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Interim Action Work Plan for Building 566 for Naval Weapons Station Earle New Jersey

Northern Division
Naval Facilities Engineering Command

Contract No. N62472-90-D-1298
Contract Task Order 0155

August 1994

Halliburton NUS
CORPORATION

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INTERIM ACTION WORK PLAN
for
BUILDING 566
NAVAL WEAPONS STATION EARLE, NEW JERSEY

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Northern Division
Environmental Branch, Code 18
Naval Facilities Engineering Command
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Contract No. N62472-90-D1298
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1.0 INTRODUCTION

The interim action work plan for Building 566 at Naval Weapons Station (NWS) Earle, Colts Neck, New Jersey, has been prepared by Halliburton NUS Corporation (HNUS) in response to a record of change memorandum, dated June 28, 1994, for Contract Task Order (CTO) 155. HNUS was tasked in the record of change memorandum to prepare draft and final work plans for an interim action measure to control the spread of oil at Building 566 and to determine the permits and/or approval required for the implementation of the work plan. The interim action preferred by the Navy is the installation of an interceptor trench. This work plan was prepared for the Northern Division (NORTHDIV) Naval Facilities Engineering Command (NAVFACENGCOM) under the Comprehensive Long-Term Environmental Action - Navy (CLEAN) Contract Number N62472-90-D-1298.

Oil is seeping from the ground surface in the vicinity of anddowngradient of a septic holding tank, septic leach field, and two underground storage tanks (USTs) located at Building 566. Building 566 is located in Mainside ordnance area "M," west of State Highway 34 and the Mainside administrative and personnel support facility. Tightness tests were performed on two USTs (UST I.D. Nos. 566/1 and 566/2) previously located at Building 566. The tanks passed the tightness tests; the piping associated with the USTs failed the test. The piping is therefore likely to have contributed to the contamination present at the site. Oil, which was accidentally pumped into the vent pipe of a septic system holding tank located at Building 566, is also probably contributing to the contamination.

1.1 PROJECT OBJECTIVES AND DELIVERABLES

The objectives of this project are to collect sufficient information to allow for the design of an interceptor trench to control the spread of oil into adjacent, downgradient wetlands, to determine the permits necessary for installation of the trench, and to install the trench. The trench will be installed a minimum of three feet upgradient of the wetlands and, where feasible, in soil where the concentration of total petroleum hydrocarbon (TPH) is less than 1,000 mg/kg. To accomplish the objectives of the project, plans and specifications for the leach field will be requested from NWS Earle Public Works Department, the permits necessary to install the trench will be determined, and the following field investigation activities will be performed:

- Delineate the lateral extent of TPH contamination in soil that is at concentrations greater than 1,000 mg/kg.
- Delineate the vertical and horizontal extent of adjacent wetlands.
- Determine the depth(s) to groundwater in areas downgradient of seeps and stressed vegetation.

- Determine soil characteristics, including grain-size distribution data, in areas downgradient of oil seeps and stressed vegetation.

- Survey ground surface elevations, soil borings locations, and the limit of the wetlands.

Based upon data gathered during field investigation activities, wetland delineation drawings, TPH d lineation drawings, design drawings and specifications, and subcontractor procurement documents will be prepared for the interceptor trench. A subcontractor will be procured to install the trench, and an operation and maintenance manual will be prepared by HNUS. The interceptor trench will be operated by the Navy. The final disposition of the interceptor trench (i.e. removal, abandonment-in-place, or continued operation) will be determined by NWS Earle. A storm-water management system will be in use during and after the installation of the trench.

Project deliverables include the submission of a draft report summarizing field investigation activities and design specifications for the interceptor trench and a draft and final report summarizing field investigation, trench installation, and storm-water management system installation activities. Wetland delin ation drawings, TPH delineation drawings, and a groundwater contour map will be submitted with the draft report summarizing field investigation activities. A manual on the operation and maintenance of the trench will be prepared and submitted with the final report. Copies of the field logbooks, laboratory analytical data packages, and survey data will be attached as appendices to the reports. The following additional documents may be generated during the design and construction phase of this project:

- Operation and maintenance manual
- Cost estimate - construction
- Cost estimate - operations and maintenance
- Specifications
- Design drawings
- Health and safety plan (HASP) (revised)
- Contract documents
- Waste classification (for construction-generated waste disposal) forms
- Submittal log
- Construction schedule forms
- Submittal schedule forms
- Quality assurance/quality control (QA/QC) report
- As-built drawings
- Change order forms and notice of change

1.2 ACTIVITIES SCHEDULE

The proposed schedule of significant events, including field investigation and trench installation activities, as measured from HNUS' receipt of written authorization to proceed, is outlined below:

Milestone Event

HNUS receives written authorization to proceed	0 weeks
Laboratory subcontractor procurement by HNUS	0 to 1 week
Fi ld investigation activities by HNUS	1 to 3 weeks
Receipt of analytical data from field investigation activities by HNUS	1 to 3 weeks
Design of interceptor trench by HNUS	3 to 5 weeks
Submission of draft report to Navy by HNUS	7 weeks
Receipt of Navy review comments on draft report	9 weeks
Excavation and installation subcontract procurement by HNUS	9 to 10 weeks
Installation of interceptor trench and storm water management system by HNUS	10 to 12 weeks
Soil disposal subcontract procurement for excavated soil by HNUS	11 to 12 weeks
Disposal of soil by HNUS	13 weeks
Submission of draft report to Navy by HNUS	15 weeks
Receipt of Navy review comments on draft report	17 weeks
Submission of final report to Navy by HNUS	19 weeks

The proposed project activities time line is presented in Figure 1-1. Specific dates will be added to the proposed schedule of significant events upon written authorization to proceed, and a copy of the amended schedule will be submitted to the Navy.

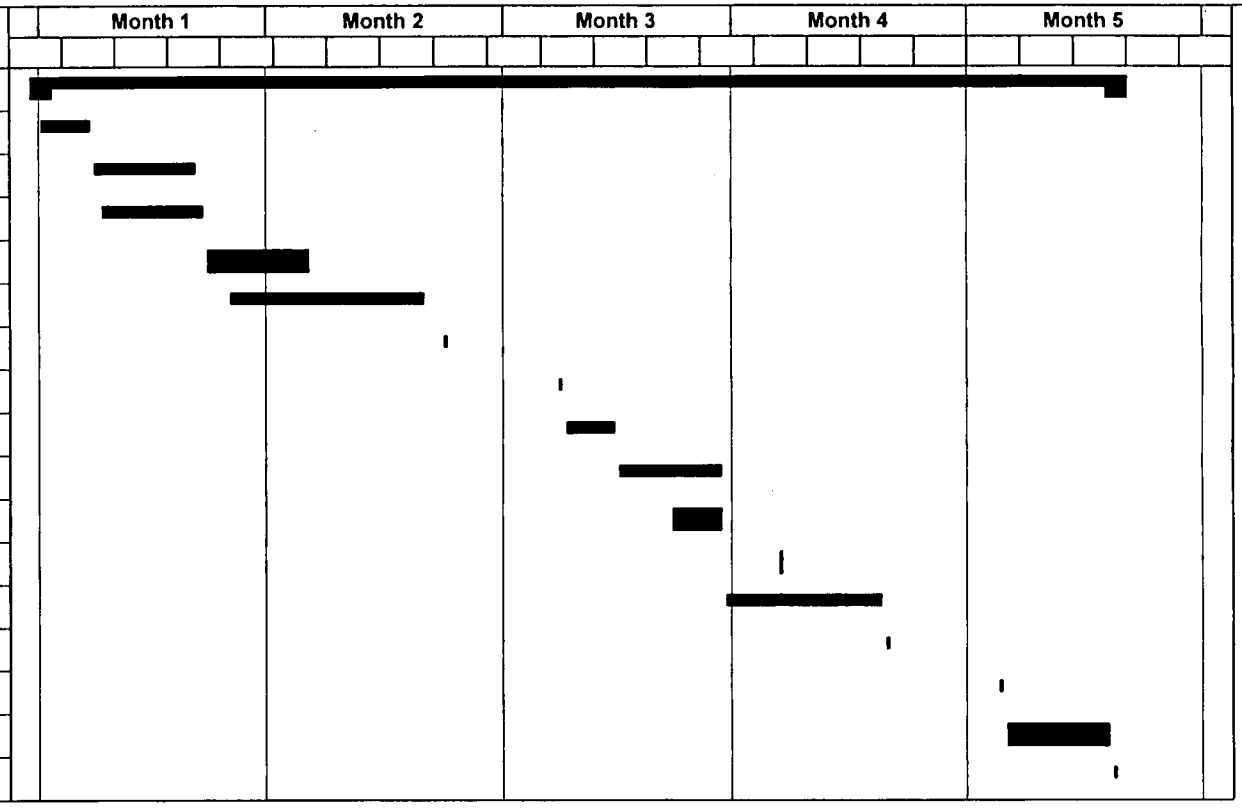
1.3 PRINCIPAL INVESTIGATORS AND RESPONSIBILITIES

HNUS will be responsible for the management and conduct of the field investigation activities presented in this work plan. The following key personnel will be involved with activities for this CTO:

- Navy remedial project manager (RPM)
- Navy legal contact
- NWS Earle facilities contact
- CLEAN program manager
- CLEAN program QA manager
- CLEAN program health and safety (H&S) manager

FIGURE 1-1 PROJECT ACTIVITIES TIME LINE

ID	Name
1	Authorization to Proceed
2	Laboratory Subcontractor Procurement
3	Field Investigation Activities
4	Receipt of Analytical Data
5	Design of Interceptor Trench
6	Draft Report (Investigation Activities)
7	Submission of Draft Report
8	Receipt of Navy Comments
9	Excavation/Installation Subcontractor Procureme
10	Installation Activities
11	Soil Disposal Subcontractor Procurement
12	Soil Disposal Activities
13	Draft Report (Investigation/Installation Activities)
14	Submission of Draft Report
15	Receipt of Navy Comments
16	Final Report
17	Submission of Final Report



- HNUS project manager
- HNUS project QA officer
- HNUS project H&S officer
- Subcontract laboratory analytical services coordinator
- Subcontract excavation and installation services coordinator
- Subcontract disposal services coordinator

The organizational chart for this project is presented in Figure 1-2.

The Navy RPM for CTO No. 155 is Brian Helland, NORTHDIV NAVFACENGCOM; he may be contacted at (610) 595-0567. As RPM, Mr. Helland is responsible for the following:

- Provide site information and history
- Provide logistical assistance
- Review results and recommendations and provide management and technical oversight

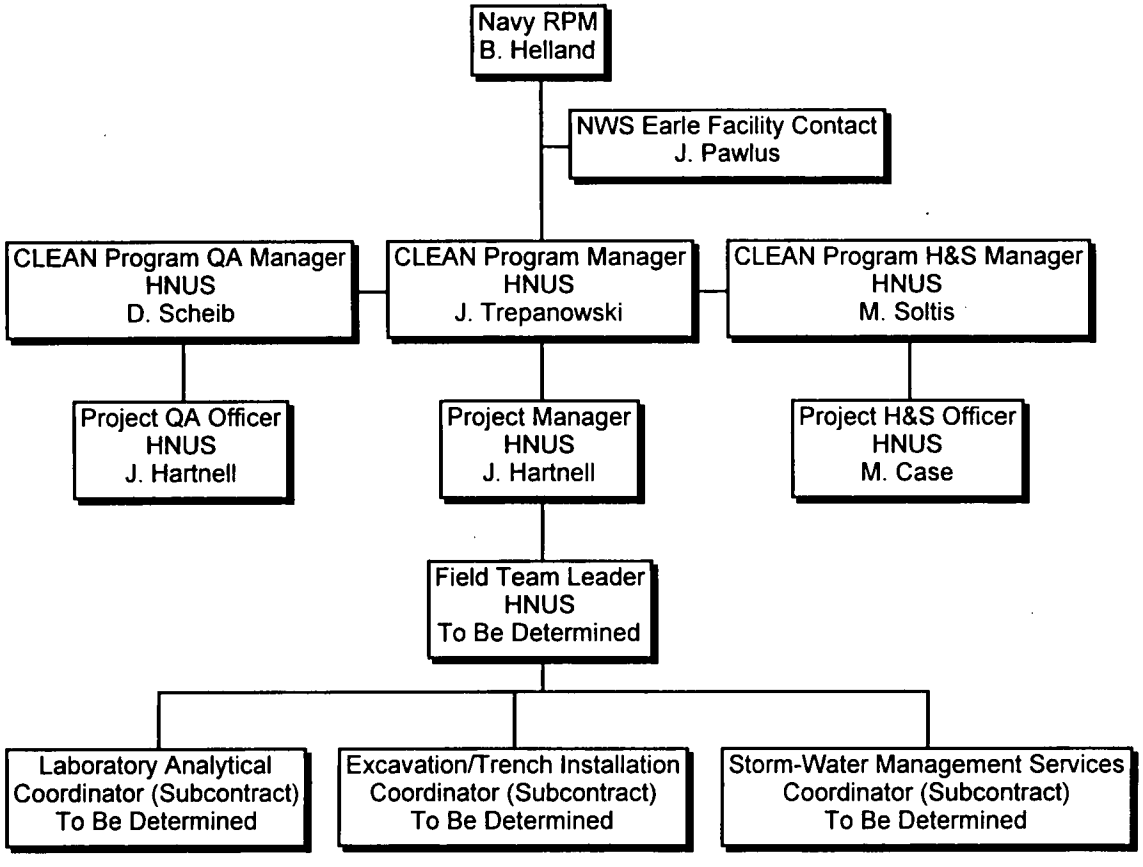
The NWS Earle facility contact is John Pawlus, NWS Earle; he may be contacted at (908) 866-2674. As facility contact, Mr. Pawlus is responsible for the following:

- Provide site information and history
- Provide logistical assistance
- Review results and recommendations and technical oversight

The CLEAN program manager is John Trepanowski, HNUS; he may be contacted at (610) 971-0900. As program manager, Mr. Trepanowski is responsible for the following:

- Ensure that contract requirements are met.
- Provide necessary resources to the project team to meet requirements of the work plan.
- Maintain consistency in procedures and work products with other CTOs.
- Establish and maintain communication among the Navy RPM, CLEAN program contracting officer, CLEAN program QA manager, CLEAN program H&S manager, and HNUS project manager.

FIGURE 1-2
PROJECT ORGANIZATIONAL CHART
CTO 155 - INTERIM ACTION WORK PLAN FOR BUILDING 566, NWS EARLE, NEW JERSEY



The CLEAN program QA manager is Debra Scheib, HNUS; she may be contacted at (412) 921-8876. As QA manager, Ms. Scheib is responsible for the following:

- Review of laboratory QA plans, work plans, audit reports, and site data.
- Identify nonconformance situations to management and provide guidance in the correction of nonconformances.
- Ensure deliverables meet the requirements of New Jersey Department of Environmental Protection and Energy (NJ DEPE) QA/QC program and the Navy QA/QC program.
- Make recommendations to the program manager and the project manager regarding corrective action.
- Supervise the responsibilities of the site QA officer.

The CLEAN program H&S manager is Matthew Soltis, HNUS; he may be contacted at (412) 921-8912. As H&S manager, Mr. Soltis is responsible for the following:

- Ensure that the site-specific HASP is in accordance with federal and state regulations and contract specifications.
- Provide technical safety and industrial hygiene oversight for all field work performed under the CLEAN contract.
- Provide clearance to the Navy for all personnel on the site in accordance with federal and state regulations and contract specifications.
- Perform audits to evaluate program effectiveness.
- Provide assistance and guidance to the project H&S officer.
- Maintain communication with the program manager, project manager, and the project H&S officer.

The project manager is Jill Hartnell, HNUS; she may be contacted at (610) 971-0900 by telephone and (610) 971-9715 by telecopier. As project manager, Ms. Hartnell is responsible for the following:

- Complete the project in a timely manner and maintain the project's scope, budget, and schedule.
- Coordinate and implement all tasks indicated in the approved site-specific work plan and quality assurance project plan (QAPP).
- Supervise the document control process.
- Approve deliverables and associated documents before transmittal.
- Implement programs and protocols related to the project.
- Establish and maintain communication among technical staff, Navy RPM, CLEAN program manager, program QA manager, program H&S manager, and regulatory agencies.

Ms. Hartnell will also be serving as the project geologist and project QA officer for this CTO. As project QA officer, Ms. Hartnell is responsible for the following:

- Ensure that protocols described in the QAPP are met.
- Provide guidance or assistance in the resolution of QA/QC problems.
- Review and evaluate quality-related changes to the work plan and QAPP. Discuss and submit changes to the program QA manager for approval.
- Ensure that nonconformances are identified and appropriate corrective actions are taken; provide assistance to the project manager with regard to corrective action and, if necessary, solicit involvement with the CLEAN program manager.

- Communicat regularly with the program QA manager and the subcontract laboratory analytical coordinator to ensure the progress of the QA tasks for the project.

- Act as the main contact for project QA matters and provide guidance about appropriate procedures to the project manager and support personnel.

The project H&S officer is Marcia Case; she may be contacted at (610) 971-0900. As project H&S officer, Ms. Case is responsible for the following:

- Prepare the site-specific HASP.

- Establish and maintain communication among the site safety officer (SSO), project manager, and the CLEAN program H&S manager.

- Verify that site personnel adhere to the site safety requirements.

- Provide guidance about appropriate corrective action procedures to project manager and support personnel.

- Perform other responsibilities as specified in the site-specific HASP.

The field team leader (FTL) for this project will be determined at a later date. The FTL is responsible for the following:

- In conjunction with the project manager, arrange for all necessary field equipment, transportation, subcontractors, etc.

- Supervise subcontractor crews and HNUS field team members during field investigation activities.

- Obtain utility clearances before the start of subsurface activities.

- Maintain field records including all sample data and field observations on the appropriate log sheets and/or in the site field logbook.

- Communicate regularly with the project manager, SSO, and facility contact to ensure the progress of field investigation tasks for the project.

Subcontracts for laboratory analytical services and geotechnical laboratory services will be procured and awarded before commencem nt of field investigation activities. The subcontract laboratory analytical services coordinator will ensure that the laboratory implements the requirements of NJ DEPE and the QAPP. The laboratory analytical services coordinator is responsible for reviewing the laboratory data before release.

Subcontracts for soil excavation/trench installation services and storm-water management installation services will be procured and awarded before the commencement of trench installation activities. The subcontract excavation/trench installation services coordinator will ensure that all excavation/installation activities are in accordance with NJ DEPE permits and regulations and HNUS requirements. The subcontract storm-water management services coordinator will ensure that all storm-water-management-related activities are in accordance with NJ DEPE permits and regulations and HNUS requirements.

A subcontract for contaminated-soil disposal services will be procured and awarded after installation of the trench. The subcontract disposal services coordinator will ensure that all sampling, transportation, and disposal activities are in accordance with NJ DEPE permits and regulations and HNUS requirements.

2.0 BACKGROUND INFORMATION FOR BUILDING 566

2.1 LOCATION

NWS Earle is located in Monmouth County, New Jersey (Figure 2-1) and consists of two major areas, Mainside and waterfront. The two major areas, which together comprise 10,865 acres, are connected by a 15-mile-long government-owned highway (Normandy Road) and railroad right-of-way. The connecting corridor encompasses 253 acres. Mainside, which covers 10,160 acres, is located along both sides of State Highway (S.H.) 34 in the townships of Colts Neck, Wall, and Howell and the borough of Tinton Falls. Building 566 is located west of S.H. 34 in Mainside ordnance area "M" (Figure 2-2). Mainside ordnance area "M" is accessed through a manned security gate. The waterfront area, which covers 705 acres, is located on the shoreline of Sandy Hook Bay in Middletown Township. A three-mile-long pier/trestle complex extends into Sandy Hook Bay.

NWS Earle was established in June 1943 for national defense purposes; before the establishment of the facility, the land was used for farming/agricultural purposes. The mission of NWS Earle is to receive, r novate, maintain, store, and issue ammunition, expendable ordnance items and/or weapons, and technical ordnance material.

Building 566 is located in Mainside ordnance area "M," east of Guadalcanal Road, south of Esperance Road, and north of Midway Road at New-Jersey state-plane coordinates 518,800 (feet) north-south and 2,140,200 (feet) east-west on the United States Geologic Survey (U.S.G.S.) Marlboro, New Jersey quadrangle, 7.5 minute series topographic map (Figure 2-2). The building is used for ordnance storage.

2.2 PREVIOUS INVESTIGATIONS

Two USTs (Tank I.D. Nos. 566/1 and 566/2), which were located southeast of Building 566, were tightness tested in 1991 under CTO 122. Tank 566/1 was a 4,000 gallon tank and contained diesel fuel, and tank 566/2 was a 6,000 tank and contained No. 2 heating oil. The tanks passed tightness tests; the piping associated with the tanks failed the tests and was subsequently repaired. One of the hold-down straps on UST 566/2 broke during the excavation of contaminated soil from around the tank. Because of this, UST 566/2 was replaced under an emergency permit in early 1992. UST 566/1 was replaced during May and June 1994. Samples collected during UST 566/1 removal activities had a maximum concentration of 25,000 mg/kg total petroleum hydrocarbon (TPH) in the soil. The incident discharge number for USTs 566/1 and 566/2 is 93-2-12-0939-57.

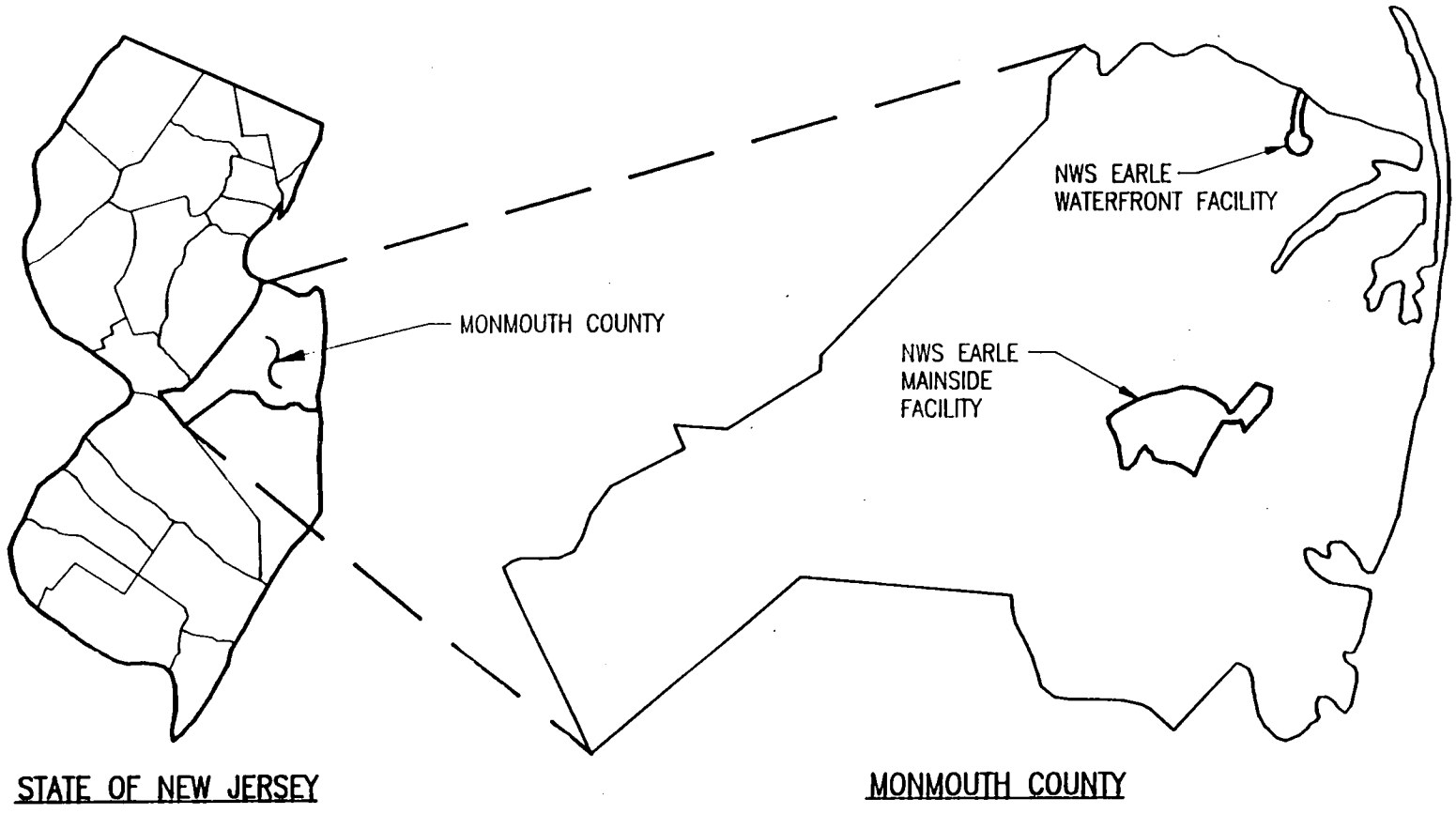


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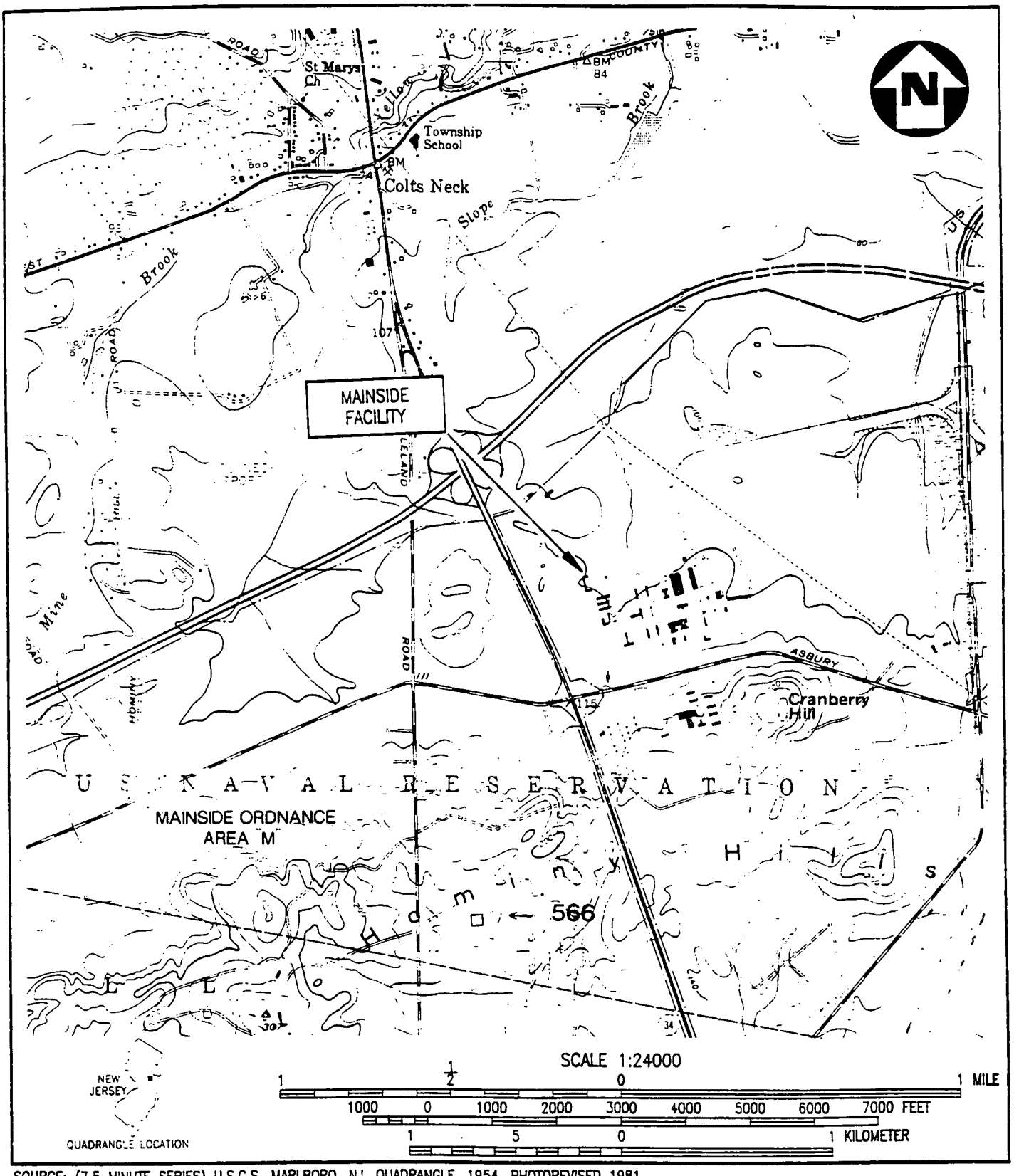
FIGURE 2-1

GENERAL LOCATION MAP
CTO 155 - INTERIM ACTION WORK PLAN FOR BUILDING 566
NWS EARLE, NEW JERSEY

HALLIBURTON NUS
Environmental Corporation



SOURCE: (7.5 MINUTE SERIES) U.S.G.S. MARLBORO, NJ, QUADRANGLE. 1954, PHOTOREVISED 1981.

FIGURE 2-2

BUILDING 566 VICINITY MAP
CTO 155 - INTERIM ACTION WORK PLAN
FOR BUILDING 566
NWS EARLE, NEW JERSEY

Halliburton NUS CORPORATION

Because TPH was detected at concentrations greater than 1,000 mg/kg, selected soil samples w re analyzed for volatile organic compounds plus 10 tentatively identified compounds (VOCs + 10). Acetone (5,700 ug/kg B), toluene (330 ug/kg estimated), methylene chloride (5,200 ug/kg estimated), 1,2-dichloroethane (2,800 ug/kg estimated), bromoform (7,700 ug/kg), 2-hexanone (37,000 ug/kg), 4-methyl-2-pentanone (27,000 ug/kg), 1,1,2,2-tetrachloroethane (22,000 ug/kg), ethyl benzene (maximum 3,100 ug/kg estimated), meta- + para-xylene (maximum 13,000 ug/kg), and ortho-xylene (3,500 ug/kg estimated) w re detected in the soil samples. The concentration reported for acetone was qualified with a "B" because acetone was identified as a probable laboratory contaminant. None of the contaminants were detected at concentrations above their residential or non-residential direct contact soil clean-up criteria listed in New Jersey Soil Clean-up Criteria (revised February 3, 1994). Only 1,2-dichloroethane, bromoform, 1,1,2,2-tetrachloroethane, and xylene were detected at concentrations above the impact to groundwater soil clean-up criteria listed in New Jersey Soil Clean-up Criteria (revised February 3, 1994). Methylene chloride, 1,2-dichloroethane, and 1,1,2,2-tetrachloroethane are chlorinated solvents, 2-hexanone, and 4-methyl-2-pentanone are oxygenated solvents, bromoform is a halogenated hydrocarbon, and styrene is an unsaturated hydrocarbon. Chlorinated solvents, oxygenated solvents, halogenated hydrocarbons, and unsaturated hydrocarbons are not typically associated with the formulation, by-products, or storage of oil products in UST systems. The presence of methylene chloride, 1,2-dichloroethane, bromoform, 2-hexanone, 4-methyl-2-pentanone, and 1,1,2,2-tetrachloroethane is therefore probably not related to the UST system.

A septic system is currently in use at Building 566; plans and specifications prepared for replacement of the existing leach field were placed on hold pending other remediation at the site. The proposed plans and details map for the septic system, including the specifications for the new leach field, is in Appendix A. Soil samples collected in support of design activities were analyzed for TPH (maximum 17,200 mg/kg), pesticides (non-detect), arsenic (maximum 8.59 mg/kg), antimony (non-detect), selenium (1.34 mg/kg), thallium (non-detect), mercury (non-detect), lead (maximum 39.5 mg/kg), total cyanide (maximum 1.77 mg/kg), total phenols (non-detect), and priority pollutant metals including beryllium (non-detect), cadmium (0.36 mg/kg), chromium (maximum 28.6 mg/kg), copper (maximum 4.58 mg/kg), nickel (non-detect), silver (non-detect), zinc (maximum 9.28 mg/kg), VOCs, and semivolatile organic compounds (SVOCs). VOCs detected included meta- and para-xylene (maximum 29,600 mg/kg), ortho-xylene (maximum 16,200 ug/kg), chloroform (12.1 ug/kg B), and various tentatively identified hydrocarbons. Chloroform was identified as a probable laboratory contaminant. SVOCs detected included acenaphthene (estimated 102 ug/kg), butylbenzyl phthalate (estimated 94.8 ug/kg), bis(2-ethylhexyl) phthalate (estimated 80.2 ug/kg), fluorene (18,100 ug/kg), n-nitrosodiphenylamine (20,400 ug/kg), phenanthrene (maximum 38,900 ug/kg), fluoranthene (maximum estimated 2,400 ug/kg), pyrene (estimated 5,400 ug/kg), benz(a)anthracene (estimated 105 ug/kg), chrysene (estimated 149 ug/kg), benzo(k)fluoranthene (estimated 101 ug/kg), beno(z)pyrene (estimated 48.4 ug/kg), and various tentatively identified SVOCs. During an oil delivery, product was believed to have been pumped by accident into the vent pipe of the septic holding tank located adjacent to the USTs at Building 566.

Oil was first observed seeping from the ground surface in the vicinity of and downgradient of the septic holding tank, septic leach field and two USTs located at Building 566 in December 1993 or January 1994. The contamination present at the site may be attributed to the piping associated with the former USTs and the oil that was pumped into the septic system. As previously stated, the purpose of this project is to install a interceptor trench to control the spread of oil into adjacent wetlands.

2.3 PHYSICAL GEOGRAPHY AND TOPOGRAPHY

Mainside is situated on the outer plain of the emergent portion of the Atlantic Coastal Plain Physiographic Province, approximately six miles inland from the Atlantic Ocean. Elevation across Mainside range from 100 to 300 feet above mean sea level (AMSL). Building 566 is located at Mainside Ordnance area "M"; elevations in the vicinity of Building 566 range from 140 to 160 feet AMSL.

2.4 POPULATION AND LAND USE

An estimated 2,500 people reside and/or work at NWS Earle. The majority of the land at Mainside is undeveloped land associated with ordnance operations and production and storage facilities; the undeveloped land is encumbered by explosive quantity distance (ESQD) arcs. Land use within 1,000 feet of the site includes ordnance storage, undeveloped wooded areas, and undeveloped open areas. Approximately 50 percent of the total land within 1,000 feet of the site is covered by buildings and other impermeable surface covers.

2.5 SURFACE WATER AND WETLANDS

Rivers and brooks in the Mainside area ultimately discharge to the Atlantic Ocean. The headwaters and drainage of Swimming, Manasquan, and Shark Rivers originate in the vicinity of Mainside. Portions of Mainside that are located west of S.H. 34, including Mainside ordnance area "M," drain via Marsh Bog Brook or Mingamahone Brook to the Manasquan River. The headwaters of the eastern branch of Mingamahone Brook have been mapped approximately 900 feet east of Building 566. The confluence of the eastern and western branches of Mingamahone Brook is located approximately 1,700 feet south of the building.

A series of small creeks, which flow generally southward toward a branch of Mingamahone Brook, are located adjacent to and downgradient of the septic holding tank and leach field. Surface runoff in this area follows topographic gradient to the small creeks or occurs as overland flow that discharges to local surface water bodies. Wetlands are present along the banks of the small creeks. The extent of wetlands downgradient of the seeps and stressed vegetation will be delineated as part of field investigation activities.

2.6 SOILS

Soils underlying the septic field are mapped as Udorthents, smoothed. Udorthents consist of areas of excavation and/or fill where little of the original soil profile remains. The fill used ranges from loamy material to concrete rubble.

Eight soil borings were installed in the leach field during 1993 septic leach field replacement activities; soil boring logs are in Appendix A. The borings ranged in depth from five feet, six inches to nine feet, six inches. A strong oil odor was noted during the drilling of seven of the borings. In general, the following soil profile was encountered: four to six inches of top soil, fine- to medium-sized stone and fine sand; one to two feet of tan, fine-grained sand; two to three feet of gray, fine-grained sand or one to two feet of medium- to coarse-sized gravel; and two feet of gray brown to black, fine- to medium-grained sand or one to two feet of orange silt and very fine-grained sand and gravel.

2.7 GEOLOGY

NWS Earle is situated in the Atlantic Coastal Plain Physiographic Province. A wedge of unconsolidated Cretaceous and Cenozoic age sands, clays, and marls overlies PreCambrian and lower Paleozoic age crystalline bedrock in the Coastal Plain. The unconsolidated sediments strike generally northeast-southwest, dip slightly to the southeast at 10 to 60 feet per mile, and thicken seaward from the Fall Line. The thickness of sediments in the Mainside area is estimated at 850 feet. The sediments crop out in a banded pattern that runs roughly parallel to the shoreline.

Geologic units mapped in the Mainside area, in descending order, are the Miocene age Cohansey Sand and Kirkwood Formation; the Paleocene age Vincentown Formation and Hornerstown Sand; the Upper Cretaceous age Tinton Sand, Red Bank Sand, Navesink Formation, Mount Laurel Sand, Wenonah Formation, Marshalltown Formation, Englishtown Formation, Woodbury Clay, Merchantville Formation, Magothy Formation, and Raritan Formation; and the Lower Cretaceous age Potomac Group. The lithologic and hydrologic characteristics of these geologic units are described in Table 2-1.

Mainside Ordnance Area "M" is probably underlain by outcrops of the quartz sand facies of the Vincentown Formation. The quartz sand facies of the Vincentown Formation is a fine- to coarse-grained, brown and gray, glauconitic quartz sand.

Table 2-1

New Jersey Coastal Plain Geologic and Hydrogeologic Units
CTO 155 - INTERIM ACTION WORK PLAN FOR BUILDING 566
NWS EARLE, NEW JERSEY

SYSTEM	SERIES	GEOLOGIC UNIT	LITHOLOGY	HYDROGEOLOGIC UNIT	HYDROLOGIC CHARACTERISTICS
Quaternary	Holocene	Alluvial deposits	Sand, silt, and black mud.	Undifferentiated	Surficial material, often hydraulically connected to underlying aquifers. Locally units may act as confining beds. Thicker sands are capable of yielding large quantities of water.
		Beach sand and gravel	Sand, quartz, light-colored, medium- to coarse-grained, pebbly.		
	Pleistocene	Cape May Formation	Sand, quartz, light-colored, heterogeneous, clayey, pebbly.		
Tertiary	Miocene	Pensauken Formation		Kirkwood-Cohansey aquifer system	A major aquifer system. Groundwater occurs generally under water-table conditions. In Cape May County, the Cohansey Sand is under artesian conditions.
		Bridgeton Formation			
		Beacon Hill Gravel	Gravel, quartz, light-colored, sandy.		
		Cohansey Sand	Sand, quartz, light-colored, medium- to coarse-grained, pebbly; local clay beds.		
		Kirkwood Formation	Sand, quartz, gray and tan, very fine- to medium-grained, micaceous, and dark-colored diatomaceous clay.	confining bed	Thick diatomaceous clay bed occurs along coast and for a short distance inland. A thin water-bearing sand occurs within the middle of this unit.
				Rio Grande water-bearing zone	
				confining bed	
				Atlantic City 800-foot sand	A major aquifer along the coast.
				Composite confining beds: Alloway Clay member or equivalent.	
	Eocene	Piney Point Formation	Sand, quartz and glauconite, fine- to coarse-grained.	Composite confining beds: Piney Point aquifer	Yields moderate quantities of water locally.
		Shark River Formation	Clay, silty and sandy, glauconitic, green, gray and brown, fine-grained quartz sand.	Composite confining beds	Poorly permeable sediments.
		Manasquan Formation			
	Paleocene	Vincentown Formation	Sand, quartz, gray and green, fine- to coarse-grained, glauconitic, and brown clayey, very fossiliferous, glauconite and quartz calcarenite.	Composite confining beds: Vincentown aquifer	Yields small to moderate quantities of water in and near its outcrop area.
		Hornerstown Sand	Sand, clayey, glauconitic, dark green, fine- to coarse-grained.	Composite confining beds	Poorly permeable sediments.
Cretaceous	Upper Cretaceous	Tinton Sand	Sand, quartz, and glauconite, brown and gray, fine- to coarse-grained, clayey, micaceous.	Composite confining beds: Red Bank Sand	Yields small quantities of water in and near its outcrop area.
		Red Bank Sand			
		Navesink Formation	Sand, clayey, silty, glauconitic, green and black, medium- to coarse-grained.	Composite confining beds	Poorly permeable sediments.
		Mount Laurel Sand	Sand, quartz, brown and gray, fine- to coarse-grained, slightly glauconitic.	Wenonah-Mount Laurel aquifer	A major aquifer.
		Wenonah Formation	Sand, very fine- to fine-grained, gray and brown, silty, slightly glauconitic.		
		Marshalltown Formation	Clay, silty, dark greenish gray, glauconitic quartz sand.	Marshalltown-Wenonah confining bed	A leaky confining bed.
		Englishtown Formation	Sand, quartz, tan and gray, fine- to medium-grained; local clay beds.	Englishtown aquifer system	A major aquifer. Two sand units in Monmouth and Ocean Counties.
		Woodbury Clay	Clay, gray and black, micaceous silt.	Merchantville-Woodbury confining bed	A major confining bed. Locally, the Merchantville Formation may contain a thin water-bearing sand.
		Merchantville Formation	Clay, glauconitic, micaceous, gray and black; locally very fine-grained quartz and glauconitic sand.		
		Magothy Formation	Sand, quartz, light gray, fine- to coarse-grained; local beds of dark gray lignitic clay.	Potomac-Raritan-Magothy aquifer system: upper aquifer	A major aquifer system. In the northern Coastal Plain, the upper aquifer is equivalent to the Old Bridge aquifer and the middle aquifer is the equivalent of the Farrington aquifer. In the Delaware River Valley, three aquifers are recognized. In the deeper subsurface, units below the upper aquifer are undifferentiated.
		Raritan Formation	Sand, quartz, light gray, fine- to coarse-grained, pebbly, arkosic, red, white, and variegated clay.	Potomac-Raritan-Magothy aquifer system: confining bed; middle aquifer; confining bed	
	Lower Cretaceous	Potomac Group	Alternating clay, silt, sand, and gravel.	Potomac-Raritan-Magothy aquifer system: lower aquifer	
Pre-Cretaceous		Bedrock	Precambrian and lower Paleozoic crystalline rocks, metamorphic schist and gneiss; locally Triassic basalt, sandstone and shale.	Bedrock confining bed	No wells obtain water from these consolidated rocks, except along the Fall Line.

Source: Zapecza, Otto S. Hydrogeologic Framework of the New Jersey Coastal Plain. USGS Open-File Report 84-730, Regional Aquifer-System Analysis. 1984.

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2.8 HYDROGEOLOGY

Sediments of the Coastal Plain area of New Jersey are an important source of potable water for the region. In general, the deeper aquifers are used for public water supplies and the shallower aquifers are used for domestic supplies. NJ DEPE Water Technical Programs Groundwater Quality Standards N.J.A.C. 7:9-6 established groundwater classification areas in New Jersey. Mainside is located in the area designated as Class II-A Groundwater Supporting Potable Water Supply. Class II-A includes those areas where groundwater is an existing source of potable water with conventional water supply treatment or a potential source.

Fifteen regional hydrogeologic units or aquifer systems have been defined in the Coastal Plain area of New Jersey by O.A. Zapecza (1984); these units are identified in Table 2-1. Of these 15 units, five regional hydrogeologic units have been identified in the vicinity of Mainside: Kirkwood-Cohansey aquifer system, Vincentown aquifer system, Wenonah-Mount Laurel aquifer, Englishtown aquifer system, and Potomac-Raritan-Magothy aquifer system.

Mainside ordnance area "M" is probably located in the outcrop and recharge area of the Vincentown Formation. The Vincentown aquifer system is developed in the sand and calcarenite facies of the Vincentown Formation. The Vincentown Formation functions as a semi-confining to confining bed three to 10 miles downdip of its outcrop area. Groundwater in the Vincentown aquifer is generally under confined conditions. The Vincentown aquifer is underlain by the composite confining beds of the Hornerstown, Tinton, and Red Bank Sands and the Navesink Formation. No wells have been identified as producing from the Vincentown aquifer or any other aquifer within one mile of Building 566. Groundwater flow in the shallow-water table aquifer present in sediments in the Mainside ordnance area "M" is anticipated to follow topography. Groundwater flow in the vicinity of the site is expected to be southward. The depth to groundwater beneath the site is estimated to range from two to six feet below grade.

3.0 INVESTIGATION PLAN

3.1 INVESTIGATION OBJECTIVES

HNUS was tasked to prepare draft and final work plans for an interim action to control the spread of oil at Building 566 and determine the permits and/or approval required for the implementation of the work plan. The interim action preferred by the Navy is the installation of an interceptor trench. The trench will be installed a minimum of three feet upgradient of the wetlands and, where feasible, in soil where the concentration of TPH is less than 1,000 mg/kg. Therefore, the objectives of this project are to collect sufficient information to allow for the design of an interceptor trench to control the spread of oil into adjacent, downgradient wetlands, determine the permits necessary for installation of the trench, and install the trench and associated storm-water management system. The objectives for field investigation activities are

- Delineate the extent of adjacent wetlands.
- Delineate the lateral extent of TPH contamination in the soil that is above 1,000 mg/kg.
- Obtain soil characteristics including grain size distribution data.
- Determine the depth(s) to groundwater in areas downgradient of seeps and stressed vegetation.
- Survey ground surface elevations, soil boring locations, and the edge of the wetlands.

In addition to the above field investigation activities, the plans and specifications of the leach field currently in use at Building 566 will be requested from NWS Earle Public Works Department and pertinent NJ DEPE and NORTHDIV representatives will be contacted about the permits and/or approvals required for the installation of the trench and the disposal of excavated soils.

Upon completion of field investigation activities, including the receipt of analytical data, wetland delineation drawings, groundwater contour map, TPH delineation drawings, and design drawings and specifications will be prepared for the interceptor trench. The interceptor trench is discussed in Section 4.0.

3.2 FIELD INVESTIGATION TASK DESCRIPTIONS

The purpose of the field investigation activities is to collect sufficient information to allow for the design of an interceptor trench to control the spread of oil into adjacent, downgradient wetlands. Field investigation methods and rationale are in the Table 3-1.

The following activities will be conducted during field investigation activities:

- Perform transects perpendicular to the creeks to confirm the presence or absence of hydrophitic vegetation, hydric soils, and saturated soil conditions.

- Collect subsurface soil samples from 10 soil boring locations for 24-hour quick-turnaround laboratory TPH analysis using a hand auger. Sample locations will be biased to delineate the lateral extent of soils with concentrations less than 1,000 mg/kg TPH. Descriptive sample logs will be prepared for each boring location using American Society for the Testing of Materials (ASTM) D 2488 - Practice for Description and Identification of Soils (Visual - Manual Method).

