Work Plan Addendum
for
Tank Farm Investigation
for
Naval Submarine Base
New London
Groton, Connecticut

Northern Division
Naval Facilities Engineering Command
Contract Number N62472-90-D-1298
Contract Task Order 0188

September 1995

Halliburton NUS
CORPORATION

R-11-94-1

WORK PLAN ADDENDUM
FOR
TANK FARM INVESTIGATION
FOR
NAVAL SUBMARINE BASE - NEW LONDON
GROTON, CONNECTICUT

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Northern Division
Environmental Branch, Code 18
Naval Facilities Engineering Command
10 Industrial Highway, Mail Stop #82
Lester, Pennsylvania 19113-2090

Submitted by:
Halliburton NUS Corporation
993 Old Eagle School Road, Suite 415
Wayne, Pennsylvania 19087-1710

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PREPARED BY:

STEVEN H. RUFFING, P.E.
PROJECT MANAGER
HALLIBURTON NUS CORPORATION
PITTSBURGH, PENNSYLVANIA

APPROVED BY:

JOHN TREPANOWSKI, P.E.
PROGRAM MANAGER
HALLIBURTON NUS CORPORATION
WAYNE, PENNSYLVANIA

TABLE OF CONTENTS

TABLE OF CONTENTS (C ntinued)

TABLE OF CONTENTS (Continued)

TABLES

FIGURES

2.0 SCOPE OF WORK

To fully characterize environmental conditions within the UST Farm, Halliburton NUS is proposing an integrated field program consisting of subsurface geophysical surveys, soil borings and monitoring well installation, investigation of underground pipelines, sediment sampling, and surface water sampling. Rationale and methodology for each individual task are provided in the following sections.

Halliburton NUS will complete the following major tasks during the Remedial Investigation (RI) to address all areas of concern:

- Project Mobilization
- Ground Penetrating Radar Survey
- Fuel Pipeline Sampling
- Pipeline Sediment Sampling
- Soil, Surface Water, and Groundwater Sampling and Analysis
- Report Preparation
- Project Management and Meetings

The scope of the investigation was developed based upon a review of readily available information provided to ERM by the SUBASE; a kick-off meeting between Mr. William Mansfield, Environmental Division, Department of Engineering and Public Works, SUBASE, New London, and ERM discussions with NAVFAC's Mr. Brian Helland (August 20, 1992); and, a series of recommendations outlined by Ms. Carol A. Keating of the U.S. Environmental Protection Agency (EPA) in a March 5, 1992 letter to the Department of the Navy. The Draft Work Plan was also reviewed by EPA Region I and CTDEP and their comments incorporated into the Final Work Plan.

Additional comments provided following review of the Final Work Plan resulted in revisions to this Plan. Due to funding constraints on ERM's contract, Halliburton NUS was tasked with modifying the document. During this time additional work has been completed with regard to sampling, therefore, UST sampling was deleted from the field investigation. Halliburton NUS submitted the revised Final Work Plan to the Navy in July, 1995.

Preliminary field investigations were commenced in August 1995 by Halliburton NUS and resulted in further revisions of the Work Plan due to the decommissioning of USTs and the corresponding changes to the field conditions as well as the performance of the SCAPS investigation.

The tasks required for the performance of the field investigation are sequenced to allow an initial data-gathering effort to provide screening information needed to finalize Task 5. Tasks 1 and 2 will be used to finalize the list of analytical parameters for the soil, sediment and groundwater sampling program, which are described in Tasks 3, 4, and 5 of this plan. Sampling locations are presented in Figures 2-1, 2-2, 2-3, and 2-4.

This scope does not include a detailed evaluation of remedial alternatives, engineering design, or preparation of remedial work plans. Remedial investigations are typically conducted in phases and it is possible that additional measures may be required to fully characterize the horizontal and vertical extent of contamination. Following characterization of the physical and chemical characteristics of the site, Halliburton NUS will provide preliminary recommendations regarding potential remedial actions.

2.1 TASK 1 - PROJECT MOBILIZATION

This task will include a kick-off meeting with SUBASE representatives to review scheduled field activities and to perform a literature search to review any additional data currently unavailable to Halliburton NUS that would be useful in finalizing the scope of this investigation. A site walk-over and sampling review with the SUBASE engineering department personnel will be conducted prior to the commencement of any field work. Mr. Mansfield had earlier indicated to ERM that there may be buried pipelines in addition to the stormwater discharge and product transfer lines in the study area that would also need to be addressed.

The existing fuel lines that extend from the pier to the UST farm were hydrostatically tested by a contractor of the Department of the Navy in 1992. Results of hydrostatic testing were inconclusive according to NAVFAC.

2.2 TASK 2 - GROUND-PENETRATION RADAR SURVEY

This task includes a site walkover by a geophysics team and the site coordinator.

The purpose of the ground-penetrating radar (GPR) survey is to confirm the locations of the stormwater lines shown on SUBASE maps and to locate any unmapped stormwater lines that connect to the existing system.

GRUNNION AVE.
FLASHER AVE.
SCORPION AVE
PERCH AVE
HERRING AVE.
ROBALO AVE.
GRAYLING AVE.
KETE AVE.
GRENADIER AVE.
TRIGGER AVE.
SHARK BLVD.
AMBERJACK RD.
ARGONAUT RD.
CISCO RD.
CORVINA RD.
CAPELIN RD.
BULLHEAD RD.
BLUEFISH RD.
ALBACORE RD.
MATCH LINE
SEE FIGURE 2-2 FOR
CONTINUATION OF GEOPROBE
SAMPLE LOCATIONS
LEGEND
PROPOSED GEOPROBE LOCATIONS (42)
SUBJECT TO CHANGE
DIESEL LINE
SCALE IN FEET
REV. DESCRIPTION PREP BY DATE APPRVD
DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
NAVAL BASE
PHILADELPHIA, PA
NORTHERN DIVISION
FUEL FARM INVESTIGATION
REVISION 1 - LOWER BASE (PIER)
PROPOSED GEOPROBE SAMPLE LOCATION PLAN
SEAL AREA
SAT TO
DATE
CODE I.D. NO.
SCALE: AS SHOWN
SPEC. NO. –
CONSTRN. CONTR. NO.
NAVFAC DRAWING NO.
SHEET OF
SIZE: D
FIGURE 2-3

LEGEND
PROPOSED GEOPROBE LOCATIONS (42) SUBJECT TO CHANGE
DIESEL LINE
MATCH LINE SEE FIGURE 2-3 FOR CONTINUATION OF GEOPROBE SAMPLE LOCATIONS
TRIGGER AVE.
GRAYLING AVE.
GRAYBACK AVE.
GOLET AVE.
TANG AVE.
FUER AVE.
S. 27 ST.
SCULPIN AVE.
RASHER AVE.
SHARK BLVD.
MILITARY
CRYSTAL
O.T.1
O.T.2
O.T.3
O.T.4
O.T.5
O.T.6
O.T.7
O.T.8
O.T.9
SCALE IN FEET
E02X
REV. DESCRIPTION PREP BY DATE APPRVD
DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
PHILADELPHIA, PA.
NORTHERN DIVISION
NAVAL BASE
FUEL FARM INVESTIGATION
REVISION 1 - LOWER BASE
PROPOSED GEOPROBE SAMPLE LOCATION PLAN
SEAL AREA
SCALE: AS SHOWN
SPEC. NO.
CONSTRN. CONTR. NO.
NAVFAC DRAWING NO.
SHEET OF
SIZE: D
FIGURE 2-2

