) direct waste disposal (solid or liquid) into the water body; and groundwater flow influx from upgradient. The relative importance of these pathways, and therefore the design of the sampling program, is controlled by the physiographic and hydrologic features of the site, the drainage basin(s) which encompass the site, and the history of site activities.

Physiographic and hydrologic features to be considered include slopes and runoff direction, areas of temporary flooding or pooling, tidal effects, artificial surface runoff controls such as berms or drainage ditches (and when they were constructed relative to site operation), and locations of springs, seeps, marshes, etc. In addition, the obvious considerations such as the location of man-made discharge points to the nearest stream (intermittent or flowing), pond, lake, estuary, etc., shall be considered.

A more subtle consideration in designing the sampling program is the potential for dispersion of dissolved or sediment-associated contaminants away from the source. The dispersion could lead to a more homogeneous distribution of contamination at low or possibly non-detectable concentrations. Such dispersion does not, however, always readily occur. For example, obtaining a representative sample of contamination from a main stream immediately below an outfall or a tributary is difficult because the inflow frequently follows a stream bank with little lateral mixing for some distance. Sampling alternatives to overcome this situation are: (1) move the site far enough downstream to allow for adequate mixing, or (2) collect integrated samples in a cross section. Also, nonhomogeneous distribution is a particular problem with regard to sediment-associated contaminants, which may accumulate in low-energy environments (coves, river bends, deep spots, or even behind boulders) near or distant from the source while higher-energy areas (main stream channels) near the source may show no contaminant accumulation.

The distribution of particulates within a sample itself is an important consideration. Many organic compounds are only slightly water soluble and tend to be absorbed by particulate matter. Nitrogen, phosphorus, and the heavy metals may also be transported by particulates. Samples will be collected with a representative amount of suspended material; transfer from the sampling device shall include transferring a proportionate amount of the suspended material.

5.2.2 Location of Sampling Stations

Accessibility is the primary factor affecting sampling costs. The desirability and utility of a sample for analysis and description of site conditions must be balanced against the costs of collection as controlled by accessibility. Bridges or piers are the first choice for locating a sampling station on a stream because bridges provide ready access and also permit the sampling technician to sample any point across the stream. A boat or pontoon (with an associated increase in cost) may be needed to sample locations on lakes and reservoirs, as well as those on larger rivers. Frequently, however, a boat will take longer to cross a water body and will hinder manipulation of the sampling equipment. Wading for samples is not recommended unless it is known that contaminant levels are low so that skin contact will not produce adverse health effects. This provides a built in margin of safety in the event that wading boots or other protective equipment should fail to function properly. If it is necessary to wade into the water body to obtain a sample, the sampler shall be careful to minimize disturbance of bottom sediments and must enter the water body downstream of the sampling location. If necessary, the sampling technician shall wait for the sediments to settle before taking a sample.

Sampling in marshes or tidal areas may require the use of an all-terrain-vehicle (ATV). The same precautions mentioned above with regard to sediment disturbance will apply.

Under ideal and uniform contaminant dispersion conditions in a flowing stream, the same concentrations of each would occur at all points along the cross section. This situation is most likely downstream of areas of high turbulence. Careful site selection is needed in order to ensure, as nearly as possible, that samples are taken where uniform flow or deposition and good mixing conditions exist.

The availability of streamflow and sediment discharge records can be an important consideration in choosing sampling sites in streams. Streamflow data in association with contaminant concentration data are essential for estimating the total contaminant loads carried by the stream. If a gaging station is not conveniently located on a selected stream, the project hydrologist shall explore the possibility of obtaining streamflow data by direct or indirect methods.

5.2.3 Frequency of Sampling

The sampling frequency and the objectives of the sampling event will be defined by the work plan. For single-event site- or area-characterization sampling, both bottom material and overlying water samples shall be collected at the specified sampling stations. If valid data are available on the distribution of the contaminant between the solid and aqueous phases it may be appropriate to sample only one phase, although this is not often recommended. If samples are collected primarily for monitoring purposes, consisting of repetitive, continuing measurements to define variations and trends at a given location, water samples shall be collected at a pre-established and constant interval as specified in the work plan (often monthly or quarterly) and during droughts and floods. Samples of bottom material shall be collected from fresh deposits at least yearly, and preferably during both spring and fall seasons.

The variability in available water-quality data shall be evaluated before deciding on the number and collection frequency of samples required to maintain an effective monitoring program.

5.3 SURFACE WATER SAMPLE COLLECTION

5.3.1 Streams, Rivers, Outfalls and Drainage Features (Ditches, Culverts)

Methods for sampling streams, rivers, outfalls and drainage features at a single point vary from the simplest of hand sampling procedures to the more sophisticated multipoint sampling techniques known as the equal-width-increment (EWI) method or the equal-discharge-increment (EDI) methods (see below).

Samples from different depths or cross-sectional locations in the water course taken during the same sampling episode shall be composited. However, samples collected along the length of the watercourse or at different times may reflect differing inputs or dilutions and therefore shall not be composited. Generally, the number and type of samples to be taken depend on the river's width, depth, discharge and on the suspended sediment the river's transports. The greater number of individual points that are sampled, the more likely that the composite sample will truly represent the overall characteristics of the water.

In small streams less than about 20 feet wide, a sampling site can generally be found where the water is well-mixed. In such cases, a single grab sample taken at mid-depth in the center of the channel is adequate to represent the entire cross-section.

For larger streams, at least one vertical composite shall be taken with one sample each from just below the surface, at mid-depth, and just above the bottom. The measurement of DO, pH, temperature, conductivity, etc., shall be made on each aliquot of the vertical composite and on the composite itself. For rivers, several vertical composites shall be collected.

5.3.2 Lakes, Ponds and Reservoirs

Lakes, ponds, and reservoirs have as much greater tendency to stratify than rivers and streams. The relative lack of mixing requires that more samples be obtained.

The number of water sampling sites on a lake, pond, or impoundment will vary with the size and shape of the basin. In ponds and small lakes, a single vertical composite at the deepest point may be sufficient. Similarly, the measurement of DO, pH, temperature, etc., is to be conducted on each aliquot of the vertical composite. In naturally-formed ponds, the deepest point may have to be determined empirically; in impoundments, the deepest point is usually near the dam.

In lakes and larger reservoirs, several vertical composites shall be composited to form a single sample. These verticals are often taken along a transect or grid. In some cases, it may be of interest to form separate composites of epilimnetic and hypolimnetic zones. In a stratified lake, the epilimnion is the thermocline which is exposed to the atmosphere. The hypolimnion is the lower, "confined" layer which is only mixed with the epilimnion and vented to the atmosphere during seasonal "overturn" (when density stratification disappears). These two zones may thus have very different concentrations of contaminants if input is only to one zone, if the contaminants are volatile (and therefore vented from the epilimnion but not the hypolimnion), or if the epilimnion only is involved in short-term flushing (i.e., inflow from or outflow to shallow streams). Normally, however, a composite consists of several verticals with samples collected at various depths.

In lakes with irregular shape and with bays and coves that are protected from the wind, separate composite samples may be needed to adequately represent water quality since it is likely that only poor mixing will occur. Similarly, additional samples are recommended where discharges, tributaries, land use characteristics, and other such factors are suspected of influencing water quality.

Many lake measurements are now made in-situ using sensors and automatic readout or recording devices. Single and multiparameter instruments are available for measuring temperature, depth, pH, oxidation-reduction potential (ORP), specific conductance, dissolved oxygen, some cations and anions, and light penetration.

5.3.3 Estuaries

Estuarine areas are by definition zones where inland freshwaters (both surface and ground) mix with oceanic saline waters. Estuaries are generally categorized into three types dependent upon freshwater inflow and mixing properties. Knowledge of the estuary type is necessary to determine sampling locations:

- Mixed estuary - characterized by the absence of a vertical halocline (gradual or no marked increase in salinity in the water column) and a gradual increase in salinity seaward. Typically this type of estuary is shallow and is found in major freshwater sheetflow areas. Being well mixed, the sampling locations are not critical in this type of estuary.

- Salt wedge estuary - characterized by a sharp vertical increase in salinity and stratified freshwater flow along the surface. In these estuaries the vertical mixing forces cannot override the density differential between fresh and saline waters. In effect, a salt wedge tapering inland moves horizontally, back and forth, with the tidal phase. If contamination is being introduced into the estuary from upstream, water sampling from the salt wedge may miss it entirely.

- Oceanic estuary - characterized by salinities approaching full strength oceanic waters. Seasonally, freshwater inflow is small with the preponderance of the fresh-saline water mixing occurring near, or at, the shore line.

Sampling in estuarine areas is normally based upon the tidal phases, with samples collected on successive slack tides (i.e. when the tide turns). Estuarine sampling programs shall include vertical salinity measurements at 1 to 5 foot increments coupled with vertical dissolved oxygen and temperature profiles.

5.3.4 Surface Water Sampling Equipment

The selection of sampling equipment depends on the site conditions and sample type required. The most frequently used samplers are:

- Open tube
- Dip sampler
- Hand pump
- Kemmerer
- Depth-Integrating Sampler

The dip sampler and the weighted bottle sampler are used most often.

The criteria for selecting a sampler include:

- Disposable and/or easily decontaminated
- Inexpensive (if the item is to be disposed of)
- Ease of operation
- Nonreactive/noncontaminating - Teflon-coating, glass, stainless steel or PVC sample chambers are preferred (in that order)

Each sample (grab or each aliquot collected for compositing) shall be measured for:

- Specific conductance
- Temperature
- pH (optional)
- Dissolved oxygen (optional)

as soon as it is recovered. These analyses will provide information on water mixing/stratification and potential contamination.

5.3.4.1 Dip Sampling

Water is often sampled by filling a container either attached to a pole or held directly, from just beneath the surface of the water (a dip or grab sample). Constituents measured in grab samples are only indicative of conditions near the surface of the water and may not be a true representation of the total concentration that is distributed throughout the water column and in the cross section. Therefore, whenever possible it is recommended to augment dip samples with samples that represent both dissolved and suspended constituents and both vertical and horizontal distributions.

5.3.4.2 Weighted Bottle Sampling

A grab sample can also be taken using a weighted holder that allows a sample to be lowered to any desired depth, opened for filling, closed, and returned to the surface. This allows discrete sampling with depth. Several of these samples can be combined to provide a vertical composite. Alternatively, an open bottle can be lowered to the bottom and raised to the surface at a uniform rate so that the bottle collects sample throughout the total depth and is just filled on reaching the surface. The resulting sample using either method will roughly approach what is known as a depth-integrated sample.

A closed weighted bottle sampler consists of a stopped glass or plastic bottle, a weight and/or holding device, and lines to open the stopper and lower or raise the bottle. The procedure for sampling is:

- Gently lower the sampler to the desired depth so as not to remove the stopper prematurely (watch for bubbles).
- Pull out the stopper with a sharp jerk of the sampler line.
- Allow the bottle to fill completely, as evidenced by the absence of air bubbles.
- Raise the sampler and cap the bottle.
- Decontaminate the outside of the bottle. The bottle can be used as the sample container (as long as original bottle is an approved container).

5.3.4.3 Kemmerer

If samples are desired at a specific depth, and the parameters to be measured do not require a Teflon coated sampler, a standard Kemmerer sampler may be used. The Kemmerer sampler is a brass, stainless steel or acrylic cylinder with rubber stoppers that leave the ends open while being lowered in a vertical position to allow free passage of water through the cylinder. "Messenger" is sent down the line when the sampler is at the designated depth, to cause the stoppers to close the cylinder, which is then raised. Water is removed through a valve to fill sample bottles.

5.3.5 Surface Water Sampling Techniques

Most samples taken during site investigations are grab samples. Typically, surface water sampling involves immersing the sample container in the body of water; however, the following suggestions are made to help ensure that the samples obtained are representative of site conditions:

- The most representative samples are obtained from mid-channel at 0.6 stream depth in a well-mixed stream.
- Even though the containers used to obtain the samples are previously laboratory cleaned, it is suggested that the sample container be rinsed at least once with the water to be sampled before the sample is taken.
- For sampling running water, it is suggested that the farthest downstream sample be obtained first and that subsequent samples be taken as one works upstream. Work from zones suspected of low contamination to zones of high contamination.
- To sample a pond or other standing body of water, the surface area may be divided into grids. A series of samples taken from each grid is combined into one sample, or several grids are selected at random.
- Care should be taken to avoid excessive agitation of the water that results in the loss of volatile constituents.
- When obtaining samples in 40 ml septum vials for volatile organics, analysis, it is important to exclude any air space in the top of the bottle and to be sure that the Teflon liner faces in after the bottle is filled and capped. The bottle can be turned upside down to check for air bubbles.
- Do not sample at the surface, unless sampling specifically for a known constituent which is immiscible and on top of the water. Instead, the sample container should be inverted, lowered to the approximate depth, and held at about a 45-degree angle with the month of the bottle facing upstream.

5.4 SEDIMENT SAMPLING

5.4.1 General

Sediment samples are usually collected at the same verticals at which water samples were collected. If only one sediment sample is to be collected, the site shall be approximately at the center of water body. Generally, the coarser grained sediments are deposited near the headwaters of the reservoir. Bed sediments near the center will be composed of fine-grained materials which may, because of their lower porosity and greater surface area available for adsorption, contain greater concentrations

of contaminants. The shape, flow pattern, bathometry (depth distribution), and water circulation patterns must all be considered when selecting sediment sampling sites. In streams, areas likely to have sediment accumulation (bends, behind islands or boulders, quiet shallow areas or very deep, low-velocity areas) shall be sampled while areas likely to show net erosion (high-velocity, turbulent areas) and suspension of fine solid materials shall be avoided.

Chemical constituents associated with bottom material may reflect an integration of chemical and biological processes. Bottom samples reflect the historical input to streams, lakes, and estuaries with respect to time, application of chemicals, and land use. Bottom sediments (especially fine-grained material) may act as a sink or reservoir for adsorbed heavy metals and organic contaminants (even if water column concentrations are below detection limits). It is therefore important to minimize the loss of low-density "fines" during any sampling process.

5.4.2 Sampling Equipment and Techniques

A bottom-material sample may consist of a single scoop or core or may be a composite of several individual samples in the cross section. Sediment samples may be obtained using on-shore or off-shore techniques.

When boats are used for sampling, life preservers must be provided and two individuals must undertake the sampling. An additional person shall remain on-shore in visual contact at all times.

The following samplers may be used to collect bottom materials:

- Scoop sampler
- Dredge samplers

5.4.2.1 Scoop Sampler

A scoop sampler consists of a pole to which a jar or scoop is attached. The pole may be made of bamboo, wood or aluminum and be either telescoping or of fixed length. The scoop or jar at the end of the pole is usually attached using a clamp.

If the water body can be sampled from the shore or if it can be waded, the easiest and "cleanest" way to collect a sediment sample is to use a scoop sampler. This reduces the potential for cross-contamination. This method is accomplished by reaching over or wading into the water body and, while facing upstream (into the current), scooping in the sample along the bottom in the upstream direction. It is very difficult not to disturb fine-grained materials of the sediment-water interface when using this method.

5.4.2.2 Dredges

Dredges are generally used to sample sediments which cannot easily be obtained using coring devices (i.e., coarse-grained or partially-cemented materials) or when large quantities of materials are required. Dredges generally consist of a clam shell arrangement of two buckets. The buckets may either close upon impact or be activated by use of a messenger. Most dredges are heavy (up to several hundred pounds) and require use of a winch and crane assembly for sample retrieval. There are three major types of dredges: Peterson, Eckman and Ponar dredges.

The Peterson dredge is used when the bottom is rocky, in very deep water, or when the flow velocity is high. The dredge shall be lowered very slowly as it approaches bottom, because it can force out and miss lighter materials if allowed to drop freely.

The Eckman dredge has only limited usefulness. It performs well where bottom material is unusually soft, as when covered with organic sludge or light mud. It is unsuitable, however, for sandy, rocky, and hard bottoms and is too light for use in streams with high flow velocities.

The Ponar dredge is a Peterson dredge modified by the addition of side plates and a screen on the top of the sample compartment. The screen over the sample compartment permits water to pass through the sampler as it descends thus reducing the "shock wave" and permitting direct access to the secured sample without opening the closed jaws. The Ponar dredge is easily operated by one person in the same fashion as the Peterson dredge. The Ponar dredge is one of the most effective samplers for general use on all types of substrates. Access to the secured sample through the covering screens permits subsampling of the secured material with coring tubes or Teflon scoops, thus minimizing the change of metal contamination from the frame of the device.

6.0 REFERENCES

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7.0 ATTACHMENTS

None.

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		Effective Date 05/04/90	Revision 2
		Applicability EMG	
		Prepared Earth Sciences	
Subject SAMPLE IDENTIFICATION AND CHAIN-OF-CUSTODY		Approved D. Senovich	

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1.0 PURPOSE

This purpose of this procedure is to provide information on chain-of-custody procedures to be used under the NUS Program.

2.0 SCOPE

This procedure describes the steps necessary for transferring samples through the use of Chain-of-Custody Records. A Chain-of-Custody Record is required, without exception, for the tracking and recording of all samples collected for on-site or off-site analysis (chemical or geotechnical) during program activities. Use of the Chain-of-Custody Record Form creates an accurate written record that can be used to trace the possession and handling of the sample from the moment of its collection through analysis and its introduction as evidence. This procedure identifies the necessary custody records and describes their completion.

This procedure does not take precedence over region-specific or site-specific requirements for chain-of-custody.

3.0 GLOSSARY

Chain-of-Custody Record Form - A Chain-of-Custody Record Form is a printed two-part form that accompanies a sample or group of samples as custody of the sample(s) is transferred from one custodian to another custodian. A Chain-of-Custody Record Form is a controlled document, provided by the regional office of EPA.

The chain-of-custody form is a two-page carbon-copy type form. The original form accompanies the samples during shipment, and the pink carbon-copy is retained in the project file.

Controlled Document - A consecutively-numbered form released by EPA or Program Management Office (PMO) for use on a particular work assignment. All unused forms must be returned or accounted for at the conclusion of the assignment.

Custodian - The person responsible for the custody of samples at a particular time, until custody is transferred to another person (and so documented), who then becomes custodian. A sample is under your custody if:

- It is in your actual possession.
- It is in your view, after being in your physical possession.
- It was in your physical possession and then you locked it up to prevent tampering.
- It is in a designated and identified secure area.

Sample - A sample is physical evidence collected from a facility or the environment, which is representative of conditions at the point and time that it was collected.

4.0 RESPONSIBILITIES

Field Operations Leader - Responsible for determining that chain-of-custody procedures are implemented up to and including release to the shipper.

Field Samplers - Responsible for initiating the Chain-of-Custody Record and maintaining custody of samples until they are relinquished to another custodian, to the shipper, or to the common carrier.

Remedial Investigation Leader - Responsible for determining that chain-of-custody procedures have been met by the sample shipper and analytical laboratory.

5.0 PROCEDURES

5.1 OVERVIEW

The term "chain-of-custody" refers to procedures which ensure that evidence presented in a court of law is what it is represented to be. The chain-of-custody procedures track the evidence from the time and place it is first obtained to the courtroom and, secondly, provide security for the evidence as it is moved and/or passes from the custody of one individual to another.

Chain-of-custody procedures, recordkeeping, and documentation are an important part of the management control of samples. Regulatory agencies must be able to provide the chain of possession and custody of any samples that are offered for evidence, or that form the basis of analytical test results introduced as evidence. Written procedures must be available and followed whenever evidence samples are collected, transferred, stored, analyzed, or destroyed.

5.2 SAMPLE IDENTIFICATION

The method of identification of a sample depends on the type of measurement or analysis performed. When in-situ measurements are made, the data are recorded directly in bound logbooks or other field data records, with identifying information.

5.2.1 Sample Label

Samples, other than in-situ measurements, are removed and transported from the sample location to a laboratory or other location for analysis. Before removal, however, a sample is often divided into portions, depending upon the analyses to be performed. Each portion is preserved in accordance with the Sampling Plan. Each sample container is identified by a sample label (see Attachment B). Sample labels are provided by the PMO. The information recorded on the sample label includes:

- **Project:** EPA Work Assignment Number (can be obtained from the Sampling Plan).
- **Station Location:** The unique sample number identifying this sample (can be obtained from the Sampling Plan).
- **Date:** A six-digit number indicating the day, month, and year of sample collection; e.g., 12/21/85.
- **Time:** A four-digit number indicating the 24-hour time of collection (for example: 0954 is 9:54 a.m., and 1629 is 4:29 p.m.).
- **Medium:** Water, soil, sediment, sludge, waste, etc.

- **Concentration:** The expected concentration (i.e., low, medium, high).
- **Sample Type:** Grab or composite.
- **Preservation:** Type of preservation added and pH levels.
- **Analysis:** VOA, BNAs, PCBs, pesticides, metals, cyanide, other.
- **Sampled By:** Printed name of the sampler.
- **Case Number:** Case number assigned by the Sample Management Office.
- **Traffic Report Number:** Number obtained from the traffic report labels.
- **Remarks:** Any pertinent additional information.

Using just the work assignment number of the sample label maintains the anonymity of sites. This may be necessary, even to the extent of preventing the laboratory performing analysis from knowing the identity of the site (e.g., if the laboratory is part of an organization that has performed previous work on the site).

5.2.2 Sample Identification Tag

A Sample Identification Tag (Attachment F) must also be used for samples collected for CLP (Contract Laboratory Program) analysis. The Sample Identification Tag is a w[illegible]e, waterproof paper label, approximately 3-by-6 inches, with a reinforced eyelet, and string or w[illegible] or attachment to the neck of the sample bottle. The Sample Tag is a controlled document, and i[illegible]ovided by the regional EPA office. Following sample analysis, the Sample Tag is retained by the la[illegible]atory as evidence of sample receipt and analysis.

The following information is recorded on the tag:

- **Project Code:** Work Assignment Number.
- **Station Number:** The middle portion of the Station Location Number, (between the hyphens).
- **Month/Day/Year:** Same as Date on Sample Label.
- **Time:** Same as Time on Sample Label.
- **Designate - Comp/Grab:** Composite or grab sample.
- **Station Location:** Same as Station Location on Sample Label.
- **Samplers:** Same as Sampled By on Sample Label.
- **Preservative:** Yes or No.
- **Analyses:** Check appropriate box(es).

- **Remarks:** Same as Remarks on Sample Label (make sure the Case Number and Traffic Report numbers are recorded).

- **Lab Sample Number:** For laboratory use only.

The tag is then tied around the neck of the sample bottle.

If the sample is to be split, it is aliquoted into similar sample containers. Identical information is completed on the label attached to each split.

Blank, duplicate, or field spike samples shall not be identified as such on the label, as they may compromise the quality control function. Sample blanks, duplicates, spikes, and splits are defined in Procedure SA-6.6.

5.3 CHAIN-OF-CUSTODY PROCEDURES

After collection, separation, identification, and preservation, the sample is maintained under chain-of-custody procedures until it is in the custody of the analytical laboratory and has been stored or disposed of.

5.3.1 Field Custody Procedures

- Samples are collected as described in the site-specific Sampling Plan. Care must be taken to record precisely the sample location and to ensure that the sample number on the label matches the sample log sheet and Chain-of-Custody Record exactly.

- The person undertaking the actual sampling in the field is responsible for the care and custody of the samples collected until they are properly transferred or dispatched.

- When photographs are taken of the sampling as part of the documentation procedure, the name of the photographer, date, time, site location, and site description are entered sequentially in the site logbook as photos are taken. Once developed, the photographic prints shall be serially numbered, corresponding to the logbook descriptions.

- Sample labels shall be completed for each sample, using waterproof ink unless prohibited by weather conditions, e.g., a logbook notation would explain that a pencil was used to fill out the sample label because a ballpoint pen would not function in freezing weather.

5.3.2 Transfer of Custody and Shipment

Samples are accompanied by a Chain-of-Custody Record Form. Chain-of-Custody Record Forms used in EPA Regions I-IV are shown in Attachments A through D. The appropriate form shall be obtained from the EPA Regional Office. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the Record. This Record documents sample custody transfer from the sampler, often through another person, to the analyst in the laboratory. The Chain-of-Custody Record is filled out as follows:

- Enter header information (project number, samplers, and project name -- project name can be obtained from the Sampling Plan).

- Sign, date, and enter the time under "Relinquished by" entry.

- Enter station number (the station number is the middle portion of the station location number, between the hyphens).
- Check composite or grab sample.
- Enter station location number (the same number as the station location on the tag and label).
- Enter the total number of containers per station number and the type of each bottle.
- Enter either the inorganic traffic report number, the organic traffic report number, or the SAS number for each station number in the remarks column.
- Enter the tag number from the bottom of the sample identification tag in the remarks column for each station location.
- Make sure that the person receiving the sample signs the "Received by" entry, or enter the name of the carrier (e.g., UPS, Federal Express) under "Received by." Receiving laboratory will sign "Received for Laboratory by" on the lower line and enter the date and time.
- Enter the bill-of-lading or Federal Express airbill number under "Remarks," in the bottom right corner, if appropriate.
- Place the original (top, signed copy) of the Chain-of-Custody Record Form in the appropriate sample shipping package. Retain the pink copy with field records.
- Sign and date the custody seal, a 1- by 3-inch white paper label with black lettering and an adhesive backing. Attachment G is an example of a custody seal. The custody seal is part of the chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field. Custody seals are provided by ZPMO on an as-needed basis.
- Place the seal across the shipping container opening so that it would be broken if the container is opened.
- Complete other carrier-required shipping papers.

The custody record is completed using black waterproof ink. Any corrections are made by drawing a line through and initialing and dating the change, then entering the correct information. Erasures are not permitted.

Common carriers will usually not accept responsibility for handling Chain-of-Custody Record Forms; this necessitates packing the record in the sample container (enclosed with other documentation in a plastic zip-lock bag). As long as custody forms are sealed inside the sample container and the custody seals are intact, commercial carriers are not required to sign off on the custody form.

If sent by mail, the package will be registered with return receipt requested. If sent by common carrier or air freight, proper documentation must be maintained.

The laboratory representative who accepts the incoming sample shipment signs and dates the Chain-of-Custody Record, completing the sample transfer process. It is then the laboratory's responsibility to maintain internal logbooks and custody records throughout sample preparation and analysis.

5.3.3 Receipt for Samples Form

Whenever samples are split with a private party or government agency, a separate Receipt for Samples Record Form is prepared for those samples and marked to indicate with whom the samples are being split. The person relinquishing the samples to the party or agency shall require the signature of a representative of the appropriate party acknowledging receipt of the samples. If a representative is unavailable or refuses to sign, this is noted in the "Received by" space. When appropriate, as in the case where the representative is unavailable, the custody record shall contain a statement that the samples were delivered to the designated location at the designated time. This form must be completed and a copy given to the owner, operator, or agent-in-charge even if the offer for split samples is declined. The original is retained by the Field Operations Leader.

6.0 REFERENCES

U.S. EPA, 1984. User's Guide to the Contract Laboratory Program, Office of Emergency and Remedial Response, Washington, D.C.

7.0 ATTACHMENTS

Attachment A - Chain-of-Custody Record Form for use in Region I
Attachment B - Chain-of-Custody Record Form for use in Region II
Attachment C - Chain-of-Custody Record Form for use in Region III
Attachment D - Chain-of-Custody Record Form for use in Region IV
Attachment E - Sample Label
Attachment F - Sample Identification Tag
Attachment G - Chain-of-Custody Seal

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1.0 PURPOSE

This procedure provides instruction for sample packaging and shipping in accordance with U.S. Department of Transportation (DOT) regulations.

2.0 SCOPE

Samples collected at hazardous waste sites usually have to be transported elsewhere for analysis. This requires that the samples be appropriately preserved to prevent or minimize chemical alteration prior to analysis, and be transported to protect their integrity, as well as to protect against any detrimental effects from leakage or breakage. Regulations for packaging, marking, labeling, and shipping hazardous materials and wastes are promulgated by the U.S. Department of Transportation and described in the Code of Federal Regulations (49 CFR 171 through 177, in particular 172.402h, Packages Containing Samples). In general, these regulations were not intended to cover shipment of samples collected at controlled or uncontrolled hazardous waste sites or samples collected during emergency responses. However, the EPA has agreed through a memorandum of agreement to package, mark, label, and ship samples observing DOT procedures. The information presented here is for general guidance.

This procedure is applicable to all samples taken from uncontrolled hazardous substance sites for analysis at laboratories away from the site.

3.0 GLOSSARY

Carrier - A person or firm engaged in the transportation of passengers or property.

Hazardous Material - A substance or material in a quantity and form which may pose an unreasonable risk to health and safety or property when transported in commerce ("commerce" here to include any traffic or transportation). Defined and regulated by DOT (49 CFR 173.2) and listed in Attachment A of this guideline.

Hazardous Waste - Any substance listed in 40 CFR Subpart D (¥261.20 et seq) or otherwise characterized as ignitable, corrosive, reactive, or EP toxic as specified under 40 CFR Subpart C (¥261.20 et seq) that would be subject to manifest requirements specified in 40 CFR 262. Defined and regulated by EPA.

Marking - Applying the descriptive name, instruction, cautions, weight, or specification marks or combination thereof required to be placed outside containers of hazardous materials.

n.o.i. - Not otherwise indicated.

n.o.s. - Not otherwise specified.

ORM - Other regulated material.

Packaging - The assembly of one or more containers and any other components necessary to assure compliance with the minimum packaging requirements of 49 CFR 174, including containers (other than freight containers or overpacks), portable tanks, cargo tanks, tank cars, multiunit tank car tanks.

Placard - Color-coded, pictorial sign depicting the hazard class symbol and name to be placed on all four sides of a vehicle transporting certain hazardous materials.

Reportable Quantity (RQ) - A parenthetical note of the form "(RQ-1000/454)" following an entry in the DOT Hazardous Materials table (49 CFR 172.101) indicates the reportable quantity of the substance in pounds and kilograms. If a spill of that amount or more of the substance occurs during transit or storage, a report must be filed with DOT according to ¥171.15-15 concerning hazardous materials incidents reports. If the material spilled is a hazardous waste, a report must always be filed, regardless of the amount, and must include a copy of the manifest. If the RQ notation appears, it must be shown either immediately before or after the proper shipping name on the shipping paper (or manifest). Most shipping papers and manifests will have a column designated "HM" which may be used for this purpose.

4.0 RESPONSIBILITIES

Field Operations Leader or Team Sampling Leader - responsible for determining that samples are properly packaged and shipped.

Sampling Personnel - responsible for implementing the packaging and shipping requirements.

5.0 PROCEDURES

5.1 INTRODUCTION

Samples collected for shipment from a site shall be classified as either environmental or hazardous material (or waste) samples. In general, environmental samples are collected off-site (for example from streams, ponds, or wells) and are not expected to be grossly contaminated with high levels of hazardous materials. On-site samples (for example, soil, water, and materials from drums or bulk storage tanks, obviously contaminated ponds, lagoons, pools, and leachates from hazardous waste sites) are considered hazardous. A distinction must be made between the two types of samples in order to:

- Determine appropriate procedures for transportation of samples. If there is any doubt, a sample shall be considered hazardous and shipped accordingly.
- Protect the health and safety of laboratory personnel receiving the samples. Special precautions are used at laboratories when samples other than environmental samples are received.

5.2 ENVIRONMENTAL SAMPLES

5.2.1 Packaging

Environmental samples may be packaged following the procedures outlined in Section 5.4 for samples classified as "flammable liquids" or "flammable solids." Requirements for marking, labeling, and shipping papers do not apply.

