Field Sampling and Analysis Plan
for
Site 1 - Former Drum Marshaling Area Naval Weapons Industrial Reserve Plant (NWIRP)
Bethpage, New York

Northern Division
Naval Facilities Engineering Command
Contract Number N62472-90-D-1298
Contract Task Order 0213

April 1995

Halliburton NUS
CORPORATION

039524/P

FIELD SAMPLING AND ANALYSIS PLAN
FOR
SITE 1 - FORMER DRUM MARSHALING AREA
NAVAL WEAPONS INDUSTRIAL RESERVE PLANT
BETHPAGE, NEW YORK

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 NUMBER N62472-90-D-1298
CONTRACT TASK ORDER 0213

APRIL 1995

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1.0 PROJECT DESCRIPTION

1.1 AUTHORIZATION

Halliburton NUS Corporation (Halliburton NUS) has prepared this Field Sampling and Analysis Plan (FSAP) as part of the Remedial Design, Phase II, for Site 1 at the Naval Weapons Industrial Reserve Plant (NWIRP), located in Bethpage, New York. This FSAP is being prepared under the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract No. N62472-90-D-1298, Contract Task Order (CTO) 0213. This FSAP specifies requirements and details the specific procedures for field work to be conducted to support remedial design activities.

The Bethpage NWIRP is located on Long Island, Nassau County, New York, see Figures 1-1 and 1-2. The NWIRP was established in 1933. Since its inception, the primary mission at the facility has been the research, prototyping, testing, design engineering, fabrication, and primary assembly of military aircraft. The NWIRP is a Government-Owned Contractor Operated (GOCO) facility operated by Grumman Corporation.

1.2 PURPOSE

The objective of this field work is to gather data to support the design of a remediation system within the area of volatile organic contamination at Site 1. Primary objectives of this investigation are:

- Further delineate the extent of contamination at Site 1 and beneath Plant 3.
- Establish the location of a pilot-scale remediation system.
- Determine subsurface soil conditions.

1.3 SCOPE OF WORK

Halliburton NUS has been tasked to prepare a Field Sampling and Analysis Plan for the performance of field work at Site 1. The field work will further delineate the extent of contamination, soil properties, and quantities of contamination at Site 1 to provide adequate information for design of the full-scale remediation system. This investigation will be performed prior to the installation of the pilot system to verify that the location of the pilot system is within the area of contamination.

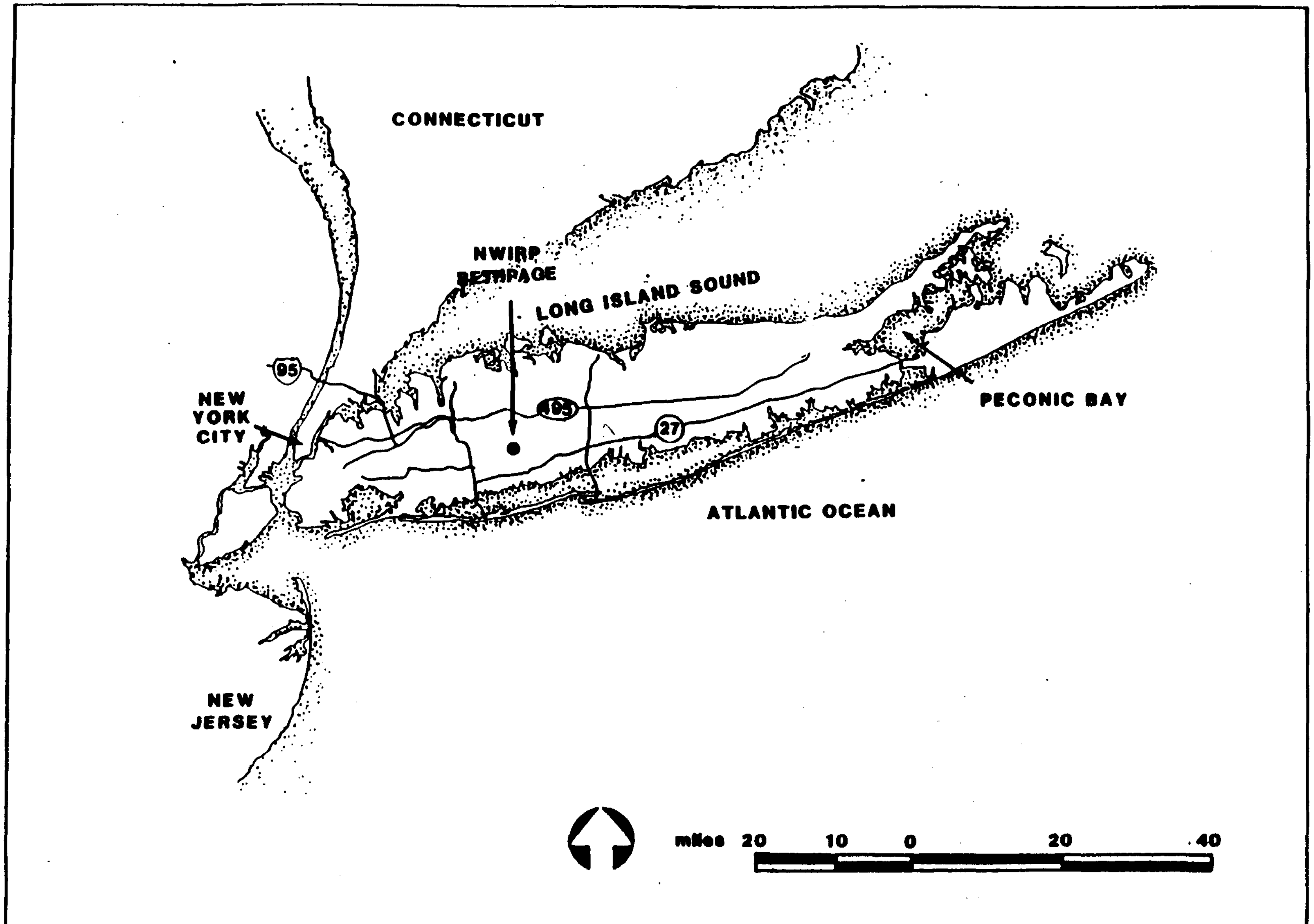

FIGURE 1-1

General Location Map
NWIRP Bethpage, New York

Naval Weapons Industrial
Reserve Plant
Bethpage
Long Island, New York

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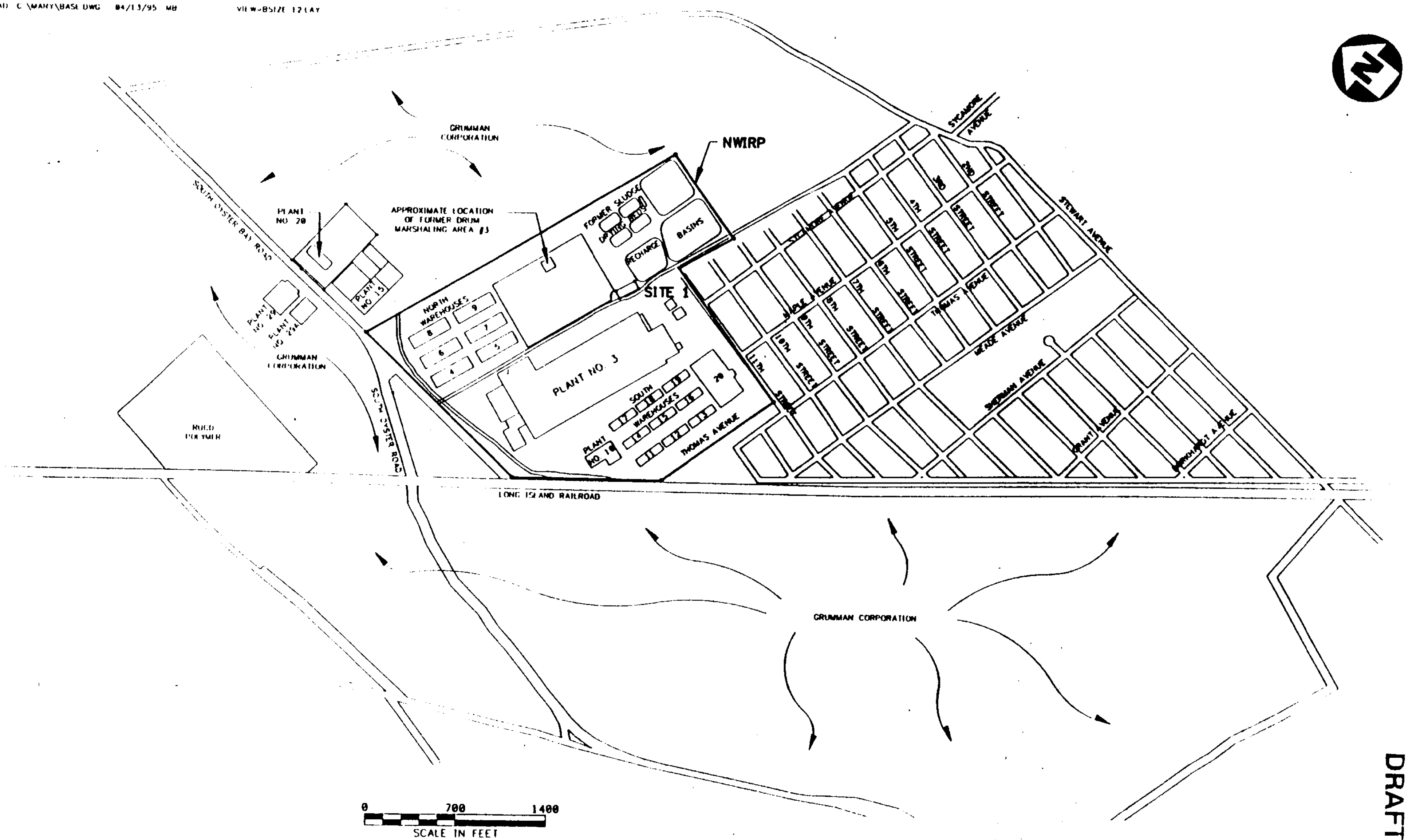

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CTO 213

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FIGURE 1-2

SITE LAYOUT MAP
NWIRP, BETHPAGE, NEW YORK

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A total of nine soil borings will be drilled to the water table at locations identified on Figure 1-3. Samples will be collected from each boring for chemical analyses and lithology.

1.4 SAMPLE MATRICES, PARAMETERS, AND FREQUENCY COLLECTION

As part of this investigation, environmental samples will be collected from the soil borings. Table 3-1 (Section 3.0) presents a full listing of all analytical parameters, container, volume, preservation, holding time, and methodology requirements. Sampling protocols to be used in this study are provided in Section 4.0 of this FSAP.

1.5 QUALITY ASSURANCE OVERVIEW

Halliburton NUS has established Quality Assurance/Quality Control (QA/QC) measures and a program to ensure that these measures are applied to the collection and interpretation of environmental quality data at the NWIRP facility. The FSAP is designed to assure that the precision, accuracy, representativeness, comparability, and completeness (the PARCC parameters) of the data are known, documented, and adequate to satisfy the data quality objectives of the study.

This plan presents the policies, organization, objectives, data-collection activities, and QA/QC activities that will be utilized to ensure that all data collected during, and reported by, this study are representative of existing conditions. Chemical testing will be conducted by a laboratory subcontractor. The laboratory will have prior Naval Energy and Environmental Support Activity (NEESA) approval. QA/QC procedures for the chemical analysis will conform to or exceed the requirements of the NYSDEC Analytical Services Protocols (ASP) and will satisfy NEESA requirements for Level C and E QC.

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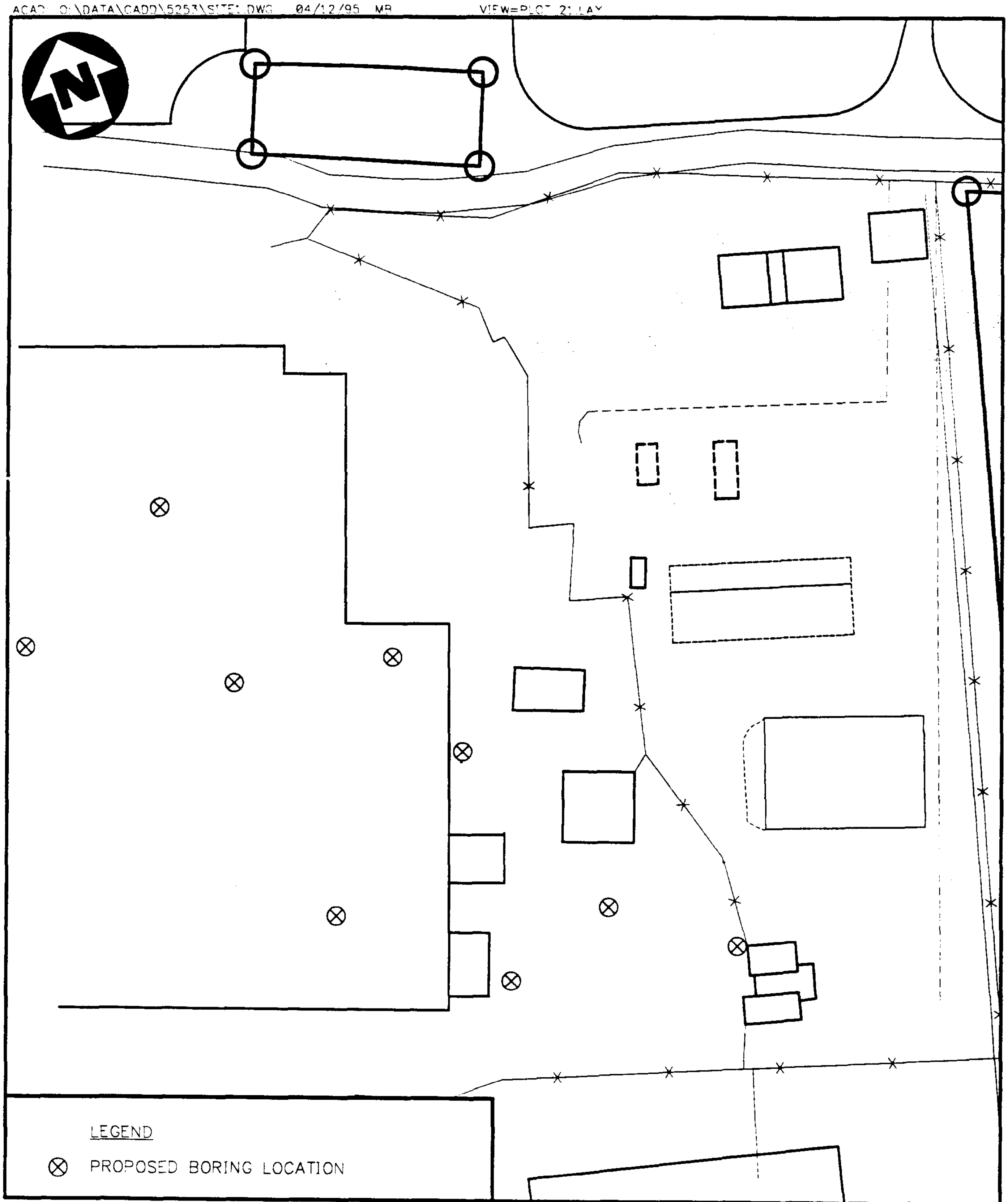

SITE 1
PROPOSED SAMPLING LOCATIONS
NWIRP, BETHPAGE, NEW YORK

0 100 200
SCALE IN FEET

FIGURE 1-3

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2.0 PROJECT ORGANIZATION AND RESPONSIBILITY

Halliburton NUS will be responsible for the overall management of the project, including the field inspection and conduct of all drilling, excavation, and sampling activities. Personnel from the Navy will be actively involved in the investigation and will coordinate with personnel from Halliburton NUS in a number of areas.