ACAD: O:\DATA\CADD\4626\SWSS.DWG 09/11/95 MB PSVIEW=PLOT, MSVIEW=DWG SWSS.LAY

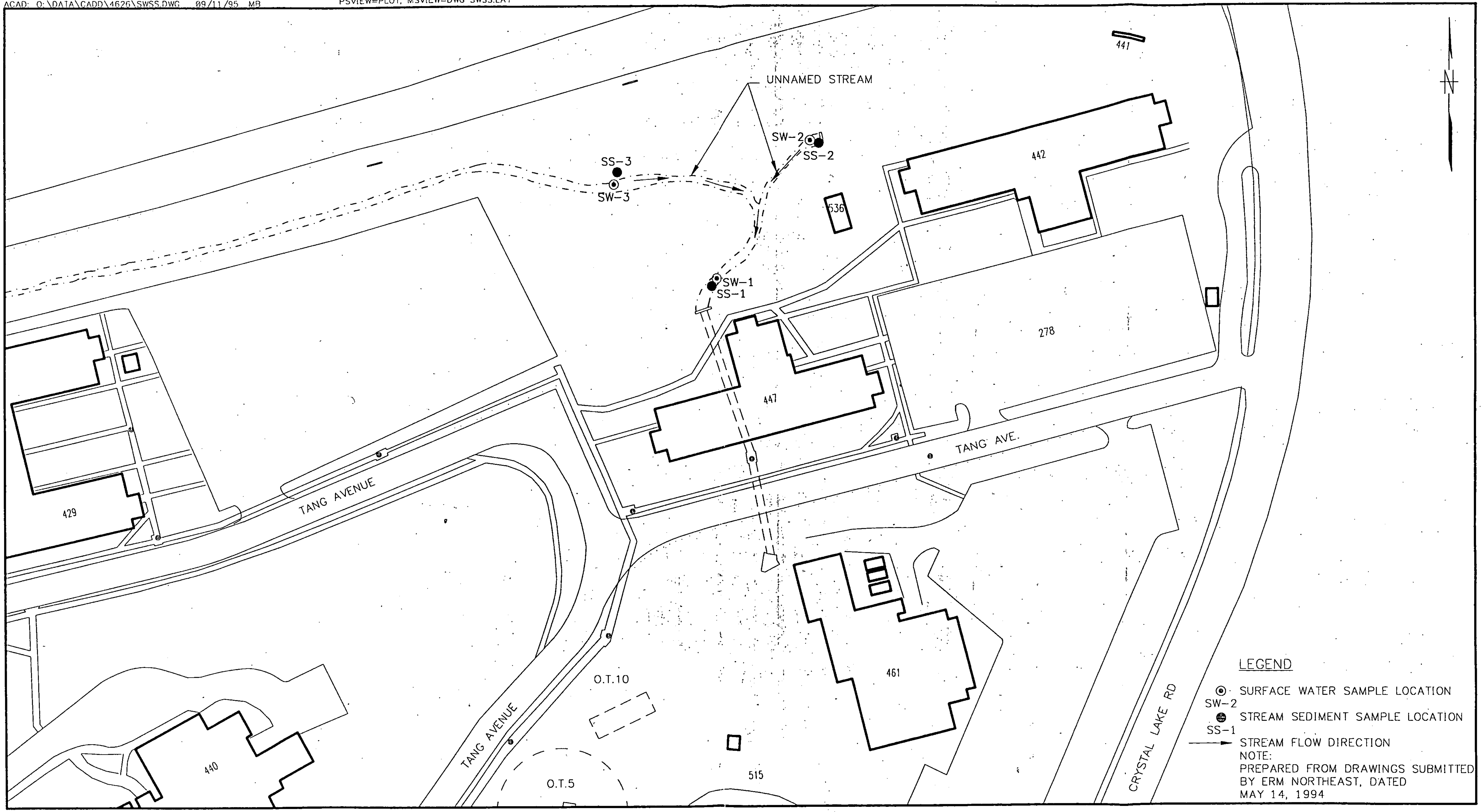

FIGURE 2-4

LOCATION OF UPSTREAM SURFACE WATER AND SEDIMENT SAMPLE
FUEL FARM UNDERGROUND STORAGE TANKS
NAVAL SUBMARINE BASE, GROTON, CONNECTICUT

Halliburton NUS CORPORATION

R-11-94-1
Addendum

2.2.1 Type of Geophysical Investigation

An integrated GPR and electromagnetic pipe locator investigation will be conducted to meet the project objectives. The GPR method is proposed because it provides detailed subsurface information directly below each survey line. The depth, size and orientation of the object of concern may be determined by analyzing the continuous reflection profiles that are obtained in the field. In some areas an electromagnetic pipe locator, or SOND, will be used in conjunction with the GPR to quickly and accurately locate any nearby buried piping. This technique is more efficient and accurate than the GPR in locating buried piping, but requires that one end of the pipe is accessible. It is assumed that access to the pipe may be possible via some catch basins.

Assumptions and exceptions are as follows:

- All GPR survey line locations are easily accessible by a four-wheel drive vehicle.
- All GPR survey lines are free from vegetation or man-made structures that would prohibit the successful completion of the survey.
- A 500-MHz transmitter will be used for the GPR survey unless the depth of penetration requirements are not met in the field. In this case, a 300-MHz transmitter will be used.
- The depth of penetration of the radio waves is restricted by the presence of conductive materials such as clay layers and water. In the event that very shallow clay layers or shallow water table are present under the survey area, the data quality may degrade proportionately.

2.2.1.1 Ground-Penetrating Radar (GPR)

Prior to geophysical surveying, a survey reference grid will be established along known pipeline locations to provide an accurate location and even distribution of geophysical measurements. The grid will follow along the known path of the stormwater lines and GPR profiles will be obtained at 3-foot intervals along the lines. The GPR data will be acquired along the suspected pipelines and perpendicular to pipelines in order to provide an optimum amount of subsurface detail. The grid will not be placed in areas where man-made structures, dense vegetation or other immovable objects are located.

The grid system will be established using a field transit such as a Brunton pocket transit and cloth or steel measuring tape. The survey grid will be tied in to permanent benchmarks, such as building corners, so that the grid could be re-occupied in the future.

GPR Methodology

The GPR method is based upon the transmission of repetitive, radio-frequency electromagnetic (EM) pulses into the subsurface. When the impinging EM wave contacts an interface of contrasting electrical properties, it returns to the surface in the form of a reflected signal. The reflected signal is detected by a receiving transducer within the GPR unit and plotted onto a graphic recorder and/or recorded digitally to a laptop computer. The GPR anomaly remains prevalent as long as the electrical contrast between media is present and constant. Any lateral or vertical changes in the electrical properties of the subsurface result in an equivalent change in the GPR signature. The system records a continuous image of the subsurface by plotting the two-way travel time of the transmitted signal versus the horizontal distance travelled by the transducers along the ground surface. Two-way travel time values can be converted to depth using known soil velocity functions.

An GSST SIR System-3 Subsurface Interface Radar System, or like instrument, will be used in this survey. The transmitter type and frequency (300 MHz or 500 MHz) will be determined in accordance with the depth of investigation and resolution requirements specified for this project by a preliminary test at the site. Initially a 500-MHz signal will be attempted. If insufficient signal is obtained, then a 300-MHz signal will be used. The 300-MHz signals provide deeper penetration; however, the use of the lower frequency antenna results in reduced vertical and lateral resolution. The depth of investigation with GPR instrumentation is a function of antenna frequency and the electrical properties (electrical conductivity and dielectric constant) of the subsurface materials. Higher frequency antennas provide greater target resolution with greater signal attenuation at depth relative to lower frequency antennas. Electrical properties of the subsurface materials also control the depth of investigation and are related to soil types, moisture content and pore fluid conductivities. Generally, unsaturated sands provide for the greatest depth of investigation, whereas clayey soils rapidly attenuate GPR signals.

All GPR data will be acquired along traverses that range in length from 15 feet to 90 feet.

If previously unmapped pipelines are discovered to diverge from the known line, then authorization for additional coverage will be requested from NAVFAC. The newly discovered line will be pursued upon authorization to proceed.

The GPR data interpretation will commence with a field profile review, followed by an identification of anomalous signatures that are characteristic of buried pipelines. The depth to each anomaly will be calculated using documented soil velocity values and known two-way travel time values to the anomaly interface. The location and depth of each GPR anomaly will be correlated with the pipe locator to better define the geographic origin of the anomaly.

2.2.1.2 Electromagnetic Pipe Locator Survey

The electromagnetic pipe locator survey will be performed at several locations in order to delineate the location and orientation of buried pipelines. Radio detection 33-MHz radio SOND, or like instrument, will be used for this survey due to its accuracy and ease of use. The system is composed of a transmitter and receiver. The SOND is guided into a stormwater pipeline via a catch basin. As the SOND is advanced through the pipeline, it generates a signal which is picked up by a receiver. The SOND can be fed into a pipeline several hundred feet depending on the condition of the line.

2.2.1.3 Quality Assurance/Quality Control

The QA/QC measures for this investigation involve the comparison of each instrument response (GPR and pipe locator) at a known base station. The responses of each are tested for repeatability and consistency of measurement.