Environmental samples may also be packed without being placed inside metal cans as required for flammable liquids or solids.

- Place sample container, properly identified and with a sealed lid, in a polyethylene bag, and seal the bag.
- Place sample in a fiberboard container or metal picnic cooler which has been lined with a large polyethylene bag.
- Pack with enough noncombustible, absorbent, cushioning materials to minimize the possibility of the container breaking.
- Seal large bag.
- Seal or close outside container.

5.2.2 Marking Labeling

Sample containers must have a completed sample identification tag and the outside container must be marked "Environmental Sample." The appropriate side of the container must be marked "This End Up" and arrows placed appropriately. No DOT marking or labeling are required.

5.2.3 Shipping Papers

No DOT shipping papers are required. However, the appropriate chain-of-custody forms must be included with the shipment.

5.2.4 Transportation

There are no DOT restrictions on mode of transportation.

5.3 DETERMINATION OF SHIPPING CLASSIFICATION FOR HAZARDOUS MATERIAL SAMPLES

Samples not determined to be environmental samples, or samples known or expected to contain hazardous materials, must be considered hazardous material samples and transported according to the requirements listed below.

5.3.1 Known Substances

If the substance in the sample is known or can be identified, package, mark, label and ship according to the specific instructions for that material (if it is listed) in the DOT Hazardous Materials Table, 49 CFR 172.101.

Unz and Company have published the following steps to help in locating a proper shipping name from the Hazardous Materials Table, 49 CFR 172.101.

1. Look first for the chemical or technical name of the material, for example, ethyl alcohol. Note that many chemicals have more than one technical name, for example, perchloroethylene (not listed in 172.101) is also called tetrachloroethylene (listed 172.101). It may be useful to consult a chemist for all possible technical names a material can have. If your material is not listed by its technical name then. . . . . .

2. Look for the chemical family name. For example, pentyl alcohol is not listed but the chemical family name is: alcohol, n.o.s. (not otherwise specified). If the chemical family name is not listed then. . . . . .

3. Look for a generic name based on end use. For example, Paint, n.o.s or Fireworks, n.o.s. If a generic name based on end use is not listed then. . . . . .

4. Look for a generic family name based on end use, for example, drugs, n.o.s. or cosmetics, n.o.s. Finally, if your material is not listed by a generic family name but you suspect or know the material is hazardous because it meets the definition of one or more hazardous classes, then. . . . . .

5. You will have to go the the general hazard class for a proper shipping name. For example, Flammable Liquid, n.o.s, or Oxidizer, n.o.s.

5.3.2 Unknown Substances

For samples of hazardous substances of unknown content, select the appropriate transportation category according to the DOT Hazardous Materials Classification (Attachment A), a priority system of transportation categories.

The correct shipping classification for an unknown sample is selected through a process of elimination, utilizing Attachment A. Unless known or demonstrated otherwise (through the use of radiation survey instruments), the sample is considered radioactive and appropriate shipping regulations for "radioactive material" followed.

If a radioactive material is eliminated, the sample is considered to contain "Poison A" materials (Attachment B), the next classification on the list. DOT defines "Poison A" as extremely dangerous poisonous gases or liquids of such a nature that a very small amount of gas, or vapor of the liquids, mixed with air is dangerous to life. Most Poison A materials are gases or compressed gases and would not be found in drum-type containers. Liquid Poison A would be found only in closed containers; however,all samples taken from closed drums do not have to be shipped as Poison A, which provides for a "worst case" situation. Based upon information available, a judgment must be made whether a sample from a closed container is a Poison A.

If Poison A is eliminated as a shipment category, the next two classifications are "flammable" or "nonflammable" gases. Since few gas samples are collected, "flammable liquid" would be the next applicable category. With the elimination of radioactive material, Poison A, flammable gas, and nonflammable gas, the sample can be classified as flammable liquid (or solid) and shipped accordingly. These procedures would also suffice for shipping any other samples classified below flammable liquids in the DOT classification table (Attachment A). For samples containing unknown materials, categories listed below flammable liquids/solids on Attachment A are generally not used because showing that these materials are not flammable liquids (or solids) requires flashpoint testing, which may be impractical and possibly dangerous at a site. Thus, unless the sample is known to consist of materials listed as less hazardous than flammable liquid (or solid) on Attachment A, it is considered a flammable liquid (or solid) and shipped as such.

For any hazardous material shipment, utilize the shipping checklist (Attachment C) as a guideline to ensure that all sample-handling requirements are satisfied.

5.4 PACKAGING AND SHIPPING OF SAMPLES CLASSIFIED AS FLAMMABLE LIQUID (OR SOLID)

5.4.1 Packaging

Applying the word "flammable" to a sample does not imply that it is in fact flammable. The word prescribes the class of packaging according to DOT regulations.

1. Collect sample in the prescribed container with a nonmetallic, Teflon-lined screw cap. To prevent leakage, fill container no more than 90 percent full.

2. Complete sample label and sample identification tag and attach securely to sample container.

3. Seal container and place in 2-mil thick (or thicker) polyethylene bag, one sample per bag. Position sample identification tag so that it can be read through bag. Seal bag.

4. Place sealed bag inside metal can and cushion it with enough noncombustible, absorbent material (for example, vermiculite or diatomaceous earth) between the bottom and sides of the can and bag to prevent breakage and absorb leakage. Pack one bag per can. Use clips, tape, or other positive means to hold can lid securely, tightly and permanently. Mark can as indicated in Paragraph 1 of Section 5.4.2, below.

5. Place one or more metal cans (or single 1-gallon bottle) into a strong outside container, such as a metal picnic cooler or a DOT-approved fiberboard box. Surround cans with noncombustible, absorbent cushioning materials for stability during transport. Mark container as indicated in Paragraph 2 of Section 5.4.2.

5.4.2 Marking/Labeling

1. Use abbreviations only where specified. Place the following information, either hand-printed or in label form, on the metal can (or 1-gallon bottle):

   - Laboratory name and address.

   - "Flammable Liquid, n.o.s. UN1993" or "Flammable Solid, n.o.s. UN1325."

Not otherwise specified (n.o.s) is not used if the flammable liquid (or solid) is identified. Then the name of the specific material is listed before the category (for example, Acetone, Flammable Liquid), followed by its appropriate UN number found in the DOT Hazardous Materials table (49 CFR 172.101).

2. Place all information on outside shipping container as on can (or bottle), specifically:

   - Proper shipping name.
   - UN or NA number.
   - Proper label(s).
   - Addressee and sender.

   Place the following labels on the outside shipping container: "Cargo Aircraft Only" and "Flammable Liquid" (or "Flammable Solid"). "Dangerous When Wet" label shall be used if the solid has not been exposed to a wet environment. "Laboratory Samples" and "THIS SIDE UP" or "THIS END UP" shall also be marked on the top of the outside container, and upward-pointing arrows shall be placed on all four sides of the container.

5.4.3 Shipping Papers

1. Use abbreviations only where specified. Complete the carrier-provided bill of lading and sign certification statement (if carrier does not provide, use standard industry form, see Attachment D). Provide the following information in the order listed (one form may be used for more than one exterior container).

   - "Flammable Liquid, n.o.s. UN1993" or "Flammable Solid, n.o.s. UN1325."
   - "Limited Quantity" (or "Ltd. Qty.").
   - "Cargo Aircraft Only."
   - Net weight (wt) or net volume (vol), just before or just after "Flammable Liquid, n.o.s." or "Flammable Solid, n.o.s.," by item, if more than one metal can is inside an exterior container.
   - "Laboratory Samples" (if applicable).

2. Include Chain-of-Custody Record, properly executed in outside container.

3. "Limited Quantity" of "Flammable Liquid, n.o.s." is limited to one pint per inner container. For "Flammable Solid, n.o.s.," net weight of inner container plus sample shall not exceed one pound; total package weight shall not exceed 25 pounds.

5.4.4 Transportation

1. Transport unknown hazardous substance samples classified as flammable liquids by rented or common carrier truck, railroad, or express overnight package services. Do not transport by any passenger-carrying air transport system, even if they have cargo-only aircraft. DOT regulations permit regular airline cargo-only aircraft, but difficulties with most suggest avoiding them. Instead, ship by airline carriers that only carry cargo.

2. For transport by government-owned vehicle, including aircraft, DOT regulations do not apply. However, procedures described above, with the exception of execution of the bill of lading with certification, shall still be used.

6.0 REFERENCES

U.S. Department of Transportation, 1983. Hazardous Materials Regulations, 49 CRF 171-177.

NUS Standard Operating Procedure SA-6.1 - Sample Identification and Chain-of-Custody

NUS Standard Operating Procedure SA-1.2 - Sample Preservation

NUS Standard Operating Procedure SF-1.5 - Compatibility Testing

7.0 ATTACHMENTS

Attachment A - DOT Hazardous Material Classification (49 CFR 173.2)
Attachment B - DOT List of Class "A" Poisons (49 CFR 172.101)
Attachment C - Hazardous Materials Shipping Checklist
Attachment D - Standard Industry Certification Form

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1.0 PURPOSE

This procedure describes the process for keeping a site logbook.

2.0 SCOPE

The site logbook is a controlled document which records all major on-site activities during a Remedial Investigation/Feasibility Study. At a minimum, the following activities/events shall be recorded in the site logbook:

- Arrival/departure of site visitors
- Arrival/departure of equipment
- Sample pickup (chain-of-custody form numbers, carrier, time)
- Sampling activities/sample logsheet numbers
- Start or completion of borehole/trench/monitoring well installation or sampling activities
- Health and Safety issues

The site logbook is initiated at the start of the first on-site activity (e.g., initial reconnaissance survey). Entries are made for every day that on-site activities take place which involve RI/FS contractor personnel. One current site logbook is maintained per site.

The site logbook becomes part of the permanent site file maintained in the RI contractor's office. Because information contained in the site logbook may be admitted as evidence in cost recovery or other legal proceedings, it is critical that this document be properly maintained.

3.0 GLOSSARY

Site Logbook - The logbook is a bound notebook with consecutively numbered pages that cannot be removed. Upon entry of data, the logbook requires signature by the responsible site leader (see Section 5.1).

4.0 RESPONSIBILITIES

The site logbook is issued by the Regional Manager (or his designee) to the Site Manager for the duration of the project. The Site Manager releases the site logbook to the Field Operations Leader or other person responsible for the direction of on-site activities (e.g., Reconnaissance Survey Team Leader, Sampling Team Leader). It is the responsibility of this person (or his designee) to keep the site logbook current while in his possession, and return it to the Site Manager or turn it over to another field team. Following the completion of all fieldwork, the site logbook is returned to the Site Manager for inclusion in the permanent site files.

5.0 PROCEDURES

5.1 GENERAL

The cover of each site logbook contains the following information:

- Project Name
- NUS Project Number
- RI/FS Contractor and Site Manager's Name
- Sequential Book Number

- Start Date
- End Date

Daily entries into the logbook may contain a variety of information. At the beginning of each day the following information must be recorded:

- Date
- Start time
- Weather
- All field personnel present
- Any visitors present

During the day, a summary of all site activities and level of personal protection shall be recorded in the logbook. The information need not duplicate that recorded in other field notebooks (e.g., sample logbook, Site Geologist's notebook, Health and Safety Officer's notebook, etc.), but shall summarize the contents of these other notebooks and refer to the page locations in these notebooks for detailed information. An example of a site logbook page is shown in Attachment A.

The sample logsheet for each sample collected (see Procedure SA-6.6) must be referenced. If measurements are made at any location, the measurements and equipment used must either be recorded in the site logbook or reference must be made to the notebook and page number(s) on which they are recorded (see Attachment A).

All entries shall be made in black pen. No erasures are permitted. If an incorrect entry is made, the data shall be crossed out with a single strike mark, and initialed and dated. At the completion of entries by any individual, the logbook must be signed. It must also be signed by the Field Operations Leader or responsible site leader at the end of each day.

5.2 PHOTOGRAPHS

When movies, slides, or photographs are taken of a site or any monitoring location, they are numbered to correspond to logbook entries. The name of the photographer, date, time, site location, site description, and weather conditions are entered in the logbook as the photographs are taken. A series entry may be used for rapid-sequence photographs. The photographer is not required to record the aperture settings and shutter speeds for photographs taken within the normal automatic exposure range. However, special lenses, films, filters, and other image-enhancement techniques must be noted in the logbook. If possible, such techniques shall be avoided, since they can adversely affect the admissibility of photographs as evidence. Chain-of-custody procedures depend upon the subject matter, type of film, and the processing it requires. Film used for aerial photography, confidential information, or criminal investigation require chain-of-custody procedures. Adequate logbook notation and receipts may be used to account for routine film processing. Once processed, the slides of photographic prints shall be serially numbered and labeled according to the logbook descriptions.

6.0 REFERENCES

None.

7.0 ATTACHMENTS

Attachment A - Typical Site Logbook Entry

ATTACHMENT A
TYPICAL SITE LOGBOOK ENTRY

START TIME: _____ DATE: _____

SITE LEADER: _____
PERSONNEL:

NUS	DRILLER	EPA
_____	_____	_____
_____	_____	_____
_____	_____	_____

WEATHER: Clear, 68°F, 2-5 mph wind from SE

ACTIVITIES:

1. Steam jenney and fire hoses were set up.

2. Drilling activities at well _____ resumes. Rig geologist was _____. See Geologist's Notebook, No. 1, page 29-30, for details of drilling activity. Sample No. 123-21-S4 collected; see sample logbook, page 42. Drilling activities completed at 11:50 and a 4 inch stainless steel well installed. See Geologist's Notebook, No. 1, page 31, and well construction details for well _____.

3. Drilling rig No. 2 steam-cleaned at decontamination pit. Then set up at location of well _____.

4. Well _____ drilled. Rig geologist was _____. See Geologist's Notebook, No. 2, page _____ for details of drilling activities. Sample numbers 123-22-S1, 123-22-S2, and 123-22-S3 collected; see sample logbook, pages 43, 44, and 45.

5. Well _____ was developed. Seven 55-gallon drums were filled in the flushing stage. The well was then pumped using the pitcher pump for 1 hour. At the end of the hour, water pumped from well was "sand free."

6. EPA remedial project manger arrives on-site at 14:25 hours.

7. Large dump truck arrives at 14:45 and is steam-cleaned. Backhoe and dump truck set up over test pit _____.

8. Test pit _____ dug with cuttings placed in dump truck. Rig geologist was _____. See Geologist's Notebook, No. 1, page 32, for details of test pit activities. Test pit subsequently filled. No samples taken for chemical analysis. Due to shallow groundwater table, filling in of test pit _____ resulted in a very soft and wet area. A mound was developed and the area roped off.

9. Express carrier picked up samples (see Sample Logbook, pages 42 through 45) at 17:50 hours. Site activities terminated at 18:22 hours. All personnel offsite, gate locked.

_____
Field Operations Leader

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6.0 REFERENCES

7.0 ATTACHMENTS

1.0 PURPOSE

This procedure describes the procedures and equipment required to measure the following parameters of an aqueous sample in the field:

- pH
- Specific Conductance
- Temperature
- Dissolved Oxygen (DO) Concentration
- Oxidation Reduction Potential
- Certain Dissolved Constituents Using Specific Ion Elements

2.0 SCOPE

This procedure is applicable for use in an on-site groundwater quality monitoring program to be conducted during a remedial investigation or site investigation program at a hazardous or non-hazardous site. The procedures and equipment described are applicable to nearly all aqueous samples, including potable well water, monitoring well water, surface water, leachate and drummed water, etc. and are not, in general, subject to solution interferences from color, turbidity and colloidal material, or suspended matter.

This procedure provides generic information for measuring the parameters listed above with instruments and techniques in common use. Since instruments from different manufacturers may vary, review of the manufacturer's literature pertaining to the use of a specific instrument is required before use.

3.0 GLOSSARY

3.1 pH MEASUREMENT

pH - The negative logarithm (base 10) of the hydrogen ion activity. The hydrogen ion activity is related to the hydrogen ion concentration, and, in relatively weak solution, the two are nearly equal. Thus, for all practical purposes, pH is a measure of the hydrogen ion concentration.

pH Paper - Paper that turns different colors depending on the pH of the solution to which it is exposed. Comparison with color standards supplied by the manufacturer will then give an indication of the solution pH.

3.2 SPECIFIC CONDUCTANCE MEASUREMENT

Ohm - Standard unit of electrical resistance (R). A siemen (or umho) is the standard unit of electrical conductance, the inverse of the ohm

Resistance - A measure of the solution's ability to oppose the passage of electrical current. For metals and solutions, resistance is defined by Ohm's law, $E = IR$, where E is the potential difference, I is the current, and R is the resistance.

Conductance - The conductance of a conductor 1 centimeter long and 1 square centimeter in cross-sectional area. Conductivity and specific conductance are used synonymously.

3.3 TEMPERATURE MEASUREMENT

None.

3.4 DISSOLVED OXYGEN MEASUREMENT

Galvanic Cell - An electrochemical cell in which chemical energy is spontaneously converted to electrical energy. The electrical energy produced is supplied to an external circuit.

Electrolytic Cell - An electrochemical cell in which electrical energy is supplied from an external source. This cell functions in much the same way as a galvanic cell, only in the opposite direction due to the external source of applied voltage.

3.5 OXIDATION-REDUCTION POTENTIAL MEASUREMENT

Oxidation - The process in which an atom or group of atoms loses electrons to achieve an increasing positive charge.

Reduction - The gaining of electrons by an atom or group of atoms and subsequent increase in negative charge.

Oxidation-Reduction Potential (ORP) - A measure of the activity ratio of oxidizing and reducing species as determined by the electromotive force developed by a noble metal electrode, immersed in water, as referenced against a standard hydrogen electrode.

3.6 SPECIFIC ION ELECTRODES MEASUREMENT

Specific Ion Electrode - An electrode which develops a potential difference across a membrane in response to the concentration differences for selected ions on either side of that membrane.

4.0 RESPONSIBILITIES

Site Manager - in consultation with the Project Geochemist, is responsible for determining which on-site water quality measurements can contribute to the RI, when these measurements shall be made, and the data quality objectives (DQOs) for these measurements. The Project Operations Plan (POP) shall contain details of type, frequency and locations of the desired measurements.

Project Geochemist - primarily responsible for determining the type, frequency and locations for on-site water quality measurements as presented in the POP and for interpreting the results, including determination of which measurements are unrepresentative.

Field Operations Leader - responsible for implementing the POP, and also for deciding under what field conditions a particular on-site measurement will be unrepresentative or unobtainable.

Field Samplers/Analysts - responsible for the actual analyses that take place, including calibration, quality control and recording of results, as well as for the care and maintenance of the equipment in the field.

5.0 GUIDELINES

5.1 MEASUREMENT OF pH

5.1.1 General

Measurement of pH is one of the most important and frequently used tests in water chemistry. Practically every phase of water supply and wastewater treatment such as acid-base neutralization, water softening, and corrosion control, is pH dependent. Likewise, the pH of leachate can be correlated with other chemical analyses to determine the probable source of contamination. It is therefore important that reasonably accurate pH measurements be taken.

Measurements of pH can also be used to check the quality and corrosivity of soil and solid waste samples. However, these samples must be immersed in water prior to analysis, and specific techniques are not described.

Two methods are given for pH measurement: the pH meter and pH indicator paper. The indicator paper is used when only a rough estimate of the pH is required, and the pH meter when a more accurate measurement is needed. The response of a pH meter can be affected to a slight degree by high levels of colloidal or suspended solids, but the effect is usually small and generally of little significance. Consequently, specific methods to overcome this interference are not described. The response of pH paper is unaffected by solution interferences from color, turbidity, colloidal or suspended materials unless extremely high levels capable of coating or masking the paper are encountered. In such cases, use of a pH meter is recommended.

5.1.2 Principles of Equipment Operation

Use of pH papers for pH measurement relies on a chemical reaction caused by the acidity or basicity of the solution with the indicator compound on the paper. Depending on the indicator and the pH range of interest, a variety of different colors can be used. Typical indicators are weak acids or bases, or both. Process chemistry and molecular transformations leading to the color change are variable and complex.

Use of a pH meter relies on the same principle as other ion-specific electrodes. Measurement relies on establishment of a potential difference across a glass or other type of membrane in response to hydrogen ion concentration across that membrane. The membrane is conductive to ionic species and, in combination with a standard or reference electrode, a potential difference proportional to hydrogen ion concentration can be generated and measured.

5.1.3 Equipment

The following equipment is needed for taking pH measurements:

- Accumet 150 portable pH meter, or equivalent.
- Combination electrode with polymer body to fit the above meter (alternately a pH electrode and a reference electrode can be used if the pH meter is equipped with suitable electrode inputs.
- pH indicator paper, such as Hydrion or Alkacid, to cover the pH range 2 through 12.
- Buffer solutions of pH 4, 7 and 10, or other buffers which bracket the expected pH range.

5.1.4 Measurement Techniques for Field Determination of pH

1. pH Meter

The following procedure is used for measuring pH with a pH meter (Standardization is according to manufacturers instructions):

a. The instrument and batteries shall be checked and calibrated prior to initiation of the field effort.

b. The accuracy of the buffer solutions used for field and laboratory calibration shall be checked. Buffer solutions need to be changed often due to degradation upon exposure to the atmosphere.

c. Immerse the tip of the electrodes in water overnight. If this is not possible due to field conditions, immerse the electrode tip in water for at least an hour before use. The electrode tip may be immersed in a rubber or plastic sack containing buffer solution for field transport or storage. This is not applicable for all electrodes as some must be stored dry.

d. Make sure all electrolyte solutions within the electrode(s) are at their proper levels and that no air bubbles are present within the electrode(s).

e. Immerse the electrode(s) in a pH-7 buffer solution.

f. Adjust the temperature compensator to the proper temperature (on models with automatic temperature adjustment, immerse the temperature probe into the buffer solution). Alternately, the buffer solution may be immersed in the sample and allowed to reach temperature equilibrium before equipment calibration. It is best to maintain buffer solution at or near expected sample temperature before calibration.

g. Adjust the pH meter to read 7.0.

h. Remove the electrode(s) from the buffer and rinse well with demineralized water. Immerse the electrode(s) in pH-4 or 10 buffer solution (depending on the expected pH of the sample) and adjust the slope control to read the appropriate pH. For best results, the standardization and slope adjustments shall be repeated at least once.

i. Immerse the electrode(s) in the unknown solution, slowly stirring the probe until the pH stabilizes. Stabilization may take several seconds to minutes. If the pH continues to drift, the sample temperature may not be stable, a chemical reaction (e.g., degassing) may be taking place in the sample, or the meter or electrode may be malfunctioning. This must be clearly noted in the logbook.

j. Read and record the pH of the solution, after adjusting the temperature compensator to the sample temperature. pH shall be recorded to the nearest 0.1 pH unit. Also record the sample temperature.

k. Rinse the electrode(s) with deionized water.

l. Keep the electrode(s) immersed in deionized water when not in use.

The sample used for pH measurement shall never be saved for subsequent conductivity or chemical analysis. All pH electrodes leak small quantities of electrolytes (e.g., sodium or potassium chloride) into the solution. Precipitation of saturated electrolyte solution, especially at colder temperatures, or in cold water, may result in slow electrode response. Any visual observation of conditions which may interfere with pH measurement, such as oily materials, or turbidity, shall be noted.

2. pH Paper

Use of pH paper is very simple and requires no sample preparation, standardization, etc. pH paper is available in several ranges, including wide-range (indicating approximately pH 1 to 12), mid-range (approximately pH 0 to 6, 6 to 9, 8 to 14) and narrow-range (many available, with ranges as narrow as 1.5 pH units). The appropriate range of pH paper shall be selected. If the pH is unknown the investigation shall start with wide-range paper.

5.2 MEASUREMENT OF SPECIFIC CONDUCTANCE

5.2.1 General

Conductance provides a measure of dissolved ionic species in water and can be used to identify the direction and extent of migration of contaminants in groundwater or surface water. It can also be used as a measure of subsurface biodegradation or to indicate alternate sources of groundwater contamination.

Conductivity is a numerical expression of the ability of a water sample to carry an electric current. This value depends on the total concentration of the ionized substances dissolved in the water and the temperature at which the measurement is made. The mobility of each of the various dissolved ions, their valences, and their actual and relative concentrations affect conductivity.

It is important to obtain a specific conductance measurement soon after taking a sample, since temperature changes, precipitation reactions, and absorption of carbon dioxide from the air all affect the specific conductance.

5.2.2 Principles of Equipment Operation

An aqueous system containing ions will conduct an electric current. In a direct-current field, the positive ions migrate toward the negative electrode, while the negatively charged ions migrate toward the positive electrode. Most inorganic acids, bases and salts (such as hydrochloric acid, sodium carbonate, or sodium chloride, respectively) are relatively good conductors. Conversely, organic compounds such as sucrose or benzene, which do not disassociate in aqueous solution, conduct a current very poorly, if at all.

A conductance cell and a Wheatstone Bridge (for the measurement of potential difference) may be used for measurement of electrical resistance. The ratio of current applied to voltage across the cell may also be used as a measure of conductance. The core element of the apparatus is the conductivity cell containing the solution of interest. Depending on ionic strength of the aqueous solution to be tested, a potential difference is developed across the cell which can be converted directly or indirectly (depending on instrument type) to a measurement of specific conductance.

5.2.3 Equipment

The following equipment is needed for taking specific conductance measurements:

- YSI Model 33 portable conductivity, meter, or equivalent
- Probe for above meter

A variety of conductivity meters are available which may also be used to monitor salinity and temperatures. Probe types and cable lengths vary, so equipment may be obtained to meet the specific requirement of the sampling program.

5.2.4 Measurement Techniques for Specific Conductance

The steps involved in taking specific conductance measurements are listed below (standardization is according to manufacturers instructions):

- Check batteries and calibrate instrument before going into the field.
- Calibrate the instrument daily when used. Potassium chloride solutions with a specific conductance closest to the values expected in the field shall be used. Attachment A may be used for guidance.
- Rinse the cell with one or more portions of the sample to be tested or with deionized water.
- Immerse the electrode in the sample and measure the conductivity. Adjust the temperature setting to the sample temperature.
- Read and record the results in a field logbook or sample log sheet.

If the specific conductance measurements become erratic, or inspection shows that any platinum black has flaked off the electrode, replatinization of the electrode is necessary. See the manufacturer's instructions for details.

Note that specific conductance is occasionally reported at temperatures other than ambient.

5.3 MEASUREMENT OF TEMPERATURE

5.3.1 General

In combination with other parameters, temperature can be a useful indicator of the likelihood of biological action in a water sample. It can also be used to trace the flow direction of contaminated groundwater. Temperature measurements shall be taken in-situ, or as quickly as possible in the field. Collected water samples may rapidly equilibrate with the temperature of their surroundings.

5.3.2 Equipment

Temperature measurements may be taken with alcohol-toluene, mercury filled or dial-type thermometers. In addition, various meters such as specific conductance or dissolved oxygen meters, which have temperature measurement capabilities, may also be used. Using such instrumentation along with suitable probes and cables, in-situ measurements of temperature at great depths can be performed.

5.3.3 Measurement Techniques for Water Temperature

If a thermometer is used on a collected water sample:

- Immerse the thermometer in the sample until temperature equilibrium is obtained (1-3 minutes). To avoid the possibility of contamination, the thermometer shall not be inserted into samples which will undergo subsequent chemical analysis.

- Record values in a field logbook or sample log sheet.

If a temperature meter or probe is to be used, the instrument shall be calibrated according to manufacturer's recommendations with an approved thermometer before each measurement or group of closely spaced measurements.

5.4 MEASUREMENT OF DISSOLVED OXYGEN CONCENTRATION

5.4.1 General

Dissolved oxygen (DO) levels in natural water and wastewater depend on the physical, chemical and biochemical activities in the water body. Conversely, the growth of many aquatic organisms as well as the rate of corrosivity, are dependent on the dissolved oxygen concentration. Thus, analysis for dissolved oxygen is a key test in water pollution and waste treatment process control. If at all possible, DO measurements shall be taken in-situ, since concentration may show a large change in a short time if the sample is not adequately preserved.

The method monitoring discussed herein is limited to the use of dissolved oxygen meters only. Chemical methods of analysis (i.e., Winkler methods) are available, but require more equipment and greater sample manipulation. Furthermore, DO meters, using a membrane electrode, are suitable for highly polluted waters, because the probe is completely submersible, and are free from interference caused by color, turbidity, colloidal material or suspended matter.

5.4.2 Principles of Equipment Operation

Dissolved oxygen probes are normally electrochemical cells that have two solid metal electrodes of different nobility immersed in an electrolyte. The electrolyte is retained by an oxygen-permeable membrane. The metal of highest nobility (the cathode) is positioned at the membrane. When a suitable potential exists between the two metals, reduction of oxygen to hydroxide ion (OH) occurs at the cathode surface. An electrical current is developed that is directly proportional to the rate of arrival of oxygen molecules at the cathode.

Since the current produced in the probe is directly proportional to the rate of arrival of oxygen at the cathode, it is important that a fresh supply of sample always be in contact with the membrane. Otherwise, the oxygen in the aqueous layer along the membrane is quickly depleted and false low readings are obtained. It is therefore necessary to stir the sample (or the probe) constantly to maintain fresh solution near the membrane interface. Stirring, however, shall not be so vigorous that additional oxygen is introduced through the air-water interface at the sample surface. To avoid this possibility, some probes are equipped with stirrers to agitate the solution near the probe, but to leave the surface of the solution undisturbed.

Dissolved oxygen probes are relatively free of interferences. Interferences that can occur are reactions with oxidizing gases (such as chlorine) or with gases such as hydrogen sulfide which are not

easily depolarized from the indicating electrode. If the gaseous interference is suspected, it shall be noted in the field log book and checked if possible. Temperature variations can also cause interference because probes exhibit temperature sensitivity. Automatic temperature compensation is normally provided by the manufacturer.

5.4.3 Equipment

The following equipment is needed to measure dissolved oxygen concentration:

- YSI Model 56 dissolved oxygen monitor or equivalent.
- Dissolved oxygen/temperature probe for above monitor.
- Sufficient cable to allow the probe to contact the sample.

5.4.4 Measurement Techniques for Dissolved Oxygen Determination

Probes differ as to specifics of use. Follow the manufacturer's instructions to obtain an accurate reading. The following general steps shall be used to measure the dissolved oxygen concentration:

- The equipment shall be calibrated and have its batteries checked in the laboratory before going to the field.

- The probe shall be conditioned in a water sample for as long a period as practical before use in the field. Long periods of dry storage followed by short periods of use in the field may result in inaccurate readings.

- The instrument shall be calibrated in the field before each measurement or group of closely spaced measurements by placing the probe in a water sample of known dissolved oxygen concentration (i.e., determined by Winkler method) or in a freshly air-saturated water sample of known temperature. Dissolved oxygen values for air-saturated water can be determined by consulting a table listing oxygen solubilities as a function of temperature and salinity (see Attachment B).

- Immerse the probe in the sample. Be sure to provide for sufficient flow past the membrane, either by stirring the sample, or placing the probe in a flowing stream. Probes without stirrers placed in wells can be moved up and down.

- Record the dissolved oxygen content and temperature of the sample in a field logbook or sample log sheet.

- Recalibrate the probe when the membrane is replaced, or as needed. Follow the manufacturer's instructions.

Note that in-situ placement of the probe is preferable, since sample handling is not involved. This however, may not always be practical. Be sure to record whether the liquid was analyzed in-situ, or if a sample was taken.

Special care shall be taken during sample collection to avoid turbulence which can lead to increased oxygen solubilization and positive test interferences.