- Collect subsurface material for analysis using ASTM D 422 - Standard Method for Particle Size Analysis of Soils, ASTM D 2487 - Standard Test Method for Classification of Soils for Engineering Purposes, and ASTM D 2488 - Practice for Description and Identification of Soils (Visual - Manual Method) from three soil boring locations.

- Install temporary two-inch-diameter, slotted polyvinyl chloride (PVC) pipe piezom ters in the 10 soil borings.

- Collect two rounds of static-water-level measurements from the temporary piezometers, a minimum of 48 hours apart.

- Survey the ground surface, soil boring locations, and the edge of the wetlands to a datum obtained from NWS Earle Drawing No. 2153926 - Replacement for Septic System for Building No. 566.

TABLE 3-1

FIELD INVESTIGATION METHODS AND RATIONALE
CTO 155 - INTERIM ACTION WORK PLAN FOR BUILDING 566, NWS EARLE, NEW JERSEY

INVESTIGATION METHOD	RATIONALE
Wetland Survey	Delineate the extent of wetlands downgradient of seeps and stressed vegetation in order to install the interceptor trench upgradient and three feet away from the outer edge of the wetlands.
Soil Borings	Delineate the extent of soil with TPH concentrations of greater than 1,000 mg/kg so that the interceptor trench can be installed in soils with TPH concentrations of less than 1,000 mg/kg, where feasible.
	Determine soil characteristics, such as grain-size distribution data, and the depths to groundwater downgradient of seeps and stressed vegetation in order to design the interceptor trench.
Topographic Survey	Determine ground surface elevations, soil borings locations, and limits of the wetlands in order to accurately design and position the interceptor trench.

Field investigation activities are presented by task in the following paragraphs. All field activities will be conducted in accordance with the NJ DEPE Field Sampling Procedures Manual (FSPM) in effect at the date of sampling, HNUS standard operating procedures (SOPs), and health and safety procedures established in the site-specific HASP. Pertinent NJ DEPE procedures and HNUS SOPs are in Appendix B; the site-specific HASP is in Appendix C.

3.2.1 Wetland Delineation

A minimum of six transects will be performed perpendicular to the creek along a segment of the creek that extends upstream and downstream of any seeps and/or areas of stressed vegetation. The precise locations of the transects will be determined in the field. The edges of the wetlands will be determined by the absence of one or more of the following three parameters: hydrophitic vegetation, hydric soils, and saturated soil. The presence or absence of hydrophitic vegetation will be noted along the length of the transect. Subsurface soils will be inspected for the presence of saturated and hydric soil at two to four locations along each transect. If all three parameters are present, the area will be mapped as a wetland. Stakes, placed approximately six inches outside the wetland, will be used to mark the edge of the wetland. To be sure the trench is positioned a minimum of three feet from the edge of the wetland, the stakes marking the edge of the wetland will be surveyed. Additionally, the center line of the creek will be surveyed.

3.2.2 Soil Borings

A minimum of 10 soil borings will be advanced to the top of the water table using a hand auger or portable generator-powered auger such as a "Little Beaver." The depth to the top of the water table is anticipated to range from one to four feet below grade. The borings will be located upgradient of wetlands delineated in Task 3.2.1 and, where possible, downgradient of oil-contaminated seeps and areas of stressed vegetation. Precise soil boring locations will be determined in the field. No borings will intentionally b installed in the septic leach field. Subsurface soil samples will be collected from within one foot of the water table in order to delineate the extent of TPH contamination that is above 1,000 mg/kg. Samples will be submitted to an NJ-DEPE-certified, Navy Energy and Environmental Support Activity (NEESA)-approved laboratory for 24-hour quick-turnaround TPH analysis. Based upon results from the 24-hour quick-turnaround TPH analysis, and if directed by the Navy, additional boring locations may be selected and subsurface soil samples collected and submitted for 24-hour quick-turnaround TPH analysis. The boring locations will be surveyed in order to position the trench in soil that has TPH concentration less than 1,000 mg/kg, where feasible.

Temporary piezometers, consisting of two-inch-diameter slotted PVC pipe, will be installed in the borings. After two rounds of static-water-level m asurements have b en obtained, the PVC piping will be removed and, unless otherwis directed by the Navy, the boreholes will be backfilled with bentonite powder or pellets.

At three of the initial boring locations, sufficient soil material (approximately five pounds) will be collected and submitted to a physical testing laboratory for geotechnical analysis.

3.2.3 Surveying

The topographic surveying will be conducted using standard land-surveying techniques. The survey will consist of establishing a 25-foot horizontal grid laid over the area of concern. The area of concern will include the existing septic holding tank and leach field, areas of stressed vegetation, visible seeps, and the stream bank. Elevations will be established at each grid point with an accuracy to the nearest 0.10 foot. In addition to the above, the position (horizontal and vertical) of each soil boring and the edge of the wetlands will be surveyed. The vertical datum used to establish elevations for this activity will be obtained from NWS Earle Drawing No. 2153926 - Replacement for Septic System for Building No. 566. The benchmarks used for reference points will be the finished floor elevation of Building No. 566 and the manhole rim elevations at the existing septic tank. The bench marks used to establish the vertical datum will be referenced on the topographic map generated from this task.

3.2.4 Investigation-Derived Waste Disposal

Wastes such as excess soil from auger buckets and decontamination fluid will be generated during field investigation activities. These wastes must be disposed in such a manner as to not contribute to further environmental contamination or pose a threat to public health or safety. The disposal of investigation-derived wastes (IDW) and construction-derived wastes is discussed in Section 5.6.

3.3 SAMPLE DESIGNATION SYSTEM

Each sample collected for analysis will be assigned a unique sample tracking number. This number will consist of a three-segment alpha-numeric code that identifies the building, the sample medium or QC sample designation, and the station or QC sample number. The alpha-numeric coding system to be used is explained in the following diagram and subsequent definitions.

NNN -	AA OR AAA -	NN OR NNNN
(AOC Identifier)	(Sample Medium or QC Sample Designation)	(Station or QC Sample Number)

Character Type:

N = Numeric, A = Aphabetic

AOC Identifier:

566 = Building 566

Sample Medium:

SB = Soil Boring Subsurface Soil Sample

QC Sample Designation:

FB = Field Blank

Station Sample Number:

All sample stations will be assigned a consecutive station number in the order of installation. The station numbers for the soil boring subsurface soil samples will consist of a four-digit number. The first two digits will refer to the geographical location of the sample, and the second two digits will be the upper depth, in feet below the ground surface, from which the sample was collected.

For example, a subsurface soil sample collected from a depth of two to 2.5 feet in the third soil boring installed would be assigned the tracking number 566-SB-0302.

QC Sample Number:

All QC samples, except field duplicate samples, will be assigned a sequential sample number. Because of the intended use of the analytical data, only field duplicates and field blanks will be collected for analysis. In order to provide a designation that blinds the location of the field duplicate samples, a "dummy" station number will be given to all duplicate samples.

For example, a duplicate subsurface soil sample collected from a depth of two to 2.5 feet in one of the 10 soil borings would be assigned the tracking number 566-SB-1102.

A field blank collected on the second day of field investigation activities would be assigned the tracking number 566-FB-02.

All pertinent information regarding sample identification will be recorded in the field logbooks and on sample log sheets where appropriate.

4.0 INTERCEPTOR TRENCH AND STORM-WATER MANAGEMENT

An interceptor trench and storm-water management system will be designed and installed at the site in an effort to control the migration of oil into areas that have b en designated as wetlands. The objective of the interceptor trench is to provide a mechanism for the collection and removal of oil and oil-contaminated groundwater before it impacts adjacent wetlands. Data generated or obtained during field investigation activities will be used to design the interceptor trench and storm-water management system. The installation of a storage tank, curbing, and stabilized outfall will control the future migration of oil and allow the interceptor trench to operate efficiently. A schematic for the proposed interceptor trench is provided in Figure 4-1; cross-sectional details for the trench are provided in Figure 4-2.

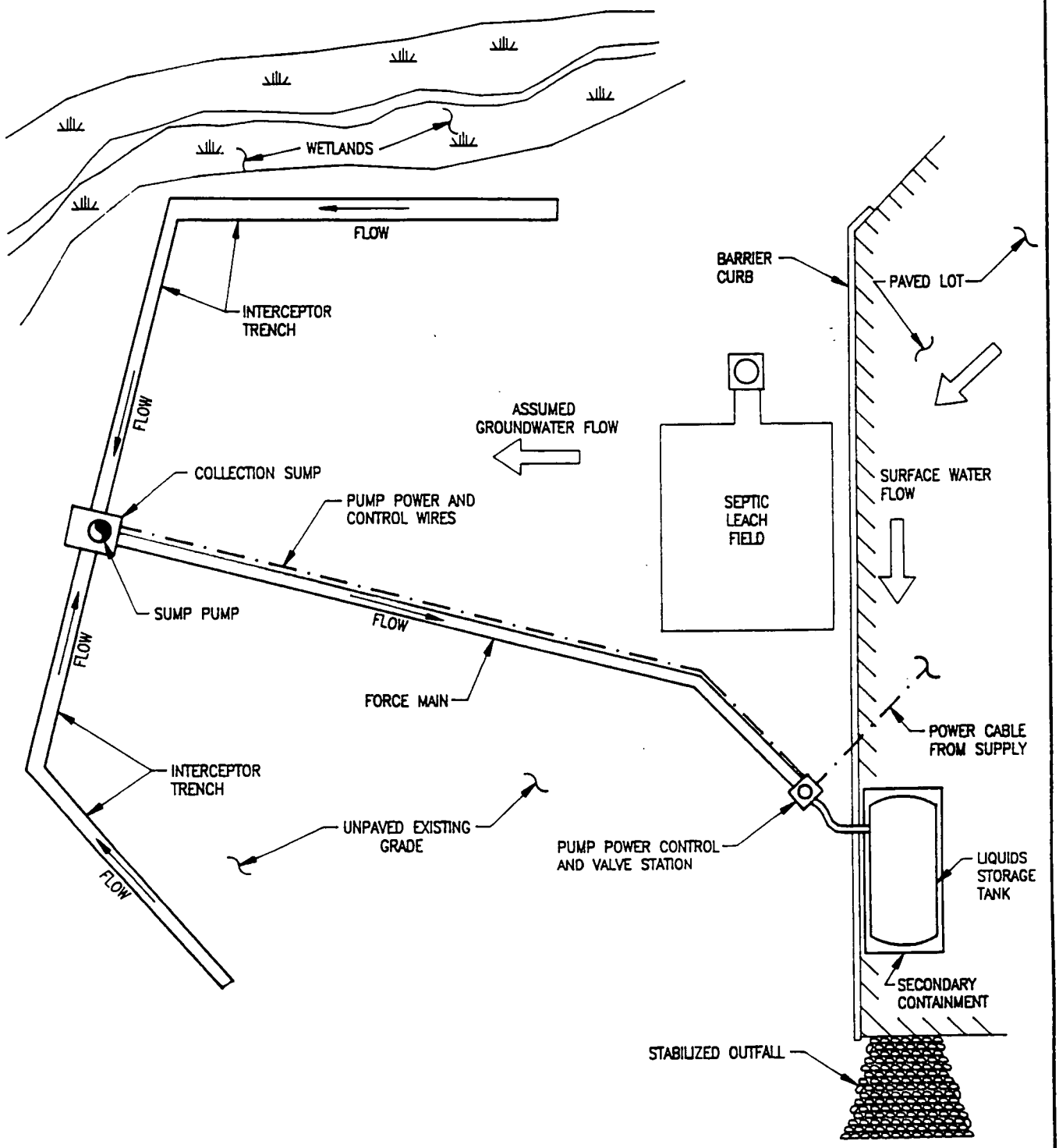
4.1 INTERCEPTOR TRENCH

An interceptor trench system will be constructed on three sides of the area where oil is known or suspected to be contaminating groundwater. The interceptor trench will be located downgradient of the septic holding tank, leach field and USTS, and upgradient of wetlands delineated as part of field investigation activities. The design of the trench will allow for permanent operation of the system. Liquids from the interceptor trench will be pumped into a storage tank that will be installed in the east parking lot of Building 599. A curb and stabilized outfall will be installed in the southeastern portion of the east parking lot to direct storm-water runoff away from the septic leach field and interceptor trench.

The interceptor trench will consist of the following nine elements:

- An excavated trench
- Geotextile
- Aggregate fill
- Perforated pipe
- Plastic sheeting
- A collection sump
- A sump pump
- A holding tank
- Trench location markers

The trench will be located between the septic holding tank/leach field and the delineated wetlands. It is anticipated that the trench will be approximately 200 feet in length, four feet in depth and will hav a minimum width of two feet.. The trench will be graded to conduct collected liquids by gravity flow to a central collection sump; the collection sump will be located at the lowest point of the trench. Liquids that collect in the sump will be pumped to a temporary holding tank until they can be treated and/or disposed off the site.



NOT TO SCALE

FIGURE 4-1

SCHEMATIC FOR PROPOSED INTERCEPTOR TRENCH
NWS EARLE, COLTS NECK, NEW JERSEY

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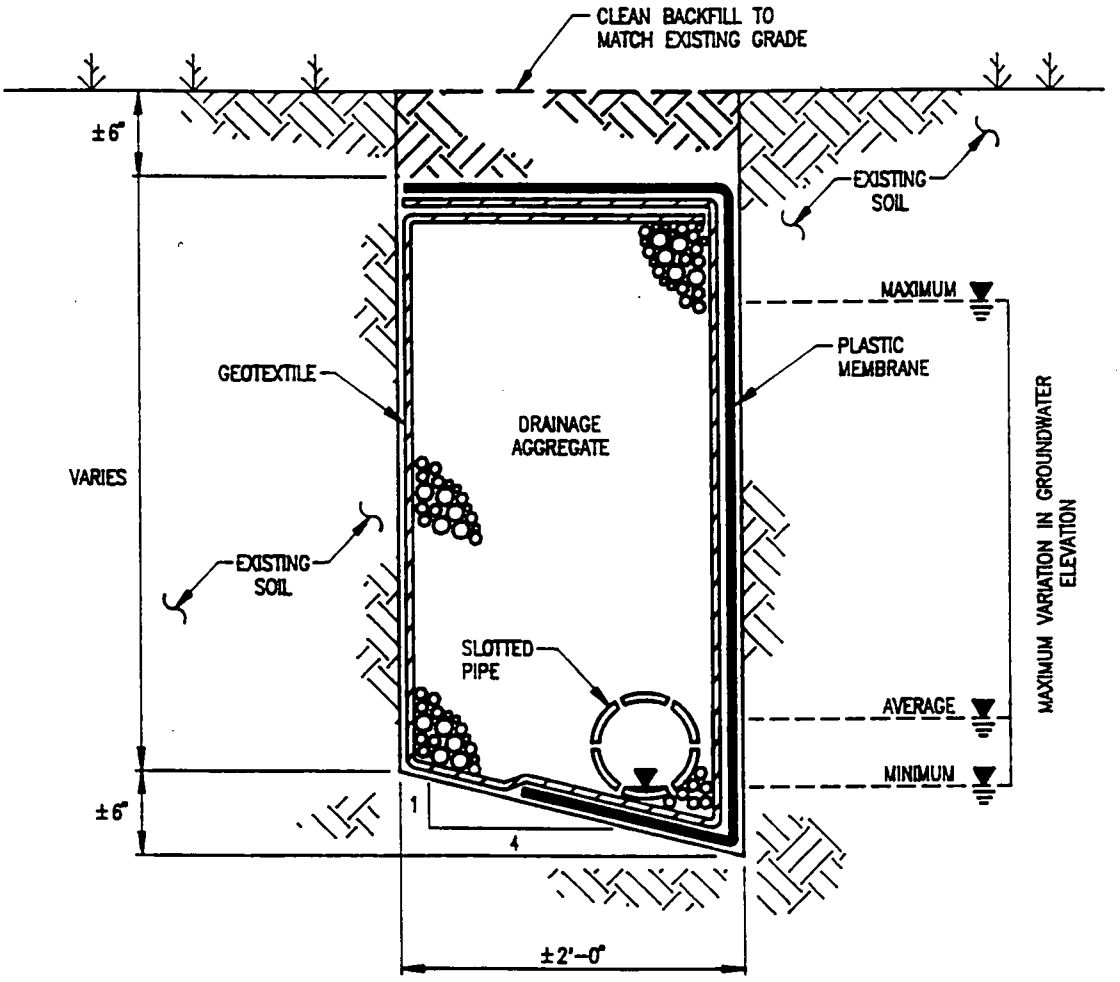

NOT TO SCALE

FIGURE 4-2

CROSS-SECTION DETAIL PLAN FOR
PROPOSED INTERCEPTOR TRENCH
NWS EARLE, COLTS NECK, NEW JERSEY

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CORPORATION

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4.1.1 Functional El ments and Mat rials

The trench system will be designed to provide a mechanism to coll ct any oil floating on the top of the water table; the mechanism will also allow the majority of the groundwater to bypass the collection system. The functional elements of the system will include an excavated trench with geotextile liner, aggregate-fill drainage media, impermeable membrane sheeting, flexible perforated smooth interior collection pipe, a non-perforated collection sump with sump pump, non-perforated pipe forced main, and a holding tank.

The trench system will be constructed for permanent operation with a design service life of approximately 25 years. The materials utilized in the construction and operation of the system will therefore be selected for structural stability and chemical compatibility with the environment in which they are intended to function. The materials will be inert to degradation by immersion in dilute organic solvents, acids, or bases, abrasion, structural stresses, and construction damage. The materials will also be evaluated for environmental considerations including Occupational Safety and Health Administration (OSHA) regulations, waste disposal requirements, and impact to the environment. In general, materials recommended for this project include a polyethylene (PE) or polyester geotextile, granite, quartz, or silica aggregate, PE membrane sheeting, PE or PVC piping, and a PE, stainless-steel, or concrete collection sump.

The geotextile will function as a filter to minimize the migration of small particles from the surrounding soil into aggregate-fill drainage media. Without the geotextile, migration of the small soil particles into the drainage media could clog the media, reducing the operating efficiency of the system. The use of aggregate-fill drainage media will create an area of permeability that is greater than the permeability in the surrounding soil and will result in flow into the media. The flow gradient will draw both oil and groundwater toward the trench and conduct the liquids downgradient along the trench toward the collection sump. Impermeable membrane sheeting will line the downgradient sides of the trench and will be used to trap the oil on the surface of the water table while allowing groundwater to flow below the membrane barrier. The collection pipe will serve as a conduit to allow the movement of oil toward the collection sump. Additional flow will occur along the length of the trench through the drainage media.

The collection sump will serve as a

- Central collection mechanism into which oil and water will flow.

- Mounting location for a sump pump that will be used to pump the liquids into a storage tank. Specifications [i.e., horse power, pump rate, head, electrical rating, National Electrical Manufacturer's Association (NEMA) rating, etc.] for the sump pump have not yet been determined, although the use of a Gorman-Rupp or Grundfos float-actuated electric-powered NEMA explosion-proof submersible pump would be appropriate.

- Sampling and metering station to gauge flow rates and monitor system efficiency.

A pressurized forced main pipe will be used to transfer liquids from the collection sump to the portable holding tank. The pipe, which will connect the sump pump and the holding tank, will be buried below grade. The pipe will be constructed of rigid or semi-rigid, pressure-rated, smooth-walled PE or PVC piping. Flexible connections will be provided at each end of each pipe. Specifications for the holding tank have not yet been determined. The size of the tank will be determined by the anticipated rate of groundwater flow onto the trench. It is assumed that the portable holding tank will be located on or near the parking lot southeast of Building 566.

Based upon data gathered during field investigation and design activities, HNUS will evaluate the appropriateness of pre-treatment devices such as carbon units, oil skimmers, and oil separators.

4.1.2 Construction Details

The major elements of construction of the interceptor trench system, in the recommended sequence of construction, include

- Survey, layout, and installation of holding tanks.
- Excavation of interceptor and utilities trenches.
- Installation of membrane, geotextile, collection and forced main pipe, and electrical conduit with wiring.
- System testing and start-up.
- Backfilling of the trench.

Any liquids that accumulate in excavation during construction of the trench will require evacuation, t mporary storage, and disposal prior to system start-up. The tank(s) will be provided for the temporary storage of construction-derived liquid waste prior to the commencement of installation activities.

Trenching will require excavation of a trench with a minimum width of 24 inches and a varying depth; the depth of the trench will be based upon topographic and groundwater data gathered during field investigation activities. Excavation of the trench will start at the low point of the sump and continue upgradient to the highest points of the trench. Because saturated non-cohesive soils, such as sands and/or gravels, will probably be encountered during the excavation of the trench, temporary bracing and shoring will be required to prevent the collapse of the trench walls. The temporary bracings and shorings will remain in

place until the backfilling of the trench has been completed. The excavated soil will be staged on a double thickness of plastic sheeting, covered in such a manner as to prevent surface runoff, and properly disposed.

Non-perforated pressurized forced main pipe and electrical conduit will be installed in a tr nch and backfilled immediately after the installation and testing of the collection sump and wiring. Membrane, geotextile, and perforated pipe will be installed in order, respectively, starting from the sump and proceeding in an upgradient direction. To the extent practicable, upgradient joint members will overlap downgradient joint members. The geotextile will be installed with lapping or sewed seams. If the seams are to be lapped, the geotextile panels will be overlapped such that upgradient panels extend over downgradient panels. The perforated pipe will be overlapped with the bell end facing upgradient and connecting to the spigot end. The spigot end therefore will face downgradient.

Testing of the system will include pressure testing of the forced main pipe prior to backfilling, testing of pump power and control wiring, and inspection of perforated pipe and associated hardware for conformance to contract specifications.

4.1.3 Operational Details

An operation and maintenance manual will be prepared by HNUS for the trench. The system will be designed to operate automatically without the presence of a human operator. Periodic inspection of the sump pump and removal of accumulated liquids from the storage tank will, however, be necessary. The inspection of the system will also include a site walk along the length of the trench to identify erosion or other conditions that could impact the operational efficiency of the system.

The operation of the system is based primarily on the gravity flow of liquids into the interceptor trench. The rate of flow into the trench will determine the other operational parameters including cycling of the pump, frequency of liquids removal from the storage tank, and power requirements for the pump. Liquids that flow into the interceptor trench and subsequently into the sump will be evacuated from the sump through the use of a sump pump. The pump will operate automatically using an on/off switch connected to a ball float. As liquid levels in the sump rise, the ball float will rise and turn the pump on; as the liquid level falls, the ball float will fall and the pump will be turned off. Check valves, to prevent the backflow of liquid into the sump, will be installed in the forced main. A single forced main connection will be provided to the storage tank. The storage tank will be a semi-permanent installation, the contents of which will periodically be pumped into a tank truck for transport and disposal. The holding tank will probably be a single tank of approximately 8,000 gallons or two or more smaller tanks connected in series. The tank will be placed within a containment system. The design of the system could be varied to allow for two connections to the forced main. Two connections would provide the flexibility to exchange full and empty tanks without system shutdown or the need for installation of a semi-permanent tank.

Operation of the system will be dependent on the flow of liquids into the interceptor trench; a portion of this flow will b generated by storm-water runoff. Th storm-water runoff may directly infiltrate into the interceptor trench or increase the flow of groundwater by infiltration into soil upgradient of the interceptor trench. In order to manage this flow, storm-water runoff that is concentrated by the parking lot located immediately upgradient of the septic holding tank and leach field will be modified.

4.1.4 Operation and Maintenance Manual

HNUS will develop operational procedures during the design analysis phase. These procedures will be incorporated into a written operation and maintenance manual. Typical operation and maintenance costs will be included as a separate document.

4.2 STORM-WATER MANAGEMENT SYSTEM

A storm-water management system will be installed and operated in conjunction with the interceptor trench. The purpose of the system is to control the spread of contamination from the leach field, prevent or minimize damage to the interceptor trench by erosion, prevent or minimize sudden high-volume/high-velocity flows into the interceptor system, and control the volume of liquids collected by the interceptor system that will require treatment and/or disposal. The completed storm-water management system will direct storm-water runoff from the parking area away from the septic holding tank and leach field. The redirected flow will be dispersed, slowed, and discharged onto the ground surface east of the parking area.

It was observed by HNUS personnel during the July 15, 1994 site visit that the impervious surface of the paved parking lot and road located on the eastern and southeastern sides of Building 566 concentrates storm-water runoff. The runoff is channeled to an area southeast of the aggregate-covered above-ground storage tanks. Erosion of soil in this area indicates that storm-water runoff flows from the paved parking lot into the unpaved area of the septic leach field. The majority of this water could reach the wetlands located downgradient of the leach field by surface flow or by infiltration into the soil. The surface runoff that infiltrates into the soil will increase the volume and flow velocity of groundwater and may rapidly decrease the depth to the top of the water table. It is likely that the spread of contamination may be accelerated by the storm-water runoff originating from the paved parking and road areas. For this reason, a storm-water management system should be operated in conjunction with the interceptor trench.

4.2.1 Functional El m nts and Materials

The storm-water management system will include two functional lements, a barrier curb and a stabilized outfall. The barrier curb will be located southeast of the existing aggregate-covered above-ground storage tanks in the southeastern portion of the parking lot. The barrier curb will be installed as a permanent structure. The barrier curb will be constructed of bituminous concrete or concrete formed to create a curb.

The stabilized outfall will be constructed of a geotextile and large stone aggregate. The stabilized outfall will be located in the southeastern corner of the parking lot, immediately adjacent to the downgradient end of the barrier curb.

4.2.2 Construction Details

The barrier curb will be installed at the edge of and directly on existing pavement. The curb will be tied into an existing curb on the upgradient side and extend to the edge of pavement on the downgradient side. The curb will be approximately six inches high and nine inches wide.

The stabilized outfall will encompass an area starting at the edge of the pavement and extending approximately 20 feet downgradient onto unpaved existing grade. The specific dimensions will be based on requirements of the NJ DEPE Soil Conservation Service (SCS) and the United States Department of Agriculture, SCS, Monmouth County Soil Conservation District. Construction of the stabilized outfall will be initiated by the grading of the existing soil and the installation of geotextile. The geotextile will be covered with layers of broken angular aggregate. The size of the aggregate will be based on the state and federal requirements.

5.0 QUALITY ASSURANCE AND QUALITY CONTROL

The quality assurance project plan (QAPP) identifies specific parameters and procedures that are applicable to the investigation:

- Project organization and responsibilities
- Analytical parameters and sample frequency
- Identification of analytical methods
- Quality assurance objectives for analytical data
- Calibration procedures
- Custody protocol
- Data reduction, validation, and reporting procedures
- Data assessment procedures

Presiding controls for this activity require compliance to NJ DEPE quality assurance requirements. If a conflict arises between NJ DEPE requirements and CLEAN program controls, the NJ DEPE requirements shall take precedence.

5.1 PROJECT ORGANIZATION AND RESPONSIBILITIES

Overall project coordination personnel and responsibilities are detailed in Section 1.3 of this work plan. The field team will begin mobilization activities for field investigation operations upon written notice of authorization from the Navy to proceed. The project manager will contact the RPM and the facility contact at NWS Earle regarding the initiation of field investigation activities. The project manager will then notify the FTL and the field team members who are to participate in the field investigations. The specific FTL and field team members will be determined at a later date. The project manager and the FTL will be responsible for arranging all necessary field equipment, transportation, subcontractors, etc. and for coordinating all on-site activities with the RPM and the facility contact. All sampling data and applicable field observations will be recorded on the appropriate log sheets and/or in the site field logbook. The site field logbook will be maintained by the FTL or designee. Utility clearance will be obtained before any subsurface activities are begun.

Subcontracts for laboratory analytical services, soil excavation and interceptor trench installation services, and waste disposal services, if necessary, will be procured and awarded by CLEAN program subcontracting officers before commencement of field activities. The subcontract laboratory analytical coordinator will ensure that the laboratory implements the requirements of the NJ DEPE and this QAPP and is responsible for reviewing the laboratory data before release. The subcontract excavation services coordinator will ensure all excavation and installation activities are in accordance with NJ DEPE permits and regulations

and HNUS requirements. The subcontract waste disposal services coordinator will nsure that waste sampling, disposal, and transportation activities are in accordance with NJ DEPE permits and regulations and HNUS requirements.

5.2 QUALITY ASSURANCE OBJECTIVES

The QA objective is to ensure that the data generated as part of the field investigation are of known and acceptable quality and are suitable for the intended use. The data quality objective (DQO) is established by identifying the end use of the data and the degree of certainty necessary to satisfy that end us . Data obtained during field investigation operations will be used in the location and design of the interceptor trench.

DQO Level E, as defined by the NEESA guidelines entitled "Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program (20.2-047B; June 1988)," is proposed for this project.

QA/QC samples will be prepared in accordance with NJ DEPE and NEESA requirements to ensure that project activities meet the DQO's objectives. No QC samples will be collected in conjunction with samples being analyzed for grain-size distribution parameters using methods specified in ASTM D 422 or ASTM D 2487. The frequency of site-specific QC samples and the analytical parameters are summarized in Table 5-1.

5.3 QUALITY ASSURANCE PROCEDURES

QA/QC samples are intended to provide control over the collection of environmental data and subsequent validation, review, and interpretation of the analytical results. Various types of blank samples and oth r r lated QA/QC concerns such as packaging, handling, and shipping of samples from the site are discuss d in this section. Analytical methodologies to be employed are detailed further in Section 5.4 and Table 5-1.

Trip Blank

The trip blank is used exclusively for the monitoring of aqueous volatile organic analysis; trip blanks are not required for non-aqueous samples unless specifically requested by NJ DEPE. Therefore, trip blanks will not be collected as part of field investigation sampling activities.

TABLE 5-1
SAMPLE REQUIREMENTS SUMMARY
CTO 155 - INTERIM ACTION WORK PLAN FOR BUILDING 566, NWS EARLE, NEW JERSEY

Analytical Methods/Quality Assurance Summary Table

SAMPLE MEDIUM	NEESA DQO LEVEL	ANALYTICAL PARAMETER	NUMBER OF SAMPLES(1)	FIELD QC SAMPLES	
				FIELD DUPLICATES(2)	FIELD BLANKS(3)
Subsurface Soil	E	TPH (24-hour turnaround)	10	1	1
	E	Grain-size (ASTM D 422)	3	0	0
		Grain-size (ASTM D 2487)	3	0	0

(1) Additional samples may be required. Applicable QC samples will be collected as necessary.
(2) Field duplicate samples will be collected in compliance with NJ DEPE requirements at a rate of five percent.
(3) Field blanks will be collected in compliance with NJ DEPE requirements at a rate of 10 percent.

Sample Volume and Sample Preservative Requirements Summary Table

ANALYTICAL PARAMETER	ANALYTICAL METHOD	NEESA DQO LEVEL	SAMPLE VOLUMES	SAMPLE PRESERVATIVE
TPH	SW-846 E418.1	E	aqueous: One 1-liter glass jar with Teflon-lined lid.	aqueous: Cool to 4°C
			soil: One 4-ounce jar with Teflon-lined lid.	soil: Cool to 4°C
Grain Size	ASTM D 422	E	Five pounds in plastic-lined bags	None
	ASTM D 2487	E	Five pounds in plastic-lined bags	None

Field Blank

The field blank (also referred to as the field rinsate blank) is used to monitor sample equipment handling, pr paration, storage, and shipment. The field blank is prepared in th field, from analyte-free wat r supplied by the laboratory, by pouring the water over dedicated or d contaminated sampling devices into clean sample bottles. For non-aqueous field samples, in accordance with NJ DEPE requirements, field blanks will only be collected and analyzed for volatile organic compounds when the non-aqueous field samples are being analyzed for volatile organic parameters. Field blanks for non-aqueous field samples will be preserved in the same manner as the non-aqueous field samples. In accordance with NJ DEPE requirements, field blank samples are collected at a rate of 10 percent of the number of environmental samples collected during the sampling event. It is not necessary to collect more than one field blank per day.

Fi Id Duplicate Samples

The field duplicate is collected to monitor the precision and reproductibility of the sampling and analytical activities. The sample is prepared by collecting two samples from the same location. In accordance with NJ DEPE requirements, these samples are collected at a rate of five percent of the total number of samples per matrix for the event. The samples are submitted as blind samples to the laboratory. Field duplicates are further discussed in Section 5.4.9.

Other Laboratory QC Analyses

The analytical laboratory will perform other QC analyses such as method blank analyses and laboratory control sample analyses, as defined in method-specific protocols. Adherence to these protocols satisfies NJ DEPE requirements.

5.4 SAMPLING METHODS

Sampling during field investigation activities will include the collection of subsurface soil and QA/QC samples. General field sampling and sample documentation procedures to be implemented are described in the NJ DEPE FSPM in effect as of the date the samples are collected and in HNUS SOPs. In all instances, NJ DEPE field sampling procedures take precedence over HNUS SOPs. Pertinent NJ DEPE procedures and HNUS SOPS are in Appendix B. The specific sampling procedures for each task are detailed in the following sections. A summary of the proposed sampling and analysis program is in Table 5-2.

TABLE 5-2
PROPOSED SAMPLING AND ANALYSIS SUMMARY
CTO-155 - INTERIM ACTION WORK PLAN FOR BUILDING 566, NWS EARLE, NEW JERSEY

SAMPLE NUMBER	MEDIUM	SAMPLE DEPTH	ANALYTICAL PARAMETERS	SAMPLING METHOD
566-SB-0102 through 566-SB-1002	Soil	two to 2.5 feet or one foot above top of the water table	TPH	Hand auger
			ASTM D 422	
			ASTM D 2487	

5.4.1 Soil Sampling

HNUS personnel shall collect subsurface soil samples from 10 soil borings installed by hand auger using methods specified in NJ DEPE FSPM and SOP GH-1.4. The soils will be monitored for organic vapors using a photoionization device (PID). One subsurface soil samples will be collected for analysis from each soil boring. Discrete soil samples from the borings will be submitted to an NJ-DEPE-certified, NEESA-approved laboratory for 24-hour-turnaround TPH analysis using EPA Method E418.1. If so directed by the Navy, additional soil borings will be installed and samples collected for 24-hour quick-turnaround TPH analysis.

During the advancement of the borings, soils will be inspected from the auger bucket to provide a lithologic record of the subsurface materials. A sample log will be maintained for the borings in accordance with ASTM D 2488 - Practice for Description and Identification of Soils (Visual - Manual Method). ASTM D 2488 covers procedures for the description of naturally occurring soils for engineering purposes by visual examination and manual tests. This classification identifies three major soil divisions: coarse-grained soils, fine-grained soils, and highly organic soils.

These three basic divisions are further subdivided into the following 15 basic soil groups.

Soil Classification Chart

Group Symbol	Group Name
GW	Well-graded gravel
GP	Poorly graded gravel
GM	Silty gravel
GC	Clayey gravel
SW	Well-graded sand
SP	Poorly graded gravel
SM	Silty sand
SC	Clayey sand
CL	Lean clay
ML	Silt
OL	Organic clay/organic silt
CH	Fat clay
MH	Elastic silt
OH	Organic clay/organic silt
PT	Peat

Descriptive information about th soil is add d to the group name to aid in the evaluation of the soil's significant properties. Descriptive information for soils includes, at a minimum, angularity, shape, color, odor, moisture condition, hydrochloric acid reaction, consistency, cementation, structure, range of particle size, maximum particle size, sand, gravel and cobble or boulder size, and hardness. An example sample log is included in Appendix B. Each log will describe the lithologies encountered, depth of contacts, water levels, sample depths, and sample numbers.

At three of the 10 initial soil boring locations, an additional five pounds of sample will be collected for ASTM D 422 - Standard Method for Particle Size Analysis of Soils, ASTM D 2487- Standard Test Method for Classification of Soils for Engineering Purposes, and ASTM D 2488 - Practice for Description and Identification of Soils (Visual - Manual Method). ASTM D 422 covers the quantitative determination of the distribution of particle sizes in soils. For particles larger than 75 um (retained on the No. 200 sieve), the distribution is determined by sieving. For particles smaller than 75 um, the distribution is determined by sedimentation using a hydrometer and either a high-speed mechanical stirrer or air dispersion.

ASTM D 2487 describes a system for classifying naturally occurring soils for engineering purposes based upon laboratory determination of particle-size characteristics, liquid limit, and plasticity index. These test methods provide qualitative information only. This standard uses the same identification system as ASTM D 2488 but the group symbol and name are based upon laboratory results instead of visual inspections. The group symbol is based upon laboratory tests performed on that portion of the sample that passes the three-inch (75 mm) sieve.

All disposable sampling equipment will be decontaminated, double bagged, and treated as municipal waste. All non-disposable sampling equipment will be decontaminated before use and between each soil boring using methods specified in NJ DEPE FSPM and SOP SF-2.3. Unless otherwise directed by the Navy, excess soil samples and decontamination fluid generated as part of field investigation activities will be disposed near Building 566 in such a manner as to not cause additional contamination or an adverse impact on adjacent wetlands.

5.4.2 Groundwater-Level Measurements

Temporary piezometers will be installed in the 10 initial soil borings for the purpose of obtaining static-water-level measurements. The piezometers will be constructed of two-inch-diameter slotted PVC pipe using methods specified in NJ DEPE FSPM and SOP GH-1.4. Methods specified in NJ DEPE FSPM and SOP GH-2.5 will be used to collect measurements. The water level will be measured from the top of the ground surface to an accuracy of 0.01 foot. After water-level measurements have been obtained, the PVC piping will be removed and decontaminated before being properly disposed, and the borings will be backfilled with bentonite pellets or powder.

All disposable sampling equipment, including the PVC piping, will be decontaminated, double bagged, and treated as municipal waste. All non-disposable sampling equipment will be decontaminated before use and betwe n ach well using methods specified in NJ DEPE FSPM and SOP SF-2.3. Unless otherwise directed by the Navy, excess soil samples and decontamination fluid generated as part of field investigation activities will be disposed near Building 566 in such a manner as to not cause additional contamination or an adverse impact on adjacent wetlands.

5.4.3 Duplicate and Split Samples

Duplicate samples will be obtained during field investigation activities to monitor sampling techniques in the field and in the laboratory. These samples will be collected at a rate of one duplicate for each 20 field samples. The laboratory will receive them as "blind" samples. Details regarding the field duplicate sampling process are further described below and are provided in the appended SOPs.

Soil samples (non-aqueous) will be collected from the same sample location. Sample material for TPH analysis will be collected prior to homogenizing to prevent loss of volatile constituents and to preserv the physical integrity of the volatile fraction.

Split samples are not proposed for this field activity. If field conditions change or the scope of work for this activity changes to include the collection of split samples, this work plan will be amended to refl ct the change.

5.5 FIELD DECONTAMINATION PROCEDURES

An important aspect of QC is the decontamination of field sampling equipment. Improperly cleaned and prepared equipment can lead to misinterpretation of environmental data due to interference from cross contamination.

All non-disposable sampling equipment that comes in contact with sample medium will be decontaminated using methods specified in NJ DEPE FSPM and SOP SF-2.3. NJ DEPE decontamination procedures follow ASTM D 5088-90 - Decontamination of Equipment. Specifically, the following decontamination requirements will be met:

- Potable water rinse
- Detergent rinse (Alconox/Liquinox)
- Tap water rinse
- Isopropyl alcohol rinse
- Distilled and deionized water rinse
- Air dry

5.6 HANDLING OF INVESTIGATION-DERIVED AND CONSTRUCTION-DERIVED WASTES

Waste that is generated during field investigation activities and construction activities must be disposed in a manner that will not further the potential for contamination.

5.6.1 Investigation-Derived Wastes

Wastes routinely generated from an investigation of this type consist of excess soil from the soil borings, decontamination fluid, and general refuse. Unless otherwise directed by the Navy, excess soil samples and decontamination fluid generated during field investigation activities will be disposed near Building 566 in such a manner as to not cause additional contamination or an adverse impact on adjacent wetlands or surface waters. Disposable sampling equipment and spent personal protection equipment (PPE) will be decontaminated, double bagged, and treated as municipal waste. Unless otherwise directed by the Navy, the double-bagged PPE will be disposed into Navy municipal waste dumpsters.

5.6.2 Construction-Derived Wastes

Wastes routinely generated from this type of construction project include excavated soil, geotextile, pip , and wire. Non-oil-contaminated wastes such as the geotextile, pipe, and wire will be treated as construction or municipal waste and, unless otherwise directed by the Navy, will be disposed into Navy construction or municipal waste dumpsters. Spent PPE will be decontaminated as much as possible and treated as municipal waste. Unless otherwise directed by the Navy, the double-bagged PPE will be disposed into Navy municipal waste dumpsters.

Oil-contaminated wastes, such as excavated soils, will be stockpiled on double thickness of plastic sh eting, covered in such a manner to prevent possible surface runoff, and properly disposed. Because of the relatively large quantity of decontamination fluid that will probably be generated and the presence of wetlands and surface water immediately downgradient of the site, the decontamination fluid will be drummed in Department of Transportation (DOT)-approved drums and properly disposed off the site. To accommodate the collection of the decontamination fluid, a temporary decontamination pad will be constructed in the parking lot. The sampling, transportation, and disposal of the oil-contaminated wastes will b performed under separate subcontract.

5.7 SAMPLE CUSTODY

Chain-of-custody (COC) procedures identified in NJ DEPE FSPM and HNUS SOPs will be followed (Appendix B).

As explained in the procedures, a sample is under custody if it is in

- The possession of the sampler/analyst
- View, after being in the possession of the sampler/analyst
- The possession of the sampler/analyst and then placed in a secured location
- A designated secure area

5.7.1 Sample Collection Custody Procedures

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

Sample labels will be completed for each sample container, using waterproof ink. Appropriate sample description and other pertinent information must be recorded in the field logbook.

5.7.2 Field Documentation/Logbooks

A summary of all field activities will be properly recorded in a bound logbook with consecutively numbered pages that cannot be removed. Logbooks will be assigned to field personnel but will be stored in a secured area when not in use. Each logbook will be identified by a unique number.

At a minimum, the following information will be recorded in the site logbook:

- The name of the person to whom the logbook is assigned.
- The logbook number.
- The project name.
- The project start date.
- The names and responsibilities of on-site project personnel including subcontractor personnel.

- The arrival/departure of site visitors.
- The arrival/departure of equipment.
- Sampling activities and sample log sheet references.
- A description of subcontractor activities.
- Sample pick-up information including COC numbers, air-bill numbers, carrier, time, and date.
- A description of field investigation, trench installation and storm-water management system installation activities.
- Health and safety issues.

All entries will be written in black ink and no erasures will be made. If an incorrect entry is made, the correction will be made by striking a single line through the incorrect information; the person making the correction will initial and date the change.

Samples will be collected following procedures outlined in Section 5.4. The equipment used to collect the sample will be noted in the logbook along with time of sampling, sampler's name, sample description, depth at which the sample was collected, and the volume and number of containers collected. QC sample information will be appropriately recorded.

Field Changes

Changes in proposed project activities may be necessary as a result of altered field conditions or unanticipated events. Amendments or revisions to approved project plans will undergo the same level of review as the original planning document. A summary of the sequence of events associated with field changes is as follows:

- The FTL notifies the project manager of the need for a change in scheduled activities.
- The project manager will discuss the change with the appropriate individuals (HNUS senior technical advisors, CLEAN program contracting officer, and Navy RPM) and will provide verbal approval or denial for the proposed change.
- The FTL will document the chang on a Task Modification Request Form and forward the

form to the project manager immediately.

- The project manager will review and sign the form and distribute copies to the CLEAN program contracting officer, CLEAN program QA manager, Navy RPM, FTL, and the project file.

- A copy of the completed Task Modification Request Form will also be attached to the field copy of the affected document (i.e., project work plan, safety plan).

Sample Documentation

A sample log sheet will be filled out for each sample collected (see example in Appendix B). A sample log sheet is used to record specific types of data pertaining to the samples. Sample-specific data include such information as the sample identification number, container type and lot number, sample volume, preservative information, media, sample description, any problems encountered during sampling, shipping information (airbill), date and time of sample collection, and sampler's signature. Sample log sheets are sequentially numbered and stored in a notebook. The notebook is included in the project file at the completion of field activities. Copies of these pages will be included as an appendix to draft and final project deliverables.

Daily Activities Record

The Daily Activities Record is designed for schedule and budget tracking and progress reporting. This record documents the pay items involved with daily activities and progress for each subcontractor. Thes sheets summarize the work performed and are used to check the subcontractor's request for payment.

The FTL supervising a subcontractor activity must complete a Daily Activities Record form. The subcontractor's signature is required at the end of each day to verify work accomplished and the various pay items (e.g., hours worked, delay time, and materials used).

Equipment Calibration Log Form

Each HNUS instrument requiring calibration will have a separate equipment calibration log form that documents that the manufacturer's instructions and the SOPs were followed for calibration of the equipment. This information should include the frequency and type of standard or calibration device. This record documents the accuracy, precision, or sensitivity of the measurement. If necessary, it will be used to determine if corrections should be applied to the readings. A separate form will be established and maintained for each field instrument.

These forms will be maintained in a binder and, at the completion of the field activities, will be stored in the project file.

5.7.3 Custody Transfer and Shipm nt Procedur s

Sample COC and shipping procedures are outlined in detail in Appendix B. Samples will be accompanied by a properly completed COC form. When transferring the possession of samples, the individuals relinquishing and receiving the samples will sign, date, and note the time of transfer on the record. The original form and one copy will be sealed inside the cooler for shipment; another carbon copy will be retained by the sampler.

Samples will be properly packaged for shipment and secured with strapping tape and custody seals. Examples of sample paperwork and detailed shipping procedures are included in Appendix B.

If the samples are sent by common carrier, a bill of lading will be used. A receipt or a bill of lading will be retained as permanent project documentation. Commercial carriers are not required to sign the custody form as long as the forms are sealed inside the shipping container and the custody forms remain intact. If the samples are sent by mail, the package will be registered with a return receipt requested.

5.7.4 Laboratory Custody Procedures

Proper custody procedures as required by NJ DEPE and "Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program," NEESA 20.2-047B (June 1988) will be followed by the laboratory.

When the samples are received by the laboratory, the bill of lading or shipping manifest will be signed and dated to document sample receipt. The laboratory will keep a copy of the manifest that will be included in the data package. The sample custodian will verify the integrity of the custody seals and the condition of the shipping containers. When the containers are opened, the temperature of the cooler will be measured and documented and the enclosed sample paperwork will be removed.

The samples will be removed from the coolers, and the condition of the bottles will be noted. All pertinent sample paperwork and labels will be inspected for discrepancies. Breakage or discrepancies will be resolved through the project manager. Sample preservation will be noted and any improper preservation will be documented on an out-of-control form; corrective action will be taken in accordance with NJ DEPE and NEESA requirements. The samples will be analyzed as rapid turnaround. Laboratory tracking procedures will be followed as discussed in the laboratory QA plan provided by the contracted laboratory.