2.3 TASK 3 - FUEL PIPELINE SAMPLING

The purpose of conducting TPH soil sampling is to define the horizontal extent of petroleum contamination in the subsurface in a cost-effective manner. By locating areas where TPH is present in soils, a plume of petroleum (dissolved or separate phase) can be rapidly delineated without installing a high-density network of groundwater monitoring wells.

Halliburton NUS, proposes to conduct soil sampling and analysis for TPH along the new and old diesel underground pipelines from the fuel loading dock (Pier 1), throughout the lower Base and the gate valve Building 322 to tanks OT-4 and OT-9. The No. 6 oil underground pipelines to tanks OT-1 and OT-3 are installed in lined trenches, which would prevent or minimize any potential soil and groundwater impact from leaks. The remaining old and new diesel lines are not, however, installed in lined trenches. Any leaks from these lines could have directly impacted the subsurface. It is estimated that there are more than 7,000 feet of diesel underground pipelines between Building 332 and the six diesel tanks, and 3,300 feet on the Lower

Base. Soil samples will be collected at intervals of approximately 100 feet along the underground diesel lines in an effort to identify potential points of leakage. As shown on Figures 2-2 and 2-3, an estimated 110 soil sampling points will be required. Soil samples will be collected using the Geoprobe soil sampling system which is described in Section 2.5.4 and analyzed for TPH.

2.4 TASK 4 - PIPELINE SEDIMENT SAMPLING

Halliburton NUS proposes to collect ten samples from all tank farm catch basins which are located at the outlet of individual sections of drainage pipe. Vitrified tile drainage pipes are present around USTs OT-1 through OT-5 and OT-6. If a release of fuel had occurred at one of the tanks listed above, petroleum could have entered the drainage pipe and discharged to a nearby catch basin.

Collection and analysis of sediment samples (SS-5 to SS-14), sampling locations will be determined in the field, will be conducted at the catch basins to provide an indication of a previous release of petroleum. Sediment analytical data from the entire tank farm may aid in isolating potential source areas. Sediment samples will be analyzed for Target Analyte/Target Compound (TAL/TCL) parameters and TPH.

2.5 TASK 5 - SOIL, SURFACE WATER, AND GROUNDWATER SAMPLING AND ANALYSIS

Revisions to the proposed sampling locations have been made throughout this section. Figures 2-1, 2-2, 2-3, and 2-4 identify the revised locations and scope of the field investigation within the fuel tank farm at New London Subase. These changes are a result of reviewing existing data, preparing contour maps of the contamination, the Ground-Penetration Radar (GPR) Survey, preliminary field activities, and the SCAPS investigation (see Section 2.5.5).

As a result of preliminary field investigations, it was found that all the USTs except for OT-5 and OT-10 have been demolished and closed in place. Of these USTs, OT-10 is not within this scope of work and closure activities are currently ongoing at OT-5. In addition, only 10 of the 30 existing wells could be field verified. Based on performance of these tasks, Halliburton NUS has finalized the scope of the investigation. The investigative changes and their basis is presented in the corresponding sections.

At the conclusion of the initial phase of activities, Halliburton NUS met with NAVFAC to discuss findings and additional tasks. Halliburton NUS has refined the scope of the investigation based on these discussions. A combination of soil borings, permanent monitoring wells, Geoprobe groundwater/soil sampling, surface water/sediment sampling, and Site Characterization and Analysis Penetrometer System (SCAPS) will be utilized to perform the site characterization efforts.

A dual approach is proposed to investigate soil and groundwater contamination at the tank farm. The combined results of these two approaches will facilitate the characterization of the extent of the subsurface contamination by petroleum products at the fuel tank farm.

The first approach is to focus the characterization in the vicinity of the tanks based on known problems from previous investigations. Section 2.5.1 describes the proposed sampling program in the vicinity of the tanks. The second approach addresses potential problems on a more site-wide basis at areas where large data gaps exist between tanks or areas downgradient of the tanks; at areas along the perimeter surrounding the tanks, addressing both upgradient conditions and conditions along underground drain or fuel lines; as well as areas within the tank farm along stormwater catch basins and drainage lines which may contribute to groundwater contamination. Section 2.5.2 describes the site-wide program.

The proposed sampling locations are shown on Figures 2-1, 2-2, 2-3, and 2-4 and the proposed environmental sampling summary is shown in Table 2-1. The proposed analytical program, including quality assurance/quality control samples, is presented on Table 3-1 contained in Section 3, Quality Assurance Project Plan. The summary descriptions of the individual sampling protocols are presented in the sections below.

2.5.1 Proposed Sampling in the Vicinity of the Tanks

This section describes the tank-specific sampling rationale. The sample collection method as well as number of samples per analyte for the entire investigation is shown on Table 2-1.

2.5.1.1 Tanks OT-1 and OT-3

These two No. 6 fuel oil tanks were investigated by ERM in 1991. Minimal soil and groundwater contamination were detected in the eight wells installed (four around each tank) at OT-1. Lead was detected at 29 ppb in well ERM-2 during the NEX Gas Station Investigation, and TPH was detected at 49 ppb in ERM-3 during the No. 6 Fuel Oil Investigation. ERM-2 is a lateral gradient well and ERM-3 is a downgradient well. At OT-3, 25 ppb of BTEX was detected in ERM-11, a downgradient well. These two tanks probably did not impact the subsurface. The low-level contamination is likely from the NEX Gas Station contaminant plume.

TABLE 2-1

ENVIRONMENTAL SAMPLING SUMMARY(1)
TANK FARM, SUBASE-NLON, GROTON, CONNECTICUT

Sample Matrix	Sample Collection Techniques	Number of Samples	Location	Full(2) Analysis	TPH	BTEX + MTBE
FUEL PIPELINE						
Soil	Geoprobe	110	GS-1 to 110		110	
PIPELINE SEDIMENT						
Sediment	Grab	10	SS-5 to 14	10	10	
OT-1						
Groundwater	Existing Wells	2	ERM-1, ERM-2		2	2
	Temp Boring/Well	3	SB/TW-1,2,3		3	3
	Perm Well	2	HNUS-1,HNUS-2		2	2
Soil	Temp Boring/Well	3	SB/TW-1,2,3		3	3
	Perm Well	2	HNUS-1,HNUS-2		2	2
OT-2						
Groundwater	Existing Wells	6	ERM-5,13,14,17,18,19		6	6
	Temp Boring/Well	1	SB/TW-4		1	1
	Perm Well	3	HNUS-3,4,5		3	3
	Temp Well	4	TW-1,2,3,4		4	4
Soil	Temp Boring/Well	1	SB/TW-4		1	1
	Perm Well	3	HNUS-3,4,5		3	3
	Soil Boring	2	SB-1,SB-2		2	2
OT-3						
Groundwater	Existing Wells	1	ERM-10		1	1
	Temp Boring/Well	1	SB/TW-8		1	1
	Perm Well	2	HNUS-6,7		2	2
	Temp Well	1	TW-5		1	1
Soil	Temp Boring/Well	1	SB/TW-8		1	1
	Perm Well	2	HNUS-6,7		2	2
OT-4						
Groundwater	Temp Boring/Well	1	SB/TW-11	1	1	
	Perm Well	2	HNUS-8,9	2	2	
	Temp New	1	TW-6	1	1	
Soil	Temp Boring/Well	1	SB/TW-11	1	1	
	Perm Well	2	HNUS-8,9	2	2	
OT-5						
Groundwater	Perm Well	2	HNUS-10,11	2	2	
Soil	Perm Well	2	HNUS-10,11	2	2	
OT-6						
Groundwater	Perm Well	2	HNUS-12,13		2	
Soil	Perm Well	2	HNUS-12,13		2	
	Soil Boring	2	SB-5,6		2	