5.5 MEASUREMENT OF OXIDATION-REDUCTION POTENTIAL

5.5.1 General

The oxidation-reduction potential (ORP) provides a measure of the tendence of organic or inorganic compounds to exist in an oxidized state. The technique therefore provides evidence of the likelihood of anaerobic degradation of biodegradable organics or the ratio of activities of oxidized to reduced species in the sample.

5.5.2 Principles of Equipment Operation

When an inert metal electrode, such as platinum, is immersed in a solution, a potential is developed at that electrode depending on the ions present in the solution. If a reference electrode is placed in the same solution, an ORP electrode pair is established. This electrode pair allows the potential difference between the two electrodes to be measured and will be dependent on the concentration of the ions in solution. By this measurement, the ability to oxidize or reduce species in solution may be determined. Supplemental measurements, such as dissolved oxygen, may be correlated with ORP to provide a knowledge of the quality of the solution, water, or wastewater.

5.5.3 Equipment

The following equipment is needed for measuring the oxidation-reduction potential of a solution:

- Accumet 150 portable pH meter or equivalent, with a millivolt scale.
- Platinum electrode to fit above pH meter.
- Reference electrode such as a calomel, silver-silver chloride, or equivalent.

5.5.4 Measurement Techniques for Oxidation-Reduction Potential

The following procedure is used for measuring oxidation-reduction potential:

- The equipment shall be calibrated and have its batteries checked before going to the field.

- Check that the platinum probe is clean and that the platinum bond or tip is unoxidized. If dirty, polish with emery paper or, if necessary, clean the electrode using aqua regia, nitric acid, or chromic acid, in accordance with manufacturer's instructions.

- Thoroughly rinse the electrode with demineralized water.

- Verify the sensitivity of the electrodes by noting the change in millivolt reading when the pH of the test solution is altered. The ORP will increase when the pH of the test solution decreases and the ORP will decrease if the test solution pH is increased. Place the sample in a clean glass beaker and agitate the sample. Insert the electrodes and note the ORP drops sharply when the caustic is added, the electrodes are sensitive and operating properly. If the ORP increases sharply when the caustic is added, the polarity is reversed and must be corrected in accordance with the manufacturer's instructions. If the ORP does not respond as above when the caustic is added, the electrodes shall be cleaned and the above procedure repeated.

- After the assembly has been checked for sensitivity, wash the electrodes with three changes of water or by means of a flowing stream of water from a wash bottle. Place the sample in a clean glass beaker or sample cup and insert the electrodes. Set temperature

compensator throughout the measurement period. Read the millivolt potential of the solution, allowing sufficient time for the system to stabilize and reach temperature equilibrium. Measure successive portions of the sample until readings on two successive portions differ by no more than 10 mV. A system that is very slow to stabilize properly will not yield a meaningful ORP. Record all results in a field logbook, including ORP (to nearest 10 mV), sample temperature and pH at the time of measurement.

5.6 SPECIFIC ION ELECTRODE MEASUREMENTS

5.6.1 General

Use of specific ion electrodes can be beneficial in the field for determining the presence and concentration of dissolved inorganic species which may be associated with contaminant plumes or leachate. Thus, electrodes can be used for rapid screening of water quality and determination of water migration pathways.

This procedure provides generic information for specific ion electrodes commonly used in groundwater quality monitoring programs and describes the essential elements of a field investigation program. Analytical methods using some specific ion electrodes have not been approved by the USEPA. In addition, calibration procedures and solutions, interferences and conditions and requirements for use for various electrodes vary greatly. Consequently, review of manufacturer's literature is mandatory prior to use.

5.6.2 Principles of Equipment Operation

All specific ion electrode measurements involve the use of a reference electrode, a pH meter, and a specific ion electrode (SIE). When the SIE and the reference electrode are immersed in a solution of the ion to be measured, a potential difference is developed between the two electrodes. This potential can be measured by a pH meter and related to the concentration of the ion of interest through the use of standard solutions and calibration curves.

Several different types of SIEs are in use: glass, solid-state, liquid-liquid membrane, and gas-sensing. All of the electrodes function using an ion exchange process as the potential determining mechanism. Glass electrodes are used for pH measurement. The glass in the tip of the electrode actually acts as a semi-permeable membrane to allow solution. Solid-state electrodes replace the glass membrane with an ionically-conducting membrane, (but act in essentially the same manner) while liquid-liquid membrane electrodes have an organic liquid ion exchanger contained in the pores of a hydrophobic membrane. Maintenance of the conducting interface, in combination with a reference electrode, allows completion of the electrical circuit and subsequent measurement of the potential difference. Gas-sensing electrodes have a membrane that permits the passage of gas only, thus allowing for the measurement of gas concentration. Regardless of the mechanism involved in the electrode, most SIEs are easy to use under field conditions. The sensitivity and applicable concentration range for various membranes and electrodes will vary.

5.6.3 Equipment

The following equipment is required for performing quantitative analyses using a specific ion electrode:

- A pH meter with a millivolt scale, or equivalent.
- The specific ion electrode for the parameter to be measured. A partial list of ions which can be measured includes cyanide, sulfide, ammonia, lead, fluoride and chloride.
- A suitable reference electrode to go with the above SIE.

Specific electrodes for other ions have also been developed, but are not widely used for field investigation efforts at this time. Note that of the specific electrodes referenced above, only fluoride and ammonia have analytical methods approved by the U.S. EPA.

5.6.4 Measurement Techniques for Inorganic Ions Using Specific Ion Electrodes

Different types of electrodes are used in slightly different ways and are applicable for different concentration ranges. Following the manufacturer's instructions, the general steps given below are usually followed:

- Immerse the electrode in water for a suitable period of time prior to sample analysis.

- Standardize the electrode according to the manufacturer's instructions, including necessary chemical additions for ionic strength adjustment, etc. Standard solutions normally differ by factors of ten in concentration. Constant stirring is needed for accurate readings.

- Immerse the electrode in the sample. Allow the reading to stabilize and record the results in a site logbook. Stir the sample at the same rate as the standards. Air bubbles near the membrane shall be avoided, since this may cause interference in millivolt readings.

(NOTE: Each SIE has substances which interfere with proper measurement. These may be eliminated using pretreatment methods as detailed by the manufacturer. It is important to know if interferences are present so that suspect readings may be noted as such.)

- If the pH meter does not read out directly, plot millivolts versus concentration for the standards and then determine sample concentration.

6.0 REFERENCES

American Public Health Association, 1980. Standard Methods for the Examination of Water and Wastewater, 15th Edition, APHA, Washington, D.C.

U.S. EPA, 1979. Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020.

U.S. Geological Survey, 1984. National Handbook of Recommended Methods for Water Data Acquisition, Chapter 5: Chemical and Physical Quality of Water and Sediment. U.S. Department of the Interior, Reston, Virginia.

7.0 ATTACHMENTS

Attachment A - Specific Conductance of KC1 Solutions at 25 degrees Centigrade

Attachment B - Variation of Dissolved Oxygen Concentration in Water as a a Function of Temperature and Salinity.

ATTACHMENT A

SPECIFIC CONDUCTANCE OF M KCl AT VARIOUS TEMPERATURES[1]

Temperature (°C)	Specific Conductance (µmhos/cm)
15	1,147
16	1,173
17	1,199
18	1,225
19	1,251
20	1,278
21	1,305
22	1,332
23	1,359
24	1,368
25	1,413
26	1,441
27	1,468
28	1,496
29	1,524
30	1,552

1 Data derived from the International Critical Tables 1-3-8.

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1.0 PURPOSE

This procedure describes the appropriate containers to be used for samples depending on the analyses to be performed, and the steps necessary to preserve the samples when shipped offsite for chemical analysis.

2.0 SCOPE

Different types of chemicals react differently with sample containers made of various materials. For example, trace metals adsorb more strongly to glass than to plastic, while many organic chemicals may dissolve various types of plastic containers. It is therefore critical to select the correct container in order to maintain the quality of the sample prior to analysis.

Many water and soil samples are unstable, and therefore require preservation when the time interval between field collection and laboratory analysis is long enough to produce changes in either the concentration or the physical condition of the constituent(s) requiring analysis. While complete and irreversible preservation of samples is not possible, preservation does retard the chemical and biological changes that inevitably take place after the sample is collected.

Preservation techniques are usually limited to pH control, chemical addition(s) and refrigeration/ freezing. Their purpose is to (1) retard biological activity, (2) retard hydrolysis of chemical compounds/complexes, (3) reduce constituent volatility, and (4) reduce adsorption effects.

3.0 GLOSSARY

HCl - Hydrochloric Acid
H_2SO_4 - Sulfuric Acid
HNO_3 - Nitric Acid
NaOH - Sodium Hydroxide

Normality (N) - Concentration of a solution expressed as equivalent per liter, an equivalent being the amount of a substance containing one gram-atom of replaceable hydrogen or its equivalent. Thus, a one molar solution of HCl, containing one gram-atom of H, is "one-normal," while a one molar solution of H_2SO_4 containing two gram-atoms of H, is "two-normal."

4.0 RESPONSIBILITIES

Field Operations Leader - retains overall responsibility for the proper storage and preservation of samples. During the actual collection of samples, the sampling technician(s) will be directly responsible for the bottling, preservation, labeling, and custody of the samples they collect until released to another party for storage or transport to the analytical laboratory.

5.0 PROCEDURES

5.1 SAMPLE CONTAINERS

For most samples and analytical parameters either glass or plastic containers are satisfactory. In general, if the analyte(s) to be determined is organic in nature, the container shall be made of glass. If the analyte(s) is inorganic, then the container shall be plastic. Since container specification will depend on the analyte and sample matrix types (as indicated in Attachment A) duplicate samples shall be taken when both organic and inorganic analyses are required. Containers shall be kept in the

dark (to minimize biological or photooxidation/photolysis breakdown of constituent) until they reach the analytical laboratory. The sample container shall allow approximately 5-10 percent air space ("ullage") to allow for expansion/vaporization if the sample is heated during transport (1 liter of water at 4°C expands by 15 ml if heated to 130°F/55°C), however, head space for volatile organic analyses shall be omitted.

For CLP laboratories, containers will be obtained through the CLP Sample Management Office. For Responsible party actions or non-CLP laboratories, the laboratory shall provide containers that have been cleaned according to U.S. EPA procedures. Sufficient lead time shall be allowed. Shipping containers for samples, consisting of sturdy ice chests, are provided by the laboratory of the remedial investigation contractor.

Once opened, the container must be used at once for storage of a particular sample. Unused but opened containers are to be considered contaminated and must be discarded; because of the potential for introduction of contamination, they cannot be reclosed and saved for later use. Likewise, any unused containers which appear contaminated upon receipt, or which are found to have loose caps or missing Teflon liner (if required for the container) shall be discarded.

General sample container and sample volume requirements are listed in Attachment A. Specific container requirements are listed in Attachment B.

5.2 PRESERVATION TECHNIQUES

The preservation techniques to be used for various analytes are listed in Attachments A and B. Reagents required for sample preservation will either be added to the sample containers by the laboratory prior to their shipment to the Field or added in the Field. In general, aqueous samples of low concentration organics (or soil samples of low or medium concentration organics) are cooled to 4°C. Medium concentration aqueous samples and high hazard organics sample are not preserved. Low concentration aqueous samples for metals are acidified with HNO_3, while medium concentration and high hazard aqueous metal samples are not preserved. Low or medium concentration soil samples for metals are cooled to 4°C while high hazard samples are not preserved.

The following subsections describe the procedures for preparing and adding chemical preservatives. Attachments A and B indicate the specific analytes which require these preservatives.

5.2.1 Addition of Acid (H_2SO_4, HCl, or HNO_3) or Base

Addition of the following acids or bases may be specified for sample preservation; these reagents shall be analytical reagent (AR) grade and shall be diluted to the required concentration with double-distilled, deionized water in the laboratory, before Field sampling commences:

Acid Base	Concentration	Normality	Amount for Acidification*
HCl	1:1 dilution of concentrated HCl	6N	5-10 ml
H_2SO_4	1:1 dilution of concentrated H_2SO_4	18N	2-5 ml
HNO_3	Undiluted concentrated HNO_3	16N	2-5 ml
NaOH	400 grams solid NaOH in 870 ml water	10N	2 ml**

* Amount of acid to add (at the specified strength) per liter of water to reduce the sample pH to less than 2, assuming that the water is initially at pH 7, and is poorly buffered and does not contain particulate matter.

** To raise pH of 1 liter of water to 12.

The approximate volumes needed to acidify one liter of neutral water to a pH of less than 2 (or raise the pH to 12) are shown in the last column of the above table. These volumes are only approximate; if the water is more alkaline, contains inorganic or organic buffers, or contains suspended particles, more acid may be required. The final pH must be checked using narrow-range pH paper.

Sample acidification or base addition shall proceed as follows:

- Check initial pH of sample with wide range (0-14) pH paper.
- Fill sample bottle to within 5-10 ml of final desired volume and add about 1/2 of estimated acid or base required, stir gently and check pH with medium range pH paper (pH 0-6 or pH 7.5-14, respectively).
- Add acid or base a few drops at a time while stirring gently. Check for final pH using narrow range (0-2.5 or 11-13, respectively) pH paper; when desired pH is reached, cap sample bottle and seal.

  Never dip pH paper into the sample; apply a drop of sample to the pH paper using the stirring rod.

5.2.2 Cyanide Preservation

Pre-sample preservation is required if oxidizing agents such as chlorine are suspected to be present. To test for oxidizing agents, place a drop of the sample on KI-starch paper; a blue color indicates the need for treatment. Add ascorbic acid to the sample, a few crystals at a time, until a drop of sample produces no color on the KI-starch paper. Then add an additional 0.6 g of ascorbic acid for each liter of sample volume. Add NaOH solution to raise pH to greater than 12 as described in 5.2.1. If oxidizing agents are not suspected, add NaOH as directed.

5.2.3 Sulfide Preservation

Samples for sulfide analysis must be preserved by addition of 4 drops (0.2 ml) of 2N zinc acetate solution per 100 ml sample. The sample pH is then raised to 9 using NaOH. The 2N zinc acetate solution is made by dissolving 220 g of zinc acetate in 870 ml of distilled water to make 1 liter of solution.

5.2.4 Preservation of Organic Samples Containing Residual Chlorine

Some organic samples containing residual chlorine must be treated to remove this chlorine upon collection (See Attachment A). Test the samples for residual chlorine using EPA methods 330.4 or 330.5 (Field Test Kits are available for this purpose). If residual chlorine is present, add 0.008% sodium thiosulfate (80 mg per liter of sample).

5.2.5 Field Filtration

When the objective is to determine concentration of dissolved inorganic constituents in a water system, the sample must be filtered through a non-metallic 0.45 micron membrane filter immediately after collection. A filtration system is recommended if large quantities of samples must be filtered in the field. The filtration system shall consist of a Büchner funnel inserted into a single-hole rubber stopper, sized to form a seal when inserted into the top of a vacuum filter flask equipped with a single side arm. Heavy-wall Tygon tubing shall be attached to the single side arm of the vacuum filter flask and the suction port of a vacuum pump. The stem of the Büchner funnel shall extend below the level of the side arm of the vacuum filter flask to prevent any solvent from entering the tubing leading to the vacuum pump. Before filtration, the filter paper, which shall be of a size to lay flat on the funnel plate, shall be wetted with the solvent in order to "seal" it to the funnel. Slowly pour the solvent into the funnel and monitor the amount of solvent entering the vacuum filter flask. When the rate of solvent entering the flask is reduced to intermittent dripping and the added aliquot of solvent in the funnel has passed through the filter, the used filter paper shall be replaced with new filter paper. If the solvent contains a high percentage of suspended solids, a coarser-sized nonmetallic membrane filter may be used prior to usage of the 0.45 micron membrane filter. This "prefiltering" step may be necessary to expedite the filtration procedure. Discard the first 20 to 50 ml of filtrate from each sample to rinse the filter and filtration apparatus to minimize the risk of altering the composition of the samples by the filtering operation. For analysis of dissolved metals, the filtrate is collected in a suitable bottle (see Section 5.1) and is immediately acidified to pH 2.0 or less with nitric acid whose purity is consistent with the measurement to be made. Inorganic anionic constituents may be determined using a portion of the filtrate that has not been acidified.

Samples used for determining temperature, dissolved oxygen, Eh, and pH should not be filtered. Do not use vacuum filtering prior to determining carbonate and bicarbonate concentration because it removes dissolved carbon dioxide and exposes the sample to the atmosphere. Pressure filtration can be done using water pressure from the well. If gas pressure is required, use an inert gas such as argon or nitrogen.

Do not filter samples for analysis of volatile organic compounds. If samples are to be filtered for analyzing other dissolved organic constituents, use a glass-fiber or metal-membrane filter and collect the samples in a suitable container (see Section 5.1). Because most organic analyses require extraction of the entire sample, do not discard any of it. After filtering, the membrane containing the suspended fraction can be sealed in a glass container and analyzed separately as soon as practicable. Total recoverable inorganic constituents may be determined using a second, unfiltered sample collected at the same time as the sample for dissolved constituents.

6.0 REFERENCES

American Public Health Association, 1981. Standard Methods for the Examination of Water and Wastewater. 15th Edition. APHA, Washington, D.C.

U.S. EPA, 1984. "Guidelines Establishing Test Procedures for the Analysis of Pollutants under Clean Water Act." Federal Register, Volume 49 (209), October 26, 1984, p. 43234.

U.S. EPA, 1979. Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020. U.S. EPA-EMSL, Cincinnati, Ohio.

7.0 ATTACHMENTS

Attachment A - General Sample Container and Preservation Requirements CERCLA/RCRA Samples

Attachment B - Required Containers, Preservation Techniques, and Holding Times (3 sheets)

NUS CORPORATION ENVIRONMENTAL MANAGEMENT GROUP	STANDARD OPERATING PROCEDURES	Number SF-2.3	Page 1 of 4
		Effective Date 05/04/90	Revision 1
		Applicability EMG	
		Prepared Earth Sciences	
Subject DECONTAMINATION OF CHEMICAL SAMPLING AND FIELD ANALYTICAL EQUIPMENT		Approved D. Senovich	

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1.0 PURPOSE

The purpose of these procedures is to provide a general methodology, protocol, and reference information on the proper decontamination procedures to be used on chemical sampling and field analytical equipment.

2.0 SCOPE

This procedure addresses chemical sampling and field analytical equipment only, and should be consulted when equipment decontamination procedures are being developed as part of project-specific plans.

3.0 GLOSSARY

None.

4.0 RESPONSIBILITIES

Site Manager - responsible for ensuring that project-specific plans and the implementation of field investigations are in compliance with these guidelines.

Field Operations Leader - responsible for ensuring that decontamination procedures for all chemical sampling and field analytical equipment are programmed prior to the actual field effort and that personnel required to accomplish the task have been briefed and trained to execute the task.

5.0 PROCEDURES

In order to assure that chemical analysis results are reflective of the actual concentrations present at sampling locations, chemical sampling and field analysis equipment must be properly decontaminated prior to the field effort, during the sampling program (i.e., between sample points) and at the conclusion of the sampling program. This will minimize the potential for cross-contamination between sample points and the transfer of contamination offsite.

This procedure incorporates only those aspects of decontamination not addressed in other procedures. Specifically it incorporates those items involved in decontamination of chemical sampling and field analytical equipment.

5.1 ACCESS FOR SAMPLING

5.1.1 Bailers and Bailing Line

The potential for cross-contamination between sampling points via the use of common bailer, or its attached line, is high unless strict procedures for decontamination are followed. It is preferable, for the aforementioned reason, to dedicate an individual bailer and its line to each sample point, although this does not eliminate the need for decontamination of dedicated bailers. For non-dedicated sampling equipment, the following conditions and/or decontamination procedures should be followed.

Before the initial sampling and after each succeeding sampling point, the bailer must be decontaminated. The following steps should be followed if sampling for organic contaminants:

- Potable water rinse
- Alconox or Liquinox detergent wash
- Scrubbing of the line and bailer with a scrub brush may be required if the sample point if heavily contaminated with heavy or extremely viscous compounds
- Potable water rinse
- Rinse with 10 percent nitric acid solution*
- Deionized water rinse
- Acetone or methanol rinse
- Hexane rinse**
- Distilled/Deionized water rinse
- Air dry

If sampling for organics only, the nitric acid, acetone, methanol, and hexane rinses may be omitted. Contract-specific requirements may permit alternative procedures.

Braided nylon or polypropylene lines may be used with a bailer, however, the same line must not come in contact with the sample medium, otherwise, the line must be discarded in an approved receptacle and replaced. Prior to use, the bailer should be wrapped in aluminum foil or polyethylene sheeting.

5.1.2 Sampling Pumps

Most sampling pumps are normally low volume (less than 2 gpm) pumps. These include peristaltic, diaphragm, air-lift, pitcher and bladder pumps, to name a few. If these pumps are used for sampling from more than one sampling point, they must be decontaminated.

The procedures to be used for decontamination of sampling pumps compare to those used for a bailer except the 10 percent nitric acid solution is omitted. Each of the liquid factions is to be pumped through the system. The amount of pumping is dependent upon the size of the pump and the length of the intake and discharge hoses. Certain types of pumps are unacceptable for sampling purposes.

An additional problem is introduced when the pump relies on absorption of water via an inlet or outlet hose. For organic sampling, this hose should be Teflon. Other types of hoses leach organics into the water being sampled (especially the phthalate esters) or adsorb organics from the sampled water. For all other sampling, the hose should be Viton, polyethylene, or polyvinyl chloride (in order of preference). Whenever possible, dedicated hoses should be used.

---

* Due to the leaching ability of nitric acid, on stainless steel, this step is to be omitted if a stainless steel sampling device is being used and metals analysis is required with detection limits less than approximately 50 ppb; or the sampling equipment is dedicated.

** If sampling for pesticides, PCBs, or fuels.

5.1.3 Filtering Equipment

Part of the sampling plan may incorporate the filtering of groundwater samples, and subsequent preservation. This should occur as soon after sample retrieval as possible; preferably in the field as soon as the sample is obtained. To this end, three basic filtration systems are most commonly used - the in-line disposable Teflon filter, the inert gas over-pressure filtration system, and the vacuum filtration system.

For the in-line filter, decontamination is not required since the filter cartridge is disposable, however, the cartridge must be disposed of in an approved receptacle and the intake and discharge lines must still be decontaminated.

For the over-pressure and the vacuum filtration systems, the portions of the apparatus which come in contact with the sample must be decontaminated as outlined in the paragraphs describing the decontamination of bailers. (Note: Varieties of both of these systems come equipped from the manufacturer with Teflon-lined surfaces for those that would come into contact with the sample. These filtration systems are preferred when decontamination procedures must be employed.)

5.2 FIELD ANALYTICAL EQUIPMENT

5.2.1 Water Level Indicators

Water level indicators that come into contact with groundwater must be decontaminated using the following steps:

- Rinse with potable water
- Rinse with deionized water
- Acetone or methanol rinse
- Rinse with deionized water

Water level indicators that do not come in contact with the groundwater but may encounter incidental contact during installation or retrieval need only undergo the first and last steps stated above.

5.2.2 Probes

Probes, e.g., pH or specific ion electrodes, geophysical probes, or thermometers which would come in direct contact with the sample, will be decontaminated using the procedures specified above unless manufacturer's instructions indicate otherwise; in those cases, the methods of decontamination must be clearly described in the FSAP. Probes that contact a volume of groundwater not used for laboratory analyses can be rinsed with deionized water. For probes which make no direct contact, e.g., OVA equipment, the probe will be wiped with clean paper-towels or cloth wetted with alcohol.

6.0 REFERENCES

None.

7.0 RECORDS

None.

1.10-8/1/1992-00061

APPENDIX C

SITE-SPECIFIC HEALTH AND SAFETY PLAN (HASP)

APPENDIX C

SITE-SPECIFIC HEALTH AND SAFETY PLAN

INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER SITE 8 - NITROGLYCERIN PLANT OFFICE INDIAN HEAD, MARYLAND

SUBMITTED BY:

Anthony P. Klimek, P.E.
Project Manager

APPROVED BY:

Matthew M. Soltis, CSP
Health and Safety Manager

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1.0 SITE INFORMATION AND PERSONNEL ASSIGNMENTS

Site Name: Indian Head Division Naval Surface Warfare Center

Client Contact: Shawn Jorgensen Phone Number: (301) 743-6745

Address: Indian Head, Maryland

Effective Date: July 24, 1992

Purpose of Site Visit: Sediment/Soil Sampling for Mercury to Determine the Extent of Contamination

Proposed Dates of Work: August 24 - September 3, 1992

Project Team:

HALLIBURTON NUS Personnel:	Discipline/Tasks Assigned:
Anthony P. Klimek	Project Manager
Terry Rojahn	Field Operations Leader (FOL)/Geologist
Thomas M. Dickson	Health and Safety Officer (HSO)
Fred Ramser	Geologist/Sampler

Non-HALLIBURTON NUS Personnel:

Paul Berkman	Chesapeake Division, Project Manager

Plan Preparation:

Prepared by: Thomas M. Dickson

Reviewed and Approved by:

HALLIBURTON NUS
Navy CLEAN
Health and Safety Manager: Matthew M. Soltis, CSP

Reviewed:

HALLIBURTON NUS

Project Manager: Anthony P. Klimek

Follow Up Report:

Responsible Person: Terry Rojahn (Must fill out Follow-Up Report)

1.1 INTRODUCTION

This Health and Safety Plan (HASP) has been developed to provide the minimum safety procedures for HALLIBURTON NUS and subcontractor personnel engaged in sampling and surveying activities at the Naval Surface Warfare Center (NSWC). This plan was developed using available information regarding known/suspected chemical contaminants and physical hazards that may be encountered during the planned activities. If additional information becomes available prior to or throughout the course of field activities, this document will be modified accordingly. Modifications will be determined by the HALLIBURTON NUS Health and Safety Officer (HSO) and will be immediately communicated to appropriate personnel. This HASP is intended to be in compliance with 29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response; Final Rule."

This HASP is structured, and may be presented, as a stand-alone document. Although the information herein is designed to function independently, it may be used in conjunction with previously generated HASPs. If this document is used in this manner, and conflicting information becomes evident, this plan will take precedence.

2.0 DESCRIPTION AND BACKGROUND

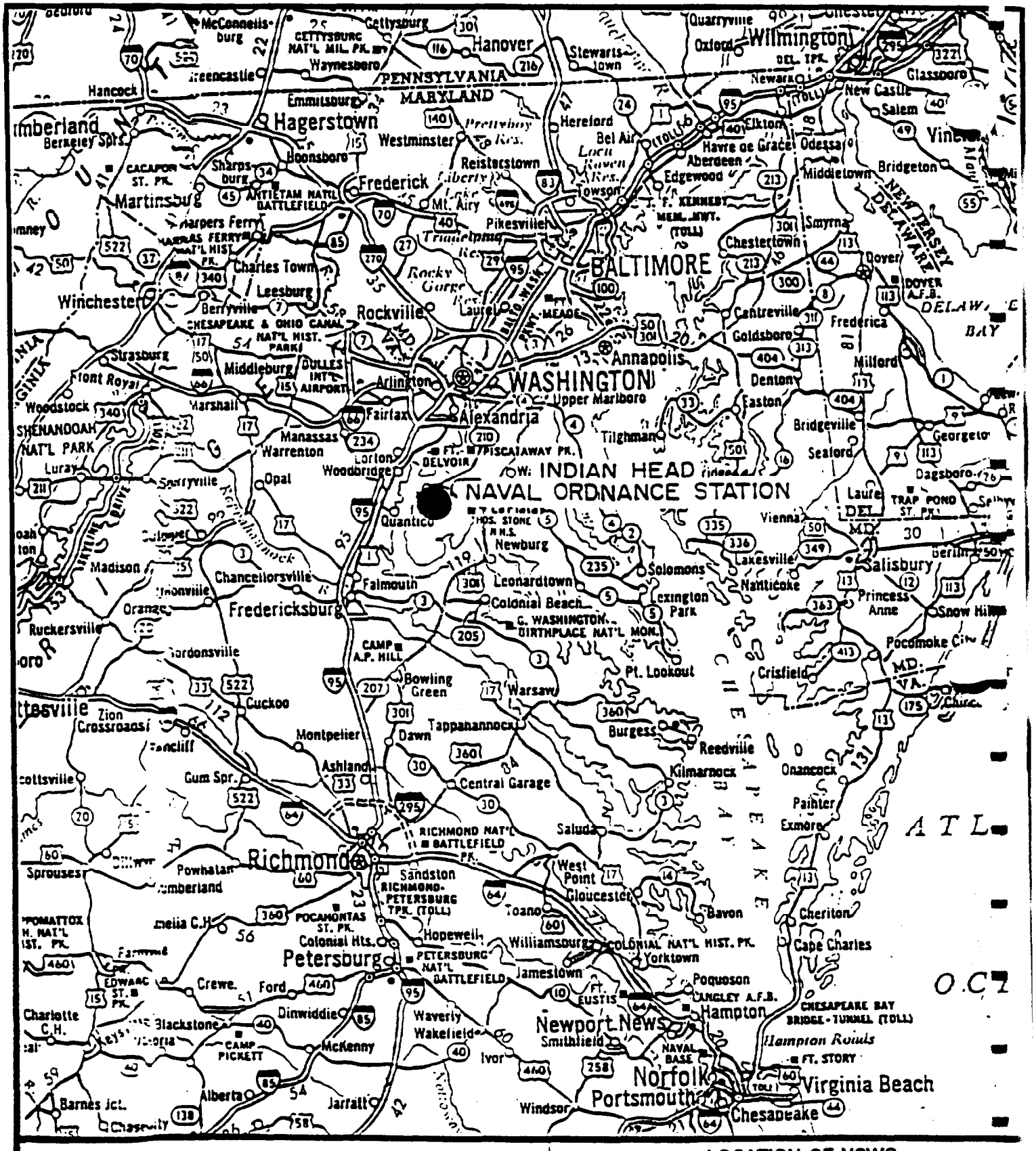
2.1 BACKGROUND INFORMATION

Indian Head Division, Naval Surface Warfare Center (NSWC) covers 3423 acres and is bounded by the Potomac River, Mattawoman Creek, Chicamuxen Creek, the town of Indian Head, and private property. It is situated in the northwestern section of Charles County, Maryland, 25 miles southwest of Washington, D.C. Figure 1 shows the location of the NSWC in relationship to the surrounding communities.

The mission of NSWC is to provide material and technical support for assigned weapons systems, weapons, or components and to perform additional tasks as directed by the Naval Sea Systems Command. These tasks may include research, development, engineering, production, and quality surveillance for weapons systems, propulsion, unconventional explosives, cartridge-actuated and propellant-actuated devices, and chemicals. Disciplines represented at NOS include expertise in weapons systems, propulsion, explosives development, and propellant and explosives chemistry.

NSWC hosts two major tenants: the Naval Explosive Ordnance Disposal Technology Center (NEODTC) and the Naval School, Explosive Ordnance Disposal (NSEOD). NEODTC was established to develop procedures for rendering safe conventional and special weapons, guided missiles, biological and chemical munitions, tools, and equipment. The mission of NSEOD is to train officers and enlisted personnel in methods and procedures for recovery, evaluation, rendering safe, and disposal of surface, underwater, conventional, and nuclear explosive ordnance.