2.1 PROJECT ORGANIZATION

The key firms and personnel involved in the investigation, as well as the chain-of-communication and responsibility of the project personnel are as follows. The Navy Remedial Project Manager is responsible for the overall management of the IR Program for the NWIRP Calverton.

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Quality Assurance/Quality Control Advisor

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Health and Safety Specialist

The Project Manager has the primary responsibility for project and technical management of this project. He is responsible for the coordination of all onsite personnel, and for providing technical assistance for all activities that are directly related to the determination of the environmental quality of the site. If quality assurance problems or deficiencies requiring specific action are identified, the project manager and project QA/QC advisor will identify the appropriate corrective action.

2.2 FIELD ORGANIZATION

The Halliburton NUS field investigation team will be organized according to the activity planned. For onsite sampling, the sampling team members will be selected based upon the type and extent of effort required. The team will consist of a combination of the following personnel.

- Field Operation Leader (FOL)
- Field Geologist
- Quality Assurance/Quality Control (QA/QC) Advisor

The FOL will be responsible for the coordination of all onsite personnel and for providing technical assistance when required. The FOL, or his designee, will coordinate and be present during all sampling activities and will assure the availability and maintenance of all sampling materials and equipment. The FOL will be responsible for the completion of all sampling and chain-of-custody documentation, will assume custody of all samples, and ensure the proper handling and shipping of samples.

The FOL will also be responsible for providing technical supervision of the drilling subcontractor and for maintaining a geologic log of all borings drilled. Copies of the forms to be used in this investigation are provided as Appendix A.

The QA/QC advisor will be responsible for the adherence of all QA/QC guidelines as defined in this work plan. Strict adherence to these procedures is critical to the collection of acceptable and representative data.

2.3 LABORATORY OPERATIONS

Analysis of all environmental samples will be performed by a NEESA-approved laboratory. The laboratory work will be performed in accordance with QC Level C and E guidance as stipulated in the NEESA guidelines (20.2-0478; 6/88). The QA/QC procedures should meet or exceed NYSDEC requirements.

3.0 QUALITY ASSURANCE OBJECTIVES FOR DATA MANAGEMENT

The overall QA objective is to develop and implement procedures for field sampling, chain-of-custody, laboratory analysis, and reporting that will provide environmental monitoring data of known and acceptable quality. Specific procedures to be used for sampling, chain-of-custody, calibration of field instruments, laboratory analysis, reporting, internal quality control, audits, preventative maintenance, and corrective actions are described in later sections of this FSAP. The purpose of this section is to address the data quality objectives in terms of the (PARCC) parameters, quantitation and detection limits, field blanks, trip blanks, rinsate blanks, and bottleware cleanliness.

3.1 DATA QUALITY OBJECTIVES

Data Quality Objectives (DQOs) are qualitative and/or quantitative statements regarding the quality of data needed to support the Remedial Design (RD), Phase II activities. The sampling rationale provided in Section 4.0 of this work plan explains the choice of sample locations and media which will supply information needed for the RD. The use of SW-846 methodology and Standard Methods listed in Table 3-1 following current protocols is expected to satisfy data quality needs in accordance with NEESA, NYSDEC, and CLP requirements.

3.2 QUANTITATION LIMITS

Both aqueous and solid sample Practical Quantitation Limits (PQLs) are the lowest reporting level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. PQLs are statistically derived theoretical numbers based on methodology and chemistry that are independent of various operators and instrumentation.

3.3 DETECTION LIMITS

Instrument detection limits (IDL) and method detection limits (MDL) are reported under SW-846 protocol. The IDLs and MDLs applicable at the date of analysis will be reported for nondetected analyte results in each data package. These numbers will be corrected for percent moisture and any applicable dilution factors. IDLs and MDLs must be less than or equal to PQLs.

TABLE 3-1

SUMMARY OF ANALYSES, BOTTLE REQUIREMENTS, PRESERVATION REQUIREMENTS AND HOLDING TIMES
SUBSURFACE SOIL SAMPLES - SITE 1
NWIRP BETHPAGE, NEW YORK

Analytical Parameter	Analytical Methodology	Number of Borings	Number of Samples[1]	Container Type	Preservation and Holding Time
Soil Classification	ASTM D2487	4	12 (3 per boring)	Two 32-oz. clear wide-mouth glass containers	Not applicable
Volatile Organic Compounds	SW-846 8240	9	27 (3 per boring)	Two 60-mL glass volatile vials	Chill to 4° C; 14 days from date of sampling to date of analysis.

(1) The number of samples only includes the number of solid environmental samples being collected. No aqueous field quality control blanks, or matrix spike/matrix spike duplicate samples are being collected for this field effort.

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3.4 PARCC PARAMETERS

The quality of the data set is measured by certain characteristics of the data, namely the PARCC (precision, accuracy, representativeness, comparability, and completeness) parameters. Some of the parameters are expressed quantitatively, while others are expressed qualitatively. The objectives of the sampling activities and the intended use of the data define the PARCC goals.

3.4.1 Precision

Precision characterizes the amount of variability and bias inherent in a data set. Precision describes the reproducibility of measurements of the same parameter for a sample under the same or similar conditions. Precision is expressed as a range (the difference between two measurements of the same parameter) or as a relative percent difference (the range relative to the mean, expressed as a percent). Range and Relative Percent Difference (RPD) values are calculated as follows:

$$Range = OR - DR$$

$$RPD = \frac{(OR - DR)}{[(1/2)(OR + DR)]} \times 100\%$$

where: OR = original sample result
DR = duplicate sample result

The internal laboratory control limits for precision are three times the standard deviation of a series of RPD or range values. RPD values may be calculated for laboratory duplicates which can be compared to the control limits as a QA check. Laboratory duplicates will be analyzed at the rate required by the SW-846 methodology employed.

3.4.2 Accuracy

Accuracy is the comparison between experimental and known or calculated values expressed as a percent recovery (%R). Percent recoveries are derived from analysis of standards spiked into deionized water (standard recovery) or into actual samples (matrix spike or surrogate spike recovery). Recovery is calculated as follows:

$$\%R = E/T \times 100\%$$

where: E = experimental result

T = true value (theoretical result)

and

T = [(sample aliq.)(sample conc.) + (spike aliq.)(spike conc.)]/(sample aliq. + spike aliq.)

Control limits for accuracy are set at the mean plus or minus three times the standard deviation of a series or %R values. Organic %R values are set at the mean plus or minus two times the standard deviation. Accuracy for aqueous and solid samples will be evaluated by use of surrogates at the SW-846 methodology-required incidences. The acceptance criteria and corrective actions noted in SW-846 apply.

3.4.3 Representativeness

All data obtained should be representative of actual conditions at the sampling location. The FSAP is designed so that the samples taken will present an accurate representation of actual site conditions. The rationales discussed in the FSAP are designed to ensure this. All sampling activities will conform to the protocols given in Section 4.0 of this FSAP.

3.4.4 Comparability

Comparability will be achieved by utilizing standardized sampling and analysis methods and data reporting format. Both analytical procedures and sample collection techniques will maximize the comparability of this new data to previous data. Additionally, consideration will be given to seasonal conditions and other environmental conditions that could influence analytical results.

3.4.5 Completeness

Completeness is a measure of the amount of valid data obtained from the measurement program, compared to the total amount collected. For relatively clean, homogeneous matrices, 100-percent completeness is expected. However, as matrix complexity and heterogeneous increase, completeness may decrease. Where analysis is precluded or where DQOs are compromised, effects on the overall investigation must be considered. Whether any particular sample is critical to the investigation will be evaluated in terms of the sample location, the parameter in question, the intended data use, and the risk associated with the error.

Critical data points may not be evaluated until all the analytical results are evaluated. If in the evaluation of results it becomes apparent that the data for a specific medium are of insufficient quality (95 percent), either with respect to the number of samples or an individual analysis, resampling of the deficient data points may be necessary.

3.5 AQUEOUS FIELD QUALITY CONTROL BLANKS

No aqueous field quality control blanks will be collected under this RD task order.

3.6 BOTTLEWARE

NEESA requires specific bottleware cleaning procedures. Precleaned bottles will be used at the NWIRP Bethpage. The required certification will be provided.

4.0 FIELD SAMPLING PLAN

4.1 SITE BACKGROUND

Halliburton NUS has been tasked to perform a pre-design investigation at the NWIRP Bethpage at Site 1 (Plant 3) to further investigate the extent of soil contamination beneath the site. The investigation is being performed prior to the installation of a pilot system to verify that the pilot system will be positioned within a significant area of contamination. The fieldwork to be performed as part of the pilot system installation will be discussed in a future addendum to this Field Sampling Plan.

4.1.1 Site 1 - Former Drum Marshaling Area

Site 1 occupies an area of approximately 4 acres. It is surrounded on three sides by a fence and on the fourth side by Plant No. 3. The site is also bisected by a fence running north-south. To the west of this fence, the surface consists of asphalt and concrete. Bulk chemical storage tanks are also present. To the east of this bisecting fence, the surface is earth, gravel, or grass. The northeastern part of the site is slightly elevated (4 feet), well vegetated and well maintained. The southeastern part of the site is gravel and earth and is used for the storage of containers, equipment, and debris. The majority of the investigation at Site 1 occurred in the southeastern portion of the site. A vegetated wind row (pine) and fence are present along the eastern edge of the site to reduce community visibility.

From the early 1950's through the late 1970's, drums containing liquid wastes were stored on a cinder-covered area on Site 1. In the late 1970's this drum marshaling area was relocated a few yards south of this cinder-covered site to a 100 ft x 100 ft concrete pad. This concrete pad was uncovered and did not have any spill containment berms. Drum storage on this concrete pad was terminated in 1982, when all waste containers were relocated to the covered Salvage Storage Area (Site 3).

Approximately 200 to 300 drums were stored at Site 1 at any given time between the early 1950's and the early 1980's. Liquid wastes contained in the drums included halogenated and nonhalogenated solvents, and liquids containing concentrations of cadmium and cyanide.

The soils at Site 1 were found to contain elevated concentrations of chlorinated solvents such as PCE (4.8 mg/kg), PCBs (0.147%) and metals (arsenic: 0.338%). In addition, PAHs, and other semivolatile organics and metals were found at concentrations greater than background levels. Solvents were detected in both subsurface and surface soils throughout Site 1. The higher concentrations were found in the subsurface soils near the former drum marshaling pad. The other contaminants were found throughout the surface soils at Site 1, indicating widespread surface soil contamination.

The soils at Site 1 contain sufficient residual volatile organic contamination to confirm the source of groundwater contamination as being near or at the former drum marshaling areas. However, based on observed groundwater contamination patterns, there are potentially other source areas at the NWIRP. The groundwater at Site 1 was found to contain elevated concentrations of chlorinated solvents (such as TCE - 1.1 mg/L, PCE - 3.6 mg/L, and TCA - 10 mg/L). Contaminated groundwater from Site 1 extends south and west to approximately the Long Island Railroad, at which point it reaches a depth of approximately 200 feet below ground surface (bgs). Computer modeling performed during the remedial investigation indicates that the contaminated groundwater plume may continue further south both laterally and vertically and eventually be intercepted by Grumman production wells.

Several inorganics (in unfiltered samples) were found at concentrations greater than drinking water criteria, including cadmium (392 μg/L), chromium (169 μg/L), and lead (134 μg/L). The chromium and cadmium results are from a monitoring well considered upgradient of Site 1, although based on the location of the well and the activities at the site, these results could potentially result from Site 1 activities. For filtered samples, inorganics were also detected at concentrations greater than drinking water criteria, including cadmium (91 μg/L) and chromium (56.7 μg/L).

4.2 FIELD OPERATIONS

The field work for this project consists of the drilling and sampling of nine soil borings within and outside of Plant 3 at Site 1 (see Figure 1-3). The borings will provide additional site characterization information in support of a soil vapor extraction - air sparging remedial design. The borings will be sampled for chemical analyses and lithologic characterizations.

4.3 MOBILIZATION/DEMOBILIZATION

Following approval of the FSAP, Halliburton NUS will procure drilling, surveying, pilot-scale installation and analytical subcontractors, and begin mobilization activities. All field team members will review the FSAP, Health and Safety Plan (HASP) and Quality Assurance Project Plan (QAPP). In addition, a field team orientation meeting will be held to familiarize personnel with the scope of the field activities. Upon mobilization at the site, the Halliburton NUS Site Safety Officer (SSO), or representative, will provide site-specific health and safety training to the field team and drilling subcontractor personnel.

The Field Operations Leader (FOL) will coordinate the mobilization activities upon arrival at the facility. The FOL will also make any equipment purchases required to conduct the field investigation. The equipment required for the field activities will be obtained in Pittsburgh and shipped to the site by the FOL. After field activities are completed, the FOL and a technician/geologist will demobilize the equipment and ship it back to Pittsburgh. The schedule for performing the site characterization will consist of one 15-day shift. Field work is anticipated to begin on May 16, 1995.

4.4 BOREHOLE DRILLING AND SAMPLING

A total of 9 soil borings are proposed to be drilled at Site 1. The borings will be used to further determine the extent and chemical composition of the Site 1 contaminants. The proposed boring locations are indicated on Figure 1-3. As shown on the figure, 5 of the 9 borings will be located inside Plant 3. Drilling and sampling will be performed in accordance with Halliburton NUS SOPs GH-1.3 and GH1.5 (Appendix A).

Subsurface soil borings will be drilled to the water table using hollow stem auger drilling techniques. During drilling operations, Standard Penetration Tests and split-spoon sampling for lithologic description will be performed every 5 feet, continuously to the bottom of each soil boring. All split-spoon samples will be screened with an Organic Vapor Analyzer (OVA) or HNu and visually inspected for lithologic description. Split spoon samplers will have a minimum outside diameter of 2 inches and be at least 2 feet long to fulfill the sample volume requirements for chemical analysis. The use of drilling fluids is prohibited during soil boring activities. Drill cuttings will be containerized onsite in 55-gallon drums.