TABLE 2-1 (Continued)
ENVIRONMENTAL SAMPLING SUMMARY[1]
TANK FARM, SUBASE-NLON, GROTON, CONNECTICUT

Sample Matrix	Sample Collection Techniques	Number of Samples	Location	Full[2] Analysis	TPH	BTEX + MTBE
OT-7						
Groundwater	Perm Well	2	HNUS-14,15		2	
	Temp Well	2	TW-7,8		2	
Soil	Perm Well	2	HNUS-14,15		2	
	Soil Boring	2	SB-7		1	
OT-8						
Groundwater	Temp Boring/Well	4	SB/TW-20,22,23,24		4	4
	Perm Well	4	HNUS-16,17,18,19		4	4
	Temp Well	1	TW-9		1	1
Soil	Temp Boring/Well	4	SB/TW-20,22,23,24		4	4
	Perm Well	4	HNUS-16,17,18,19		4	4
OT-9						
Groundwater	Existing Well	1	MW-11		1	1
	Perm Well	3	HNUS-20,21,22		3	3
	Temp Well	2	TW-10,11		2	2
Soil	Perm Well	3	HNUS-20,21,22		3	3
	Soil Boring	2	SB-8,9		2	2
LOADING AREA						
Soils	Soil Boring	2	SB-3,4		2	
SITE WIDE INVESTIGATION						
Groundwater	Existing Well	1	8MW-4	1	1	
	Temp Boring/Well	18	SEE FOOTNOTE 3	18	18	
	Perm Well	2	HNUS-23,24	2	2	
	Temp Well	1	TW-12	1	1	
Soil	Temp Boring/Well	18	SEE FOOTNOTE 3	18	18	
	Perm Well	2	HNUS-23,24	2	2	
SURFACE WATER AND SEDIMENT						
Surface Water	Grab	3	SW-1,2,3	3	3	
Sediment	Grab	4	SS-1,2,3,4	4	4	

Notes:

Drill Locations Proposed Summary
Permanent Wells .... 24 - Drill Rig
Temp Boring/Well .... 28 - Geoprobe
Soil Boring .... 9 - Drill Rig (convert to well if evidence of contamination is found)
Temp Well .... 12 - Geoprobe

Other
Pipeline Sediment .... 10 - By Hand
Surface Water .... 3 - By Hand
Sediment.................. 4 - By Hand

(1) Table 2-1 depicts environmental samples only. QC samples are shown on Table 3-1.
(2) Full analysis includes TCL organics (VOCs, SVOCs, pesticides/PCBs)/TAL metals plus cyanide.
(3) Wells included are: SB/TW-5,6,7,9,10,12,13,14,15,16,17,18,19,21,25,26,27,28.

During preliminary field activities at OT-1, wells ERM-3 and ERM-4 could not be located. These wells will be replaced with wells HNUS-1 and HNUS-2 to establish monitoring points along the perimeter of the fuel farm. Three temporary borings/wells (SB/TW-1, 2, and 3) will also be installed along the west side of OT-1 to address data gaps and to aid in assessing the storm sewers. Soil and groundwater samples will be collected from the new HNUS-1 and HNUS-2 monitoring wells as well as the temporary borings/wells. Also, groundwater samples will be collected from existing wells ERM-1 and ERM-2. Soil and groundwater samples collected at OT-1 will be analyzed for TPH, BTEX and MTBE.

At OT-3, monitoring wells ERM-9, ERM-11, and ERM-12 could not be located during preliminary field activities. ERM-9 and ERM-12 will be replaced with permanent monitoring wells HNUS-6 and HNUS-7 because they are in an area of known contamination. A temporary boring/well (SB/TW-8) will be installed in the vicinity of the former ERM-11 because it is in an area of known contamination, however, it is located in the outfield of a baseball field and would be difficult to relocate at a future time. Soil and groundwater samples will be taken from the new HNUS-6 and HNUS-7 monitoring wells and the temporary boring/well (SB/TW-8) in the vicinity of the former ERM-11. One temporary well (TW-5) will be installed south of ERM-12 and a groundwater sample collected to help define the gasoline plume. Also, a groundwater sample will be collected at existing well ERM-10. Soil and groundwater samples collected at OT-3 will be analyzed for TPH, BTEX and MTBE.

2.5.1.2 Tank OT-2

The area around No. 6 fuel oil tank OT-2 is characterized by two distinct problems:

- A plume of dissolved gasoline extends southward from the NEX station area to the north and west side of the tank.

- Oil was found in the soil above the water table of well ERM-7 located on the southwest side of the tank.

During preliminary field activities at OT-2, wells ERM-6, 7, 8, 15, and 16 could not be located. Four temporary wells (TW-1, 2, 3, and 4) will be installed around ERM-19 and groundwater samples collected to define the extent of the contaminant plume from the NEX Gas Station, as well as to define the limits of previously detected TPH. Monitoring wells ERM-6 and ERM-7 will be replaced with permanent monitoring wells HNUS-4 and HNUS-5 because they are in an area of known contamination. Soil and groundwater samples will be collected at each permanent well installation. Monitoring well ERM-16 will be replaced with HNUS-3 and soil and groundwater samples will be collected. However, HNUS-3 will be moved west of the previous ERM-16 well location to help define the limits of the plume from the NEX Gas Station and its affect on the tank farm. One temporary boring/well (SB/TW-4) will be installed to the north of ERM-7 to define the edge of previously detected soil contamination and to provide information regarding the NEX Gas Station contaminant plume. Two soil borings (SB-1 and SB-2) will also be installed around ERM-7 and soil samples collected to completely define the limits of previous contamination. Soil and groundwater samples collected at OT-2 will be analyzed for TPH, BTEX and MTBE.

The six existing wells (ERM-5, ERM-13, ERM-14, ERM-17, ERM-18, and ERM-19) in the vicinity of tank OT-2 will also be resampled as part of the groundwater quality assessment.

2.5.1.3 Tank OT-4

Four soil borings (TB-1 through TB-4) were drilled by F&O in 1989, around this diesel oil tank, however, no wells were installed. Up to 940 mg/kg of TPH (Fuel oil scan) were found in boring TB-4, located on the eastern side of tank OT-4.

Halliburton NUS proposes to drill and sample two soil borings (HNUS-8 and HNUS-9) on the downgradient western and southwestern sides of the tank which will extend to the base of the tank. To complete the groundwater quality characterization, these borings will be converted into monitoring wells. These two wells will allow verification of the inferred westerly to southwesterly groundwater flow direction. To complement the groundwater quality data, one temporary boring/well is proposed upgradient of the tank (SB/TW-11). In addition, one temporary well (TW-6) will be installed adjacent to the SCAPs investigation location NLFF05 (see Section 2.5.4) to assess groundwater. Soil and groundwater samples collected at OT-4 will be analyzed for TPH and full analysis which includes pesticides/PCBs, TCL organics, TAL metals plus cyanide.

2.5.1.4 Tanks OT-5 and OT-6

During an investigation performed by Halliburton NUS in 1994, four permanent wells and one temporary well were installed through tank OT-5. Five organic compounds (acetone, chloroform, bromodichloromethane, tetrachloroethene, and 2,6-dinitrotoluene) were found in three of these wells. In addition, various inorganic compounds were found. Soil samples taken below the tank indicated two organic compounds (methylene chloride and di-n-butylphthalate) and various inorganic compounds.

Additional wells were installed near OT-5 during the Halliburton NUS investigation of OT-10. Samples from these wells indicated three organic compounds (total xylenes, di-n-butylphthalate, and heptachlor) and various inorganics in the groundwater as well as several organic compounds (BTEX, 2-butanone, pyrene, and 4,4'-DDE) and various inorganics in the soils.

The GZA report stated that PCBs and pesticides were detected in one area outside of tank OT-5. Aroclor-1260 was detected at 32 ppm at 0 to 2 feet below grade at a site close to the former fill opening and current truck dumping pad. PCB laden oil possibly resulted from spillage during filling of the waste oil tanks. No PCBs were found at greater depths outside of OT-5.

Due to the extensive investigation that has been performed at OT-5 previously, as well as the fact that it is currently being decommissioned, minimal investigative work is being proposed in this area. Two downgradient wells (HNUS-10 and HNUS-11) will be installed to determine if OT-5 is a source of contamination to the fuel farm. Soil and groundwater samples collected at OT-5 will be analyzed for TPH and full analysis which includes pesticides/PCBs, TCL organics, TAL metals plus cyanide.

Minimal information is available for the Tank OT-6 area, therefore the necessary scope remains unclear. Halliburton NUS proposes that four soil borings (SB-5, SB-6, HNUS-12, and HNUS-13) be installed to assess this tank. Each boring will be field screened, and based on this screening, permanent wells will be installed. As a minimum, however, two of the borings will be converted to permanent wells. Soil and groundwater samples will be collected at OT-6 and analyzed for TPH.

2.5.1.5 Tank OT-7

Four wells (MW-1 through MW-4) were installed by F&O in 1989, around this diesel fuel tank. However, during preliminary field activities, Halliburton could not locate these wells. Dissolved fuel oil was detected in well MW-1 on the north side of the tank. Groundwater in the remaining wells is apparently uncontaminated. Groundwater elevations in the vicinity of tank OT-7 suggest a northeasterly groundwater flow.