Mercury is used as a catalyst at NSWC to perform a purity analysis of nitroglycerin. The nitrate-ester analysis is conducted at a laboratory in the Nitroglycerin (NG) Plant Laboratory Office (Building 766). Accidentally, droplets of waste mercury were disposed of down the sink and floor drains in the laboratory which lead to a small stream. For over 20 years prior to 1981 small amounts of mercury used in laboratory tests in Building 766 had been discharged into a storm drainage manhole outside the building and then into the open stream in this manner. The floor drain has been sealed off and these practices have been discontinued. The stream flows across 0.75 miles of Navy property into a tidal pond and then into Mattawoman Creek. The drainage has a total relief of 36 feet and discharges into a tidally influenced area of Mattawoman Creek. This ditch and tidal pond comprise Site 8, the location of which is presented on Figure 2.



LOCATION OF NSWC INDIAN HEAD

SCALE IN MILES

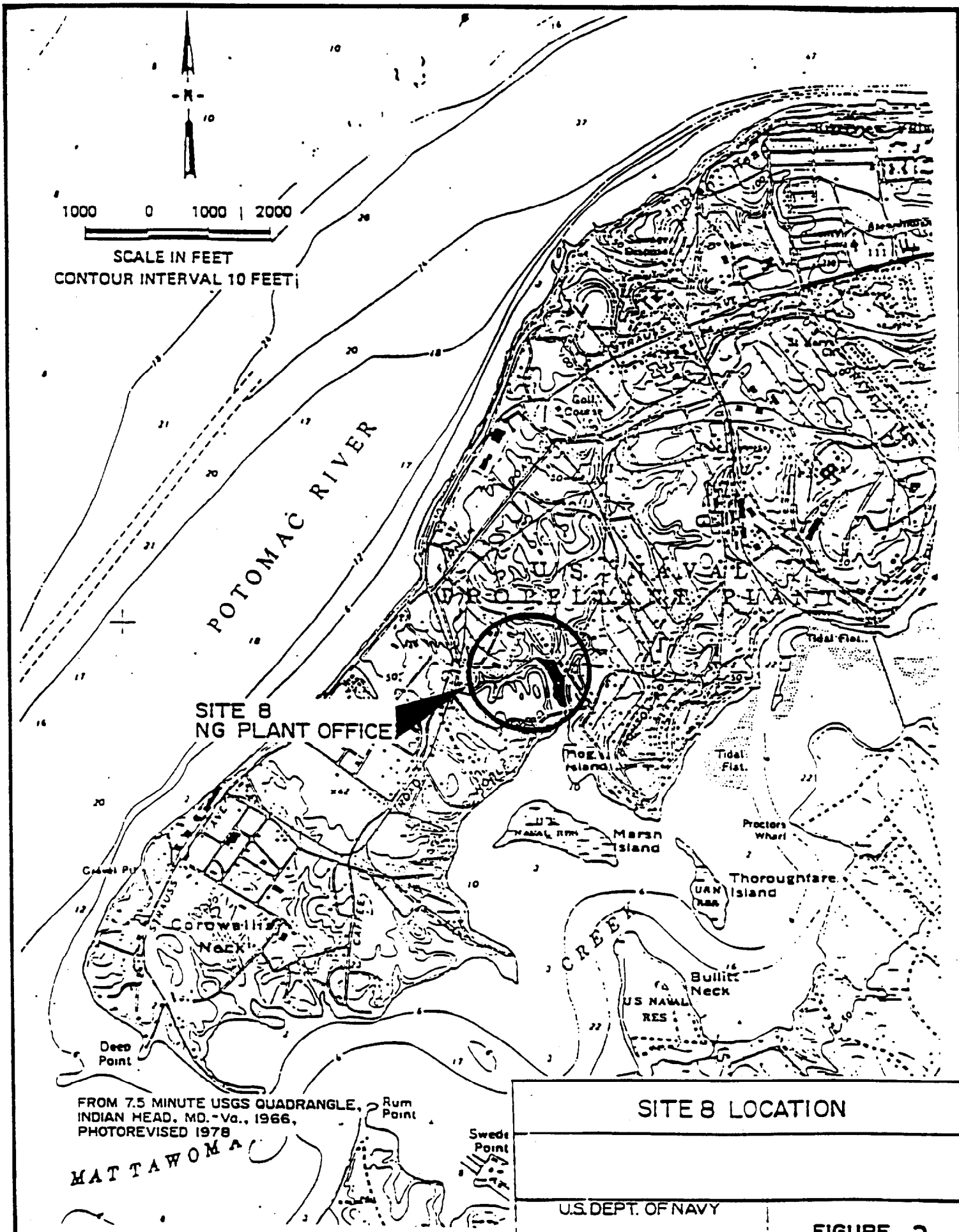
25 50

2-2

U.S. DEPT. OF NAVY

INDIAN HEAD, MARYLAND

FIGURE 1



SITE 8 LOCATION

U.S. DEPT. OF NAVY

INDIAN HEAD, MARYLAND

FIGURE 2

3.0 PROJECT SCOPE OF WORK

Environmental sampling and analysis will be performed to determine the horizontal and vertical extent of mercury contamination at various location around Site 8. The field work will be performed in a phased manner. Up to 200 sediment/soil samples and 10 surface water samples will be collected and analyzed. Soil samples will be collected using manually powered tools such as hand augers. Most sediment/soil and water samples will be collected on foot. However, some water and sediment samples will be collected out of the tidal pond/swamp area using a small boat. A detailed description of the Phase I sampling locations are found in Section 4.0 of the Abbreviated Field Sampling Plan. After completion of sampling activities, a survey team will survey the actual sampling points.

Sampling activities will also involve collecting samples from a stormwater drainage system which had been previously part of the source prior to its closure. These efforts, if at all possible, will be performed using remote sampling activities. If personnel entry into this system becomes necessary, the procedures specified in Section 14.0 of this HASP shall be strictly observed.

4.0 HAZARD ASSESSMENT

4.1 CHEMICAL HAZARDS

The primary hazard associated with this investigation will be the potential for dermal contact and inhalation exposure with the waste/contamination in general. The chief contaminant of concern during this sampling period is mercury. Previous sampling results would indicate mercury contamination of significant levels still exist within the physical parameters of the sampling area (See Appendix A). Table 4-1 presents a compilation of information on mercury, and can be used as a quick reference. Additional information concerning the health effects may be found in Appendix B.

The use of real-time monitoring instruments (Jerome 411 Mercury Vapor Analyzer) and visual observation will help to identify potential exposure to the site contaminant. Personal protective equipment (PPE), proper decontamination, site control, and standard work practices, Sections 6.0, 7.0, 12.0, and 10.0 of this plan, respectively, will be used when necessary to help reduce or eliminate exposures and therefore reduce the potential for adverse health effects.

4.2 PHYSICAL HAZARDS ON SITE

During the execution of the proposed scope of work (see section 3.0) certain physical hazards may be encountered by field personnel while engaged in on site activities. Based on the hazard analysis, it is anticipated the physical hazards could involve but not limited to the following items:

- Work in Ordnance Production Area
- Uneven or unstable terrain (slip, trip hazards)
- Strain or muscle pulls
- Noise in excess of 85 dBA
- Heat stress
- Water hazards
- Natural hazards (Ticks, Snakes, and other indigenous creatures)
- Hazards involved in Confined Space Entry activities
- Inclement weather

Control efforts for these potential hazards shall employ a variety of safety measures to mitigate these hazards. These measures shall be discussed individually with each area of concern mentioned above.

TABLE 4-1

PRIMARY CHEMICAL CONTAMINANT

Names & Synonyms	Chemical Abstract Service Number (CAS No.)	Safe Exposure Limit, OSHA; ACGIH; NIOSH	Method of Detection	Warning Properties	Signs & Symptoms of Overexposure	Physical Properties
Mercury (Vapor) Synonyms: -Quick Silver -Metallic Mercury -Colloidal Mercury	7439-97-6	0.05 mg/m^3 All forms except alkyl vapor, as Hg 0.01 mg/m^3 Alkyl compounds IDLH: 28 mg/m^3	Jerome Gold Film Mercury Vapor Analyzer	-Excessive Salvation -Metallic Taste Note: No adequate warning properties exist to avoid exposure. Those stated above are initial signs and symptoms of early exposure.	<u>Routes of Exposure:</u> Inhalation, contact irritating to eyes and skin, excessive salvation, foul breath, blackening of the teeth, reddening of the gums, cough, chest pain, difficulty in breathing, bronchitis, pneumonitis, fatigue, weakness, upset stomach, GI disturbance. <u>CNS Effects:</u> Insomnia, irritability, headaches, trumbling indecision, confusion	Boiling Pt: 674°F Melting Pt: Not Available Freezing Pt: -38°F -3.3°C Solubility: Insoluble Specific Gravity: 13.6 Vapor Pressure: 0.0012 mm Flash Pt: Noncombustible LEL: Noncombustible UEL: Noncombustible <u>Incompatibles:</u> Acetylene, ammonia, chlorine dioxide, azides, calcium (amalgam formation), sodium carbide, lithium rubidium, and copper

4.2.1 WORK IN ORDNANCE PRODUCTION AREA

The Indian Head Division, Naval Surface Warfare Center is an active ordnance production facility. Although no active production operation are anticipated to occur during the field sampling effort , the field crew will observe all required procedures and rules associated with work in the area. These rules include but not limited to :

- All personnel will sign in at Building 765, daily prior to the start of field work
- No sparking equipment
- No Two-Way Radios
- No fires and/or Smoking

4.2.2 UNEVEN OR UNSTABLE TERRAIN

During the surface water/sediment sampling there is potential for slip, trip, and falls associated with wet, steep or unstable banks and sediment surfaces along the ditches and tidal pond and other areas associated with the sampling task. To minimize the hazards of this nature, personnel required to work in and along areas prone to these types of hazards will be required to employ life lines and/or safety harnesses, ring buoys and other means of personnel extraction suitable for the task at hand. Additionally areas of the tidal pond at Site 8 which will require sampling, is covered with approximately 8 to 20 inches of soft muck. This soft muck will not support a mans weight rendering movement difficult if not impossible. All sampling within the tidal pond will require sampling from a supported platform (boat). All sampling conducted will be performed utilizing the Buddy system with one member of the team in position for extraction, whether into the boat or to bankside.

4.2.3 STRAIN, SPRAINS AND/OR MUSCLE PULLS

During execution of this scope of work there is potential for strains, sprains and/or muscle pulls due to the physical demands and nature of this task. To avoid injury, during lifting tasks personnel are to lift with the force of the load carried by their legs and not their backs. When lifting or handling heavy material or equipment, use an appropriate number of personnel. Due to the type of environment/topography (soft muck, swampy type environment), locomotion and operation will be extremely difficult. These conditions increase hazard potential and make even small jobs more difficult. Therefore extreme caution and best professional judgement should be exercised to mitigate these hazards as they are encountered.

4.2.4 NOISE IN EXCESS OF 85 dBA

As this sampling will be accomplished through manual means it is not anticipated that noise in excess of 85 dBA will be encountered. However as a precautionary measure hearing protection will be available on site should it be required.

4.2.5 Heat Stress

As this scope of work will require personnel to employ personal protective equipment (PPE) as a means of protection from both chemical and physical hazards, the potential for heat related disorders during the proposed field dates is significant. To combat this problem the Project Manager and the Health and Safety Officer shall initiate Heat stress monitoring, and effect the appropriate control efforts, in accordance with HALLIBURTON NUS Standard Operating Procedures HS-09 "Heat Stress Control", (a copy of which is included as Appendix C-III), and the following ACGIH recommended control measures.

The HSO shall visually monitor personnel to note for signs of heat stress. Field personnel will also be instructed to observe for symptoms of heat stress and methods on how to control it. One or more of the following control measures can be used to help control heat stress:

- Provide adequate liquids to replace lost body fluids. Personnel must replace water and salt lost from sweating. Personnel must be encouraged to drink more than the amount required to satisfy thirst. Thirst satisfaction is not an accurate indicator of adequate salt and fluid replacement.

- Replacement fluids can be commercial mixes such as Gatorade®.

- Establish a work regime that will provide adequate rest periods for cooling down. This may require additional shifts of workers.

- Cooling devices such as vortex tubes or cooling vests can be worn beneath protective garments.

- Breaks are to be taken in a cool rest area (77°F is best).

- Personnel shall remove impermeable protective garments during rest periods.

- Personnel shall not be assigned other tasks during rest periods.

- Personnel shall be informed of the importance of adequate rest, acclimation, and proper diet in the prevention of heat stress.

The heat stress of personnel on-site may be monitored utilizing biological monitoring or the Wet Bulb Globe Temperature Index (WBGT) technique when workers are not wearing protective coveralls (i.e. Tyvek®). This method will require the use of a heat stress monitoring device.

One of the following biological monitoring procedures shall be followed when the workplace temperature is 70°F or above.

- Heart rate (HR) shall be measured by the pulse for 30 seconds as early as possible in the resting period. The HR at the beginning of the rest period should not exceed 110 beats/minute. If the HR is higher, the next work period should be shortened by 10 minutes (or 33 percent), while the length of rest period stays the same. If the pulse rate is 100 beats/minute at the beginning of the next rest period, the following work cycle should be shortened by 33 percent. The length of the initial work period will be determined by using the table below.

PERMISSIBLE HEAT EXPOSURE THRESHOLD LIMIT VALUES

Work-Rest Regimen	Work Load		
	Light	Moderate	Heavy
Continuous	80.0°F	80.0°F	77.0°F
75% Work - 25% Rest, Each Hour	87.0°F	82.4°F	78.6°F
50% Work - 50% Rest, Each Hour	88.5°F	85.0°F	82.2°F
25% Work - 75% Rest, Each Hour	90.0°F	88.0°F	86.0°F

- Body temperature shall be measured orally with a clinical thermometer as early as possible in the resting period. Oral temperature at the beginning of the rest period should not exceed 99°F. If it does, the next work period should be shortened by 10 minutes (or 33 percent), while the length of the rest period stays the same. However, if the oral temperature exceeds 99.7°F at the beginning of the next rest period, the following work cycle shall be further shortened by 33 percent. OT should be measured at the end of the rest period to make sure that it has dropped below 99°F. At no time shall work begin with the oral temperature above 99°F.

NOTE: External temperatures in excess of those stated above shall be regarded as inclement weather. Work continuation, termination, or alteration of the work schedule will be at the discretion of the FTL and on site health and safety representative.

4.2.6 WATER HAZARDS

There are sampling points proposed within the sampling plan only accessible by boat or along waters edge. To avoid potential hazards associated with working on waters edge or over water (drowning) the field team shall employ life lines, safety harnesses, and U.S Coast Guard approved flotation devices when working on or within four feet of the water. As stated earlier some of these devices or a combination of, may be used for other reasons within this scope of work, however

the objective, when on or near water, is quick effective personnel extraction. All activities on water or at waters edge will be terminated should inclement weather conditions arise. This will be at the discretion and direction of the field team leader and the on site health and safety representative.

4.2.7 NATURAL HAZARDS (TICKS, SNAKES, MOSQUITOS, AND OTHER INDIGENOUS CREATURES)

Natural hazards such as poisonous plants, bites from poisonous or disease carrying animals or insects (i.e., snakes, ticks, mosquitos) cannot be avoided within this type of environment. However in an effort to offset the impact of this hazard field personnel will have access to commercially available snake bite kits,and insect repellants. Nesting areas in and about sampling points shall be avoided and another point selected within the vicinity. Lastly, within recent years a marked increase in Lyme Disease has been reported. For this operation this is a significant point as ticks are the primary vector. In an effort to control this hazard close attention must be given during operations and personal hygiene to detect and remove ticks once they have adhered to the body. Instruction will be given as to the hazard presented, control methods, and proper tick removal procedures (See Appendix D).

4.2.8 INCLEMENT WEATHER

As all work will be conducted outdoors, inclement weather may be encountered. As conditions may vary, it will be at the discretion of the field team leader and acting health and safety representative on the team to terminate work or continue work if these conditions present themselves. All activities shall be terminated in the event of electrical storms.

4.2.9 CONFINED SPACE ENTRY OPERATIONS

As previously stated, sampling activities involving the drywell system will be performed utilizing remote sampling activities to the greatest possible extent. If actual entry into the system becomes absolutely necessary, the procedures specified in Section 14.0 of this HASP will be strictly observed. Hazards associated with these types of activities involve encountering oxygen-deficient or toxic environments, limited working space (restricted mobility), poor illumination, energized utilities, product lines, and other hazards.

5.0 AIR MONITORING AND ACTION LEVELS

5.1 AIR MONITORING REQUIREMENTS

The Jerome 411 Mercury Vapor Analyzer will be used to detect any mercury vapor concentrations in the air. The range of the Jerome 411 is from 0.000 to 1.999 mg/m^3 Hg. The gold film sensor is inherently stable and selective to mercury, eliminating interferences such as particulates, hydrocarbons and magnetic fields, common to ultraviolet sensors.

5.2 FREQUENCY OF MONITORING

Continuous monitoring with the Jerome Gold-Film Mercury Analyzer will be conducted during all sampling activities. Monitoring will be initiated at any potential source of emissions, then moved to the worker's breathing zone for assessment.

The LEL/O2 Meter will be used in the event of confined space entry operations. Continuous monitoring will be required for all confined space activities. In addition, the Confined Space Entry Procedures (Section 14.0) will be followed.

5.3 AIR MONITORING ACTION LEVELS

All monitoring instrumentation used onsite will be calibrated and maintained in accordance with HALLIBURTON NUS Health and Safety SOPs and/or the manufacturer's recommendations. On a daily basis, before site work begins, background readings from a clean area will be obtained for instruments that will be used for field work. From this background level, the appropriate action level as described in this section will be observed.

5.3.1 Level B Respiratory Protection

Atmosphere supplying respiratory protection, SCBA or air-line, will be utilized anytime the following criteria is met:

- Anytime sustained readings above background are observed on the Jerome Gold-Film Mercury Analyzer.

- During all confined space entry operations.

5.3.2 Combustible Gas/Oxygen Meter

Action levels while monitoring with the LEL/O2 meter are as follows:

General

- If percent oxygen is measured less than 19.5 percent, work must stop and personnel must evacuate the area until oxygen levels stabilize and the situation can be re-evaluated.

- At 10 percent LEL, work shall proceed with caution, monitoring shall become more frequent, and samplers must limit activities to non-spark generating operations.

- At 20 percent LEL, all work shall stop and personnel shall evacuate to a safe (unaffected) area. Efforts must be taken to reduce levels before any activity may continue.

NOTE: For confined space entry operations, follow the action levels set forth in Section 14.0, Confined Space Entry Procedures.

6.0 PERSONAL PROTECTIVE EQUIPMENT (PPE)

Personal Protective Equipment (PPE) anticipated for use has been summarized in Table 6-1.

6.1 PPE SELECTION CRITERIA/LIMITATIONS:

- Safety glasses and steel toe, hard sole work boots were selected as minimum requirements to protect personnel from the physical hazards which may exist onsite. Neoprene outer and butyl inner gloves were selected as a precaution against direct skin contact with site contaminants. Tyvek coveralls were selected for tasks that involve a potential for contamination only by dust, dirt, or tick infestation. Saranex coveralls were selected for all other tasks including those to be conducted on or near water. Rubber boots or chemical-resistant boot covers were selected to prevent contamination and saturation of work boots.

- Respiratory protection, as described in Section 5.0, will be worn in accordance with the action levels set forth in that section.

- Sampling activities performed out of boating vessels and in the immediate vicinity of the tidal pond shall carry an additional requirement for the use of U.S. Coastal Guard-approved personal flotation devices.

- Hip waders may be required if sampling in especially muddy areas is necessary.

- TLD badges are required for all HALLIBURTON NUS personnel.

6.2 ACCEPTABLE MODIFICATIONS TO PERSONAL PROTECTION REQUIREMENTS

- Chemical resistant gloves will be worn whenever there is a potential for direct contact with site contaminants. Tyvek coveralls will be worn whenever contamination of street clothes by contaminant-laden dust or dirt is possible. Saranex coveralls will be worn when working on or near water and anytime free phase product in encountered. Joints between protective garments (i.e., at wrists and ankles) will be taped as necessary.

TABLE 6-1
PPE ANTICIPATED FOR EACH SITE TASK/OPERATION
INDIAN HEAD, MD

TASK/OPERATION	PPE ANTICIPATED
Soil Sampling	Safety glasses, steel-toe, hard sole work boots, Tyvek* coveralls, neoprene outer gloves, butyl inner gloves, rubber boots or chemical protective clothing boot covers, taped ankle/wrist seams. Respirators as per Section 5.0, Air Monitoring and Action Levels.
Surface Water and Sediment Sampling	Same as above only Saranex coveralls will be worn in place of Tyvek coveralls. This will be done when there is potential for direct contact with the contaminant in liquid phase, or contaminated media.
Surveying	Safety glasses, steel-toe boots, surgical-style gloves, rubber boot covers, Tyvek coveralls as necessary to prevent contamination of street clothes and protection from tick infestation.

* If free phase product in encountered or the potential exists for the Tyvek to become saturated, Saranex coveralls will be worn in place of Tyvek.

7.0 DECONTAMINATION

7.1 PERSONNEL DECONTAMINATION REQUIREMENTS

The decontamination of personnel and their protective clothing shall be performed in three stages. Stage 1 includes removing contamination from reusable protective clothing with a detergent/water solution and soft bristle scrub brushes. Stage 2 shall include removal of protective clothing (disposable items shall be discarded into a container conspicuously marked "Potentially Contaminated Clothing"). Stage 3 shall consist of workers washing hands and face with potable water and soap whenever they remove PPE and leave the exclusion zone.

All decontamination waste fluids and potentially contaminated PPE shall be contained and handled in accordance with the requirements stipulated by the client contact.

7.2 DECONTAMINATION OF SAMPLING TOOLS

All sampling equipment that will be leaving the site will require a thorough decontamination. This can be accomplished either by steam cleaning or by a detergent wash and potable water rinse until tools are visibly clean. Decontamination of sampling tools to prevent cross contamination of samples shall be performed in accordance with client specifications. All equipment, prior to leaving the site, will be inspected by the FTL to verify it has been properly decontaminated.

7.3 PPE REQUIREMENTS FOR DECONTAMINATION OPERATIONS

All decontamination efforts will require the use of chemical protective clothing as described below:

- PVC coveralls
- Neoprene outer gloves
- Butyl inner gloves
- Rubber boots (or rubber boot covers)
- Splash shield (if respirator not worn)
- Respiratory protection (if needed*)

* The same level of respiratory protection worn for the work assignment, will be worn when decontaminating the equipment used for that assignment.

8.0 TRAINING REQUIREMENTS

This section describes the minimum requirements for initial, refresher, supervisory, and site-specific training.

8.1 INTRODUCTORY AND REFRESHER TRAINING

8.1.1 REQUIREMENTS FOR HALLIBURTON NUS PERSONNEL

All HALLIBURTON NUS personnel must complete 40 hours of introductory hazardous waste site training prior to performing work at Indian Head. Additionally, HALLIBURTON NUS personnel who have had introductory training more than 12 months prior to site work must have completed 8 hours of refresher training within the past 12 months before being cleared for site work.

Documentation of HALLIBURTON NUS introductory and refresher training will be maintained at the project. Copies of certificates or other official documentation will be used to fulfill this requirement.

8.1.2 REQUIREMENTS FOR SUBCONTRACTORS

All HALLIBURTON NUS subcontractor personnel must have completed introductory hazardous waste site training or equivalent work experience as defined in OSHA Standard 29 CFR 1910.120(e) and 8 hours of refresher training meeting the requirements of 29 CFR 1910.120(e)(8) prior to performing field work Indian Head. HALLIBURTON NUS subcontractors must certify that each employee has had such training by sending HALLIBURTON NUS a letter, on company letterhead, containing the information in the example letter provided as Figure 8-1. Figures 8-1 and 9-2 can be combined into one letter.

8.2 SITE-SPECIFIC TRAINING

HALLIBURTON NUS will provide site-specific training to all HALLIBURTON NUS employees and subcontractor personnel who will perform work at this project. Site-specific training will include:

- Names of personnel and alternates responsible for site safety and health
- Safety, health and other hazards present on site
- Use of personal protective equipment
- Work practices to minimize risks from hazards
- Safe use of engineering controls and equipment
- Medical surveillance requirements

- Signs and symptoms of overexposure
- The contents of the health and safety plan and addendum
- Emergency response procedures (evacuation and assembly points)
- Review the contents of relevant Material Safety Data Sheets

8.2.1 SITE-SPECIFIC TRAINING DOCUMENTATION

HALLIBURTON NUS and subcontractor personnel will be required to sign a statement indicating receipt of site-specific training and understanding of site hazards and control measures. Figure 8-2 will be used to document site-specific training.

8.3 CONFINED SPACE ENTRY

If entry into the drywell system becomes absolutely necessary, all involved personnel shall be trained in the procedures specified in Section 14.0 of this HASP.

FIGURE 8-1

OSHA TRAINING CERTIFICATION

The following statements must be typed on company letterhead and signed by an officer of the company:

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

Month, day, year

Mr. Anthony Klimek
Project Manager
HALLIBURTON NUS Environmental Corp.
661 Andersen Drive
Pittsburgh, Pennsylvania 15220

Subject: Hazardous Waste Site Training - NSWC Indian Head

Dear Mr Klimek:

The employees listed below have had introductory hazardous waste site training or equivalent work experience as required by 29 CFR 1910.120(e). In addition, those employees listed below who have received their introductory training more than 12 months ago have also received 8 hours of refresher training in accordance with 29 CFR 1910.120 (e)(8) within the past 12 months.

LIST FULL NAMES OF EMPLOYEES AND THEIR SOCIAL SECURITY NUMBERS HERE

Should you have any questions, please contact me at (555) 555-5555.

Sincerely,

(Name of Company Officer)

FIGURE 8-2

SITE-SPECIFIC TRAINING DOCUMENTATION

My signature below indicates that I am aware of the potential hazardous nature of performing investigation activities at NSWC Indian Head and that I have received site-specific training which included the elements presented below:

- Names of personnel and alternates responsible for site safety and health
- Safety, health and other hazards present on site
- Use of personal protective equipment
- Work practices to minimize risks from hazards
- Safe use of engineering controls and equipment
- Medical surveillance requirements
- Signs and symptoms of overexposure
- The contents of the health and safety plan
- Emergency response procedures (evacuation and assembly points)
- Review contents of relevant Material Safety Data Sheets

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

NAME	SIGNATURE	DATE

9.0 MEDICAL SURVEILLANCE

9.1 REQUIREMENTS FOR HALLIBURTON NUS PERSONNEL

All HALLIBURTON NUS personnel participating in project field activities will have had a physical examination meeting the requirements of HALLIBURTON NUS' medical surveillance program and will be medically qualified to perform hazardous waste site work using respiratory protection.

Documentation for medical clearances will be maintained in the HALLIBURTON NUS Pittsburgh office and made available as necessary.

9.2 REQUIREMENTS FOR SUBCONTRACTORS

Subcontractors are required to obtain a certificate of their ability to perform hazardous waste site work and to wear respiratory protection. The "Subcontractor Medical Approval Form" (Figure 9-1) can be used to satisfy this requirement providing it is properly completed and signed by a licensed physician.

Subcontractors who have a company medical surveillance program meeting the requirements of paragraph (f) of OSHA 29 CFR 1910.120 can substitute Figure 9-1 with a letter, on company letterhead, containing all of the information in the example letter presented as Figure 9-2. Figures 8-1 and 9-2 can be combined into one letter.

9.3 REQUIREMENTS FOR ALL FIELD PERSONNEL

Each field team member (including subcontractors) shall be required to complete and submit a copy of Attachment C (Medical Data Sheet). This shall be provided to the HSO prior to participating in site activities.

FIGURE 9-1

SUBCONTRACTOR MEDICAL APPROVAL FORM

For employees of _____
Company Name

Participant Name: _____ Date of Exam: _____

Part A

The above-named individual has:

1. Undergone a physical examination in accordance with OSHA Standard 29 CFR 1910.120, paragraph (f) and found to be medically -

   ( ) qualified to perform work at the NSWC Indian Head work site
   ( ) not qualified to perform work at the NSWC Indian Head work site

   and,

2. Undergone a physical examination as per OSHA 29 CFR 1910.134(b)(10) and found to be medically -

   ( ) qualified to wear respiratory protection
   ( ) not qualified to wear respiratory protection

My evaluation has been based on the following information, as provided to me by the employer.

( ) A copy of OSHA Standard 29 CFR 1910.120 and appendices.
( ) A description of the employee's duties as they relate to the employee's exposures.
( ) A list of known/suspected contaminants and their concentrations (if known).
( ) A description of any personal protective equipment used or to be used.
( ) Information from previous medical examinations of the employee which is not readily available to the examining physician.

Part B

I, _____, have examined _____
Physician's Name (print) Participant's Name (print)
and have determined the following information:

FIGURE 9-1
SUBCONTRACTOR MEDICAL APPROVAL FORM
PAGE TWO

1. Results of the medical examination and tests (excluding finding or diagnoses unrelated to occupational exposure):

_____

_____

_____

2. Any detected medical conditions which would place the employee at increased risk of material impairment of the employee's health:

_____

_____

---

3. Recommended limitations upon the employee's assigned work:

_____

_____

_____

_____

I have informed this participant of the results of this medical examination and any medical conditions which require further examination of treatment.

Based on the information provided to me, and in view of the activities and hazard potentials involved at the _____ work site, this participant

( ) may
( ) may not

perform his/her assigned task.

Physician's Signature _____

Address _____

Phone Number _____

NOTE: Copies of test results are maintained and available at:

_____
Address

FIGURE 9-2

MEDICAL SURVEILLANCE LETTER

The following statements must be typed on company letterhead and signed by an officer of he company:

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

Month, day, year

Mr. Anthony Klimek
Project Manager
HALLIBURTON NUS Environmental Corp.
661 Andersen Drive
Pittsburgh, Pennsylvania 15220

Subject: Medical Surveillance - NSWC Indian Head

Dear Mr Klimek:

As an officer of XYZ Corporation, I hereby state that the persons listed below participate in a medical surveillance program meeting the requirements contained in paragraph (f) of Title 29 of the Code of Federal Regulations (CFR), Part 1910.120 entitled "Hazardous Waste Operations and Emergency Response: Final Rule." I further state that the persons listed below have had physical examinations under this program within the past 12 months and that they have been cleared, by a licensed physician, to perform hazardous waste site work and to wear positive and negative pressure respiratory protection. I also state that, to my knowledge, no person listed below has any medical restriction that would preclude him/her from working at NSWC Indian Head.

LIST FULL NAMES OF EMPLOYEES AND THEIR SOCIAL SECURITY NUMBERS HERE

Should you have any questions, please contact me at (555) 555-5555.

Sincerely,

(Name of Company Officer)

10.0 STANDARD WORK PRACTICES

The following Standard Work Practices are to be applied in addition to the Health and Safety Standard Operating procedures:

* Eating, drinking, chewing gum or tobacco, taking medication, and smoking are prohibited in the exclusion or decontamination zones, or any location where there is a possibility for contact with site contaminants exists.

* Upon leaving the exclusion zone, hands and face must be thoroughly washed with soap and potable water. Any protective outer clothing is to be decontaminated and removed as specified in this HASP, and left at a designated area prior to entering the clean area.

* Contact with potentially-contaminated substances must be avoided. Contact with the ground or with contaminated equipment must also be avoided.

* No facial hair, which interferes with a satisfactory fit of the mask-to-face seal, is permitted on personnel required to wear respiratory protective equipment.

* All personnel must satisfy all training requirements (40-hr, 8-hr refresher, site specific training, emergency response training) prior to commencing site activities.

* All personnel must have a working knowledge of this HASP. Including being aware of the action levels for upgrading/downgrading levels of protective equipment, and emergency procedures.