5.8 CALIBRATION PROCEDURES

5.8.1 Fi ld Calibration and Pr ventative Maint nance Proc dures

It is the project manager's responsibility to ensure that field team members are trained in the calibration, use, and maintenance of all applicable field instruments and equipment. Equipment used during field activities and sample collection will be calibrated in accordance with SOPs and manufacturers' instructions. Equipment will be inspected at the beginning of each day to ensure that it is in operable condition and calibrated. All calibration activities will be documented on equipment calibration log sheets. Instruments in need of repair will be removed from service and clearly marked to ensure against further use.

The field logbook will clearly identify the specific instruments used for each task.

5.8.2 Laboratory Calibration Procedures

The laboratory is responsible for properly calibrating and maintaining analytical instrumentation. The laboratory's approved QA plan and method-specific QC activities must be in compliance with NJ DEPE requirements and the NEESA Guidelines 20.2-047B (June 1988). Sufficient documentation of compliance will be provided by the laboratory and will be included as part of the data package.

5.9 ANALYTICAL PROCEDURES

All sampling and monitoring activities conducted in the field will be documented including calibration and use records for field instrumentation. All data generated will be reviewed by the FTL and approved before they are accepted.

Off-site analytical support will be provided by NJ-DEPE-certified, NEESA-approved analytical and physical testing laboratories. These laboratories are responsible for compliance to all applicable NJ DEPE and NEESA requirements. Analyses will be conducted according to methods specified in Table 5-1. These requirements are further addressed in Section 5.9.2. All method-specific QA/QC requirements and NJ DEPE program requirements will be met.

5.9.1 Laboratory Sample Storage Procedures

The laboratory is required to follow the sample storage procedures outlined in the laboratory's approved QA plan. Specifically, the samples will be maintained under custody and will be stored in compliance with all applicable method-specific and program QA/QC requirements.

5.9.2 Laboratory Data D liv rabl Format

The analytical laboratory will be required to report only sample and associated laboratory method blank analysis results for the NEESA Level E TPH analyses. These data results will be reported via telecopier to the project manager with hard copies to follow by express mail. Sample results for NEESA Level E geotechnical analyses will be reported to the project manager by express mail.

5.10 DATA REDUCTION, VALIDATION, AND REPORTING

Data reduction will be performed by the laboratory in accordance with the laboratory's approved QA plan, laboratory SOPs, and NJ DEPE and NEESA requirements. Documentation to support the data review will be included in the data package. The content and format of the analytical data packages are discussed in the preceding section.

Th data pertaining to the TPH analysis will be evaluated using field quality control blank results and laboratory method blank results to determine if any false positive sample values have been reported. This evaluation will be performed by qualified HNUS personnel in accordance with established evaluation procedures. Additionally, false positives will be qualified (flagged) and removed from further consideration and field duplicate precision will be evaluated.

The validation described above is documented in memoranda to the file (complete with support documentation) per each data package evaluated. Data validation memoranda are QA checked by the CLEAN program QA manager before submittal to the project manager.

6.0 HEALTH AND SAFETY

6.1 PROJECT ORGANIZATION AND RESPONSIBILITIES

The CLEAN program H&S manager is responsible for ensuring that the site-specific HASP is in accordance with federal and state regulations and contract specifications. The CLEAN program H&S manager also provides technical safety and industrial hygiene oversight for all field work performed under the CLEAN contract and provides assistance and guidance to the project H&S officer. The project H&S officer is responsible for preparing the site-specific HASP and for verifying that site personnel adhere to the site safety requirements. The project H&S officer also provides guidance about appropriate corrective action procedures and maintains communication among the SSO, project manager, and CLEAN program H&S manager.

6.2 HEALTH AND SAFETY OBJECTIVES

HNUS has established a comprehensive health, safety, and training program for all field activities, particularly those that have the potential for chemical exposures. The program is intended to provide adequate procedures, protective gear, monitoring, and follow-up to protect the health of HNUS, subcontractor, and client, as well as the public near our work sites.

This program is driven by the requirement to comply with federal and state OSHA regulations, the need to minimize the risk of adverse health effects from exposure to work hazards, and the savings inherent in safe work activities. In this regard, our objective is to comply with all standards, training requirements, medical monitorings, and employee protection requirements for workers engaged in hazardous waste operations, as required by 29 Code of Federal Regulations (CFR) 1910.120 March 6, 1989.

The site-specific HASP is in Appendix C.

Health and Safety Plan
for
Naval Weapons Station Earle Interim Action - Building 566

Colts Neck, New Jersey

Northern Division
Naval Facilities Engineering Command

Contract No. N62472-90-D-1298
Contract Task Order 0155

August 1994

DRAFT

R-51-7-4-18

HEALTH AND SAFETY PLAN
NAVAL WEAPONS STATION EARLE
INTERIM ACTION - BUILDING 566

COLTS NECK, NEW JERSEY

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
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Naval Facilities Engineering Command
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1.0 INTRODUCTION AND PERSONNEL ASSIGNMENTS

1.1 INTRODUCTION

This Health and Safety Plan (HASP) has been developed to provide safety procedures for Halliburton NUS Corporation (HNUS) employees and HNUS subcontractor personnel engaged in interim action activities for Building 566 at Naval Weapons Station (NWS) Earle. This plan was developed using available information regarding known/suspected chemical contaminants and physical hazards that may be encountered during 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 HNUS Health and Safety Manager (HSM) and will be immediately communicated to appropriate personnel. The HASP is intended to be in compliance with 29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response."

1.2 SITE INFORMATION AND PERSONNEL ASSIGNMENTS

Site Name: NWS Earle
Address: Colts Neck, New Jersey

Client Contact: John Pawlus - NWS Earle
Phone Number: (908) 866-2674
Client Contact: Brian Helland (RPM) NorthDiv
Phone Number: (610) 595-0567

Effective Date: August 1994
Purpose of Site Visit: Interim Action
Proposed Dates of Work: TBA

Project Team:

Halliburton NUS Personnel:	Discipline/Tasks Assigned:
Jill Hartnell	Project Manager
TBA	Field Team Leader (FTL)
TBA	Health and Safety Officer (HSO)
TBA	Sampler

Non-Halliburton NUS Personnel/Affiliation:	

Plan Preparation:
Prepared by: Marcia Case, Halliburton NUS
Reviewed and approved by: Matthew M. Soltis, Halliburton NUS

Reviewed:
Halliburton NUS
Project Manager: Jill Hartnell

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

2.0 DESCRIPTION AND BACKGROUND

2.1 SITE DESCRIPTION

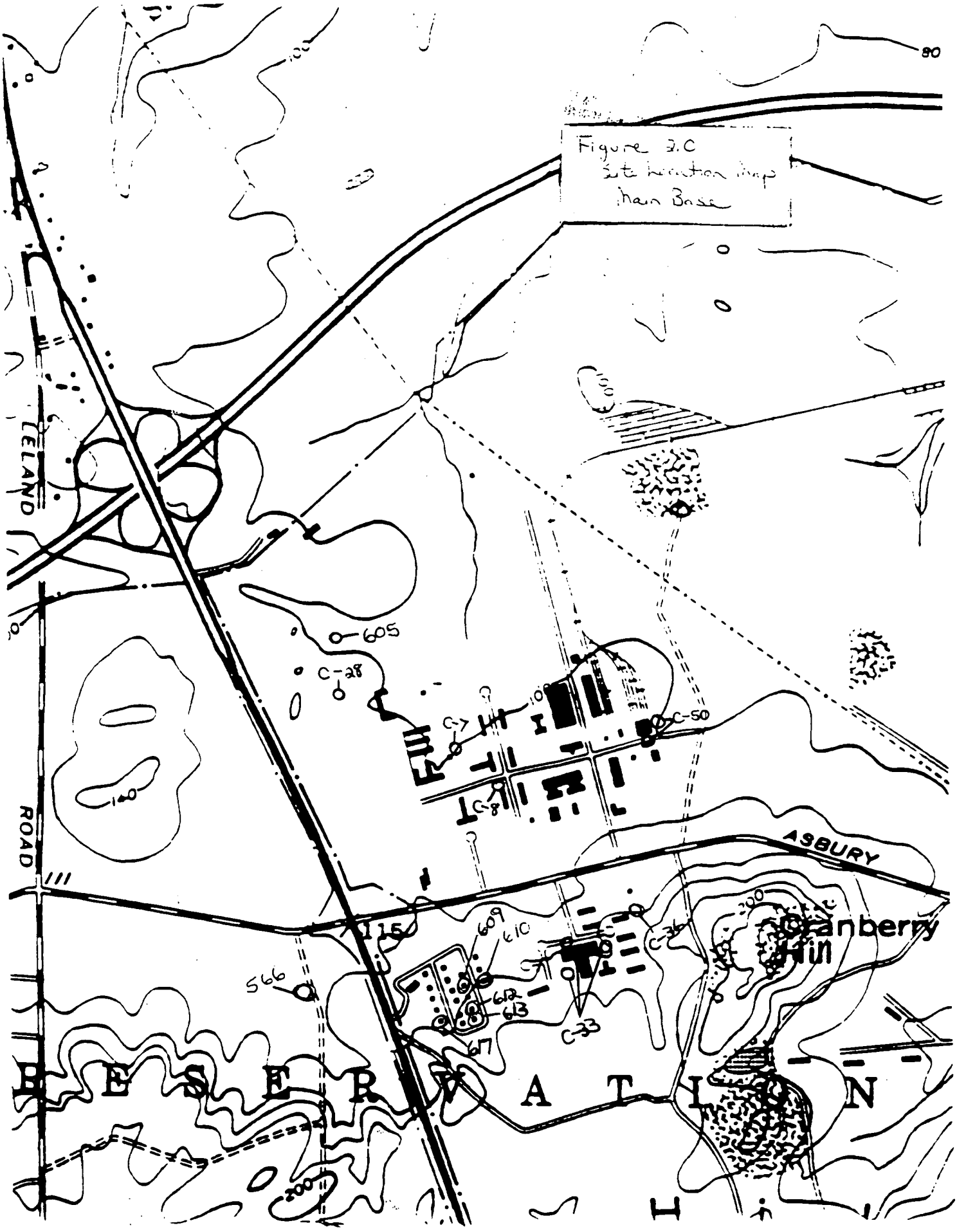
The NWS Earle facility is located south of Colts Neck, Monmouth County, New Jersey, approximately six miles inland from the Atlantic Ocean. The station is divided into three physically separate areas. The largest of these is the Mainside Base, which reportedly occupies 10,428 acres. The two smaller areas, the waterfront and Chapel Hill, occupy 706 acres combined.

2.2 BACKGROUND

Building 566 is located at the Mainside Base in the Ordnance M area (see Figure 2.1, page 2-2). Reportedly, fuel oil was inadvertently released directly to the septic tank at this location. Oil has been noted seeping from the ground, and immediate action is necessary to stop the oil from spreading to an adjacent wetland.

Previous sampling efforts, conducted in this general area as part of an underground diesel fuel storage tank removal activity, revealed total petroleum hydrocarbon (TPH) levels of 25,000 mg/kg. Additionally, methylene chloride, 1,2-dichloroethane, 1,1,2,2-tetrachloroethane, 2-hexanone, 4-methyl-2-pentanone, and bromoform were detected in soil samples collected from the underground storage tank (UST) excavation at this building. The source of that volatile organic compound (VOC) contamination has not been determined. A 4,000-gallon underground heating oil storage tank has also been removed from this area. There are currently two above-ground heating oil tanks at this location.

HNUS has been tasked to prepare a plan for interim action to control the spread of contamination. The preferred method of containment is a cut-off or interceptor trench.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Main Base
LELAND
ROAD
ASBURY
Cranberry
Hill
605
C-28
C-50
C-8
609
610
612
613
C-33
566
607
200
100
90
R E S E R V A T I O N

3.0 SCOPE OF WORK

The following field tasks will be performed as part of Phase I:

- Collect three 5-pound bags of soil by hand digging. This soil will be used for sieve analysis.
- Using a hand auger and slotted polyvinyl chloride (PVC) tubing, determine the depth to groundwater.
- Collect soil samples and submit for analysis to determine the extent of contamination. This will be accomplished using the "Little Beaver" and hand augers.
- Delineate the wetlands.
- Survey surface elevations.
- Drum contaminated decontamination waters.

The following field tasks will be performed as part of Phase II:

- Install the cut-off trench, sump, and water collection containers. This will involve confined-space entry operations.
- Install erosion control barriers (this may include sand bags or asphalt diversion curbs).
- Stabilize the new runoff outfall.
- Stockpile excavated soil and contain it (this may include the use of sandbags and plastic sheeting).

The following field task will be performed as part of Phase III:

- Remove or properly abandon the trench when excavation activities have been completed.

Additional activities may include performing additional site reconnaissance activities.

4.0 RISK ANALYSIS

The primary hazards associated with the activities listed in Section 3.0 are dangers inherent with confined-space operations. Section 12.0, Confined-Space Operations, identifies these hazards and outlines control measures that will be used for all confined-space activities.

Additionally, chemical and physical hazards and controls are addressed in this section.

4.1 CHEMICAL HAZARD OVERVIEW

Historical information suggests that fuel oil was discharged to the septic tank at this location and that the heating oil has contaminated the soils. This area previously housed a 6,000-gallon underground diesel fuel storage tank and a 4,000-gallon underground heating oil tank. Sampling performed when the diesel fuel tank was removed revealed elevated levels of TPHs. According to Patty's Industrial Hygiene and Toxicology, in general, as the molecular weight of these substances increases, so does their toxicity but with a consequent decrease in the vapor pressure and inhalation potential.

Other contaminants were also detected in the soils at the time of excavation activities. Table 4.1 (page 4-2) presents the contaminants known or suspected to be present in the area of concern and outlines toxicity data. The primary hazards associated with this investigation include potential exposure via inhalation of vapors and direct skin/eye contact.

The use of real-time monitoring instruments, visual observation, olfactory observation, and perception of irritation will aid in the identification of exposure to site contaminants. Personal protective equipment (PPE) and standard work practices (Sections 6.0 and 5.0 of this plan) will be used when necessary to help reduce or eliminate exposures and, therefore, reduce the potential for adverse health effects.

Table 4.2 (page 4-3) identifies potential hazards associated with each task and presents control measures to be utilized in an effort to reduce and/or eliminate those hazards.

4.2 PHYSICAL HAZARDS

Aside from the hazards presented by chemical substances, physical hazards must also be addressed. Physical hazards could involve the following:

- Fire/explosion
- Contact with energized sources

DRAFT

TABLE 4.1
POTENTIAL CHEMICAL HAZARDS
NWS EARLE

Substance	CAS No.	Appearance and Odor	Exposure Limits	Ionization Potential	Toxic and Pharmacologic Effects	Flammability, etc.
No. 2 Fuel Oil (Diesel Fuel)	none listed	Brown, slightly viscose liquid	none listed	none listed	• Mildly toxic by ingestion	Flammable when exposed to heat or flame. Reacts with oxidizing materials.
No. 6 Fuel Oil	none listed	Dark brown, viscose liquid	none listed	none listed	• Is of low-order toxicity due to low volatility • High aromatic content may cause systemic effects from repeated and prolonged dermal exposure	Flammable when exposed to heat or flame
1,2-Dichloroethane (ethylene dichloride)	107-06-2	Colorless liquid with chloroform-like odor	PEL: 50 ppm TLV: 10 ppm IDLH: Suspected carcinogen	11.05	• CNS depressant • Nausea, vomiting • Dermatitis • Eye irritant	Incompatible with strong oxidizers and chemically active metals
2-Hexanone	591-78-6	Colorless liquid with acetone-like odor	PEL: 100 ppm TLV: 5 ppm IDLH: 5,000 ppm	9.34	• Eye and nose irritant • Weakness, headache, drowsiness	Incompatible with strong oxidizers
Methylene chloride	75-09-2	Colorless liquid with chloroform-like odor	PEL: 500 ppm TLV: 50 ppm IDLH: 5,000 ppm carcinogen	11.32	• Fatigue, weakness, sleepiness • Eye and skin irritant	Incompatible with strong oxidizers, chemically active metals, and concentrated nitric acid
Chlorobenzene	108-90-7	Colorless liquid with almond-like odor	PEL: 75 ppm TLV: 10 ppm IDLH: 2,400 ppm	9.07	• Skin, eye, and nose irritant • Drowsiness	Incompatible with strong oxidizers
Bromoform	75-25-2	Colorless to yellow liquid with chloroform-like odor	PEL: 0.5 ppm TLV: 0.5 ppm IDLH: Unknown	10.48	• Eye and respiratory irritant • CNS depressant	Incompatible with lithium, sodium, acetone, strong caustics
4-methyl-2-pentanone (hexone)	108-10-1	Colorless liquid with a pleasant odor	PEL: 100 ppm TLV: 50 ppm IDLH: 3,000 ppm	9.30	• Eye and mucus membrane irritant • Headache, coma	Incompatible with strong oxidizers
1,1,2,2-Tetrachloroethane	79-34-5	Colorless to pale yellow liquid with pungent chloroform-like odor	PEL: 5 ppm TLV: 1 ppm IDLH: 150 ppm carcinogen	11.10	• Nausea, vomiting, abdominal pain • Finger tremors • Jaundice	Incompatible with chemically active metals, strong caustics, and fuming sulfuric acid

TABLE 4.2
RISK ANALYSIS SUMMARY - NWS EARLE

Task	Potential Hazards	Controls
Intrusive activities such as hand digging, hand augering, mechanical augering, and excavation, as well as the handling of potentially contaminated materials such as decontamination fluids and excavated soils. Installation of sump, water collection container, and erosion control barriers. Stabilization of runoff outfall.	Inhalation of airborne contaminants	• Stand upwind. • Utilize monitoring instruments. • Use proper respiratory PPE (Section 6.0) • Wet down dusty areas (if appropriate).
	Direct contact with contaminants	• Avoid unnecessary contact. • Utilize PPE (Section 6.0) • Follow decontamination procedures (Section 9.0) • Utilize good personal hygiene practices. • Follow "Site Standard Work Practices" (Section 5.0).
	Ingestion of contaminants	• No hand-to-mouth contact. • Utilize good personal hygiene practices. • Follow decontamination procedures (Section 9.0). • Follow "Site Standard Work Practices" (Section 5.0).
	Contact with moving/ rotating machinery parts	• Follow "Site Standard Work Practices" (Section 5.0). • Do not operate any equipment unless all appropriate machine guarding devices are in place and in proper working order. • HSO will perform initial and periodic inspections.
	Contact with overhead or Underground utilities	• Follow "Site Standard Work Practices" (Section 5.0). • Underground utilities must be identified and marked before the performance of subsurface activities. • Septic system will be shut down during work activities.
	Excessive noise	• Ear protection will be available on site and will be used at the discretion of the HSO.
	Overhead and eye hazards	• Hard hats and safety glasses will be worn if within 20 feet of heavy equipment operations and as required by the HSO.
	Manual lifting	• Utilize proper lifting techniques.

Task	Potential Hazards	Controls
Intrusive activities (continued)	Cold/heat stress	• Team members will monitor each other for cold/heat stress symptoms. • Utilize work/rest regimes.
	Fire/explosion	• Use appropriate monitoring instruments and follow action levels. • Ventilate as appropriate. • Eliminate ignition sources.
	Uneven/unstable terrain	• Utilize extreme caution when moving heavy equipment across the site. • Utilize least steep path. • Utilize safety harnesses and life-lines as determined by the HSO.
	Biological hazards	• Utilize proper PPE. • Utilize proper decontamination procedures (alcohol wipes). • Check body for ticks.
Confined-Space Operations	In addition to the hazards listed above (intrusive activities): Engulfment	• Utilize proper sloping and shoring in accordance with 29 CFR 1926, Subpart P. • Follow "Site Standard Work Practices" (Section 5.0).

TABLE 4.2
RISK ANALYSIS SUMMARY - NWS EARLE
PAGE TWO

Task	Potential Hazards	Controls
Site reconnaissance activities (non-intrusive)	Inhalation of airborne contaminants	• Stand upwind. • Utilize monitoring instruments. • Use proper respiratory PPE (Section 6.0) • Wet down dusty areas (if appropriate) to control particulates.
	Direct contact with contaminants	• Avoid unnecessary contact. • Utilize PPE (Section 6.0) Follow decontamination procedures (Section 9.0) • Utilize good personal hygiene practices. • Follow "Site Standard Work Practices" (Section 5.0).
	Ingestion of contaminants	• No hand-to-mouth contact. • Utilize good personal hygiene practices. • Follow decontamination procedures (Section 9.0). • Follow "Site Standard Work Practices" (Section 5.0).
	Manual lifting	• Utilize proper lifting techniques.
	Cold/heat stress	• Team members will monitor each other for cold/heat stress symptoms. • Utilize work/rest regimes.
	Uneven/unstable terrain	• Utilize extreme caution when moving heavy equipment across the site. • Utilize least steep path. • Utilize safety harnesses and life-lines as determined by the HSO.
	Biological hazards	• Utilize proper PPE. • Utilize proper decontamination procedures (alcohol wipes). • Check body for ticks.

- Exposure to moving machinery
- Uneven or unstable terrain (slip, trip hazard)
- Strain or muscle pulls from manual lifting
- Noise in excess of 85 dBA
- Overhead and eye hazards
- Falling into deep waters
- Heat/cold stress
- Engulfment
- Biological hazards

All the petroleum products known to have been stored or released in this area are considered flammable or combustible liquids. Methane and hydrogen sulfide (flammable gases) are also a concern near the septic system. This potential hazard will be controlled by monitoring with a lower explosive limit/oxygen (LEL/O_2) meter and by elimination of potential ignition sources. Refer to Table 6-1 for action levels.

Control efforts for contact with energized sources include requirements that no projecting items shall be permitted within a 20-foot radius of energized overhead sources. Also, any areas targeted for subsurface investigation shall first be investigated to determine the presence of underground utilities. No subsurface activities will commence until the work area has been positively cleared of utilities.

Additional underground structures that must be avoided include the septic system tanks and pipes. The septic system will be shut down during work activities. This is being done as a precautionary measure to minimize the potential for release. It is the responsibility of the field team leader to ensure that the system has been shut down.

P rsonnel shall be advised of hazards from contact with moving machinery pinch points. All machinery on site must be kept properly maintained, positioned, guarded, and operated. Personal protective clothing must fit properly and be taped, not only to minimize chemical exposure but also to minimize potential entanglement with moving machinery. Additionally, equipment will be shut down and locked out before maintenance functions are performed. The HSO will be responsible for initial and periodic inspections of all safety devices to ensure that they are in place and functioning properly. This inspection will also be performed after any maintenance activities.

Uneven and unstable terrain are both concerns at this site. A steep bank heads toward the creek. At the time of the preliminary assessment, one individual fell knee-deep into a "wash out" hole. On the surface, the ground appeared solid but, when the individual took a step, the surface thatch gave way. This is a concern not only for site workers but also for any equipment that must be moved across the area.

During lifting tasks, personnel are to lift with the force of the load carried by their legs and not by their backs. An appropriate number of personnel must be used when lifting or handling heavy equipment. These procedures are to be employed to minimize the potential for back strain.

Ear protection will be available on site. Use will be determined by the HSO, based on the following: If individuals must raise their voices to be heard when standing within two feet of a co-worker, ear protection must be worn.

Overhead and eye hazards will be controlled by utilizing hard hats and safety glasses if personnel are within 20 feet of heavy equipment operations. Personnel must also be aware of their surroundings with respect to overhead and eye hazards.

The surface water near which work is to be performed is a slow-moving, shallow tributary. If, however, deep waters are encountered, the following precautions will be taken. To avoid unintentional falls into deep waters, site personnel will utilize approved safety harnesses when performing work near the water. These harnesses will be tied to a life line, which will be tethered to a stationary object. United States Coast Guard-approved personal flotation devices will also be worn.

Employees will be monitored for signs of heat/cold stress. Fluids will be increased, and breaks will be provided as necessary and at the HSO's discretion. Heat and cold stress procedures are provided in Appendix C of this HASP.

Engulfment hazards will exist primarily during excavation operations and are created when the walls of the excavation are not shored or are improperly sloped. No one will enter the excavation until proper sloping and shoring techniques, as required by OSHA 29 CFR 1926, Subpart P, have been implemented. A stairway, ladder, ramp, or other safe means of egress will be properly installed prior to entry into xcavations that are four feet or more in depth.

Additional control measures for these physical hazards are included in Section 5.0, Standard Work Practices.

4.3 BIOLOGICAL HAZARDS

Biological hazards that could be encountered include insect bites (ticks, mosquitoes), bee stings, snakes, and poisonous plants (oak, ivy, and sumac). Workers must be aware of their surroundings and must wear appropriate PPE. It is recommended that workers check their bodies for ticks.

Additional biological hazards could be associated with the leech field of the septic system. Bacteria and oth r microorganisms capable of producing diseases in humans can be carried through the wastewater. This hazard is being recognized due to the close proximity of the septic system to the work area. Site workers are required to wear appropriate PPE and are also encouraged to thoroughly wash their hands and faces. Alcohol wipes will be available on site and are required as part of the personal decontamination process. An alcohol rinse will also be added to the decontamination process for sampling equipment.

5.0 SITE STANDARD WORK PRACTICES

All activities will follow HNUS Health and Safety Standard Operating Procedures where appropriate.

The following requirements are HNUS health and safety standard work procedures:

- Eating, drinking, chewing gum or tobacco, taking medication, and smoking are prohibited in any location where the possibility for the transfer of contamination exists.

- Upon leaving a contaminated area, hands and face must be thoroughly washed. Any protective outer clothing is to be decontaminated, removed, and left at a designated area before personnel enter a clean area.

- Contact with potentially contaminated substances must be avoided. Whenever possible, 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 allowed on personnel required to wear respiratory protection equipment. All personnel will be required to be fit-tested if respiratory protection is necessary.

- The use of contact lenses is prohibited for all hazardous waste site operations.

- All personnel must procure a site-specific health and safety plan from the project health and safety officer prior to commencing work on site. Additionally, a Site Safety Follow-Up Report must be filed with each trip report following completion of a task. This report will be filed by the FTL.

- All personnel must satisfy medical monitoring procedures.

- All personnel must follow action levels presented in the Personal Protective Equipment (PPE) section of this report (Section 6.0).

- All electrical tools must be connected to a ground fault interrupter (GFI) and/or must be grounded with a third wire, and the cord must be double insulated and in good working condition.

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

- No drilling within 20 feet in any direction of overhead power lines will be permitted. The locations of all underground utilities must be identified and marked before any subsurface activities are initiated.

- Personnel must develop hand signals with equipment operators.

- All drill rigs and other machinery with exposed moving parts must be equipped with an operational emergency stop device. Drillers and geologists must be aware of the location of this device. This device must be tested prior to job initiation and periodically thereafter. The driller and helper shall not simultaneously handle moving augers unless there is a standby person to activate the emergency stop.

- The driller must never leave the controls while the tools are rotating unless all personnel are kept clear of the rotating equipment.

- A long-handled shovel or equivalent must be used to clear drill cuttings away from the hole and from rotating tools. Hands and/or feet are not to be used for this purpose.

- A remote sampling device must be used to sample drill cutting if the tools are rotating or if the tools are readily capable of rotating. Samplers must not reach into or near the rotating equipment. If personnel must work near any tools that could rotate, the driller must shut down the rig prior to initiating such work.

- Drillers, helpers, and samplers must secure all loose clothing when in the vicinity of drilling operations.

- Only equipment that has been approved by the manufacturer may be used in conjunction with site equipment and specifically to attach sections of drilling tools together. Pins that protrude excessively from augers shall not be allowed.

- No person shall climb the drill mast while tools are rotating.

- No person shall climb the drill mast without the use of American National Standards Institute (ANSI)-approved fall protection (i.e., approved belts, lanyards, and a fall protection slide rail) or portable ladder that meets the requirements of Occupational Safety and Health Administration (OSHA) standards.

- All compressed gas cylinders must be stored and used in an upright position, properly secured from damage, and segregated and labeled as empty or full.

- The HSO must make an entry into the health and safety logbook each day including weather conditions, site personnel, new arrivals, and "clearance for site work" air monitoring data summary, indications or suspicions of inhalation exposure, PPE used per task, deviations from HASP, and general health and safety problems and corrective actions.

- Site personnel are not to undertake any activity that would be considered a confined-space entry without first being trained in the proper procedures and obtaining a Confined Space Entry Permit.

- Site personnel must immediately notify HNUS 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 notify the HSO for further direction.

- Any new analytical data must be promptly conveyed via telephone to the project HSO by the laboratory technician or team leader.

- All site personnel including subcontractors must complete a medical data sheet, to be maintained on site.

- Decontamination solutions and sample preservatives must be handled in well-ventilated areas. Stand upwind when possible.

- The "buddy-system" shall be employed for all activities.

- All machinery will be inspected by the HSO for the presence of all necessary safe guards. These inspections will be performed prior to initial start-up, after any maintenance operations, and periodically during the performance of work activities.

- Work shall be discontinued in the event of severe inclement weather (i.e., electrical storms), at the discretion of the HSO and the FTL.

- Post Exhibits 1 and 2 (attached) on site, preferably near the most readily available telephone.
- Post the OSHA poster (8-1/2- by 14-inch size).
- If excavations are to be entered by personnel, adequate protective systems are to be used. These protective systems must comply with 29 CFR 1926.652.
- Stairways, ladders, ramps, or other safe means of egress will be provided in trenches that are four feet or more in depth.
- Water will not be permitted to accumulate in trenches that will be entered by personnel.
- All excavation activities will be conducted in accordance with 29 CFR 1926 Subpart P.
- Personnel required to enter an excavation to perform work must wear a full body harness equipped with a retrieval line.
- Open excavations that will be left unattended for any period of time must be properly barricaded and posted.
- The HSO shall frequently inspect the test pits for slide or cave-in potential.
- Support personnel must not lean over excavations.
- Personnel must stand upwind from the excavations and away from the reach of the backhoe.
- Personnel must develop hand signals with the equipment operators.
- The excavation shall not be undermined.
- All work areas must be kept free of ground clutter.
- The equipment shall operate from the upwind side of the excavation.

EXHIBIT 1

EMERGENCY REFERENCE INFORMATION

(P st On Site)

Site: NWS Earle Project Number: N62472-90-1298/CTO 0155

On-Site Emergency Information:

Ambulance:	NSW Earle	(908) 866-2300 Mainside
Police:	NWS Earle Security	(908) 866-2291
Fire Department:	NWS Earle Fire	(908) 866-2333 Mainside
Project Manager:	Jill Hartnell	(215) 971-0900
Site Health and Safety Officer:	TBA	On site

Off-Site Emergency Information:

Police:	Colts Neck	(908) 462-4343
Hospital (Name):	Riverview	(908) 741-2700

Note: In the event of an emergency, call the Naval base number first. Follow their instructions for alerting off-site emergency services.

Emergency Contacts (Medical and Health):

- Navy CLEAN Health and Safety Manager Matthew M. Soltis, CSP
  Office: (412) 921-8912
- National Response Center (**for environmental emergency only**): 1-800-424-8802

Directions to Hospital:

From the Main Base: Take Route 34 north to County Road. At the "T," turn right onto Swimming River Road. Make a left onto Sycamore Avenue. In Shrewsbury, turn left onto Broad Street. Make a right onto Front Street and an immediate left onto Wharf Avenue. The hospital is on the right.

AMERICAN RED CROSS

First Aid

EMERGENCY TELEPHONE NUMBERS	
Police:	(908) 866-2291
Fire Department:	(908) 866-2333 (Main) X 7133 (
Doctor:	(908) 866-2300 Mainside
Ambulance:	(908) 866-7180 Waterfront
Hospital:	(908) 741-2700
Poison Control Center:	

BITES

Animal Bites - Thoroughly wash the wound with soap and water. Flush the area with running water and apply a sterile dressing. Immobilize affected part until the victim has been attended by a physician. See that the animal is kept alive and in quarantine. Obtain name and address of the owner of the animal.

Insect Bites - Remove "stinger" if present. Keep affected part down below the level of the heart. Apply ice bag. For minor bites and stings, apply soothing lotions, such as calamine.

BURNS AND SCALDS

Minor Burns - DO NOT APPLY VASELINE OR GREASE OF ANY KIND. Apply cold water applications until pain subsides. Cover with a dry, sterile gauze dressing. Do not break blisters or remove tissue. Seek medical attention.

Severe Burns - Do not remove adhered particles of clothing. Do not apply ice or immerse in cold water. Do not apply ointment, grease, or vaseline. Cover burns with thick sterile dressings. Keep burned feet or legs elevated. Seek medical attention immediately.

Chemical Burns - Wash away the chemical-soaked clothing with large amounts of water. Remove victim's chemical-soaked clothing. If dry lime, brush away before flushing. Apply sterile dressing and seek medical attention.

CRAMPS

Symptoms - Cramps in muscles of abdomen and extremities. Heat exhaustion may also be present.

Treatment - Same as for heat exhaustion.

CUTS

Apply pressure with sterile gauze dressing and elevate the area until bleeding stops. Apply a bandage and seek medical attention.

EYES

Foreign Objects - Keep the victim from rubbing his eye. Flush the eye with water. If flushing fails to remove the object, apply a dry protective dressing and consult a physician.

Chemicals - Flood the eye thoroughly with water for 15 minutes. Cover the eye with a dry pad and seek medical attention.

FAINTING

Keep the victim lying down. Loosen tight clothing. If victim vomits, roll him onto his side or turn his head to the side. If necessary, wipe out his mouth. Maintain an open airway. Bathe his face gently with cool water. Unless recovery is prompt, seek medical attention.

FRACTURES

Deformity of an injured part usually means a fracture. If fracture is suspected, splint the part. DO NOT ATTEMPT TO MOVE THE INJURED PERSON; seek medical attention immediately.

FROSTBITE

Symptoms - Just before frostbite occurs, the skin may be flushed, then change to white or grayish-yellow. Pain may be felt early and then subside. Blisters may appear; affected part feels very cold and numb.

Treatment - Bring victim indoors and cover the frozen area; provide extra clothing and blankets. Rewarm frozen area quickly by immersion in warm water - - NOT HOT WATER. DO NOT RUB THE PART. Seek medical attention immediately.

HEAT EXHAUSTION

Caused by exposure to heat (either sun or indoors).

Symptoms - Near-normal body temperature. Skin is pale and clammy. Profuse sweating, tiredness, weakness, headache, perhaps crams, nausea, dizziness, and possible fainting.

Treatment - Keep in lying position and raise victim's feet. Loosen clothing, and apply cool wet cloths. If conscious, give sips of salt water (1 teaspoon of salt per glass) over a period of one hour. If vomiting occurs, discontinue the salt water. Seek medical attention immediately.

SUNSTROKE

Symptoms - Body temperature is high (106°F or higher). Skin is hot, red, and dry. Pulse is rapid and strong. Victim may be unconscious.

Treatment - Keep victim in lying position with head elevated. Remove clothing and repeatedly sponge the bare skin with cool water or rubbing alcohol. Seek medical attention immediately.

POISONING

Call the Poison Control Center for instruction on immediate care. If victim becomes unconscious, keep the airway open. If breathing stops, give artificial respiration by mouth-to-mouth breathing. Call an emergency squad as soon as possible.

POISON IVY

Remove contaminated clothing; wash all exposed areas thoroughly with soap and water followed by rubbing alcohol. If rash is mild, apply calamine or other soothing skin lotion. If a severe reaction occurs, seek medical attention.

PUNCTURE WOUNDS

If puncture would is deeper than skin surface, seek medical attention. Serious infection can arise unless proper treatment is received.

SPRAINS

Elevate injured part and apply ice bag or cold packs. DO NOT SOAK IN HOT WATER. If pain and swelling persist, seek medical attention.

UNCONSCIOUSNESS

Never attempt to give anything by mouth. Keep victim lying flat; maintain open airway. If victim is not breathing, provide artificial respiration by mouth-to-mouth breathing and call an emergency squad as soon as possible.

EXHIBIT 2

AMERICAN RED CROSS INFORMATION SHEET

HALLIBURTON NUS
Environmental Corporation

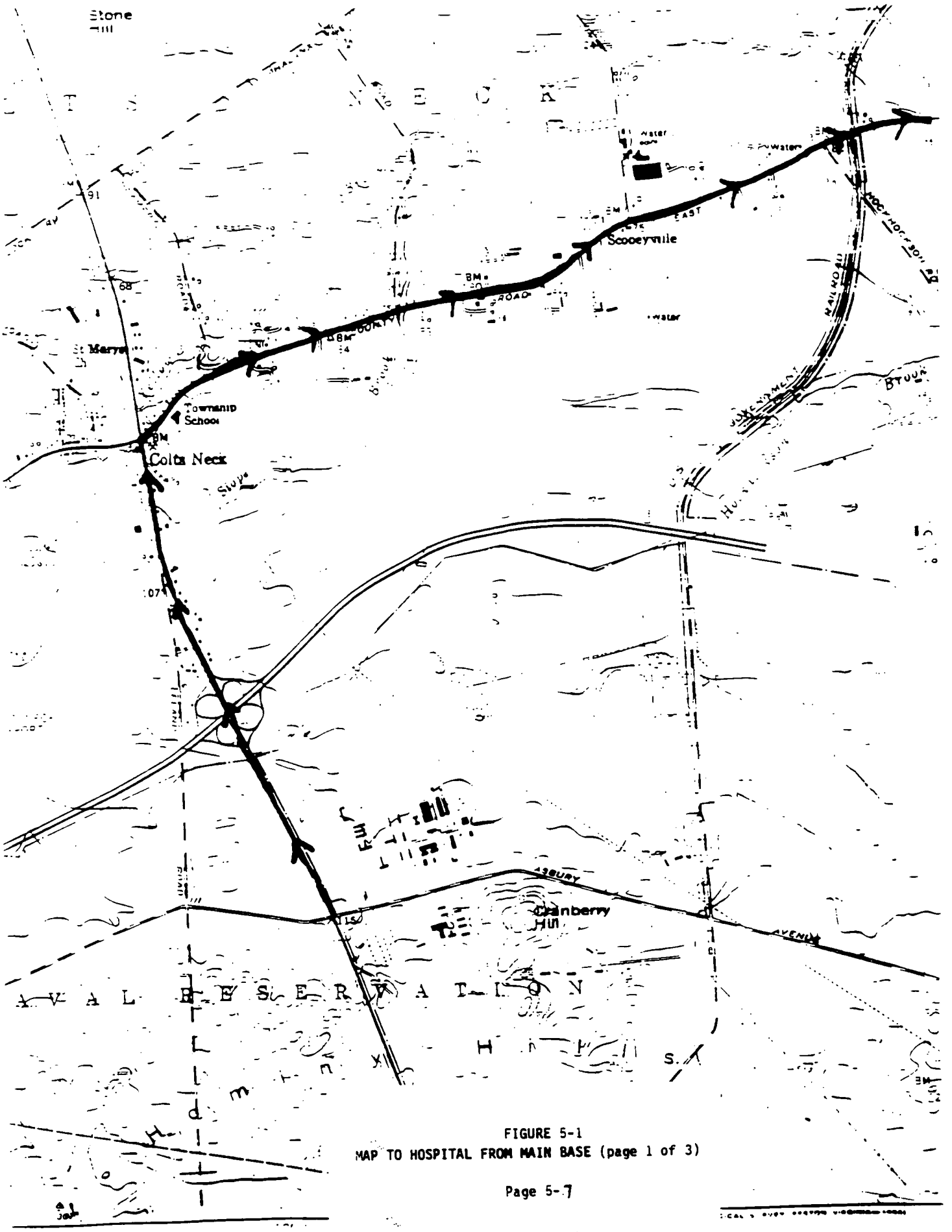

FIGURE 5-1
MAP TO HOSPITAL FROM MAIN BASE (page 1 of 3)

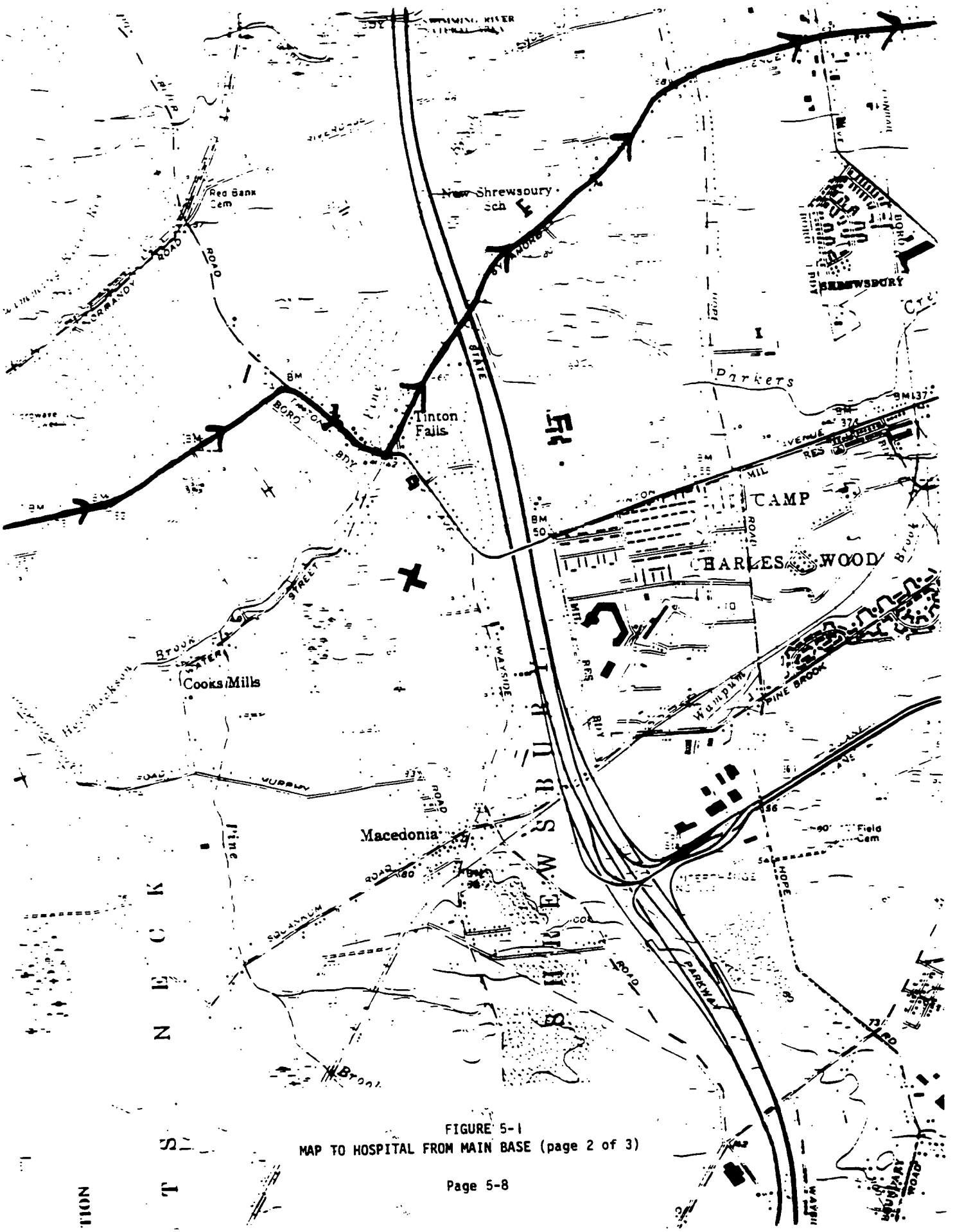

FIGURE 5-1
MAP TO HOSPITAL FROM MAIN BASE (page 2 of 3)

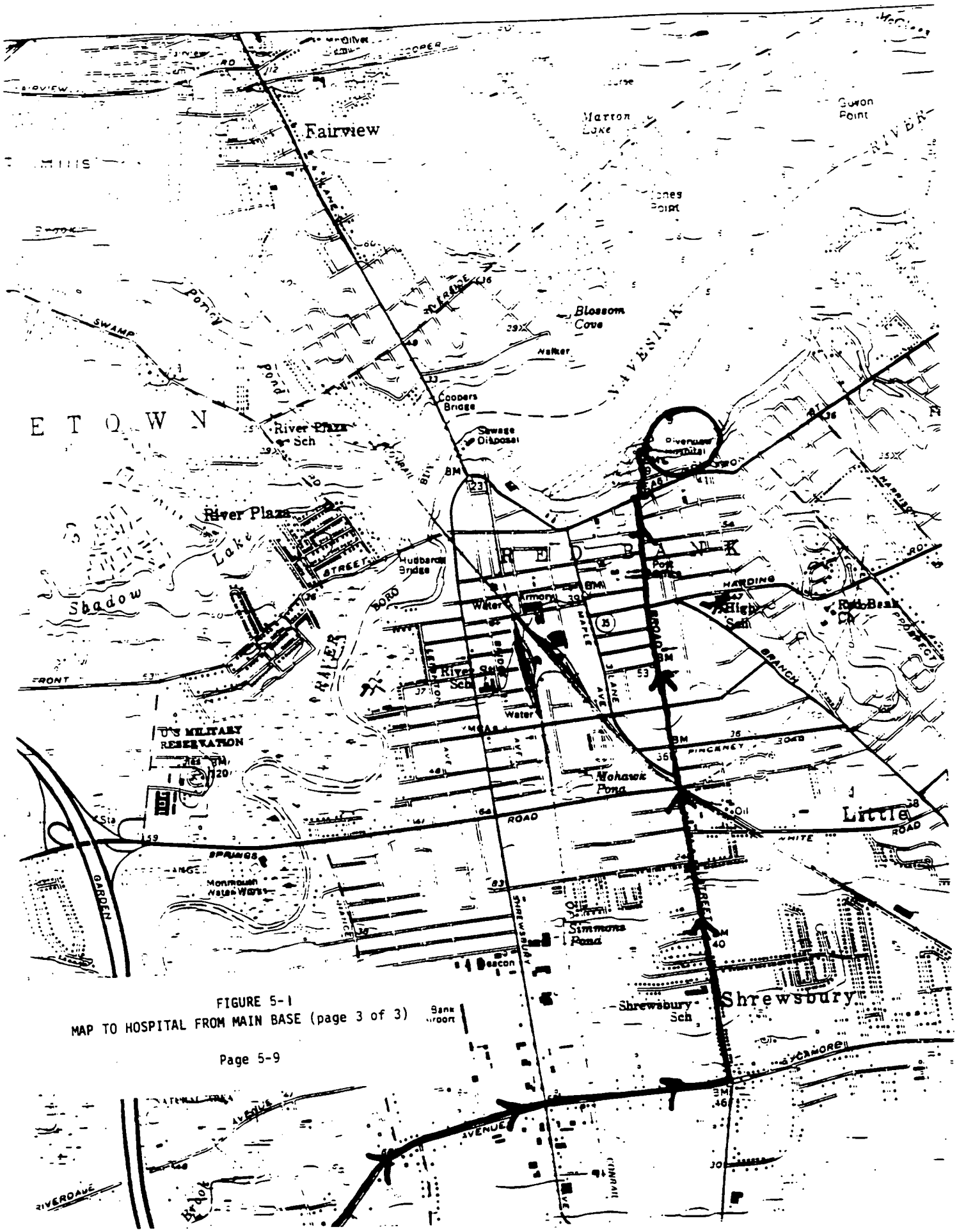

FIGURE 5-1
MAP TO HOSPITAL FROM MAIN BASE (page 3 of 3)

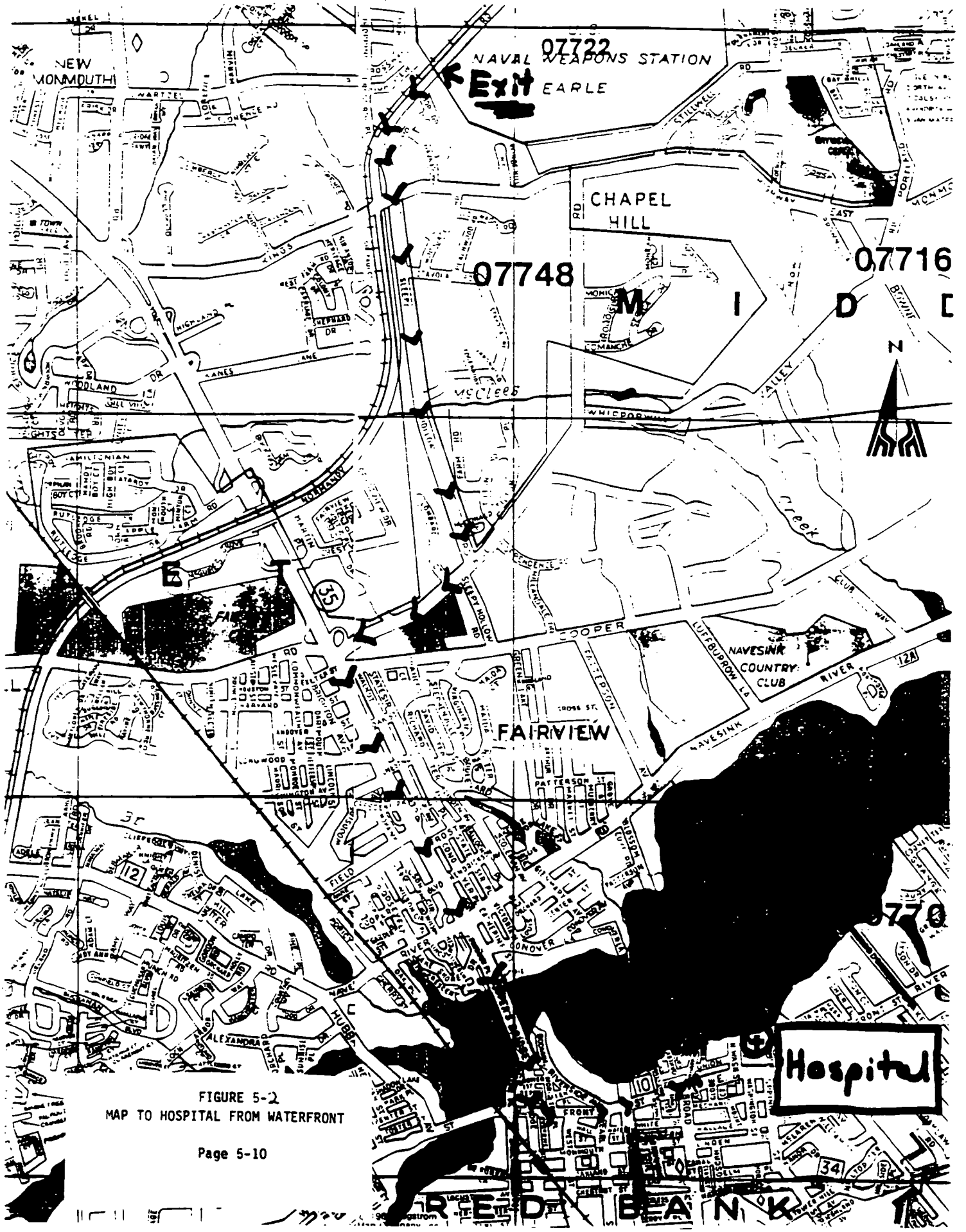

FIGURE 5-2
MAP TO HOSPITAL FROM WATERFRONT

6.0 PERSONAL PROTECTIVE EQUIPMENT

6.1 PPE REQUIREMENTS (GENERAL)

All personnel must wear, as a minimum, steel-toed/hard-soled work boots, long pants, and long-sleeve shirts while on site. Hard hats and side-shielded safety glasses must be worn if personnel are within 20 feet of heavy equipment operations or if other conditions exist where head protection or eye protection may be necessary. Ear plugs will be available should conditions dictate their use. Respiratory protection will be used as necessary in accordance with Table 6.1, Action Levels (page 6-2).