Based on previous studies minimal contamination has been detected in this area. Therefore, as with OT-6, borings will be installed and field screened to determine well locations. Three soil borings (SB-7, HNUS-14, and HNUS-15) will be installed to assess this tank. Borings will be field screened, and based on this screening, two permanent wells will be installed (HNUS-14 and 15). Two additional downgradient temporary wells (TW-7 and TW-8) will be installed and groundwater samples will be collected to determine if the source of the previous contamination is still present. Soil and groundwater samples collected at OT-7 will be analyzed for TPH.

2.5.1.6 Tank OT-8

F&O installed four wells (MW-5 through MW-8) around this diesel fuel tank in 1989. During preliminary field activities these wells could not be located. A gas chromatography (GC) scan indicated dissolved fuel oil in two wells: five ppm in upgradient well MW-6 and 52 ppm in well MW-7 located on the south side. Groundwater flows in a northwesterly direction around this tank. During the 1991 No. 6 fuel oil tanks investigation, ERM also measured groundwater levels in the F&O wells installed around the two diesel tanks, OT-8 and OT-9, in order to establish a more complete groundwater contour map. More than 2 feet of floating oil was found in well MW-7 during well gauging.

The floating product and associated groundwater contamination in the vicinity of diesel tank OT-8 needs to be delineated to determine the most effective method for recovering the floating product and to determine the extent of the associated plume of the diesel oil dissolved constituents.

Monitoring wells MW-5, MW-6, MW-7, and MW-8 will be replaced with new permanent wells (HNUS-16, 17, 18, and 19) because they are in an expected area of contamination based on previous sampling and analysis. One temporary boring/well (SB/TW-20) will be installed to the east of the tank to define the edge of the former contaminant plume and address a data gap. Three temporary borings/wells (SB/TW-22, 23, and 24) will be installed around the former location of MW-7 to assess if free product still exists and to what extent. One temporary well (TW-9) will be installed to the southwest of the tank to define the edge of the former contaminant plume. Soil and groundwater samples collected at OT-8 will be analyzed for TPH, BTEX and MTBE.

2.5.1.7 Tank OT-9

Four wells (MW-9 through MW-12) were installed by F&O in 1989. Wells MW-9 and MW-10 were unable to be located during the preliminary field investigation. Well MW-11 was located during the preliminary field investigation. Well MW-12 on the southwest side of this diesel fuel tank was not field verified, however, in 1989 and on three occasions in 1991 during the ERM investigation this well was found to be dry. During previous sampling and analysis, the remaining three wells (MW-9 to MW-11) contained dissolved fuel oil from 4 to 14 ppm. Groundwater flows to the northwest in the vicinity of the tank.

Monitoring wells MW-9, MW-10, and MW-12 will be replaced with new permanent wells (HNUS-20, 21, and 22) because they are located in the downgradient boundary of the fuel farm and may be required for future monitoring purposes. A groundwater sample will be collected from existing well MW-11. Two soil borings (SB-8 and SB-9) will be installed around MW-11 and the soil sampled to determine the presence of residual fuels as identified during previous investigations. Two temporary wells (TW-10 and TW-11) will be installed to the northwest and west of the tank to assess data gaps. Soil and groundwater samples collected at OT-9 will be analyzed for TPH, BTEX and MTBE.

2.5.1.8 Loading Area

Two soil borings (SB-3 and SB-4) will be initially drilled within 10 to 15 feet east and west of the fuel truck loading area near Building 482 for visual inspection and screening with a PID/FID. Soil samples will be collected from these borings and analyzed for TPH..

2.5.2 Proposed Sampling on a Site-Wide Basis

Additional subsurface sampling is proposed on a more site-wide basis at areas not located in the immediate vicinity of the tanks. These additional sampling locations will assess potential contamination associated with the major stormwater drain lines and diesel fuel lines and will help fill some of the major data gaps in areas between the tanks.

To address concerns with the stormwater lines, Halliburton NUS proposes to collect 18 temporary borings/wells (SB/TW-5 to 7, 9, 10, 12 to 19, 21, and 25 to 28) at locations throughout the fuel tank farm. In addition, 2 permanent wells (HNUS-23 and 24) will be installed to assess remaining data gaps. The locations of these sampling points are shown on Figure 2-1, and will assist in obtaining a better understanding of subsurface conditions between the tanks. The two permanent wells will be placed at the perimeter of the fuel farm to help assess offsite flow of contamination. One of the permanent monitoring wells will be placed in the southwest corner of the tank farm and the other will be installed on the south side of Crystal Lake Road. In addition, existing well MW-4, located in the parking lot of the Nautilus Memorial, will be sampled. This well is the nearest well to the stormwater drain outfall.

A summary of the collection methods, as well as the number of samples per analyte for the entire investigation, is shown in Table 2-1.

All invasive sampling locations will be approved by the SUBASE Public Works Department. However, in case of a breech of an underground tank or line, the SUBASE HAZMAT and Spill Response Team will be notified.

2.5.2.1 Surface Water and Sediment Sampling

Halliburton NUS proposes to collect surface water (SW-1, 2, and 3) and sediment samples (SS-1, 2, and 3) from the unnamed stream which enters the tank farm from the east (Figure 2-4). The stream flows beneath the tank farm via underground piping and discharges at the storm drainage outlet. These samples may help to determine whether contaminated surface water is entering the tank farm from an unidentified upstream source. A review of aerial photographs indicated that the stream historically flowed in close proximity to at least one former service station facility. The stream currently flows both parallel to Route 12 and the SUBASE property. Contaminants from street runoff may impact the stream.

In addition, Halliburton NUS proposes to collect one sediment sample (SS-4) from the outfall of the existing storm sewer adjacent to the Thames River to review the impact of the previously noted spills.

2.5.3 Soil Borings

Soil borings will be drilled with a hollow-stem auger rig. Continuous split-spoon samples will be collected from each boring and logged by the supervising Halliburton NUS field geologist. The borings will be terminated at the water table, or extended to the base of the tanks, when the boring is located near a tank.

Each sample will be screened for the presence of volatile organic compounds (VOCs) using a PID. Samples exhibiting elevated readings will be retained for analysis. Where no elevated readings are present, samples from just above groundwater levels will be retained.

A summary of the collection methods, as well as the number of samples per analyte for the entire investigation, is shown in Table 2-1.

2.5.4 Geoprobe Soil Sampling

The Geoprobe soil sampling system will be used to collect additional soil samples at depth where the use of a drill rig is either difficult or not warranted. The soil sampling will employ the use of a 45-inch macro core open tube sampler (2-inch outside diameter). At each location, the soil will be sampled at 4-foot intervals to a depth of 1 interval below the groundwater table. At locations which are covered with asphalt or concrete a portable coring machine will be used to drill through the surface material, then collection of the soil samples will proceed.

Following removal of the macro core tube from the hole, the sample will be extruded. The Geoprobe system to be used allows the soil to be contained in a polyethylene terephthalate (PETG) sleeve until it is placed into sample containers. The sleeve will be split lengthwise with a decontaminated knife and screened over its entire length for organic vapor emissions using an HNu. The section of the interval which provides the highest vapor emissions reading will be retained for analysis. If no reading is obtained on the HNu, the soil in the interval below the groundwater surface will be retained.

Soils will be removed from the liner and placed into the appropriate sample containers using a decontaminated stainless steel sampling trowel. All sampling locations will be returned to their original condition by filling with soil, gravel, asphalt cold patch, or concrete seal.

2.5.5 In-Situ Groundwater Sampling Procedures Using Geoprobe

In-situ groundwater sampling requires the use of a truck mounted hydraulic ram to advance the Geoprobe sampler to the required depth. For this task, soil borings will be advanced to the water table using a 1 inch continuous sampler. Depth to groundwater is between 2 to 7 feet, based on gauging data from previous studies.

Once the soil boring is completed, the temporary well points will be assembled and attached to a drive rod using procedures specified by the manufacturer. Since groundwater is relatively shallow, no more than two lengths of rod will be needed. No joints between the well point and the drill rods will be below the water table. The temporary well points will be driven approximately 3 feet into the water table. This depth has been selected since it will allow for the collection of both groundwater and petroleum samples, in the event that floating product is encountered. Liquid samples will be collected from the screened portion of the well points using the low flow sampling techniques described in Section 3.2.3.