* All personnel must satisfy medical monitoring procedures.

* All personnel must complete a medical data sheet, to be maintained on site (see Attachment C).

* All personnel working in sight restriction areas of heavy vegetation or where the topography does not permit line of sight contact must utilize the buddy system.

* When lifting or moving equipment or material, use proper lifting techniques.

* All work areas must be kept free of ground clutter.

* No flames or open fires will be permitted on site.

* Site personnel must immediately notify HALLIBURTON NUS Health Sciences of all incidents for OSHA recordkeeping purposes.

* If personnel note any warning properties of chemicals (irritation, odors, symptoms, etc.) or even remotely suspect the occurrence of exposure, they must immediately notify the CHSO for further direction.

* Site personnel are not to undertake any activity which would be considered a confined-space entry without first being trained in the proper procedures by the CHSO, and obtaining a Confined Space/Limited Egress Permit.

* A full-sized copy of the OSHA poster included as Attachment B of this HASP shall be conspicuously posted on site.

11.0 SPILL CONTROL

11.1 SPILL CONTROL

Bulk liquids will not be handled during this work and major spills of hazardous materials are, therefore, not anticipated and a spill discharge and control plan is not necessary.

12.0 SITE CONTROL MEASURES

12.1 EXISTING PERIMETER AND/OR ZONE CONTROLS

Perimeter, zone, and site control will be accomplished through implementation of the following control factors:

* Base Security
* Perimeter/Zone Identification (Map)
* Traffic Control/Number of Personnel
* Sampling Area Security

12.1.1 BASE SECURITY

Restriction of general traffic will be accomplished through Base security. Restriction of unauthorized base personnel will be coordinated through the Base contact and Safety and Environmental Management Section.

12.1.2 PERIMETER/ZONE IDENTIFICATION

Perimeter/Zone identification will be accomplished in a dual step approach. The first step will be the overall identification of the sampling areas utilizing maps in section 1.0, and the maps available illustrating the proposed sampling points. This will be used to educate field personnel the potential areas of contamination and therefore areas of restriction. As it would be impossible to secure the entire area to be sampled, a three zone delineation shall be utilized in step two of the dual stage approach. Security of the work zones will be established in and about the sampling points to restrict unauthorized personnel during intrusive activities (sampling) when potential for incidental exposure would be the greatest.

12.1.3 THREE ZONE DELINEATION OF THE SAMPLING POINTS

A three zone approach will be used to secure sampling points, control potential migration of site contaminants, and to protect the health and welfare of the site workers, base personnel, and general public.

This approach will designate the sampling point and a ten foot circumference as the Exclusion Zone,the area of known contamination. A ten foot circumference outside the exclusion zone shall act as the Contamination Reduction Zone, where all decontamination activities will take place. All operations conducted within these two zones shall employ extra measures of protection stipulated in this plan to be utilized in the presence of contamination. The third, and final zone is the support zone. This is a designated clean zone where no contamination is present.

All materials and support for these operations will be routed from this zone. Movement between the zones will be done through control points. All movement from the exclusion zone outward toward the support zone will require complete decontamination and approval from the field team leader or the on site health and safety representative for all equipment and personnel.

12.2 BUDDY SYSTEM

Personnel while engaged in on site activities will practices the "buddy system" to insure the safety of all personnel involved in this operation.

12.3 COMMUNICATIONS

As personnel will be working within close proximity to one another during field activities no supported means of communications will be necessary. Buiding 765 is an active office building located at the west end of the site. The communications system in this building will serve as the primary link with the emergency services should the need arise.

12.4 MATERIAL SAFETY DATA SHEETS (MSDS) REQUIREMENTS

HALLIBURTON NUS personnel will provide MSDS's for all chemicals brought on site. The MSDS's will be maintained in a central location (i.e.temporary office)and will be available for anyone to review upon request.

13.0 EMERGENCY RESPONSE PLAN

In the event of any on-site emergencies (i.e. fires, significant spills or releases, etc.), site personnel shall be immediately evacuated to a safe place of refuse and notify appropriate off-site response agencies (Figure 13-1), the HALLIBURTON NUS Project Manager (Anthony Klimek), and the CLEAN Health and Safety Manager (Matthew M. Soltis). In view of this approach, this section of the Health and Safety Plan is provided to be in compliance with OSHA Standard 29 CFR 1910.38(a) [as permitted by OSHA 29 CFR 1910.120(l)(1)(ii)].

13.1 EMERGENCY ESCAPE

If site evacuation becomes necessary, personnel shall immediately take the most direct route to the main gate where they will await further instruction from the HALLIBURTON NUS Field Operations Leader.

13.2 MAINTENANCE OF CRITICAL OPERATIONS

It is not anticipated that any personnel will need to remain at their worksite to maintain any critical operations. If this condition should change, the site Health and Safety Officer shall identify the personnel an their responsibilities in this regard and amend this Plan accordingly. Any such modifications must be communicated to the Health and Safety Manager for concurrence.

13.3 PERSONNEL ACCOUNTING

In the event of an emergency evacuation, personnel shall immediately report to the designated refuge location, and remain there. The Site Safety Officer, assisted by the Field Operations Leader, shall conduct a roll call (using the site log book) to account for all personnel to ensure that a total worksite evacuation has taken place. If the roll call identifies that any personnel are not accounted for, this information shall be immediately communicated to the off-site emergency response agency upon their arrival. This information is to be supplemented with any additional information available which could be of assistance in conducting rescue operations (i.e., last known location of the missing personnel, etc.). Site personnel are not authorized to participate in emergency response/rescue operations.

13.4 RESCUE AND MEDICAL DUTIES

Site personnel are not authorized to participate rescue in activities. However, any personnel present who are trained and to perform emergency first aid activities may perform these functions, if needed, after rescue or evacuation operations have been completed.

13.5 EMERGENCY REPORTING

Emergency reporting functions shall be the responsibility of the Field Operations Leader. Figure 13-1 identifies the agencies to be contacted. The Field Operations Leader will become thoroughly familiar with this Plan prior to the initiation of any site work activities.

In the event that an emergency incident occurs and off-site response assistance is necessary, the Field Operations Leader shall contact the appropriate agency (or agencies) and communicate the following information:

- Nature of the incident (fire, spill, chemical exposure, physical injury, etc.)
- Number of injuries and type(s) of injury (injuries)
- Possible contaminants which may be encountered in response efforts

13.6 SITE EMERGENCY ALARM SYSTEM

All workers will be in close proximity to each other, therefore, an emergency alarm system is not needed.

FIGURE 13-1

EMERGENCY NOTIFICATION AND DIRECTIONS TO HOSPITAL

EMERGENCY PHONE NUMBERS

FIRE DEPARTMENT	(NSWC)	(301) 743-4281
POLICE DEPARTMENT	(NSWC)	(301) 743-4333
RESCUE/AMBULANCE	(NSWC)	(301) 743-4449
PRIMARY HOSPITAL	(Physicians Memorial)	(301) 645-0100
ALTERNATE HOSPITAL	(Southern Maryland)	(301) 868-8000
OFF-SITE EMERGENCY SERVICE	(Sheriff)	(301) 870-3232
POISON CONTROL CENTER		(800) 962-1253
NATIONAL RESPONSE CENTER		(800) 424-8802
PROJECT MANAGER	Anthony P. Klimek	(412) 921-8640
OFFICE HSO	Matthew Soltis, CSP	(412) 921-8912

DIRECTIONS TO HOSPITAL:

PHYSICIANS MEMORIAL HOSPITAL, LA PLATA, MARYLAND (PRIMARY)

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

SOUTHERN MARYLAND HOSPITAL, CLINTON, MARYLAND (ALTERNATE)

Take Indian Head Highway (MD. Route 210) North to MD. Route 373. Follow until intersection with Branch Ave. (MD. Route 5). Turn left on Branch Ave., right on Surratts Road. The hospital is just past the Colony South Hotel.

14.0 CONFINED SPACE ENTRY PROCEDURES

To accomplish the aforemention scope of work, there is reasonable possibility an individual will have to enter the manhole of the stormwater system. This section contains practices and procedures to protect personnel from the inherent hazards involved in this type of operation. If at all possible, entry will be avoided and sampling will be accomplished from outside the manhole.

As it has been determined that entry into a confined space is imminent, the following procedure will be utilized to insure the safety of those individuals involved in these operations.

14.1 PERMIT SYSTEM

The permit serves as written authorization for entry into a confined space, which through evaluation of the task, no other alternative means exist for obtaining the necessary and required results. The permit provided in Figure 14-1 will be used for this purpose. Other permit formats may be acceptable alternatives, as long as they address the minimum issues presented in Figure 14-1. Prior to the commencement of any confined space activities a permit will be filled out in order to systematically address the following concerns.

- The hazards specific to the permit space

- The measures for isolating the permit space which may include:
  - Lockout/Tagout procedures *
  - Purging/Flushing supply lines **
  - Blocking/Blinding supply lines
  - Ventilation for the removal or control of existing hazards **

  * See Section 14.10 for more detailed information on this topic.
  ** See Section 14.9 for information on these topics.

- Acceptable environmental conditions and the maintenance of those conditions.

- Testing and Monitoring of the conditions within the permit space, and the action levels for the implementation of alternative plans and protective measures (See Section 14.6).

- Rescue services which would be summoned in an emergency (See Section 14.5).

- Communications for entrants and emergency services.

- Safety equipment to be used and validification for the decision logic in selecting the equipment (See Section 14.7).

FIGURE 14-1

WORK PERMIT FOR CS/LE OPERATIONS

EXPIRATION DATE:

Location of CS/LE:

Description of task:

Identified Hazards (see checklist):

Personnel Assigned

Name: Duties:

Name: Duties:

Name: Duties:

Name: Duties:

Special Equipment Required:

Special Safety Requirements/Procedures:

Initial Atmospheric Tests:

AT ENTRY INSIDE:	DEPTHS 4'	8'	12'	16'	20'
Oxygen Levels:					
Combustible Gas:					
Toxics:					

Level of Protection

Adequate PPE Supply

Isolation Complete

Rescue Equipment

Ventilation Functions

Tools & Equipment Approved

Lighting & Elec. Approved

Communications

Permit Prepared by: _____ Health and Safety Officer _____ Date

Permit Approved by: _____ Office Health and Safety Officer _____ Date

- Any additional information which may impact the safety of the entrants or other personnel involved in this operations.

An example of a permit which is recommended for use is given in Figure 14-1. All information requested on the permit will be addressed and completed, DO NOT LEAVE ANY SECTIONS BLANK.

14.2 TRAINING FOR AUTHORIZED ENTRANTS

All personnel authorized for entrance into the permit space must be trained in the following topics and hazards, in addition, to any other training they may have recieved manner to perform their duties under the permit entry procedures. Authorized entrants must be trained in the following topics.

- Hazard Recognition of those hazards which may be encountered during or as a result of entry into the permit space.

- Communication procedures to be used with the hole attendant to maintain contact.

- Protective equipment to be used for entrance into the permit space, execution of duties, and exit.

- Evacuation procedures by the entrant but not limited to
  - Attendant orders evacuation
  - Automatic alarms are activated
  - Entrants perceives hazard or dangerous conditions

14.3 TRAINING DUTIES FOR ATTENDANTS

Permit space attendants shall be stationed at the entrance of the permit space at all times during confined space operations. Training for permit space attendants shall consist of the following items, which are, in addition, to those required for entrants as stipulated in Section 14.2

- Record the number of entrants.

- Recognize hazards outside the permit space which may endanger the entrants.

- Warn unauthorized persons of confined space operations, and request they exit the area.

- Warn entrants if unauthorized persons have entered the permit space.

It is the intent to train both groups (entrants/attendants) to equal levels to facilitate smooth interaction between groups during confined space operations,

however, it has been presented in this manner to illustrate the difference in task requirements.

14.4 TRAINING DUTIES FOR CONFINED SPACE OPERATIONS SUPERVISORS

To ensure individuals authorizing entry are qualified to do so, they shall receive training to be competent to ensure that the following aspects are observed.

- Permits contain the required information.
- Necessary procedures, practices, and equipment are in place to address the hazards which are presented, and those anticipated prior to authorizing entry.
- Operations remain consistent with the terms of entry.
- Cancel operations whenever unacceptable entry conditions change or if the operating parameters/action levels change with regard to the terms of entry.
- Take appropriate action to conclude operations once the task is complete, such as, closing a permit or closing the permit space.
- Take appropriate action to insure the safety of unauthorized personnel who are in or near confined space operations and the entrants involved in those operations.

To facilitate these requirements, HALLIBURTON NUS will use the HSO to govern confined space operations and issue permits as these individuals have extensive training in this area.

14.5 RESCUE OPERATIONS

On-site permit space operations will use outside services for rescue operations, as specified in Section 13.0 of this HASP. Upon notification of emergency services, specified rescuers will be informed of the hazards they may confront in the execution of their duties which will enable the teams to equip, train, and conduct itself accordingly.

14.6 TESTING AND MONITORING

Absolutely no CS/LE entry without use of appropriate supplied-air respirators and dermal protection is to be initiated until appropriate initial testing has been conducted to assure the atmosphere in the CS/LE Area is safe. Monitoring shall be conducted for oxygen content, combustible gases/vapors, toxic contaminants,

and any other tests specified by the HSO. Monitoring of the CS/LE Area shall be done on a continuous basis while personnel are in the CS/LE enclosure.

Entry into the CS/LE Area shall not be permitted, or evacuation of the region undertaken, without use of appropriate supplied-air respirators and dermal protection under the following conditions:

1. Oxygen concentrations less than 19.5% or greater than 23.5%.

2. Flammability measurements greater than 25% of the lower explosive limits (LEL) for Non-Hot Work Operations.

3. Flammability measurements greater than 10% of the LEL for Hot Work Operations.

4. Toxicity measurements indicating that an Immediate Dangerous to Life and Health (IDLH) atmosphere exists in the CS/LE Area.

* Based on Atmospheric Pressure of 760mm Hg (Sea Level).

Whenever any of the NO ENTRY PERMITTED/EVACUATION conditions occur, the volumes of mechanical ventilation supplied to the space shall be increased and maintained. Entry or re-entry will be permitted when: 1) oxygen levels are measured greater than 19.5% and less than 23.5%; 2) LEL measurements fall below 10%; and 3) an IDLH atmospheric condition no longer exists.

Initial atmospheric samples shall be drawn while outside the CS/LE, at least at the following locations:

1. Outside the entry point(s).
2. Immediately inside the entry point(s).
3. At least every four feet in depth of the CS/LE Area to the surface of the floor or any remaining residues.

All initial monitoring results will be recorded on the entry permit.

14.7 PROTECTIVE EQUIPMENT AND CLOTHING

The entry permit will specify the level of protection to be used for the CS/LE entry. When the nature of the air contamination present is unknown, supplied-air respirator protection will be required.

Additional safety equipment in the form of safety belts, body harness, or wrist type harnesses with life lines shall be provided and used for all CS/LE entries. Lifelines shall be attached to extraction devices outside the CS/LE Area, so that nonentry rescues may be accomplished.

Standby personnel shall be equipped with at least the same level of protection as the entry team, as well as be supplied with respirators suitable for IDLH atmospheres.

Other safety equipment that may be utilized (where appropriate) include safety nets, life jackets, electrical insulations, and barriers as the particular CS/LE Area warrants.

14.8 WORK PRACTICES

As part of the pre-entry procedure, the HSO shall review the entry permit with all members of the entry and standby team and will be present during the operation. He will maintain communications and have ready access to emergency and support services and facilities.

14.9 PURGING AND VENTILATION

All CS/LE enclosures shall be subject to purging and continuous ventilation after initial atmospheric testing, but prior to any actual entry. The only exception to this requirement is where entry is made solely to obtain samples of materials remaining in the CS/LE Area AND initial atmospheric testing indicates:

1. No oxygen deficiency or enrichment.

2. LEL measurements are less than 10%.

3. Toxicity measurement is less than 10% of the established IDLH of the airborne contaminant present.

4. Organic vapor measurements coincide with the appropriate level of personal protective equipment employed for confined spaces.

5. Special conditions exist, such that the above criteria do not apply and specific authorization is obtained from the CLEAN Health and Safety Manager.

14.10 ISOLATION/LOCKOUT AND TAGGING

Except for such CS/LE Areas as manholes, sewers, and tunnels, where complete isolation is not physically possible, all CS/LE Areas shall be completely isolated from all other systems by means such as double block and bleed, blanking, or physical disconnection of all lines into the areas. All lines that have been subject to the isolation actions shall be tagged to identify the reason for blocking, blanking, and/or disconnection. The Tag shall contain the following statement:

THIS EQUIPMENT
REMOVED FROM SERVICE DUE
TO CONFINED SPACE WORK
AT _____

DO NOT OPERATE

The CS/LE Area shall be electrically isolated to prevent accidental activation of moving parts or other electrical equipment serving the Work Area. Electrical isolation shall be accomplished by lockout of circuit breakers and/or power disconnects in the open (OFF) position by key-type padlock. Each person entering the CS/LE Area shall have placed a lock on the circuit breaker/disconnect and shall maintain possession of the only key to the lock. Any circuit breaker/disconnect that is locked out, shall also be tagged to identify the reason for the lockout.

Mechanical isolation of moving parts shall be achieved by disconnecting linkages, or removing chain or belt drives. Other moving mechanical parts shall be blocked in such a way to preclude accidental rotation. Any mechanical isolation shall be tagged to identify the reason for the isolation.

14.11 SAMPLING

Initial sampling of any CS/LE Area shall be done from the outside, if at all feasible. If initial atmospheric testing shows a flammable atmosphere approaching the lower explosive limit (LEL) in the enclosure, it shall be inert gas-purged prior to starting sampling activities.

The sampling process itself may create an additional potential for hazard in the CS/LE. Examples of such conditions include:

1. Excessive heat stress in the enclosed space.

2. Build-up of toxic materials.

3. Potential for fire and explosion or O2 deficiency.

14.12 EQUIPMENT, INSTRUMENTS, AND TOOLS

All tools and other equipment, including monitoring instruments, for use in CS/LE Areas shall be inspected for compliance with the following requirements:

1. Tools and equipment will be kept clean and in a good state of repair.

2. All electrical equipment such as portable tools, lighting, and power cords shall meet approvals in accordance with OSHA regulations found in 29 CFR 1910 subpart S, including provisions for ground fault interruption protection and visual inspection of equipment for defects or damage.

3. Lighting used in CS/LE Areas shall be of explosion-proof design, equipped with necessary guards, and bear Underwriters Laboratories (UL) or other appropriate approval listings.

4. Air-activated tools shall be used, where flammable liquids are present, and shall be bonded to the CS/LE Area.

5. Compressed gas cylinders, except those that are part of a SCBA or resuscitation equipment, shall never be permitted inside a CS/LE Area. Cylinders used to supply compressed gases to CS shall be turned off at the cylinder valve when not in actual use and the supply lines shall be removed from the Area.

6. Ladders, scaffolding, and staging shall be adequately designed, secured, and be in conformance with OSHA regulations found in 29 CFR 1910 subpart D.

7. Any equipment or instrumentation subject to use in the CS/LE Area, where flammable atmospheres may occur, shall be listed as explosion-proof or intrinsically safe by a recognized testing laboratory.

14.13 RECORDKEEPING

Copies of the entry permit will be maintained in an employee exposure record, as required under 29 CFR 1910.20.

14.14 REFERENCES

1. Criteria for a Recommended Standard. Working in Confined Spaces, DHEW (NIOSH) Publication Number 80-106. Cincinnati, U.S. Department of Health Education and Welfare, Public Health Service, National Institute for Occupational Safety and Health. 1979.

2. Limited Egress/Confined Spaces, Los Alamos, New Mexico, Los Alamos Scientific Laboratory. 1980.

3. Proposed Michigan State Confined Space Entry Standard, Part 90 Rule 408. Ann Arbor, Michigan, Michigan Occupational Safety and Health Administration. 1984.

4. Standard Practice for Confined Area Entry, ASTM D4276-84, Philadelphia, Pennsylvania, American Society for Testing and Materials. 1984.

5. AA Primer on Confined Area Entry, Malvern, Pennsylvania, Bio Marine Industries, Inc., 17 pp.

15.0 MATERIALS AND DOCUMENTS

The HALLIBURTON NUS Field Operations Leader shall ensure the following materials/documents are taken to the project site and utilized as required.

- Incident Reports (blank)
- Medical Data Sheets (blank)
- Follow-Up Reports (to be completed by the Field Operations Leader - see Attachment A)
- OSHA Job Safety and Health Poster (Posted in site trailer - see Attachment B)
- Training Documentation Form (Blank)

APPENDIX C-I

Concentrations of Mercury in Water and Sediment
and
Total Mercury Analytical Results

CONCENTRATIONS OF MERCURY IN WATER AND SEDIMENT
SITE 8, NG PLANT OFFICE

Station	Water (mg/L)	Sediment (mg/kg)
7[a]	0.0002	0.45
2-7	--	1.5[c]
8[a]	0.17[bc]	1,100[c]
2-8A-S	--	131.7[c]
2-8B-S	--	146.9[c]
2-8A-D	--	146.9[c]
9[ab]	0.019[bc]	8.5[c]
2-9-S	--	11.1[c]
2-9-D	--	0.98
10[ab]	0.11[bc]	188[c]
2-10-1-S	--	1.5[c]
2-10-1-D	--	1.98
2-10-2-S	--	10.8[c]
2-10-2-D	--	1.3[c]
2-10-3-S	--	<0.4
2-10-4-S	--	<0.4
2-10-5-S	--	40.1[c]
2-10-5-D	--	21.4[c]
2-10-6-S	--	53.7[c]
2-10-6-D	--	14.4[c]
2-10-7A-S	--	9.8[c]
2-10-7B-S	--	40.3[c]
2-10-8-S	--	19.9[c]
2-10-8-D	--	32.2[c]
2-10-9-S	--	223[c]
2-10-9-D	--	63.3[c]
2-10-10-S	--	67.7[c]
2-10-10-S	--	7.6[c]
2-10-11-S	--	26.3[c]
2-10-11-D	--	22.2[c]
11[a]	0.0002	0.95
12[a]	0.0003[c]	0.60
13[ab]	0.0004[c]	6.0[c]
14[a]	0.0006[c]	4.6[c]
2-15	--	3.5[c]

NOTE: Sediment concentrations in dry weight.

[a] January 1984 sample, 0.0 to 0.3 foot; all others January 1985.

[b] Exceeds average natural abundance (Table 9).

[c] Exceeds MCL and some saltwater toxicity criterion (Table 18).

[d] Composite sample.

S: Indicates shallow (0.0 to 5.0 foot) sample. D: Indicates deep (0.3 to 1.0 foot).
A and B: Indicates paired samples (taken at same depth, but not strict duplicates).
Reprinted from the NACTP Confirmation study (CH2M Hill, 1985).

TOTAL MERCURY ANALYTICAL RESULTS
SEDIMENT SAMPLES
TASK 2--SUPPLEMENTAL SITE CHARACTERIZATION
NOS INDIAN HEAD

Station number	Sample number	Mercury concentration (mg/kg) versus sample depth				
		0-1 ft	1-2 ft	2-3 ft	3-4 ft	4-5 ft
Noble Rd.	SD-02	BDL	BDL	BDL	--	--
2+00	SD-03-B	1.1	3.3	BDL	BDL	BDL
	SD-03-C	0.2	BDL	BDL	--	--
5+00	SD-04-A	1.2	BDL	BDL	BDL	BDL
	SD-04-B	1.2	BDL	--	BDL	0.36
	SD-04-C	1.5	0.85	BDL	BDL	BDL
NE stream	SD-05-A	0.42	BDL	BDL	BDL	BDL
	SD-05-B	BDL	BDL	BDL	BDL	BDL
	SD-05-C	1.25	BDL	BDL	BDL	0.1
8+00	SD-07-A	10	0.1	2.2	BDL	0.13
	SD-07-B	0.34	BDL	BDL	BDL	BDL
	SD-07-C	1.0	BDL	BDL	BDL	BDL
10+00	SD-08-A	2.2	0.14	BDL	BDL	0.1
	SD-08-B	1	0.3	BDL	BDL	BDL
	SD-08-C	21	0.35	0.15	0.1	BDL
12+00	SD-10	0.44	3.9	BDL	--	--
16+00	SD-11	9.6	1.6	0.98	--	--
20+00	SD-12	4.1	2.7	1.1	--	--
24+00	SD-13	(1)	0.22	--	--	--
Manhole	SD-14	3.4	--	--	--	--

NOTES: BDL = Below Laboratory Detection Limit of 0.1 mg/kg.
A, B, and C refer to locations shown on Figure 2-3.
-- indicates sample not taken.

[1] Free mercury was visible in sample SD-13-A; sample was not analyzed.

Reprinted from Supplemental Site Characterization (E.C. Jordan, 1987).

APPENDIX C-II

Mercury

MERCURY

A host of mercury compounds has served in clinical medicine as antiseptics, antisyphilitics, cathartics, and diuretics. The occupational uses and hazards of mercury are legion; some unusual or important examples are fingerprint photographers (Agate and Buckell, 1949), dentists (McCord, 1961), hatters (Neal and Jones, 1938), medical laboratory personnel (Noe, 1959) and painters. Allergic dermatitis is a frequent complication arising from sensitization to mercuric sulfide (cinnabar), the red pigment usually employed in tattoos (Davis, 1960; Goldberg, 1959). Modern agriculture also employs many organic and inorganic derivatives of mercury in the form of dusts, wettable powders, solutions and fumigant vapors; these preparations serve as fungicides and as seed and cereal protectants. Many forms of paper contain mercury, and one person is known to have become intoxicated as a result of paper pica, perhaps secondary to an iron deficiency anemia (Olynyk and Sharpe, 1982). A polyvinyl alcohol preservative used in the collection of fecal specimens for examination of parasitic infestations contains 4.5% mercuric chloride (Seidel, 1980). Hair bleaches have also been a cause of poisonings (Wustner *et al.*, 1975).

As indicated below, all forms of mercury are poisonous if absorbed. Each has given rise to typical mercury intoxication under appropriate circumstances; this includes the free metal, calomel, mercurial antiseptic dyes, mercury-containing pesticides and mercurial diuretic drugs. The poisonous actions of mercury are usually associated with the mercuric ion, which these inorganic and organic materials furnish rapidly or slowly. Alkyl and some other organic mercurials, however, may have toxic effects due to the parent compound. Acute poisoning is perhaps the major threat in the home and on the farm, but, because mercury is a cumulative poison, subacute and chronic intoxications are recognized, particularly in industry.

Toxicology of inorganic mercury salts: One of the commonest and most toxic salts of mercury is mercuric chloride ($HgCl_2$), commonly known as bichloride of mercury or corrosive sublimate. The oral LD_{50} is 10 mg./kg. in mice and 37 mg./kg. in rats. Human fatalities have resulted from as little as 0.5 gm. by mouth, although the mean lethal dose in adults probably lies between 1 and 4 gm. The alimentary effects of many mercury compounds (notably mercuric chloride) are so rapid that the course and prognosis are determined largely by events within the first 10 to 15 minutes, particularly by the intervention of vomiting or a therapeutic lavage.

Acute systemic mercurialism may end fatally within a few minutes, but death (in uremia) is usually delayed 5 to 12 days.

Ionizable mercuric salts like mercuric chloride are corrosive. When ingested, necrosis begins immediately in the mouth, throat, esophagus, and stomach. Within a few minutes violent pain, profuse vomiting and severe purging are experienced, and the patient may die within a few hours from peripheral vascular collapse secondary to fluid and electrolyte losses (Augustine, 1956; Lowe, 1959). If the patient survives this phase, the primary gastroenteritis usually subsides spontaneously within a few days, but severe hemorrhagic colitis has occurred as late as 9 days following ingestion (Sanchez-Sicillia *et al.*, 1963).

A second phase, developing within 1 to 3 days after the exposure, is characterized by stomatitis, membranous colitis, and tubular nephritis (nephrosis). This second phase, which is seen even with noncorrosive preparations of mercury and is independent of the portal of entry, is associated with a slow and prolonged excretion of mercury by the salivary glands, the gastrointestinal mucosa, and the kidneys. Death in this phase is usually the result of complete renal failure (Troen *et al.*, 1951).

Mental and nervous symptoms are uncommon in acute mercurialism, in contrast to chronic mercury poisoning (Breiger and Rieders, 1959), but central nervous system involvement is common with some organic mercury compounds (see below). Ultrastructural changes have been described in rat hepatocytes (Desnoyers and Chang, 1975), but mercury is not usually a significant hepatotoxin. Sometimes a nephrotic syndrome is the major or sole indication of mercury intoxication, particularly after chronic exposure (*e.g.*, Cook and Yates, 1969). In some instances it has been ascribed to an allergic response (Becker *et al.*, 1962; Kazantzis *et al.*, 1962), but direct nephrotoxic actions are well known.

The primary renal lesion in acute mercurialism appears to be a generalized increase in the permeability of the tubular epithelium. Transient polyuria and then anuria are regarded as consequences of the permeability change. It has been suggested that the anuria is due to complete resorption of tubular fluid because of the colloid oncotic pressure of peritubular fluid, not because of tubular blockade (Bank *et al.*, 1967; Gottlieb and Coye, 1962; Rodin and Crowson, 1962). In dogs, however, the proximal convoluted tubules may become so filled with the cytoplasmic debris of sloughed epithelial cells that the back pressure can lead to a cessation of filtration (Baehler *et al.*, 1977).

Some metabolic changes in rat kidney after acute renal failure induced by mercuric chloride suggest that the metal may have a direct effect on mitochondrial electron transport (Trifillis *et al.*, 1981). Kidney uptake of mercury is markedly enhanced by excess cysteine, and the uptake of mercuric cysteine is slowed by an excess of histidine or lysine, suggesting that the metal complex is actively transported (Richardson *et al.*, 1975a). Rats were shown to acquire resistance to mercuric chloride nephrotoxicity, but cross-resistance to other nephrotoxic agents (potassium chromate, biphenyl, hexachloro-1,3-butadiene) did not occur (Kluwe, 1982). Conversely, pretreatment with sodium chromate, *p*-aminophenol, sodium maleate or uranyl acetate in doses sufficient to cause renal damage offered protection against mercury renal damage. These effects were not related to the renal contents of metallothionein or mercury (Tandon *et al.*, 1980).

In pregnant women absorbed ionic mercury is also a hazard to the fetus, but most reported fetal poisonings have been traced to mercury vapor (see elemental mercury below) or to organic mercurials, especially methyl mercury (Koos and Longo, 1976). In animal tests all forms of mercury have proven to be teratogenic. Many mercury compounds (including mercuric chloride in concentrations of 1 to 5%) are irritating to the skin and may produce dermatitis with or without vesication. Contact with the eyes causes ulceration of the conjunctiva and cornea.

Absorbed ionic mercury is excreted primarily in urine and feces (Friberg and Vostal, 1972). Although not a major mechanism for its metabolism or excretion, reductive pathways in animals and presumably in man are capable of converting Hg^{2+} to the free metal, which can be excreted in the expired breath. A dose-dependent increase in this conversion was observed after ethanol in mice, as evidenced by a 10-fold increase in the expired mercury vapor (Dunn *et al.*, 1981). The converse reaction is also well established, and at least part of an absorbed dose of elemental mercury vapor is oxidized to the mercuric ion (see below).