A complete log of each boring will be maintained by the field geologist. Appendix B contains an example of the boring log form. At a minimum, the boring log will contain the following information, when applicable, for each overburden boring:

- Sample numbers and types
- Sample depths
- Standard Penetration Test data
- Sample recovery/sample interval
- Soil density or cohesiveness
- Soil color
- Unified Soil Classification System (USCS) material description and symbol

In addition, depths of changes in lithology, sample moisture observations, depth to water, OVA readings, drilling method, and total depth of each borehole should be included on each boring log, as well as any other pertinent observations. Sample bottles containing soil samples collected solely for lithologic description will be numbered consecutively starting with S-1. In addition, the following information shall be recorded on the lid of the sample jars:

- Job number and name
- Boring and sample number
- Date
- Depth interval
- Blow counts

Three samples will be collected for chemical analysis from each of the 9 borings (approximately 27 samples) and submitted to a fixed base laboratory for TCL Volatile Organics Compound analysis. In each boring, one sample for chemical analysis will be collected from immediately above the soil/water interface. The two remaining samples will be collected from the top and middle of each boring. Exact sampled intervals will be determined in the field. No QA/QC samples will be collected from any of the soil borings. In addition, three (3) samples will be collected from four of the nine soil borings (approximately 12 samples) for geotechnical parameters (Soil Classification - ASTM D2487). The borings to be sampled for geotechnical parameters will be determined in the field, but as a minimum, will be located so as to provide representative data throughout the site.

Samples for chemical analysis will be collected by splitting the soil sample open longitudinally and extracting soil from the entire length of the interior of the sample. Portions of the sample submitted for volatile organic analysis will be placed directly into the required containers. A stainless steel or dedicated plastic trowel will be used to place the sample into the required containers. Decontamination of drilling and sampling equipment will be performed as described in Section 4.8.

4.5 SURVEYING

The horizontal and vertical locations of all 9 borings will be surveyed following complete installation of the pilot-scale system. Existing survey monuments located near Site 1 at the NWIRP, Bethpage facility will be used as reference points. Horizontal locations will be referenced to the New York State Plane Coordinate System. The horizontal locations of all surveyed points shall be completed to the nearest 0.10 foot. The vertical locations of all surveyed points shall be completed to the nearest 0.010 foot.

4.6 SAMPLE IDENTIFICATION SYSTEM

Each sample submitted to a fixed base laboratory for chemical analysis will be assigned a unique sample tracking number. The sample tracking number will consist of a two-segment, alpha-numeric code that identifies the sample medium and location, and sample depth interval. Any other pertinent information regarding sample identification will be recorded in the field log books and sample log sheets.

The alpha-numeric coding to be used in the sample system is explained below.

(AANN)	(NN/NN)
(Medium & Location)	(Sample Depth Interval)

Character Type:

A = Alpha
N = Numeric

Medium:

SB = Soil boring

Sample Location:

Soil boring = boring number

Sample Depth Interval:

First number indicates the minimum estimated depth for the sample.
Second number indicates the maximum estimated depth for the sample.

For example, a soil sample collected from soil boring SB01 between the estimated depth interval of 10 feet to 15 feet would be designated as SB01-10/15.

Notes detailing the sample number, time, date, and type will be recorded in the field log book and/or sample logsheets.

Information regarding sample labels and tags to be attached before shipment to a laboratory is contained in Section 5.2 of the Halliburton NUS SOP SA-6.1. No trip blanks, field duplicates, rinsate blanks or field blanks shall be collected during this sampling activity.

4.7 SAMPLE HANDLING

Sample handling includes the field-related considerations regarding the selection of sample containers, preservatives, allowable holding times and analyses requested. Table 3-1 summarizes the sample handling considerations for this field investigation. The Federal Register (EPA, October 26, 1984) address the topics of containers and sample preservations.

4.7.1 Sample Packaging and Shipping

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

- Sample Labels
- Chain-of-Custody Forms
- Appropriate labels applied to shipping coolers
- Chain-of-Custody Labels
- Federal Express Air Bills

4.7.2 Sample Custody

Custody of samples must be maintained and documented at all times. Chain-of-custody begins with the collection of the samples in the field. Section 5.3 of Halliburton NUS SOP SA-6.1 (Appendix A) provides a description of the chain-of-custody procedures to be followed. A sample chain-of-custody form is attached in Appendix B.

4.8 EQUIPMENT DECONTAMINATION

The equipment involved in field sampling activities will be decontaminated prior to and during drilling and sampling activities. This equipment includes drilling rigs, downhole tools, augers, and all sampling equipment.

4.8.1 Major Equipment

All downhole drilling and sampling tools shall be steam cleaned prior to beginning work, between well borings, any time the drilling rig leaves the site prior to completing a boring, and at the completion of the drilling program.

These decontamination operations will consist of washing the equipment using a high-pressure steam wash. All decontamination activities will take place at a location determined during mobilization. It is assumed that the facility will provide a suitable location for decontamination operations along with potable water and electricity. Additional requirements for drilling equipment decontamination can be found in Halliburton NUS SOP SF-2.3: Section 5 (Appendix A).

4.8.2 Sampling Equipment

All sampling equipment used for collecting samples will be decontaminated both prior to beginning field sampling and between samples. The following decontamination steps will be taken:

- Potable water rinse
- Alconox or liquinox detergent wash
- Potable water rinse
- Methanol rinse
- Steam distilled water rinse
- Air dry

Field analytical equipment such as pH, conductivity and temperature instrument probes will be rinsed first with steam distilled water, then with the sample liquid. Split-Barrel samplers will be cleaned using an alconox wash followed by a potable water rinse.

4.9 WASTE MANAGEMENT

All decontamination liquids and Personal Protective Equipment (PPE) will be collected, containerized and stored on site in DOT-approved (Specification 17-C), 55-gallon drums. All drill cuttings will also be stored in the DOT-approved 55-gallon drums. All drums will be sealed and labeled with drum contents, soil boring number, and date. This information will also be documented in the field logbook. NWIRP Bethpage will take possession of the drums upon completion of the project and will determine whether off-site disposal and/or treatment is required pending analytical results from the sampling.

5.0 DOCUMENTATION AND CHAIN-OF CUSTODY

Sample custody procedures are designed to provide documentation of preparation, handling, storage, and shipping of all samples collected. An example of the chain-of-custody form, which will be used during this investigation, is included in Appendix B.

Samples collected during the site investigation will be the responsibility of identified persons from the time they are collected until they, or their derived data, are incorporated into the final report. Stringent chain-of-custody procedures will be followed to document sample possession.

5.1 FIELD CUSTODY

- The FOL, or his or her designee, is responsible for the care and custody of the samples collected until they are delivered to the analyzing laboratory or entrusted to a carrier.

- Sample logs or other records will always be signed and dated.

- Chain-of-custody sample forms will be completed to the fullest extent possible prior to sample shipment. They will include the following information: project name, sample number, time collected, source of sample and location, description of sample location, matrix, type of sample, grab or composite designation, preservative, number and size of bottle, analysis, and name of sampler.

  These forms will be filled out in a legible manner, using waterproof ink, and will be signed by the sampler. Similar information will be provided on the sample label which will be securely attached to the sample bottle. The label will also include the general analyses to be conducted. In addition, sampling forms will be used to document collection, filtration, and preparation procedures. Copies of all field documentation forms are provided in Appendix B.

5.2 TRANSFER OF CUSTODY AND SHIPMENT

The following procedures will be used when transferring custody of samples:

- Samples will always be accompanied by a chain-of-custody record. When transferring samples, the individuals relinquishing and receiving them will sign, date, and note the time of the chain-of-custody record. This record documents the sample custody transfer from the sampler to the laboratory, often through another person or agency (common carrier). Upon arrival at the laboratory, internal sample custody procedures will be followed.

- Prior to shipment to the laboratory for analysis, samples will be properly packaged. Individual custody records will accompany each shipment. Shipping containers will then be sealed for shipment to the laboratory. The methods of shipment, courier name, and other pertinent information, will be entered in the remarks section of the custody record.

- All shipments will be accompanied by the chain-of-custody record identifying the contents. The original record will accompany the shipment; and a copy will be retained by the field sampler.

- Proper documentation will be maintained for shipments by common carrier.

5.3 SAMPLE SHIPMENT PROCEDURES

The following procedures will be followed when shipping samples for laboratory analysis:

- Samples requiring refrigeration will be promptly chilled with ice or Blue Ice to a temperature of 4°C and will be packaged in an insulated cooler for transport to the laboratory. Ice will be sealed in containers to prevent leakage of water. Samples will not be frozen.

- Only shipping containers that meet all applicable state and Federal standards for safe shipment will be used.

- Shipping containers will be sealed with nylon strapping tape, custody seals will be signed, dated, and affixed, in a manner that will allow the receiver to quickly identify any tampering that may have occurred during transport to the laboratory.

- Shipment will be made by overnight courier. After samples have been taken, they must be sent to the laboratory within 24 hours.

5.4 FIELD DOCUMENTATION RESPONSIBILITIES

It will be the responsibility of the FOL to secure all documents produced in the field (geologist's daily logs, lithologic and sampling logs, communications) at the end of each work day.

The possession of all records will be documented; however, only the project FOL or designee may remove field data from the site for reduction and evaluation.

The data generated by the laboratory will be sent to Halliburton NUS, reviewed by the Project Manager and/or staff chemist for completion and acceptance by Halliburton NUS.

6.0 CALIBRATION PROCEDURES

Field equipment such as the Organic Volatile Analyzer (OVA), HNu, the pH and specific conductance meters, will be calibrated and operated in accordance with the manufacturer's instructions and manuals. A log will be kept documenting the calibration results for each field instrument. The log will include the date, standards, personnel, and results of the calibration.

Calibration procedures for laboratory equipment used in the analysis of environmental samples will be performed in accordance with method-specific criteria.

7.0 SAMPLE PREPARATION AND ANALYTICAL PROCEDURES

Environmental samples collected during the field investigation for chemical analyses will be analyzed using the appropriate analytical procedures as outlined in Table 3-1 of this FSAP. The methods are referenced to the appropriate CLP, EPA, or other guidance.

8.0 DATA REDUCTION, VALIDATION, AND REPORTING

Data reduction, validation, and reporting are basic steps in the control and processing of field and laboratory project-generated data. Data will be presented in tabular form with site background result (for inorganics) and relevant requirements for organic results used as screening criteria. Data validation procedures are described below.

Data validation consists of a stringent review of an analytical chemical data package with respect to sample receipt and handling, analytical methods, data reporting and deliverables, and document control. The quality of data generated by a laboratory is extremely important; it is an integral part of the investigation and should be clearly tied to the project goals. Data used to develop qualitative trends, for example, will not have the same data validation requirements as data used for litigation purposes. No data validation will be performed for the data generated under this RD task order.

9.0 INTERNAL QUALITY CONTROL CHECKS

No quality control samples will be generated by Halliburton NUS.

There are two types of quality assurance mechanisms used to ensure the production of analytical data of known and documented quality. The internal laboratory quality control procedures for the analytical services are specified in the analytical methodology. These specifications include the types of control samples required (sample spikes, surrogate spikes, controls, and blanks), the frequency of each control, the compounds to be used for sample spikes and surrogate spikes, and the quality control acceptance criteria. It will be the laboratory's responsibility to document, in each data package, that both initial and on-going instrument and analytical QC criteria are met.

Analytical results will also be compared to acceptance criteria, and documentation will be performed showing that criteria have been met. Any samples in nonconformance with the QC criteria will be identified and reanalyzed by the laboratory, as required. The following procedures will be employed for the processing of NWIRP Bethpage samples:

- Proper storage of samples.
- Use of qualified and/or certified technicians.
- Use of calibrated equipment.
- Use of standardized test procedures.

10.0 PERFORMANCE AND SYSTEM AUDITS

System audits will be performed on a semi-continuous basis, as appropriate, to assure that the work is being implemented in accordance with the approved project SOPs and in an overall satisfactory manner.

- The FOL will supervise and check on a daily basis that the soil borings are installed correctly, field measurements are made accurately, equipment is thoroughly decontaminated, samples are collected and handled properly, and the field work is accurately and neatly documented.

- The project manager will oversee the FOL, and check that management of the acquired data proceeds in an organized and expeditious manner.

- System audits for the laboratory are performed on a regular basis.

  A formal audit of the field sampling procedures may be conducted in addition to the auditing that is an inherent part of the daily project activities. If so conducted, the auditors will check that sample collection, sample handling, decontamination protocols, and instrument calibration and use are in accordance with the approved project SOPs. The auditors will also check that the field documentation logs and chain-of-custody forms are being filled out properly.

11.0 PREVENTATIVE MAINTENANCE

Halliburton NUS has established a program for the maintenance of field equipment to ensure the availability of equipment in good working order when and where it is needed. This program consists of the following elements:

- The equipment manager keeps an inventory of the equipment in terms of items (model and serial number) quantity and condition. Each item of equipment is signed out when in use, and its operating condition and cleanliness checked upon return.
- The equipment manager conducts routine checks on the status of equipment and is responsible for the stocking of spare parts and equipment readiness.
- The equipment manager maintains the equipment manual library and trains field personnel in the proper use and care of equipment.
- The FOL is responsible for working with the equipment manager to make sure that the equipment is tested, cleaned, charged, and calibrated in accordance with the manufacturer's instructions before being taken to the job site.

The laboratory follows a well-defined program to prevent the failure of laboratory equipment and instrumentation. This preventative program, includes the periodic inspection, lubrication, cleaning, and replacement of parts of the equipment.

12.0 DATA ASSESSMENT PROCEDURES

12.1 REPRESENTATIVENESS, ACCURACY, AND PRECISION

All data generated in the investigation will be assessed for its representativeness, accuracy, and precision. The completeness of the data will also be assessed by comparing the valid acquired data to the project objectives to see that these objectives are being addressed and met. The specific procedures used to determine data precision, accuracy, and completeness will be provided in the analytical reports. Accuracy will be determined using laboratory spiked samples.

The representativeness of the data will be assessed by determining if the data are consistent with known or anticipated hydrogeologic or chemical conditions and accepted principles. Field measurements will be checked for completeness of procedures and documentation of procedures and results.

Precision and accuracy will be determined using replicate samples and blank and spiked samples, respectively. The specific procedures for determining PARCC parameters are outlined in Section 5.0.

12.2 VALIDATION

No data validation is being performed for this RD project.

13.0 CORRECTIVE ACTIONS

The QA program will enable problems to be identified, controlled, and corrected. Potential problems may involve nonconformance with the SOPs and/or analytical procedures established for the project or other unforeseen difficulties. Any person identifying an unacceptable condition will notify the project manager. The project manager, with the assistance of the project QA/QC officer, will be responsible for developing and initiating appropriate corrective action and verifying that the correction action has been effective. Corrective actions may include the following: resampling and/or reanalysis of sample, amending or adjusting project procedures. If warranted by the severity of the problem (for example, if a change in the approved FSAP is required), the Navy will be notified in writing and their approval will be obtained prior to implementing any change. Additional work that is dependent on a nonconforming activity will not be performed until the problem has been eliminated.

The laboratory maintains an internal closed-loop corrective action system that operates under the direction of the laboratory QA coordinator.

14.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

The QA/QC advisor will review all aspects of the implementation of the FSAP on a regular basis and with the use of designated support personnel, will prepare a summary report. Reviews will be performed at the completion of each field activity and reports will be completed at this time. These reports will include an assessment of data quality and the results of system and/or performance audits. Any significant QA deficiencies will be reported and identified, and corrective action possibilities discussed. The laboratory will issue monthly progress reports. Other QA/QC reports are listed in Section 8.0.

REFERENCES

ASTM, March 1988. Annual Book of Standards - Soil and Rock, Building Stones; Geotextiles. Section 4, Volume 04.08.