The temporary well point is a slotted stainless-steel barrel with a drive point at the end approximately 4 feet in length and 1 inch in diameter. The well point is attached to drilling rods and pushed, or driven, to the desired sampling depth from the ground surface or from the bottom of a drilled borehole.

Drilling equipment and temporary well points will be steam cleaned between borings to present the possibility of cross-well contamination. Potable water will be obtained from the SUBASE water supply for this purpose.

Groundwater will be gauged in the temporary well points before the sample has been collected. Depth to water will be measured from the top of the rod and then the section of the rod above grade will be subtracted. Grade will be surveyed. Measurement accuracy is expected to the nearest 0.1 foot. This data will provide a check for the groundwater table map developed from monitoring well measurements and acts as a check to assure the well point is properly positioned straddling the water table.

2.5.6 Site Characterization and Analysis Penetrometer System (SCAPS)

Cone penetrometer testing (CPT) methods have been successfully utilized to collect characterization data for stratigraphic studies related to geotechnical design. Typical data collected for geotechnical studies include zone seismic velocity surveys, soil pore pressure, zone tip resistance and sleeve friction as the penetrometer is advanced. In recent years, use of the technology has been expanded to collect information to support environmental efforts including pore pressure data, ground water samples, soil samples, and soil gas samples.

The SCAPS is an innovative technology that augments standard CPT capabilities by permitting subsurface characterization for both subsurface stratigraphy and hydrocarbon detection. The technology obtains subsurface data by hydraulically driving a 1.25 (approximately) inch diameter instrumented probe vertically into the earth. Data on in-situ hydrocarbon is gathered with fluorometry methods, while geologic characterization is determined with transducers measuring probe resistance and sleeve friction as the unit is advanced. In addition, other probes allow the measurement of electrical resistivity of formation material, and collection of fluid/soil samples at depth. All data is transmitted from the transducer to the data acquisition equipment via a fiber optic system. Data is processed by the SCAPS computer data system, and essentially provides real time data.

The SCAPS is capable of obtaining a nearly continuous data log of subsurface conditions which is critical in engineering a remediation system at a hydrocarbon contaminated site. During preliminary field investigation activities, SCAPS was used as a preliminary screening tool to approximate the horizontal and vertical extent of a contamination plume. The preliminary data obtained by the SCAPS was used to finalize the location of the sampling points at the fuel tank farm.

Although SCAPS is intended as a preliminary screening tool, it offers several advantages with respect to conventional borings and well systems. Advantages include the following:

- Provides detailed subsurface information
- Minimizes the volume of hazardous waste generated
- Reduces worker exposure to hazardous substances
- Offers real time data processing and on-site evaluation

The Naval Facilities Engineering Service Center (NFESC) has provided and operated the SCAPS unit and performed all associated work (i.e., decontamination, sample collection). Halliburton NUS performed oversight of the work and was responsible for disposal of investigative derived waste (IDW).

2.5.6.1 Technology Description

The penetrometer system is mounted in a specially engineered truck (weighing approximately 20 tons) designed with protected work spaces which allow for access to toxic and hazardous sites while minimizing contaminant exposure of the work crew. SCAPS consists of a penetrometer system for soil determination and laser/fiber optic-based sensor system for detection of petroleum hydrocarbons in the subsurface. This system has been integrated with a cone penetrometer system for use in real-time subsurface screening of petroleum, oils, and lubricants (POLs).

POLs can be detected by SCAPS to depths of about 100 feet, with a vertical resolution of approximately 1 inch, as the probe is pushed into the ground (at a rate of about 3 feet per minute). In addition, soil classification information is collected and spatially correlated with the chemical information.

Specifically, certain polynuclear aromatic hydrocarbon (PAH) components of petroleum hydrocarbons are induced to fluoresce by excitation with a laser source. The laser light is transmitted via fiber optics to the subsurface through the penetrometer probe and an optical window mounted on the probe. PAHs in the soil are induced to fluoresce as the optical window passes by. This fluorescence signal is carried back to the surface through a second optical fiber. The returned signal is analyzed by a linear photobiotic array spectrophotometer and recorded by the on-board computer. This data is then semi-quantified against a standard curve to provide a fluorescence response measurement.

As the probe is recovered after each push, the SCAPS pumps a cement/bentonite grout mixture through the probe which permanently seals the 1-1/2 inch diameter hole.

The SCAPS was used to systematically estimate the extent, in three dimensions, of subsurface contamination. Sites were investigated using an observational approach. The push locations (NLFF01 to NLFF30) at the fuel tank farm are located on Figure 2-1. Following the initial effort, additional push points were selected using field data to successively define any potential plume.

Utility surveys were undertaken primarily to determine if there were subsurface features (i.e., drums, pipes, etc.) in the area where the penetrometer unit would be operating. The activity provided a site-specific utility map. In addition, each push location was cleared using geophysical techniques prior to operation of the SCAPS. The geophysical techniques available for use in conjunction with the SCAPS truck were a cable locator and ground penetrating radar. The SCAPS is capable of obtaining both soil and fluid samples using commercially available attachments. Where conventional monitoring well or soil boring techniques are not used, samples will be collected using the procedures described in Sections 2.5.4 and 2.5.5.

2.5.6.2 Decontamination Procedures

All sampling and data collection devices contacting potentially contaminated materials were decontaminated in accordance with ASTM 5088, Practice for Decontamination of Field Equipment Used at Non-Radioactive Waste Site. Upon completion of push operations for penetration and fluoroscopic tests, the push rod and probe are cleaned as they are withdrawn using pressurized hot water. The hot water is flushed through a cleaning collar (connected to a hot water storage system which contains all wash fluids) located beneath the truck.

2.5.6.3 Grouting

The SCAPS probe is equipped with an internal grout tube which runs the length of the probe. Following the data collection activities for each push, a grout pump was attached to the internal grout tube. Initially, a sacrificial tip was blown off. Grout was then pumped into the hole as the probe was withdrawn. The grout material consisted of a cement with 2% (nominal) bentonite and a non-toxic friction reducing additive (Sikament). A constant pressure, supplied by the grout pump, was maintained as the probe was withdrawn. Grout flow was visually monitored to identify any blockage of the tubing.

2.5.6.4 Report Preparation

The preliminary field plots produced after each probe will be available to the RPM following each work day. A final report, shall include a description of the methods used, the results of the investigation, and final versions of plots.

2.5.6.5 Investigation-Derived Waste

Investigation-derived waste (IDW) was generated during operation of the CPT system. Types of waste that are normally produced include: (1) wash water from sampling equipment and decontamination operations, (2) solidified grout, and (3) wash water from grouting equipment cleanup. IDW was placed in 55-gallon drums, labeled, and stored on site. NFESC will document IDW drum information on a Waste Container Tracking Form which will be submitted to the activity.

The decontamination wastewater is expected to contain traces of petroleum hydrocarbons and suspended solids. Although the wash water is not expected to meet hazardous classification as defined in RCRA, the material was containerized, labeled, and stored at the Halliburton NUS IDW staging area.

Fifty-five gallon Department of Transportation (DOT) standard drums with open top were used to contain the IDW produced during the investigation. Once filled, the drums were labeled and delivered to the Halliburton NUS IDW staging area.

2.5.6.6 Data Collection and Reduction

The data collected consists of probe location (northing, easting, elevation), tip resistance, sleeve friction, soil fluorescence, and depth. All data was collected for each probe approximately every 2 centimeters from the ground surface to a depth of 2 to 5 feet below the potentiometric surface or until refusal, unless specified. The tip resistance and sleeve friction data will be used to produce soil classification information. The soil fluorometry data will be converted to estimations of concentrations of fuel product in units of milligrams per kilogram (mg/kg). This conversion is based on comparison of fluorescent response during pushes to the fluorescent response during generation of a standard curve using the site-specific soil inoculated with petroleum hydrocarbons.

During each probe a monitor displays fluorescence and soil classification data collected in realtime. More refined processing is required and can be performed in the field or at NFESC before producing finalized plots (hard copies). The field plots can be produced within minutes to display results on a near real-time basis.

2.5.6.7 System Calibration and System Checks

The SCAPS has been engineered to allow for chemical calibration by comparison to a standard curve comprising site specific soil and standard additions of known quantities of specific fuels. System checks for the chemical sensor are performed before and after each individual push using a 10 parts per million (ppm) quinine sulfate solution. The physical parameter components are calibrated one to two times per week during deployment using a load cell and a string pot displacement sensor.