6.2 PPE REQUIREMENTS FOR WORKERS INVOLVED IN INTRUSIVE ACTIVITIES

All personnel involved in intrusive activities and who could come in contact with waste material are required to wear, in addition to the PPE listed above, standard Tyvek coveralls, Nitrile outer gloves, latex inner gloves, boot covers, and taped ankle and wrist seams. PVC coveralls will be required if free-phase product and/or heavily contaminated soil is encountered or if the potential for saturation of work clothes exists. Modification of PPE is at the discretion of the HSO. Respiratory protection will be in accordance with Table 6.1, Action Levels (page 6-2).

6.3 PPE REQUIREMENTS FOR WORKERS INVOLVED IN NON-INTRUSIVE ACTIVITIES

In addition to the general requirements specified in Section 6.1 above, surveying and reconnaissance personnel will wear surgical-style inner gloves and boot covers. Respiratory protection will be in accordance with Table 6.1, Action Levels (page 6-2).

6.4 RESPIRATORY PROTECTION

The need for respiratory protective equipment is not anticipated; however, if a respiratory hazard is identified by monitoring instrumentation, such protection must be utilized. Table 6-1 presents the action levels for upgrading or downgrading respiratory protection.

In addition, full-face air-purifying respirator (APR) with GMC-H cartridges will be worn if dry and dusty conditions exist. This determination will be made at the discretion of the HSO.

TABLE 6.1
ACTION LEVELS OF RESPIRATORY UPGRADES
NWS EARLE

Monitoring Device	Action Level	Action
Photoionization Detector (PID)	≤ Background	• Continue work
	> Background	• Monitor breathing zone
	Sustained readings greater than background in the breathing zone	• Leave the area and allow it to ventilate. • Return when levels return to background or upgrade to pressure-demand supplied-air respirator.
Flame Ionization Detector (FID)	≤ Background	• Continue work
	> Background	• Monitor breathing zone
	Sustained readings greater than background in the breathing zone	• Leave the area and allow it to ventilate. • Return when levels return to background or upgrade to pressure-demand supplied-air respirator.
LEL/O_2 Meter	< 10 percent LEL	• Continue work • Use non-sparking tools • Increase monitoring efforts
	> 10 percent LEL	• Evacuate the area
	< 19.5 percent or > 23.5 percent oxygen	• Pressure-demand supplied-air respirator

6.5 PPE MAINTENANCE AND STORAGE

Unused clothing is to be stored in the project vehicle in empty/clean coolers or in their original cartons. Respiratory equipment will be thoroughly cleaned by users after each use and stored in its original container in the project vehicle. Respirator face pieces must never be placed on the ground and must always be protected from physical damage.

6.6 TRAINING, INSPECTION, AND FITTING OF PPE

Site-specific training will include sufficient instruction on the proper use and inspection techniques of PPE. Personnel will be instructed on the importance of wearing the proper size of protective clothing. Various sizes of protective clothing will be present on site and available for use. Those persons who have not been respirator fit-tested within the past year will be fit-tested by the HSO prior to wearing respiratory protection.

6.7 PPE WORK MISSION DURATION

The majority of items of PPE will involve single-use-only procedures: The items will be discarded after each use. Therefore, the potential for exceeding appropriate work mission durations for these items is unlikely. Exceptions to this procedure include reusable items such as hard hats, safety footwear, and prescription eyewear. These items will undergo appropriate decontamination between uses and after use.

7.0 AIR MONITORING

7.1 TYPE AND FREQUENCY

The following instruments will be used to monitor air quality at both the potential source and in the worker's breathing zone:

- HNU P101, 11.7 eV probe
- OVA

At a minimum, monitoring with the HNu or OVA will be conducted 1) at the beginning of each task and frequently thereafter, 2) before entering a confined space, and 3) continuously when employees are inside a confined space.

The following instrument will be used periodically to determine explosive and/or oxygen-deficient atmospheres:

- LEL/Oxygen meter

At a minimum, this monitoring will be conducted before entering a confined space and continuously when employees are inside the confined space. Additionally, the monitoring will be performed at any location where flammable atmospheres could accumulate. These locations may include but are not limited to auger holes and shallow excavations.

Before an employee enters a confined space, the internal atmosphere will be tested in the following order:

1) Oxygen content
2) Flammable gases and vapors
3) Potential toxic air contaminants

S e Section 6.0 (table 6.1) for Action Levels and Respiratory Upgrades.

TLD badges will be worn by HNUS personnel.

7.2 METHODS OF MAINTENANCE AND CALIBRATION

All HNUS equipment maintenance and calibration efforts shall be conducted by Thomas Patton at the HNUS Pittsburgh warehouse facility. Additionally, daily field calibrations and operational checks will be conducted and documented by the HSO. These efforts shall be performed in accordance with the following HNUS Health and Safety Standard Operating Procedures (SOPs):

- No. ME01: Use, Calibration, and Maintenance of the HNU PI-101
- No. ME02: Use, Calibration, and Maintenance of the OVA 128 Organic Vapor Analyzer
- No. ME04: Use, Calibration, and Maintenance of the Oxygen Meter
- No. ME05: Use, Calibration, and Maintenance of the Combustible Gas Indicator

All subcontractor equipment maintenance and calibration efforts will be conducted by the HNUS subcontractor. These efforts will be performed in accordance with manufacturers' recommendations.

7.3 FIELD CALIBRATION

The HNu, OVA, and LEL/O_2 meter will be calibrated each day. The results of instrument calibration performed in the field must be recorded on Table 7.1 (page 7-3) and returned to the Health Sciences Department with the Site Health and Safety Follow-Up Report.

7.4 DIRECT-READING INSTRUMENT RESPONSE DATA

Any readings obtained through the use of direct-reading instruments must be recorded throughout the duration of project activities. This information is to be recorded on Table 7.2 (page 7-4) and returned to the Health Sciences Department with the Site Health and Safety Follow-Up Report at the conclusion of the project site activities. Any action taken as the result of air monitoring readings will be documented in the field logbook.

DRAFT

TABLE 7.1
DOCUMENTATION OF FIELD CALIBRATION

SITE NAME: NWS EARLE PROJECT NO.: 0155

Date of Calibration	Instrument Name and Model	HNUS Instrument I.D. Number	Person Performing Calibration	Instrument Settings		Instrument Readings		Calibration Standard (Lot Number)	Remarks/ Comments
				Pre-Calibration	Post-Calibration	Pre-Calibration	Post-Calibration		

DRAFT

TABLE 7.2
DIRECT-READING INSTRUMENT RESPONSE DATA

SITE NAME: NWS EARLE

PROJECT NO.: 0155

PAGE _____ OF _____

Date and Time(s)	Instrument Operator Name	Instrument Used	Instrument Reading and Duration	Location (e.g., borehole vs breathing zone)	Operation(s) Being Performed	Personnel in Vicinity at Time of Readings and Level of PPE Worn
Example 12-12-91/14:30	Joe Field	HNU 101	15 ppm/15 min.	breathing zone	sample location no. 12	Jim Technician/Level B George Grunt/Level B

DRAFT

TABLE 7.2
DIRECT-READING INSTRUMENT RESPONSE DATA
PAGE TWO

SITE NAME: NWS EARLE

PROJECT NO.: 0155

PAGE _____ OF _____

Date and Time(s)	Instrument Operator Name	Instrument Used	Instrument Reading and Duration	Location (e.g., borehole vs breathing zone)	Operation(s) Being Performed	Personnel in Vicinity at Time of Readings and Level of PPE Worn

8.0 MEDICAL SURVEILLANCE

8.1 REQUIREMENTS FOR HALLIBURTON NUS PERSONNEL

HNUS personnel whose work may require their presence in areas where potential exposures to hazardous materials exist shall participate in the HNUS medical monitoring program and must have a completed Medical Data Sheet (Exhibit 3). All medical examinations performed for HNUS personnel shall be conducted in accordance with OSHA General Industry Standards 29 CFR 1910.120 and 1910.134. This clears personnel for work with hazardous waste operations and the use of respiratory protective equipment.

8.2 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 8.1, page 8-3) can be used to satisfy this requirement, providing it is properly completed and signed by a licensed physician. Subcontractors shall have a company medical surveillance program meeting the requirements of paragraph (f) of 29 CFR 1910.120 and shall also submit a letter, on company letterhead, containing all of the information in the example letter presented as Figure 8.2. Figure 8.2 and Figure 10.1 can be combined into one letter.

EXHIBIT 3
MEDICAL DATA SHEET

This form must be completed by all on-site HNUS personnel and subcontractors, prior to the commencement of activities, and shall be kept in the site command post during site activities. This form must be delivered to any attending physician when medical assistance is needed.

Site _____

Name _____ Home Telephone (____) _____

Address _____

Date of most recent physical examination* ____/____/____

Age _____ Height _____ Weight ____

Name of next of kin _____ Telephone (____) _____

Drug allergies or other allergies _____

_____

Previous Illnesses or Exposures to Hazardous Substances:

_____

_____

Current Medication (prescription and non-prescription):

_____

_____

Medical Restrictions _____

_____

Name, address, and phone number of personal physician _____

_____

_____

*Confirmed by Site HSO _____ ____/____/____
Signature of HSO Date

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 _____ work site
   ( ) not qualified to perform work at the _____ work site

   and,

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

   ( ) qualified to work in respiratory protection
   ( ) not qualified to perform work in 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 employe '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:

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

_____

_____

_____

FIGURE 8.1
SUBCONTRACTOR MEDICAL APPROVAL FORM

Halliburton NUS CORPORATION

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 or 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 assignment task.

Physician's Signature _____
Address _____
Phone Number _____

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

_____
Address

FIGURE 8.1 (CONTINUED)
SUBCONTRACTOR MEDICAL APPROVAL FORM

Halliburton NUS CORPORATION

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

Ms. Jill Hartnell
Halliburton NUS Corporation
993 Old Eagle School Road, Suite 415
Wayne, Pennsylvania 19087-1710

Subject: Medical Surveillance
NWS Earle

Dear Ms. Hartnell:

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, Part 1910.120 entitled "Hazardous Waste Operations and Emergency Response." I further state that the persons listed below have had physical examinations under this program within the last 12 months and that they have been cleared, by a licensed physician, to perform hazardous waste site work and to wear respiratory protection. I also state that, to my knowledge, no person listed below has any medical restrictions that would preclude him/her from performing their assigned activities at the NWS Earle Site.

LIST EMPLOYEE NAMES AND DATES OF MOST RECENT PHYSICAL EXAMS HERE

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

Sincerely,

(Name of Company Officer)
Title

FIGURE 8.2
MEDICAL SURVEILLANCE LETTER

Halliburton NUS CORPORATION

9.0 DECONTAMINATION PROCEDURES

All employees and equipment leaving the work site must go through proper decontamination procedures.

Sp cific PPE Decontamination Procedures for Sampling Personnel

- Equipment drop
- Wash and rinse boot covers and outer gloves
- Remove tape (if worn)
- Remove SCBA harness assembly (if worn)
- Remove boot covers
- Remove coveralls
- Remove outer gloves
- Remove respirator (if worn)
- Remove inner gloves
- Hand and face wash
- Hand and face wipe with alcohol wipes

Decontamination of Sampling Bottles or Other Equipment

- Potable water rinse
- Alconox wash
- Tap water rinse
- Isopropyl alcohol rinse
- Distilled/deionized water rinse
- Allow to air dry

Material Safety Data Sheets (MSDS) for Alconox and isopropyl alcohol can be found in Appendix B and will be reviewed by all team members during site-specific training.

Decontamination Evaluation and Modification

- Any grossly contaminated reusable items (i.e., boot covers) that are not visibly cleaned via decontamination efforts are to be discarded.

- Discard and replace decontamination wash and rinse solutions when they become visibly discolored or otherwise noticeably affected.

- Screen employees with monitoring instruments before and after decontamination operations periodically.

D contamination and/or disposal procedures for decontamination equipment, solutions, or solvents shall follow Navy directions, to be determined by the Project Manager and implemented by the Field Team Leader.

10.0 TRAINING REQUIREMENTS

10.1 INTRODUCTORY AND REFRESHER TRAINING

10.1.1 Requirements for HNUS Personnel

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

Documentation of HNUS introductory and refresher training is specified on Table 10.1 (page 10-2) of this section.

In addition, the HNUS field operations leader is required to have completed an eight-hour supervisory training course.

All personnel participating in confined-space entry operations will receive thorough training in all aspects of their anticipated duties. See Section 12.0, Confined-Space Operations Training.

10.1.2 Requirements for Subcontractors

All HNUS 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 eight hours of refresher training meeting the requirements of 29 CFR 1910.120(e)(8) prior to performing field activities at NWS Earle. HNUS subcontractors must certify that each employee has had such training by sending HNUS copies of training certificates and a letter, on company letterhead, containing the information in the example letter provided as Figure 10.1 (page 10-3). Figures 10.1 and 8.2 can be combined into one lett r.

All personnel participating in confined-space entry operations will receive thorough training in all aspects of their anticipated duties. See Section 12.0, Confined-Space Operations Training.

10.2 SITE-SPECIFIC TRAINING

HNUS will provide site-specific training to all HNUS employees and HNUS subcontractors who will perform work on this project. This training will only be provided once, and personnel who do not attend will not be permitted to perform work at this project. Site-specific training will include the following:

- Names of personnel and alternates responsible for site safety and health
- Safety, health, and other hazards present on site
- Use of PPE
- 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 addenda
- The elements of the site emergency response plan
- Review of relevant MSDS for substances brought on site
- Confined-space entry procedures

This training will be documented using Figure 10.2 (page 10-4).

TABLE 10.1
PREVIOUS TRAINING RECORD

Name	Type(s) of Training Received	Date(s) Training Received
Jill Hartnell	40-Hour Introductory 8-Hour Refresher 8-Hour Supervisory	January 1990 April 1994 March 1991
	40-Hour Introductory 8-Hour Refresher 8-Hour Supervisory	
	40-Hour Introductory 8-Hour Refresher 8-Hour Supervisory	

Training records for additional HNUS personnel will be added as assignments are made.

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

Ms. Jill Hartnell, Project Manager
Halliburton NUS Corporation
993 Old Eagle School Road, Suite 415
Wayne, Pennsylvania 19087-1710

Subject: OSHA Compliance and Training
NWS Earle

Dear Ms. Hartnell:

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

I also understand that Title 29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response," requires, but is not limited to, medical surveillance, for applicable employees, and appropriate level of training as required in paragraph (e) of 29 CFR 1910.120 for employees engaged in certain hazardous waste operations. I hereby state that I have reviewed these requirements; that I understand Title 29 of the CFR, Parts 1900 through 1910, and Part 1926; and that XYZ Corporation and all of its employees who will perform work at NWS Earle are in full compliance.

The following employees have had 40 hours of introductory hazardous waste site training or equivalent work experience as required by 29 CFR 1910.120(e) and have had eight hours of refresher training as required by 29 CFR 1910.120(e)(8).

LIST EMPLOYEE NAMES, TYPE(S) OF TRAINING RECEIVED, AND DATES OF TRAINING HERE

Sincerely,

(Name of Company Officer)
Title

FIGURE 10.1
OSHA COMPLIANCE LETTER

Halliburton NUS CORPORATION

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

Ms. Jill Hartnell, Project Manager
Halliburton NUS Corporation
993 Old Eagle School Road, Suite 415
Wayne, Pennsylvania 19087-1710

Subject: OSHA Compliance and Training
NWS Earle

Dear Ms. Hartnell:

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

I also understand that Title 29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response," requires, but is not limited to, medical surveillance, for applicable employees, and appropriate level of training as required in paragraph (e) of 29 CFR 1910.120 for employees engaged in certain hazardous waste operations. I hereby state that I have reviewed these requirements; that I understand Title 29 of the CFR, Parts 1900 through 1910, and Part 1926; and that XYZ Corporation and all of its employees who will perform work at NWS Earle are in full compliance.

The following employees have had 40 hours of introductory hazardous waste site training or equivalent work experience as required by 29 CFR 1910.120(e) and have had eight hours of refresher training as required by 29 CFR 1910.120(e)(8).

LIST EMPLOYEE NAMES, TYPE(S) OF TRAINING RECEIVED, AND DATES OF TRAINING HERE

Sincerely,

(Name of Company Officer)
Title

FIGURE 10.1
OSHA COMPLIANCE LETTER

Halliburton NUS CORPORATION

11.0 EMERGENCY RESPONSE PLAN (ERP)

Through the course of site activities, potentials for emergency response efforts exist. Pre-emergency planning (such as determining and/or verifying appropriate off-site emergency response agencies) is the responsibility of the site HSO. Emergency reference information is included in Site Standard Work Practices (Section 5.0) of this HASP. The site HSO is also responsible for determining and documenting the following information, upon arrival at NWS Earle, prior to the initiation of any field activities and for communicating these requirements to all affected site personnel.

In the event of any on-site emergencies (i.e., fires, significant spills or releases, etc.), site personnel shall be immediately evacuated to a predetermined safe place of refuge and shall notify the HNUS Project Manager (Jill Hartnell) and the HSM (Matthew M. Soltis) and appropriate response agencies. In view of this approach, this section of the HASP 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)].

11.1 EMERGENCY ESCAPE PROCEDURES AND ESCAPE ROUTE ASSIGNMENTS

Emergency escape routes and safe places of refuge shall be identified and established for each of the work site locations and communicated to all affected personnel prior to task initiation. When these routes and locations are designated, consideration shall be given to factors such as accessibility, prevalent and/or existing wind speed and direction, distance from potentially affected areas, etc. The information shall be modified, if necessary, as work progresses. Any such modifications shall be effected by the site HSO.

11.2 PROCEDURES TO BE FOLLOWED BY PERSONNEL WHO MUST REMAIN ON SITE TO OPERATE ANY CRITICAL OPERATIONS BEFORE EVACUATING

In the event of an emergency, all personnel at the work site are to immediately report to the designated safe place of refuge via the identified primary (or secondary) emergency escape routes indicated by the site HSO. At the time of this ERP preparation, it is not anticipated that any personnel will need to remain at their work site to maintain any critical operations. If this condition should change, the site HSO shall identify the personnel and their responsibilities in this regard and amend this plan accordingly. Any such modifications must be communicated to the HNUS HSM for concurrence.

11.3 PROCEDURES TO ACCOUNT FOR ALL PERSONNEL FOLLOWING AN EVACUATION

In the event that an emergency evacuation is effected during the course of site work at any of the site areas, personnel shall immediately report to the designated refuge location and remain there. The HSO, assisted by the FTL, shall conduct a roll call (using the site logbook) to account for all personnel to ensure that a total work site evacuation has taken place. The FTL shall be responsible for concurrently initiating the emergency communication procedures (notifying NWS Earle personnel). If/when all personnel have been accounted for, an evaluation of the event that led to the evacuation shall be conducted to determine if work is to be resumed (and, if so, under what conditions - if any) or if personnel are to go through any necessary decontamination efforts and leave the site. This evaluation is to be performed by the site HSO, with assistance from the FTL and guidance from the HNUS HSM and appropriate Navy personnel. Under no circumstances are workers to depart from the refuge location until so directed.

If the roll call identifies that any personnel are not accounted for, this information shall be immediately communicated to the emergency response agency upon their arrival. This information is to be supplemented with any additional information available that 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.

11.4 RESCUE AND MEDICAL DUTIES

Site personnel are not authorized to participate in rescue and first aid procedures. However, any personnel present who are trained to perform emergency first aid activities may perform these functions if needed. Any such personnel are identified below:

	Name	Trained In	Certified by	Expiration Dat of Certification
1.				

Any use of first aid equipment must be documented on the attached First Aid Supply Usage Form (page 11-3).

FIRST AID SUPPLY USAGE FORM

Project Number	Date	Item(s) Used	Kit Number

Please submit this form as soon as possible to the HNUS Equipment Manager for first aid supply replenishment.

11.5 EMERGENCY REPORTING PROCEDURES

Upon arrival at the work site, prior to the initiation of any field activities, the site HSO shall obtain the information specified on the attached Emergency Reference and American Red Cross First Aid forms and post copies of these near all on-site telephones (Exhibits 1 and 2 in Section 5.0).

Emergency reporting functions shall be the responsibility of the FTL. The FTL 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 response assistance is necessary, the FTL shall contact the appropriate Navy 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 that may be encountered in response efforts

If off-site emergency response is needed, those agencies will be contacted as directed by Navy personnel.

On-site emergency event coordination efforts (i.e.,controlling the affected areas, accounting for site personnel, etc.) shall be the responsibility of the HNUS site HSO, until/unless relieved of these duties by the arrival of Navy personnel or appropriate off-site emergency response personnel.

11.6 SITE EMERGENCY ALARM SYSTEM

Work areas are anticipated to consist of small areas where all personnel are within visible and audible range of each other and will therefore not need any special alarm systems as long as verbal communication is not hampered.

11.7 ERP INITIAL TRAINING AND REFRESHER TRAINING

All site personnel shall be trained in the contents of this ERP as part of the initial site-specific health and safety training. All site visitors shall be informed of restricted areas, emergency communication signals, refuge location, and other safety requirements. Site visitors must be escorted by HNUS or Navy personnel at all times. Any visitors must also be entered in the site logbook so they can be accounted for in the event of any evacuations.

Refresher training on emergency response shall also be conducted for site personnel if employees' responsibilities or designated actions under the plan change or if the contents of this plan are changed.

12.0 CONFINED-SPACE OPERATIONS

This section presents the written Permit-Required Confined-Space Program for NWS Earle, Colts Neck, New Jersey, interceptor trench installation.

Workplace

Excavations

Potential Hazards

- Presence of toxic gases: The main contaminants of concern in the soil are fuel oil and bromoform. Other contaminants could include 1,2-dichloroethane and methylene chloride. See Section 4.0 of this HASP for toxicological information.

- Oxygen deficiency: In the presence of other vapors and gases, oxygen is often displaced. Due to the potential contamination of soils and the possible presence of toxic gases, there is the potential for this hazard.

- Engulfment via cave-in of excavations.

- Engulfment via water in excavation.

Permits

- Confined-Space Entry Permit: All excavations greater than five feet deep shall be considered permit-required confined spaces. The confined-space entry permit (page 12-5) must be completed before approval can be given to enter a permit-required confin d space. This permit verifies completion of items listed below and shall be kept accessible to workers at the job site for the duration of the job. At the completion of the job, the HSO will submit this permit to Marcia Case and it will be reviewed after one year.

Training

All personnel involved in confined-space entry operations will receive the training necessary to perform their assigned duties. This training will comply with the requirements specified in 29 CFR 1910.146 Permit-required confined spaces. Documentation of this training will be generated and then maintained at the job site.

Attendant Responsibilities

Th attendant will be stationed outside the confined space and is required to monitor the entrants for signs of exposure and potential physical harm. If necessary, the attendant will be responsible for ordering an evacuation of the space, summoning rescue services, and refusing unauthorized entrants. Unless relieved by another attendant, the attendant must remain outside the permit space during entry operations. The name of this attendant will be given on the permit.

Entry Supervisor Responsibilities

Th entry supervisor will be responsible for accurately completing the entry permit and verifying that all pre-entry conditions have been met prior to approving the entry itself. If necessary, the entry supervisor will remove unauthorized individuals during confined-space entry operations. In addition, it is the responsibility of the entry supervisor to terminate the entry and cancel the permit if an unacceptable condition develops or if the operation has been completed. The entry supervisor will be named on the permit.

Authorized Entrant Responsibilities

The authorized entrants will be responsible for proper equipment use, communicating with the attendant, alerting the attendant of unacceptable conditions, and, if necessary, exiting the confined space when ordered by the attendant. Authorized entrants will be named on the permit.

Authorization

The FTL will act as the entry supervisor and may authorize an employee to enter a confined space. It is the FTL's responsibility to complete the confined-space entry permit and to verify that pre-entry testing has been performed prior to endorsing the permit. The FTL shall terminate the entry and cancel the entry permit if an unacceptable condition arises in or near the permit space or when entry operations have been complet d.

Atmospheric Monitoring

Entrants will be trained in the use and interpretation of the atmospheric monitoring equipment that will be used. Monitoring for oxygen deficiency, explosive/flammable gases, and toxic gases will be conducted prior to entry and continuously during entry. A written record of this monitoring will be maintained at the work site.

Secure the Area

Cones or flagging tape will be used to identify an area where a confined-space entry is being performed. The attendant will police the area to identify additional external hazards that could affect the safety of entrants. These hazards will be eliminated prior to entry. In addition, cones, flagging tape, signs, and barricades will be used to identify unattended open excavations.

Ventilation

If pre-entry monitoring indicates the presence of an unacceptable atmosphere, the permit-required confined space will be ventilated for 10 minutes prior to entry. A mechanical blower will be used to provide outside air. Entry may not begin until testing has demonstrated the condition of the atmosphere and appropriate controls for entry have been determined. If required for entry, ventilation of the space will continue until the entry is terminated.

Illumination

If a potentially explosive atmosphere is indicated, lighting equipment shall be intrinsically safe.

Personal Protective Equipment

Please refer to Section 6.0 of this HASP.

Entry Procedures

- The following procedure shall be observed when pre-entry testing demonstrates an acceptable atmosphere within the confined space:

All entry personnel must be trained. The attendant shall stand by the top of the space ready to give assistance. A body harness with an attached lifeline shall be used by all workers entering a space greater than five feet deep. If at any time monitoring instruments indicate an unacceptable atmosphere, all entrants will evacuate the space. If there is any questionable action or non-movement by the entrant, a verbal check will be made. If th re is no response, the entrant will be removed immediately.

- The following procedure shall be used when pre-entry testing demonstrates a toxic or oxygen-deficient atmosphere within the confined space:

  All personnel involved with the confined-space entry must be trained. The attendant shall stand by the top of the excavation ready to give assistance, and an additional rescue person shall be within close proximity. A body harness with an attached lifeline shall be used by all workers entering the space. The entrant will utilize a positive pressure-demand air-line respirator with a five-minute escape air supply device (MSA Hip-Air). The entrant will descend into the space.

- In addition to the procedures outlined above, the following procedures shall be observ d when flammable/explosive conditions exist:

  If LEL levels are greater than zero but less than 10 percent, all lighting and electrical equipment shall be Class 1, Division 1, rated per National Electric Code. No ignition sources shall be introduced into the area.

  If LEL levels are greater than 10 percent, employees shall not enter the space. Entrants who are inside when this condition develops shall immediately exit the space.

Rescue

All entrants into excavations that are greater than five feet deep are required to be tethered to a lifeline. In the event of an emergency, this lifeline will be used to extract entrants. All employees shall be trained in the use of this retrieval equipment. Caution must be used during rescue activities. Emergency services will be summoned if needed. Please refer to Exhibit 1 (page 5-4). The attendant must be able to notify emergency services without abandoning his/her post. This will be accomplished by providing the attendant with radio communications to the command post or by having an additional stand-by person who is capable of summoning help.

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CONFINED SPACES ENTRY PERMIT

①	LOCATION OF CONFINED SPACE	DATE/TIME:
	PURPOSE OF ENTRY	DURATION:
	AUTHORIZED BY	EXPIRES ON:
	ATTENDANT(S)	

② AUTHORIZED ENTRANTS (LIST OTHERS ON BACK OF FORM)

③

• MEASURES FOR ISOLATING & EQUIPMENT •	YES	NO	• MEASURES FOR ISOLATING & EQUIPMENT •	YES	NO
Lock Out — De-Energize — Tag-Out Equipment			Self-Contained Breathing Apparatus (SCBA)		
Line(s) Broken — Capped — Blanked			Air-Line Respirators w/Emergency-Escape Capability		
Purge — Flush and Vent			Air-Purifying Respirators and Cartridges		
Ventilation			Resuscitator/Inhaler		
Secure Area (Post and Flag)			Communications Equipment		
Full Body Harness w/"D" Ring			Protective Clothing		
Tripod Emergency Escape Unit			Head/Eye/Hearing Protection (circle type(s))		
Lifelines			Hot Work Permit Required		
Fire Extinguishers					
Lighting (Explosion-Proof)					

ATMOSPHERE MONITORING

④

TEST(S) TO BE TAKEN	YES	NO	Acceptable Entry Conditions (Circle Appropriate Level) TLV*	PEL**	—	Test # / DATE / —.M.	1 DATE —.M.	2 DATE —.M.	3 DATE —.M.	4 DATE —.M.	5 DATE —.M.	6 DATE —.M.	7 DATE —.M.	8 DATE —.M.
Oxygen			19.5-23.5%											
Combustible Gas			Below 10% LEL			S								
Carbon Monoxide			0-25 PPM	0-50 PPm		A								
Hydrogen Sulfide			0-10 PPM	0-10 PPM		M								
Hydrogen Cyanide			0-10 PPM	0-10 PPM		P								
Sulfur Dioxide			0-2 PPM	0-5 PPM		L								
						E								

Individual Conducting Test (name) _____

Any questions pertaining to test requirements, contact _____

⑤

• INSTRUMENTS USED •	• NAME •	• TYPE •	• IDENTIFICATION NO. •

• STANDBY PERSON(S) •	
YES ☐	
NO ☐	

FOR RESCUE & EMERGENCY SERVICES CALL _____

ENTRY SUPERVISOR AUTHORIZING ALL ABOVE CONDITIONS SATISFIED _____

LEL = Lower Explosive Limit PPM = Parts-Per-Million

* As listed in 1992-93 Threshold Limit Values published by American Conference of Governmental Industrial Hygienists

** Permissible Exposure Limits as listed in OSHA 29CFR 1910.1000

13.0 FIELD TEAM REVIEW

Must be signed by each field team m mber prior to the site visit.

I have read and understand the contents of this HASP and will comply with its provisions, requirements, and restrictions.

Site: NWS EARLE

Name (PRINT)	Signature	Date

14.0 SPILL CONTAINMENT PROGRAM

Due to the nature of planned activities, the occurrence of a significant spill event (e.g., more than 55 gallons) is considered to represent minimal potential. However, employees will be instructed in th following:

In case of an accidental spill, notify the on-site Emergency Personnel in the NWS Earle fire department at (908) 866-2333 for the Mainside Base and (908) 866-7133 for the Waterfront. This department will respond themselves or make the necessary arrangements. The FTL shall activate, if necessary, the Emergency Response Plan specified in the HASP (Section 11.0).

15.0 SITE CONTROL

Work zones will be delineated for each of the site ar as included in this effort. The HSO is responsible for delineating these zones based on site conditions. HNUS will designate and utilize these work zones in conjunction with proper decontamination procedures to prevent the spread of contaminants into previously unaffected areas of the site. It is anticipated that a three-zone approach will be used during work at this site: exclusion zone, contamination reduction zone, and support zone. Figures in Section 2 show the individual site layouts. These figures may be used by the HSO to aid in determining appropriate work zones at each site.

15.1 EXCLUSION ZONE

The exclusion zone (EZ) will be considered those areas of the site of known or suspected contamination. The EZs for this project will be limited to those areas where active work is being performed and/or anywhere there is believed to be the potential for exposure to site contaminants. Where appropriate, EZs will be designated as the actual work area, minimizing their size. For example, the work area in the immediate vicinity of a drill rig (approximately a 20-foot radius around the rig) will commonly be established as an EZ.

No one may enter or perform work in an established EZ unless they satisfy all medical surveillance and training requirements and they are properly outfitted in the appropriate PPE.

15.2 CONTAMINATION REDUCTION ZONE

A contamination reduction zone (CRZ) will be established as a buffer area between the designated EZs and any areas of the site where contamination is not suspected. CRZ locations will be established at the p rimeter of the EZ locations. The heavy equipment decontamination area established for this project will be designated and established as a separate CRZ.

15.3 SUPPORT ZONE

The support zone for this project will be established at areas of the site where exposure to site contaminants would not be expected during normal working conditions or foreseeable emergencies.

The support zone will be the area where the site command post (i.e., site trailer) is positioned and where supplies and equipment are maintained.

15.4 SITE RESTORATION

Once site work has been completed, the FTL and HSO will assure that the work areas have been cleaned and reclaimed and are suitable for passage of the general public.

APPENDIX 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 each site visit.

Person responsible for follow-up report: _____

Actual date(s) of work: _____

1. **Actual Project Team:**

Halliburton NUS Personnel	Discipline/Tasks

Non-Halliburton NUS Personnel	Discipline/Tasks

2. **P rsonal Prot ctive Equipment Used:**

• Level of Respiratory Protection Used	Activity

• Field Dress	Activity

3. **G n ral Safety**

Were any health or safety problems encountered while on site?

Explain: _____

4. Incident R port Informati n

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 Health and Safety Plan adequate? _____ Yes _____ No

What changes would you recommend?

_____

_____

_____

_____

_____

FIRST AID SUPPLIES USAGE FORM

Project Number	Date	Item(s) Used	Kit Number

Please submit this information as soon as possible to the HNUS/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 Number	Satisfactory Checkout (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

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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 at 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 of 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 Exposure	_____ Faint/Dizziness
_____ Bites		_____ Toxic Respiratory
_____ Respiratory Allergy	_____ Toxic Ingestion	_____ Dermal Allergy

Part of the 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):

L vel of personal protective equipment required by 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, if required)

Witnesses to accident: _____

_____

_____

Signature of Preparer _____

Signature of Site Manager _____

3. **Department Appraisal and Recommendation**

In your opinion, what actions or equipment contributed to this accident?

_____

_____

_____

Your recommendation:

_____

_____

_____

Date: _____ Signature of Department Manager _____

4. **C sts f th Incid nt (to be c mpl t d by Health Sci nc s D partment)**

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		Name and Address	
of Hospital	_____	of Physician	_____
	_____		_____

cc: Office Health and Safety Supervisor
Administrative Manager
Manager of Health Sciences
Medical Consultant

DRAFT

INCIDENT FOLLOW-UP REPORT

(To b C mpl ted by H alth Sci nces Departm nt)

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 Services
Medical Consultant

APPENDIX B

MATERIAL SAFETY DATA SHEETS

Appendix B

ORIGINAL
IN N.M.

Hardwell

FIELD SAMPLING PROCEDURES MANUAL

State of New Jersey
JIM FLORIO
GOVERNOR

New Jersey Department of Environmental Protection and Energy

SCOTT WEINER
COMMISSIONER

May 1992

May 1, 1992

Dear Citizen,

I am pleased to present the latest edition of the NJDEPE Field Sampling Procedures Manual. This document is the department's most recent effort to provide technical guidance to the regulated community regarding environmental sampling and compliance monitoring activities. The manual represents our commitment to be fair, predictable, technically consistent and responsive in all our dealings with the public.

Until now, the department has published two separate sampling manuals -- one for hazardous waste programs and one for water data acquisition. Beginning with this edition, technical guidance for both programs will be provided in one document. This approach for technical guidance on how to comply with regulations will promote greater consistency in sample collection and will enhance the department's ability to evaluate sample results.

The recommended procedures have been placed in one document so that those of you who prepare sampling plans -- contractors, engineers, planners and facility operators -- are clear about what is expected of you. The manual includes comprehensive analytical tables, detailed descriptions of sampling techniques and information on the equipment necessary to get the job done. I present this to you knowing that each project contains variables that must be factored into a final site specific sampling plan, but I believe that your use of this technical reference will make you more confident when presenting the sampling portion of a project plan for the department's review.

The success of this manual rests on how well you and the department evaluate it. I encourage you to let my staff know how well it works for you and to contribute ideas on ways to improve it. I trust you will find it a useful tool in dealing with the technically complex nature of your work.

Sincerely,

Scott A. Weiner
Commissioner

In addition to the above considerations, the requirements of the New Jersey Pollution Discharge Elimination System (NJPDES) must be followed for all discharges to ground water and stormwater. The NJPDES Program requires the issuance of a permit for these discharges.

It is preferable to complete discharges of development, purge, and decon waters at a single, known contaminated area on-site. This area will be selected by the NJDEPE. In cases where such an area cannot be located, as with contaminated well field projects, discharges will occur as close to the well or sampling location as reasonably possible.

D. PROCEDURES FOR QUALITY ASSURANCE AND QUALITY CONTROL (QA/QC)

QA/QC samples are intended to provide control over the collection of environmental measurements and subsequent validation, review, and interpretation of generated analytical data. The various types of blank samples currently used by the NJDEPE and related QA/QC concerns such as packaging, handling, preparation and actual procurement of samples from field locations are discussed below.

The trip blank is used exclusively for volatile organic analysis (aqueous sampling only) and its purpose is to measure possible cross contamination of samples during shipping to and from the site. The trip blank is never opened and travels to the site <u>with</u> the empty sample bottles and back from the site <u>with</u> the collected samples in an effort to simulate sample handling conditions. Contaminated trip blanks may also indicate inadequate bottle cleaning or blank water of questionable quality.

The primary purpose of this type of blank is to detect additional sources of contamination that might potentially influence contaminant values reported in actual samples both quantitatively and qualitatively. The following have been identified as potential sources of contamination.

- Laboratory reagent water
- Sample containers
- Cross contamination in shipment, bottle handling and storage
- Ambient air or contact with analytical instrumentation during preparation and analysis at the laboratory
- Laboratory reagents used in analytical procedures

The purpose of a field blank is to place a mechanism of control on sample equipment handling, preparation, storage, and shipment. The field blank travels and is stored with the samples bottles, and is also representative of bottle shipment effects on sample quality. By being opened in the field and transferred over a cleaned sampling device (where applicable), the field blank is indicative of ambient conditions and/or equipment conditions that may potentially affect the quality of the associated samples.

The primary purpose of this type of blank is to provide an additional check on possible sources of contamination beyond that which is intended for trip blanks. A field blank serves a similar purpose as a trip blank regarding blank water quality and sample bottle preparation. However, it is primarily used to indicate potential contamination from ambient air as well as from sampling instruments used to collect and transfer samples from point of collection into sample containers (it may also be referred to as the field rinsate blank).

The following is a breakdown by matrix of blank sample requirements.

1. NON-AQUEOUS MATRIX

a. Field Blanks

i. Description - The performance of field blanks requires two (2) sets of <u>identical</u> bottles; one set filled with demonstrated analyte free water provided by the laboratory performing the sample analysis, and one empty set of bottles. The bottles should also be identical to those provided for aqueous sample collection. Note: Since field blanks are aqueous, the lab must provide water for volatile analysis in 40 ml septum vials. Although for <u>soil VOA sample</u> collection the lab may provide 4 oz wide mouth bottles. At the field location, in an area suspected to be contaminated, the water is passed from the full set of bottles through the dedicated or field decontaminated sampling device(s) and into the empty set of bottles. This will constitute identical bottle to bottle transfer. <u>Field blanks must be preserved in the same manner as samples and only need to be collected and analyzed for volatile organics when volatile organics constitute a parameter being</u>

investigated. On a site specific basis, QA parameter requirements may be amended at the discretion of NJDEPE. Note: for logistical purposes it is recommended that the lab provide at least one extra full 40 ml vial to perform the field blank.

ii. Frequency - For sampling events lasting more than one day, field blanks for the non-aqueous matrix should be performed at a rate of 10% of the total number of samples collected throughout the event. If, for example, 40 samples were to be collected over a six day period, then only four field blanks would be required. For one-day sampling events, with the total number of samples collected being less than 10, it is required that one field blank be collected. On a site specific basis, QA frequency requirements may be amended at the discretion of NJDEPE. However, it is not necessary to collect more than one field blank per day.

b. Trip Blanks

TRIP BLANKS ARE NOT REQUIRED FOR THE NON-AQUEOUS MATRIX unless specifically requested for Special Analytical Services (SAS) by NJDEPE.

2. Aqueous Matrix

a. Field Blanks

i. Description - Same as a.1. above with one exception: Field blanks must be analyzed for all the same parameters as samples collected that day.

ii. Field Blanks are generally not required for potable well sampling events or when a sample is collected directly from a source into a sampling container.

iii. Field Blanks may be required to detect cross contamination from ambient air during potable sampling events if known sources of contamination are within close proximity or monitoring instruments indicate the presence of contamination above background levels.

iv. Frequency - Field blanks for the aqueous matrix must be performed at a rate of one per day.

b. Trip Blanks

i. Description - Trip blanks are required for aqueous sampling events. They consist of a set of sample bottles filled at the laboratory with laboratory demonstrated analyte free water. These samples then accompany the bottles that are prepared at the lab into the field and back to the laboratory, along with the collected samples for analysis. These bottles are never opened in the field. Trip blanks must return to the lab with the same set of bottles they accompanied to the field. At a minimum trip blanks must be analyzed for volatile organic parameters. The inclusion of additional parameters or amendments to the requirements for trip blanks is at the discretion of NJDEPE. Trip blanks and associated samples shall not be held on site for more than two (2) calendar days.

ii. Frequency - Trip blanks must be included at a rate of one per sample shipment (not to exceed two (2) consecutive field days).

3. Air Matrix

Trip and field blank procedures and frequencies for the various air sampling methods available should follow the specifications of the individual analytical method utilized. QA sample requirements may be amended at the discretion of NJDEPE.