Halliburton NUS, May 1992. Final Remedial Investigation Report, Naval Weapons Industrial Reserve Plant.

Halliburton NUS, July 1993. Phase 2 Remedial Investigation Report for Naval Weapons Industrial Reserve Plant.

Halliburton NUS, March 1994. Feasibility Study Report for Naval Weapons Industrial Reserve Plant.

Naval Energy and Environmental Support Activity (NEESA), June 1988. Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program. NEESA, Port Hueneme, CA. NEESA 20.2-047B.

NYSDEC (New York State Department of Environmental Conservation), 1989. NYSDEC Analytical Services Protocols (ASP). NYSDEC Division of Water, Bureau of Technical Services and Research, September.

NYSDEC, 1991. RCRA Quality Assurance Project Plan Guidance, NYSDEC Division of Hazardous Substances Regulation, March.

U.S. EPA, 1986. Test Methods for Evaluating Solid Waste - SW846.

U.S. EPA, September 1986, Test Methods for Evaluating of Solid Waste - Physical/Chemical Methods SW846.

U.S. EPA, February 1988, Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses.

U.S. EPA, July 1988, Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses.

APPENDIX A
STANDARD OPERATING PROCEDURES

GH-1.3	Soil and Rock Sampling
GH-1.5	Borehole and Sample Logging
SA-6.1	Sample Identification and Chain-of-Custody
SA-6.2	Sampling Packaging and Shipping
SA-6.3	Site Logbook
SF-2.3	Decontamination of Chemical Sampling and Field Analytical Equipment

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 <u>Thin Walled Tube (Shelby Tube) Sampling (ASTM D1587-83)</u>

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 sampIng 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 25.4.
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 penetration 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.

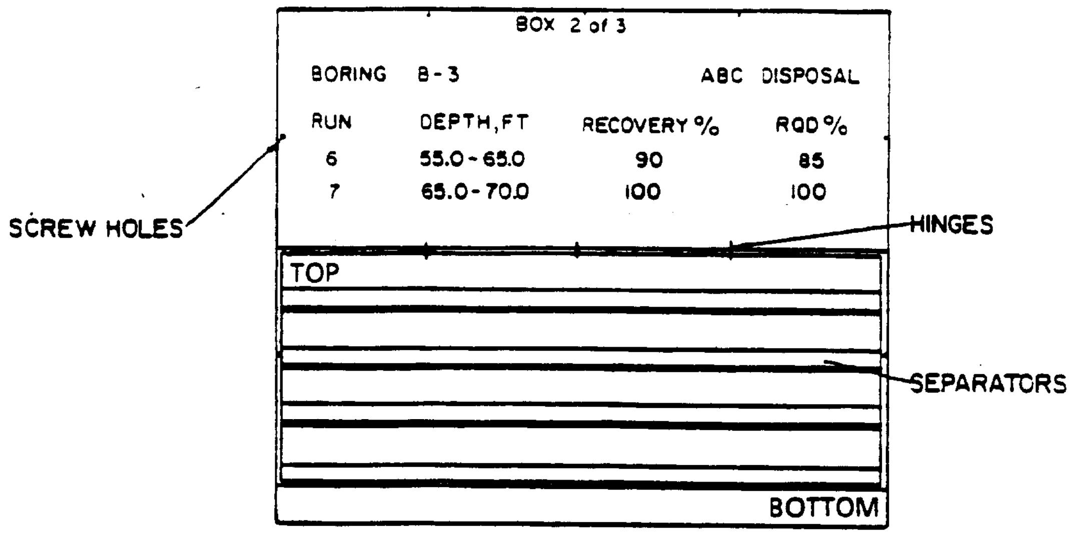
The inside and outside of the core-box lid shall be marked by indelible ink to show all pertinent data on the box's contents. At a minimum, the following information shall be included:

- 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).

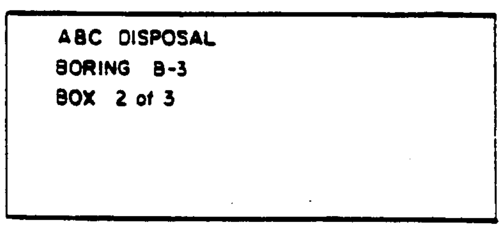
For easy retrieval when core boxes are stacked, the sides and ends of the box shall also be labeled and include project number, boring number, top and bottom depths of core and box number. Attachment No. 2 illustrates a typical rock core box.

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).

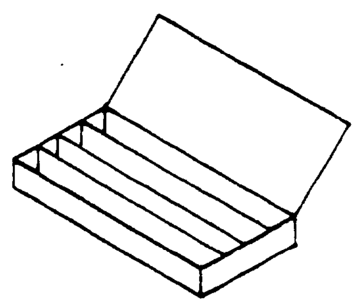
ATTACHMENT 2

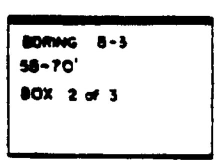


CORE BOX (OBLIQUE VIEW)



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.

1.0 PURPOSE

The purpose of this document is to establish standard procedures and technical guidance on borehole and sample logging.

2.0 SCOPE

These procedures provide descriptions of the standard techniques for borehole and sample logging. These techniques shall be used for each boring logged to provide consistent descriptions of subsurface lithology. While experience is the only method to develop confidence and accuracy in the description of soil and rock, the field geologist/engineer can do a good job of classification by careful, thoughtful observation and by being consistent throughout the classification procedure.

3.0 GLOSSARY

None.

4.0 RESPONSIBILITIES

Site Geologist - Responsible for supervising all boring activities and assuring that each borehole is completely logged. If more than one rig is being used onsite the Site Geologist must make sure that each field geologist is properly trained in logging procedures. A brief review or training session may be necessary prior to the start up of the field program and/or upon completion of the first boring.

5.0 PROCEDURES

The classification of soil and rocks is one of the most important jobs of the field geologist/engineer. To maintain a consistent flow of information, it is imperative that the field geologist/engineer understand and accurately use the field classification system described in this SOP. This identification is based on visual examination and manual tests.

5.1 MATERIALS NEEDED

When logging soil and rock samples, the geologist or engineer may be equipped with the following:

- Rock hammer
- Knife
- Camera
- Dilute HCl
- Ruler (marked in tenths and hundreths of feet)
- Hand Lens

5.2 CLASSIFICATION OF SOILS

All data shall be written directly on the boring log (Exhibit 4-1) or in a field notebook if more space is needed. Details on filling out the boring log are discussed in Section 5.5.

5.2.1 USCS Classification

Soils are to be classified according to the Unified Soil Classification System (USCS). This method of classification is detailed in Exhibit 4-2. This method of classification identifies soil types on the basis of grain size and cohesiveness.

Fine-grained soils, or fines, are smaller than the No. 200 sieve and are of two types: silt (M) and clay (C). Some classification systems define size ranges for these soil particles, but for field classification purposes, they are identified by their respective behaviors. Organic material (O) is a common component of soil but has no size range; it is recognized by its composition. The careful study of the USCS will aid in developing the competence and consistency necessary for the classification of soils.

Coarse grained soils shall be divided into rock fragments, sand, or gravel. The terms and sand and gravel not only refer to the size of the soil particles but also to their depositional history. To insure accuracy in description, the term rock fragments shall be used to indicate angular granular materials resulting from the breakup of rock. The sharp edges typically observed indicate little or no transport from their source area, and therefore the term provides additional information in reconstructing the depositional environment of the soils encountered. When the term "rock fragments" is used it shall be followed by a size designation such as (1/4 inchΦ-1/2 inchΦ)" or "coarse-sand size" either immediately after the entry or in the remarks column. The USCS classification would not be affected by this variation in terms.

5.2.2 Color

Soil colors shall be described utilizing a single color descriptor preceded, when necessary, by a modifier to denote variations in shade or color mixtures. A soil could therefore be referred to as "gray" or "light gray" or "blue-gray." Since color can be utilized in correlating units between sampling locations, it is important for color descriptions to be consistent from one boring to another.

Colors must be described while the sample is still moist. Soil samples shall be broken or split vertically to describe colors. Samplers tend to smear the sample surface creating color variations between the sample interior and exterior.

The term "mottled" shall be used to indicate soils irregularly marked with spots of different colors. Mottling in soils usually indicates poor aeration and lack of good drainage.

Soil Color Charts shall not be used unless specified by the project manager.

5.2.3 Relative Density and Consistency

To classify the relative density and/or consistency of a soil, the geologist is to first identify the soil type. Granular soils contain predominantly sands and gravels. They are noncohesive (particles do not adhere well when compressed). Finer grained soils (silts and clays) are cohesive (particles will adhere together when compressed).

The density of noncohesive, granular soils is classified according to standard penetration resistances obtained from split barrel sampling performed according to the methods detailed in Standard Operating Procedures GH-1.3 and SA-1.2. Those designations are:

Designation	Standard Penetration Resistance (Blows per Foot)
Very loose	0 to 4
Loose	5 to 10
Medium dense	11 to 30
Dense	31 to 50
Very dense	Over 50

Standard penetration resistance is the number of blows required to drive a split-barrel sampler with a 2-inch outside diameter 12 inches into the material using a 140 pound hammer falling freely through 30 inches. The sampler is driven through an 18-inch sample interval, and the number of blows is recorded for each 6-inch increment. The density designation of granular soils is obtained by adding the number of blows required to penetrate the last 12 inches of each sample interval. It is important to note that if gravel or rock fragments are broken by the sampler or if rock fragments are lodged in the tip, the resulting blow count will be erroneously high, reflecting a higher density than actually exists. This shall be noted on the log and referenced to the sample number. Granular soils are given the USCS classifications GW, GP, GM, SW, SP, SM, GC, and SC (see Exhibit 4-2).

The consistency of cohesive soils is determined by performing field tests and identifying the consistency as shown in Exhibit 4-3. Cohesive soils are given the USCS classifications ML, MH, CL, CH, OL, or OH (see Exhibit 4-2).

The consistency of cohesive soils is determined either by blow counts, a pocket penetrometer (values listed in the table as Unconfined Compressive Strength) or by hand by determining the resistance to penetration by the thumb. The pocket penetrometer and thumb determination methods are conducted on a selected sample of the soil, preferably the lowest 0.5 foot of the sample in the split-barrel sampler. The sample shall be broken in half and the thumb or penetrometer pushed into the end of the sample to determine the consistency. Do not determine consistency by attempting to penetrate a rock fragment. If the sample is decomposed rock, it is classified as a soft decomposed rock rather than a hard soil. Consistency shall not be determined solely by blow counts. One of the other methods shall be used in conjunction with it. The designations used to describe the consistency of cohesive soils are as follows:

Consistency	Unc. Compressive Str. Tons/Square Foot	Standard Penetration Resistance (Blows per Foot)	Field Identification Methods
Very soft	Less than 0.25	0 to 2	Easily penetrated several inches by fist
Soft	0.25 to 0.50	2 to 4	Easily penetrated several inches by thumb
Medium stiff	0.50 to 1.0	4 to 8	Can be penetrated several inches by thumb
Very stiff	1.0 to 2.0	8 to 15	Readily indented by thumb
Hard	2.0 to 4.0	15 to 30	Readily indented by thumbnail
Hard	More than 4.0	Over 30	Indented with difficulty by thumbnail

5.2.4 Weight Percentages

In nature, soils are comprised of particles of varying size and shape, and are combinations of the various grain types. The following terms are useful in the description of soil:

Terms of Identifying Proportion of the Component	Defining Range of Percentages by Weight
trace	0 - 10 percent
some	11 - 30 percent
and or adjective form of the soil type (e.g., "sandy")	31 - 50 percent

Examples:

- Silty fine sand: 50 to 69 percent fine sand, 31 to 50 percent silt.
- Medium to coarse sand, some silt: 70 to 80 percent medium to coarse sand, 11 to 30 percent silt.
- Fine sandy silt, trace clay: 50 to 68 percent silt, 31 to 49 percent fine sand, 1 to 10 percent clay.
- Clayey silt, some coarse sand: 70 to 89 percent clayey silt, 11 to 30 percent coarse sand.

5.2.5 Moisture

Moisture content is estimated in the field according to four categories: dry, moist, wet, and saturated. In dry soil, there appears to be little or no water. Saturated samples obviously have all the water they can hold. Moist and wet classifications are somewhat subjective and often are determined by the individual's judgment. A suggested parameter for this would be calling a soil wet if rolling it in the hand or on a porous surface liberates water, i.e., dirties or muddies the surface. Whatever method is adopted for describing moisture, it is important that the method used by an individual remains consistent throughout an entire drilling job.

Laboratory tests for water content shall be performed if the natural water content is important.

5.2.6 Stratification

Stratification can only be determined after the sample barrel is opened. The stratification or bedding thickness for soil and rock is depending on grain size and composition. The classification to be used for stratification description is shown in Exhibit 4-4.

5.2.7 Texture/Fabric/Bedding

The texture/fabric/bedding of the soil shall be described. Texture is described as the relative angularity of the particles: rounded, subrounded, subangular, and angular. Fabric shall be noted as to whether the particles are flat or bulky and whether there is a particular relation between particles (i.e., all the flat particles are parallel or there is some cementation). The bedding or structure shall also be noted (e.g., stratified, lensed, nonstratified, heterogeneous varved).

5.2.8 Summary of Soil Classification

In summary, soils shall be classified in a similar manner by each geologist/engineer at a project site. The hierarchy of classification is as follows:

- Density and/or consistency
- Color
- Plasticity (Optional)
- Soil types
- Moisture content
- Stratification
- Texture, fabric, bedding
- Other distinguishing features

5.3 CLASSIFICATION OF ROCKS

Rocks are grouped into three main divisions, including sedimentary, igneous and metamorphic rocks. Sedimentary rocks are by far the predominant type exposed at the earth's surface. The following basic names are applied to the types of rocks found in sedimentary sequences:

- Sandstone - Made up predominantly of granular materials ranging between 1/16 to 2 mm in diameter.

- Siltstone - Made up of granular materials less than 1/16 to 1/256 mm in diameter. ractures irregularly. Medium thick to thick bedded.

- Claystone - Vary fine grained rock made up of clay and silt-size materials. Fractures irregularly. Very smooth to touch. Generally has irregularly spaced pitting on surface of drilled cores.

- Shale - A fissile very fine grained rock. Fractures along bedding planes.

- Limestone - Rock made up predominantly of calcite ($CaCO_3$). Effervesces strongly upon the application of dilute hydrochloric acid.

- Coal - Rock consisting mainly of organic remains.

- Others - Numerous other sedimentary rock types are present in lesser amounts in the stratigraphic record. The local abundance of any of these rock types is dependent upon the depositional history of the area. These include conglomerate, halite, gypsum, dolomite, anhydrite, lignite, etc. are some of the rock types found in lesser amounts.

In classifying a sedimentary rock the following hierarchy shall be noted:

- Rock type
- Color
- Bedding thickness
- Hardness
- Fracturing
- Weathering
- Other characteristics

5.3.1 Rock Type

As described above, there are numerous names of sedimentary rocks. In most cases a rock will be a combination of several grain types, therefore, a modifier such as a sandy siltstone, or a silty sandstone can be used. The modifier indicates that a significant portion of the rock type is composed of the modifier. Other modifiers can include carbonaceous, calcareous, siliceous, etc.