2.5.7 Monitoring Well Installation

Monitoring wells will be installed to provide a long-term groundwater monitoring and hydrogeologic measuring.

Twenty-four monitoring wells (HNUS-1 through HNUS-24) will be installed using a hollow-stem auger drilling rig. Continuous split-spoon samples will be collected from each boring and logged by the supervising hydrogeologist from Halliburton NUS. All split spoons will be screened for the presence of VOCs using a PID. The PID will be used to determine relative concentrations of total ionizable volatile organics. Each sample will be screened by testing the headspace of each soil sample in a partly filled jar. If drilling occurs in the cold months, then samples will be heated in a field vehicle, trailer or building before analyzing headspace.

The PID will be equipped with 10.2-eV lamp. The 10.2-eV ionization potential will allow for the detection of benzene, toluene, ethylbenzene, and total xylenes, which have lower ionization potentials of 9.24, 8.82, 8.76 and 8.44-8.56, respectively.

Soil samples will be collected from the highest field screening detection interval or from immediately above the water table in each boring and submitted for laboratory analysis.

A summary of the collection methods as well as the number of samples per analyte for the entire investigation is shown in Table 2-1.

All monitoring wells will be constructed with a maximum of 10 feet of 2-inch, internal diameter (I.D.), 0.020-inch, machine-slotted, polyvinyl chloride (PVC) well screen and flush-threaded PVC riser. The annular space will be gravel packed with graded silica sand to a depth of at least 1 foot above the top of the well screen followed by a minimum 1-foot-thick bentonite pellet seal. The remaining annular space will be filled with a bentonite-cement grout. Each well will be completed at the land surface with a 6- or 8-inch-diameter utility-type, flush-mounted steel protective road box. The area around each well will be returned to its pre-existing condition after well installation has been completed.

The SUBASE Department of Public Works (DPW) will be contacted at least 10 days in advance of installation of monitoring wells. The DPW will be provided with documents indicating proposed well locations, well construction procedures and materials, and anticipated drilling schedule.

2.5.8 Monitoring Well Gauging and Sampling

Monitoring well gauging and groundwater sampling will be performed upon completion of well installation activities. Wells will be gauged using a petroleum/water interface probe, or a clear bailer, for the detection of separate-phase product. All monitoring wells which do not contain separate-phase product will be sampled. Section 3 contains sampling procedures for the collection of groundwater samples. Groundwater gauging will be conducted on a quarterly basis for one year to aid in determining potential seasonal variations in groundwater elevations and flow directions.

2.5.9 Elevation Survey

The top of the PVC well casing and ground surface elevation for each new monitoring well will be established relative to SUBASE Vertical Datum (SVD) by a Connecticut Certified Land Surveyor. The ground surface elevation at each punch sampling point will also be determined. The SVD is 1.321 feet below mean sea level (NGVD, 1929 with a 1967 adjustment).

2.5.10 In-situ Permeability Tests

In-situ permeability tests, (slug tests) will be conducted in selected monitoring wells (HNUS-4, 8, 12, 16, and 22) to determine hydraulic conductivity of the aquifer throughout the fuel farm. A determination of hydraulic conductivity is necessary in providing an estimate of groundwater and contaminant migration rates. These rates shall be used for the design of groundwater recovery and treatment system should remedial action be required.

Slug tests will be conducted using the rising-head method. This method is used when determining hydraulic conductivity in wells that are not screened across the entire thickness of the unconfined aquifer. The test is conducted by lowering a solid slug (constructed of Teflon®, PVC, or stainless steel) into the well and allowing the water level to equilibrate to static conditions. Once equilibrium conditions have been achieved, the test is initiated by quickly withdrawing the slug from the well. Removal of the slug rapidly displaces the column of water into the lower portion of the well, resulting in recharge from surrounding aquifer. The rate of recharge is recorded over time until the water level in the well has again achieved static conditions. These data will later be used in the calculation of hydraulic conductivity. For the tests proposed by Halliburton NUS, changes in water level will be recorded automatically using a pressure transducer and data logger. By using automatic measuring equipment, changes in water level can be recorded as frequently as 1-second intervals or less during the early part of the test.

Slug tests in fine to medium sand, such as those which exist in this area, typically require less than an hour for groundwater to return to the pre-test level. Monitoring of background wells for naturally-occurring fluctuation of groundwater elevation is not necessary because changes over the short time period are considered negligible. As previously explained in Section 1.6, there is no tidal influence.

Slug test data will be analyzed using the Bouwer and Rice method (or other approved method) to determine formation permeabilities in the immediate vicinity of the selected wells.

2.5.11 Equipment Decontamination

All sampling equipment will be decontaminated both prior to beginning field sampling and between samples. The following procedures will be used:

- Major sampling equipment (augers, split-spoons, etc.) will be decontaminated using steam cleaning equipment and potable water supplied by the SUBASE.

- All nondedicated sampling equipment will be decontaminated as described below:

  - Potable water rinse
  - Alconox or liquinox detergent wash
  - Generous potable water rinse
  - 10% Nitric acid rinse diluted with deionized water (when sampling metals)
  - Methanol rinse (when sampling organics, semivolatiles, pesticides or PCBs)

- Analyte-free water rinse
- Air dry
- Wrap in aluminum foil

Field analytical equipment such as pH, conductivity and temperature instrument probes will be rinsed first with analyte-free water, then with the sample liquid. All decontamination activities will be performed over a container, and fluids will be containerized for proper disposal.

2.5.12 Waste Handling

All decontamination and purge liquids will be collected, containerized, and stored on site in Department of Transportation (DOT)-approved (Specification 17-C), 55-gallon drums. All drill cuttings will also be collected and stored on site in the DOT-approved drums. All drums will be sealed and labeled with drum contents, well/boring number, site or origin, volume, and date. The drums will be stored at a centralized location on base pending analyses results. Halliburton NUS will dispose of the waste in an appropriate manner based on the analytical results.

2.6 TASK 6 - REPORT PREPARATION

Halliburton NUS will prepare a draft and final report. The final report will consider and incorporate the Navy's comments on the draft and will be in a format that is acceptable for submittal to USEPA. The report will be illustrated with clear, concise figures and maps, where appropriate. The report will include:

- Introduction
- Background
- Scope of Work
- Data Interpretation
- Boring and Well Logs
- Groundwater Flow Maps
- Site Map Showing All Sampling Locations
- Contaminant Distribution Map
- Contaminant Contour Map
- Cross Sections
- Tabulated Analytical Results

List of Applicable or Relevant and Appropriate Requirements (ARARs) Used in Evaluating the Data

- Slug Test Data
- GPR Survey Results
- Survey Data
- Water Level Measurement Records
- Soil-gas Survey Data
- Chain-of-Custody Forms
- Laboratory Analysis and QA/QC Data
- Conclusions and Recommendations

2.7 TASK 7 - PROJECT MANAGEMENT AND MEETINGS

The purpose of this task is to ensure completion of the project on-time and on-budget, provide oversight of project personnel, and ensure regular interaction with Navy personnel. This task includes general communication and coordination, financial management, and personnel and project scheduling. In addition to an initial project planning meeting, the Halliburton NUS project team will be available for public or private meetings to present and discuss results and recommendations.

TABLE 3-1

ANALYTICAL PROGRAM
TANK FARM, SUBASE-NLON, GROTON, CONNECTICUT

Parameter	Method[1]	Sample Type	Number of Environmental Samples	Total Trip Blanks[2]	Total Equipment Rinsates[3]	Total Field Blanks[4]	Total Field Duplicates[5]	Total Number of Samples Including Blanks
FUEL PIPELINES								
TPH	418.1	Soil	110		10		11	131
PIPELINE SEDIMENT								
Full Analysis	[6]	Sediment	10	2	2		1	15
TPH	418.1	Sediment	10		2		1	13
TANK OT-1								
BTEX + MTBE	8020	Groundwater	7	1				8
		Soil	5	1	2			8
TPH	418.1	Groundwater	7					7
		Soil	5		2			7
TANK OT-2								
BTEX + MTBE	8020	Groundwater	14	2			2	18
		Soil	6	1	3		1	11
TPH	418.1	Groundwater	14				2	16
		Soil	6		3		1	10
TANK OT-3								
BTEX + MTBE	8020	Groundwater	5	1				6
		Soil	3	1	1			5
TPH	418.1	Groundwater	5					5
		Soil	3		1			4
TANK OT-4								
Full Analysis	[6]	Groundwater	4	1				5
		Soil	3	1	1	1		6
TPH	418.1	Groundwater	4					4
		Soil	3		1	1		5