Toxicology of elemental mercury: Metallic mercury (quicksilver) constitutes a special case among mercury compounds because dangerous symptoms are commonly encountered only after inhalation of the vapor. Liquid mercury is absorbed through the intact skin of man and animals, but no quantitative estimates of the rate of penetration appear to be available (Friberg and Vostal, 1972). In most cases of poisonings allegedly due to percutaneous exposure, inhalation cannot be ruled out as the major route of mercury entry. Only small amounts of mercury are absorbed after the oral administration of the liquid metal to rats (Bornmann *et al.*, 1970). The accidental release of large quantities of metallic mercury into the gastrointestinal tract during surgical manipulations produced no more serious reaction than nonpersistent fistu-

lous tracts (Cantor, 1951). In an exceptional case, however, a preexisting small bowel fistula apparently allowed mercury to accumulate in retroperitoneal tissues, where conditions may have been more favorable for oxidation of Hg^0 to Hg^{2+}. The patient died with signs like those seen in systemic poisonings by mercuric salts (Bredfeldt and Moeller, 1978). In most cases broken glass is the chief hazard associated with the accidental biting of mercury thermometers.

In a case of intravenous self-administration of liquid mercury, pulmonary embolization terminated life before there were signs of systemic intoxication (Conrad *et al.*, 1957). In several other cases, however, one involving intravenous injection of as much as 20 ml., the systemic signs and symptoms of malaise, pleuritic chest pain and shortness of breath resolved quickly, and hypoxemia and respiratory alkalosis were no longer apparent at the end of a week (Celli and Khan, 1976). Embolization is also a potential hazard of accidents during some cardiac catheterization procedures (Buxton *et al.*, 1965). Mercury depots are clearly and bizarrely visible on X-ray (Schulz and Beskind, 1960; Teitelbaum and Ott, 1969; Vas *et al.*, 1980) over periods of years without signs of systemic intoxication (Ambre *et al.*, 1977; Chitakara *et al.*, 1978). It has been suggested, however, that such deposits in the lung fields may also arise from aspiration of ingested liquid mercury (Stanojevich and Kostitch, 1968). Rupture of a mercury filled bag on the end of an intestinal tube resulted in aspiration and mercury deposits that were visible on X-ray for 22 years (Dzau *et al.*, 1977).

Respiratory exposure to mercury vapor results in high initial concentrations in the lungs (Kudsk, 1965; Teisinger and Fiserova-Bergerova, 1965). Most of this lung burden is absorbed rapidly, but a small depot is absorbed slowly (Berlin *et al.*, 1969a; Gage, 1961; Hayes and Rothstein, 1962). High concentrations exist transiently in brain and probably explain the preponderance of central nervous system signs, as opposed to renal damage, seen after this route of exposure (Berlin and Johansson, 1964; Magos, 1968a). Indeed, some evidence suggests that mercury penetrates into the nervous system primarily as the elemental form (Berlin *et al.*, 1969b; Magos, 1967, 1968a). The kidneys, however, eventually accumulate the greatest share of the total body burden (Hayes and Rothstein, 1962), presumably because atomically dispersed mercury is oxidized to ionic mercury rather promptly. A large share (98%) of mercury vapor in blood is concentrated in the red cells, where it may be gradually oxidized to Hg^{2+} and then released into the plasma, so that the red cell-to-plasma ratio falls to about 2 within 20 hours (Cherian *et al.*, 1978). (Many organomercurials follow a similar pattern of distribution and redistribution in blood.) It has been alleged that after a respiratory exposure to mercury vapor appreciable amounts of mercury are excreted in sweat (Sunderman, 1978).

A unique reaction occurs on massive vapor exposures as in confined spaces or on heating the liquid, namely acute pulmonary edema (Burke and Quagliana, 1963; Campbell, 1948; Matthes *et al.*, 1958; Milne *et al.*, 1970; Natelson *et al.*, 1971; Snodgrass *et al.*, 1981a; Tennant *et al.*, 1961). In fatal cases diffuse interstitial pneumonitis with profuse fibrinous exudation was observed at autopsy. If the exposure is not fatal, recovery from the acute illness usually occurs over several days to weeks with only mild exertional dyspnea and a dry cough persisting for longer periods (Hallee, 1969; Moutinho *et al.*, 1981; Seaton and Bishop, 1978). Perhaps this acute lung reaction is auto-protective since renal sequelae and central nervous system involvement were absent in survivors. See also NITROGEN OXIDES (p. III-323 and pp. IV-14–16) for management of pulmonary complications.

Most human exposures to mercury vapor, however, are mild but prolonged. In these cases pulmonary symptoms are rare, and significant pulmonary lesions do not occur. The hazard here is the accumulation of enough mercury in various organs and tissues to produce chronic mercury poisoning.

Chronic mercury poisoning: Long-term, low-level exposure to mercury vapor is a common hazard in varous industries and among dentists. The inhalation of dusts of inorganic mercuric salts is also an occupational hazard in some industrial plants. Whether the exposure is to elemental or ionic mercury, or even to organomercurials that breakdown *in vivo* to release the mercuric ion (see aryl and alkoxyalkyl mercury below), chronic mercurialism is believed to express itself in the same diverse ways; only alkyl mercury poisoning is clinically distinctive (see below). Even the portal of entry does not influence significantly the nature of the symptom complex, unless the daily dose is large enough to provoke an acute reaction. If enough mercury is retained in the body after a large single dose, the signs and symptoms of chronic mercury poisoning may appear gradually as the victim recovers from his acute injuries, but this sequence is uncommon today.

The predominant manifestations are neurologic. The violent gastrointestinal reactions elicited in acute poisonings are absent, but excessive salivation (ptyalism), anorexia, digestive disturbances, vague abdominal distress and mild diarrhea are common. Renal involvement is usually absent or mild, although a few, possibly hypertensive individuals develop nephrosis, *i.e.*, intense proteinuria without azotemia (Becker *et al.*, 1962). Peripheral neuropathies are described (*e.g.*, Hryhorczuk *et al.*, 1982; Levine *et al.*, 1982); in one patient it was the only sign of

mercurialism (Iyer *et al.*, 1976). Both motor and sensory nerves may be affected, with numbness and weakness but rarely complete paralysis or muscle atrophy. Sometimes muscle fasciculations and pain with or without tenderness have been described. The central nervous system, however, is the principal target of damage.

Tremors are frequently encountered; they typically involve the hands and fingers, less often eyelids, lips, cheeks, tongue and legs, and they are usually fine (but later coarse and irregular), bilateral and exaggerated by intention (Neal and Jones, 1938). Tendon reflexes may be hypo- or hyperactive. Various forms of motor control may become impaired (slurred or scanning speech, ataxic gait). Ptosis and visual disturbances are reported occasionally, but only rarely (*e.g.*, Hryhorczuk *et al.*, 1982) has constriction of the visual fields been ascribed to any form of mercurialism except that induced by alkyl mercury (see below). Deafness and other sensory losses are sometimes reported (Wustner *et al.*, 1975).

At least as common as tremors in chronic mercury poisoning is a syndrome known as erethism. It has long been recognized and associated with occupational exposures to mercury (Neal and Jones, 1938; Smith, 1978). Erethism consists of subtle or dramatic changes in behavior and personality: depression, despondency, fearfulness, restlessness, irritability, irascibility, timidity, indecision, and easy embarrassment. These psychic and behavioral characteristics are often accompanied by insomnia, drowsiness, headache and fatigue. In advanced cases, memory loss, hallucinations and mental deterioration may occur. It is alleged that Sir Isaac Newton went mad for a period of 1 year while engaged heavily in alchemy. Recent analyses of samples of his hair showed high concentrations of mercury (Broad, 1981).

In addition to ptyalism, a metallic taste is a common complaint. Gingivitis of various grades has often been described; in advanced cases it led to "pyorrhea" and the loosening of teeth. Other occasional manifestations of mucosal inflammation include stomatitis, pharyngitis, conjunctivitis and otitis. A dark, bluish line may appear along the gingival margins (Neal and Jones, 1938). It is less common and less impressive than a characteristic discoloration of the anterior lens surface, known as mercurialentis, which is a diagnostically useful sign of chronic mercury exposure (Atkinson, 1943; Parameshvara, 1967). Skin signs include abnormal blushing, dermatographia, excessive sweating and irregular erythematous or macular rashes. Because of anorexia, painful mouth and digestive disorders, victims of advanced mercurialism may be pale and cachectic, according to descriptions in the older literature.

Acrodynia: Subacute or chronic mercurialism occasionally manifests itself by an uncommon syndrome known as acrodynia (Warkany and Hubbard, 1948; 1953). Infantile acrodynia was first described in 1828, but many adult cases have been reported since. It is also called "pink disease" because of the color of the extremities. The manifestations include apathy, anorexia, flush, fever, a nephrotic syndrome with albuminuria and generalized edema, diaphoresis, photophobia, insomnia and most characteristically a pruritic and sometimes painful scaling or peeling of the skin of the hands and feet with bullous lesions. Atypical cases of unknown etiology but apparently not due to mercury are also recognized. The term, acrodynia, is also used for the condition in rats caused by pyridoxine (vitamin B_6) deficiency, which has some features in common with the acrodynia of mercurialism.

Most early cases were associated with the use of insoluble mercurous chloride (calomel) as a laxative or diuretic (Bivings and Lewis, 1948; Cheek, 1960; Clements, 1960; Warkany and Hubbard, 1948). However, the syndrome has also been induced by exposure to metallic mercury (Alexander and Rosario, 1971; Johnson *et al.*, 1978), ammoniated mercury (Snaiman and Flagler, 1971), mercurial antiseptics such as merbromin and thiomersal (Matheson *et al.*, 1980; Yeh *et al.*, 1978), alkoxyalkyl mercury fungicides (Prediger, 1976) and a phenylmercury fungicide in paint (Hirschman *et al.*, 1963).

Urinary mercury levels are characteristically low in acrodynia, suggesting a hypersensitivity reaction. Increased excretion of catecholamines and other signs of sympathetic nervous system dysfunction often accompany the disease (Hirschman *et al.*, 1963). In the case reported by Johnson *et al.* (1978), the disease was thought to have an autoimmune basis; it was accompanied by a profound neutropenia and terminated fatally. In describing a congenitally agammaglobulinemic adult who had received γ-globulin injections for 15 years, Matheson *et al.* (1980) pointed out that most available globulin preparations contain thiomersal as a bacteriostatic agent. In a case reported by Yeh *et al.* (1978) a neonate had been treated with local applications of merbromin for only 5 days.

Although some favorable responses have been reported, the value of BAL is not established in acrodynia (Bivings and Lewis, 1948; Warkany and Hubbard, 1953). Two cases appeared to respond favorably to *N*-acetyl-D,L-penicillamine (Aronow and Fleischmann, 1976; Hirschman *et al.*, 1963), with transient improvement in another (Johnson *et al.*, 1978). Fortunately, in most cases recovery follows spontaneously when the exposure is terminated. Furthermore, acrodynia has become exceedingly uncommon since mercurial ointments and other medicinal forms of mercury are no longer used in pediatrics.

Toxicology of aryl and alkoxyalkyl mercury: These two classes of organomercurials are

rather similar in terms of toxicity, instability *in vivo*, tissue distribution, retention and excretion; they differ markedly from alkyl mercury compounds discussed below (Swensson and Ulfvarson, 1963). In the aryl mercurials, mercury is joined by a Hg-to-carbon bond to an aromatic ring such as benzene, toluene, phenol, cresol, nitrophenol, etc. The commonest examples are phenylmercuric salts of inorganic acids (*e.g.*, hydrochloric, nitric, boric, etc.) or of organic acids (*e.g.*, acetate, salicylate, oleate, benzoate, etc.). Phenylmercuric salts are widely employed in agriculture. For example, seeds treated with them to prevent fungal growth and then fed to hens led to the production of mercury-contaminated eggs (Englander *et al.*, 1980). Various alkoxyalkyl mercurials such as methoxyethylmercuric chloride and acetate are also used as agricultural fungicides. Several alkoxyalkyl compounds of mercury long served in medicine as mercurial diuretics; they have, however, been discarded for this purpose.

In terms of acute LD_{50} values in rats and mice, most organic mercury derivatives tested are somewhat less lethal than mercuric chloride (summarized by Friberg and Vostal, 1972). For example, the oral LD_{50} of phenylmercuric acetate is reported to be 22 mg.(of Hg)/kg. in rats and 26 in mice. On the other hand, the oral LD_{50} of methoxyethyl mercury acetate is only 10 to 16 mg. (of Hg)/kg. in rats, which is less than the reported LD_{50} of mercuric chloride. Phenylmercuric acetate is known to be well absorbed through all portals, including intact skin.

Signs and symptoms in acutely poisoned men and test animals have not been adequately described. Local irritant effects are well established, such as dermatitis and burns from skin exposures to phenylmercuric salts (Goldwater *et al.*, 1964; Ladd *et al.*, 1964). Blistering has occurred when methoxyethyl mercury acetate was applied to the skin in high concentrations, and pulmonary symptoms have arisen when methoxyethyl mercury oxalate or silicate was inhaled (Friberg and Vostal, 1972). In terms of systemic effects the only well documented acute reaction is sudden death during intravenous mercurial diuretic therapy (Barker *et al.*, 1942; DeGraff and Nadler, 1942). Most of these deaths were ascribed to cardiac arrest or ventricular fibrillation, but rarely respiratory failure was observed without cardiac manifestations. Hypersensitivity reactions have also been reported (Ladd *et al.*, 1964).

No unequivocal central neural effects have been recognized in acute exposures. Even an attempted suicide with phenyl mercury is said to have elicited no significant neurological signs (Ishida, 1970, as cited by Hayes, 1982). The same was true of a suicidal ingestion of 5.7 gm. of methoxyethyl mercury chloride, which elicited vomiting and chemical burns of the mouth and throat but little else (Köppel *et al.*, 1982). Most intoxications by aryl and alkoxyalkyl mercury, however, have not been detected until after repeated or continuous exposures of long duration. Even then, the number of reported poisonings, aside from skin rashes, is remarkably low (Ladd *et al.*, 1964).

In subacute and chronic poisonings and probably sometimes in the late stages of acute poisonings, these organomercurials appear to produce intoxication syndromes that are in practice indistinguishable from those induced by inorganic mercury. For example, renal damage has been reported in rats and mice given repeated parenteral doses of phenylmercuric salts and of alkoxyalkyl mercurials. Death in renal failure, as well as the production of a nephrotic syndrome, has been ascribed to mercurial diuretics (Freeman *et al.*, 1962; Robillard *et al.*, 1976; Scott, 1964; Wallner and Herman, 1950). Nephrosis also appeared in a 60-year-old man who for 5 years had handled grain treated with methoxyethyl mercury silicate (Strunge, 1970). A 5-year-old boy exposed to a methoxyethyl mercury seed disinfectant developed acrodynia (Prediger, 1976). As in chronic inorganic mercury poisoning, neurological signs (tremor, motor and sensory nerve disorders) have been detected in a few individuals chronically exposed to these forms of organic mercury (Friberg and Vostal, 1972; Hayes, 1982). A 39-year-old farmer who had used no precautions in dusting oat seeds with phenylmercuric acetate over a period of 5 to 6 years and who excreted large amounts of mercury in the urine died of an apparently progressive neurologic disease resembling amyotrophic lateral sclerosis (Brown, 1954). Five other farmers similarly exposed were said to have various motor disabilities.

That the syndromes of chronic intoxication induced by inorganic mercury and by many organic mercurials are very similar is probably explained by the rapid metabolic breakdown of these mercurials to the mercuric ion. For example, studies on the fate and excretion of phenylmercuric acetate in rats, dogs and chicks indicate that phenyl mercury is absorbed intact from many portals, transported largely in red blood cells, metabolized in the liver and perhaps elsewhere to release inorganic mercury, which in the rat is excreted mostly in feces (Daniel and Gage, 1971; Miller *et al.*, 1960). Within 2 to 4 days, essentially all of the phenyl mercury was broken down. Hydroxylation of the phenyl ring was thought to precede rupture of the carbon-to-mercury bond; hydroxyphenyl mercury compounds decompose spontaneously in the presence of acid and cysteine or BAL (Canty and Kishimoto, 1975; Daniel and Gage, 1971). Methoxyethyl mercury salts and at least some of the

mercurial diuretics may be even more labile. In rats subcutaneously injected methoxyethyl mercury chloride decomposed (either spontaneously or enzymatically) with a half-time of about 1 day to release inorganic mercury that largely migrated to the kidneys and was eventually excreted (Daniel *et al.*, 1971).

Perhaps because these various forms of organic mercury are so rapidly converted to inorganic mercury, they do not appear to cross the blood-brain barrier appreciably. Thus, shortly after single exposures the brains of laboratory mammals contain much less mercury than do other organs and tissues; kidneys and liver accumulate the major burden (Berlin and Ullberg, 1963a–c; Gage, 1964; Swensson and Ulfvarson, 1967; Takeda *et al.*, 1968). With time the retained mercury is redistributed, so that the blood/brain concentration ratio falls toward 1.0 (Friberg and Vostal, 1972). As with inorganic salts of mercury, repeated exposure to these organomercurials causes slow but progressive increases in brain levels of mercury.

Toxicology of alkyl mercury: Methyl, ethyl, *n*-propyl and perhaps *n*-butyl mercury derivatives (Takeda *et al.*, 1968) are virulent neurotoxins on either acute or chronic exposure (*e.g.*, Okinaka *et al.*, 1964). They are especially hazardous because of their volatility, their ability to penetrate epithelial and blood-brain barriers and their persistence *in vivo*. Methyl mercury was absorbed 15 to 35 times more rapidly from ligated segments of the rat gastrointestinal tract than was mercuric chloride (Sasser *et al.*, 1978). The mean half-life in man is 65 days, but the range was 40 to 105 days (Bakir *et al.*, 1973). By contrast, mercury in the form of phenylmercuric salts (above) is much safer because phenylmercurials are less volatile, much less able to enter the brain, much more readily metabolized and so more rapidly excreted.

Toxic encephalopathy of epidemic proportions with high mortality occurred as a result of the ingestion of sea foods obtained from Minamata Bay in Japan (Minamata disease) (Tsubaki and Irukayama, 1977). The waters were highly polluted with industrial wastes containing mercury compounds (Matsumoto *et al.*, 1965). Ionic mercury is readily methylated by microorganisms in detritus and sediments under bodies of water. After methylation the mercury enters into and is concentrated in natural food chains. Minamata disease is characterized by progressive muscular weakness, loss of vision, paralysis, coma and death. More than 100 persons died or suffered severe neurologic damage and 17 babies were born in the area with infantile cerebral palsy. A milder outbreak occurred among fish-eating Indians and Inuits in Ontario (Wheatley *et al.*, 1979).

In Iraq consumption of seed grain treated with methyl mercury fungicides resulted in more than 6,500 hospital admissions and 500 deaths (Clarkson *et al.*, 1976). Patients exhibited paresthesias of hands and feet and around the mouth, dysarthria, ataxia, concentric constriction of visual fields (tunnel vision) and hearing loss (Bakir *et al.*, 1973). Three members of a family in Almagordo, New Mexico, were similarly afflicted after consumption of pork from swine that had been fed methyl mercury treated grain (Pierce *et al.*, 1972). Thus methyl mercury is seen to pass through food chains unchanged (Snyder and Seelinger, 1976).

Not only does methyl mercury readily cross the placenta (Koos and Longo, 1976), but suckling infants may acquire high levels via breast milk (Amin-Zaki *et al.*, 1976). In a group of 32 infants exposed prenatally, there were 9 cases of cerebral palsy. Although the mothers usually improved, damage to the fetal nervous system may be permanent. After 5 years developmental retardation, exaggerated tendon reflexes and pathologic extensor plantar reflexes (minimal brain damage syndrome) were still apparent (Amin-Zaki *et al.*, 1979). In children poisoned after birth the degree of recovery was related to the severity of the intoxication. Children with mild to moderate poisoning slowly but steadily improved. All had residual general hyperreflexia. Ataxia and motor weakness disappeared in some but visual changes improved less completely. Of 17 children who were blind, only 5 recovered partial sight. Almost half of a severely poisoned group were left physically and mentally incapacitated (Amin-Zaki *et al.*, 1978). In a few cases the neuromuscular disorder was said to respond well to neostigmine (Rustam *et al.*, 1975).

In man the effects of methyl mercury are critically dependent on the dose, *i.e.*, the dose-response curve appears to be very steep. Paresthesias are associated with an estimated total body burden of 40 mg., whereas death occurred at an estimated 200 mg. (Bakir *et al.*, 1973). Given by mouth as single doses to animals, however, mercuric chloride is more toxic than methyl mercury, although both fall into toxicity class 5 (Clarkson, 1972).

Given by mouth to healthy volunteers the radiolabel of methyl mercury (^{203}Hg) accumulated in the liver (half the total dose) and in the head (10% of the dose). It was excreted primarily in the feces, but urinary excretion increased with time up to 30 days (Aberg *et al.*, 1969). In the blood it is largely bound to red cells or hemoglobin (Lundgren *et al.*, 1967). In the victims of Minamata disease mercury was widely distributed. Residual deposits were readily detected in the kidneys, liver and reticuloendothelial system, with lesser but detectable amounts in the thyroid, adrenal glands, spermatocytes of testis, pancreas and skin. It tended to accumulate more

slowly in nervous tissue and to remain there for longer periods of time (Okabe and Takeuchi, 1980). A correlation was noted between the concentration of mercury in maternal hair and the severity of intoxication both in mothers and in the children delivered from them (Amin-Zaki *et al.*, 1979; Marsh *et al.*, 1981). In two fatal cases involving ethyl mercury in Iraq, 8 to 10 ppm were found in the kidney, 6 to 7 ppm in liver, 3 to 5 ppm in cerebellum and 15 ppm in blood (Hilmy *et al.*, 1976).

Remarkable species differences are recognized in methyl mercury poisoning; sheep and hens, for example, do not respond with neurologic signs (Hilmy *et al.*, 1978). Age is a significant factor in toxicity in humans; transplacental intoxication may be the worst and younger children are more susceptible than older ones (Snyder and Seelinger, 1976). Young rats are more susceptible than those 18 days of age, and the increased toxicity is associated with a decreased whole body clearance (Thomas *et al.*, 1982). The long half-life in neonatal rats appears to be due to an impaired ability to secrete mercury (perhaps in the form of a glutathione complex) into bile, which is a major route of elimination in adults (Ballatori and Clarkson, 1982). When rat tissues were depleted of glutathione by pretreatment with diethyl maleate, mercury deposition in kidney, red cells and to a lesser extent brain was also decreased (Richardson and Murphy, 1975). In mice, however, older animals were said to be more susceptible, and males were more susceptible than females. Toxicity was also greater at low ambient temperatures (Nomiyama *et al.*, 1980) and when alcohol was consumed concurrently in the drinking water (Takahashi *et al.*, 1978).

Methyl mercury has effects on brain neurotransmitters (Taylor and DiStefano, 1976) and on the enzymes which synthesize them (Tsuzuki, 1981). Protein synthesis is inhibited in both brain and liver (Omata *et al.*, 1978; 1980). As studied in human fetal neurons and astrocytes in tissue culture, damage to plasma membranes and neurotubular injury are early features of methyl mercury toxicity. These changes occur more readily in neurons than in astrocytes, but eventually irreversible degeneration occurs in both cell types (Choi *et al.*, 1981). These degenerative changes presumably underlie the clinical syndrome of amyotrophic lateral sclerosis, which has been documented in 11 individuals in Iraq who consumed bread prepared from wheat treated with the seed disinfectant Granosan M (Kantarjian, 1961).

Forms of treatment: Extensive clinical experience with dimercaprol (BAL) has established it as the antidote of choice in acute poisonings due to inorganic mercury salts, where the critical target organ is usually the kidneys (Longcope and Leutscher, 1946; Swensson and Ulfvarson, 1967). When introduced in 1945–1946, it made obsolete an earlier antidote that had enjoyed some success, namely sodium formaldehyde sulfoxylate (Rosenthal, 1935; Wolpaw and Alpers, 1942).

BAL is maximally effective when given early in the course of an acute episode and is often lifesaving under those circumstances. In general, it enhances the renal excretion of mercury, and it usually (but not always) decreases the amount of metal retained in the kidney (Gabard, 1976b; Swensson and Ulfvarson, 1967). In some cases it also promotes the fecal excretion of mercury (Longcope and Leutscher, 1946; Swensson and Ulfvarson, 1967), presumably because of the biliary secretion of the BAL-mercury complex. Probably the complex can be resorbed in the bowel (enterohepatic cycling), which could explain why BAL does not always increase the mercury content of feces (Gabard, 1976b). When injected in rats shortly after an injection of mercuric chloride, BAL caused a small increase in the brain content of mercury (Magos, 1968b), but when begun a few hours later, a 5-day course of BAL therapy led to lower mercury levels in the brains of treated animals than of untreated controls (Gabard, 1976b). Caution is indicated with BAL therapy in cases of acute renal insufficiency, where it may aggravate the renal damage or manifest its own toxicity (see p. III-50) (Doolan *et al.*, 1953). Because of the biliary excretory route, however, renal failure is not an absolute contraindication to BAL therapy.

BAL is much less effective in acrodynia and in chronic mercurialism, where the brain is the critically diseased organ. Although it often provokes an increase in urinary mercury, the rise is usually small in terms of the estimated body burden, and the clinical improvement, if any, is typically marginal (Battigelli, 1960). The same is often true of other chelating agents, such as D-penicillamine and its *N*-acetyl isomers (see below). A trial course of therapy with one or another chelator is probably warranted, however, because some patients have experienced considerable improvement. Often a 10-day or 2-week course with D-penicillamine is followed by a rest period of 1 to 2 weeks and then a 7- to 10-day trial of BAL (or vice versa). With BAL (*e.g.*, Sunderman, 1978), D-penicillamine (Iyer *et al.*, 1976; Markowitz and Schaumburg, 1980), and *N*-acetyl-D,L-penicillamine (Aronow and Fleischmann, 1976; Smith and Miller, 1961), favorable clinical and biochemical responses have been charted. Even when cases of alkyl mercury poisoning are excluded, however, failures of chelation therapy probably outnumber successes in chronic mercurialism, although the contrary opinion has been expressed with respect to *N*-acetyl-D,L-penicillamine (Kark *et al.*, 1971).

Although BAL has also been used in treating acute pneumonitis due to the inhalation of mer-

cury vapor in high concentrations (Tennant *et al.*, 1961), its efficacy for this purpose is not established. Because of the tendency for absorbed mercury vapor to enter the brain (Berlin and Johansson, 1964; Berlin *et al.*, 1969b) and for BAL therapy to increase mercury levels in the brain (Berlin and Lewander, 1965), the penicillamines (see below) are probably preferable to BAL as antidotes in acute vapor exposures (Snodgrass *et al.*, 1981). For the same two reasons (Berlin and Rylander, 1964), it is possible that BAL should be withheld in any acute poisoning due to a phenylmercuric salt. On the other hand BAL proved to be highly effective in protecting rats against the lethal actions of phenyl mercury hydroxide injected subcutaneously (Swensson and Ulfvarson, 1967). In the same study BAL accelerated the demise of rats given subcutaneous methoxyethyl mercury hydroxide. As noted above, clinical experience with these forms of organic mercury is too limited to settle the issue. Certainly BAL is not useful in methyl mercury poisoning (see below).

In contrast to BAL, D-penicillamine and *N*-acetyl-D,L-penicillamine are effective chelating agents when taken by mouth. In test animals and human patients they are useful in both acute (Aposhian and Aposhian, 1959; Swensson and Ulfvarson, 1967) and chronic mercurialism (*e.g.*, Hirschman *et al.*, 1963; Kark *et al.*, 1971; Smith and Miller, 1961). In view of the long history and widespread use of the penicillamines, it is disconcerting to learn that they have not received FDA approval as therapeutic agents in mercury poisoning and that *N*-acetyl-D,L-penicillamine is not even available in the United States as a pharmaceutical. There should be no hesitancy, however, about using these "orphan drugs" when indicated, and the acetyl derivative is available from the Aldrich Chemical Co. of Milwaukee, Wisconsin. These two penicillamines are usually used in the same dose (250 mg. every 6 hours, *i.e.*, 4 times daily); in this dose they are usually well tolerated. Perhaps the *N*-acetyl form is less toxic, but until more experience accumulates, one should assume that it can elicit all the toxic reactions reported after D-penicillamine (see latter in Section II).

As noted above, the penicillamines appear to be superior to BAL in treating acute poisoning by mercury vapor and chronic mercurialism of almost any form. Not yet established, however, is their antidotal effectiveness in acute poisonings by phenyl mercury or alkoxyalkyl mercury, and their value in alkyl mercury intoxication is equivocal. In acute poisonings due to the ingestion of inorganic salts of mercury, intramuscular BAL is far preferable to oral penicillamine for three reasons: vomiting may prevent retention of penicillamine; penicillamine may enhance the gastrointestinal absorption of mercury; and once absorbed, penicillamine is less successful than BAL in preventing death, at least in rats given Hg^{2+} by parenteral routes (*e.g.*, Swensson and Ulfvarson, 1967). Furthermore, the penicillamines are probably contraindicated in the presence of a severe renal injury because they promote mercury excretion only by that route; unlike BAL, they do not enhance the biliary (fecal) excretion of the metal (Yonaga and Morita, 1981).

In some countries varous other sulfhydryl chelating agents have been tested and approved. D-Penicillamine, *N*-acetyl-D-penicillamine and 2,3-dimercaptosuccinic acid (DMSA), when given in equimolar doses to rats at 48 and 54 hours after mercuric chloride, were all able to reduce the mercury content of the kidneys, but DMSA was by far the most effective. Only DMSA significantly increased the urinary excretion of mercury (Tandon and Magos, 1980). Gabard (1976b) tested 15 chelating agents (not including DMSA) in rats and found that the most favorable effects on urinary excretion and organ content of mercury were obtained with sodium 2,3-dimercaptopropane-1-sulfonate (DMPS). Neither DMSA nor DMPS is presently an approved drug in the United States.

In spite of a few apparent clinical successes, edetate calcium disodium (p. III-163) is probably contraindicated in all forms of mercurialism (Glömme and Gustavson, 1959). Hemodialysis and peritoneal dialysis may be helpful in renal insufficiency, but they have little or no value for removing mercury, presumably because it is bound tightly to plasma and tissue proteins (Doolan *et al.*, 1953; Fishman *et al.*, 1948; Kahn *et al.*, 1977; Leumann and Brandenberg, 1977; Sanchez-Sicillia *et al.*, 1963). As noted below, however, dialysis techniques may be useful in conjunction with chelation therapy to remove some of the low molecular weight chelates of mercury.

Methyl and other alkyl derivatives of mercury pose more formidable problems in therapy than other mercurials because they are rapidly absorbed and penetrate quickly into the brain (Thomas and Smith, 1982). When given one day after three daily doses of methyl mercury in dogs or several days after methyl mercury in rats, BAL was less effective than D-penicillamine in preventing the occurrence of toxic signs (Zimmer and Carter, 1978; 1979). Other experimental evidence and clinical impressions (Engleson and Herner, 1952; Glömme and Gustavson, 1959; Lundgren and Swensson, 1960) suggest that BAL has only limited usefulness in alkyl mercury poisonings and may even exacerbate the nervous symptoms. In mice and pregnant rats given single doses of methyl mercury, *N*-acetyl-D,L-penicillamine was judged to be superior to D-penicillamine and several other sulfhydryl chelators in mobilizing mercury from various tissues (Aaseth, 1976; Aaseth *et al.*, 1976). BAL

was not used in the Iraq epidemic but D-penicillamine was. The results were quite variable: dramatic falls in blood mercury levels occurred in some patients but not in others (Bakir *et al.*, 1973).