4. Blank Water Quality

The demonstrated analyte free water used in the field and trip blanks must originate from one common source and physical location within the laboratory and must be the same as the method blank water used by the laboratory performing the specific analysis. The use of commercially prepared water or water not originating from the laboratory analyzing the samples is not permitted. An exception to this requirement is allowable if:

1. it is the same water used for method blank analysis,
2. the laboratory has analyzed that water and generated data from a specific batch/lot of containers,
3. the blank sample is drawn from an unopened container from the same batch/lot thus documenting the water is free of contaminants (demonstrated analyte free).

a. Duplicate Samples Obtained in the Field

Collection of duplicate samples provides for the evaluation of the laboratory's performance by comparing analytical results of two samples from the same location. Duplicate samples are to be included for each matrix at a minimum rate of one for every twenty samples (5% of total) and be submitted to the lab as "blind" samples. If less than twenty samples are collected during a particular sampling episode, one duplicate should be performed. Duplicate requirements may be waived or expanded depending on the particular regulatory program or remedial phase involved.

i. Aqueous Matrix Duplicates

Duplicates of water samples (potable well, monitor well, surface water) should be obtained by alternately filling sample containers from the same sampling device for each parameter. Samples for volatile organics analysis from monitor wells should be filled from the same bailer full of water whenever possible and be the first set of containers filled. When other sampling devices are used, the vials for volatile organics should be alternately filled. If heterogeneity is suspected, separate samples of each phase should be collected as the nature of phased liquids precludes homogenization. It is generally not necessary to homogenize ground water or surface water samples.

ii. Non-Aqueous Matrix Duplicates

Obtaining duplicate samples in a soil or sediment matrix requires homogenization of the sample aliquot prior to filling sample containers. Regardless, volatile organic samples must always be taken from discrete locations or intervals without compositing or mixing. This practice is necessary to prevent loss of volatile constituents and to preserve, to the extent practicable, the physical integrity of the volatile fraction (see Chapter 7. "Sample Collection", Section B."Soils" for further information on the procedures for collecting volatile organics). Homogenization of the sample for remaining parameters is necessary to generate two equally representative samples. Note that enough sample must be collected at one time in order to fill all the necessary sample containers. It may be necessary to co-locate or depth integrate collection so enough sample volume is available. A description of this process should be provided in the sampling plan. Moisture content, particle size, and adsorption properties of various soils, sediments, and waste materials may inhibit the ability to achieve complete mixing prior to filling sample containers.

Homogenization should be accomplished by filling a properly decontaminated stainless steel tray or bowl with the sample and mixing it with a decontaminated stainless steel or Teflon R instrument. The extent of mixing required will depend on the nature of the sample and should be done to achieve a consistent physical appearance prior to filling sample containers.

Once mixing is completed the sample should be divided in half and containers should be filled by scooping sample material alternately from each half.

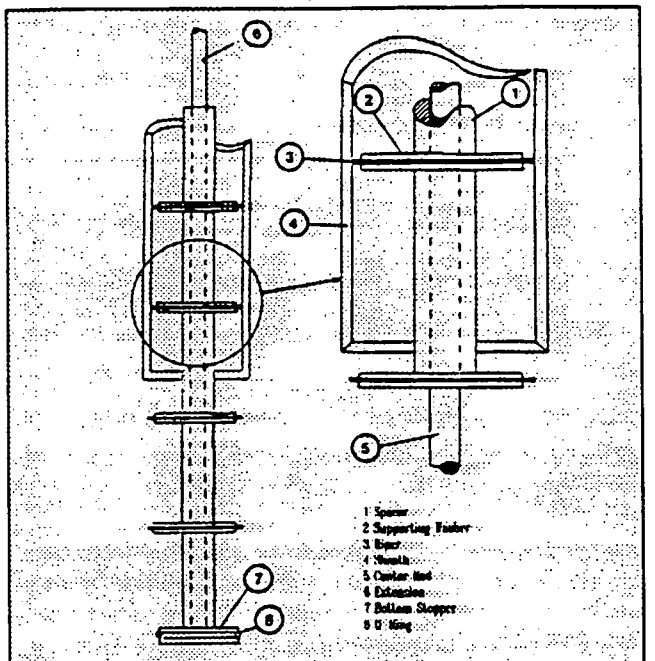
Several laboratory methodologies for compositing samples published by the American Society for Testing and Materials (ASTM) have been suggested for use in the field; however, they were not specifically designed for homogenization of known or suspected hazardous materials and often must be "modified" to be useful. They tend to assume a uniform sample exists to begin with and their intent may be to calculate average grain size, predict weight to volume ratios, or to reduce the size of a sample to one more convenient for handling and analysis. They also tend to assume a much larger volume of material will be subject to the particular methodology. Therefore, these methods are not recommended for generating duplicate samples in the field.

b. Splitting Samples with Responsible Parties

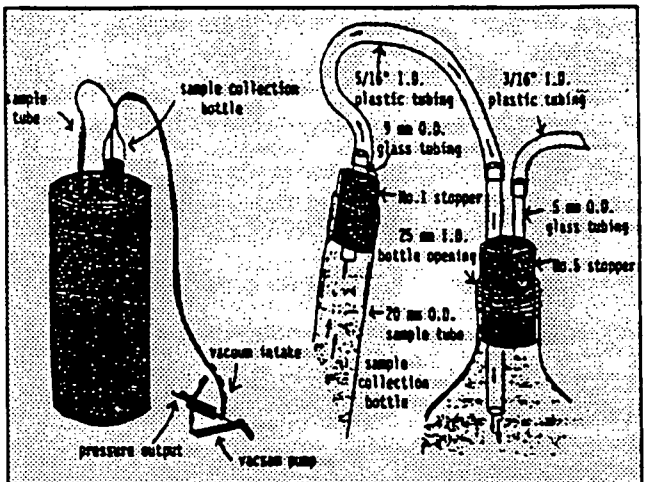
When various sites are under investigation, property owners and other interested parties may desire to obtain samples for analysis which are duplicates of those obtained by NJDEPE personnel or contractors. If this becomes necessary, procedures for obtaining duplicate samples described above should be followed.

In order to maintain the integrity of any sample "split" between interested parties, the following procedures shall be followed:

i. Personnel authorized by NJDEPE (e.g. contractors or treatment facilities) using approved NJDEPE sampling methods shall be permitted to obtain all sample aliquots.



STRATIFIED SAMPLE THIEF
FIGURE 6-15



VACSAM
FIGURE 6-16

d. Vacsam

The Vacsam system is a liquid waste sampling device (Figure 6-16) that utilizes a sample tube attached to a vacsam pump. When the pump is operated with the foot, the sample is transferred from its original container to a sample container.

Procedures for Use

i. Assemble vacsam sampler, attaching tubing to pump and sample bottle.
ii. Pump desired volume directly from container into laboratory cleaned sample bottle(s).
iii. Follow procedures for preservation and transport (see Chapter 2. "Quality Assurance").

Advantages

- ease and speed of operation
- can sample discrete layers in a multi-phase waste

Disadvantages

- usually only samples from a single phase in a multi-phase sample

C. NON-AQUEOUS SAMPLING EQUIPMENT

Sampling of non-aqueous matrices encompasses several different types of wastes; from solids in drums and containers to soils and sludges. There are many factors involved when choosing the proper sampling equipment for these materials.

The most important aspect of sampling is to get a representative sample of all horizons present. An attempt must also be made to maintain sample integrity by preserving its physical form and therefore its chemical composition. The use of proper sampling equipment can accomplish these goals.

This section is divided into three subparts: soils, sediment/sludges and containerized solids/waste piles. The three subparts deal with samplers designed for the specific materials involved.

1. Soils

Soil sampling is performed for a number of reasons. These include: determination of contamination in soils, possibility of contamination of ground water and determination of extent of contamination. Soils can be sampled at the surface or below surface depending on the type of information required. Soils are typically divided by depth into two categories: surface and subsurface. Surface soils include the zone between ground level and 24 inches. Subsurface soils include any depth below 24 inches. There are several different

types of samplers that can be used to collect a soil sample at any depth.

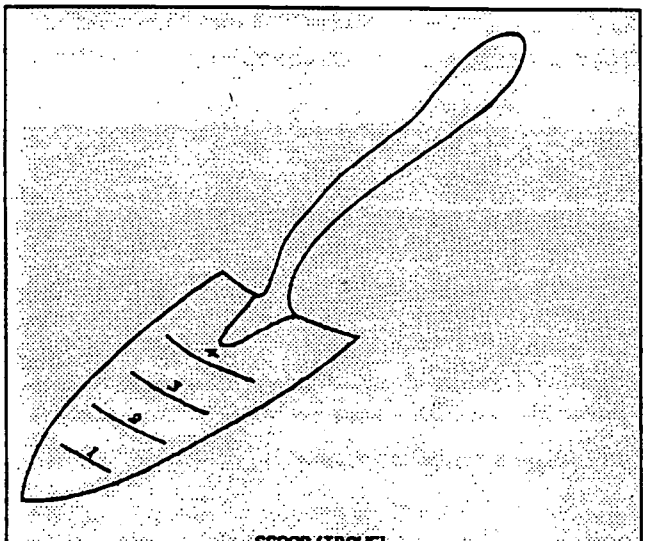
a. Scoop/Trowel

The trowel or scoop (Figure 6-17) can be used in collecting surface soil samples. They can also be used for a variety of other solid waste samples.

A trowel looks like a small shovel. A laboratory scoop is similar to the trowel, but the blade is usually more curved and has a closed upper end to permit the containment of material. Scoops come in different sizes and makes. Many are coated with chrome paint which can peel off and get into the sample: these are unacceptable. Stainless steel scoops are preferred, however, scoops made from alternative materials may be applicable in certain instances. The decision for equipment construction of material other than stainless steel will be made at the discretion of NJDEPE. Stainless steel trowels and scoops can be purchased from scientific or forestry equipment supply houses.

Procedures for Use

i. At specified intervals, take small, equal portions of sample from the surface and immediately below the surface.
ii. Transfer sample into laboratory cleaned sample bottles and follow procedures for preservation and transport (see Chapter 2. "Quality Assurance").



SCOOP/TROWEL
FIGURE 6-17

Advantages

- easy to use and clean

Disadvantages

- sometimes difficult to maneuver sample, particularly if placing sample into VOA vials

b. Bucket Auger

This tool (Figure 6-18) consists of a hard metal central shaft and sharpened spiral blades. When the tool is rotated clockwise by its T-handle, it cuts the soil as it moves forward and discharges most of the loose soil upward. Cutting diameters vary. The length is about 1 m (40 in.), and can be increased with the use of extensions. Depending on soil characteristics there are three general types of augers available, e.g., sand augers, clay/mud augers, and augers for more typical mixed soils. These tools can be purchased from scientific or forestry equipment supply houses.

The auger is particularly useful in collecting soil samples at depths greater than 8 cm (3 in.). However, this sampler destroys the structure of cohesive soil and does not distinguish between samples collected near the surface or toward the bottom. It is not recommended, therefore, when an undisturbed soil sample for volatile organics (VOA) is desired. It should be noted that this exception does not include analysis of base neutrals, acid extractables, total petroleum hydrocarbons or total organic carbon.

Procedures for Use

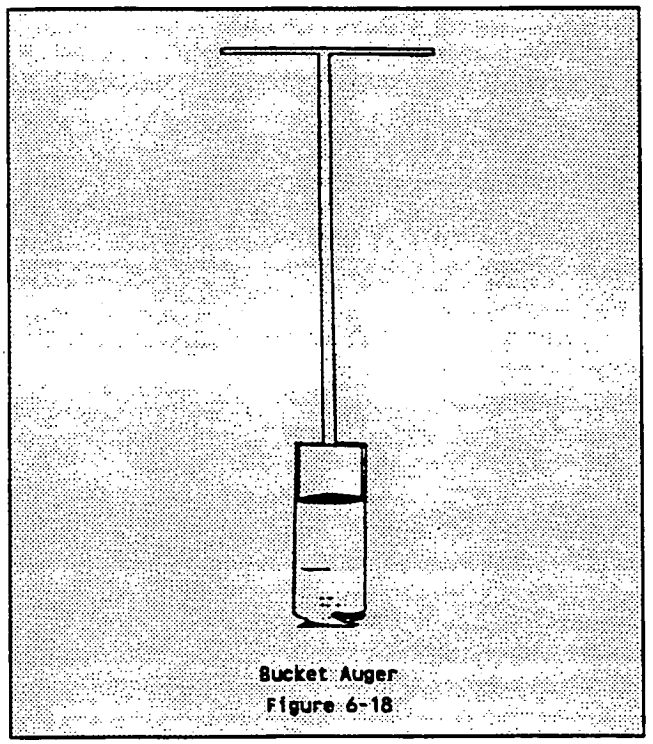
i. Remove unnecessary rocks, twigs, and other non-soil materials from selected sampling point.
ii. Attach the bucket and handle to an extension rod.
iii. Begin turning the auger with a clockwise motion and continue until the desired sampling depth is obtained.
iv. Use a second auger to collect the sample. The auger utilized for hole advancement is not acceptable for sample collection.
v. Transfer the sample into laboratory cleaned sample containers using a clean decontaminated stainless steel spoon or trowel.
vi. When collecting samples at depths greater then 12 inches, it is advisable to discard one-half inch of material in top of the auger due to cave-in
vii. Follow procedures for preservation and transport (see Chapter 2. "Quality Assurance").

Advantages

- relatively speedy operation for subsurface samples

Disadvantages

- destroys soil horizons as it samples
- not recommended for sampling of volatile organics



Bucket Auger
Figure 6-18

c. Soil Coring Device/Silver Bullet Sampler

The soil coring device and the silver bullet sampler (Figures 6-19 and 6-20) are used when a core sample is desired.

The soil coring device consists of a brass cylinder with a handle for turning. The bit of the corer is sharp plastic. A plastic collection tube which will hold a sample is placed on the inside of the brass cylinder.

This device may be substituted for the soil auger if core analysis of depth profiles need to be performed. A serious limitation of this instrument is the depth of the core is only half a meter (1.6 feet). Also, the cutting edge of the coring devices is plastic and is unable to pass through very rocky or tightly packed soil.

The silver bullet sampler consists of a cylinder into which a borosilicated glass collection tube is inserted. The top of the sampler is fitted with a T-handle which is used to manipulate the sampler. The bit is changeable.

The silver bullet sampler was designed to take core samples in peat substrates. Due to its design, it lends itself well to uses in hazardous waste sampling. It is versatile and can be used as a soil coring device because the body is adjustable to reach greater depth. Also, the silver bullet sampler has a serrated bit which allows the sampler to move through rocky or tightly packed substrate more easily.

Procedures for Use

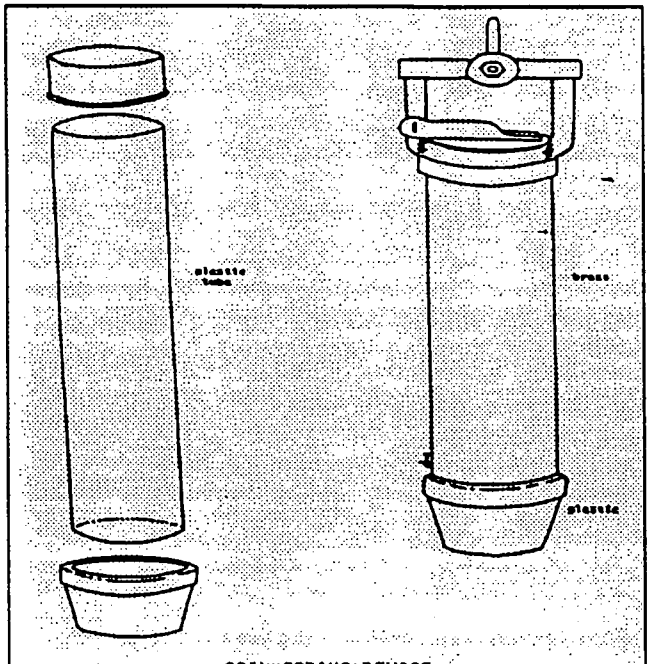
i. Insert borosilicate collection tube into the sampler.
ii. Place the sampler in position with the bit touching the ground.
iii. Press down on the T-handle while rotating the sampler clockwise.
iv. After reaching the required depth, turn the sampler 360° counter clockwise and remove from the ground taking care not to lose any of the sample.
v. Remove the borosilicate glass collection tube and transfer to a laboratory cleaned sample container, or cap at both ends for sample shipment.
vi. Follow procedures for preservation and transport (see Chapter 2. "Quality Assurance").

Advantages

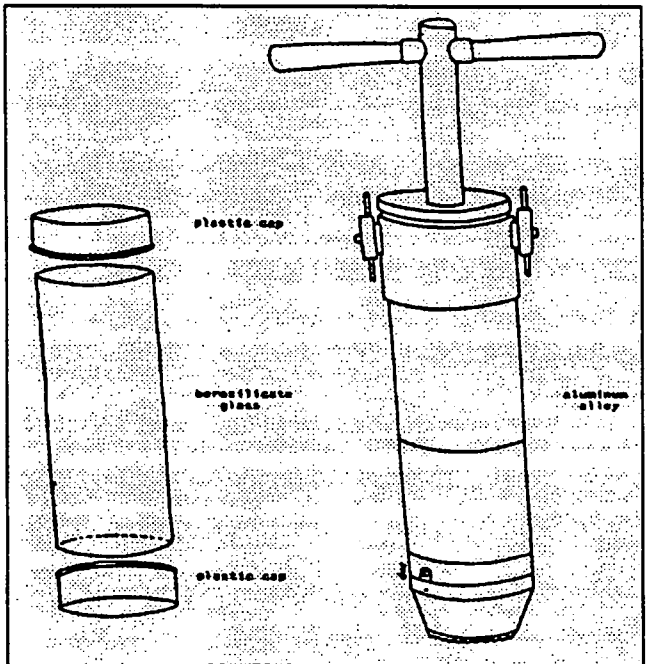
- can be used in various substances
- core sample remains relatively intact
- bit is replaceable (on silver bullet sampler)

Disadvantages

- depth restrictions (soil coring device)
- not useful in rocky or tightly packed soils (soil coring device)
- only soil coring devices of stainless steel construction are recommended for collection of soils for chemical analysis



SOIL CORING DEVICE
FIGURE 6-19



SILVER BULLET SAMPLER
FIGURE 6-20

d. Power Auger

A power auger is used in conjunction with a bucket auger or similar sampling device to obtain a soil sample at depths greater than six inches.

The power auger is composed of an auger flight with a cutting head, attached to a power device which turns the auger. Various sizes and types of power devices are available, from one man units to truck mounted units. Additional auger flights can be used to increase the depth obtainable by the unit.

The power auger is used to drill just above the desired sampling depth. A bucket auger or similar device (smaller in diameter than the auger flight) is then used to obtain the sample.

Advantages

- reduces sampling time
- samples at depth easily obtainable

Disadvantages

- initial expense
- use of gasoline powered engine increases possibility of contamination of sample
- not useful in rocky soils
- Extensive decontamination procedure (steam cleaning of drill rig and associated auger flights)

e. Split Spoon Sampler

A split spoon sampler is utilized to collect representative soil samples at depth. The sampler itself is a length of carbon or stainless steel tubing split longitudinally and equipped with a drive shoe and a drive head. These are available in a variety of lengths and diameters.

Procedures for Use

i. Assemble the sampler by aligning both sides of the barrel and then screwing the drive shoe with retainer on the bottom and the heavier head piece on top.
ii. Place the sampler in a perpendicular position on the material to be sampled.
iii. Drive the tube utilizing a sledge hammer or well rig if available. Do not drive past the bottom of the head piece as this will result in compression of the sample.
iv. Record the length of the tube that penetrated the material being sampled and the number of blows required to obtain this depth.
v. Withdraw the sampler and open by unscrewing drive shoe and head and splitting barrel. If split samples are desired, a decontaminated stainless

2. Equipment Preparation

After selection of the proper device, consideration must be given to equipment decontamination. When the decontamination procedure is properly performed (Chapter 2. Table 2-2), the potential for cross contamination can be significantly reduced. Care must be taken if a parameter of concern (i.e. acetone) is part of the decontamination process, or, if the potential for washing out elements and equipment damage by the reagents used during decontamination is a possibility (i.e. nitric rinse on components of a sampling device constructed of bronze or carbon steel). When these site-specific questions arise, discussion with the regulatory authority may be prudent before a sampling plan is finalized (also note Chapter 2. Section C. "Decontamination of Sampling Equipment" and ASTM D-5088-90).

All soil sampling devices used for chemical analysis must be decontaminated prior to use and in between sample locations. Once the equipment has been cleaned, it must be wrapped in aluminum foil which has either been cleaned in the same manner as the sampling device, or cleaned and oven baked as described in Chapter 2. - Footnote number 4.

Additionally, any heavy equipment necessary for the advancement of any sampling device must be steam cleaned prior to and between sample locations. This would include but is not limited to power augers and respective accessories, drill rig, auger flights, drill rods, backhoe buckets etc.

Depending on site conditions or sampling requirements, soil may have to be collected from beneath concrete pads, floors or asphalt paved areas. In these instances, the equipment used to expose the earthern surface must also be steam cleaned or cleaned by a laboratory grade glassware detergent and water wash followed by a distilled and deionized water rinse if the equipment will contact the sample directly. Similar to the treatment of heavy equipment, this procedure must be performed prior to each sample acquisition. Particular attention should be paid to the lubricating water associated with concrete coring equipment. If a potable water source is not available and the potential integrity of the sample is in jeopardy, analysis of the lubricating water used may be necessary.

It can not be overstated that costly and lengthy cleanup or permit decisions are based on the outcome of soil samples collected in relatively short order. Therefore, initial attention to equipment selection and its preparation can offer a significant reduction in oversight expense while providing the most professional results.

3. Soil Logs

During the collection of soil samples, soil logging should be performed in order to develop a description of the subsurface lithology. It is important that each person logging the samples does so in a knowledgeable and consistent manner to insure that strata and contaminant distribution can be correlated from borehole to borehole.

Soil logs must follow one of the following classification systems:

1. Burmeister
2. Unified Soil Classification Systems (USCS)
3. United States Dept. of Agriculture System (USDA)

When logging soils at a site, the same classification system must be used during the entire investigation. Soil descriptions must provide at a minimum the following information in the required format of the classification system chosen:

1. Color - soil colors should be determined with the use of a color chart (i.e. Munsell).
2. Soil Texture - this is the amount of sand, silts and clays in a soil.
3. Particle Shape - shape of individual soil particles.
4. Mottles - blotches or spots of contrasting color interspersed with the dominant soil color.
5. Structure - shape of the natural soil aggregates.
6. Consistence - degree of resistance to breaking or crushing; descriptions will vary with moisture condition.
7. Horizon Thickness - layers of soil with distinct changes of above features.

It is essential that boreholes are accurately logged in order to provide information which is useful in the determination of geological conditions and ultimately in the assessment of contaminant distribution and evaluation of remedial alternatives.
In addition to soil type and physical characteristics, depth to ground water, field instrument measurements, presence of odor, vapors, discoloration and presence of free product must be recorded in the soil log for documentation purposes. Finally, all soil locations

should be photographed.

4. SURFACE SAMPLE C LLECTION

Determination of the sample location is the first-step in sample collection. If a sampling plan has been developed, confirm the locations before sampling by taking the appropriate measurements. If a sampling plan is not available, or relocation due to refusal is necessary, take measurements from fixed objects and record. This will assure that if resampling for further investigation is necessary, the sample locations can be identified at a later date. Next, at the desired location, clear all inconsequential surface debris (e.g., vegetation, rocks, etc.). Donning disposable gloves and using a stainless steel trowel or scoop, collect an adequate portion of soil from a depth of 0-6" for initial investigations. All analytical parameters, <u>except</u> the volatile organic fraction, must be homogenized either in-situ or in a stainless steel bowl or tray before being placed into the sample container.

* Volatile Organic Sampling Depth and Technique

When sampling for the volatile organic fraction at the surface (defined as 0 - 2'), certain specific considerations must be taken. First, the sampling device used must be able to provide a soil core from which a 24" profile can be observed (assuming 100% recovery). Then, disregarding the six inch interval closest to the surface, field screen the core with a properly calibrated PID or FID. Use the procedure described below (5. "Subsurface Sample Collection", 4th paragraph) for soil scoring and instrument recording. The six inch interval registering the highest FID/PID measurement must be subsampled from an undisturbed portion of the core and laboratory analyzed for volatile organics.

If field screening is not conducted, surface depth for volatile organic collection must be based on soil type using the following guidelines:

1. Sample at six to twelve (6 - 12) inches if the soil consists of 50% or more silt/clay.
2. Sample at eighteen to twenty-four (18 - 24) inches if soil consists of 15 - 50% silt/clay.
3. If surface soil consists of less than 15% silt/clay, sample the six (6) inch interval above the water table or a six (6) inch interval within the next lower soil horizon consisting of 15% or more silt/clay, or at nine and one-half - ten (9.5-10) feet, whichever is encountered first.

In all cases, samples must be collected in discrete six inch increments. If more or less than a six inch increment is collected because of poor sample recovery or other field logistical problems, an explanation must be provided in the soil log.

Care must be taken in collecting and handling the sample for volatile analysis. The sample should be transferred into the sample bottle as quickly as possible, without mixing and only with the aid of stainless steel tools. This will assure that the volatile fraction is not lost or compromised. It is also recommended that for volatile organics analysis of soils, the laboratory performing the analysis be instructed to provide wide mouth bottles (4 ounce) for sample collection. The sample should be packed tightly, but not at the risk of creating more volatile loss than necessary. Small rocks or vegetation should be avoided to the extent most practical. Following this procedure will reduce disturbance of the sample and will aid in the prevention of volatile loss.

5. SUBSURFACE SAMPLE COLLECTION

As with the surface samples, all down-hole devices must be thoroughly decontaminated. Once the desired depth is reached, a decontaminated sampling device (e.g., split spoon or Shelby tube) may be advanced by the drill rig. The advancement of any downhole sampling device must follow ASTM #D1586-84 for disturbed (split spoon) samples, or, ASTM #D1586-83 for undisturbed (Shelby tube) samples. Upon retrieval the split spoon should be opened, its contents logged, and then proceeding in the appropriate manner (see paragraph 4 below) transfer the sample into a sample bottle using a decontaminated stainless steel spatula or spoon. If a Shelby tube is utilized it should be properly sealed and prepared for shipment.

When using a split spoon sampling device, the retaining basket must be in place. This will prevent the representative interval contained within the spoon from falling back into the bore hole while mechanically raising the spoon to the surface.

Once retrieved, remove the drive shoe and drive head and strike the spoon to open being cautious to retain all soil in only one split barrel. When mud rotary well construction is being employed in conjunction with split spoon sampling, the top one to two inches of soil in the spoon should be discarded. This is necessary to minimize the impacts of drilling fluid on the sample's analytical results. Immediately collect the volatile fraction (if a parameter of concern) from a discrete

six inch interval. Once this is completed, proceed to mix the remaining sample in a stainless steel mixing bowl or tray before filling the remaining sample containers. Do not collect any sample that has fallen outside of the spoon as unwanted contamination may be introduced.

An air-monitoring device (FID or PID) may be required to record the presence of any volatiles (See Chapter 8 for more information on these instruments). To obtain the most representative monitor reading, use a decontaminated stainless steel spoon, knife or other appropriately constructed device and make a cross sectional slice(s) of the soil core, or, score a longitudinal line the length of the core deep enough to expose a porous surface. Simultaneously place the probe of the monitoring device into the opened area being careful not to touch the sample, or, move the probe slowly above the lateral scoring and record the results. If the probe of an air monitoring device is simply moved above the soil core without breaking the smooth compact surface, instrument readings may be biased low.

Continuous split spoon sampling often calls for field screening of headspace for all collected intervals with only one or two worst case samples being selected for laboratory analysis based on the outcome of headspace readings. While a variety of methods may be employed to obtain a satisfactory result, there are some important points to consider: 1) The sample collected for screening is collected <u>after</u> all other parameters are secured; 2) the headspace sample must be placed in an air tight container (most preferred: zip-lock plastic bag, least preferred: aluminum foil over glass soil jar held in place with rubber bands or screw cap lid); 3) when penetrating the container with a PID or FID probe, keep infiltration of ambient air to an absolute minimum and; 4) warm the sample to induce volatilization prior to monitoring. The value of this seemingly routine procedure is becoming increasingly recognized as a critical component of site investigation. Therefore, it cannot be overstated that the technique utilized be performed with strict attention to detail in order maintain and achieve consistent results.

In addition to soil classification logs, accurate field logs are essential to the evaluation and interpretation of analytical results. A field log for each sampling point should be prepared and include:

- date/time/weather
- sampler/geologist/soil scientist name(s)
- sample point identification (same number used in sampling plan summary table)
- sketch showing the sampling point location (including reference distances)
- depth to water and/or bedrock (refusal) when encountered
- soil profile with Unified Soil Classification System (USCS), Burmeister, or USDA classification system textual classification and blow counts
- sample recovery (and portion submitted for analysis)
- sampling equipment used
- field measures of any monitoring devices, their calibration, and settings
- general comments (e.g., odor, staining, etc.)

When sampling is completed the tailings from the unused portion of the sample should be placed back down the bore hole. This will reduce the surface spreading of potentially contaminated soil taken at depth. In many cases it may also be required to seal bore holes at or near the water table with non-shrinking impermeable material. These holes may otherwise act as a conduit for contamination.

Soil borings may require permits from the NJDEPE. All borings must be performed in accordance with the procedures and regulatory requirements pursuant to the Subsurface and Percolating Water Act, N.J.S.A. 58:4A-4.1 et. seq. This law requires that a permit be obtained prior to drilling a boring greater than 25 feet below grade.

6. Test Pits

Test pit excavation is useful in the identification of waste material buried on site and to determine the soil horizons or any apparent band of soil contamination. However, this method of accessing a sample is limited. Due to the amount of disturbance involved, test pit samples are not reproducible and are not considered to represent the undisturbed formation. Additionally the depth of the evacuation is limited by equipment, visual observation, distance and the integrity of the trench walls. The health and safety hazard associated with test pits is great. Because the trench walls may be unstable, no personnel should enter any test pit that is deeper than three (3) feet. Care must be taken in working near the backhoe. All personnel must be alert to the machine's movement and be prepared for any potential release from the excavation. During test pit operations, the potential exists to leave contaminated soils at the surface where it may not have been present before excavation. Consideration must be given to potential exposures from the contaminated surface

record in field logbook.

If no release valve exists, slowly loosen hatch cover bolts to relieve pressure in the tank. Again, stop if pressure is too great or if a release occurs. Do not remove hatch cover bolts until tank is at atmospheric pressure.

If a discharge to ambient air occurs, sampling may need to be postponed until the proper equipment is available to control the release.

Once the tank has been stabilized, sample collection may begin using one of the previously recommended samplers for containerized liquids and solids and employing the proper safety precautions and backup personnel. If the contents of the tank have stratified, each strata should be sampled discretely. At a minimum, a top, middle and bottom sample should be collected. If the container has separate compartments, each should be sampled separately at varying depths, as required. Depending on the objective of the sampling event (e.g., characterization for disposal) compositing of samples in the laboratory on a weight/weight or volume/volume basis prior to analysis may be permissible.

Upon retrieval, immediately transfer the sample into the sample bottle. If the sampling device is disposable, it may be left in the container sampled. Otherwise the device must be thoroughly decontaminated before collecting the next sample.

3. TRANSF RMERS

The peculiarities that are associated with transformers warrant that these containers be considered separate from drums and tanks. Because transformers are often located in secured, out-of-the-way locations, access may present a problem. For pole mounted transformers a power operated scissor lift or cherry picker may be needed. In other cases the transformer may be in an underground cell.

The toxic nature and degree of hazard posed by PCBs which may be present in a transformer dictate that a high level of caution be used. Appropriate protection should be worn by sampling and support personnel. Spill prevention and control must be planned; plastic sheeting and sorbent pads should be employed. And most importantly, the transformer must be certified as "off-line" and de-energized by an electrician or other responsible person.

Once the power source to the transformer is cut and spill control measures (plastic sheeting on ground and/or floor surface of lift) are in place, the cover of the transformer can be removed with hand tools. A sample of the dielectric fluid is most efficiently obtained with a disposable glass COLIWASA.

In order to obtain a representative sample, lower this device at a rate that allows the levels of the fluid inside and outside the sampler to remain the same. When the sampler reaches the bottom of the transformer, close it and as it is retrieved, wipe the COLIWASA with a disposable absorbent pad. Transfer the sample directly into the sample bottle. If a disposable sampling device is used, and if the transformer is out of service, it may be possible to leave the used sampler in the sampled materials. However this should only be done after consultation with the responsible authorities. Otherwise the sampler should be drummed along with protective clothing, sheeting and absorbant pads, and disposed of at a pre-determined approved location.

The transformer drain valve should never be utilized for sample collection for several reasons. The integrity of these valves cannot be assured. The valve may be rusty, may break or may become jammed in the open position resulting in the uncontrolled release of the transformer's contents. Secondly, it is likely that transformer contents may have stratified. Since PCBs are heavier than other insulating oils this stratification may prevent the collection of representative samples. Samples obtained from the valve near the bottom of the transformer might reveal higher PCB concentrations than the true concentration of the total dielectric fluid.

D. WASTE PILE SAMPLING

This recommended protocol outlines general procedures for collecting samples from waste piles and other waste materials, equipment necessary for sampling, and the adequate representation of the material. Also presented will be necessary factors for consideration when formulating a sampling plan. Because of the variables involved in waste material sampling, including: shape and size of piles; size, compactness and structure of the waste material; and make-up throughout the material, exact procedures cannot be outlined for every sampling situation. Considerations must be made for the above mentioned variables, the

purpose of sampling, and the intended use of the data to help determine correct sampling methodology.

1. Considerations for the Sampling Plan

The physical and chemical make-up of the waste pile and the purpose of sampling should be considered in planning for the sampling. Information about these items is presented below.

a. Shape and Size

Shape and size of waste material and waste piles may vary greatly in a real extent and height. The pile may be cone shaped, long and rectangular, square, oval or irregularly shaped. State and federal regulations often require a specified number of samples per volume of waste, therefore size and shape must be used to calculate volume and to plan for the correct number of samples. Shape must also be considered when planning physical access to the sampling point and the type of equipment necessary to successfully collect the sample at that location.

b. Characteristics of the Material

i. Type of Material

Material to be sampled may be homogeneous or heterogeneous. Homogeneous material resulting from known situations (e.g., process wastes) may not require an extensive sampling protocol if the material remains homogeneous. Heterogeneous and unknown wastes require more extensive sampling and analysis to ensure the different components are being represented.

ii. Chemical Stability

Waste materials may be affected by their inherent chemical stability. Exposure to the elements and leaching over time may cause older material to differ in chemical composition from newly deposited material in the same pile. Heterogeneous material may undergo chemical reactions resulting in pockets or layers of different compounds.

iii. Particle Size

The particle size of the material affects sampling by preventing certain volumes from being analyzed. Large chunks of material which are left behind and not sampled may result in positive or negative bias of contaminants in samples. If it is necessary to sample larger material, provisions must be made in the planning stage to render the larger material capable of producing a sample.

iv. Compactness/Structure of Material

The compactness/structure of the material may vary across the diameter of the pile. The material may range from monolithic to free-flowing, and of a consistency from muddy to compact and dry. This should be considered when planning sampling procedures.

c. Purpose of Sampling

During the investigation of a site, areas of waste materials or waste piles are often encountered. For complete evaluation of a site, these areas must be characterized. Often information about the waste is available, thus providing insight to its chemical composition. If sufficient information is known about the process generating the waste and it is homogeneous, sampling may not be required for classification. However, for verification of that information, or when no information is available about the nature of the material, the involved Site Remediation Program in NJDEPE will direct the first round of sampling for analysis of the waste. This can be performed at or about the same time as the first round of sampling for the rest of the site. From the analytical data generated, two scenarios are commonly encountered: contaminant concentrations below specific action levels which usually allows the material to remain on site after delineation; or contaminant concentrations above action levels requiring additional evaluation of the waste.

When additional evaluation is required, the next step is to determine whether a material is a hazardous waste in accordance with New Jersey Administrative Code (NJAC) 7:26-8 et. seq. This is performed under the direction of NJDEPE and the Hazardous Regulation Element/Bureau of Regulation, which promulgates the requirements necessary to render a waste classification. The main objective at this point is to quantify the contaminants of concern, to look for the presence of wastes listed in N.J.A.C. 7:26-8.13, 8.14 and 8.15, and look for any other characteristics that would give reason to consider the waste hazardous.

After the waste has been classified as hazardous, additional sample points and analysis for a wide range of parameters is usually required. The sampling scheme should address delineation of the extent of hazardous

material exceeding clean-up criteria. It should characterize waste with contaminant concentrations above a specific, significant level but below removal criteria which may be removed to another approved facility, remain on site after risk assessment, or undergo some other form of remediation such as on-site treatment.

2. Sampling Procedures

As with soil sampling, waste pile samples can be collected at the surface or at depth, and different equipment is required in each instance. Surface samples can be collected most efficiently with a trowel or scoop. For samples at depth, a decontaminated bucket auger may be required to advance the hole, then another decontaminated auger used for sample collection. For a sample core, waste pile samplers or grain samplers may be used.

Waste pile sampling is generally accomplished through the use of one of the following samplers:

- scoop or trowel
- waste pile sampler
- sampling trier
- soil auger
- grain sampler
- Veihmeyer sampler
- split spoon sampler
- soil coring device (e.g. Shelby tube)

a. Surface

At the desired location, clear surface debris. Collect the adequate volume of waste from a depth of 0-6 inches using a trowel, scoop or auger. For a core sample from the surface use the waste pile sampler, trier, or other listed corer/sampler. Transfer the sample directly into the sample container, or use a decontaminated trowel or spatula for transfer if necessary. A wide mouth bottle is preferable for containing the sample, as it requires less disturbance of the sample transferred into the bottle.

b. At Depth

At the sampling location, advance the hole to the desired sampling depth with a decontaminated bucket auger or power auger. Use another decontaminated bucket auger or corer/sampler to collect the sample, and, if necessary, a decontaminated spatula to transfer the sample into the sample bottle. For samples greater than three feet, a hand operated hammer and extension rod may be utilized with a split spoon for sample collection. Upon retrieval the split spoon should be opened, its contents logged if necessary, and immediately transferred into a sample bottle using a decontaminated spatula or spoon.

3. Required Analytes and Frequency

a. Waste Classification

Requirements to render a waste classification pursuant to N.J.A.C.7:26-8 et.seq. are promulgated by Hazardous Waste Regulation Program. The applicable requirements, in terms of frequency of sample, analysis and quality assurance are specified in the guidance document for waste classification. This document is available from the Bureau of Advisement and Manifest within the Program.

The requirements consist of a sampling plan and an analytical test of the material. The sampling plan specifies the number of samples to be taken per volume of waste. Required analyses include RCRA characteristics, total petroleum hydrocarbons (TPHC) content, and total polychlorinated biphenyl (PCB) content. If the TPHC exceeds 10,000 ppm, a priority pollutants analysis is required to determine the presence of listed wastes or hazardous constituents as specified in N.J.A.C. 7:26-8.13, 8.14, 8.15, 8.16 and 8.20. Details on the test requirements can be obtained from the Bureau of Advisement and Manifest.

b. Quality Assurance

For the purpose of analytical quality assurance, the laboratory performing the requested analysis must be certified for that specific contaminant or parameter by the N.J. Laboratory Certification Program. The analytical results and the corresponding detection limits must be submitted on the stationary of the laboratory performing the analysis with the laboratory's certification ID number. Chain of custody and quality control procedures as specified by EPA SW-846 3rd (or most recent) Edition must be submitted along with analytical results.

c. Characterization

When the material is being evaluated to determine if it can be left on site, the considerations previously mentioned in this section should be used to plan a sampling strategy. The characterization may require one or several phases of sampling, but the first phase should be positively biased or statistically random.

Once contaminants of concern have been identified and quantified, additional sampling and analysis may be necessary. Due to the site specific aspects of waste pile sampling and the various reasons for which it is performed, the number of required samples and analytes should be determined by the personnel accumulating the data and directing the investigation from the NJDEPE Site Remediation Program.

If the materials to be characterized are excavated soils, a guidance document entitled "Management of Excavated Soil" can be obtained from the Bureau of Regulation within the Hazardous Regulation Element. This document provides guidance on the evaluation of soils in order to determine their regulatory status and recommends appropriate sampling in support of the determinations.

E. SURFICIAL SAMPLING

This recommended protocol outlines procedures and equipment for the collection of representative wipe, chip and sweep samples.

Surficial sampling is used to assess the existence and/or extent of contamination on various surfaces rather than in a soil, water or air matrix. For example, the interior of a building may be assessed by collecting wipe samples of the process vessels and interiors of ventilation ducts. Though all three types of samples are for similar purposes, the three types of sampling are performed in very different ways because they are intended to assess different surface areas.

1. WIPE SAMPLES

This method of monitoring surficial contamination is intended for non-volatile species of analytes (e.g., PCB, TCDD, TCDF) on non-porous surfaces (e.g., metal, glass). Sample points should be carefully chosen and should be based on site history, manufacturing processes, personnel practices, obvious contamination, migration pathways and available surface area. Suggested sampling points include process vessels, ventilation ducts and fans, exposed beams, window panes, etc. The area wiped should be large enough to provide a sufficient amount of sample for analysis (smaller sample volumes cause higher detection limits).

To collect a wipe sample the following equipment is needed:

- a ruler or measuring tape to measure out the area being wiped
- disposable surgical gloves, to be changed prior to handling clean gauze, sample container or solvent
- sterile, wrapped gauze pad (3 in. x 3 in.)
- appropriate pesticide grade solvent or distilled and deionized water

To facilitate the collection of a wipe sample, 3 in. x 3 in. gauze should be utilized. The use of filter paper for wipe sampling is not recommended. Filter paper will tend to rip and crumble if the surface wiped is slightly rough. If filter paper is to be used, it should be four inch diameter heavy gauge paper, such as Whatman #4 Filter Paper.

The solvent of choice may change based upon the analytes of interest and surface being sampled. Gauze pads for semi-volatiles, pesticide and PCB samples should be moistened in a 1:4 acetone/hexane mixture, and those for metals with distilled and deionized water. The gauze pad should be soaked and excess squeezed out immediately before the collection of each sample. Use of pre-soaked pads is not acceptable. Alternate solvents may be acceptable for certain parameters, however, their approval for use will be at the discretion of NJDEPE.

Occasionally samples are desired from painted or waxed surfaces. Since hexane may degrade the finish or pick up interfering substances, an alternate solvent should be used. In this case, methanol or distilled/deionized water for semi-volatiles, pesticides and PCB's and distilled and deionized water alone for metals should be used. Surface interferences should be recorded in the field logbook.

Once the sample location has been determined, sample collection can begin. It is recommended that an area be premeasured (e.g. 25 cm x 25 cm) to allow for easier calculation of final results. However, this is not

critical as the composition of the laboratory sample containers. Recommended materials for bailers, pump parts, tubing, other sampling devices and associated apparatus in decreasing order of preference are: PTFE (Teflon^R), stainless steel 316, stainless steel 304, polypropylene, linear polyethylene, PVC, Viton, conventional polyethylene.

The majority of NJDEPE regulatory programs require that the bailers be constructed of PTFE or stainless steel. Additionally, any other devices contacting the water to be sampled should be constructed of PTFE or stainless steel. The reader is cautioned that exceptions to this requirement should be confirmed and approved by the regulatory program having project oversight authority.

Tubing utilized in well evacuation may consist of materials other than PTFE, but may not be utilized for sample collection and it is recommended that it should be dedicated for use in each individual well for that particular sampling event.

c. Quality Control Blanks

In an attempt to identify external variables affecting ground water sample integrity, the NJDEPE has initiated a program of quality control blanks. The quality control blank sample program is a two track approach using both a trip and field blank. The trip blank acts as a check on potential contamination sources in sample container preparation, method blank water, and sample transport. The field blank serves as a check on the cleanliness of the sampling equipment, potential atmospheric contamination and the effects of sampling procedures on the analytes of interest.

It is the NJDEPE's policy that all ground water sample data that will be submitted for review and validation must be accompanied by field and trip blank data. ANY DEVIATION FROM THIS POLICY MUST BE APPROVED BY THE NJDEPE IN WRITING PRIOR TO THE COMMENCEMENT OF ANY SAMPLE COLLECTION.

For more information on blank samples (handling time restrictions, preparation methods, frequencies, etc.) refer to Chapter 2 of this manual.

5. Sampling Procedures

a. Sampling Monitor Wells

(See also, c. "Well Purging or Evacuation Procedures" and d. "Ground Water Sampling Procedures")

Evacuation of the water column in a monitor well is required prior to sample collection. This removes the standing water column and induces ground water flow from the surrounding formation into the well. The only exception to this standard procedure is if the objective of the sampling event is to determine the presence of dense or light phase non-aqueous phase liquids.

Access to monitor wells may be difficult and the wells themselves hard to locate in the field. Obtain information on the location, access, permission, etc. before visiting the site. Monitor wells usually have a friction cap or screw cap, and should be locked. Therefore, keys to unlock the wells and tools for removing the caps are often necessary.

If several monitor wells must be sampled, proper identification of each well is essential. The well permit number assigned by the NJDEPE or any other assigned number should be known. If numbers are not assigned, a precise field description of each well location is essential to avoid confusion of sample results. When several monitor wells of known or suspected contamination will be sampled, the least contaminated well should be sampled first, and thereafter sampled in ascending order of contamination. Well head readings using photo or flame ionization detectors (PID or FID) can aid in determining the order in which wells should be sampled by providing information on levels of contamination.

b. Field Measurements

i. Water Level Measurements

Well depths and water table depths can be determined by various measuring devices. A commonly used device is the electronic water level indicator. These units have a tape divided into incremental measurements of .01 feet and two conductors forming a probe. When ground water is encountered the circuit is complete and a light, meter or audible buzzer is activated. The depth to ground water is then measured from this point to the

reference mark on the inner casing of the monitor well.

Water indicator paste/gel acts as colormetric test method when the paste comes in contact with water. It is applied to the bottom few feet of a measuring tape or rod. The tape or rod is then lowered into the well and remains for less than one minute. The wetted tape/stick gives the depth to the top of the liquid and the color change section indicates the depth to water. This procedure is good to ± 0.02 feet.

The least recommended device is a measuring tape with a stainless steel metal cup on the end which makes a "pop" sound when hitting the water surface, hence the name "popper".

Wells with a non-aqueous phase liquid layer on the surface pose a problem when measuring the level of ground water. Electronic water level indicators will not work in this material, so alternate methods must be used. These include water indicator paste, bailers and interface probes.

Once the surface level of the non-aqueous phase liquid layer has been determined, a clear bailer is lowered into the well and slowly into the product, being careful not to submerge the bailer. The bailer is raised and the product thickness measured. Once the product thickness is known, the depth to water may be determined. This method has inaccuracies due to the operation of the bailer.

A more accurate and easier device to use is the interface probe. This probe uses an optical sensor to determine if the probe is in liquid and a conductivity sensor to determine if the probe is in water. When using this probe, each phase can be measured independently. The hydrocarbon-air interface reading should be taken first going from the air to the hydrocarbon surface to prevent dripping hydrocarbons from enhancing the thickness reading. The hydrocarbon-water reading is best taken going up from the water to the hydrocarbon layer to prevent hydrocarbons from coating the conductivity probe which would also enhance the hydrocarbon thickness reading. This is best done by lowering the probe quickly through the hydrocarbon layer minimizing the contact time of the probe in the hydrocarbon phase.