TABLE 3-1 (C ntinued)
ANALYTICAL PROGRAM
TANK FARM, SUBASE-NLON, GROTON, CONNECTICUT

Parameter	Method[1]	Sample Type	Number of Environmental Samples	Total Trip Blanks[2]	Total Equipment Rinsates[3]	Total Field Blanks[4]	Total Field Duplicates[5]	Total Number of Samples Including Blanks
TANK OT-5								
Full Analysis	[6]	Groundwater	2	1			1	4
		Soil	2	1	1		1	5
TPH	418.1	Groundwater	2				1	3
		Soil	2		1		1	4
TANK OT-6								
TPH	418.1	Groundwater	2					2
		Soil	4		1			5
TANK OT-7								
TPH	418.1	Groundwater	4				1	5
		Soil	3		1		1	5
TANK OT-8								
BTEX + MTBE	8020	Groundwater	9	2			1	12
		Soil	8	2	3		1	14
TPH	418.1	Groundwater	9				1	10
		Soil	8		3		1	12
TANK OT-9								
BTEX + MTBE	8020	Groundwater	6	2			1	9
		Soil	5	1	2		1	9
TPH	418.1	Groundwater	6				1	7
		Soil	5		2		1	8
LOADING AREA								
TPH	418.1	Soil	2		1			3

TABLE 3-1 (Continued)
ANALYTICAL PROGRAM
TANK FARM, SUBASE-NLON, GROTON, CONNECTICUT

Parameter	Method[1]	Sample Type	Number of Environmental Samples	Total Trip Blanks[2]	Total Equipment Rinsates[3]	Total Field Blanks[4]	Total Field Duplicates[5]	Total Number of Samples Including Blanks
SITE WIDE INVESTIGATION								
Full Analysis	[6]	Groundwater	22	6			1	29
		Soil	20	6	5		2	33
TPH	418.1	Groundwater	22				1	23
		Soil	20		5		2	27
SURFACE WATER AND SEDIMENT								
Full Analysis	[6]	Surface Water	3	1	1		1	6
		Sediment	4	1	1		1	7
TPH	418.1	Sediment	4		1		1	6

(1) Methodology as per the latest updates or revisions to the Contract Laboratory Program Statement of Work, Test Method for Evaluating Solid Waste (SW-846), or methods for the chemical analysis of water and wastes (e.g., 418.1).

(2) Trip Blanks - Samples which originate from analyte free water taken from the laboratory to the sampling site and returned to the laboratory with the volatile organic compound samples. One trip blank per cooler containing VOC samples. Trip blanks are analyzed for VOCs only.

(3) Rinsate blanks are collected at frequency of 1/sampling train/day. Per NEESA guidelines (20.2-047B; 6/88) only rinsates from every other day will be analyzed unless significant levels of contaminants are noted. Those rinsate blanks to be "held" will be marked accordingly on the chain-of-custody forms.

(4) Obtained at frequency of 1/source/event. One water source is applicable. All samples will be obtained in one field event. Consists of water sources used for decontamination. A sample of analyte-free water used to collect the rinsate blanks (i.e. sample acquisition blank) for the groundwaters and soils shall be collected as a field blank and analyzed for groundwater and soil aqueous analytical parameters.

(5) Field Duplicates - A single sample split into two portions during a single act of sampling. Assesses the overall precision of the sampling and analysis program. Obtained at a frequency of 10% of the number of samples.

(6) Full analysis includes TCL organics (VOCs, SVOCs, pesticides/PCBs)/TAL metals plus cyanide. See Table 3-2 of Work Plan for analytical methods.

Note: Matrix spike/matrix spike duplicate (MS/MSD) samples will be analyzed at a frequency of 1/20 for all samples.

TABLE 3-2

SUMMARY OF ANALYSIS, BOTTLE REQUIREMENTS, PRESERVATION REQUIREMENTS, AND HOLDING TIMES
TANK FARM, SUBASE-NLON, GROTON, CONNECTICUT

Parameter	Sample Container	Container Volume	Preservation[1]	Maximum Holding Time	Analytical Methodology[2]
AQUEOUS (GROUNDWATER AND SURFACE WATER)					
TCL Volatile Organic Compounds	Glass, septum-seal	(2) 40 mL	Cool to 4°C, dark, HCl to pH < 2	14 days	U.S. EPA-CLP SOW for Organic Analysis, Multi-Media, Multi-Concentration (Doc. OLM01.8) 5/90
TCL Semivolatile Organic Compounds	Amber glass, Teflon-lined cap	2000 mL	Cool to 4°C, dark	Extraction 7 days, analysis within 40 days	U.S. EPA-CLP SOW for Organic Analysis, Multi-Media, Multi-Concentration (Doc. OLM01.8) 5/90
TCL Pesticides and Polychlorinated Biphenyls (PCBs)	Amber glass, Teflon-lined cap	2000 mL	Cool to 4°C, dark	Extraction 7 days, analysis within 40 days	U.S. EPA-CLP SOW for Organic Analysis, Multi-Media, Multi-Concentration (Doc. OLM01.8) 5/90
TAL Metals	Polyethylene bottle, plastic cap, plastic liner	1000 mL	Cool to 4°C, HNO_3 to pH < 2	180 days; mercury 28 days	U.S. EPA-CLP SOW for Inorganic Analysis, Multi-Media, Multi-Concentration (Doc. ILM02.1)
Cyanide	Polyethylene bottle, plastic cap, plastic liner	1000 mL	Cool to 4°C, Na OH to pH > 12, $CaCO_3$ in presence of sulfide	14 days	U.S. EPA-CLP SOW for Inorganic Analysis, Multi-Media, Multi-Concentration (Doc. ILM02.1)
SOLID (SURFACE SOIL, SUBSURFACE SOIL, AND SEDIMENT)					
TCL Volatile Organic Compounds	Glass, polypropylene cap, white Teflon-liner	2 oz.	Cool to 4°C, dark	14 days	U.S. EPA-CLP SOW for Organic Analysis, Multi-Media, Multi-Concentration (Doc. OLM01.8) 5/90

TABLE 3-2 (C ntinued)
SUMMARY OF ANALYSIS, BOTTLE REQUIREMENTS, PRESERVATION REQUIREMENTS, AND HOLDING TIMES
TANK FARM, SUBASE-NLON, GROTON, CONNECTICUT

Parameter	Sample Container	Container Volume	Preservation[1]	Maximum Holding Time	Analytical Methodology[2]
SOLID (SURFACE SOIL, SUBSURFACE SOIL, AND SEDIMENT) (Continued)					
TCL Semivolatile Organic Compounds	Glass, Teflon-lined cap	4 oz.	Cool to 4°C, dark	Extraction 7 days, analysis within 40 days	U.S. EPA-CLP SOW for Organic Analysis, Multi-Media, Multi-Concentration (Doc. OLM01.8) 5/90
TCL Pesticides and Polychlorinated Biphenyls (PCBs)	Glass, Teflon-lined cap	4 oz.	Cool to 4°C, dark	Extraction 7 days, analysis within 40 days	U.S. EPA-CLP SOW for Organic Analysis, Multi-Media, Multi-Concentration (Doc. OLM01.8) 5/90
TAL Metals	Flint glass bottle, black phenolic cap, polyethylene liner	4 oz.	Cool to 4°C	180 days except mercury 28 days	U.S. EPA-CLP SOW for Inorganic Analysis, Multi-Media, Multi-Concentration (Doc. ILM02.1)
Cyanide	Polyethylene bottle, plastic cap, plastic liner	4 oz.	Cool to 4°C	14 days	U.S. EPA-CLP SOW for Inorganic Analysis, Multi-Media, Multi-Concentration (Doc. ILM02.1)
Total Petroleum Hydrocarbons (TPH)	Wide mouth glass	4 oz	Cool to 4°C	14 days	Methods for the Chemical Analysis of Water and Wastes EPA 600/4-79-020; rev. 1983 or most current

(1) $Na_2S_2O_3$ = Sodium Thiosulfate, Cl_2 = Chlorine, HCl = Hydrochloric acid, NaOH = Sodium Hydroxide.
(2) Methodology as per the latest updates or revisions to the Contract Laboratory Program Statement of Work, Test Methods for the Evaluation of Solid Waste (SW-846), or Methods for the chemical Analysis of Water and Wastes EPA 600/4-79-020; rev. 1983 or most current.