Grain size is the basis for the classification of clastic sedimentary rocks. Exhibit 4-5 is the Udden-Wentworth classification that will be assigned to sedimentary rocks. The individual boundaries are slightly different than the USCS subdivision for soil classification. For field determination of grain sizes, a scale can be used for the coarse grained rocks. For example, the division between siltstone and claystone may not be measurable in the field. The boundary shall be determined by use of a hand lens. If the grains cannot be seen with the naked eye but are distinguishable with a handlens, the rock is a siltstone. If the grains are not distinguishable with a handlens, the rock is a claystone.

5.3.2 Color

The color of a rock can be determined in a similar manner as for soil samples. Rock core samples shall be classified while wet, when possible, and air cored samples shall be scraped clean of cuttings prior to color classifications.

Rock Color Charts shall not be used unless specified by the project manager.

5.3.3 Bedding Thickness

The bedding thickness designations applied to soil classification will also be used for rock classification.

5.3.4 Hardness

The hardness of a rock is a function of the compaction, cementation, and mineralogical composition of the rock. A relative scale for sedimentary rock hardness is as follows:

- Soft - Weathered, considerable erosion of core, easily gouged by screwdriver, scratched by fingernail. Soft rock crushes or deforms under pressure of a pressed hammer. This term is always used for the hardness of the saprolite (decomposed rock which occupies the zone between the lowest soil horizon and firm bedrock).

- Medium soft - Slight erosion of core, slightly gouged by screwdriver, or breaks with crumbly edges from single hammer blow.

- Medium hard - No core erosion, easily scratched by screwdriver, or breaks with sharp edges from single hammer blow.

- Hard - Requires several hammer blows to break and has sharp conchoidal breaks. Cannot be scratched with screwdriver.

Note the difference in usage here of the works "scratch" and "gouge." A scratch shall be considered a slight depression in the rock (do not mistake the scraping off of rock flour from drilling with a scratch in the rock itself), while a gouge is much deeper.

5.3.5 Fracturing

The degree of fracturing or brokeness of a rock is described by measuring the fractures or joint spacing. After eliminating drilling breaks, the average spacing is calculated and the fracturing is described by the following terms:

- Very broken (V. BR.) - Less than 2 in. spacing between fractures
- Broken (BR.) - 2 in. to 1 ft. spacing between fractures
- Blocky (BL.) - 1 to 3 ft. spacing between fractures
- Massive (M.) - 3 to 10 ft. spacing between fractures

The structural integrity of the rock can be approximated by calculating the Rock Quality Designation (RQD) of cores recovered. The RQD is determined by adding the total lengths of all pieces exceeding 4 inches and dividing by the total length of the coring run, to obtain a percentage.

Method of Calculating RQD
(After Deere, 1964)

$$RQD \% = r/l \times 100$$

r = Total length of all pieces of the lithologic unit being measured, which are greater than 4 inches length, and have resulted from natural breaks. Natural breaks include slickensides, joints, compaction slicks, bedding plane partings (not caused by drilling), friable zones, etc.

l = Total length of the coring run.

5.3.6 Weathering

The degree of weathering is a significant parameter that is important in determining weathering profiles and is also useful in engineering designs. The following terms can be applied to distinguish the degree of weathering:

- Fresh - Rock shows little or no weathering effect. Fractures or joints have little or no staining and rock has a bright appearance.

- Slight - Rock has some staining which may penetrate several centimeters into the rock. Clay filling of joints may occur. Feldspar grains may show some alteration.

- Moderate - Most of the rock, with exception of quartz grains, is stained. Rock is weakened due to weathering and can be easily broken with hammer.

- Severe - All rock including quartz grains is stained. Some of the rock is weathered to the extent of becoming a soil. Rock is very weak.

5.3.7 Other Characteristics

The following items shall be included in the rock description:

- Description of contact between two rock units. These can be sharp or gradational.
- Stratification (parallel, cross stratified)
- Description of any filled cavities or vugs.
- Cementation (calcoreous, siliceous, hematitic)

- Description of any joints or open fractures.
- Observation of the presence of fossils.
- Notation of joints with depth, approximate angle to horizontal, any mineral filling or coating, and degree of weathering.

All information shown on the boring logs shall be neat to the point where it can be reproduced on a copy machine for report presentation. The data shall be kept current to provide control of the drilling program and to indicate various areas requiring special consideration and sampling.

5.3.8 Additional Terms Used in the Description of Rock

The following terms are used to further identify rocks:

- Seam - Thin (12 inch or less), probably continuous layer.

- Some - Indicates significant (15 to 40 percent) amounts of the accessory material. For example, rock composed of seams of sandstone (70 percent) and shale (30 percent) would be "sandstone -- some shale seams."

- Few - Indicates insignificant (0 to 15 percent) amounts of the accessory material. For example, rock composed of seam of sandstone (90 percent) and shale (10 percent) would be "sandstone -- few shale seams."

- Interbedded - Used to indicate thin or very thin alternating seams of material occurring in approximately equal amounts. For example, rock composed of thin alternating seams of sandstone (50 percent) and shale (50 percent) would be "interbedded sandstone and shale."

- Interlayered - Used to indicate thick alternating seams of material occurring in approximately equal amounts.

The preceding sections describe the classification of sedimentary rocks. The following are some basic names that are applied to igneous rocks:

- Basalt - A fine-grained extrusive rock composed primarily of calcic plagioclase and pyroxene.

- Rhyolite - A fine-grained volcanic rock containing abundant quartz and orthoclase. The fine-grained equivalent of a granite.

- Granite - A coarse-grained plutonic rock consisting essentially of alkali feldspar and quartz.

- Diorite - A coarse-grained plutonic rock consisting essentially of sodic plagioclase and hornblende.

- Gabbro - A coarse-grained plutonic rock consisting of calcic plagioclase and clinopyroxene. Loosely used for any coarse grained dark igneous rock.

The following are some basic names that are applied to metamorphic rocks:

- Slate - A very fine-grained foliated rock possessing a well developed slaty cleavage. Contains predominantly chlorite, mica, quartz, and sericite.
- Phyllite - A fine-grained foliated rock that splits into thin flaky sheets with a silky sheen on cleavage surface.
- Schist - A medium to coarse-grained foliated rock with subparallel arrangement of the micaceous minerals which dominate its composition.
- Gneiss - A coarse-grained foliated rock with bands rich in granular and platy minerals.
- Quartzite - A fine to coarse-grained nonfoliated rock breaking across grains, consisting essentially of quartz sand with silica cement.

5.4 ABBREVIATIONS

Abbreviations may be used in the description of a rock or soil. However, they shall be kept at a minimum. Following are some of the abbreviations that may be used:

C - Coarse	Lt - Light	Yl - Yellow
Med - Medium	BR - Broken	Or - Orange
F - Fine	BL - Blocky	SS - Sandstone
V - Very	M - Massive	Sh - Shale
Sl - Slight	Br - Brown	LS - Limestone
Occ - Occasional	Bl - Black	Fgr - Fine grained
Tr - Trace		

5.5 BORING LOGS AND DOCUMENTATION

This section describes in more detail the procedures to be used in completing boring logs in the field. Information obtained from the preceeding sections shall be used to complete the logs. A sample boring log has been provided as Exhibit 4-6. The field geologist/engineer shall use this example as a guide in completing each borings log. Each boring log shall be fully described by the geologist/engineer as the boring is being drilled. Every sheet contains space for 25 feet of log. Information regarding classification details is provided on the back of the boring log, for field use.

5.5.1 Soil Classification

- Identify site name, boring number, job number, etc. Elevations and water level data to be entered when surveyed data is available.
- Enter sample number (from SPT) under appropriate column. Enter depth sample was taken from (1 block = 1 foot). Fractional footages, i.e., change of lithology a 13.7 feet, shall be lined off at the proportional location between the 13 and 14 foot marks. Enter blow counts (Standard Penetration Resistance) diagonally (as shown). Standard penetration resistance is covered in Section 5.2.3.

- Determine sample recovery/sample length as shown. Measure the total length of sample recovered from the split spoon sampler, including material in the drive shoe. Do not include cuttings or wash material that may be in the upper portion of the sample tube.

- Indicate any change in lithology by drawing a line at the appropriate depth. For example, if clayey silt was encountered from 0 to 5.5 feet and shale from 5.5 to 6.0 feet, a line shall be drawn at this increment. This information is helpful in the construction of cross-sections. As an alternative, symbols may be used to identify each change in lithology.

- The density of granular soils is obtained by adding the number of blows for the last two increments. Refer to Density of Granular Soils Chart of back of log sheet. For consistency of cohesive soils refer also to the back of log sheet - Consistency of Cohesive Soils. Enter this information under the appropriate column. Refer to Section 5.2.3.

- Enter color of the material in the appropriate column.

- Describe material using the USCS. Limit this column for sample description only. The predominate material is described last. If the primary soil is silt but has fines (clay) - use clayey silt. Limit soil descriptors to the following:

  - Trace 0 - 10 percent
  - Some 11 - 30 percent
  - And 31 - 50 percent

- Also indicate under Material Classification if the material is fill or natural soils. Indicate roots, organic material, etc.

- Enter USCS symbol - use chart on back of boring log as a guide. If the soils fall into one of two basic groups, a borderline symbol may be used with the two symbols separated by a slash. For example ML/CL or SM/SP.

- The following information shall be entered under the Remarks Column and shall include, but is not limited by the following:

  - Moisture - estimate moisture content using the following terms - dry, moist, wet and saturated. These terms are determined by the individual. Whatever method is used to determine moisture, be consistent throughout the log.

  - Angularity - describe angularity of coarse grained particles using Angular, Subangular, Subrounded, Rounded. Refer to ASTM D 2488 or Earth Manual for criteria for these terms.

  - Particle shape - flat, elongated, or flat and elongated.

  - Maximum particle size or dimension.

  - Water level observations.

  - Reaction with HCl - none, weak or strong.

- Additional comments:

  - Indicate presence of mica, caving of hole, when water was encountered, difficulty in drilling, loss or gain of water.

  - Indicate odor and HNu or OVA reading if applicable.

  - Indicate any change in lithology by drawing in line through the lithology change column and indicate the depth. This will help later on when cross-sections are constructed.

  - At the bottom of the page indicate type of rig, drilling method, hammer size and drop and any other useful information (i.e., borehole size, casing set, changes in drilling method).

  - Vertical lines shall be drawn (as shown in Exhibit 4.6) in columns 5 to 8 from the bottom of each sample to the top of the next sample to indicate consistency of material from sample to sample, if the material is consistent. Horizontal lines shall be drawn if there is a change in lithology, then vertical lines drawn to that point.

  - Indicate screened interval of well, as needed, in the lithology column. Show top and bottom of screen. Other details of well construction are provided on the well construction forms.

5.5.2 Rock Classification

- Indicate depth at which coring began by drawing a line at the appropriate depth. Indicate core run depths by drawing coring run lines (as shown) under the first and fourth columns on the log sheet. Indicate RQD, core run number, RQD percent and core recovery under the appropriate columns.

- Indicate lithology change by drawing a line at the appropriate depth as explained in Section 5.5.1.

- Rock hardness is entered under designated column using terms as described on the back of the log or as explained earlier in this section.

- Enter color as determined while the core sample is wet; if the sample is cored by air, the core shall be scraped clean prior to describing color.

- Enter rock type based on sedimentary, igneous or metamorphic. For sedimentary rocks use terms as described in Section 5.3. Again, be consistent in classification. Use modifiers and additional terms as needed. For igneous and metamorphic rock types use terms as described in Sections 5.3.8.

- Enter brokeness of rock or degree of fracturing under the appropriate column using symbols VBR, BR, BL, or M as explained in Section 5.3.5 and as noted on the back of the Boring Log.

- The following information shall be entered under the remarks column. Items shall include but are not limited to the following:

  - Indicate depths of joints, fractures and breaks and also approximate to horizontal angle (such as high, low), i.e., 70° angle from horizontal, high angle.
  - Indicate calcareous zones, description of any cavities or vugs.
  - Indicate any loss or gain of drill water.
  - Indicate drop of drill tools or change in color of drill water.

- Remarks at the bottom of Boring Log shall include:

  - Type and size of core obtained.
  - Depth casing was set.
  - Type of Rig used.

- As a final check the boring log shall include the following:

  - Vertical lines shall be drawn as explained for soil classification to indicate consistency of bedrock material.

  - If applicable, indicate screened interval in the lithology column. Show top and bottom of screen. Other details of well construction are provided on the well construction forms.

5.5.3 <u>Classification of Soil and Rock from Drill Cuttings</u>

The previous sections describe procedures for classifying soil and rock samples when cores are obtained. However, some drilling methods (air/mud rotary) may require classification and borehole logging based on identifying drill cuttings removed from the borehole. Such cuttings provide only general information on subsurface lithology. Some procedures that shall be followed when logging cuttings are:

- Obtain cutting samples at approximately 5 foot intervals, sieve the cuttings (if mud rotary drilling) to obtain a cleaner sample, place the sample into a small sample bottle or "zip lock" bag for future reference, and label the jar or bag (i.e. hole number, depth, date etc.). Cuttings shall be closely examined to determine general lithology.

- Note any change in color of drilling fluid or cuttings, to estimate changes in lithology.

- Note drop or chattering of drilling tools or a change in the rate of drilling, to determine fracture locations or lithologic changes.

- Observe loss or gain of drilling fluids or air (if air rotary methods are used), to identify potential fracture zones.

- Record this and any other useful information onto the boring log as provided in Exhibit 4-1.

This logging provides a general description of subsurface lithology and adequate information can be obtained through careful observation of the drilling process. It is recommended that split barrel and rock core sampling methods be used at selected boring locations during the field investigation to provide detailed information to supplement the less detailed data generated through borings drilled using air/mud rotary methods.

5.6 REVIEW

Upon completion of the borings logs, copies shall be made and reviewed. Items to be reviewed include:

- Checking for consistency of all logs
- Checking for conformance to the guideline
- Checking to see that all information is entered in their respective columns and spaces

6.0 REFERENCES

Unified Soil Classification System (USCS)

ASTM D2488, 1985

Earth Manual, U.S. Department of the Interior, 1974

7.0 RECORDS

Originals of the boring logs shall be retained in the project files.

EXHIBIT 4-1

BORING LOG ***NUS CORPORATION***

PROJECT: .... BORING NO.: ....
PROJECT NO.: .... DATE: .... DRILLER: ....
ELEVATION: .... FIELD GEOLOGIST: ....
WATER LEVEL DATA : ....
(Date, Time & Conditions) ....