The key to accurate readings by any method is proper collection of the measurements from the same survey point, preferably by the same person and tape to avoid any procedural differences. Readings should be made three to four times. All well measurements should be performed the same day and prior to evacuation of any wells which may influence ground water elevations in the area of the investigation.

Water level elevation equipment should be properly decontaminated to avoid cross contamination. In certain circumstances sensitive components of an interface probe may be compromised by the use of standard decontamination solvents. Alternative solvents may be used upon approval of NJDEPE.

Once a well has been located and properly identified, the field measurements listed below should be noted in a field logbook. Be certain that the proper well is being selected. The misidentification of a sampling point in the field will result in erroneous data that may affect important decisions.

ii. Physical Measurements

- diameter of protective outer casing
- security and integrity of the well
- well number & well permit number
- inner diameter and construction material of the inner well casing
- total depth of the well from the top of the inner casing or surveyor's mark, if present (measured to 0.01 foot)
- depth from the top of the casing to water (recorded to 0.01 foot)
- thickness of floating product, if any
- calculation of the linear feet of water in the well by subtracting the depth to water from the total depth of the well. Note: water levels should be obtained from all wells prior to sampling the first well, thus avoiding interference problems. This also allows one to determine if any well is damaged or may pose a problem for sampling. The capacity of common casing diameters are as follows:

Casing Diameter (ft.)	Gallons/Linear foot
2 inch (0.1667)	0.1632
4 inch (0.3333)	0.6528
6 inch (0.5000)	1.4688
8 inch (0.6667)	2.6112
10 inch (0.8333)	4.0800
12 inch (1.0000)	5.8752

The amount of water within the well casing is calculated by multiplying the linear feet of water by the volume per foot for the proper diameter casing.

Example:

Total depth of well casing:	100 ft.
Depth to water:	-20 ft.
Linear feet of water:	80 ft.
2 inch casing:	x 0.1632
amount of water in casing:	=13.06 gal.

The amount of standing water in the casing should then be multiplied by three (3) to determine the minimum volume to be purged from the well prior to sample collection. The total volume purged should not exceed five (5) times the amount of standing water in the well.

Alternately, one can use this formula to determine the gallons in any diameter well:

Number of gallons = $5.8752 \times C^2 \times H$
Where: C = casing diameter in feet
H = height of water column in feet

iii. Physio-Chemical Parameters

In addition, to the physical measurements taken above and other information that may identify the well, physio-chemical information including specific conductance, pH, and temperature should be recorded during well evacuation and before and after sample collection.

c. Well Purging or Evacuation Procedures

i. Theory

Obtaining representative ground water samples from monitor wells is required for all ground water pollution investigations in New Jersey. The length of time for ground water conditions to become representative at and near the monitor well (the stabilization period) will vary depending on site hydrogeologic conditions, drilling methods and monitor-well development methods. Ground water flow velocities are typically less than one foot per day and natural flushing rates are generally slow. If a monitor well is drilled, installed and developed so that a 14-foot radius around the well was left as unrepresentative, and a natural ground water flow rate was one foot per day, it would take 14 days for representative ground water to reach the well. Sampling a monitor well immediately after development will generally not be representative of the static ground water quality conditions at the horizontal and vertical location of the monitor well's intake interval. Therefore, all newly constructed and developed monitor wells must be allowed to stabilize and equilibrate with the aquifer for a minimum of two weeks prior to sampling.

Monitor well development is required to: remove drilling fluid residues remaining in the borehole or surrounding aquifer, remove imported drilling water lost to the aquifer during the drilling procedure, remove ground water in the borehole or surrounding aquifer which has been affected by the drilling process or drilling or well construction materials, restore the hydraulic properties of the formation immediately surrounding the monitor well, and allow ground water to freely flow to the monitor well.

Installation and construction of monitor wells may themselves alter the quality of ground water in the surrounding aquifer. Site-specific subsurface conditions should be used to determine the appropriate well development techniques. Many times it is a combination of the techniques mentioned below which will be necessary to produce a properly developed monitor well. Also discussed are certain outcomes inherent to the well development techniques which can be mitigated by following the 14 day stabilization period.

- High velocity air jetting, air lift or surge block development methods may introduce air into the aquifer surrounding the monitor well, and this air has the potential for altering ground water quality, particularly for volatile organics.

- Overpumping of a monitor well for development may draw ground water to the monitor well from considerable distances and draw ground water of quality not representative of the horizontal and vertical location required by the monitor well, especially in an isotropic and/or bedrock aquifers.

- Organic drilling fluid residues and inorganic residues of bentonite have been found to remain in and near wells, even after proper development, and these residues have been found to affect water quality including chemical oxygen demand of ground water samples for up to 100 days after completion of development.

- Non-aqueous phase liquid contaminants may be pushed away or drawn to a monitor well location during development, depending on the development method, resulting in non-representative ground water samples being obtained.

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		Prepared Design Engineering	
Subject PREPARATION, REVIEW, APPROVAL, AND RETENTION OF DESIGN SPECIFICATIONS		Approved D. Senovich	

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1.0 PURPOSE

The purpose of this document is to establish a standard procedure for the preparation, review, approval, and retention of Design Specifications.

2.0 APPLICABILITY

This procedure is applicable to Specifications which are utilized for design and/or construction, or equipment. This procedure may include both design and construction requirements or may be restricted to either by deletion of applicable sections. If appropriate, a separate fabrication specification may be used.

3.0 GLOSSARY

Responsible Discipline - the technical discipline within NUS that is responsible for preparing, reviewing, and approving the Design Specification.

4.0 RESPONSIBILITIES

The responsible discipline will prepare Design Specifications and Design Drawings based on criteria contained in the Design Input Requirement Document (DE-1.0) as prepared for the project.

5.0 PROCEDURES

5.1 DISCUSSION

The Design Specification is the vehicle by which the design criteria are translated into specific design requirements in sufficient detail to provide (as required) a complete basis for design, stress analysis, construction, examination, testing, cleaning, and packaging.

If the design of an item is performed by NUS Corporation, EMG Design Engineering, then the Design Specification prepared in accordance with this procedure is acceptable for performing the design, drawings, and stress analyses as required by the project.

The format presented in Exhibit 2-1 of this procedure shall be followed unless a client requests an alternate format. When a format other than that specified is required to be followed, it shall be ensured that the required contents of the Design specification are included.

Design Specifications shall normally include sections identified in the following sample Table of Contents.

TABLE OF CONTENTS FOR DESIGN SPECIFICATIONS

Section	Title
1.0	Scope
2.0	Applicable Documents
3.0	Design and Performance Requirements
4.0	Construction Requirements
5.0	Examination and Test Requirements
6.0	Preparation for Shipment Requirements
7.0	Document Requirements
Table I	Loading Combinations and Stress Limits
Table II	Design Transients

5.2 CONTENTS OF INDIVIDUAL SECTIONS

5.2.1 Section 1.0, Scope

The scope of the document shall be briefly and clearly defined. Subsections or exclusions, definitions, and scope of supply of Seller, Owner, or others (if involved) is generally appropriate.

5.2.2 Section 2.0, Applicable Documents

This section lists the standards, codes, specifications, and other documents referenced in the text. It gives the number, complete title, and, if pertinent, the author or organization that prepared it. The listed standards are not automatically invoked; the applicable standard or portions thereof shall be specifically invoked in latter sections of the specification.

5.2.3 Section 3.0, Design and Performance Requirements

Design and performance requirements may be detailed in narrative form but the practice of utilizing (by appending to the specification) supplementary standards and/or data sheets to the extent practicable is encouraged. The data sheets can be used to convey information as well as to request information.

Design and Performance Requirements shall include:

- The functions of the equipment and major considerations on which the functional performance depends.
- Design pressure, design temperature, and design mechanical loads such as weight, superimposed loads, wind loads, snow loads, earthquake loads, support reactions, and thermal expansion loads.
- Design transients for normal, upset, emergency, and faulted conditions.

- Environmental conditions including radiation.
- Chemistry of fluids that are in contact with or that influence the functions of the equipment, due to corrosion, erosion, and mechanical abrasion.
- Material requirements, including prohibited materials, impact test requirements, heat treatment requirements, and cleanliness requirements.
- Design life of the item.
- Physical dimensions, tolerances, and deformation limits.
- Electrical, instrumentation, and control requirements where appropriate.

5.2.4 Section 4.0, Construction Requirements

The requirements pertaining to construction shall be presented in this section of the specification. These requirements shall include items such as the following:

- Codes and standards which must be satisfied relative to the construction project.
- Prohibited procedures or materials.
- Special safety requirements or precautions.
- Materials joining requirements (welding, brazing, soldering, crimping, mechanical fastening and locking, etc.).
- Repair requirements.
- Cleaning requirements.
- Inspection requirements.
- Painting or coating requirements.

5.2.5 Section 5.0, Examination and Test Requirements

The requirements pertaining to the examination and performance or acceptance tests to be performed by the suppliers shall be presented in this section of the specification and shall include items such as the following:

- Nondestructive examination (NDE) (visual, ultrasonic, magnetic particle, dye penetrant, and radiographic) requirements and acceptance criteria.
- Special test, if any, for materials.
- Hydrostatic or pressure test requirements and acceptance criteria.
- Leak test requirements and acceptance criteria.

- Tests for electrical appurtenances.

- Seismic qualification tests, if required.

5.2.6 Section 6.0, Preparation for Shipment Requirements

The requirements pertaining to preparing the system or component for shipment shall be presented in this section of the specification. Items such as cleaning, packing, and labeling shall be included. In addition, any restriction on methods of shipment or maximum allowable accelerations during shipment shall be identified.

5.2.7 Section 7.0, Documentation Requirements

This section of the specification shall identify those documents which must be submitted, by the subcontractor, to the Project Manager.

The following items, as applicable, are required for approval from the subcontractor:

- Quality Assurance Program and Procedures.
- Project plan and schedule.
- Periodic progress reports.
- Personnel and equipment qualification procedures for NDE operations.
- Detailed design drawings.
- NDE procedures and acceptance criteria.
- Test procedures.
- Cleaning, packaging, and shipping procedures.
- Seismic test procedures, if applicable.
- As-built drawings.

The following reports and other documents are required to be submitted by the subcontractor as part of the data package:

- Certified Material Test Reports or, if applicable, Material Manufacturer's Certificate of Compliance.

- Welder and NDE personnel qualification reports.

- Dimensional examination reports.

- Seismic test reports, if applicable.

- NDE reports.

- Functional or performance test reports.

5.3 REVIEW, REVISION, AND APPROVAL

Design specifications shall be internally reviewed in accordance with the requirements of DE-4.0. The signature of the author, reviewer, and applicable levels of management, shall be affixed to the cover sheet (see Exhibit 2-1 of this procedure) of the Design Specification. The cover sheet shall incorporate Proprietary Statement, Listing of Attachments, Professional Certification, etc., as appropriate.

Two systems for identifying revisions to design specifications are provided; an alphabetical designation system which is used during the design development and approval stages and numerical designation system which replaces the alphabetical system at the time the specification package is released for construction. If client approval is not required, the Project Manager and the lead technical discipline shall jointly determine when a specification is to be released for construction.

A specification retains its designation throughout the review cycle and incorporation of comments and is issued with the same revision designator as when it was reviewed. For example: Rev. B is a modified or "marked up" version of Rev. A and is to be considered as a prospective Rev. B during the origination and review cycle. Upon resolution and incorporation of comments, it is issued as Rev. B. Any copies distributed before final issue of a particular revision shall be designated as "PRELIMINARY" or "IN REVIEW" to depict their interim status.

In all cases, there must be visual evidence that a design specification is being revised. As a minimum, the current revision designation shall be struck through, e.g., (~~A~~), to indicate that changes are being made. The "strike through" is to be removed at the time the succeeding revision sign-offs are completed. Each revision shall contain sidelines to mark revised areas, and the revision number shall be marked next to the sideline.

All marked sidelines and revision numbers due to previous revisions shall be erased when later revisions are made to the same material.

5.4 RECORDS

A copy of the Design Specification and the appropriate review documentation shall be retained in the project file.

6.0 REFERENCES

None.

7.0 ATTACHMENTS

Exhibit 2-1 Design specification cover sheet and format.

EXHIBIT 2-1

NUS CORPORATION

PLANT: _____ NUS PROJECT NO.: _____

CLIENT: _____ SPECIFICATION NO.: _____

LOCATION: _____ REVISION: _____

TITLE:

RELEASED FOR: ☐ REVIEW ☐ BID ☐ FABRICATION ☐ INSTALLATION

I, the undersigned, being a Registered Professional Engineer in the State of _____ have examined this design specification and related general design specifications (See Attachments) and certify that to the best of my knowledge and belief it is a complete and correct design specification.

Certified by _____ P.E.

Registration No _____ State _____

Date _____

2ND LEVEL REVIEW COMPLETED			P.E. CERTIFICATION	
REV.	ENG.	DATE	ENG.	DATE

PROPRIETARY INFORMATION

THIS SPECIFICATION IS THE PROPERTY OF *NUS CORP.* IT IS NOT TO BE REPRODUCED OR COPIED IN WHOLE OR IN PART, AND ITS INFORMATION SHALL NOT BE USED FOR ANY PURPOSE OTHER THAN THAT DESIGNATED BY *NUS CORP.* WITHOUT THE WRITTEN CONSENT OF *NUS CORP.*

APPROVED _____ DATE _____
Client

APPROVED _____ DATE _____
Project

APPROVED _____ DATE _____
Quality Assurance

APPROVED _____ DATE _____
Discipline Manager

PREPARED BY _____ DATE _____
Author

	PREPARED	DATE	APPROVED	DATE	APPROVED	DATE	APPROVED	DATE	APPROVED	DATE
	NUS CORPORATION								CLIENT	

NUS 320 0384

EXHIBIT 2-1
PAGE TWO

1.0 SCOPE

2.0 APPLICABLE DOCUMENTS

2.1 a.
b.

2.2

2.3

3.0 DESIGN AND PERFORMANCE REQUIREMENTS

3.1* **Design Requirements**

3.1.1

a.**
b.

3.1.2

3.1.3

a.
b.
c.
etc.

* The test of each subsection is brought back to the left hand margin.
** Listings may be identified by a letter breakout.

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- 5.9 RECORDS

6.0 REFERENCES

7.0 ATTACHMENTS

1.0 PURPOSE

This procedure specifies the requirements to be met in the preparation, review, approval, distribution, and record control of engineering drawings prepared by Design Engineering.

2.0 SCOPE

This procedure applies to all formal engineering drawings initiated by the Environmental Management Group.

This procedure does not apply to "informal" engineering sketches which are typically used for studies and design concepts.

3.0 GLOSSARY

As-Built Drawing - A drawing status indicating that construction of fabrication of the depicted system or components has been completed, all approved change notices have been incorporated and the drawing has been revised to reflect any other known differences with the system or component.

Design Change Notice (DCN) - The documentation of an accelerated change to a design document. The change is described on a DCN form and is approved by the same disciplines who approved the original design document.

Design Document Status Report (DDSR) - A document that is developed, promulgated, and identified by the number, name, revision status, and associated release data for projects.

Field Change Request (FCR) - A request for change of design detail/criteria initiated at the site of construction; normally by the client. The FCR may be in-house or by the client.

Prefinal and Final Drawings - Prefinal drawings are essentially 90 percent completed but are subject to clients comments as changes. Final drawings are drawings corrected to clients comments or changes.

4.0 RESPONSIBILITIES

The Manager of Design Engineering is responsible for the preparation of the drawings on the project and shall plan the number and type of drawings that are required. The Supervisor of Design shall assure that the drawings are listed on the Design Document Status Report (DDSR) as required in DE-9.0.

5.0 PROCEDURES

5.1 PREPARATION

5.1.1 The standard drawing sizes shall be:

- B-Size 11" x 17"
- C-Size 18" x 24"
  D-Size 24" x 36"

- E-Size 30" x 42"
- F-Size 30" x 42"

For sketches, 8 1/2" x 11" size may be used.

5.1.2 The drawings shall be sequentially numbered starting with 1 through infinity preceded by a number and drawing letter size as follows:

- Discipline Designator:

  - 2 = Site Plan/Arrangement
  - 3 = Civil
  - 4 = Structural
  - 5 = Mechanical
  - 6 = Electrical

- Example:

  - A 24" x 36" General Arrangement Drawing would be identified as 2D1, 2D2, etc.
  - An 18" x 24" Foundation Drawing would be identified as 3C1, 3C2, etc.

5.1.3 When a drawing is voided the number shall not be reused. Drawings may, however, be totally redrawn using the same drawing number if revision continuity is maintained.

5.1.4 The line and lettering quality of the drawings shall be such that they may be reduced for reproduction in report sizes, and that they may be microfilmed to meet aperture card quality requirements as specified by clients.

5.1.5 Each drawing shall indicate its status (e.g., Preliminary, For Client Comment, Prefinal, Final, Approved for Construction [AFC], as-built) in a space above the title block. Prefinal is 90% completion and final is 100% completion.

5.1.6 Drawings issued prior to construction shall carry an alphabetic revision designator. The initial issue of a drawing shall be designated "A."

5.1.7 Drawings issued for construction shall carry the numerical designator of "O." Revision designations after such issue shall be numerical starting with "1."

5.1.8 A drawing may be issued AFC without having all details of it engineered. In those cases, "holds" shall be placed on the drawings showing areas which are not to be constructed.

5.1.9 When a drawing is voided, the word **"VOIDED"** shall be written in bold face across the original and prints issued to original distribution.

5.2 REVIEW

5.2.1 The drawings shall be reviewed and the review comments resolved per DE-4.0.

5.2.2 Prior to routing a drawing for formal interface or review, the drawing must be initialed or signed, as a minimum, by the Draftsman and the Discipline Engineer in the revision block.

5.2.3 The Draftsman shall also sign the drawing in the title block.

5.3 **APPROVAL AND SIGN-OFF**

5.3.1 After all review comment resolutions are incorporated and the drawing is readied for issue, the drawing shall be signed or initialed in the revision block. The sign-offs shall be obtained by the Supervisor of Design. Sign-offs shall include Lead Designers, Lead Discipline Engineer, Project Manager/Engineer and Manager of Design Engineering and Lead Process Engineer, where applicable. The Manager of Design Engineering will determine required signatures.

5.3.2 The interface discipline spaces shall be left blank where signatures are not required.

5.3.3 When the drawing is issued "Approved for Construction" the title block sign-off shall be completed, in addition to the revision block. The Manager of Design Engineering shall sign-off before drawing is "Issued for Construction."

5.3.4 When required, a Registered Professional Engineer (PE) familiar with the project shall stamp the drawing at the AFC stage. The PE shall review the drawing for the endorsement of seal.

5.4 **REVISIONS**

5.4.1 When a drawing is being revised, the current revision designator will be struck through, e.g., (~~A~~). This signifies an open revision.

5.4.2 The next or proposed revision designator shall be entered adjacent to the struck through designation.

5.4.3 The changes made in the revision shall be briefly described. Revisions after the drawing has been AFC shall also be bubbled and the revision area identified with a triangle.

5.4.4 Revision bubbles and triangles shall not be carried forward for each revision. Revision bubbles are not required for "As-built" drawings.

5.4.5 A drawing once issued must be revised and re-issued with the next sequential revision designator anytime a change, no matter how minor, is made on the drawing. This requirement is waived only when recording Design Change Notices (DCNs) per 5.6.4.

5.4.6 Unless specifically waived, each revision shall have a review and the same departmental interface review as the previous revision once the drawing has undergone review in accordance with DE-4.0. If the review for a particular revision was waived due to insignificant changes, by the Project Manager, the Department Manager may sign as the reviewer.

5.4.7 A drawing retains the same revision designation throughout its review cycle and incorporation of comments and is issued with the same revision designator as when it was put into review.

5.4.8 The revision is considered issued when a) the last required signature is obtained, normally the Project Manager's, and b) the revision is dated.

5.5 DISTRIBUTION

5.5.1 Drawings shall be distributed as specified by the Project Manager. The Project Manager shall make distribution of CONTROLLED COPIES of each revision of each drawing within NUS and to the client.

5.6 DESIGN CHANGE NOTICE (DCN)

5.6.1 All DCNs issued against drawings shall be prepared, reviewed, approved, and distributed in the same manner as specified for the drawings. Signing the original DCN shall be evidence that it has been reviewed. (Exhibit 3-1A shall be used.) Instructions for filling out the form are shown in Exhibit 3-1B.

5.6.2 DCN numbers shall be obtained from the Project Manager who will assign numbers sequentially irrespective of document or discipline affected.

5.6.3 The DCN column on the DDSR shall be checked to signify that a DCN is outstanding against a drawing (see DE-9.0). When the DCN is incorporated, it should be noted in the revision column on the drawing and the check mark erased from the DDSR.

5.6.4 The DCN issued against a particular drawing is to be recorded on the Outstanding DCNs block on the drawing. When the DCN has been incorporated in the drawing, the notation shall be erased from the Outstanding DCN block on the drawing.

5.6.5 The DCN/FCR log should be updated per DE-9.0 under the direction of the Manager of Design Engineering.

5.7 FIELD CHANGE REQUESTS (FCRs)

5.7.1 FCRs are normally generated by organizations other than NUS (i.e., the client or constructor). FCRs will be received by the Project Manager and routed for review. Based on technical discipline review results, the Project Manager shall return the FCR to the client either approved or disapproved. A copy of the approved FCR shall be distributed to the Manager of Design Engineering.

5.8 CLIENT-SPECIFIC REQUIREMENTS

5.8.1 Clients sometimes impose drawing formats to be compatible with their drawing system. In those cases, the requirements listed in paragraph 3.1 shall be modified by the Project Manager. Similarly, revision designations may be different, as well as the actual required approval signatures, on the drawing itself.

5.9 RECORDS

5.9.1 The original of each drawing shall be kept in the drawing files.

5.9.2 A copy of each revision of the drawing with the associated review copies shall be kept in the project file.

5.9.3 A copy of each DCN is to be kept in the project file.

5.9.4 A copy of each FCR, its disposition and associated review copies shall be kept in the project file.

5.9.5 In event client desires the original drawing upon completion of project, copies are to be made for internal record purposes.

5.9.6 A record CAD disk shall be kept on file at all times. The Supervisor of Design will maintain these files.

6.0 REFERENCES

None.

7.0 ATTACHMENTS

- Exhibit 3-1A NUS Form 334 0579
- Exhibit 3-1B Instructions for Completing Form NUS 334 0579
- Exhibit 3-2 NUS Standard Drawing Title Block

EXHIBIT 3-1A

SHEET ___ OF ___

NUS CORPORATION
ENGINEERING DIVISION

(1) FIELD CHANGE REQUEST NO. _____

DESIGN CHANGE NOTICE NO. _____

(2) PROJECT Name _____

(3) DOCUMENT Drawing _____ Rev. _____ Sheet _____ Specification _____ Rev. _____ Other _____ Rev. _____

(4) CHANGE DESCRIPTION

(5) JUSTIFICATION

(6) SUBMITTED: _____ Date _____ _____ Date _____

(7) APPROVALS:

Originator	Date	Project	Date
Operating Manager	Date	Client	Date
Quality Assurance	Date	Other	Date
Prof. Eng. Reg. No	Date	Other	Date

Instructions for utilizing this form are provided on separate sheet

NUS 334 (8/79)

SPECIMEN

EXHIBIT 3-1B
INSTRUCTIONS FOR COMPLETION OF FORM NUS 334 0579
(Dual Purpose Form)

General: Ensure all pages are accounted for and numbered. Form is Page 1 and all subsequent pages are numbered consecutively.

(1) Fill in the correct number(s) based on whether form is being utilized as Field Change Request (FCR), Design Change Notice (DCN), or both.

(2) Insert Project Name.

(3) Identify Document number by listing project number (which is common to all document numbers) on left line and then filling in the document number on the applicable line being careful to identify revision (and sheet number in case of drawing).

(4) Insert narrative description of FCR or DCN and/or sketches as appropriate.

(5) Provide brief narrative description of justification for FCR or DCN.

(6) Used only for FCR submittals - include name(s), date, and organization (if originated by organization other than NUS).

(7) Seven blanks are provided for "normal" signatures, i.e., Originator, second level review (if applicable), Discipline Manager, Quality Assurance (if required), Professional Engineer (include registration number), Project Manager, and Client (if required). One signature line labeled "other" is provided for possible additional required signatures. All signatures must be dated.

EXHIBIT 3-2

NUS STANDARD DRAWING TITLE BLOCK (EXAMPLE)

DRAWN	K. Christner	(4/24/90)	
CHECKED	A. M. Finke	4/25/90	
DESIGN ENGINEER	A. M. Finke	4/25/90	
PROCESS ENGINEER			
PROJECT MANAGER	Jean-Luc Jonieux	JLG 4/25/90	
DIVISION MANAGER			
CLIENT APPROVAL			

NUS CORPORATION
PARK WEST TWO
CLIFF MINE ROAD
PITTSBURGH, PA 15275

TITLE: TREATMENT BUILDING ARRANGEMENT SECTIONS
DOWNGRADIENT GROUNDWATER REMEDIATION SYSTEM
HELEVA LANDFILL SITE LEHIGH COUNTY, PA

CLIENT: US EPA		CONTRACT: 0224
SCALE: AS NOTED	DATE: JANUARY 14, 1990	SHEET 1 OF 1
DRAWING NO.: 0224—2D3	APPLE NAME: 0224\2D3.DWG	REV.: C

NUS CORPORATION ENVIRONMENTAL MANAGEMENT GROUP	STANDARD OPERATING PROCEDURES	Number DE-11.0	Page 1 of 4
		Effective Date 06/15/90	Revision 1
		Applicability EMG	
		Prepared Design Engineering	
Subject SURVEYING		Approved D. Senovich	

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6.0 REFERENCES

7.0 RECORDS

1.0 PURPOSE

This procedure provides controls and responsibilities necessary to perform surveying activities in accordance with sound surveying practices.

2.0 SCOPE

Surveying performed by EMG, and its subcontractors, shall be governed by this procedure.

3.0 GLOSSARY

None.

4.0 RESPONSIBILITIES

The Project Manager shall stipulate the limitations and accuracies necessary to meet the requirements of the work assignment. If the Project Manager does not stipulate the limitations and accuracies, the surveying procedures provided herein shall apply.

Personnel performing surveying activities are responsible for adhering to the requirements of the work assignment.

The Survey Party Chief, is responsible for the performance of daily activities of the surveying crews. He is also responsible for the supervision required during the preparation and review stages of the surveying product specified in the work assignment.

The Manager of Engineering has overall authority for the surveying activities performed by EMG and its subcontractors. He is also responsible for the final review and approval of all survey drawings prepared for a client, whether prepared by EMG or its subcontractors.

5.0 PROCEDURES

Ground control surveying practices will follow acceptable methods and techniques currently being used in industry.

Horizontal Control establishment will be accomplished through a field traverse with control points being set. Control will begin and terminate at known points of reference, or will be a closed geometric loop. Traverse points will be referenced to three permanent landmarks where practical. Reference distances will be measured to the nearest 0.01'.

Angular measurement will be made with a theodolite capable of reading to the nearest 20 seconds (minimum). The angular measurement will be repeated four (4) times with an average measurement used. The total angular error for primary survey traverse is not to exceed 5 seconds times the square root of the number of points in the primary traverse. Secondary control survey traverse requires a total angular tolerance error not to exceed 10 seconds times the square root of the number of points in the secondary traverse.

Distance measurements will be with an EDM (Electronic Distance Meter) or by conventional steel tape. Measurement of traverse lines will be made in both directions with the mean measurement used provided the accuracies meet the requirements of paragraph 7.2.

Slope distance measurement will require the vertical angle to be made twice, direct and inverted, with the mean measurement used.

Leveling will be by differential leveling methods only (no trigonometric leveling). Benchmark points will be turned on as a part of the level circuit. Only previously adjusted turning points will be used as benchmarks.

Monitoring well surveying practices will follow acceptable methods and techniques currently being used in industry.

Horizontal Control will be located directly off primary or secondary control survey base lines.

Angular measures will be made with a transit or theodolite capable of reading to the nearest 20 seconds. The angular measurement will be repeated twice and will require an average angle within 10 seconds of the first angle.

Distance measurements will be with an EDM or a steel tape and measured level or with correction made for slope reduction. Stadia distances are <u>not</u> acceptable, unless approved by the Project Manager.

Wells will be located horizontally from two stations where applicable (practical).

Leveling measurements will be made on well casings as part of a level circuit. <u>Each well casing will be a turning point of the circuit</u>. Turns will be made on the highest point of the exterior of the well casing and marked with paint, unless otherwise specified by the Project Manager.

Stick-up distances from ground elevation shall be recorded to the nearest tenth of a foot.

5.1 DISCUSSION

Surveying assignments shall be performed with qualified personnel under the direction of a licensed surveyor.

Surveys for property or enforcement action projects require a licensed surveyor in the State where the project is located. All survey drawings supplied by a licensed surveyor should be stamped with the state seal.

Surveys performed by a subcontractor will be reviewed by a licensed surveyor of EMG. Review will be of a sufficient magnitude to verify that the accuracy stipulated in the contract agreement submitted to the subcontractor has been achieved.

5.2 STANDARD OF ACCURACY FOR GROUND CONTROL SURVEYS

Horizontal angular measurement will be repeated four (4) times and will require an average angle within 15 seconds of the initial measurement used. The total allowable angular error for primary survey traverse is 5 seconds $\sqrt{n}$. Secondary control survey traverse requires a total angular tolerance error of 10 seconds $\sqrt{n}$ (n = number of stations).

Distance measurements will be taken to the nearest 0.01' (one one-hundredth of a foot). An EDM (Electronic Distance Meter) shall be used with the proper adjustment for atmospheric pressure and temperature. <u>Measurement between stations will be recorded from both stations</u>. Both primary and secondary control survey error is not to exceed 0.005 feet per 100 feet.

Vertical control will be established on traverse points and on benchmarks. The elevation on these points shall be determined through a closed level circuit. Each traverse point will be a turning point of the circuit and tolerance of closure will not exceed 2.0 mm $\sqrt{K}$ (where K is kilometer = .62137 miles or 3280.83').

5.3 STANDARD OF ACCURACY FOR MONITORING WELL SURVEYS

Horizontal angle measurement will be repeated twice and will require an average angle within 10 seconds of the first angle. Distance measurements will be taken to the nearest 0.01 of a foot.

Elevations will be established on well casings through a closed level circuit. Each casing will be a turning point of the circuit and tolerance of closure will not exceed 0.01'/1000'.

5.4 DOCUMENTATION

Field Survey Notes will be accurately recorded by the Survey Party Chief in a clear and legible manner.

The field notebook shall include the following notations:

- First page of daily activity will be dated and include the names/duties of field crew personnel (first initial and last name).
- Also on this page,a job title, project number, instrument numbers, weather, and any other pertinent information to that day's activities shall be so noted.
- Information that has been used on the survey shall be clearly noted and referenced; any assumption made shall be so noted; and calculations by the party chief shall be recorded. All information in the notebook shall be complete and clear.

In no instance shall any field notes be erased or made illegible. Notes in error shall be marked "void," dated, and initialed.

6.0 REFERENCES

None.

7.0 RECORDS

- Field survey notes and drawings
- Survey logbook

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		Applicability EMG	
		Prepared Earth Sciences	
Subject SOIL AND ROCK SAMPLING		Approved D. Senovich	

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6.0 REFERENCES

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1.0 PURPOSE

The purpose of this procedure is to identify the equipment, sequence of events, and appropriate methods necessary to obtain soil, both surface and subsurface, and rock samples during field sampling activities.

2.0 SCOPE

The methods described within this procedure are applicable while collecting surface and subsurface soil samples; obtaining rock core samples for lithologic and hydrogeologic evaluation; excavation/foundation design and related civil engineering purposes.

3.0 GLOSSARY

Hand Auger- A sampling device used to extract soil from the ground in a relatively undisturbed form.

Thin-Walled Tube Sampler - A thin-walled metal tube (also called Shelby tube) used to recover relatively undisturbed soil samples. These tubes are available in various sizes, ranging from 2 to 5 inches O.D. and 18 to 54 inches long. A stationary piston device may be included in the sampler to reduce sampling disturbance and increase sample recovery.

Split-Barrel Sampler - A steel tube, split in half lengthwise, with the halves held together by threaded collars at either end of the tube. Also called a split-spoon sampler, this device can be driven into resistant materials using a drive weight mounted in the drilling string. A standard split spoon sampler (used for performing Standard Penetration Tests) is 2 inches outside diameter (OD) and 1-3/8 inches inside diameter (ID). This standard spoon typically is available in two common lengths, providing either 20-inch or 26-inch longitudinal clearance for obtaining 18-inch or 24-inch long samples, respectively. These split-spoon samplers range in size from 2-inch O.D. to 3-1/2-inch O.D., depending upon manufacturer. The larger sizes are commonly used when a larger volume of material is required.

Rock Coring - A method in which a continuous solid cylindrical sample of rock or compact rock-like soil is obtained by the use of a double tube core barrel that is equipped with an appropriat diamond-studded drill bit which is advanced with a hydraulic rotary drilling machine.

Wire-Line Coring - As an alternate for conventional coring, this is valuable in deep hole drilling, since this method eliminates trips in and out of the hole with the coring equipment. With this technique the core barrel becomes an integral part of the drill rod string. The drill rod serves as both a coring device and casing.

4.0 RESPONSIBILITIES

Field Operations Leader - Responsible for overall management of field activities and ensuring that the appropriate sampling procedures are being implemented.

Site Geologist - The site geologist directly oversees the sampling procedures, classifies soil and rock samples, and directs the packaging and shipping of soil samples. Such duties may also be performed by geotechnical engineers, field technicians, or other qualified field personnel.

5.0 PROCEDURES

5.1 SUBSURFACE SOIL SAMPLES

Subsurface soil samples are used to characterize subsurface stratigraphy. This characterization can indicate the potential for migration of chemical contaminants in the subsurface. In addition, definition of the actual migration of contaminants can be obtained through chemical analysis of the soil samples. Where the remedial activities may include in-situ treatment or the excavation and removal of the contaminated soil, the depth and areal extent of contamination must be known as accurately as possible.

Engineering and physical properties of soil may also be of interest should site construction activities be planned. Soil types, grain size distribution, shear strength, compressibility, permeability, plasticity, unit weight, and moisture content are some of the physical characteristics that may be determined for soil samples.

Penetration tests are also described in this procedure. The tests can be used to estimate various physical and engineering parameters such as relative density, unconfined compressive strength, and consolidation characteristics of soils.

The procedures described here are representative of a larger number of possible drilling and sampling techniques. The choice of techniques is based on a large number of variables such as cost, DQOs, local geology, etc. The final choice of methods must be made with the assistance of drilling subcontractors familiar with the local geologic conditions. Alternative techniques must be based upon the underlying principles of quality assurance implicit in the following procedures.

5.1.1 Equipment

The following equipment is used for subsurface soil sampling and test boring:

- Drilling equipment, provided by subcontractor.
- Split barrel (split spoon) samplers, OD 2 inches, ID 1-3/8 inches, either 20-inch or 26 inches long. Larger O.D. samplers are available if a larger volume of sample is needed. A common size is 3-inch O.D. (2-1/2-inch I.D.).
- Thin walled tubes (Shelby), O.D. 2 to 5 inches, 18 to 54 inches long.
- Drive weight assembly, 140-lb. (± 2 lb.) weight, driving head and guide permitting free fall of 30 inches (± 1 inch).
- Drive weight assembly, 300-lb. (± 2 lb.) weight, driving head and guide permitting free fall of 18 inches (± 1 inch).
- Accessory equipment, including labels, logbook, paraffin, and sample jars.

5.1.2 Split Barrel (Split Spoon) Sampling (ASTM D1586-84)

The following method will be used for split barrel sampling:

- Clean out the borehole to the desired sampling depth using equipment that will ensure that the material to be sampled is not disturbed by the operation. In saturated sands and silts, withdraw the drill bit slowly to prevent loosening of the soil around the hole and maintain the water level in the hole at or above groundwater level.

- Side-discharge bits are permissible. A bottom-discharge bit shall not be used. The process of jetting through an open tube sampler and then sampling when the desired depth is reached shall not be permitted. Where casing is used, it may not be driven below the sampling elevation.

- Install the split barrel sampler and sampling rods into the boring to the desired sampling depth. After seating the sampler by means of a single hammer blow, three 6-inch increments shall be marked on the sampling rod so that the progress of the sampler can be monitored.

- The 2-inch OD split barrel sampler shall be driven with blows from a 140-lb. (± 2 lb.) hammer falling 30 inches (± 1 inch) until either a total of 50 blows have been applied during any one of the three 6-inch increments, a total of 100 blows have been applied, there is no observed advance of the sampler for 10 successive hammer blows, or until the sampler has advanced 18 inches without reaching any of the blow count limitation constraints described herein. This process is referred to as the Standard Penetration Test.

- A 300-lb. weight falling 18 inches is sometimes used to drive a 2-1/2-inch or 3-inch O.D. spoon sampler. This procedure is used where dense materials are enountered or when a large volume of sample is required. However, this method does not conform the ASTM specifications.

- Repeat this operation at intervals not greater than 5 feet in homogeneous strata, or as specified in the sampling plan.

- Record the number of blows required to effect each 6 inches of penetration or fraction thereof. The first 6 inches is considered to be seating drive. The sum of the number of blows required for the second and third 6 inches of penetration is termed the penetration resistance, N. If the sampler is driven less than 18 inches, the penetration resistance is that for the last 1 foot penetrated.

- Bring the sampler to the surface and remove both ends and one half of the split barrel so that the soil recovered rests in the remaining half of the barrel. Describe carefully the sample interval, recovery (length), composition, structure, consistency, color, condition, etc., of the recovered soil then put a representative portion of each sample into a jar, without ramming. Jars with samples not taken for chemical analysis shall be sealed with wax, or hermetically sealed (using a teflon cap liner) to prevent evaporation of the soil moisture, if the sample is to be later evaluated for moisture content. Affix labels to the jar and complete Chain-of-Custody and other required sample data forms. Protect samples against extreme temperature changes and breakage by placing them in appropriate cartons stored in a protected area. Pertinent data which shall be noted on the label or written on the jar lid for each sample includes the project number, boring number, sample number, depth interval, blow counts, and date of sampling.

- An addition to the sampler mentioned above is an internal liner, which is split longitudinally and has a thin-wall brass, steel, or paper liner inserted inside, which will preserve the sample. However, since the development of the thin-walled samplers (mentioned below) the split barrel sampler with liner has declined in use.

5.1.3 Thin Walled Tube (Shelby Tube) Sampling (ASTM D1587-83)

When it is desired to take undisturbed samples of soil, thin-walled seamless tube samplers (Shelby tubes) will be used. The following method will be used:

- Clean out the borehole to the sampling depth, being careful to minimize the chance for disturbance of the material to be sampled. In saturated materials, withdraw the drill bit slowly to prevent loosening of the soil around the borehole and maintain the water level in the hole at or above groundwater level.

- The use of bottom discharge bits or jetting through an open-tube sampler to clean out the hole shall not be allowed. Any side discharge bits are permitted.

- A stationary piston-type sampler may be required to limit sample disturbance and aid in retaining the sample. Either the hydraulically operated or control rod activated-type of stationary piston sampler may be used. Prior to inserting the tube sampler in the hole, check to ensure that the sampler head contains a check valve. The check valve is necessary to keep water in the sampling rods from pushing the sample out of the tube sampler during sample withdrawal and to maintain a suction within the tube to help retain the sample.

- To minimize chemical reaction between the sample and the sampling tube, brass tubes may be required, especially if the tube is stored for an extended time prior to testing. While steel tubes coated with shellac are less expensive than brass, they are more reactive, and shall only be used when the sample will be tested within a few days after sampling or if chemical reaction is not anticipated. With the sampling tube resting on the bottom of the hole and the water level in the boring at the groundwater level or above, push the tube into the soil by a continuous and rapid motion, without impacting or twisting. In no case shall the tube be pushed farther than the length provided for the soil sample. Allow about 3 inches in the tube for cuttings and sludge.

- Upon removal of the sampler tube from the hole, measure the length of sample in the tube and also the length penetrated. Remove disturbed material in the upper end of the tube and measure the length of sample again. After removing at least an inch of soil from the lower end and after inserting an impervious disk, seal both ends of the tube with at least a 1/2-inch thickness of wax applied in a way that will prevent the wax from entering the sample. Newspaper or other types of filler must be placed in voids at either end of the sampler prior to sealing with wax. Place plastic caps on the ends of the sampler, tape in the caps place, and dip the ends in wax.

- Affix labels to the tubes as required and record sample number, depth, penetration, and recovery length on the label. Mark the same information and "up" direction on the tube with indelible ink, and mark the end of the sample. Complete Chain-of-Custody and other required forms. Do not allow tubes to freeze and store the samples vertically (with the same orientation they had in the ground, i.e., top of sample is up) in a cool place out of the

sun at all times. Ship samples protected with suitable resilient packing material to reduce shock, vibration, and disturbance.

Thin-walled undisturbed tube samplers are restricted in their usage by the consistency of the soil to be sampled. Often, very loose and/or wet samples cannot be retrieved by the samplers, and soils with a consistency in excess of very stiff cannot be penetrated by the sampler. Devices such as Denison or Pitcher core samplers can be used to obtain undisturbed samples of stiff soils. Using these devices normally increases sampling costs and therefore their use shall be weighed against the increased cost and the need for an undisturbed sample. In any case, if a sample cannot be obtained with a tube sampler, an attempt shall be made with a split barrel sampler at the same depth so that at least a sample can be obtained for classification purposes.

5.1.4 Continuous Core Soil Samples

The CME continuous sample tube system provides a method of sampling soil continuously during hollow stem augering. The 5-foot sample barrel fits within the lead auger of a hollow auger column. The sampling system can be used with a wide range of I.D. hollow stem augers (from 3-1/4-inch to 8-1/4-inch I.D.). This method has been used to sample many different materials such as glacial drift, hard clays and shales, mine tailigs, etc. This method is particularly used when SPT samples are not required and a large volume of material is needed. Also, this method is useful when a visual description of the subsurface lithology is required.

5.2 SURFACE SOIL SAMPLES

For loosely packed earth or waste pile samples, stainless steel scoops or trowels can be used to collect representative samples. For densely packed soils or deeper soil samples, a hand or power soil auger may be used.

The following methods are to be used:

- Use a soil auger for deep samples (6 to 24 inches) or a scoop or trowel for surface samples. Remove debris, rocks, twigs, and vegetation before collection of soil. Mark the location with a numbered stake if possible and locate sample points on a sketch of the site.
- Use a new or freshly-decontaminated sampler for each sample taken. Attach a label and identification tag. Record all required information in the field logbook and on the sample log sheet, Chain-of-Custody record, and other required forms.
- Pack and ship accordingly.
- When a representative composited sample is to be prepared (e.g., samples taken from a gridded area or from several different depths), it is best to composite individual samples in the laboratory where they can be more precisely composited on a weight or volume basis. If this is not possible, the individual samples (all of equal volume, i.e., the sample bottles shall be full) shall be placed in a decontaminated stainless steel bucket, mixed thoroughly using a stainless steel spatula or trowel, and a composite sample collected.

5.3 WASTE PILE SAMPLES

The use of stainless steel scoops or trowels to obtain small discrete samples of homogeneous waste piles is usually sufficient for most conditions. Layered (nonhomogeneous) piles require the use of tube samplers to obtain cross-sectional samples.

- Collect small, equal portions of the waste from several points around the pile, penetrating it as far as practical. Use numbered stakes, if possible, to mark the sampling locations and locate sampling points on the site sketch.

- Place the waste sample in a glass container. Attach a label and identification tag. Record all the required information in the field logbook and on the sample log sheet and other required forms.

For layered, nonhomogeneous piles, grain samplers, sampling triers, or waste pile samplers must be used at several representative locations to acquire a cross-section of the pile. The basic steps to obtain each sample are

- Insert a sampler into the pile at a 0- to 45-degree angle from the horizontal to minimize spillage.

- Rotate the sampler once or twice to cut a core of waste material. Rotate the grain sampler inner tube to the open position and then shake the sampler a few times to allow the material to enter the open slits. Move the sampler into position with slots upward (grain sampler closed) and slowly withdraw from the pile.

5.4 ROCK SAMPLING (CORING) (ASTM D2113-83)

Rock coring enables a detailed assessment of borehole conditions to be made, showing precisely all lithologic changes and characteristics. Because coring is an expensive drilling method, it is commonly used for shallow studies of 500 feet or less, or for specific intervals in the drill hole that require detailed logging and/or analyzing. It can, however, proceed for thousands of feet continuously, depending on the size of the drill rig. It yields better quality data than air rotary drilling, although at a substantially reduced drilling rate. Rate of drilling varies widely, depending on the characteristics of lithologies encountered, drilling methods, depth of drilling, and condition of drilling equipment. Average output in a 10-hour day ranges from 40 to over 200 feet. Downhole geophysical logging or television camera monitoring is sometimes used to complement the data generated by coring.

Borehole diameter can be drilled to various sizes, depending on the information needed. Standard sizes of core barrels (showing core diameter) and casing are shown in Attachment No. 1.

Core drilling is used when formations are too hard to be sampled by soil sampling methods and a continuous solid sample is desired. Usually, soil samples are used for overburden, and coring begins in sound bedrock. Casing is set into bedrock before coring begins to prevent loose material from entering the borehole, to prevent loss of drilling fluid, and to prevent cross contamination of aquifers.

ATTACHMENT 1

STANDARD SIZES OF CORE BARRELS AND CASING

Coring bit size	Nominal *		Set size *	
	O.D.	I.D.	O.D.	I.D.
RWT	$1\frac{5}{32}$	$\frac{3}{4}$	1.160	.735
EWT	$1\frac{1}{2}$	$\frac{29}{32}$	1.470	905
EX, EXL, EWG, EWM	$1\frac{1}{2}$	$\frac{13}{16}$	1.470	.845
AWT	$1\frac{7}{8}$	$1\frac{9}{32}$	1.875	1.281
AX, AXL, AWG, AWM	$1\frac{7}{8}$	$1\frac{3}{16}$	1.875	1.185
BWT	$2\frac{3}{8}$	$1\frac{3}{4}$	2.345	1.750
BX, BXL, BWG, BWM	$2\frac{3}{8}$	$1\frac{5}{8}$	2.345	1.655
NWT	3	$2\frac{5}{16}$	2.965	2.313
NX, NXL, NWG, NWM	3	$2\frac{1}{8}$	2.965	2.155
HWT	$3\frac{29}{32}$	$3\frac{3}{16}$	3.889	3.187
HWG	$3\frac{29}{32}$	3	3.889	3.000
$2\frac{3}{4} \times 3\frac{7}{8}$	$3\frac{7}{8}$	$2\frac{3}{4}$	3.840	2.690
$4 \times 5\frac{1}{2}$	$5\frac{1}{2}$	4	5.435	3.970
$6 \times 7\frac{3}{4}$	$7\frac{3}{4}$	6	7.655	5.970
AX Wire line 1/	$1\frac{7}{8}$	1	1.875	1.000
BX Wire line 1/	$2\frac{3}{8}$	$1\frac{7}{16}$	2.345	1.437
NX Wire line 1/	3	$1\frac{15}{16}$	2.965	1.937

* All dimensions are in inches; to convert to millimeters, multiply by 254.
1/ Wire line dimensions and designations may vary according to manufacturer.