Both DMSA and DMPS appeared to be superior to other agents when tested under comparable conditions in methyl mercury poisoned animals (Aaseth and Friedheim, 1978; Gabard, 1976c; Planas-Bohne, 1981). DMSA was judged to be better than DMPS in removing mercury from the brains of poisoned mice (Aaseth and Friedheim, 1978), whereas DMPS was superior to DMSA in removing mercury from the kidneys (Gabard, 1976a; Planas-Bohne, 1981). In rats DMSA was effective in reversing toxic signs when given even as late as 5 days after methyl mercury (Magos *et al.*, 1978). In patients in the Iraq epidemic the mean half-life of methyl mercury was about 65 days. It decreased to 10 days in patients receiving DMPS whereas it was 17 to 26 days in patients treated with D-penicillamine or *N*-acetyl-D,L-penicillamine (Clarkson *et al.*, 1981).

A synthetic thiolated resin was also used in Iraqi victims to thwart the enterohepatic recycling of methyl mercury (Clarkson *et al.*, 1973). It decreased the plasma half-life in eight of these patients to 20 days. Other polymeric resins are in the developmental stages (Harbison *et al.*, 1977; Takahashi *et al.*, 1975).

In contrast to the experience with lead chelates, promising results have been obtained using a combination of chelation and extracorporeal hemodialysis. Perhaps the effort was successful because the chelator was infused into arterial blood just before it entered the dialyzer. Both the complex and the chelating agents (D-penicillamine, *N*-acetyl-D,L-penicillamine, cysteine and acetylcysteine) were found to be highly dialyzable, so that very little of the free chelator was returned to the systemic circulation (Kostyniak *et al.*, 1975). Rates of removal of methyl mercury from dogs were increased by a factor of 100 (Kostyniak *et al.*, 1977). This technique has been tried in at least two patients, one of whom was said to have shown considerable improvement (Al-Abbasi *et al.*, 1978). Although most of the experience has been accrued with cysteine, in dogs DMSA was superior to cysteine by a factor of about two (Kostyniak, 1982). Conventional hemodialysis after intramuscular injections of BAL was of little use in a victim of acute mercuric cyanide poisoning (Leumann and Brandenberger, 1977).

Symptomatology: (For information about respiratory exposures, chronic exposures and organomercurials, see text above.)

A. *First phase after ingestion of inorganic mercury salts*

1. Burning pain, sense of constriction, and ashen discoloration of the mucous membrane in mouth and pharynx, occurring immediately after the ingestion of corrosive mercury salts.
2. Within a few minutes intense epigastric pain, followed by diffuse abdominal pain and associated with almost continuous vomiting of mucoid material, which frequently contains blood and shreds of mucous membrane.
3. Severe purging, with liquid, bloody feces and considerable tenesmus.
4. Metallic taste, excessive salivation and thirst.
5. A rapid, weak pulse; shallow breathing; pallor; prostration, collapse, and death.
6. Signs and symptoms listed above are not encountered with mercury compounds of low irritancy or with portals of entry other than the mouth. In these cases the first clinical evidence of poisoning may be phase 2 (see B).

B. *Second phase.* If death does not intervene, phase 2 begins in 1 to 3 days in untreated cases (unless vomiting so effectively removed the poison that absorption was negligible).

1. The gastroenteritis described above tends to subside in about 36 hours under the influence of local treatment.
2. Mercurial stomatitis may (or may not) appear within 24 to 36 hours. It is characterized by a glossitis and ulcerative gingivitis. Salivation is marked (ptyalism). In chronic neglected cases severe infections, loosening of teeth, and necrosis of the jaw are major complications.
3. Necrosis of the renal tubules is evident within 2 to 3 days. In sequence the results are transient polyuria, albuminuria, cylindruria, hematuria, anuria, and eventual death associated with azotemia and renal acidosis, or recovery within 10 to 14 days.
4. Especially in untreated cases, a membranous colitis may first appear many days after the original exposure. It is evidenced by dysentery, tenesmus, ulceration of the colonic mucosa, and hemorrhage. Liver necrosis sometimes develops. In neglected cases collapse and death may occur weeks after the start of the illness.
5. Rarely neurologic signs and symptoms (*e.g.*, tremors, peripheral neuropathies) may appear late in the course of a slow convalescence after an acute exposure. In these atypical cases the syndrome of acute mercurialism is succeeded by that of chronic mercurialism (see text above).

Treatment: (Speed is imperative.)

1. As soon as possible, drink milk (with or without raw egg whites stirred into it) or a slurry of activated charcoal (see p. 1-4) to help precipitate mercury in the stomach.
2. Gastric lavage with tap water, milk, or 2 to 5% solution of sodium bicarbonate, unless spontaneous vomiting is intense and productive.
3. Administer through the lavage tube 0.5 to 1 oz. of sodium or magnesium sulfate in 6 to 8 oz. of water (unless spontaneous purging has already begun) and a slurry of activated charcoal.
4. Administer BAL (dimercaprol) intramuscularly as a 10% solution in oil. If given within 3 hours after ingestion, severe renal damage may be prevented. Dosage schedules are suggested in Table III-2 (p. III-52). See p. III-51 also for information about the clinical toxicity of BAL and for a discussion about the basis of the doses recommended. Collect urine before and after BAL therapy for mercury analyses.
5. Demulcents (*e.g.*, milk of magnesia, starch, bismuth subcarbonate) and analgetic drugs may be useful and necessary.
6. Because the BAL-mercury complex excreted in bile may be partly resorbed in the bowel, it is probably useful to administer activated charcoal every few hours, starting as soon as vomiting subsides.
7. Treat shock (peripheral vascular collapse) by correcting dehydration and electrolyte imbalances (see pp. IV-17 and 64-67).
8. If renal insufficiency develops, see p. IV-53 for the management of acute renal failure.
9. The maintenance of an adequate nutritional status (see p. IV-75) may be troublesome if stomatitis or colitis become severe or persistent.
10. If toxic signs or symptoms recur after an apparent recovery, another course of chelation therapy is warranted. BAL is still appropriate, but a trial with D-penicillamine or with *N*-acetyl-D,L-penicillamine may be preferable (see text above). Either penicillamine is given by mouth, usually with an empty stomach, in a dose of 250 mg. 4 times daily in adults or 10 mg./kg. 3 times daily in children, for 5 to 10 days. After the ingestion of inorganic mercury, BAL should always be used first. If chosen for a second course of chelation therapy, penicillamine should be withheld until ingested mercury is cleared out of the bowel.
11. Watch for late cicatricial gastric stenosis in those who survive the ingestion of corrosive mercuric salts (Gonzales *et al.*, 1962).

Laboratory:

1. Various methods are available for the quantitative analysis of mercury in blood, urine, feces and hair, but no reliable analytical procedure is simple. The degree of exposure and severity of symptoms are not highly correlated with mercury levels in tissues or excreta (Goldwater and Nicolau, 1966). Considerable overlap exists in the ranges of mercury found in the general population, in exposed asymptomatic individuals and in overtly ill patients. In the general population, excluding those with known exposures, mercury concentrations are said to range from <0.005 to 0.07 ppm in whole blood and from <0.001 to 0.22 ppm (but only rarely above 0.05) in urine (Hayes, 1982). Thus, an analytic value of more than 0.1 ppm (10 μg./dl.) in either blood or urine suggests an unusual exposure. Mercury accumulates in hair as the hair grows at its root; concentrations in newly formed hair average about 250 times greater than concurrent blood levels. Mean (or median) values of mercury in the hair of the general population range from 2 to 9 ppm. Although the intestinal tract is an important excretory route for mercury, apparently too few specimens of feces have been analyzed to establish normal limits.
2. Determination of β_2-microglobulins has been recommended as a useful test for evaluating renal tubular function (Pesce *et al.*, 1977).
3. Electroencephalographic changes may be correlated closely with the clinical state, particularly in methyl mercury intoxication (Brenner and Snyder, 1980).

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APPENDIX C-III

Standard Operating Procedures

NUS CORPORATION ENVIRONMENTAL MANAGEMENT GROUP	STANDARD OPERATING PROCEDURES	Number HS-09	Page 1 of 6
		Effective Date 05/04/90	Revision 2
		Applicability EMG	
		Prepared Health and Safety	
Subject HEAT STRESS CONTROL		Approved D. Senovich	

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1.0 PURPOSE

To establish procedures for the implementation, operations, and monitoring of a heat stress prevention, evaluation, and response program.

To describe signs and symptoms which characterize excessive exposure of field personnel to heat. Recognition of these signs and symptoms necessitates prompt corrective action to prevent injury or death.

2.0 SCOPE

Applies to all NUS/EMG activities where personnel may be exposed to environments exceeding 70°F.

3.0 GLOSSARY

Wet-Bulb Globe Temperature (WBGT) - This is the simplest and most suitable technique to measure the environmental factors associated with heat stress. The value is calculated by using equations shown in Section 5.2.2 of this procedure.

Work-Rest Regimen - This is a ratio of time spent working versus time spent resting. The ratio applies to 1 hour periods. For example, a work-rest regimen of 75 percent work, 25 percent rest corresponds to 45 minutes work, 15 minutes rest each hour.

4.0 RESPONSIBILITIES

All Site Personnel - All site personnel must be alert to signs and symptoms of heat strain in themselves or in those working with them. Personnel must also be aware of emergency corrective action described in first-aid tests.

Health and Safety Officer (HSO) - The HSO is responsible for implementing heat stress monitoring according to this guideline. He/she also is charged with enforcing the work/rest regime to control heat stress.

5.0 PROCEDURES

5.1 EFFECTS OF HEAT STRESS

Adverse weather conditions are important considerations in planning and conducting site operations. Hot weather can cause physical discomfort, loss of efficiency, and personal injury. Of particular importance is heat stress, resulting when protective clothing decreases natural body ventilation. Because of these factors, a heat stress evaluation procedure is essential to the health and safety of personnel conducting field work.

If the body's physiological processes fail to maintain a normal body temperature because of excessive heat, a number of physical reactions can occur ranging from mild (such as fatigue; irritability; anxiety; and decreased concentration, dexterity, or movement) to fatal. Standard reference books shall be consulted for specific first-aid treatment.

Heat-related problems include:

1. Heat Rash caused by continuous exposure to heat and humid air and aggravated by chafing clothes. Decreases ability to tolerate heat as well as being a nuisance.

2. Heat Cramps caused by profuse perspiration with inadequate fluid intake and chemical replacement (especially salts). Signs: muscle spasms and pain in the extremities and abdomen.

3. Heat Exhaustion caused by increased stress on various organs to meet increased demands to cool the body. Signs: shallow breathing; pale, cool, moist skin; profuse sweating; dizziness; or lassitude.

4. Heat Stroke, the most severe form of heat stress. Body must be cooled immediately to prevent severe injury and/or death. Signs and symptoms are: red, hot, dry skin; no perspiration; nausea, dizziness and confusion; strong, rapid pulse; or coma.

5.2 HEAT STRESS MONITORING

5.2.1 Work-Rest Regimen

In order to establish a proper work-rest regimen, the WBGT may be used in conjunction with the work load required to perform each task. Light work examples include sitting or standing to control machines or performing light hand or arm work. Moderate work includes walking about with moderate lifting and pushing or use of coated coveralls and respirators. Heavy work corresponds to pick and shovel-type work or the use of full body protective clothing. It must be assumed that any activity involving this type of clothing will be considered heavy work.

The work-rest regimen selected, using the WBGT procedure, will be utilized as a baseline. The actual or adjusted period of work will be determined based on the biological monitoring outlined in Section 5.2.3 of this procedure.

5.2.2 WBGT Determination

In order to determine the WBGT the following equations will be used:

- Outdoors with solar load:
  WBGT = 0.7 NWB + 0.2 GT + 0.1 DB

- Indoors or outdoors with no solar load:
  WBGT = 0.7 NWB + 0.3 GT

  Where:
  WBGT = Wet-Bulb Globe Temperature Index
  NWB = Natural Wet-Bulb Temperature
  DB = Dry-Bulb Temperature
  GT = Globe Temperature

The factors involved in the equations on page 4 can be measured in the following manner:

- Through the use of a direct-reading heat stress monitor, capable of measuring all of the individual factors associated with the WBGT equation. For example, the Reuter-Strokes Wibget No. RSS-214 heat stress monitor.

- By measuring the individual factors manually, using the following type of equipment:

  - Dry-bulb thermometer
  - Natural wet-bulb thermometer
  - Globe thermometer
  - Stand

The measurement of the individual factors shall be performed as follows:

The range of the dry and the natural wet-bulb thermometers shall be -5°C to 50°C with an accuracy of 0.5°C. The dry-bulb thermometer must be shielded from the sun and the other radiant surfaces of the environment without restricting the airflow around the bulb. The wick of the natural wet-bulb thermometer shall be kept wet with distilled water for at least 1/2 hour before the temperature reading is made. It is an inadequate procedure to immerse the other end of the wick into a reservoir of distilled water and wait until the whole wick becomes wet by capillary. The wick shall be wetted by direct application of water, 1/2 hour before each reading. It shall extend over the bulb of the thermometer, covering the stem about one additional bulb length. The wick should always be clean and a new one shall be washed before using.

A globe thermometer, consisting of a 15cm (6 inch)-diameter hollow copper sphere painted on the outside with a matte black finish or equivalent, shall be used. The bulb or sensor of a thermometer (range -5°C to 100°C with an accuracy of ± 0.5°C) must be fixed in the center of the sphere. The globe thermometer shall be exposed at least 25 minutes before it is read.

A stand shall be used to suspend the three thermometers so that they do not restrict free air flow around the bulbs; and the dry-bulb, wet-bulb, and globe thermometers are not shaded.

It is permissible to use any other type of temperature sensor that gives identical readings to that of a mercury thermometer under the same conditions.

The thermometers must be so placed that the readings are representative of the conditions where the men work or rest, respectively. All readings shall be recorded on the site log.

5.2.3 Biological Monitoring

One of the following procedures shall be followed when the work-place temperature is 70°F or above, and/or upon this site HSO's discretion, in order to make sure the work/rest regime is providing proper personal protection and to document exposure.

1. Heart rate (HR) shall be measured by the pulse for 30 seconds as early as possible in the resting period. The HR, at the beginning of the rest period, should not exceed 110 beats/min. If the HR is higher, the next work period should be shortened by 10 minutes (or 33 percent), while the length of rest period stays the same. If the pulse rate is 100 beats/min at the beginning of the next rest period, the following work cycle should be shortened by 33 percent. The length of the initial work period will be determined by using the table below.

PERMISSIBLE EXPOSURE THRESHOLD LIMIT VALUES
(Values Are Given in °F WBGT)

Work-Rest Regimen	Work Load		
	Light	Moderate	Heavy
Continuous Work	80.0	80.0	77.0
75% Work - 25% Rest, Each Hour	87.0	82.4	78.6
50% Work – 50% Rest, Each Hour	88.5	85.0	82.2
25% Work – 75% Rest, Each Hour	90.0	88.0	86.0

2. Body temperature shall be measured orally with a clinical thermometer as early as possible in the resting period. Oral temperature (OT) at the beginning of the rest period should not exceed 99°F. If it does, the next work period should be shortened by 10 minutes (or 33 percent), while the length of the rest period stays the same. However, if the OT exceeds 99.7°F at the beginning of the next rest period, the following work cycle should be further shortened by 33 percent. The worker's OT should be measured at the end of the rest period to make sure that it has dropped below 99°F. At no time shall work begin with an OT above 99°F.

5.3 HEAT STRESS CONTROL

Of particular importance is heat stress, resulting when protective clothing decreases natural body ventilation. One or more of the following will help reduce heat stress:

1. Drinking water shall be made available to the workers in such a way that they are stimulated to frequently drink small amounts, i.e., one cup every 15-20 minutes (about 150 ml or 1/4 pint).

   The water shall be kept reasonably cool (55-60°F) and shall be placed close to the workplace so that the worker can reach it without abandoning the work area. However, where contaminants are known/suspected to exist that pose an ingestion toxicity hazard potential, workers shall not be permitted to consume any fluids without first being decontaminated and going to a noncontaminated area.

2. Long cotton underwear acts as a wick to help absorb moisture and protect the skin from direct contact with heat-absorbing protective clothing. It should be the minimum undergarment worn.

3. When necessary/applicable, install mobile showers and/or hose-down facilities to reduce body temperature and cool protective clothing.

4. In the extremely hot weather, conduct non-emergency response operations in the early morning or evening.

5. In hot weather, rotate shifts of workers wearing impervious clothing.

6. Good hygienic standards must be maintained by frequent changes of clothing and daily showering. Clothing should be permitted to dry during rest periods. Persons who notice skin problems should immediately consult medical personnel.

7. Acclimatization to heat involves a series of physiological and psychological adjustments that occur in an individual during his first week of exposure to hot environmental conditions. The work-rest regimen in this procedure is valid for acclimated workers who are physically fit. Extra caution must be employed when unacclimated or physically unfit workers must be exposed to heat stress conditions.

6.0 REFERENCES

None.

7.0 ATTACHMENTS

None.

APPENDIX C-IV

Lyme Disease

Lyme disease - A newly recognized infectious disease characterized by fever, joint pain, and a distinctive red annular rash. Transmission of this disease is accomplished via a vector in this case ticks. Once the infected tick attaches to the host(field personnel) it passes the bacteria (spirochete) via the bloodstream. From introduction of the bacteria to the onset of the signs and symptoms of the disease may vary from individual to individual however generally ranges from 1 to 4 weeks for initial symptoms. Initial treatment would indicate those individuals infected have responded well to treatment with penicillin. In addition to the aforemention disease ticks affectively vector many other maladies such as Rocky Mountain Spotted Fever, Tularaemia, and Tick paralysis.

Identification and Control

Several species of hard-backed ticks exist in a variety of climates, however, reward flourish during the early spring and summer. Typically, ticks exist in warm moist climates, heavily vegetative, and attach to their host through contact as the host passes by through grasses and underbrush. Tick identification may be accomplished through their markings and structure. To aid in this identification examples of different types of ticks which may be encountered have been included in Figure 1-D.

Tick Control. Climatic factors are probably the most important in natural control of ticks. As the timing of the field activities is not coordinated with the climatic and natural control of this hazard additional control measures must be implemented.

Control Measures. Every effort should be made to discover the presence of ticks on the body and clothing by careful examination, especially of the head, promptly after exposure to tick infested areas. Tyvek uniforms will be worn for all movement through the brush(potential tick infested areas). These uniforms will be discarded between excursions into the infested areas. These uniforms will be stored away from other garments to avoid potential infestation. Commercially produced repellants have been found to be fairly effective when applied to the outer garments prior to engaging in field activities. For this reason these compounds will be employed. Additional precautions such as securing outer garments at the pants legs, wrists, and neck to avoid the opportunity of attachment. Field personnel shall assist one another in the detection of ticks inspection of one another on exposed portions of the body.

Tick Removal. Should ticks sucessfully attach, they can be encouraged to release their mouthparts (means of attachment) by applying chloroform, turpentine, alcohol, or a heated needle to their body. Once removed a topical medication such as Tincture of iodine should be forced into the hole evacuated by the mouthparts. Care should be taken not to get the blood of crushed ticks into the eyes or into scratches or breaks in the skin. Prompt removal of discovered ticks will reduce the chance of serious consequences.

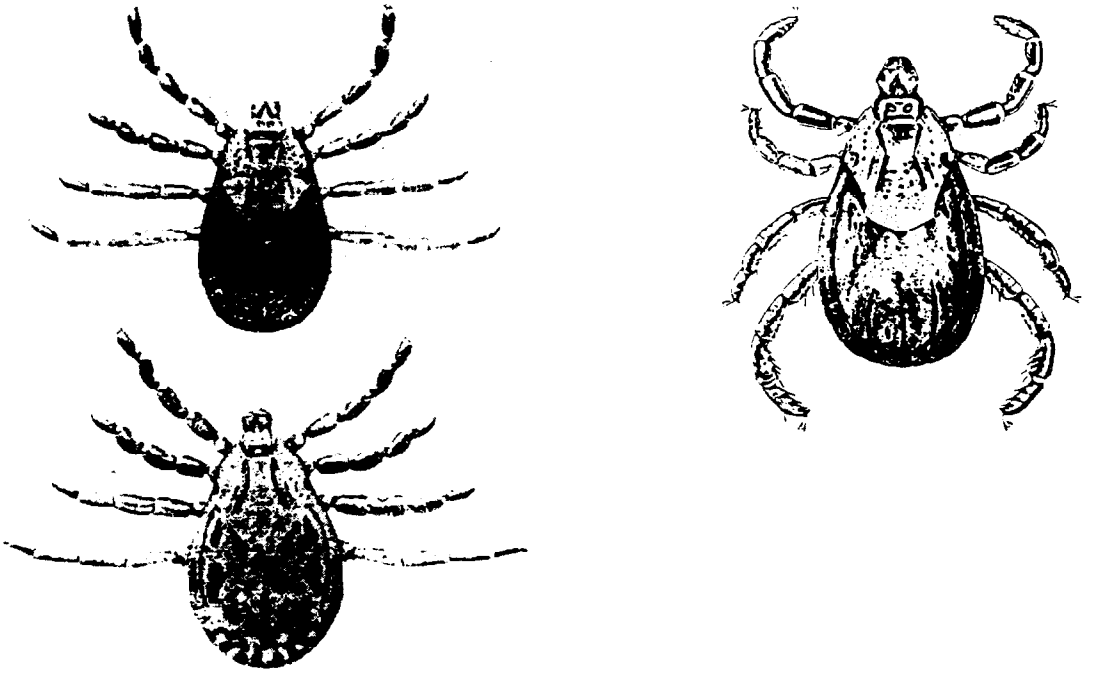

FIGURE 1-D

Above are examples of hard-back ticks which may be encountered during field activities.

ATTACHMENT A

SITE HEALTH AND SAFETY
FOLLOW-UP REPORT

SITE HEALTH AND SAFETY FOLLOW-UP REPORT

Appendix A must be filled out and returned to the Site Health and Safety Officer after the conclusion of each site visit.

Person responsible for follow-up report: _____

Actual date(s) of work: _____

1. <u>Actual Project Team:</u>

HALLIBURTON NUS Personnel:	Discipline/Tasks:

Non-HALLIBURTON NUS Personnel/Affiliation:	Discipline/Tasks

2. **Personal Protective Equipment Used:**

• Level of Respiratory Protection Used	Activity

• Field Dress	Activity

3. **General Safety**

Were any health or safety problems encountered while on site?

Explain: _____

4. Incident Report Information

Did any team member report:	Yes	No
• Chemical exposure	_____	_____
• Illness, discomfort, or unusual symptoms	_____	_____
• Environmental problems (heat, cold, etc.)	_____	_____
• Injury	_____	_____

Explain: _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Was an Employee Incident Report Completed? ___ Yes ___ No

5. Evaluation of Site Health and Safety Plan

Was the Health and Safety Plan adequate? _____ Yes _____ No

What changes would you recommend?

_____

_____

_____

_____

_____

FIRST AID SUPPLIES USAGE FORM

Project No.	Date	Item(s) Used	Kit No.

Please submit this information as soon as possible to to the HALLIBURTON NUS/EMG Equipment Manager for first-aid supply replenishment. Telephone number (412) 262-4583

SCBA LOG

Site: _____

Location: _____

Dates of Investigation: _____

User	Date of Use	SCBA #	Satisfactory Check-Out (Yes/No - Initials)	Date Cleaned

SCBA Performance Comments:

_____ Site Manager

_____ Date

Return to HSO at Completion of Activity

AIR PURIFYING
RESPIRATOR LOG

Type of Respirator: _____

Site: _____

Location: _____

Dates of Investigation: _____

User	Date of Use	Cleaned and Inspected Prior To Use (Initials)	Cartridges Changed Prior to Use (Yes/No)	Total Hours On Cartridge

_____ Site Manager

_____ Date

Return to HSO at Completion of Activity

INCIDENT REPORT

Report No. _____

Site: _____ Project No. _____

Location: _____

Date of Report: _____ Preparer's Name: _____

Name and Address of Injured: _____ SSN: _____ Age: _____

_____ Sex: _____

Years of Service: _____ Time of Present Job: _____ Title/Classification: _____

Division/Department: _____ Date of Incident: _____ Time: _____

Incident Category: _____ Motor Vehicle _____ Property Damage _____ Fire

_____ Chemical Exposure _____ Near-Miss _____ Other

Severity of Injury or Illness: _____ Nondisabling _____ Disabling

_____ Medical Treatment _____ Fatality

Amount of Damage: $_____ Property Damage: _____

Estimated Number of Days Away from Job: _____

Nature of Injury or Illness: _____

1. **Classification of Injury:**

_____	Fractures	_____	Heat Burns	_____	Cold Exposure
_____	Dislocations	_____	Chemical Burns	_____	Frostbite
_____	Sprains	_____	Radiation Burns	_____	Heat Stroke
_____	Abrasions	_____	Bruises	_____	Heat Exhaustion
_____	Lacerations	_____	Blisters	_____	Concussion
_____	Punctures	_____	Toxic Respiratory	_____	Faint/Dizziness
_____	Bites		Exposure	_____	Toxic Respiratory
_____	Respiratory Allergy	_____	Toxic Ingestion	_____	Dermal Allergy

Part of Body Affected: _____

Degree of Disability: _____

Date Medical Care Was Received: _____

Where Medical Care Was Received: _____

Address (if off site): _____

2. **Incident Location**

Causative agent most directly related to accident (object, substance, material, machinery, equipment, conditions): _____

_____

_____

_____

Was weather a factor? _____

Unsafe mechanical/physical/environmental condition at time of accident (Be specific):

_____

_____

_____

Unsafe act by injured and/or others contributing to the accident (Be specific, must be answered):

_____

_____

_____

Personal factors (improper attitude, lack of knowledge or skill, slow reaction, fatigue):

_____

_____

_____

Level of personal protection equipment required in Site Safety Plan:

_____

_____

_____

Modifications: _____

_____

_____

_____

Was injured using required equipment? _____

_____

_____

If not, how did actual equipment use differ from plan? _____

_____

_____

_____

What can be done to prevent a recurrence of this type of accident (modification of machine; mechanical guards; correct environment; training)?

_____

_____

_____

Detailed narrative description (how did accident occur, why; objects, equipment tools used, circumstances, assigned duties). Be specific:

_____

_____

_____

(Use back of sheet, as required)

Witnesses to accident: _____

_____

_____

Signature of Preparer _____

Signature of Site Manager _____

3. <u>Department Appraisal and Recommendation</u>

In your opinion, what actions or equipment contributed to this accident?

_____

_____

_____

Your recommendation:

_____

_____

_____

Date: _____ Signature of Department Manager _____

4. **Costs of the Incident (to be completed by Health Sciences Department)**

Temporary total	_____	Permanent partial	_____
Death or permanent total	_____		
Started losing time	_____	Part of body	_____
Returned to work	_____	Percent loss or	
Time charge	_____	loss of use	_____
		Time charge	_____
Compensation	$_____	Medical	$_____
Other	$_____	Total	$_____

Name and Address of Hospital _____

_____

Name and Address of Physician _____

_____

cc: Office Health and Safety Supervisor
Administrative Manager
Manager of Health Sciences
Medical Consultant

INCIDENT FOLLOW-UP REPORT

(To be Completed by Health Sciences Department)

Date of Incident: _____

Name: _____ Employee No. _____

Site: _____

Brief description of incident: _____

_____

_____

_____

_____

_____

_____

Outcome of incident: _____

_____

_____

_____

_____

_____

_____

Physician's recommendations: _____

_____

_____

_____

_____

_____

_____

Date returned to work: _____

ATTACH ANY ADDITIONAL INFORMATION TO THIS FORM

cc: Office Health and Safety Supervisor

Administrative Manager

Manager of Health Sciences

Medical Consultant

ATTACHMENT B

OSHA POSTER

JOB SAFETY & HEALTH PROTECTION

The Occupational Safety and Health Act of 1970 provides job safety and health protection for workers by promoting safe and healthful working conditions throughout the Nation. Requirements of the Act include the following:

Employers

All employers must furnish to employees employment and a place of employment free from recognized hazards that are causing or are likely to cause death or serious harm to employees. Employers must comply with occupational safety and health standards issued under the Act.

Employees

Employees must comply with all occupational safety and health standards, rules, regulations and orders issued under the Act that apply to their own actions and conduct on the job.

The Occupational Safety and Health Administration (OSHA) of the U.S. Department of Labor has the primary responsibility for administering the Act. OSHA issues occupational safety and health standards, and its Compliance Safety and Health Officers conduct jobsite inspections to help ensure compliance with the Act.

Inspection

The Act requires that a representative of the employer and a representative authorized by the employees be given an opportunity to accompany the OSHA inspector for the purpose of aiding the inspection.

Where there is no authorized employee representative, the OSHA Compliance Officer must consult with a reasonable number of employees concerning safety and health conditions in the workplace.

Complaint

Employees or their representatives have the right to file a complaint with the nearest OSHA office requesting an inspection if they believe unsafe or unhealthful conditions exist in their workplace. OSHA will withhold, on request, names of employees complaining.

The Act provides that employees may not be discharged or discriminated against in any way for filing safety and health complaints or for otherwise exercising their rights under the Act.

Employees who believe they have been discriminated against may file a complaint with their nearest OSHA office within 30 days of the alleged discrimination.

Citation

If upon inspection OSHA believes an employer has violated the Act, a citation alleging such violations will be issued to the employer. Each citation will specify a time period within which the alleged violation must be corrected.

The OSHA citation must be prominently displayed at or near the place of alleged violation for three days, or until it is corrected, whichever is later, to warn employees of dangers that may exist there.

Proposed Penalty

The Act provides for mandatory penalties against employers of up to $1,000 for each serious violation and for optional penalties of up to $1,000 for each nonserious violation. Penalties of up to $1,000 per day may be proposed for failure to correct violations within the proposed time period. Also, any employer who willfully or repeatedly violates the Act may be assessed penalties of up to $10,000 for each such violation.

Criminal penalties are also provided for in the Act. Any willful violation resulting in death of an employee, upon conviction, is punishable by a fine of not more than $10,000, or by imprisonment for not more than six months, or by both. Conviction of an employer after a first conviction doubles these maximum penalties.

Voluntary Activity

While providing penalties for violations, the Act also encourages efforts by labor and management, before an OSHA inspection, to reduce workplace hazards voluntarily and to develop and improve safety and health programs in all workplaces and industries. OSHA's Voluntary Protection Programs recognize outstanding efforts of this nature.

Such voluntary action should initially focus on the identification and elimination of hazards that could cause death, injury, or illness to employees and supervisors. There are many public and private organizations that can provide information and assistance in this effort, if requested. Also, your local OSHA office can provide considerable help and advice on solving safety and health problems or can refer you to other sources for help such as training.

Consultation

Free consultative assistance, without citation or penalty, is available to employers, on request, through OSHA supported programs in most State departments of labor or health.

More Information

Additional information and copies of the Act, specific OSHA safety and health standards, and other applicable regulations may be obtained from your employer or from the nearest OSHA Regional Office in the following locations:

Atlanta, Georgia
Boston, Massachusetts
Chicago, Illinois
Dallas, Texas
Denver, Colorado
Kansas City, Missouri
New York, New York
Philadelphia, Pennsylvania
San Francisco, California
Seattle, Washington

Telephone numbers for these offices, and additional area office locations, are listed in the telephone directory under the United States Department of Labor in the United States Government listing.