SAMPLE NO. & TYPE OR RQD	DEPTH (ft.) OR RUN NO.	BLOWS/ 6" OR RQD (%)	SAMPLE RECOVERY /SAMPLE LENGTH	LITHOLOGY CHANGE (Depth,ft.) OR SCREENED INTERVAL	MATERIAL DESCRIPTION			USCS OR ROCK BROKENESS	REMARKS
					SOIL DENSITY/ CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION		

REMARKS ______________________________

BORING ________

PAGE _____ OF _____

D334901

EXHIBIT 4-2

SOIL TERMS

UNIFIED SOIL CLASSIFICATION (USCS)

COARSE GRAINED SOILS

More than half of material is LARGER than No. 200 sieve size

FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 3" & basing fractions on estimated weights)			GROUP SYMBOL	TYPICAL NAMES
GRAVELS 50%(+) > ¼"Ø	CLEAN GRAVELS (Low % fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes	GW	Well graded gravels, gravel sand mixtures, little or no fines.
		Predominantly one size or a range of sizes with some intermediate sizes missing.	GP	Poorly graded gravels, gravel-sand mixtures, little or no fines.
	GRAVELS W/FINES (High % fines)	Non plastic fines (for identification procedures see ML)	GM	Silty gravels, poorly graded gravel sand silt mixtures.
		Plastic fines (for identification procedures see CL)	GC	Clayey gravels, poorly graded gravel-sand-clay mixtures.
SANDS 50%(+) < ¼"Ø	CLEAN SANDS (Low % fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.	SW	Well graded sand, gravelly sands, little or no fines.
		Predominantly one size or a range of sizes with some intermediate sizes missing.	SP	Poorly graded sands, gravelly sands, little or no fines.
	SANDS W/FINES (High % fines)	Non plastic fines (for identification procedures see ML)	SM	Silty sands, poorly graded sand-silt mixtures.
		Plastic fines (for identification procedures see CL)	SC	Clayey sands, poorly graded sand-clay mixtures.

FINE GRAINED SOILS

More than half of material is SMALLER than No. 200 sieve size

FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 3" & basing fractions on estimated weights) — Identification procedures on fraction smaller than No. 40 sieve size	DRY STRENGTH (Crushing Characteristics)	DILATANCY (Reaction to Shaking)	TOUGHNESS (Consistency Near Plastic Limit)	GROUP SYMBOL	TYPICAL NAMES
SILTS & CLAYS Liquid limit < 50	None to slight	Quick to slow	None	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity
	Medium to high	None to very slow	Medium	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
	Slight to medium	Slow	Slight	OL	Organic silts and organic silt clays of low plasticity
SILTS & CLAYS Liquid limit > 50	Slight to medium	Slow to none	Slight to medium	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
	High to very high	None	High	CH	Inorganic clays of high plasticity, fat clays
	Medium to high	None to very slow	Slight to medium	OH	Organic clays of medium to high plasticity
HIGHLY ORGANIC SOILS	Readily identified by color, odor, spongy feel and frequently by fibrous texture.			Pt	Peat and other organic soils

Boundary classifications: Soils possessing characteristics of two groups are designated by combining group symbols. For example GW-GC, well graded gravel-sand mixture with clay binder.
All sieve sizes on this chart are U.S. standard.

DENSITY OF GRANULAR SOILS

DESIGNATION	STANDARD PENETRATION RESISTANCE - BLOWS/FOOT
Very loose	0-4
Loose	5-10
Medium dense	11-30
Dense	31-50
Very dense	Over 50

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	UNC. COMPRESSIVE STR. TONS/SQ. FT	STANDARD PENETRATION RESISTANCE - BLOWS/FOOT	FIELD IDENTIFICATION METHODS
Very soft	Less than 0.25	0 to 2	Easily penetrated several inches by fist
Soft	0.25 to 0.50	2 to 4	Easily penetrated several inches by thumb
Medium stiff	0.50 to 1.0	4 to 8	Can be penetrated several inches by thumb
Stiff	1.0 to 2.0	8 to 15	Readily indented by thumb
Very stiff	2.0 to 4.0	15 to 30	Readily indented by thumbnail
Hard	More than 4.0	Over 30	Indented with difficulty by thumbnail

ROCK TERMS

ROCK HARDNESS (FROM CORE SAMPLES)

DESCRIPTIVE TERMS	SCREWDRIVER OR KNIFE EFFECTS	HAMMER EFFECTS
Soft	Easily gouged	Crushes when pressed with hammer
Medium soft	Can be gouged	Breaks (one blow) Crumbly edges
Medium hard	Can be scratched	Breaks (one blow) Sharp edges
Hard	Cannot be scratched	Breaks conchoidally (several blows) Sharp edges

ROCK BROKENNESS

DESCRIPTIVE TERMS	ABBREVIATION	SPACING
Very broken	(V. Br.)	0 - 2"
Broken	(Br.)	2" - 1'
Blocky	(Bl.)	1' - 3'
Massive	(M.)	3' - 10'

LEGEND

SOIL SAMPLES - TYPES

S - 2" O.D. Split Barrel Sample
ST - 3" O.D. Undisturbed Sample
O - Other Samples, Specify in Remarks

ROCK SAMPLES - TYPES

X - NX (Conventional) Core (~2-1/8" O.D.
Q - NQ (Wireline) Core (~1-7/8" O.D.)
Z - Other Core Sizes, Specify in Remarks

WATER LEVELS

12/18
▼ 12.6' Initial Level w/Date & Depth

12/18
▼ 12.6' Stabilized Level w/Date & Depth

EXHIBIT 4-3

CONSISTENCY FOR COHESIVE SOILS

Consistency	(Blows per Foot)	Unconfined Compressive Strength (tons/square foot by pocket penetration	Field Identification
Very soft	0 to 2	Less than 0.25	Easily penetrated several inches by fist
Soft	2 to 4	0.25 to 0.50	Easily penetrated several inches by thumb
Medium stiff	4 to 8	0.50 to 1.0	Can be penetrated several inches by thumb with moderate effort
Stiff	8 to 15	1.0 to 2.0	Readily indented by thumb but penetrated only with great effort
Very stiff	15 to 30	2.0 to 4.0	Readily indented by thumbnail
Hard	Over 30	More than 4.0	Indented by thumbnail

EXHIBIT 4-4

BEDDING THICKNESS CLASSIFICATION

Thickness (Metric)	Thickness (Approximate English Equivalent)	Classification
> 1.0 meter	> 3.3′	Massive
30 cm - 1 meter	1.0′ - 3.3′	Thick Bedded
10 cm - 30 cm	4″ - 1.0′	Medium Bedded
3 cm - 10 cm	1″ - 4″	Thin Bedded
1 cm - 3 cm	2/5″ - 1″	Very Thin Bedded
3 mm - 1 cm	1/8″ - 2/5″	Laminated
1 mm - 3 mm	1/32″ - 1/8″	Thinly Laminated
< 1 mm	< 1/32″	Micro Laminated

(Weir, 1973 and Ingram, 1954)

EXHIBIT 4-5

GRAIN SIZE CLASSIFICATION FOR ROCKS

Particle Name	Grain Size Diameter
Cobbles	> 64 mm
Pebbles	4-64 mm
Granules	2-4 mm
Very Coarse Sand	1-2 mm
Coarse Sand	0.5-1 mm
Medium Sand	0.25-0.5 mm
Fine Sand	0.125-0.25 mm
Very Fine Sand	0.0625-0.125 mm
Silt	0.0039-0.0625 mm

After Wentworth, 1922

BORING LOG — **NUS CORPORATION**

PROJECT: HEBELKA SITE — BORING NO: MW 3A
PROJECT NO: 619Y — DATE: 9-21-87 — DRILLER: B. GOLLIHUE
ELEVATION: 510.07 — FIELD GEOLOGIST: SJ CONTI
WATER LEVEL DATA (Date, Time & Conditions): WL 26.35 - TPVC 10-16-87

Sample No & Type/ RQD	Depth (ft.)/ Run No.	Blows/6" or RQD (%)	Sample Recovery/ Sample Length	Lithology Change (Depth/ft.) or Screen Int	Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS or Rock Brokenness	Remarks
S-1	0.0	3 / 6	1.5/1.5		STIFF	BRN	CLAYEY SILT - TR SHALE	ML	0-6" TOPSOIL MOIST 0PPM
	1.5	6					FRAG - TR ORG.		RESIDUAL SOIL.
	5.0								
S-2	6.0	11 / 100/.5	0.8/1.0	5.5 / 6.0	M.SOFT	GRAY BRN	DEC SHALE AND SILT	VBR	DAMP 0PPM
					TO				REFUSAL @ 6' 5.5 TOP OF DEC
					M.HARD				ROCK
									AUGERED TO 15' W/SOLID STEM AUG.
									CUTTING MOIST @ ≈8' WATER @ 11' ±
									WL @ 12:10 PM WAS
									≈ 9' FROM G.S.
									SET 4" PVC CAS. @ 15.0'
9-21	15.0								
9-22					M.HARD	BRN GRAY	SILTY SHALE - FEW	VBR	SEVERAL 0 PPM
							QUARTZ PCS		Fe STAINED JOINTS \ ON CORE
									THRUOUT RUN. JOINTS AND BREAKS
									ARE HORIZ TO LO ∠. W/ VUGS ON LOWER
0.2/10.0	①	0%	7.9/10.0						PORTION 23 TO 25 OF CORE
	25.0								

REMARKS: ACKER AD II RIG - SOLID STEM AUGERS USED TO ADVANCE BORING - 140 LB WT & 30" DROP - TO TAKE 2" Φ SP SPOON SAMPLES - SET UP OVER HOLE @ 11:10 AM. WILL SAMPLE THIS HOLE - SET 4" CASING THEN DO SHALLOW WELL. STARTED TO CORE 9-22-87 USING THE WIRE-LINE CORING METHOD.

* See Legend on Back

BORING MW 3A

PAGE 1 OF 3

BORING LOG — **NUS CORPORATION**

PROJECT: HEBELKA SITE BORING NO.: MW 3A
PROJECT NO.: 619Y DATE: 9-22-87 DRILLER: B. GOLLIHUE
ELEVATION FIELD GEOLOGIST: SJ CONTI
WATER LEVEL DATA
(Date, Time & Conditions)

	Sample No. & Type RQD	Depth (Ft.) Run	Blows 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth ft.)	MATERIAL DESCRIPTION* Soil Density/Consistency or Rock Hardness	Color	Material Classification	USCS	REMARKS
9-22		25.0				M.HARD	GRAY	SILTY SHALE	VBR	SHALE IS VBR W/ HORIZ TO LO ∠ JNTS
								(SILTSTONE)		≈26 TO 27 2- VERT
								- FEW QUARTZ		JOINTS. IRON STAINS ON JNTS
								SEAMS		ROCK BECOMES AND BREAKS MORE LIKE
										A SILTSTONE WITH DEPTH.
	0/10.0	②	0%	8.7/10.0						
									BR	≈32 TO 33 FEW QUARTZ PIECES W/
									VBR	VUGS. SL. MICACEOUS
										VF QUARTZ GRAINS IN MATRIX- 30X MAG.
		35.0								≈34 TO 35 · 2 VERT JOINTS
						M.HARD	GRAY	SILTY SHALE (SILTSTONE)	VBR	35.0-35.5 QUARTZ PIECES
								- FEW QUARTZ	BR	
								SEAMS	VBR	BECOMES SL. CALCAR. @ 37± THIN CALCITE
										LAMINATIONS. WATER STAINED JNTS
									BR	THRUOUT RUN MORE SO 35-37±
	1-0/10.0	③	10%	9.3/10.0					VBR	39.5 → 42.0
										42.7 → 43.0 HI ∠ JNT
									BR	42.4 → 42.7 VERT JNT
									↓	
		45.0							VBR	
										45.3 → 45.5 VERT JNT. & VBR
										47.5 VERT JOINT
									BR	48. HI ∠ JOINT
										SLIGHTLY CALCAREOUS MORE CALCITE
										PRESENT

REMARKS

BORING MW 3A

PAGE 2 OF 3

* See Legend on Back

BORING LOG — **NUS CORPORATION**

PROJECT: HEBELKA SITE
BORING NO: MW 3A
PROJECT NO.: 619Y
DATE: 9-22-87
DRILLER: B. GOLLIHUE
ELEVATION:
FIELD GEOLOGIST: SJ CONTI
WATER LEVEL DATA
(Date, Time & Conditions)

SAMPLE NO & TYPE	DEPTH (Ft)	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY / SAMPLE LENGTH	LITHOLOGY CHANGE (Depth Ft)	SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	USCS	REMARKS
1.9/10.0	(4)	19%	10.0/10.0		M.HARD	GRAY	SILTY SHALE (SILTSTONE)	VBR	50.5 → 51.0 VBR
							SL. CALCAREOUS	BR	51.5 → 54.0 BR w/ SEV LO & JOINTS
	55.0								
								VBR	POOR RECOVERY w/ SOFT ZONES.
0/10	(5)	0%	1.8/10.0						
	65.0								
				66					
									68.0 - DRILLER NOTED SOFT AREA - LOSS OF 1/3 OF WATER - CHANGE IN COLOR OF DRILL WATER TO YELLOW BROWN
0/0	(6)	0%	1.3/10.0						
									POOR RECOVERY
									FEW CALCAREOUS ZONES.
	75.0			76					

REMARKS: AT 75' @ 1:45 PM - PULLING TOOLS - TO REAM HOLE. AT 1:50 PM CORED HOLE TO 75' REAMED TWICE DUE TO RUNNING SAND (FRACTURE) AT ≈ 68. REAMED 2ND TIME TO 81'. SET WELL 66'-76'.

BORING MW 3A
PAGE 3 OF 3

* See Legend on Back

EXHIBIT 4-6

BORING LOG — **NUS CORPORATION**

PROJECT: WESTLINE SITE — BORING NO.: MW 013
PROJECT NO.: 473 Y — DATE: 7-7-87 — DRILLER: B ERICSON
ELEVATION: 1462.37 — FIELD GEOLOGIST: S.J CONTI — PENN - DRILL
WATER LEVEL DATA (Date, Time & Conditions): 5.54' @ 8:50 AM 7-23-87 T-PVC — ACKER AD-II

SAMPLE NO. & TYPE OR RQD	DEPTH (FT.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY / SAMPLE LENGTH	LITHOLOGY CHANGE (Depth ft.) OR SCREEN INT.	MATERIAL DESCRIPTION: SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK OR BROKENNESS / USCS	REMARKS (HNU) (HEAD SP)
	0.0	5 / 3	1.4/1.5		Loose	BLK BRN	CLAYEY SILT AND CINDER	ML	MOIST (0PPM)
S-1		2			↓	↓	TR- COAL FRAG	↓	3/4" Φ FRAG- NEAR OLD RR. LINE.
							TR- CC FRAG		
							(FILL)		
	5.0				↓	RED	↓	↓	
S-2		1 / 1	1.3/1.5	6.0	V. LOOSE	BRN TO	SANDY SILT - TR [illegible] TO	SM	MOIST TO WET (0PPM)
	6.5	3			↓	GRAY	SILTY SAND - TR GRAVEL	↓	GRAY SAND @ 6' ± MICACEOUS LOOKS NATURAL
									DRILLER NOTE H2O 8-10'
	10.0				↓	↓	↓	↓	
S-3		11 / 23	1.2/1.5		DENSE	BRN	SILTY SAND AND S.S.	GM	WET (0PPM)
	11.5	27			↓	↓	FRAGS. (GRAV)	↓	1" Φ SIZE MAX SIZE SUBANGULAR TO SUBROUNDED GRAVEL
	15.0				↓	↓	↓	↓	
S-4		7 / 47	1.0/1.5		V. DENSE	BRN	SILTY FINE TO C. SAND	SM	WET (0PPM)
	16.5	43			↓	↓	AND GRAVEL	↓	1" Φ SIZE MAX SIZE SUBANGULAR TO SUBROUNDED GRAVEL
	20.0				↓	↓	↓	↓	
S-5	20.9	17 / 50/.4	.4/.9		V. DENSE	ORANG BRN	SILTY SAND - SOME	GM	WET (0PPM)
					↓	↓	GRAVEL AND	↓	MOIST
							S.S FRAGS		BECOMES MORE LIKE SANDY SILT AT BOTM OF SAMPLE
					↓	↓	↓	↓	

REMARKS: START @ 1:15 PM - 7-7-87 USING 4 1/4" ID HOLLOW STEMS
S-4 @ 3:30 PM TO ADVANCE THE BORING USING
S-5 @ 4:30 PM ACKER DRILL- MOUNTED ON
FORD 8000 TRUCK
SAMPLES TAKEN
USING 140 lb WT AND 30 INCH DROP.