ATTACHMENT 1
PAGE TWO

Size Designations			Casing coupling					Approximate core diameter	
Casing; Casing coupling; Casing bits; Core barrel bits	Rod; Rod couplings	Casing O.D., inches	O.D., inches	I.D., inches	Casing bit, O.D., inches	Core barrel bit O.D., inches*	Drill rod O.D., inches	Normal, inches	Thinwall, inches
RX	RW	1.437	1.437	1.188	1.485	1.160	1.094	—	735
EX	E	1.812	1.812	1.500	1.875	1.470	1.313	.845	.905
AX	A	2.250	2.250	1.906	2.345	1.875	1.625	1.185	1.281
BX	B	2.875	2.875	2.375	2.965	2.345	1.906	1.655	1.750
NX	N	3.500	3.500	3.000	3.615	2.965	2.375	2.155	2.313
HX	HW	4.500	4.500	3.938	4.625	3.890	3.500	3.000	3.187
RW	RW	1.437	Flush joint	No coupling	1.485	1.160	1.094	—	.735
EW	EW	1.812			1.875	1.470	1.375	.845	.905
AW	AW	2.250			2.345	1.875	1.750	1.185	1.281
BW	BW	2.875			2.965	2.345	2.125	1.655	1.750
NW	NW	3.500			3.615	2.965	2.625	2.155	2.313
HW	HW	4.500			4.625	3.890	3.500	3.000	3.187
PW	—	5.500			5.650	—	—	—	—
SW	—	6.625			6.790	—	—	—	—
UW	—	7.625			7.800	—	—	—	—
ZW	—	8.625			8.810	—	—	—	—
—	AX 1/	—	—	—	—	1.875	1.750	1.000	—
—	BX 1/	—	—	—	—	2.345	2.250	1.437	—
—	NX 1/	—	—	—	—	2.965	2.813	1.937	—

* For hole diameter approximation, assume $\frac{1}{32}$ inch larger than core barrel bit.

1/ Wire line size designation, drill rod only, serves as both casing and drill rod. Wire line core bit, and core diameters vary slightly according to manufacturer.

NOMINAL DIMENSIONS FOR DRILL CASINGS AND ACCESSORIES. (DIAMOND CORE DRILL MANUFACTURERS ASSOCIATION). 288-D-2889.

Drilling through bedrock is initiated by using a diamond-tipped core bit threaded to a drill rod (outer core barrel) with a rate of drilling determined by the downward pressure, rotation speed of drill rods, drilling fluid pressure in the borehole, and the characteristics of the rock (mineralogy, cementation, weathering).

5.4.1 Diamond Core Drilling

A p netration of typically less than 6 inches per 50 blows using a 140-lb. hammer dropping 30 inches with a 2-inch split spoon sampler shall be considered an indication that soil sampling methods may not be applicable and that coring may be necessary to obtain samples.

When formations are encountered that are too hard to be sampled by soil sampling methods, the following diamond core drilling procedure may be used.

- Firmly seat a casing into the bedrock or the hard material to prevent loose materials from entering the hole and to prevent the loss of drilling fluid return. Level the surface of the rock or hard material when necessary by the use of a fishtail or other bits. If the drill hole can be retained open without the casing and if cross contamination of aquifers in the unconsolidated materials is unlikely, it may be omitted.

- Begin the core drilling using a double-tube swivel-core barrel of the desired size. After drilling no more than 10 feet (3 m), remove the core barrel from the hole, and take out the core. If the core blocks the flow of the drilling fluid during drilling, remove the core barrel immediately. In soft materials, a large starting size may be specified for the coring tools; where local experience indicates satisfactory core recovery or where hard, sound materials are anticipated, a smaller size or the single-tube type may be specified and longer runs may be drilled. NX/NW size coring equpment is the most commonly used size.

- When soft materials are encountered that produce less than 50 percent recovery, stop the core drilling. If soil samples are desired, secure such samples in accordance with the procedures described in ASTM Method D 1586 (Split Barrel Sampling) or in Method D 1587 (Thin-Walled Tube Sampling) for Sampling of Soils (see Section 5.1.1 and 5.1.2). Resume diamond core drilling when refusal materials are again encountered.

- Since rock structures and the occurrence of seams, fissures, cavities, and broken areas are among the most important items to be detected and described, take special care to obtain and record these features. If such broken zones or cavities prevent further advance of the boring, one of the following three steps shall be taken: (1) cement the hole; (2) ream and case; or (3) case and advance with the next smaller size core barrel, as the conditions warrant.

- In soft, seamy, or otherwise unsound rock, where core recovery may be difficult, M-design core barrels may be used. In hard, sound rock where a high percentage of core recovery is anticipated, the single-tube core barrel may be employed.

5.4.2 Rock Sample Preparation and Documentation

Once the rock coring has been completed and the core recovered, the rock core shall be carefully removed from the barrel, placed in a core tray (previously labeled "top" and "bottom" to avoid confusion), classified, and measured for percentage of recovery as well as the rock quality designation (RQD). Each core shall be described, classified, and logged using a uniform system as presented in Procedure GH-1.5. If moisture content will be determined or if it is desirable to prevent drying (e.g.,

to prevent shrinkage of clay formations) or oxidation of the core, the core shall be wrapped in plastic sleeves immediately after logging. Each plastic sleeve shall be labeled with indelible ink. The boring number, run number, and the footage represented in each sleeve shall be included, as well as the top and bottom of the core run.

After sampling, rock cores shall be placed in the sequence of recovery in well-constructed wooden boxes provided by the drilling contractor. Rock cores from two different borings shall not be placed in the same core box unless accepted by the Site Geologist. The core boxes shall be constructed to accommodate at least 20 linear feet of core in rows of approximately 5 feet each and shall be constructed with hinged tops secured with screws, and a latch (usually a hook and eye) to keep the top securely fastened down. Wood partitions shall be placed at the end of each core run and between rows. The depth from the surface of the boring to the top and bottom of the drill run and run number shall be marked on the wooden partitions with indelible ink. A wooden partition (wooden block) shall be placed at the end of each run with the depth of the bottom of the run written on the block. These blocks will serve to separate successive core runs and indicate depth intervals for each run. The order of placing cores shall be the same in all core boxes. Rock core shall be placed in the box so that, when the box is open, with the inside of the lid facing the observer,the top of the cored interval contained within the box is in the upper left corner of the box,and the bottom of the cored interval is in the lower right corner of the box (see Attachment 2). The top and bottom of each core obtained and its true depth shall be clearly and permanently marked on each box. The width of each row must be compatible with the core diameter to prevent lateral movement of the core in the box. Similarly, an empty space in a row shall be filled with an appropriate filler material or spacers to prevent longitudinal movement of the core in the box.

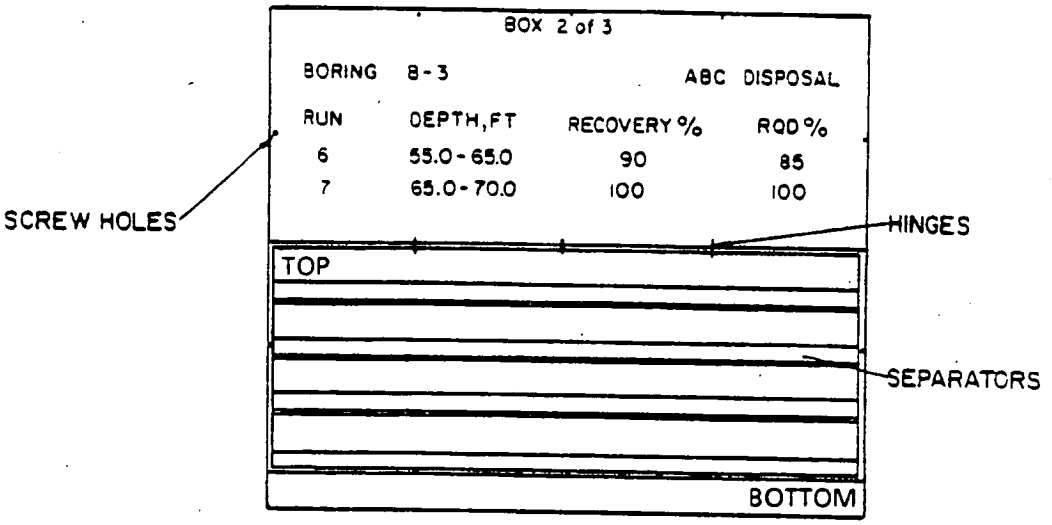
The inside and outside of the core-box lid shall be marked by indelible ink to show all pertinent data on the box's contents. At a minimum, the following information shall be included:

- Project name
- Project number
- Boring number
- Run numbers
- Footage (depths)
- Recovery
- RQD (%)
- Box number and total number of boxes for that boring (Example: Box 5 of 7).

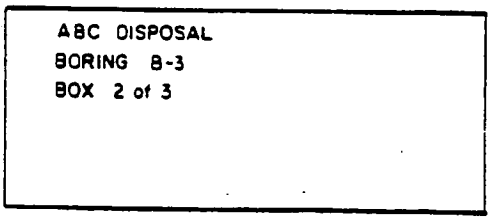
For easy retrieval when core boxes are stacked, the sides and ends of the box shall also be labeled and include project number, boring number, top and bottom depths of core and box number. Attachment No. 2 illustrates a typical rock core box.

Prior to final closing of the core box, a photograph of the recovered core and the labeling on the inside cover shall be taken. If moisture content is not critical, the core shall be wetted and wiped clean for the photograph. (This will help to show true colors and bedding features in the cores).

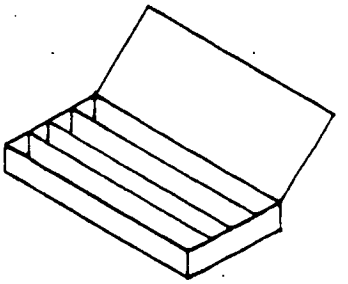
ATTACHMENT 2

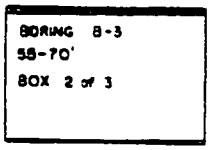


CORE BOX (OBLIQUE VIEW)



CORE BOX (TOP VIEW)





CORE BOX (END VIEW)

TYPICAL ROCK CORE BOX

NOT TO SCALE

NUS CORPORATION
A Halliburton Company

6.0 REFERENCES

American Society for Testing and Materials, 1985. Method for Penetration Test and Split Barrel Sampling of Soils. ASTM Method D 1586-84, Annual Book of Standards, ASTM, Philadelphia, Pennsylvania.

American Society for Testing and Materials, 1985. Thin-Walled Tube Sampling of Soils. Method D-1587-83, Annual Book of Standards, ASTM, Philadelphia, Pennsylvania.

Acker Drill Co., 1958. Basic Procedures of Soil Sampling. Acker Drill Co., Scranton, Pennsylvania.

American Society for Testing and Materials, 1989. Standrd Practice for Diamond Core Drilling for Site Investigation. ASTM Method D2113-83 (reapproved 1987), Annual Book of Standards, ASTM, Philadelphia, Pennsylvania.

U.S. Department of the Interior, 1974, Earth Manual, A Water Resources Technical Publication, 810 pages.

Central Mine Equipment Company, Drilling Equipment, St. Louis, Missouri.

7.0 RECORDS

None.

NUS CORPORATION ENVIRONMENTAL MANAGEMENT GROUP	STANDARD OPERATING PROCEDURES	Number GH-1.7	Page 1 of 17
		Effective Date 05/04/90	Revision 1
		Applicability EMG	
		Prepared Earth Sciences	
Subject GROUNDWATER MONITORING POINT INSTALLATION		Approved D. Senovich	

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1.0 PURPOSE

This procedure describes methods for proper monitoring well design, installation, and development.

2.0 SCOPE

This procedure is applicable to the construction of permanent monitoring wells at hazardous waste sites. The methods described herein may be modified by project-specific requirements for monitoring well construction. In addition, many regulatory agencies have specific regulations pertaining to monitoring well construction and permitting. These requirements must be ascertained during the development of the investigation and any required permits which may have to be obtained before field work begins. Innovative monitoring well installation techniques, which typically are not used, will be discussed only generally in this procedure.

3.0 GLOSSARY

Monitoring Well - A well which is properly screened (if screening is necessary), cased, and sealed which is capable of providing a groundwater level and groundwater sample representative of the zone being monitored.

Piezometer - A pipe or tube inserted into the water bearing zone, typically open to water flow at the bottom and to the atmosphere at the top, and used to measure water level elevations. Piezometers may range in size from 1/2-inch diameter plastic tubes to well points or monitoring wells.

Potentiometric Surface - The surface to which water in an aquifer would rise by hydrostatic pressure.

Well Point (Drive Point) - A screened or perforated tube (Typically 1-1/4 or 2 inches in diameter) with a solid, conical, hardened point at one end, which is attached to a riser pipe and driven into the ground with a sledge hammer, drop weight, or mechanical vibrator. Well points may be used for groundwater injection and recovery, as piezometers (i.e., to measure water levels) or to provid groundwater samples for water quality data.

4.0 RESPONSIBILITIES

Driller - The driller provides adequate and operable equipment, sufficient quantities of materials, and an experienced and efficient labor force to perform all phases of proper monitoring well installation and construction. He may also be responsible for obtaining, in advance, any required permits for monitoring well installation and construction.

Rig Geologist - The rig geologist supervises well installation and construction by the Driller, documents all phases of well installation and construction, and insures that well construction is adequate to provide representative ground water data from the monitored interval. Geotechnical engineers, field technicians, or other suitable trained personnel may also serve in this capacity.

5.0 PROCEDURES

5.1 EQUIPMENT/ITEMS NEEDED

Below is a list of items that may be needed while installing a monitoring well.

- Health and safety equipment as required by the site safety officer.
- Well drilling and installation equipment with associated materials (typically supplied by the driller).
- Hydrogeologic equipment (weighted engineers tape, water level indicator, retractable engineers rule electronic calculator, clipboard, mirror and flashlight - for observing downhole activities, paint and ink marker for marking monitoring wells, sample jars, well installation forms, and a field notebook).
- Drive point installations tools (Sledge Hammer, drop hammer, or mechanical vibrator; tripod, pipe wrenches, drive points, riser pipe, and end caps).

5.2 WELL DESIGN

The objectives for each monitoring well and its intended use must be clearly defined before the monitoring system is designed. Within the monitoring system, different monitoring wells may serve different purposes and, therefore, require different types of construction. During all phases of the well design, attention must be given to clearly documenting the basis for design decisions, the details of well construction, and the materials to be used. The objectives for installing the monitoring wells may include:

- Determining groundwater flow directions and velocities.
- Sampling or monitoring for trace contaminants.
- Determining aquifer characteristics (e.g., hydraulic conductivity)

Siting of monitoring wells shall be performed after a preliminary estimation of the groundwater flow direction. In most cases, these can be determined through the review of geologic data and the site terrain. In addition, production wells or other monitoring wells in the area may be used to determine the groundwater flow direction. If these methods cannot be used, piezometers, which are relatively inexpensive to install, may have to be installed in a preliminary phase to determine groundwater flow direction.

5.2.1 Well Depth, Diameter, and Monitored Interval

The well depth, diameter, and monitored internal must be tailored to the specific monitoring needs of each investigation. Specification of these items generally depends on the purpose of the monitoring system and the characteristics of the hydrogeologic system being monitored. Wells of different depth, diameter, and monitored interval can be employed in the same groundwater monitoring system. For instance, varying the monitored interval in several wells, at the same location (cluster wells) can help to determine the vertical gradient and the levels at which contaminants are present. Conversly, a fully penetrating well is usually not used to quantify or vertically locate a contamination plume, since groundwater samples collected in wells that are screened over the full thickness of the water bearing zone will be representative of average conditions across the entire monitored interval. However, fully penetrating wells can be used to establish the existence of

contamination in water bearing zone. The well diameter would depend upon the hydraulic characteristics of the water bearing zone. Sampling requirements, drilling method and cost.

The decision concerning the monitored interval and well depth is based on the following information:

- The vertical location of the contaminant source in relation to the water bearing zone.
- The depth, thickness and uniformity of the water bearing zone.
- The anticipated depth, thickness, and characteristics (e.g., density relative to water) of the contaminant plume.
- Fluctuation in groundwater levels (due to pumping, tidal influences, or natural recharge/discharge events).
- The presence and location of contaminants encountered during drilling.
- Whether the purpose of the installation is for determining existence or non-existence of contamination or if a particular stratigraphic zone is being investigated.
- The analysis of borehole geophysical logs.

In most situations where groundwater flow lines are horizontal, depending on the purpose of the well and the site conditions, monitored intervals are 20 feet or less. Shorter screen lengths (1 to 2 feet) are usually required where flow lines are not horizontal, (ie., if the wells are to be used for accurate measurement of the potentiometric head at a specific point).

Many factors influence the diameter of a monitoring well. The diameter of the monitoring well depends on the application. In determining well diameter, the following needs must be considered:

- Adequate water volume for sampling.
- Drilling methodology.
- Type of sampling device to be used.
- Costs

Standard monitoring well diameters are 2, 4, 6, or 8 inches. However, drive points are typically 1-1/4 or 2 inches in diameter. For monitoring programs which require screened monitoring wells, either a 2-inch or 4-inch diameter well is preferred. Typically, well diameters greater than 4 inches are used in monitoring programs in which open hole monitoring wells are required. In the smaller diameter wells, the volume of stagnant water in the well is minimized, and well construction costs are reduced, however, the type of sampling devices that can be used are limited. In specifying well diameter, sampling requirements must be considered. Up to a total of 4 gallons of water may be r quired for a single sample to account for full organic and inorganic analyses, and split samples. The water in the monitoring well available for sampling is dependent on the well diameter as follows:

Casing Inside Diameter, Inch	Standing Water Depth to Obtain 1 Gal Water (feet)	Total Depth of Standing Water for 4 Gal. (feet)
2	6.13	25
4	1.53	6
6	0.68	3

However, if a specific well recharges quickly after purging, then well diameter may not be an important factor regarding sample volume requirements.

Pumping tests for determining aquifer characteristics may require larger diameter wells; however, in small diameter wells.in-situ permeability tests can be performed during drilling or aft r well installation is completed.

5.2.2 Riser Pipe and Screen Materials

Well materials are specified by diameter, type of material, and thickness of pipe. Well screens require an additional specification of slot size. Thickness of pipe is referred to as "schedule" for polyvinyl chloride (PVC) casing and is usually Schedule 40 (thinner wall) or 80 (thicker wall). Steel pipe thickness is often referred to as "Strength" and Standard Strength is usually adequate for monitoring well purposes. With larger diameter pipe, the wall thickness must be greater to maintain adequate strength. The required thickness is also dependent on the method of installation;-risers for drive points require greater strength than wells installed inside drilled borings.

The selection of well screen and riser materials depends on the method of drilling, the type of subsurface materials in which the well penetrates, the type of contamination expected, and natural water quality and depth. Cost and the level of accuracy required are also important. The materials generally available are Teflon, stainless steel, PVC, galvanized steel, and carbon steel. Each has advantages and limitations (see Attachment A of this guideline for an extensive discussion on this topic). The two most commonly used materials are PVC and stainless steel for wells in which screens are installed and are compared in Attachment B. Stainless steel is preferred where trace metals or organic sampling is required; however, costs are high. Teflon materials are extremely expensive, but are relatively inert and provide the least opportunity for water contamination due to well materials. PVC has many advantages, including low cost, excellent availability, light weight, and ease of manipulation; however, there are also some questions about organic chemical sorption and leaching that are currently being researched (see Barcelona et al., 1983). Concern about the use of PVC can be minimized if PVC wells are used strictly for geohydrologic measurements and not for chemical sampling. The crushing strength of PVC may limit the depth of installation, but schedule 80 materials normally used for wells greater than 50 feet deep may overcome some of the problems associated with depth. However, the smaller inside diameter of Schedule 80 pipe may be an important factor when considering the size of bailers or pumps to be used for sampling or testing. Due to this problem, the minimum well pipe size recommended for schedule 80 wells is 4 inch I.D.

Screens and risers may have to be decontaminated before use because oil-based preservatives and oil used during thread cutting and screen manufacturing may contaminate samples. Metal pipe, may corrode and release metal ions or chemically react with organic constituents, but this is considered by some to be less of a problem than the problem associated with PVC material. Galvanized steel is not recommended for metal analyses, as zinc and cadmium levels in groundwater samples may be elevated from the zinc coating.

Threaded, flush-joint casing is most often preferred for monitoring well applications. PVC, Teflon, and steel can all be obtained with threaded joints at slightly more costs. Welded-joint steel casing is also acceptable. Glued PVC may release organic contamination into the well and therefore should not be used if the well is to be sampled for organic contaminants.

When the water bearing zone is in consolidated bedrock, such as limestone or fractured granite, a well screen is often not necessary (the well is simply an open hole in bedrock). Unconsolidated materials, such as sands, clay, and silts require a screen. A screen slot size of 0.010 or 0.020 inch is generally used when a screen is necessary and the screened interval is artificially packed with a fine sand. The slot size controls the quantity of water entering the well and prevents entry of natural materials or sand pack. The screen shall pass no more than 10 percent of the pack material, or in-situ aquifer material. The rig geologist shall specify the combination of screen slot size and sand pack which will be compatible with the water bearing zone, to maximize groundwater inflow and minimize head losses and movement of fines into the wells. (For example, as a standard procedure, a Morie No. 1 or Ottowa sand may be used with a 0.010-inch slot screen, however, with a 0.020-inch slot screen, the filter pack material must be the material retained on a No. 20 to No. 30 U.S. standard sieve.)

5.2.3 Annular Materials

Materials placed in the annular space between the borehole and riser pipe and screen include a sand pack when necessary, a bentonite seal, and cement-bentonite grout. The sand pack is usually a fine to medium grained well graded, silica sand. The quantity of sand placed in the annular space is dependent upon the length of the screened interval but should always extend at least 1 foot above the top of the screen. At least one to three feet of bentonite pellets or equivalent shall be placed above the sand pack. The cement-bentonite grout or equivalent extends from the top of the bentonite pellets to the ground surface.

On occasion, and with the concurrence of the involved regulatory agencies, monitoring wells may be packed naturally, i.e., no artificial sand pack will be installed, and the natural formation material will be allowed to collapse around the well screen after the well is installed. This method has been utilized where the formation material itself is a relatively uniform grain size, or when artificial sand packing is not possible due to borehole collapse.

Bentonite expands by absorbing water and provides a seal between the screened interval and the overlying portion of the annular space and formation. Cement-bentonite grout is placed on top of the bentonite pellets to the surface. The grout effectively seals the well and eliminates the possibility for surface infiltration reaching the screened interval. Grouting also replaces material removed during drilling and prevents hole collapse and subsidence around the well. A tremie pipe should be used to introduce grout from the bottom of the hole upward, to prevent bridging and to provide a better seal. However, in boreholes that don't collapse, it may be more practical to pour the grout from the surface without a tremie pipe.

Grout is a general term which has several different connotations. For all practical purposes within the monitoring well installation industry, grout refers to the solidified material which is installed and occupies the annular space above the bentonite pellet seal. Grout, most of the time, is made up of two assemblages of material, i.e., a cement-bentonite grout. A cement bentonite grout normally is a mixture of cement, bentonite and water at a ratio of one 90-pound bag of Portland Type I cement, 3-5 pounds of granular or flake-type bentonite and 6 gallons of water. A neat cement is made up of one ninety-pound bag of Portland Type I cement and 6 gallons of water.

In certain cases, the borehole may be drilled to a depth greater than the anticipated well installation depth. For these cases, the well shall be backfilled to the desired depth with bentonite pellets or equivalent. A short (1'-2') section of capped riser pipe sump is sometimes installed immediately below the screen, as a silt reservoir, when significant post-development silting is anticipated. This will ensure that the entire screen surface remains unobstructed.

5.2.4 Protective Casing

When the well is completed and grouted to the surface, a protective steel casing is often placed over the top for the well. This casing generally has a hinged cap and can be locked to prevent vandalism. A vent hole shall be provided in the cap to allow venting of gases and maintain atmospheric pressure as water levels rise or fall in the well. The protective casing has a larger diameter than the well and is set into the wet cement grout over the well upon completion. In addition, one hole is drilled just above the cement collar through the protective casing which acts as a weep hole for the flow of water which may enter the annulus during well development, purging, or sampling.

A Protective casing which is level with the ground surface is used in roadway or parking lot applications where the top of a monitoring well must be below the pavement. The top of the riser pipe is placed 4 to 5 inches below the pavement, and a locking protective casing is cemented in place to 3 inches below the pavement. A large diameter protective sleeve is set into the wet cement around the well with the top set level with the pavement. A manhole type lid placed over the protective sleeve. The cement should be slightly mounded to direct pooled water away from the well head.

5.3 MONITORING WELL INSTALLATION

5.3.1 Monitoring Wells in Unconsolidated Sediments

After the borehole is drilled to the desired depth, well installation can begin. The procedure for well installation will partially be dictated by the stability of the formation in which the well is being placed. If the borehole collapses immediately after the drilling tools are withdrawn, then a temporary casing must be installed and well installation will proceed through the center of the temporary casing, and continue as the temporary casing is withdrawn from the borehole. In the case of hollow stem auger drilling, the augers will act to stabilize the borehole during well installation.

Before the screen and riser pipe are lowered into the borehole, all pipe and screen sections should be measured with an engineers rule to ensure proper well placement. When measuring sections, the threads on one end of the pipe or screen must be excluded while measuring, since the pipe and screen sections are screwed flush together.

After the screen and riser pipe are lowered through the temporary casing, then the sand pack can be installed. A weighted tape measure must be used during the procedure in order to carefully monitor installation progress. The sand is poured into the annulus between the riser pipe and temporary casing, as the casing is withdrawn. Sand should always be kept within the temporary casing during withdrawal in order to ensure an adequate sand pack. However, if too much sand is within the temporary casing (greater than 1 foot above the bottom of the casing) bridging between the temporary casing and riser pipe may occur.

After the sand pack is installed to the desired depth, (at least 1 foot above the top of the screen) then the bentonite pellet seal or equivalent, can be installed, in the same manner as the sand pack. At least 1 to 3 feet of bentonite pellets should be installed above the sand pack.

The cement-bentonite grout is then mixed and either poured or tremied into the annulus as the temporary casing or augers are withdrawn. Finally, the protective casing can be installed as detailed in Section 5.2.4.

In stable formations where borehole collapse does not occur, the well can be installed as discussed above, and the use of a temporary casing is not needed. However, centralizers may have to be installed, one above, and one below the screen, to assure enough annular space for sand pack placement. A typical overburden monitoring well sheet is shown.

5.3.2 Confining Layer Monitoring Wells

When drilling and installing a well in a confined aquifer, proper well installation techniques must be applied to avoid cross contamination between. Under most conditions, this can be accomplished by installing double-cased wells. This is accomplished by drilling a large diameter boring through the upper aquifer, 1 to 3 feet into the underlying confining layer, and setting and pressure grouting or tremie grouting the outer casing into the confining layer. The grout material must fill the space between the native material and the outer casing. A smaller diameter boring is then continued through the confining layer for installation of the monitoring well as detailed for overburden monitoring wells, with the exception of not using a temporary casing during installation. Sufficient time which will be determined by the rig geologist, must be allowed for setting of the grout prior to drilling through the confined layer. A typical confining layer monitoring well sheet is shown in Attachment C.

5.3.3 Bedrock Monitoring Wells

When installing bedrock monitoring wells, a large diameter boring is drilled through the overburden and approximately 5 feet into the bedrock. A casing (typically steel) is installed and either pressure grouted or tremie grouted in place. After the grout is cured, a smaller diameter boring is continued through the bedrock to the desired depth. If the boring does not collapse, the well can be left open, and a screen is not necessary. If the boring collapses, then a screen is required and can be installed as detailed for overburden monitoring wells. However, if a screen is to be used, then the casing which is installed through the overburden and into the bedrock does not require grouting and can be installed temporary until final well installation is completed. Typical well construction forms for b drock monitoring wells are shown in Attachment C.

5.3.4 Drive Points

Drive points can be installed with either a sledge hammer, drop hammer, or a mechanical vibrator. The screen is threaded and tightened onto the riser pipe with pipe wrenches. The drive point is simply pounded into the subsurface to the desired depth. If a heavy drop hammer is used, then a tripod and pulley setup is required to lift the hammer. Drive points typically cannot be driven to depths exceeding 10 feet.

5.3.5 Innovative Monitoring Well Installation Techniques

Certain innovative sampling devices have proven advantageous. These devices are essentially screened samplers installed in a borehole with only one or two small-diameter tubes extending to the surface. Manufacturers of these types of samplers claim that four samplers can be installed in a 3-inch diameter borehole. This reduces drilling costs, decreases the volume of stagnant water, and provides a sampling system that minimizes cross contamination from sampling equipment. These samplers also perform w ll when the water table is within 25 feet from the surface (the typical range of suction pumps). Two manufacturers of these samplers are Timco Manufacturing Company, Inc., of

Prairie du Sac, Wisconsin, and BARCAD Systems, Inc., of Concord, Massachusetts. Each offers various construction materials.

Two additional types of multilevel sampling systems have been developed. Both employ individual screened openings through a small-diameter casing. One of these systems (marketed by Westbay Instruments Ltd. of Vancouver, British Columbia, Canada) uses a screened port and a sampling probe to obtain samples and head measurements or perform permeability tests. this system allows sampling ports at intervals as close as 5 feet, if desired, in boreholes from 3 to 4.8 inches in diameter.

The other system, developed at the University of Waterloo at Waterloo, Ontario, Canada, requires field assembly of the individual sampling ports and tubes that actuate a simple piston pump and force the samples to the surface. Where the depth to ground water is less than 25 feet, the piston pumps are not required. The assembly is made of easily obtained materials; however, the cost of labor to assemble these monitoring systems may not be cost-effective.

5.4 WELL DEVELOPMENT METHODS

The purpose of well development is to stabilize and increase the permeability of the gravel pack around the well screen, and to restore the permeability of the formation which may have been reduced by drilling operations. Wells are typically developed until all fine material and drilling water is removed from the well. Sequential measurements of pH, conductivity and temperature taken during development may yield information (stabilized values) that sufficient development is reached. The selection of the well development method (shall) be made by the rig geologist and is based on the drilling methods, well construction and installation details, and the characteristics of the formation that the well is screened in. The primary methods of well development are summarized below. A more detailed discussion may be found in Driscoll (1986).

Overpumping and Backwashing - Wells may be developed by alternatively drawing the water level down at a high rate (by pumping or bailing) and then reversing the flow direction (backwashing) so that water is passing from the well into the formation. This back and forth movement of water through the well screen and gravel pack serves to remove fines from the formation immediately adjacent to the well, while preventing bridging (wedging) of sand grains. Backwashing can be accomplished by several methods including pouring water into the well and then bailing, starting and stopping a pump intermittently to change water levels, or forcing water into the well under pressure through a water-tight fitting ("rawhiding"). Care should be taken when backwashing not to apply too much pressure, which could damage or destroy the well screen.

Surging with a Surge Plunger - A surge plunger (also called a surge block) is approximately the same diameter as the well casing and is used to agitate the water, causing it to move in and out of the screens. This movement of water rpulls fine materials into the well, where they may be removed by any of several methods, and prevents bridging of sand particles in the gravel pack. There are two basic types of surge plungers; solid and valved surge plungers. In formations with low yields, a valved surge plunger may be preferred, as solid plungers tend to force water out of the well at a greater rate than it will flow back in. Valved plungers are designed to produce a greater inflow than outflow of water during surging.

Compressed Air - Compressed air can be used to develop a well by either of two methods: backwashing or surging. Backwashing is done by forcing water out through the screens, using increasing air pressure inside a sealed well, then releasing the pressurized air to allow the water to flow back into the well. Care should be taken when using this method so that the water level does not drop below the top of the screen, thus reducing well yield. Surging, or the "open well" method, consists of alternately releasing large volumes of air suddenly into an open well below the water level

to produce a strong surge by virtue of the resistance of water head, friction, and inertia. Pumping the well is subsequently done with the air lift method.

High Velocity Jetting - In the high velocity jetting method, water is forced at high velocities from a plunger-type device and through the well screen to loosen fine particles from the sand pack and surrounding formation. The jetting tool is slowly rotated and raised and lowered along the length of the well screen to develop the entire screened area. Jetting using a hose lowered into the well may also be effective. The fines washed into the screen during this process can then be bailed or pumped from the well.

6.0 REFERENCES

Scalf, M. R., J. F. McNabb, W. J. Dunlap, R. L. Cosby, and J. Fryberger, 1981. Manual of Groundwater Sampling Procedures. R. S. Kerr Environmental Research Laboratory, Office of Research and Development, U.S. EPA, Ada, Oklahoma.

Barcelona, M. J., P. P. Gibb and R. A. Miller, 1983. A Guide to the selection of Materials for Monitoring Well Construction and Groundwater Sampling. ISWS Contract Report 327, Illinois State Water Survey, Champaign, Illinois.

U.S. EPA, 1980. Procedures Manual for Groundwater Monitoring of Solid Waste Disposal Facilities. Publication SW-611, Office of Solid Waste, U.S. EPA, Washington, D.C.

Driscoll, Fletcher G., 1986. Groundwater and Wells. Johnson Division, St. Paul, Minnesota, 1989 p.

7.0 RECORDS

A critical part of monitoring well installation is recording of significant details and events in the field notebook. The Geologist must record the exact depths of significant hydrogeological features screen placement, gravel pack placement, and bentonite placement.

A Monitoring Well Sheet (Attachment C) shall be used which allows the uniform recording of data for each installation and rapid identification of missing information. Well depth, length, materials of construction, length and openings of screen, length and type of riser, and depth and type of all backfill materials shall be recorded. Additional information (shall) include location, installation date, problems encountered, water levels before and after well installation, cross-reference to the geologic boring log, and methods used during the installation and development process. The documentation is very important to prevent problems involving questionable sample validity. Somewhat different information will need to be recorded.depending on whether the well is completed in overburden, in a confined layer, in bedrock with a cased well, or as an open hole in bedrock.

The quantities of sand, bentonite, and grout placed in the well are also important. The Geologist shall calculate the annular space volume and have a general idea of the quantity of material needed to fill the annular space. Volumes of backfill significantly higher than the calculated volume may indicate a problem such as a large cavity, while a smaller backfill volume may indicate a cave-in. Any problems with rig operation or down time shall be recorded and may determine the driller's final fee.

ATTACHMENT A

TABLE 7-4 RELATIVE COMPATIBILITY OF RIGID WELL-CASING MATERIAL (PERCENT)

	PVC 1	Galvanized Steel	Carbon Steel	Lo-carbon Steel	Stainless steel 304	Stainless steel 316	Teflon*
Buffered Weak Acid	100	56	51	59	97	100	100
Weak Acid	98	59	43	47	96	100	100
Miner Acid/High Solids	100	48	57	60	80	82	100
Aqueous/Organic Mixtures	64	69	73	73	98	100	100
Percent Overall Rating	91	58	56	59	93	96	100

Preliminary Ranking of Rigid Materials

1 Teflon®
2 Stainless Steel 316
3 Stainless Steel 304
4 PVC 1
5 Lo-Carbon Steel
6 Galvanized Steel
7 Carbon Steel
* Trademark of DuPont

RELATIVE COMPATIBILITY OF SEMI-RIGID OR ELASTOMERIC MATERIALS (PERCENT)

	PVC Flexible	PP	PE Conv.	PE Linear	PMM	Viton®*	Silicone	Neoprene	Teflon®*
Buffered Weak Acid	97	97	100	97	90	92	87	85	100
Weak Acid	92	90	94	96	78	78	75	75	100
Mineral Acid/High Solids	100	100	100	100	95	100	78	82	100
Aqueous/Organic Mixtures	62	71	40	60	49	78	49	44	100
Percent Overall Rating	88	90	84	88	78	87	72	72	100

Preliminary Ranking of Semi-Rigid or Elastomeric Materials

1 Teflon®
2 Polypropylene (PP)
3 PVC flexible/PE linear
4 Viton®
5 PE Conventional
6 Plexiglas/Lucite (PMM)
7 Silicone/Neoprene
Source: Barcelona et al., 1983
* Trademark of DuPont

ATTACHMENT B

COMPARISON OF STAINLESS STEEL AND PVC FOR MONITORING WELL CONSTRUCTION

Characteristic	Stainless Steel	PVC
Strength	Use in deep wells to prevent compression and closing of screen/riser.	Use when shear and compressive strength not critical.
Weight	Relatively heavier	Lightweight, floats in water
Cost	Relatively expensive	Relatively inexpensive
Corrosivity	Deteriorates more rapidly in corrosive water	Non-corrosive--may deteriorate in presence of ketones, aromatics, alkyl sulfides, or some chlorinated HC
Ease of Use	Difficult to adjust size or length in the field.	Easy to handle and work in the field.
Preparation for Use	Should be steam-cleaned for organics sampling	Never use glue fittings--pipes should be threaded or pressure-fitted. Should be steam cleaned if used for monitoring wells.
Interaction with Contaminants*	May sorb organic or inorganic substances when oxidized	May sorb or release organic substances.

* See also Attachment A.

ATTACHMENT C

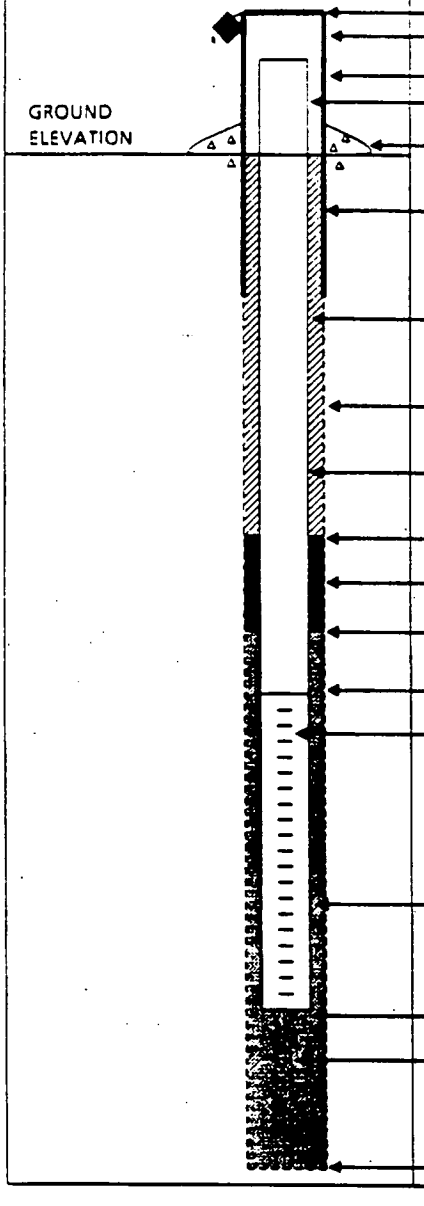
NUS CORPORATION
A Halliburton Company

BORING NO _____

OVERBURDEN MONITORING WELL SHEET

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

DRILLER _____
DRILLING METHOD _____
DEVELOPMENT METHOD _____



ELEVATION OF TOP OF SURFACE CASING : _____
ELEVATION OF TOP OF RISER PIPE: _____

STICK - UP TOP OF SURFACE CASING: _____
STICK - UP RISER PIPE : _____

TYPE OF SURFACE SEAL: _____

I.D. OF SURFACE CASING: _____
TYPE OF SURFACE CASING: _____

RISER PIPE I.D. _____
TYPE OF RISER PIPE: _____

BOREHOLE DIAMETER: _____

TYPE OF BACKFILL: _____

ELEVATION / DEPTH TOP OF SEAL: _____

TYPE OF SEAL: _____

DEPTH TOP OF SAND PACK: _____

ELEVATION / DEPTH TOP OF SCREEN: _____

TYPE OF SCREEN: _____

SLOT SIZE x LENGTH: _____

I.D. OF SCREEN: _____

TYPE OF SAND PACK: _____

ELEVATION / DEPTH BOTTOM OF SCREEN: _____

ELEVATION / DEPTH BOTTOM OF SAND PACK: _____
TYPE OF BACKFILL BELOW OBSERVATION WELL: _____

ELEVATION / DEPTH OF HOLE: _____

ATTACHMENT C
PAGE TWO

NUS CORPORATION

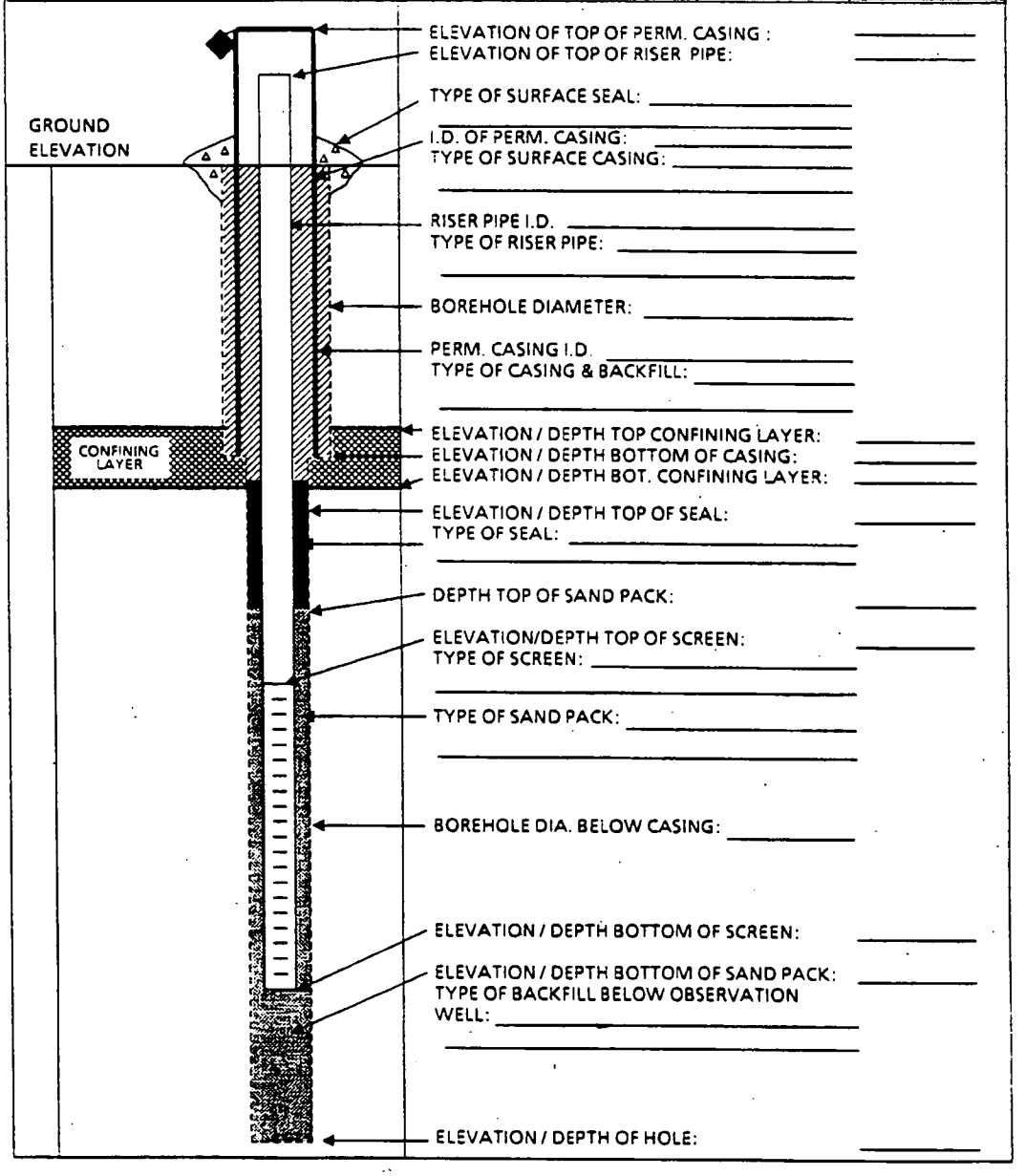
BORING NO.: _____

CONFINING LAYER
MONITORING WELL SHEET

11-5-87

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

DRILLER _____
DRILLING METHOD _____
DEVELOPMENT METHOD _____



ATTACHMENT C
PAGE THREE

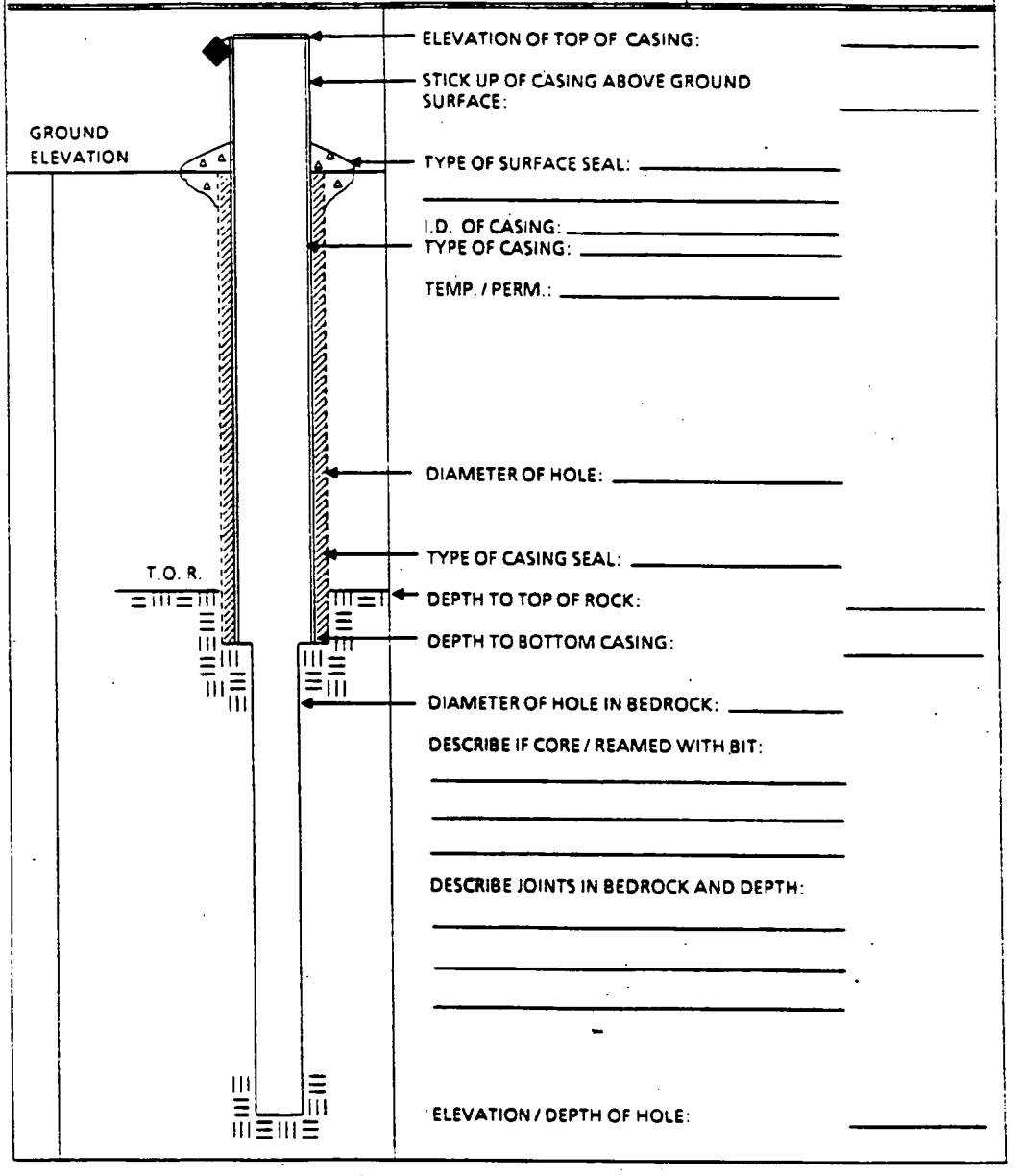
NUS CORPORATION
A Halliburton Company

BORING NO.: _____

BEDROCK
MONITORING WELL SHEET
OPEN HOLE WELL

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

DRILLER _____
DRILLING METHOD _____
DEVELOPMENT METHOD _____



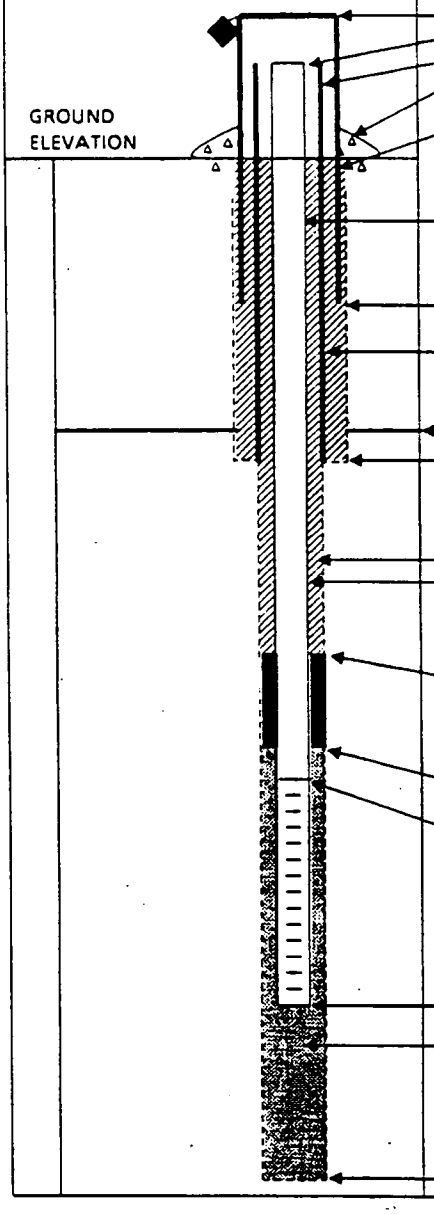
ATTACHMENT C
PAGE FOUR

BORING NO.: _____

BEDROCK
MONITORING WELL SHEET
WELL INSTALLED IN BEDROCK

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

DRILLER _____
DRILLING METHOD _____
DEVELOPMENT METHOD _____



ELEVATION OF TOP OF SURFACE CASING : _____
ELEVATION OF TOP OF RISER PIPE: _____
ELEVATION TOP OF PERM. CASING: _____
TYPE OF SURFACE SEAL: _____