Washington, D.C.
1988 (Revised)
OSHA 2203

Ann McLaughlin, Secretary of Labor

U.S. Department of Labor

Occupational Safety and Health Administration

Under provisions of Title 29, Code of Federal Regulations, Part 1903.2(a)(1) employers must post this notice (or a facsimile) in a conspicuous place where notices to employees are customarily posted.

GPO : 1988 O - 219-667

ATTACHMENT C

MEDICAL DATA SHEET

Medical Data Sheet and Field Team Review

This brief Medical Data Sheet will be completed by all onsite personnel and will be kept in the command post during the conduct of site operations. This data sheet will accompany any personnel when medical assistance is needed or if transport to hospital facilities is required.

Project _____

Name _____ Home Telephone _____

Address _____

Age _____ Height _____ Weight _____

Name of Next Kin _____

Drug or other Allergies _____

Particular Sensitivities _____

Do You Wear Contacts? _____

Provide a Checklist of Previous Illnesses or Exposure to Hazardous Chemicals _____

_____

_____

What medications are you presently using? _____

_____

_____

Do you have any medical restrictions? _____

_____

_____

Name, Address, and Phone Number of personal physician: _____

_____

_____

_____

_____

==========

I am the individual described above. I have read and understand this HASP.

_____ _____

Signature Date

APPENDIX D

QUALITY ASSURANCE PROJECT PLAN

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1.0 PROJECT DESCRIPTION

As requested by the U.S. Navy, HALLIBURTON NUS has prepared this Quality Assurance Project Plan (QAPP) for environmental sampling and analysis work at Site 8 - Nitroglycerin Plant Office at the Indian Head Division, Naval Surface Warfare Center (IHDIVNAVSURFWARCEN or NSWC) in Indian Head, Maryland.

HALLIBURTON NUS has established quality assurance/quality control (QA/QC) measures and a program to ensure that these measures are applied to the collection and interpretation of all environmental quality data at the site. The QAPP is designed to assure that the precision, accuracy, representativeness, comparability, and completeness (the PARCC parameters) of the data are known, documented, and adequate to satisfy the data quality objectives of the project.

This plan represents the policies, organization, objectives, data-collection activities, and QA/QC activities that will be utilized to ensure that all data collected during, and reported by, this project are representative of existing conditions. Chemical analyses will be conducted by a laboratory subcontractor. The laboratory will be either NEESA approved or have worked for the Navy on a recent project. It is anticipated that General Physics Environmental Services, Inc. (Gaithersburg, Maryland) will be the project laboratory. The laboratory shall deliver the data in a Level D format except for form 14. Form 14 will not be provided with the analytical packages.

2.0 PROJECT SCOPE OF WORK

Environmental sampling and analysis will be performed to determine the extent of mercury contamination at Site 8. The field work will be performed in a phased manner. Up to 200 sediment/soil samples and 10 surface water samples will be collected and analyzed. A detailed description of the Phase I sampling locations are found in Section 4.0 of the Abbreviated Field Sampling PLan (AFSP). Details of the methods and procedures to be used during the field work are continued in Sections 2.0 and 3.0. A brief history of the site is contained in Section 1.0 of the AFSP.

3.0 SAMPLE MATRICES, PARAMETERS, AND FREQUENCY COLLECTION

As part of the field work, environmental quality samples will be collected from the following matrices: sediment/soil and surface water. A listing of the sample matrices, parameters, and frequency of collection is found in Table 3-1. Sampling procedure to be used in this study are provided in Section 6.0 of this QAPP. As required by NEESA, a sampling rationale is included in Section 4.0 of the Abbreviated Field Sampling Plan. All samples submitted for laboratory analysis will be analyzed for mercury. The analytical program is summarized in Table 3-1. Table 3-2 presents the bottle requirements, preservation requirements, and allowable holding times for the required analyses.

TABLE 3-1

ANALYTICAL PROGRAM SUMMARY

Parameter	Method	Detection Limit	Sample Matrix	Estimated No. Samples	Equipment Rinsate Blanks(1)	Field Blanks(2)	Duplicates(3)	Total Samples
Mercury (dry weight basis)	SW 846/7471	0.1 mg/kg (ppm)(4)	Sediment/Soil	192	5	2	20	219
Mercury(5) (Total)	SW 846/7470	0.2 µg/L (ppb)	Surface Water	10	2	1	1	14
Mercury(6) (Dissolved)	SW 846/7470	0.2 µg/L (ppb)	Surface Water	10	2	0	1	13
TAL Metals(7) plus cyanide	6010/7000 CLP/SOW 3/90	NA	Sediment/Soil	4	0	0	1	5
TCLP Metals(8)	1311 6010/7000	NA	Sediment/Soil	4	0	0	0	4
			TOTALS	220	9	3	23	255

(1) Equipment Rinsate Blank - Samples obtained by pouring analyte-free water over sample collection equipment after decontamination. Assesses the effectiveness of field decontamination procedure. Obtained at a frequency of 1/day/media/analysis but analyzed every other day unless positive detection are recorded. Number of samples reflects the number of actual laboratory analyses performed.

(2) Field Blank - Samples consisting of the source water used in decontamination. Obtained at a frequency of 1/event/media.

(3) Duplicates - A single sample split into two portions during a signal act of sampling. Assess the overall precision of the sampling and analysis program. Obtained at a frequency of 10 percent of the number of samples.

(4) Detection Limit for sediment/soil samples on a wet weight basis.

(5) Total - For the determination of total mercury, the sample is not filtered before acidification.

(6) Dissolved - For the determination of dissolved mercury the sample will be field filtered through a 0.45 micron filter before acidification.

(7) TAL Metals - Target analyte list of 23 metals.

(8) TCLP Metals - Toxicity Characteristics Leaching Procedure of 8 metals (including mercury).

TABLE 3-2

SUMMARY OF ANALYSIS,BOTTLE REQUIREMENTS, PRESERVATION REQUIREMENTS AND HOLDING TIMES

Media	Analysis	Number of Samples	Number of Containers per Sample	Container Type	Preservation Requirements	Holding Times
Sediment/Soil	Mercury (Total Recoverable)	212	1	4 oz. wide mouth glass jar	Cool to 4°C	28 days
Surface Water(1)	Mercury (Total Recoverable)	11	1	500 ml polyethylene bottle	HNO_3 to pH<2; Cool to 4°C	28 days
	Mercury (Dissolved)	11	1	500 ml polyethylene bottle	Field Filtered; HNO_3 to pH<2; Cool to 4°C	28 days
Sediment/Soil	TCL Metals plus Cyanide	5	1	8 oz. wide mouth glass jar	Cool to 4°C	6 months
Sediment/Soil	TCLP Metals	4	1	8 oz. wide mouth glass jar	Cool to 4°C	6 months
Equipment Rinsate and Field Blanks	Mercury (Total Recoverable)	10	1	500 ml polyethylene bottle	HNO_3 to pH<2; Cool to 4°C	28 days
	Mercury (Dissolved)	2	1	500 ml polyethylene bottle	Field Filtered; HNO_3 to pH<2; Cool to 4°C	28 days
	TOTAL	255	-	-	-	-

(1) All duplicate water samples will be collected in four bottles - one will be the actual sample, one will be the duplicate (field QC), one will be used for matrix spike analysis (lab QC), and one will be used for matrix spike duplicate analysis (lab QC).

4.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

HALLIBURTON NUS will be responsible for the overall management of the project, including all field sampling activities. Personnel from Navy will support HALLIBURTON NUS in a number of areas during the project.

4.1 NAVY SUPPORT

Mr. Paul Berkman will be the CHESDIV Remedial Project Manager (RPM). He will be the primary Navy point of contact for the project. All project activities, including reporting and field activities, will be coordinated through Mr. Berkman. Any changes in scope will be approved through Mr. Berkman prior to implementation. Mr. Berkman may be contacted at the following address:

Mr. Paul Berkman, Code 1812
Chesapeake Division
Naval Facilities Engineering Command
Washington Naval Yard, Building 212
Washington, DC 20374-2121
(202) 433-3760

Mr. Shawn Jorgensen will be the primary point of contact at Indian Head Division, NSWC. All field work will be coordinated through Mr. Jorgensen; he will notify appropriate personnel (security, etc.) and make arrangements for equipment (boat and support equipment) that will be provided by the Navy. Mr. Jorgensen may be contacted at the following address:

Mr. Shawn Jorgensen, Code 0965
Indian Head Division
Naval Surface Warfare Center
Building D28
Indian Head, MD 20640-5000
(301) 743-6745

4.2 PROJECT ORGANIZATION

The project will be staffed with personnel from the Pittsburgh office. The address and main phone number for the Pittsburgh office is:

HALLIBURTON NUS Environmental Corporation
Foster Plaza VII
661 Andersen Drive
Pittsburgh, Pennsylvania 15220
(412) 921-7090

Key management staff and project staff members for this project are as follows:

- John Trepanowski, P.E. - Program Manager (215) 971-0900
- Debra Wroblewski - Deputy Program Manager (412) 921-8968
- Patricia Patton - Contracting Officer (301) 258-8644
- Patricia Armstrong - Quality Assurance Manager (215) 971-0900
- Matt Soltis - Health and Safety Manager (412) 921-8912
- Anthony Klimek, P.E . - Project Manager (412) 921-8640
- Andrew Kendrick - Project Geologist (412) 921-8623

The Project Manager has the primary responsibility for project and technical management of this project. He is responsible for the coordination of all onsite personnel, and for providing technical assistance for all activities that are directly related to the project. If quality assurance problems or deficiencies requiring special action are identified, the Project Manager, Deputy Program Manager, and Quality Assurance Manager will identify the appropriate corrective action.

4.3 FIELD ORGANIZATION

The HALLIBURTON NUS field investigation team will consist of a combination of the following personnel:

- Field Operations Leader (FOL)
- Field hydrogeologist/geologist

The FOL will be responsible for the coordination of all onsite personnel and for providing technical assistance when required. The FOL, or his or her designee will coordinate and be present during all

sampling activities and will assure the availability and maintenance of all sampling materials/equipment. The FOL will be responsible for the completion of all sampling and chain-of-custody documentation, and will assume custody of all samples and ensure the proper handling and shipping of samples.

The Quality Assurance Manager, although not formally part of the field team, will be responsible for the adherence of all QA/QC guidelines as defined in this QAPP. Strict adherence to these procedures is critical to the collection of acceptable and representative data.

A site health and safety officer will be designated prior to field activities and will be responsible for assuring that all team members adhere to the designated health and safety requirements.

5.0 QUALITY ASSURANCE OBJECTIVES

The overall QA objective is to develop and implement procedures for field sampling, chain-of-custody, laboratory analysis, and reporting that will provide environmental monitoring data of known and acceptable quality. Specific procedures to be used for sampling, chain-of-custody, calibration of field instruments, laboratory analysis, reporting, internal quality control, audits, preventative maintenance, and corrective actions are described in later sections of this QAPP. The purpose of this section is to address the data quality objectives in terms of the (PARCC) parameters, quantitation and detection limits, field blanks, rinsate blanks, duplicates, and bottleware cleanliness.

5.1 DATA QUALITY OBJECTIVES

Data Quality Objectives (DQOs) are qualitative and/or quantitative statements regarding the quality of data needed to support the project activities. The sampling rationale provided in the Abbreviated Field Sampling Plan explains the choice of sample locations and media which will supply information needed for the SI.

5.2 PARCC PARAMETERS

The quality of data set is measured by certain characteristics of the data, namely the PARCC parameters. Some of the parameters are expressed quantitatively, while others are expressed qualitatively. The objectives of the project and the intended use of the data define the PARCC goals.

5.2.1 Precision

Precision characterizes the amount of variability and bias inherent in a data set. Precision describes the reproducibility of measurements of the same parameter for a sample under the same or similar conditions. Precision is expressed as a range (the difference between two measurements of the same parameter) or as a relative percent difference (the range relative to the mean, expressed as a percent). Range and Relative Percent Difference (RPD) values are calculated as follows:

$$\text{Range} = \text{OR} - \text{DR}$$

$$\text{RPD} = \frac{[\text{OR} - \text{DR}]}{1/2\,(\text{OR} + \text{DR})} \times 100\%$$

where: OR = original sample result

DR = duplicate sample result

The internal laboratory control limits for precision are three times the standard deviation of a series of RPD or range values. RPD values may be calculated for both laboratory and field duplicates, and can be compared to the control limits as a QA check. Laboratory duplicates will be analyzed at the rate required by NEESA. Field duplicates will be collected for 10 percent of all samples collected.

5.2.2 Accuracy

Accuracy is the comparison between experimental and known or calculated values expressed as a percent recovery (%R). Percent recoveries are derived from analysis of standards spiked into deionized water (standard recovery) or into actual samples (matrix spike or surrogate spike recovery). Recovery is calculated as follows:

$$\%R = \frac{E}{T} \times 100\%$$

where: E = experimental result

T = true value (theoretical result)

and

$$T = \frac{(\text{sample aliq.})(\text{sample conc.}) + (\text{spike aliq.})(\text{spike conc.})}{\text{sample aliq.} + \text{spike aliq.}}$$

Control limits for accuracy are set at the mean plus or minus three times the standard deviation of a series or %R values.

Accuracy for aqueous and solid samples will be evaluated by use of surrogate and matrix spikes. Out-of-criteria results will be reviewed for data applicability as a part of data validation.

5.2.3 Representativeness

All data obtained should be representative of actual conditions at the sampling location. The AFSP is designed so that the samples taken will present an accurate representation of actual site conditions. All sampling activities will conform to the protocols given in Section 6.0 of this QAPP. The use of NEESA

approved analytical protocols and data deliverables will ensure that analytical results and deliverables are representative, and both consistently performed and reported.

5.2.4 Comparability

Comparability will be achieved by utilizing standardized sampling and analysis methods and data reporting format. Both analytical procedures and sample collection techniques will maximize the comparability of this new data to previous data. Additionally, consideration will be given to seasonal conditions and other environmental conditions that could influence analytical results.

5.2.5 Completeness

Completeness is a measure of the amount of valid data obtained from the measurement program, compared to the total amount collected. For relatively clean, homogeneous matrices, 100-percent completeness is expected. However, as matrix complexity and heterogenicity increase, completeness may decrease. Where analysis is precluded or where DQOs are compromised, effects on the overall investigation must be considered. Whether any particular sample is critical to the investigation will be evaluated in terms of the sample location, the parameter in question, the intended data use, and the risk associated with the error.

Critical data points may not be evaluated until all the analytical results are evaluated. If in the evaluation of results it becomes apparent that the data for a specific medium are of insufficient quality (95 percent), either with respect to the number of samples or an individual analysis, resampling of the deficient data points may be necessary.

5.3 FIELD BLANKS

Field blanks are obtained by sampling the water(s) used in decontamination during the field investigation. Samples consist of analyte-free and potable water used for decontamination of sampling equipment. Field blanks will be used to confirm the effectiveness of decontamination procedures, and to determine if the analyte-free water may be contributing to sample contamination. Field blanks will be collected for each type of water used for decontamination and will be submitted at a frequency of one per sampling event per media.

5.4 RINSATE BLANKS

Equipment rinsate blanks are obtained under representative field conditions by running analyte-free water through sample collection equipment (trowel, hand auger, corer, etc.) after decontamination and placing it in the appropriate sample containers for analysis. Equipment blanks will be used to assess the effectiveness of decontamination procedures. Equipment blanks will be collected for each type of non-dedicated sampling equipment used and will be submitted at a frequency of one per day per media. Equipment blanks, however, will only be analyzed every other day unless positive detections are recorded in the prior sample blank. It will be the responsibility of the FOL to communicate to the laboratory whether an equipment blank is, or is not, to be analyzed as stated above.

5.5 FIELD DUPLICATES

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

5.6 BOTTLE WARE

NEESA requires specific bottleware cleaning procedures. Precleaned bottles will be used for project sampling activities. Precleaned bottles will be provided by the subcontracted laboratory who will also be responsible for providing the required certification.

6.0 SAMPLING PROCEDURES

6.1 SITE BACKGROUND

The site background information is provided in Section 1.0 of the AFSP.

6.2 SAMPLING OBJECTIVES

The objective of the sampling is to obtain sufficient data to define the extent of mercury contamination at Site 8. The data will be used to perform an Engineering Evaluation/Cost Analysis (EE/CA) and subsequently used to justify no further action or used to prepare an interim removal action plan if appropriate.

6.3 SAMPLE LOCATION AND FREQUENCY

Sediment/soil and surface water samples will be collected during the field activities. These samples will be analyzed in accordance with NEESA methodology for mercury. In addition, several sediment/soil samples may be analyzed for TAL and TCLP metals. Surface water samples are to be analyzed for both total and dissolved mercury. A list of the analytes, analytical method, containers, preservatives, and holding times are provided in Table 3-2 of this QAPP.

The proposed sampling will be performed in a phased manner. The location and frequency of the Phase I sediment/soil and surface water samples are described in Section 4,0 of the AFSP. Phase II sampling will be performed, if necessary, based on the results of the Phase I.

6.4 SAMPLE DESIGNATION

Each sample collected will be assigned a unique sample tracking number. The sample tracking number will consist of a three-segment, alpha-numeric code that identifies the sample medium and location, sample depth (for sediment/soil samples) or sampling round (for surface water samples), and QA designation, if required.

Any other pertinent information regarding sample identification will be recorded in the field log books.

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

(AANN)	-	(NN/NN) on (NN)	-	(A)
Medium & Location		Sample depth (sediment/soil)		QA designation
		or		
		Sampling round (surface water)		

Character Type:

A = Alpha

N = Numeric

Medium:

SW = Surface water

SS = Soil/Sediment

Sample Location:

Sample location number.

Sample Depth or Sampling Round:

For sediment/soil samples depth of sample in inches - Examples:

- Sample collected on surface - (00/00)
- Sample collected 6 inches to 12 inches deep - 06/12

For surface water samples round of sampling - Examples:

- First round of sampling 01
- Second round of sampling 02

QA Sample Designation:

D = Duplicate (Soil/Groundwater)

E = Equipment Rinsate Blank

F = Field Blank

6.5 SAMPLE EQUIPMENT AND PROTOCOLS

The sampling equipment and protocols to be used are presented in Appendix B.

6.6 SAMPLE HANDLING AND ANALYSIS

Sample handling and analysis are presented in Sections 5.0, 6.0, and 7.0 of this QAPP.

6.7 EQUIPMENT DECONTAMINATION

The equipment involved in field sampling activities will be decontaminated prior to and during sampling activities All sampling equipment used for collecting samples will be decontaminated both prior to beginning field sampling and between samples. The following decontamination steps will be taken:

- Potable water rinse
- Alconox or Liquinox detergent wash
- Potable water rinse
- Nitric acid rinse
- Analyte-free water rinse
- Air dry

Field analytical equipment such as pH, conductivity and temperature instrument probes will be rinsed first with analyte-free water, then with the sample liquid.

7.0 SAMPLE CUSTODY

Sample custody procedures are designed to provide documentation of preparation, handling, storage, and shipping of all samples collected. An example of the chain-of-custody form, which will be used during this investigation, is included in Appendix A of the Abbreviated Field Sampling Plan. A copy of the procedure is included in Appendix B.

Samples collected during the site investigation will be the responsibility of identified persons from the time they are collected until they, or their derived data, are incorporated into the final report. Stringent chain-of-custody procedures will be followed to document sample possession.

7.1 FIELD CUSTODY

- The FOL, or his or her designee, is responsible for the care and custody of the samples collected until they are delivered to the analyzing laboratory or entrusted to a carrier.

- Sample records will always be signed and dated.

- Chain-of-custody sample forms will be completed to the fullest extent possible prior to sample shipment. They will include the following information: project name, sample number, time collected, source of sample and location, description of sample location, matrix, type of sample, grab or composite designation, preservative, and name of sampler.

  These forms will be filled out in a legible manner, using waterproof ink, and will be signed by the sampler. Similar information will be provided on the sample label which will be securely attached to the sample bottle. The label will also include the general analyses to be conducted. In addition, sampling forms will be used to document collection, filtration, and preparation procedures. Copies of all forms used during field activities are provided in Appendix A.

7.2 TRANSFER OF CUSTODY AND SHIPMENT

The following procedures will be used when transferring custody of samples:

- Samples will always be accompanied by a chain-of-custody record. When transferring samples, the individuals relinquishing and receiving them will sign, date, and note the time of the chain-of-custody record. This record documents the sample custody transfer from the sampler to the laboratory, often through another person or agency (common carrier). Upon arrival at the laboratory, internal sample custody procedures will be followed.

- Prior to shipment to the laboratory for analysis, samples will be properly packaged. Individual custody records will accompany each shipment. Shipping containers will then be sealed for shipment to the laboratory. The methods of shipment, courier name, and other pertinent information, will be entered in the remarks section of the custody record.

- All shipments will be accompanied by the chain-of-custody record identifying the contents. The original record will accompany the shipment; and a copy will be retained by the field sampler.

- Proper documentation will be maintained for shipments by common carrier.

7.3 SAMPLE SHIPMENT PROCEDURES

The following procedures will be followed when shipping samples for laboratory analysis:

- Samples requiring refrigeration will be promptly chilled with ice or Blue Ice to a temperature of 4°C and will be packaged in an insulated cooler for transport to the laboratory. Ice will be sealed in containers to prevent leakage of water. Samples will not be frozen.

- Only shipping containers that meet all applicable state and Federal standards for safe shipment will be used.

- Shipping containers will be sealed with nylon strapping tape, custody seals will be signed, dated, and affixed, in a manner that will allow the receiver to quickly identify any tampering that may have occurred during transport to the laboratory.

- The field chain-of-custody document will be placed inside the shipping container in a sealed plastic envelope after the courier has signed the document.

- Shipment will be made by a public courier or by the analytical laboratory pickup and delivery service. After samples have been collected, they will be sent to the laboratory within 48 hours.

7.4 FIELD DOCUMENTATION RESPONSIBILITIES

It will be the responsibility of the FOL to secure all documents produced in the field (geologist's daily logs, lithologic and sampling logs, calibration forms, communications) at the end of each work day. A copy of all forms used during field activities are included in Appendix A.

The possession of all records will be documented; however, only the project FOL or designee may remove field data from the site for reduction and evaluation.

8.0 CALIBRATION PROCEDURES

Field equipment such as the photoionization equipment (HNU), the pH and specific conductance meters, and any other equipment used during this project will be calibrated and operated in accordance with the manufacturer's instructions and manuals. A log will be kept documenting the calibration results for each field instrument. The log will include the date, standards, personnel, and results of the calibration. A copy of the calibration form used during the field investigation is included in Appendix A. The SOP for calibration procedures is included in Appendix B.

9.0 ANALYTICAL PROCEDURES

Environmental samples collected during the field investigation for chemical analyses will be analyzed using the appropriate analytical procedures as outlined in Section 3.0 of this QAPP.

10.0 DATA REDUCTION, VALIDATION, AND REPORTING

Data reduction, validation, and reporting are basic steps in the control and processing of field and laboratory project-generated data. Data validation procedures are described below.

Data validation consists of a stringent review of an analytical chemical data package with respect to sample receipt and handling, analytical methods, data reporting and deliverables, and document control. The quality of data generated by a laboratory is extremely important; it is an integral part of the investigation and should be clearly tied to the project goals. Data used to develop qualitative trends, for example, will not have the same data validation requirements as data used for litigation purposes.

A qualified HALLIBURTON NUS chemist will review the analytical data packages using EPA procedures. All laboratory samples will be validated. After the data is validated, a listing of non-conformities will be generated and used to determine whether the data can be utilized for its intended purpose. Non-conformities require data qualifiers, which are used to alert the data user to inaccurate or imprecise data. For example, if holding times are exceeded, the data reviewer must qualify all positive results as estimated and all sample quantitation limits as estimated. For situations in which there are several quality control criteria out of specification (with regard to the limits specified in the Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program, NEESA 20.2-047B, June 1988), the data validator may make professional judgments and/or comments on the validity of the overall data package. In situations where the validity of an entire data package is in question, it may be necessary for the sample(s) to be re-analyzed. The reviewer will then prepare a technical memorandum presenting changes in the data, if necessary, and the rationale for making such changes.

The net result is a data package that has been carefully reviewed for its adherence to prescribed requirements and is suitable for its intended use. Data validation thus plays a major role in determining the confidence with which key technical evaluations may be made.

The final Site Characterization Report will include a data summary. The summary of analytical data will exclude non-detected compounds. No subtraction of blanks will be allowed. Data will be flagged if blank contamination occurs. All data flags will follow the result in the summary.

The laboratory data for each sample will be reported in an appendix. These data will be presented in a spreadsheet format with all field, and laboratory blanks marked. The format recommended by NEESA will be used. Field forms may be included in another appendix.

11.0 INTERNAL QUALITY CONTROL CHECKS

Quality control samples generated by HALLIBURTON NUS will include the collection of field duplicates, the preparation of field blanks, and the preparation of equipment/rinsate blanks. An approximate 10 percent duplication (one per 10 samples or one per sample matrix if less than 10 samples) will be collected. See Section 3.0 for the required number of sample duplicates.

As there are no VOCs analyses to be performed, no trip blanks will be prepared for this investigation. Rinsates, prepared by running distilled water through the sampling equipment, will be analyzed to determine whether the sampling procedures may be biasing the data. Field blanks will be prepared at a rate of one per source per event. Procedures for collecting these samples are contained in the Section 6.0 of this QAPP.

There are two types of quality assurance mechanisms used to ensure the production of analytical data of known and documented quality. The internal quality control procedures for the analytical services are specified under NEESA guidelines. These specifications include the types of control samples required (sample spikes, surrogate spikes, controls, and blanks), the frequency of each control, the compounds to be used for sample spikes and surrogate spikes, and the quality control acceptance criteria. It will be the laboratory's responsibility to document, in each package, that both initial and on-going instrument and analytical QC criteria are met. This documentation will be included in the data packages generated by contract laboratory.

Analytical results of field-collected quality control samples will also be compared to acceptance criteria, and documentation will be performed showing that criteria have been met. Any samples in nonconformance with the QC criteria will be identified and reanalyzed by the laboratory, if possible. The following procedures will be employed for the Site 8 samples:

- Proper storage of samples.
- Use of qualified and/or certified technicians.
- Use of calibrated equipment.
- Formal independent confirmation of all computation and reduction of laboratory data and results.

- Use of standardized test procedures.

- Inclusion of replicate samples at a frequency of one replicate per 10 samples or one per sample matrix if less than 10 samples are collected.

12.0 PERFORMANCE AND SYSTEM AUDITS

System audits will be performed as appropriate, to assure that the work is being implemented in accordance with the approved project SOPs and in an overall satisfactory manner.

- The FOL will supervise and check on a daily basis that the monitoring wells are installed and developed correctly, field measurements are made accurately, equipment is thoroughly decontaminated, samples are collected and handled properly, and the field work is accurately and neatly documented.

- The data validator will review (on a timely basis) the data packages submitted by the laboratory. The data validator will check that the data was obtained through the approved methodology, that the appropriate level of QC effort and reporting was conducted, that holding times were met, and that the results are in conformance with the QC criteria. On the basis of these factors, the data validator will evaluate the data quality and limitations.

- The project manager will oversee the FOL and data validator, and check that management of the acquired data proceeds in an organized and expeditious manner.

- System audits for the laboratory are conducted by NEESA on a regular basis as required.

- A formal audit of the field sampling procedures may be conducted in addition to the auditing that is an inherent part of the daily project activities.

- The auditors will check that sample collection, sample handling, decontamination protocols, and instrument calibration and use are in accordance with the approved project SOPs. The auditors will also check that the field documentation logs and chain-of-custody forms are being filled out properly.

The subcontracted analytical laboratory must be either NEESA approved or have worked for the Navy on a recent project, be eligible to perform the required analysis under NEESA protocols, and must have site-specific approval prior to commencement of work.

13.0 PREVENTATIVE MAINTENANCE

HALLIBURTON NUS has established a program for the maintenance of field equipment to ensure the availability of equipment in good working order when and where it is needed. This program consists of the following elements:

- The equipment manager keeps an inventory of the equipment in terms of items (model and serial number) quantity and condition. Each item of equipment is signed out when in use, and its operating condition and cleanliness checked upon return.

- The equipment manager conducts routine checks on the status of equipment and is responsible for the stocking of spare parts and equipment readiness.

- The equipment manager maintains the equipment manual library and trains field personnel in the proper use and care of equipment.

- The FOL is responsible for working with the equipment manager to make sure that the equipment is tested, cleaned, charged, and calibrated in accordance with the manufacturer's instructions and HALLIBURTON NUS SOP's before being taken to the job site and during field activities.

14.0 DATA ASSESSMENT PROCEDURES

14.1 REPRESENTATIVENESS, ACCURACY, AND PRECISION

All data generated in the investigation will be assessed for its representativeness, accuracy, and precision. The completeness of the data will also be assessed by comparing the valid acquired data to the project objectives to see that these objectives are being addressed and met. The specific procedures used to determine data precision, accuracy, and completeness will be provided in the analytical reports. Accuracy will be determined using laboratory spiked samples and laboratory field blanks.

The representativeness of the data will be assessed by determining if the data are consistent with known or anticipated hydrogeologic or chemical conditions and accepted principles. Field measurements will be checked for completeness of procedures and documentation of procedures and results.

Precision and accuracy will be determined using replicate samples and blank and spiked samples, respectively. The specific procedures for determining PARCC parameters are outlined in Section 5.0.

14.2 VALIDATION

All analytical data prepared for this project will be validated.

14.3 DATA EVALUATION

The evaluation of the data collected during the field investigation will be a comparison of: mercury contamination at sampling locations throughout the site, current and previous mercury contamination, and chemical concentrations in soils versus background and risk-based concentrations.

The total and dissolved mercury concentrations in the surface water will be compared to each other historical results and background levels.

Evaluation of the sediment/soil data collected during the field investigation will include a comparison of: contaminant concentrations throughout the site, chemical concentrations in the background (natural)

samples versus the chemical concentration in the onsite samples; and chemical concentrations in site soils versus regulatory standards risk-based concentrations.

15.0 CORRECTIVE ACTION

The QA program will enable problems to be identified, controlled, and corrected. Potential problems may involve nonconformance with the SOPs and/or analytical procedures established for the project or other unforeseen difficulties. Any person identifying an unacceptable condition will notify the project manager. The project manager, with the assistance of the CLEAN Quality Assurance Manager, will be responsible for developing and initiating appropriate corrective action and verifying that the correction action has been effective. Corrective actions may include the following: resampling and/or reanalysis of sample, amending or adjusting project procedures. If warranted by the severity of the problem (for example, if a change in the approved AFSP is required), the Navy will be notified in writing and their approval will be obtained prior to implementing any change. Additional work that is dependent on a nonconforming activity will not be performed until the problem has been eliminated.

The laboratory will maintain an internal closed-loop corrective action system that operates under the direction of the laboratory QA coordinator.

16.0 QUALITY ASSURANCE REPORTS

The QA/QC advisor will review all aspects of the implementation of this QAPP on a regular basis and may prepare a summary report. Reviews will be performed at the completion of each field activity and reports will be completed at this time. These reports will include an assessment of data quality and the results of system and/or performance audits. Any significant QA deficiencies will be reported and identified, and corrective action possibilities discussed. The laboratory will issue monthly progress reports. Other QA/QC reports are listed in Section 8.0.

17.0 REFERENCES

American Society of Agronomy, 1986. Methods of Soil Analysis. Madison, Wisconsin.

Naval Energy and Environmental Support Activity (NEESA). June 1988. Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program. NEESA, Port Hueneme, CA. NEESA 20.2-047B.

U.S. EPA, 1986. Test Methods for Evaluating Solid Waste - SW846.