BORING MW 013
PAGE 1 OF 4

BORING LOG **NUS CORPORATION**

PROJECT: WESTLINE SITE
PROJECT NO.: 473Y
ELEVATION:
WATER LEVEL DATA:
(Date, Time & Conditions)

DATE: 7-7-87
FIELD GEOLOGIST: SJ CONTI
BORING NO.: MW013
DRILLER: E EPISON

SAMPLE NO. & TYPE OR RQD	DEPTH (Ft.) OR RUN NO	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth/Ft.) OR SCREEN INT	MATERIAL DESCRIPTION: SOIL DENSITY/CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BROKENNESS & USCS	REMARKS (HNU)
S-6	25.0 26.5	6 17 30	1.1/1.5		DENSE	OLIVE BLUE GRAY	SILTY SAND - SOME GRAVEL - TR CLAY TR. SS. FRAG	GM	WET 0PPM C.S. IS FRIABLE FIRST CHANGE IN COLOR. NOT ENOUGH CLAY TO BE CONFINING NOTE: MAY SET ZONE 2 CASING ≈ 28'
7/7	30.0					MOTTLED			
7/8 S-7	31.5	17 27 36	1.4/1.5		V.DENSE	BRN BLUE GRAY	SILTY SAND - SOME GRAVEL TR SS FRAG TR CLAY	SM/GM	MOIST → WET (0PPM) CONSISTS OF BLUE GRAY & FRIABLE SUBROUNDED GRAVEL NOT MUCH CLAY - BUT MAY BE SEMI-CONFINING.
	35.0								
S-8	35.9	30 50/.4	0.7/0.9		V.DENSE	BLUE GRAY	SILTY F. TO C. SAND - SOME GRAVEL TR. SS. FRAG	SM/GM	MOIST → WET (0PPM) V.SL. TR. CLAY - LESS THAN S-7 1" Ø FRAG. - MORE COARSE SAND THAN ABOVE POSSIBLE 35 TO 45 SCREEN LOC.
	40.0					BLUE			SQUEEZED
S-9	41.5	31 34 24	1.2/1.5		V.DENSE	BRN GRAY	SILTY SAND (FINE TO M.) SOME GRAVEL - TR CLAY	SM/GM	HOLDS TOGETHER WHEN MOIST → WET (0PPM) LITTLE MORE CLAY THAN S-8 SUBROUNDED GRAVEL VERY SLOW DRILLING 40-45 (RIG STALLS) LESS CLAY LAST 3" OF SAMPLE
	45.0					BLUE			
S-10	46.5	13 34 50	1.2/1.5		V.DENSE	BRN GRAY	SILTY SAND (FINE TO M.) SOME GRAVEL - TR CLAY	SM/GM	MOIST → WET (0PPM) 1" Ø SIZE - HOLDS TOGETHER WHEN SQUEEZED BUT NOT COHESIVE CLASSIFICATION CONT DRILLING TO 50'

REMARKS S-6 @ 4:40 PM
S-8 @ 8:36 AM 7-8-87
S-10 @ 10:40 AM S-11 @

BORING MW013
PAGE 2 OF 4

BORING LOG — NUS CORPORATION

PROJECT: WESTLINE SITE BORING NO.: MW 013
PROJECT NO.: 473Y DATE: 7-8-87 DRILLER: B. ERICSON
ELEVATION: FIELD GEOLOGIST: SJ CONTI
WATER LEVEL DATA:
(Date, Time & Conditions)

	SAMPLE NO & TYPE OR RQD	DEPTH (ft) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY / SAMPLE LENGTH	LITHOLOGY CHANGE (Depth ft) OR SCREEN INT	SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	USCS	REMARKS
	S-11	50.0	15 / 41	1.0/1.3		V. DENSE	MOTTLED BUFF	SILTY SAND - SOME GR.	SM	MOIST - (OPPM)
		51.3	50/.3				GRN GRAY	TR CLAY	SM	MOTTLED W/ PCS OF BLACK COAL/LIGNITE
										MORE CLAY THAN ABOVE PORTIONS OF SAMPLE - COHESIVE CLASSIF.
		55.0			55.0					
	S-12		11 / 15	1.4/1.5		V. STIFF TO STIFF	GRAY ORANG BRN	SANDY CLAY / CLAYEY SAND	SC	MOIST → WET (OPPM)
		56.5	26					SOME GRAVEL		NOTE COLOR CHANGE ALSO - MORE CLAY THAN ANY SAMPLE SUB-ROUNDED GRAINS
										FIRST COHESIVE TYPE CLASSIF.
		60.0	40							
	S-13	60.9	50/.4	0.7/0.9		V. DENSE	ORANG BRN	SANDY CLAY / CLAYEY SAND - SOME GRAVEL	SC / GW	MOIST → WET (OPPM)
										NOT AS MUCH CLAY AS S-12 BUT VERY COMPACT. SUBROUNDED GRAINS
										SET CAS. @ 62'.
		65.0								
7/13	S-14	65.8	37 / 50/.3	0.7/0.8		V. DENSE	BRN ORANG	SILTY SAND. SOME GR AND ROCK FRAG - TR. CLAY	SM / GW	MOIST (OPPM)
					68.0					MORE CLAY TOWARDS TOP OF SAMPLE MAX 3/4" Ø SIZE
							YELLOW BRN			COLOR CHANGE AT ~68' MORE SAND PER DRILLER - BOTM OF SEMI CONF LAYER ?
		70.0								
7/14	S-15		39 / 39	1.0/1.5		V. DENSE	YELLOW BRN	CLAYEY SAND (F. TO C.) SOME GRAVEL - TR ROCK FRAG.	SC / GC	MOIST → WET (OPPM)
		71.5	41							1" MAX GRAVEL
										MORE GRAVEL @ 72' PER DRILLER

REMARKS: USING HOLLOW STEMS TO ADVANCE BORING - WASHING OUT THRU AUGERS, WHEN NEEDED TO OBTAIN SAMPLE
S-12 @ 1:46 PM
S-13 → 3:32 PM - LOGGED IN BY 3:47 PM
SET 6" Ø STEEL CASING TO 62' - WILL DRILL BEYOND CASING AFTER GROUT SETS UP. S-14 @ 3:20 PM 7-13-87
S-15 - 7:57 AM 7-14-87

BORING MW 013
PAGE 3 OF 4

BORING LOG — **NUS CORPORATION**

PROJECT: WESTLINE SITE — BORING NO.: MW013
PROJECT NO.: 437Y — DATE: 7-13-87 / 7-14-87 — DRILLER: B. ERICSON
ELEVATION: — FIELD GEOLOGIST: SJ CONTI
WATER LEVEL DATA
(Date, Time & Conditions)

SAMPLE NO. & TYPE OR ROD	DEPTH (Ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY / SAMPLE LENGTH	LITHOLOGY CHANGE (Depth ft.) or SCR. INT. 75	SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	USCS	REMARKS (HNU)
S-16	75.0	28 / 50/.5	0.9/1.0		V. DENSE	GRAY ORANG BRN	FINE TO C. CLAYEY SAND - SOME GRAVEL - TR ROCK FRAG (S.S.)	GC	WET (OPPM) NOT AS MUCH CLAY AS S-15 - BOTM OF SAMPLE BECOMES MORE SANDY MAX 1" Ø RC.
	76.0								
	80.0								NO SAMPLE @ 80' - DECIDED TO GO TO 85'.
	85.0	50/.4	0.4/0.4		V. DENSE	GRAY ORANG BRN	SILTY F. TO C. SAND - SOME GRAVEL - TR S.S. FRAG - TR CLAY	GW	WET (OPPM) SUBROUNDED GRAINS V. SL TR CLAY - WILL SET SCREEN ≈ 75 TO 85' IN THIS BORING.
S-17	85.4			85					
							BOTM OF HOLE @ 85.0'		

REMARKS: S-17 @ 2:20 PM 7-14-87 - METHOD BEING 6" CASING SPUN 4" Ø - 5 7/8" OD CASING TO BOTM. USING WATER AS DRILLING FLUID

BORING MW 013
PAGE 4 OF 4

4.0 RESPONSIBILITIES

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

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

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

5.0 PROCEDURES

5.1 OVERVIEW

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

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

5.2 SAMPLE IDENTIFICATION

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

5.2.1 Sample Label

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

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

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

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

5.2.2 Sample Identification Tag

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

The following information is recorded on the tag:

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

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

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

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

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

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

5.3 CHAIN-OF-CUSTODY PROCEDURES

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

5.3.1 Field Custody Procedures

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

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

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

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

5.3.2 Transfer of Custody and Shipment

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

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

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

- Enter station number (the station number is the middle portion of the station location number, between the hyphens).

- Check composite or grab sample.

- Enter station location number (the same number as the station location on the tag and label).

- Enter the total number of containers per station number and the type of each bottle.

- Enter either the inorganic traffic report number, the organic traffic report number, or the SAS number for each station number in the remarks column.

- Enter the tag number from the bottom of the sample identification tag in the remarks column for each station location.

- Make sure that the person receiving the sample signs the "Received by" entry, or enter the name of the carrier (e.g., UPS, Federal Express) under "Received by." Receiving laboratory will sign "Received for Laboratory by" on the lower line and enter the date and time.

- Enter the bill-of-lading or Federal Express airbill number under "Remarks," in the bottom right corner, if appropriate.

- Place the original (top, signed copy) of the Chain-of-Custody Record Form in the appropriate sample shipping package. Retain the pink copy with field records.

- Sign and date the custody seal, a 1- by 3-inch white paper label with black lettering and an adhesive backing. Attachment G is an example of a custody seal. The custody seal is part of the chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field. Custody seals are provided by ZPMO on an as-needed basis.

- Place the seal across the shipping container opening so that it would be broken if the container is opened.

- Complete other carrier-required shipping papers.

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

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

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

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

5.3.3 Receipt for Samples Form

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

6.0 REFERENCES

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

7.0 ATTACHMENTS

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

ATTACHMENT A
CHAIN-OF-CUSTODY RECORD FORM FOR USE IN REGION I
(Original is 8-1/2 by 11)

	PROJECT NAME												
SAMPLERS: *(Signature)*						NO. OF CONTAINERS							REMARKS
STA. NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION								

Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*	Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*
Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*	Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*
Relinquished by: *(Signature)*	Date / Time	Received for Laboratory by: *(Signature)*	Date / Time	Remarks:	

D334901

ATTACHMENT B
CHAIN-OF-CUSTODY RECORD FORM FOR USE IN REGION II
(Original is 8 by 10-1/2)

CHAIN OF CUSTODY RECORD

ENVIRONMENTAL PROTECTION AGENCY – REGION II
SURVEILLANCE & ANALYSIS DIVISION
EDISON, NEW JERSEY 08817

Name of Unit and Address		
Sample Number	**Number of Containers**	**Description of Samples**

Person Assuming Responsibility for Sample	Time	Date

Sample Number	Relinquished By:	Received By:	Time	Date	Reason for Change of Custody
Sample Number	Relinquished By:	Received By:	Time	Date	Reason for Change of Custody
Sample Number	Relinquished By:	Received By:	Time	Date	Reason for Change of Custody
Sample Number	Relinquished By:	Received By:	Time	Date	Reason for Change of Custody

ATTACHMENT C
CHAIN-OF-CUSTODY RECORD FORM FOR USE IN REGION III
(Original is 8-1/2 x 11-3/4")

ENVIRONMENTAL PROTECTION AGENCY
Office of Enforcement

REGION 3
Curtis Bldg., 6th & Walnut Sts.
Philadelphia, Pennsylvania 19106

CHAIN OF CUSTODY RECORD

PROJ. NO.	PROJECT NAME	NO. OF CONTAINERS		REMARKS
SAMPLERS: *(Signature)*				

STA. NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION	NO. OF CONTAINERS							REMARKS

Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*	Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*
Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*	Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*
Relinquished by: *(Signature)*	Date / Time	Received for Laboratory by: *(Signature)*	Date / Time	Remarks	

Distribution: Original Accompanies Shipment, Copy to Coordinator Field Files

3-15966

ATTACHMENT D

CHAIN-OF-CUSTODY RECORD FORM FOR USE IN REGION IV
(Original is 8-1/2 by 14)

U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION 4

CHAIN OF CUSTODY RECORD

ENVIRONMENTAL SERVICES DIVISION
COLLEGE STATION ROAD
ATHENS, GEORGIA 30613

PROJ. NO.	PROJECT NAME
SAMPLERS *(Signature)*	

STA. NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	Water/Wastewater: Gal C (ext org)	Gal G (EP)	[illegible] (VOA)	Gal P (BOD, COD, TSS)	Pt G (phenols)	Pt G (metals, Hg)	Pt P (metals)	Pt P (S⁻)	Pt P (TOC, COD)	Qt G (O&G or Fuel)	[illegible] P (CN)	[illegible] (Cl, F, SO₄)	Qt G (ext org, EP)	[illegible] G (VOA)	Pt P (met, Hg, CN, S⁻)	Soil/Sed: [illegible] G (ext org, VOA, met, Hg, CN)	[illegible] G (EP, S⁻, FP)	Sldg/Waste:			Misc:		REMARKS/TAG NUMBERS

Relinquished by: *(Signature)*	Date/Time	Received by: *(Signature)*	Relinquished by: *(Signature)*	Date/Time	Received by: *(Signature)*	Remarks
Relinquished by: *(Signature)*	Date/Time	Received by: *(Signature)*	Relinquished by: *(Signature)*	Date/Time	Received by: *(Signature)*	

DISTRIBUTION: Original and Pink copies accompany sample shipment to laboratory. Pink copy retained by laboratory.
Yellow copy retained by samplers. Blue copy extra copy as needed.

№ 4 3526

ATTACHMENT E
SAMPLE LABEL

PROJECT: ____________________

STATION LOCATION: ____________________

DATE: ___/___/___ TIME: __________ hrs.