I.D. OF SURFACE CASING: _____
TYPE OF SURFACE CASING: _____

RISER PIPE I.D. _____
TYPE OF RISER PIPE: _____

BOREHOLE DIAMETER: _____

PERM. CASING I.D. _____
TYPE OF CASING & BACKFILL: _____

ELEVATION / DEPTH TO BEDROCK: _____
ELEVATION/DEPTH BOTTOM OF CASING: _____

BOREHOLE DIA. BELOW CASING: _____
TYPE OF BACKFILL: _____

ELEVATION / DEPTH TOP OF SEAL: _____
TYPE OF SEAL: _____

ELEVATION / DEPTH TOP OF SAND PACK: _____

ELEVATION/DEPTH TOP OF SCREEN: _____
TYPE OF SCREEN: _____

TYPE OF SAND PACK: _____

ELEVATION / DEPTH BOTTOM OF SCREEN: _____

ELEVATION / DEPTH BOTTOM OF SAND PACK: _____
TYPE OF BACKFILL BELOW OBSERVATION WELL: _____

ELEVATION / DEPTH OF HOLE: _____

ATTACHMENT C
PAGE FIVE

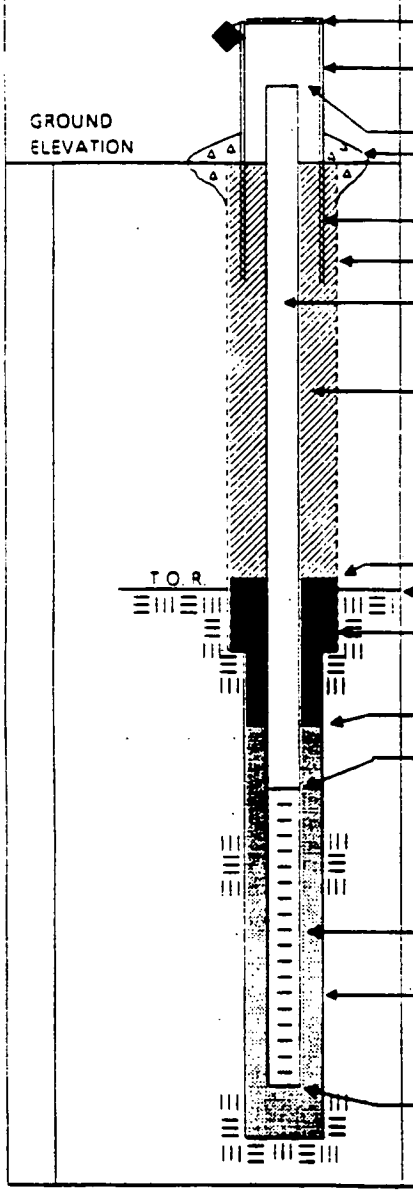
NUS CORPORATION
A Halliburton Company

BORING NO.: _____

BEDROCK
MONITORING WELL SHEET
WELL INSTALLED IN BEDROCK

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

DRILLER _____
DRILLING METHOD _____
DEVELOPMENT METHOD _____



ELEVATION OF TOP OF SURFACE CASING: _____

STICK UP OF CASING ABOVE GROUND SURFACE: _____

ELEVATION TOP OF RISER: _____

TYPE OF SURFACE SEAL: _____

I.D. OF SURFACE CASING: _____

DIAMETER OF HOLE: _____

RISER PIPE I.D.: _____

TYPE OF RISER PIPE: _____

TYPE OF BACKFILL: _____

ELEVATION / DEPTH TOP OF SEAL: _____

ELEVATION / DEPTH TOP OF BEDROCK: _____

TYPE OF SEAL: _____

ELEVATION / DEPTH TOP OF SAND: _____

ELEVATION / DEPTH TOP OF SCREEN: _____

TYPE OF SCREEN: _____

SLOT SIZE x LENGTH: _____

I.D. SCREEN: _____

TYPE OF SAND PACK: _____

DIAMETER OF HOLE IN BEDROCK:

CORE / REAM: _____

ELEVATION / DEPTH BOTTOM SCREEN: _____

ELEVATION / DEPTH BOTTOM OF HOLE: _____

NUS CORPORATION ENVIRONMENTAL MANAGEMENT GROUP	STANDARD OPERATING PROCEDURES	Number GH-2.5	Page 1 of 10
		Effective Date 05/04/90	Revision 1
		Applicability EMG	
		Prepared Earth Sciences	
Subject WATER LEVEL MEASUREMENT/CONTOUR MAPPING		Approved D. Senovich	

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1.0 PURPOSE

The objective of this procedure is to provide general reference information and technical guidance on the measurement of hydraulic head levels and the determination of the direction of groundwater flow, using contour maps of the water table or the potentiometric surface of an unconfined or confined aquifer.

2.0 SCOPE

This procedure gives overall technical guidance for obtaining hydraulic head measurements in wells (frequently conducted in conjunction with groundwater sampling) and preparation of groundwater contour maps. The specific methods could be modified by requirements of project-specific plans.

3.0 GLOSSARY

Hydraulic Head - The height to which water will rise in a well.

Water Table - A surface in an unconfined aquifer where groundwater pressure is equal to atmospheric pressure (i.e., the pressure head is zero).

Potentiometric Surface - A surface which is defined by the levels to which water will rise in wells which are screened or open in a specified zone of an unconfined or confined aquifer.

Unconfined (water table) Aquifer - An aquifer in which the water table forms the upper boundary.

Confined Aquifer - An aquifer confined between two low permeability layers (aquitards).

Artesian Conditions - A common condition in a confined aquifer in which the water level in a well completed within the aquifer rises above the top of the aquifer.

Flow Net - A diagram of groundwater flow, showing flow lines and equipotential lines.

Flow Line - A line indicating the direction of groundwater movement within the saturated zone. Flow lines are drawn perpendicular to equipotential lines.

Equipotential Line - A contour line on the potentiometric surface or water table showing uniform hydraulic head levels. Equipotential lines on the water table are also called water-table contour lines.

4.0 RESPONSIBILITIES

Project Hydrogeologist - has overall responsibility for obtaining water level measurements and developing groundwater contour maps. The hydrogeologist shall specify the reference point from which water levels are measured (usually a specific point on the upper edge of the inner well casing), the number of data points needed and which wells shall be used for a contour map, and how many complete sets of water levels are required to adequately define groundwater flow directions (e.g., if there are seasonal variations).

Field Personnel - must have a basic familiarity with the equipment and procedures involved in obtaining water levels, and must be aware of any project-specific requirements.

5.0 PROCEDURES

5.1 GENERAL

Groundwater level measurements can be made in monitoring wells, private or public water wells, piezometers, open boreholes, or test pits (after stabilization). Groundwater measurements should generally not be made in boreholes with drilling rods or auger flights present. If groundwater sampling activities are to occur, groundwater level measurements shall take place prior to well evacuation or sampling.

All groundwater level measurements shall be made to the nearest 0.01 foot, and recorded in the geologist's field notebook or on the Groundwater Level Measurement Sheet (Attachment A), along with the date and time of the reading. The total depth of the well shall be measured and recorded, if not already known. Weather changes that occur over the period of time during which water levels are being taken, such as precipitation and bariometric pressure changes, should be noted.

In measuring groundwater levels, there shall be a clearly-established reference point of known elevation, which is normally identified by a mark on the upper edge of the inner well casing. The reference point shall be noted in the field notebook. To be useful, the reference point should be tied in with an established USGS benchmark or other properly surveyed elevation datum. An arbitrary datum could be used for an isolated group of wells if necessary.

Cascading water within a borehole or steel well casings can cause false readings with some types of sounding devices (chalked line, electrical). Oil layers may also cause problems in determining the true water level in a well. Special devices (interface probes) are available for measuring the thickness of oil layers and true depth to groundwater if required.

Water level readings shall be taken regularly, as required by the site hydrogeologist. Monitoring wells or open-cased boreholes that are subject to tidal fluctuations should be read in conjunction with a tidal chart (or preferably in conjunction with readings of a tide staff or tide level recorder installed in the adjacent water body); the frequency of such readings shall be established by the site hydrogeologist. All water level measurements at a site used to develop a groundwater contour map shall be made in the shortest practical time to minimize affects due weather changes, and at least during the same day.

5.2 WATER LEVEL MEASURING TECHNIQUES

There are several methods for determining standing or changing water levels in boreholes and monitoring wells. Certain methods have particular advantages and disadvantages depending upon well conditions. A general description of these methods is presented, along with a listing of various advantages and disadvantages of each technique. An effective technique shall be selected for the particular site conditions by the onsite hydrogeologist.

In most instances, preparation of accurate potentiometric surface requires that static water level measurements be obtained to a precision of 0.01 feet. To obtain such measurements in individual accessible wells, the Chalked Tape or Electrical Water Level Indicator methods have been found best, and thus are the most often utilized. Other, less precise methods, such as the Popper or Bell Sound or Bailer Line methods, may be appropriate for developing preliminary estimates of hydraulic conditions. When a large number of (or continuous) readings are required, time-consuming individual readings are not usually feasible. In such cases, it is best to use the Float Recorder or Pressure Transducer methods. When conditions in the well limit readings (i.e., turbulence in the

water surface or limited access through small diameter tubing), less precise, but appropriate, methods such as the Air Line or Capillary Tubing methods can be used.

5.2.1 Methods

Water levels can be measured by several different techniques, but the same steps shall be followed in each case. The proper sequence is as follows:

1. Check operation of recording equipment above ground. Prior to opening the well, don personal protective equipment as required.

2. Record all information specified below in the geologist's field notebook or on the Groundwater Level Measurement Sheet.

   a. Well number.
   b. Record water level to the nearest 0.01 foot (0.3 cm). Water levels shall be taken from the surveyed reference mark on the top edge of the inner well casing.
   c. Record the time and day of the measurement.

Water level measuring devices with permanently marked intervals shall be used when possible. If water level measuring devices marked by metal or plastic bands clamped at intervals along the measuring line are used, the spacing and accuracy of these bands shall be checked frequently as they may loosen and slide up or down the line, resulting in inaccurate reference points (see Section 5.2.3).

5.2.2 Water Level Measuring Devices

Chalked Steel Tape

The water level is measured by chalking a weighted steel tape and lowering it a known distance (to any convenient whole foot mark) into the well or borehole. The water level is determined by subtracting the wetted chalked mark from the total length lowered into the hole.

The tape shall be withdrawn quickly from the well because water has a tendency to rise up the chalk due to capillary action. A water finding paste may be used in place of chalk. The paste is spread on the tape the same way as the chalk, and turns red upon contacting water.

Disadvantages to this method include the following: depths are limited by the inconvenience of using heavier weights to properly tension longer tape lengths; ineffective if borehole/well wall is wet or inflow is occurring above the static water level; chalking the tape is time consuming; difficult to use during periods of precipitation.

Electric Water Level Indicators

These devices consist of a spool of small-diameter cable and a weighted probe attached to the end. When the probe comes in contact with the water, an electrical circuit is closed and a meter, light, and/or buzzer attached to the spool will signal the contact.

There are a number of commercial electric sounders available, none of which is entirely reliable under all conditions likely to occur in a contaminated monitoring well. In conditions where there is oil on the water, groundwater with high specific conductance, water cascading into the well, steel well casing, or a turbulent water surface in the well, measuring with an electric sounder may be difficult.

For accurate readings, the probe shall be lowered slowly into the well. The electric tape is marked at the measuring point where contact with the water surface was indicated. The distance from the mark to the nearest tape band is measured using an engineer's folding ruler or steel tape and added to the band reading to obtain the depth to water. If band is not a permanent marking band, spacing shall be checked periodically as described in Section 5.2.3.

Popper or Bell Sounder

A bell- or cup-shaped weight that is hollow on the bottom is attached to a measuring tape and lowered into the well. A "plopping" or "popping" sound is made when the weight strikes the surface of the water. An accurate reading can be determined by lifting and lowering the weight in short strokes, and reading the tape when the weight strikes the water. This method is not sufficiently accurate to obtain water levels to 0.01 feet, and thus is more appropriate for obtaining only approximate water levels quickly.

Float Recorder

A float or an electromechanically actuated water-seeking probe may be used to detect vertical changes of the water surface in the hole. A paper-covered recording chart drum is rotated by the up and down motion of the float via a pulley and reduction gear mechanism, while a clock drive moves a recording pen horizontally across the chart. To ensure continuous records, the recorder shall be inspected, maintained, and adjusted periodically. This type of device is useful for continuously measuring periodic water level fluctuations, such as tidal fluctuations or influences of pumping wells.

Air Line

An air line is especially useful in pumped wells where water turbulence may preclude the use of other devices. A small-diameter weighted tube of known length is installed from the surface to a depth below the lowest water level expected. Compressed air (from a compressor, bottled air, or air pump) is used to purge the water from the tube, until air begins to escape the lower end of the tube, and is seen (or heard) to be bubbling up through the water in the well. The pressure needed to purge the water from the air line multiplied by 2.307 (feet of water for 1 psi) equals the length in feet of submerged air line. The depth to water below the center of the pressure gauge can be calculated by subtracting the length of air line below the water surface from the total length of the air line.

The disadvantages to this method include the need for an air supply and lower level of accuracy (unless a very accurate air pressure gauge is used, this method cannot be used to obtain water level readings to the nearest 0.01 ft).

Capillary Tubing

In small diameter piezometer tubing, water levels are determined by using a capillary tube. Colored or clear water is placed in a small "U"-shaped loop in one end of the tube (the rest of the tube contains air). The other end of the capillary tube is lowered down the piezometer tubing until the water in the loop moves, indicating that the water level has been reached. The point is then measured from the bottom of the capillary tube or recorded if the capillary tube is calibrated. This is the best method for very small diameter tubing monitoring systems such as Barcad and other multilevel samples. Unless the capillary tube is calibrated, two people may be required to measure the length of capillary tubing used to reach the groundwater. Since the piezometer tubing and capillary tubing usually are somewhat coiled when installed, it is difficult to accurately measure absolute water level elevations using this method. However, the method is useful in accurately measuring differences or changes in water levels (i.e., during pumping tests).

Pressure Transducer

Pressure transducers can be lowered into a well or borehole to measure the pressure of water and therefore the water elevation above the transducer. The transducer is wired into a recorder at the surface to record changes in water level with time. The recorder digitizes the information and can provide a printout or transfer the information to a computer for evaluation (using a well drawdown/recovery model). The pressure transducer should be initially calibrated with another water level measurement technique to ensure accuracy. This technique is very useful for hydraulic conductivity testing in highly permeable material where repeated, accurate water level measurements are required in a very short period of time. A sensitive transducer element is required to measure water levels to 0.01 foot accuracy.

Borehole Geophysics

Approximate water levels can be determined during geophysical logging of the borehole (although this is not the primary purpose for geophysical logging and such logging is not cost-effective if used only for this purpose). Several logging techniques will indicate water level. Commonly-used logs which will indicate saturated/unsaturated conditions include the spontaneous potential (SP) log and the neutron log.

Bailer Line Method

Water levels can be measured during a bailing test of a well by marking and measuring the bailer line from the bottom of the bailer (where water is first encountered) to the point even with the top of the well casing. This is a useful technique during bailing tests (particularly if recovery is rapid) if the bailer is heard hitting the water. However, it is not recommended for measuring static water levels because it is not usually as accurate as some of the other methods described above.

5.2.3 Data Recording

Water level measurements, time, data, and weather conditions shall be recorded in the geologist's field notebook or on the Groundwater Level Measurement Sheet. All water level measurements shall be measured from a known reference point. The reference point is generally a marked point on the upper edge of the inner well casing that has been surveyed for an elevation. The exact reference point shall be marked with permanent ink on the casing since the top of the casing may not be entirely level. It is important to note changes in weather conditions because changes in the barometric pressure may affect the water level within the well.

5.2.4 Specific Quality Control Procedures for Water Level Measuring Devices

All groundwater level measurement devices must be cleaned before and after each use to prevent cross contamination of wells.

Some devices used to measure groundwater levels may need to be calibrated. These devices shall be calibrated to 0.01 foot accuracy periodically. A water level indicator calibration sheet shall be completed each time the measuring device is checked. A water level indicator calibration form is shown in Attachment A. The "actual reading" column on the sheet is the actual length of the interval from the end of the indicator to the appropriate marked depth interval. In many cases, these measurements are different because the water level measuring device is connected to the end of the measuring tape or line, and may extend beyond "0" feet on the measuring line.

5.3 POTENTIOMETRIC SURFACE MAPPING

5.3.1 Selection of Wells

All wells used to prepare a flow net in a plan or map view should represent the same hydrogeologic unit, be it aquifer or aquitard. All water level measurements used shall be collected on the same day.

Before mapping, review the recorded water levels and monitoring-well construction data, site geology and topographic setting to ascertain that the wells are completed in the same hydrogeologic unit and to determine if strong vertical hydraulic gradients may be present. Such conditions will be manifested by a pronounced correlation between well depth and water level, or by a difference in water level between two wells located near each other but set to different depths or having different screen lengths. Professional judgment of the hydrogeologist is important in this decision. If vertical gradients are significant, the data to be used must be limited vertically, and only wells finished in a chosen vertical zone of the hydrogeologic unit can be used.

At least three wells must be used to provide an estimation of the direction of groundwater flow, and many more wells will be needed to provide an accurate contour map. Generally, shallow systems require more wells than deep systems for accurate contour mapping.

5.3.2 Construction of Equipotential Lines

Plot the water elevations in the chosen wells on a site map. Other hydrogeologic features associated with the zone of interest -- such as seeps, wetlands, and surface-water bodies -- should also be plotted along with their elevations.

The data should then be contoured, using mathematically valid and generally accepted techniques. Linear interpolation is most commonly used, as it is the simplest technique. However, quadratic interpolation or any technique of trend-surface analysis or data smoothing is acceptable. Computer-generated contour maps may be useful for large data sets. Contour lines shall be drawn as smooth, continuous lines which never cross one another.

Inspect the contour map, noting known features, such as pumping wells and site topography. The contour lines must be adjusted in accordance with these, utilizing the professional judgment of the hydrogeologist. Closed contours should be avoided unless a known sink exists. Groundwater mounding is common under landfills and lagoons; if the data imply this, the feature must show in the contour plot.

5.3.3 Determination of Groundwater-Flow Direction

Flow lines shall be drawn so that they are perpendicular to equipotential lines. Flow lines will begin at high head elevations and end at low head elevations. Closed highs will be the source of additional flow lines. Closed depressions will be the termination of some flow lines. Care must be used in areas with significant vertical gradients to avoid erroneous conclusions concerning gradients and flow directions.

5.4 HEALTH AND SAFETY CONSIDERATIONS

Groundwater contaminated by volatile organic compounds may release toxic vapors into the air space inside the well pipe. The release of this air when the well is initially opened is a Health/Safety hazard which must be considered. Initial monitoring of the well headspace and breathing zone

concentrations using a PID (HNU) or FID (OVA) and combustible gas meters shall be performed to determine required levels of protection.

6.0 REFERENCES

Freeze, R. A. and J. A. Cherry, 1979. Groundwater. Prentice-Hall, Englewood Cliffs, New Jersey, 604 pp.

Cedergren, H. R., 1977. Seepage, Drainage and Flow Nets (2nd edition). John Wiley and Sons, New York.

Fetter, C. W., 1980. Applied Hydrogeology. Me [illegible], Columbus, Ohio, 488 pp.

7.0 ATTACHMENTS

Attachment A - Groundwater Level Measurem[illegible]neet

Attachment B - Water Level Indicator Calibration Sheet.

ATTACHMENT A

GROUNDWATER LEVEL MEASUREMENT SHEET

Project Name: _____
Project No.: _____
Personnel: _____
Date: _____

LOCATION

Municipality: _____
County: _____
State: _____
Street or Map Location (If Off-Site) _____

WEATHER CONDITIONS

Temperature Range: _____
Precipitation: _____
Barometric Pressure: _____

Equipment No.: _____
Equipment Name: _____
Latest Calibration Date: _____

Tidally-Influenced: [ ] Yes [ ] No

Well or Piezometer Number	Date/Time	Elevation of Reference Point (Feet)*	Water Level Indicator Reading (Feet)*	Adjusted Depth (Feet)*	Groundwater Elevation (Feet)*

* All elevations to nearest 0.01 foot.

ATTACHMENT B

WATER LEVEL INDICATOR CALIBRATION SHEET

Project Name _____ Date _____

Project No. _____

Equipment No. _____

Equipment Name _____

Water Level Indicator Marking (Feet)	Actual Reading* (Feet)
0.0	
5.0	
10.0	
15.0	
20.0	
25.0	
30.0	
35.0	
40.0	
45.0	
50.0	
55.0	
60.0	
65.0	
70.0	
75.0	
80.0	
85.0	
90.0	
95.0	
100.0	

* Record readings to the nearest 0.01 foot. The actual reading may be different than marking because the water level measuring device (electrode, popper, etc.) may extend beyond the "0" feet mark on the measuring line.

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- 5.3 CALIBRATION
- 5.4 SPECIALIZED USES
- 5.5 INSTRUMENT ADVANTAGES
- 5.6 CAUTIONS

6.0 REFERENCES

7.0 ATTACHMENTS

1.0 PURPOSE

To establish procedures for the use, maintenance, and calibration of the HNU PI-101 Organic Vapor Meter.

2.0 SCOPE

Applies to each usage of the HNU PI-101 photoionization detector by NUS/EMG personnel.

3.0 GLOSSARY

None.

4.0 RESPONSIBILITIES

Office Health and Safety Supervisor (OHSS) - The OHSS shall insure that the user has been appropriately trained and certified in the usage of the HNU instrument. He/she shall also insure that the instrument is properly maintained and calibrated prior to its release for field service.

Instrument User - The user should be personally secure that he/she has been adequately trained and understands the operation and limitations of the instrument. He/she is further responsible to insure that the appropriate probe(s) have been selected for compounds to be found on site and that the instrument has been calibrated and is working properly.

5.0 PROCEDURES

5.1 PRINCIPLE OF OPERATION

The HNU System portable photoionizer detects the concentration of many organic gases as well as a few inorganic gases. The basis for detection is the ionization of gaseous species. The incoming gas molecules are subjected to ultraviolet (UV) radiation, which is energetic enough to ionize many gaseous compounds. The molecule is transformed into charged-ion pairs, creating a current between two electrodes. Each molecule has a characteristic ionization potential, which is the energy required to remove an electron from the molecule, yielding a positively-charged ion and the free electron. The instrument measures this energy level.

5.2 INSTRUMENT CONFIGURATION

Three probes, each containing a different UV light source, are available for use with the HNU. Probe energies are 9.5, 10.2, and 11.7eV. All three detect many aromatic and large-molecule hydrocarbons. The 10.2 and 11.7eV probes, in addition, detect some smaller organic molecules and some halogenated hydrocarbons. The 10.2eV probe is the most useful for environmental response work, since it is more durable than the 11.7eV probe and detects more compounds than the 9.5eV probe.

5.3 CALIBRATION

The primary HNU calibration gas is benzene (or isobutylene, a benzene equivalent). The span potentiometer knob is adjusted for benzene calibration. A knob setting of zero increases the sensitivity to benzene approximately ten-fold. The instrument's response can be adjusted to give more accurate readings for specific gases and eliminate the necessity for calibration charts. Daily calibration is to be performed in accordance with Attachment G.

5.4 SPECIALIZED USES

While the HNU is used primarily as a qualitative instrument, it can also be used to detect certain contaminants or at least to narrow the range of possibilities. Noting instrument response to a contaminant source with different probes can eliminate some contaminants from consideration. For instance, a compound's ionizing potential may be such that the 9.5eV probe produces no response, but the 10.2 and 11.7eV probes do elicit a response. Also, HNU does not detect methane or hydrogen cyanide.

5.5 INSTRUMENT ADVANTAGES

The HNU is easy to use in comparison to many other types of monitoring instrumentation. Its range detection limit is also in the low parts per million range. Response time is rapid; the meter needle reaches 90 percent of the indicated concentration in 3 seconds for benzene. HNU can be zeroed in a contaminated atmosphere.

5.6 CAUTIONS

The instrument can monitor only certain vapors and gases in air. Nonvolatile liquids, toxic solids, particulates, and many other toxic gases and vapors cannot be detected. Because the types of compounds that the HNU can detect is only a fraction of the chemicals possibly present at a field site, a zero reading does not necessarily signify the absence of air contaminants.

The instrument is nonspecific, and its response to different compounds is relative to the calibration setting. Instrument readings may be higher or lower then the true concentration. These discrepancies can be especially serious problems when monitoring for total contaminant concentrations, if several different compounds are being detected at once. In addition, the response of this instrument is not linear over the entire detection range. Care must, therefore, be taken when interpreting the data. All identifications should be reported as tentative until they can be confirmed by more precise analysis. Concentrations should be reported in terms of the calibration gas and span potentiometer of the gas-select-knob setting.

The instrument cannot be used as an indicator for combustible gases or oxygen deficiency.

6.0 REFERENCES

HNU Systems, Inc. Instruction Manual for Model PI 101 Photoionization Analyzer, 1975.

E. & E. FIT Operation and Field Manual: HNU Systems PI 101 Photoionization Detector and Century Systems (Foxboro) Model OVA-128 Organic Vapor Analyzer.

Personal Communication with Fran Connel, HNU Systems, Inc., January 4, 1984.

7.0 ATTACHMENTS

Attachment A - Start-up and Shutdown Procedures
Attachment B - Maintenance and Calibration Schedule
Attachment C - Calibration Procedure
Attachment D - Cleaning the UV Light Source Window
Attachment E - Cleaning the Ionization Chamber
Attachment F - Troubleshooting
Attachment G - Daily Calibration

ATTACHMENT A

START-UP AND SHUTDOWN PROCEDURES

Start-up

1. Attach the probe to the readout unit. Match the alignment key, then twist the connector clockwise until a distinct locking is felt.

2. Turn the FUNCTION switch to the battery check position. Check to ensure that the indicator reads within or beyond the green battery arc on the scale plate. If the indicator is below the green arc, or if the red LED comes on, the battery must be charged prior to using.

3. To zero the instrument, turn the FUNCTION switch to the STANDBY position and rotate the ZERO POTENTIOMETER until the meter reads zero. Wait 15-20 seconds to ensure that the zero adjustment is stable. If not, then readjust.

4. Check to see that the SPAN POTENTIOMETER is set at the appropriate setting for the probe being used. Follow procedures in Attachment G in the performance of daily calibrations.

5. Set the FUNCTION switch to the desired ppm range.

6. Listen for the fan operation to verify fan function.

7. Check instrument with an organic point source (such as a magic marker) prior to usage to verify instrument function.

Shut Down

1. Turn FUNCTION switch to OFF.

2. Place the instrument on the charger.

ATTACHMENT B

MAINTENANCE AND CALIBRATION SCHEDULE

Function	Frequency
• Routine Calibration	Prior to each use*
• Factory Check-out and Calibration	Yearly or when malfunctioning
• Wipe Down Read-Out Unit	After each use
• Clean UV Light Source Window	Every month or as use and site conditions dictate
Clean the Ionization Chamber	Monthly
Recharge Battery	After each use

* In accordance with the specifications identified in Attachment G.

ATTACHMENT C

CALIBRATION PROCEDURE

Calibration Procedure 1

1. Run through start-up procedures as per Attachment 1.
2. Fill a sampling bag with HNU calibration gas of known contents.
3. Allow sample bag contents to be drawn into the probe and check response in ppm.
4. If the reading deviates ± 15 percent from the concentration of the calibration gas, the instrument requires maintenance.
5. Each office must develop a mechanism for the documentation of calibration results. This documentation includes:
   a. date inspected
   b. person who calibrated the instrument
   c. the instrument number (Serial number or Other ID number)
   d. the result of the calibration (ppm, probe ev, span pot setting)
   e. identification of the calibration gas (source, type, concentration)

Calibration Procedure 2 (for HNU Calibration Canisters Equipped with a Regulator)

1. Run through start up procedures as per Attachment 1.
2. Connect a sampling hose to the regulator outlet and the other end to the sampling probe of the HNU.
3. Crack the regulator valve.
4. Take reading after 5-10 seconds.
5. If the reading deviates ± 15 percent from the concentration of the calibration gas, the instrument requires maintenance.
6. Calibration documentation should be as in No. 5 above.

ATTACHMENT D

CLEANING THE UV LIGHT SOURCE WINDOW

1. Turn the FUNCTION switch to the OFF position and disconnect the sensor/probe from the Read Out/Control unit.

2. Remove the exhaust screw located near the base of the probe. Grasp the end cap in one hand and the probe shell in the other. Separate the end cap and lamp housing from the shell.

3. Loosen the screws on the top of the end cap and separate the end cap and ion chamber from the lamp housing, taking care that the lamp does not fall out of this housing.

4. Tilt the lamp housing with one hand over the opening, so that the lamp slides out of the housing into your hand.

5. The lamp window may now be cleaned with any of the following compounds using lens paper:

   a. HNU Cleaning Compound-All lamps except the 11.7 eV
   b. Carbon tetrachloride-All lamps except the 11.7 eV
   c. Methanol-All lamps

6. Following cleaning, reassemble by first sliding the lamp back into the lamp housing. Place the ion chamber on top of the housing, making sure the contacts are properly aligned.

7. Place the end cap on top of the ion chamber and replace the two screws. Tighten the screws only enough to seal the O-ring. Do Not Overtighten.

8. Line up the pins on the base of the lamp housing with pins inside the probe shell and slide the housing assembly into the shell. It will only fit one way.

ATTACHMENT E

CLEANING THE IONIZATION CHAMBER

1. Turn the FUNCTION switch to the OFF position and disconnect the sensor/probe from the Read Out/Control unit.

2. Remove the exhaust screw located near the base of the probe. Grasp the end cap in one hand and the probe shell in the other. Separate the end cap and lamp housing from the shell.

3. Loosen the screws on the top of the end cap and separate the end cap and ion chamber from the lamp housing, taking care that the lamp does not fall out of this housing.

4. The ion chamber may now be cleaned according to the following sequence:

   a. acetone rinse with agitation (10 min.), then dry (preferably with oven at 100°C).

   b. methanol rinse with agitation (10 min.), then dry (preferably with oven at 100°C).

5. Place the ion chamber on top of the housing, making sure the contacts are properly aligned.

7. Place the end cap on top of the ion chamber and replace the two screws. Tighten the screws only enough to seal the O-ring. Do Not Overtighten.

8. Line up the pins on the base of the lamp housing with pins inside the probe shell and slide the housing assembly into the shell. It will only fit one way.

ATTACHMENT F

TROUBLESHOOTING

To be performed by qualified technician only.

1. No meter response in any switch position (including BATT CHK).

   A. Broken meter movement.

      (1) Tip instrument rapidly from side to side. Meter needle should move freely and return to zero.

   B. Electrical connection to meter is broken.

      (1) Check all wires leading to meter and clean the contacts of quick-disconnects.

   C. Battery is completely dead.

      (1) Disconnect battery and check voltage with a volt-ohm meter.

   D. If none of the above solves the problem, consult the factory.

2. Meter responds in BATT CHK position, but reads zero or near zero for all others.

   A. Power supply defective.

      (1) Check power supply voltages per Figure 11 of the HNU owner's manual. If any voltage is out of specification, consult the factory.

   B. Input transistor or amplifier has failed.

      (1) Rotate zero control; meter should deflect up/down, as control is turned.

      (2) Open probe. Both transistors should be fully seated in sockets.

   C. Input signal connection broken in probe or readout.

      (1) Check input connector on printed circuit board. The input connector should be firmly pressed down.

      (2) Check components on back side of printed circuit board. All connections should be solid and no wires should touch any other object.

      (3) Check all wires in readout for solid connections.

ATTACHMENT G

DAILY CALIBRATION OF HNU PI-101

HNU PI-101 organic vapor meters are to be field calibrated at the beginning of each work day, prior to actual on site usage.

In order to accomplish this, HNUs assigned to jobs shall be accompanied with a calibration gas cylinder, an appropriate fitting, and a flexible connecting hose. The procedure for performing field calibration is as follows:

1. Connect the probe to the instrument and turn it on.
2. Attach the eight-inch extension to the probe.
3. Set the Span Potentiometer to the setting specified on the calibration cylinder.
4. Connect the cylinder fitting to the cylinder.
5. Connect the cylinder and the instrument together with the flexible tubing.
6. Open the cylinder valve and wait 15 seconds.
7. Instrument reading should coincide with the designed reading stated on the calibration cylinder label.
8. If item number 7 does not coincide, adjust the Span Potentiometer until the desired reading is achieved. Any such adjustments must be within the following limits:

Probe	Initial Span Pot. Setting	Maximum Acceptable Span Pot. Adjustment
9.5 eV	5.0	1.0
10.2 eV	9.8	8.5
11.7 eV	5.0	2.0

If these limits are exceeded, the sensitivity and accuracy of the instrument is hindered. At these points, the instruments are to be returned to the NUS Equipment Manager for inspection, necessary cleaning and maintenance, and recalibration.

The manufacturer also recommends that the lamp inside of the probe be checked twice per week (16 hours of use) and cleaned at least weekly. This involves removing any noticeable obstructions or contamination from the lamp by wiping it off with a clean, soft cloth being careful not to scratch the circular window.

ATTACHMENT G
DAILY CALIBRATION OF HNU PI-101
PAGE TWO

In using this instrument to protect NUS employees and subcontractors, it is imperative that it is accurately responding to airborne substances present at the work site. By implementing these procedures, this end will be better achieved.

Additionally, all calibration activities must be documented in field log books, instrument calibration log sheets, or equivalent. This information must include the date inspected, the person calibrating the instrument, the instrument serial or identification number, the probe lamp eV (9.5 , 10.2, or 11.7), identification of calibration gas (gas source stated on the cylinder label), the initial and final Span Potentiometer settings, and the instrument resultant reading. This information must be submitted to the Site Safety officer at the completion of the job.

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1.0 PURPOSE

To establish a procedure for the use and calibration of Radiation Survey Meters.

2.0 SCOPE

Applies to each usage of radiation survey meters by NUS/EMG personnel.

3.0 GLOSSARY

Alpha Radiation - Particles, consisting of two protons and two neutrons, equivalent to the nucleus of a helium atom. Tissue (skin) is almost opaque to alpha radiation.

Beta Radiation - Electrons emitted during the radioactive decay of certain nuclei. Depending upon electron energy, will penetrate tissue from 0.05 to 8 mm.

Gamma Radiation - Electromagnetic radiation produced in atomic nuclei. Highly penetrating, passing through the body and through long distances in air. Gamma radiation constitutes the most common type of external radiation exposure.

4.0 RESPONSIBILITIES

Office Health and Safety Supervisor (OHSS) - The OHSS shall ensure that the radiation survey instrument user has been properly trained and certified in the use of the instrument. He shall also audit that the instrument is properly maintained and is calibrated according to manufacturer recommendations, or at least every 12 months.

5.0 PROCEDURES

5.1 INTRODUCTION

None of the ionizing radiations is detectable by any of man's five senses. Therefore, all indications of their presence and intensity must be obtained by instruments. Radiation detection devices, like other measuring instruments, operate because of some effect the phenomenon being measured has on matter. In the case of radiation, this effect is ionization. Survey meters are similar to other radiation detection instruments in their operational characteristics. A good survey meter should be portable, rugged, sensitive, simple in construction, and reliable. Portability implies lightness and compaction with a suitable handle or strap for carrying. Ruggedness requires that an instrument be capable of withstanding mild shock without damage. Sensitivity demands an instrument which will respond to the type and energy of radiation being measured. Rarely does one find an instrument capable of measuring all types and energies of radiation that are encountered in practice. "Simplicity in construction" necessitates convenient arrangement of components and "simple circuitry" is comprised of parts which may be replaced easily. "Reliability" is that attribute which implies ability to duplicate response under similar circumstances. All these conditions are not met in any one instrument, but they are approached in many. In any monitoring operation, one must select the proper instrument, use it intelligently, and then be able to interpret the results of the meter readings.

5.2 TYPES OF RADIATION SURVEY METERS

5.2.1 Ionization Chambers

Ionization chambers are instruments in which the ionization, initially produced within the chamber by radiation, is measured without further gas-amplification. Primary ions formed in the chamber are attracted to their respective electrodes and the current pulses are amplified externally to a measurable current. The gas-amplification factor is, thus, one.

Ionization chambers are usually about 30 to 50 cubic inches in volume and are filled with air at atmospheric pressure. The chamber wall design and type of material used in its construction determine its characteristics and, thus, the radiation energy to which it is sensitive. The larger the chamber, the more sensitive the instrument will become. Also, greater voltage will be required for proper operation of the larger chambers. In ionization chamber instruments with movable shields, it is possible to discriminate between types of radiation. In general, ionization chamber survey meters are used to measure relatively high level intensities. Their low sensitivity enhances their capacity to measure radiation at higher dosages or exposure rates.

Most ionization chamber survey instruments have a selector switch marked "off," "wait," and X1, X10, X100. When the switch is off, the batteries are disconnected and the meter is short-circuited, making the instrument inoperative. With the switch in the wait position, the batteries are connected, permitting the circuit to warm up and the instrument to be zeroed, after a warmup period of from 1 to 5 minutes. The meter is connected while the ionization chamber is disconnected, making it possible to adjust the meter accurately to zero, even in the presence of radiation.

No aural indication is typically used in ionization chamber instruments. Thus, the operator must constantly watch the meter to ascertain the field intensity. There is a lag between the instant radiation enters the chamber and the time when the meter reaches its maximum reading. Therefore, one must allow time for the meter to reach its maximum before taking a reading. This interval is usually just a few seconds.

Perhaps the most widely used and one of the most versatile ionization chamber instruments available for radiological survey work is the "Cutie Pie." These instruments are available with maximum scale readings up to 50 roentgens/hour.

5.2.2 Geiger-Mueller Instruments

Essentially, the theory of ion collection in the Geiger-Mueller type detector is the same as for the ionization chamber instrument, except that there is the formation of secondary electrons. In this process, primary ions, formed by the incident radiations, are accelerated (given energy) by the high voltage potential. This added energy enables them to produce secondary ion-pairs. For control of the amplification, a quenching gas is introduced. An ionization avalanche, caused by radiation entering the Geiger-Mueller tube, sends a pulse to the indicating unit of the survey instrument. The quenching gas functions to stop the avalanche and makes the Geiger-Mueller ready for another ionization event. The amplification, inherent in the detector tube, allows a single beta particle or gamma proton to be detected.

Most Geiger-Mueller tube walls are designed so that all but the weakest beta particles may enter. Allowing for the errors due to simultaneous entry, each and every beta particle entering the tube will be counted. Gamma ray counting is not nearly so efficient.

Since one measures each beta particle and each gamma ray that produces ionization within the sensitive tube volume, the instrument is extremely sensitive to radiation. On the most sensitive scales, background levels can be read.

A discriminating shield is usually provided for the Geiger-Mueller tube or probe which, when open, admits both beta and gamma particles. With the shield closed, only gamma is admitted.

To count efficiently, Geiger-Mueller tubes must have adequate means for quenching the ionization avalanche started by a particle entering the tube. In survey Geiger-Mueller counters, the tubes are invariably self-quenching. That is, the gas within the tube contains from 10 to 25 percent vapor of a substance, such as ethylene or iso-butane. Quenching gas is decomposed by radiation. Hence, a self-quenching tube has a limited lifetime. Therefore, a Geiger-Mueller counter should not be left turned on when not in use, especially near a source of radiation.

The indicating mechanism on most Geiger-Mueller counters is usually two-fold; that is, earphones for aural indication and a meter for visual indication. The meters are in reality microammeters that indicate radiation intensity by a pointer on a scale. The pointer or needle will waver slightly and an average reading should be used. In general, the dial is calibrated either in counts/minute or in milliroentgens (mr)/hour, or both. Also, the instrument has a switch for selecting different ranges of sensitivity. For the mr/hr scale, the sensitivities are usually indexed, indicating full scale values at a particular switch position. The counts/minute scale is usually marked by X1, X10, x100, or X1000 of full scale, as read on the face of the dial.

Equipment failure is generally due to batteries (some instruments have a battery check in the "on" position), loose connections, or faulty Geiger-Mueller tube.

The operation of the Geiger-Mueller Survey Instrument is essentially the same as that of the ionization chamber survey instrument. The warmup period is much less critical, and usually 5 to 10 seconds is ample. Care should be taken not to exceed the maximum capacity of the instrument. Such excessive exposure will likely damage the Geiger-Mueller detecting tube. The Geiger-Mueller tub is in operation when it is in the "on" position and no zero adjustment is possible. It is important to remember that Geiger-Mueller survey meters are sensitive instruments and, in general, do not read high levels of radiation intensity.

5.2.3 Other Radiation Survey Instruments

Other radiation survey instruments which operate under different physical principles are available, but are not usually used in waste site survey activity. These are: (1) proportional survey instruments utilized primarily in specialized alpha surveys and, (2) scintillation survey instruments, which are extremely sensitive, but radiation type-selective, depending upon the scintillating phosphor or crystal used.

5.3 CALIBRATION

Instruments are designed by manufacturers to read directly in radiation intensity units, generally mr/hr or r/hr; however, there is considerable error in a direct reading, since the characteristics of individual components causes variations in instrument response. Each instrument must be calibrated for accurate interpretation. Instrument response (intended by the manufacturer) is related to one type of radiation, usually of a definite energy range. If radiation of a different energy or type is measured, the results will be incorrect. Thus the instrument must be recalibrated with radiation of the same type and energy that is to be measured.

Gamma ray calibration instruments can be checked by placing them in a known field of radiation. Radium and Co_{60} are the most frequently-used sources for gamma calibration. A plot of scale readings versus true radiation intensity is made, by comparing scale readings at known distances from the source against the true intensities at these distances, employing the formula given below.

$$I = \frac{milligrams\,of\,Ra}{D^2}, or\, I = \frac{1.59\ x\ millicuries\,of\,Co^{60}}{D^2}$$

where: I = Intensity, mr/hr
D = Distance from source to detector, yards

Five to ten equally-spaced scale readings shall be taken. A graph of these values versus the calculated intensities at the corresponding points is plotted on linear graph paper. A typical calibration curve plots meter readings on the ordinate and corresponding "true" intensities on the abscissa.

When calibrating an instrument, the reference point of the instrument is generally considered as the center of the sensitive volume. It should be pointed out that the ionization chamber-type survey instrument, when properly calibrated, will give a good measurement of x-ray or gamma radiation intensity. However, for alpha and beta radiation, only qualitative measurements can be made.

In calibrating Geiger-Mueller instruments, a less intense radiation source shall be used, since the sensitivity is much greater than that of the ionization chamber-type instrument.

6.0 REFERENCES

None.

7.0 ATTACHMENTS

None.