MEDIA: WATER ☐ SOIL ☐ SEDIMENT ☐ __________ ☐

CONCENTRATION: LOW ☐ MED ☐ HIGH ☐

TYPE: GRAB ☐ COMPOSITE ☐

ANALYSIS	PRESERVATION
VOA ☐ BNA's ☐	Cool to 4°C ☐
PCB's ☐ PESTICIDES ☐	HNO_3 to pH <2 ☐
METALS: TOTAL ☐ DISSOLVED ☐	NAOH to pH>12 ☐
CYANIDE ☐	__________ ☐
__________ ☐	

Sampled by: ____________________

Case No.: __________ Traffic Report No.: __________

Remarks:

ACFILE: FORMS\BOTLABL

ATTACHMENT F
SAMPLE IDENTIFICATION TAG

☆ GPO 505-552

Designate: Grab | Comp.

Time

Month/Day/Year

Station No.

Project Code

Samplers (Signatures)

Station Location

Preservative:
Yes ☐ No ☐

ANALYSES

BOD Anions Solids (TSS) (TDS) (SS)	
COD, TOC, Nutrients	
Phenolics	
Mercury	
Metals	
Cyanide	
Oil and Grease	
Organics GC/MS	
Priority Pollutants	
Volatile Organics	
Pesticides	
Mutagenicity	
Bacteriology	

Remarks:

Tag No.	Lab Sample No.
3 60966	

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

EPA

ATTACHMENT G
CHAIN-OF-CUSTODY SEAL

Signature ________________

Date ________________

CUSTODY SEAL

NUS CORPORATION

NUS CORPORATION

CUSTODY SEAL

Date ________________

Signature ________________

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

4.0 RESPONSIBILITIES

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

<u>Sampling Personnel</u> - responsible for implementing the packaging and shipping requirements.

5.0 PROCEDURES

5.1 INTRODUCTION

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

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

5.2 ENVIRONMENTAL SAMPLES

5.2.1 <u>Packaging</u>

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

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

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

5.2.2 Marking Labeling

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

5.2.3 Shipping Papers

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

5.2.4 Transportation

There are no DOT restrictions on mode of transportation.

5.3 DETERMINATION OF SHIPPING CLASSIFICATION FOR HAZARDOUS MATERIAL SAMPLES

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

5.3.1 Known Substances

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

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

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

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

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

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

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

5.3.2 Unknown Substances

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

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

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

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

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

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

5.4.1 Packaging

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

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

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

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

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

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

5.4.2 Marking/Labeling

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

   - Laboratory name and address.
   - "Flammable Liquid, n.o.s. UN1993" or "Flammable Solid, n.o.s. UN1325."

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

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

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

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

5.4.3 Shipping Papers

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

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

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

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

5.4.4 Transportation

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

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

6.0 REFERENCES

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

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

NUS Standard Operating Procedure SA-1.2 - Sample Preservation

NUS Standard Operating Procedure SF-1.5 - Compatibility Testing

7.0 ATTACHMENTS

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

ATTACHMENT A

DOT HAZARDOUS MATERIAL CLASSIFICATION (49 CFR 173.2)

1. Radioactive material (except a limited quantity)
2. Poison A
3. Flammable gas
4. Nonflammable gas
5. Flammable liquid
6. Oxidizer
7. Flammable Solid
8. Corrosive material (liquid)
9. Poison B
10. Corrosive material (solid)
11. Irritating material
12. Combustible liquid (in containers having capacities exceeding 110 gallons [416 liters])
13. ORM-B
14. ORM-A
15. Combustible liquid (in containers having capacities of 110 gallons [416 liters] or less)
16. ORM-E

ATTACHMENT B

DOT LIST OF CLASS "A" POISON (49 CFR 172.101)

Material	Physical State at Standard Temperature
Arsine	Gas
Bromoacetone	Liquid
Chloropicrin and methyl chloride mixture	Gas
Chloropicrin and nonflammable,nonliquefied compressed gas mixture	Gas
Cyanogen chloride	Gas (>13.1°C)
Cyanogen gas	Gas
Gas identification set	Gas
Gelatin dynamite (H. E. Germaine)	----
Grenade (with Poison "A" gas charge)	----
Hexaethyl tetraphosphate/compressed gas mixture	Gas
Hydrocyanic (prussic) acid solution	Liquid
Hydrocyanic acid, liquefied	Gas
Insecticide (liquefied) gas containing Poison "A" or Poison "B" material	Gas
Methyldichloroarsine	Liquid
Nitric oxide	Gas
Nitrogen peroxide	Gas
Nitrogen tetroxide	Gas
Nitrogen dioxide, liquid	Gas
Parathion/compressed gas mixture	Gas
Phosgene (diphosgene)	Liquid

ATTACHMENT C
HAZARDOUS MATERIALS SHIPPING CHECKLIST

PACKAGING

1. Check DOT 172.500 table for appropriate type of package for hazardous substance.
2. Check for container integrity, especially the closure.
3. Check for sufficient absorbent material in package.
4. Check for sample tags and log sheets for each sample, and chain-of-custody record.

SHIPPING PAPERS

1. Check that entries contain only approved DOT abbreviations.
2. Check that entries are in English.
3. Check that hazardous material entries are specially marked to differentiate them from any nonhazardous materials being sent using same shipping paper.
4. Be careful all hazardous classes are shown for multiclass materials.
5. Check total amounts by weight, quantity, or other measures used.
6. Check that any limited-quantity exemptions are so designated on the shipping paper.
7. Offer driver proper placards for transporting vehicle.
8. Check that certification is signed by shipper.
9. Make certain driver signs for shipment.

RCRA MANIFEST

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

ATTACHMENT D

STANDARD INDUSTRY CERTIFICATION FORM

NO PCS	SIZE	GROSS WEIGHT	HM	DOT PROPER SHIPPING NAME	HAZARD CLASS	CODE	[illegible]	CONTAINER NUMBERS	PIC	BULK
1	55 gal	200 lbs.	x	Nitric Acid, Fuming	Oxidizer	SS-BM	C	1	✓	
1	55 gal	450 lbs	x	Flammable Liquid, n.o.s.	Flammable Liquid	SS-ABF	—	2		✓
1	55 gal	250 lbs	x	Flammable Liquid, n.o.s.	Flammable Liquid	SS-BM	B	3	✓	
1	16-A	12 lbs.	x	Bromine	Corrosive Material	SS-BM	C	4	✓	

SHIPPER'S CERTIFICATION

This is to certify that the above named materials are properly classified, described, packaged, marked and labeled and are in proper condition for transportation according to the applicable regulations of the Department of Transportation.

Shipper's Signature

Placards Req'd

Shipment Date

Manifest No

Disposal Work Order

Service Order No

Rev 1-79

1.0 PURPOSE

This procedure describes the process for keeping a site logbook.

2.0 SCOPE

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

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

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

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

3.0 GLOSSARY

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

4.0 RESPONSIBILITIES

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

5.0 PROCEDURES

5.1 GENERAL

The cover of each site logbook contains the following information:

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

- Start Date
- End Date

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

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

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

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

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

5.2 PHOTOGRAPHS

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

6.0 REFERENCES

None.

7.0 ATTACHMENTS

Attachment A - Typical Site Logbook Entry

ATTACHMENT A
TYPICAL SITE LOGBOOK ENTRY

START TIME: ______________ DATE: ______________

SITE LEADER: ______________________
PERSONNEL:

NUS	DRILLER	EPA

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

ACTIVITIES:

1. Steam jenney and fire hoses were set up.

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

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

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

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

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

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

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

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

____
Field Operations Leader

1.0 PURPOSE

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

2.0 SCOPE

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

3.0 GLOSSARY

None.

4.0 RESPONSIBILITIES

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

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

5.0 PROCEDURES

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

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

5.1 ACCESS FOR SAMPLING

5.1.1 Bailers and Bailing Line

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

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

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

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

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

5.1.2 Sampling Pumps

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

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

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

---

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

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

5.1.3 Filtering Equipment

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

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

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

5.2 FIELD ANALYTICAL EQUIPMENT

5.2.1 Water Level Indicators

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

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

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

5.2.2 Probes

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

6.0 REFERENCES

None.

7.0 RECORDS

None.

APPENDIX B

FORMS

BORING LOG

HALLIBURTON NUS

PROJECT: ____________________ BORING NO.: ____________

PROJECT NO.: ____________ DATE: ____________ DRILLER: ____________

ELEVATION: ____________ FIELD GEOLOGIST: ____________

WATER LEVEL DATA : ____________________

(Date, Time & Conditions) ____________________

SAMPLE NO. & TYPE	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY /SAMPLE LENGTH	LITHOLOGY CHANGE (Depth/ft.)	MATERIAL DESCRIPTION*			ROCK BR. OR USCS	REMARKS
					SOIL DENSITY/ CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION		

REMARKS ____________________

BORING ____________

PAGE ____ OF ____

* See Legend on Back

SOIL TERMS

UNIFIED SOIL CLASSIFICATION (USCS)

COARSE GRAINED SOILS

More than half of material is LARGER than No. 200 sieve size

FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 3" & basing fractions on estimated weights)			GROUP SYMBOL	TYPICAL NAMES
GRAVELS 50%(+)> ¼"Ø	CLEAN GRAVELS (Low % fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.	GW	Well graded gravels, gravel-sand mixtures, little or no fines.
		Predominantly one size or a range of sizes with some intermediate sizes missing	GP	Poorly graded gravels, gravel-sand mixtures, little or no fines
	GRAVELS W/FINES (High % fines)	Non plastic fines (for identification procedures see ML)	GM	Silty gravels, poorly graded gravel-sand-silt mixtures.
		Plastic fines (for identification procedures see CL)	GC	Clayey gravels, poorly graded gravel-sand-clay mixtures.
SANDS 50%(+)< ¼"Ø	CLEAN SANDS (Low % fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.	SW	Well graded sand, gravelly sands, little or no fines.
		Predominantly one size or a range of sizes with some intermediate sizes missing.	SP	Poorly graded sands, gravelly sands, little or no fines.
	SANDS W/FINES (High % fines)	Non plastic fines (for identification procedures see ML)	SM	Silty sands, poorly graded sand-silt mixtures.
		Plastic fines (for identification procedures see CL)	SC	Clayey sands, poorly graded sand-clay mixtures.

FINE GRAINED SOILS

More than half of material is SMALLER than No. 200 sieve size

FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 3" & basing fractions on estimated weights)				GROUP SYMBOL	TYPICAL NAMES
Identification procedures on fraction smaller than No. 40 sieve size					
	DRY STRENGTH (Crushing Characteristics)	DILATANCY (Reaction to Shaking)	TOUGHNESS (Consistency Near Plastic Limit)		
SILTS & CLAYS Liquid limit < 50	None to slight	Quick to slow	None	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity
	Medium to high	None to very slow	Medium	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
	Slight to medium	Slow	Slight	OL	Organic silts and organic silt clays of low plasticity
SILTS & CLAYS Liquid limit > 50	Slight to medium	Slow to none	Slight to medium	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
	High to very high	None	High	CH	Inorganic clays of high plasticity, fat clays
	Medium to high	None to very slow	Slight to medium	OH	Organic clays of medium to high plasticity
HIGHLY ORGANIC SOILS	Readily identified by color, odor, spongy feel and frequently by fibrous texture.			Pt	Peat and other organic soils

Boundary classifications: Soils possessing characteristics of two groups are designated by combining group symbols. For example GW-GC, well graded gravel-sand mixture with clay binder.
All sieve sizes on this chart are U.S. standard.

LEGEND

SOIL SAMPLES - TYPES

S - 2" O.D. Split Barrel Sample
ST - 3" O.D. Undisturbed Sample
O - Other Samples, Specify in Remarks

ROCK SAMPLES - TYPES

X - NX (Conventional) Core (~2-1/8" O.D.)
Q - NQ (Wireline) Core (~1-7/8" O.D.)
Z - Other Core Sizes, Specify in Remarks

WATER LEVELS

12/18
▼12.6' Initial Level w/Date & Depth

12/18
▼12.6' Stabilized Level w/Date & Dept

DENSITY OF GRANULAR SOILS

DESIGNATION	STANDARD PENETRATION RESISTANCE - BLOWS/FOOT
Very loose	0-4
Loose	5-10
Medium dense	11-30
Dense	31-50
Very dense	Over 50

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	UNC. COMPRESSIVE STR. TONS/SQ. FT.	STANDARD PENETRATION RESISTANCE - BLOWS/FOOT	FIELD IDENTIFICATION METHODS
Very soft	Less than 0.25	0 to 2	Easily penetrated several inches by fist
Soft	0.25 to 0.50	2 to 4	Easily penetrated several inches by thumb
Medium stiff	0.50 to 1.0	4 to 8	Can be penetrated several inches by thumb
Stiff	1.0 to 2.0	8 to 15	Readily indented by thumb
Very stiff	2.0 to 4.0	15 to 30	Readily indented by thumbnail
Hard	More than 4.0	Over 30	Indented with difficulty by thumbnail

ROCK TERMS

ROCK HARDNESS (FROM CORE SAMPLES)

DESCRIPTIVE TERMS	SCREWDRIVER OR KNIFE EFFECTS	HAMMER EFFECTS
Soft	Easily gouged	Crushes when pressed with hammer
Medium soft	Can be gouged	Breaks (one blow) Crumbly edges
Medium hard	Can be scratched	Breaks (one blow) Sharp edges
Hard	Cannot be scratched	Breaks conchoidally (several blows) Sharp edges

ROCK BROKENNESS

DESCRIPTIVE TERMS	ABBREVIATION	SPACING
Very broken	(V. Br.)	0 - 2"
Broken	(Br.)	2" - 1'
Blocky	(Bl.)	1' - 3'
Massive	(M.)	3' - 10'

CHAIN OF CUSTODY RECORD

PROJECT NO.:	SITE NAME:					NO. OF CON-TAINERS								REMARKS
SAMPLERS (SIGNATURE):														
STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION									

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

Order No. 70440 (0693)

HALLIBURTON NUS
Environmental Corporation

EQUIPMENT CALIBRATION LOG

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

Manufacturer ______________________________ **Date Purchased** ____________________

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

HALLIBURTON NUS
Environmental Corporation

SAMPLE LOG SHEET

PAGE____OF____

- ☐ SURFACE SOIL
- ☐ SUBSURFACE SOIL
- ☐ SEDIMENT
- ☐ LAGOON/POND
- ☐ OTHER

SAMPLERS SIGNATURE________________________

SITE NAME________________________________

SITE NUMBER______________________________

SAMPLE No.	SAMPLE METHOD	DEPTH (FT)	DATE	TIME	SAMPLED BY	CONCENTRATION (L)LOW (H)HIGH	(G)GRAB (C)COMPOSITE	ANALYSES							No. OF CONT (TOTAL)	SOIL DESCRIPTION

REMARKS:

LAB:

ACAD: FORMS\LOG.DWG 2/11/93 MB

DAILY ACTIVITIES RECORD **HALLIBURTON NUS**

PROJECT ____________________ LOCATION ____________________

CLIENT ____________________ ARRIVAL TIME ________ JOB NO. __________

DATE ____________________ DEPARTURE TIME ____________

CONTRACTOR ____________________ DRILLER ____________________

BORING NO.-____________________ HNUS REPRESENTATIVE ________________

ITEM	QUANTITY ESTIMATE	QUANTITY TODAY	PREVIOUS TOTAL QUANTITY	CUMULATIVE QUANTITY TO DATE

COMMENTS: ____

APPROVED BY:

HNUS FIELD REPRESENTATIVE

DRILLER OR REPRESENTATIVE