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Work Plan

for

Denitrification-Based Biodegradation Pilot Test Navy Exchange Service Station

Naval Air Station Brunswick, Maine

Engineering Field Activity Northeast Naval Facilities Engineering Command

Contract Number N62472-03-D-0057
Contract Task Order 014

November 2004

TETRA TECH NUS, INC.

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WORK PLAN

FOR

DENITRIFICATION-BASED BIODEGRADATION PILOT TEST NAVY EXCHANGE SERVICE STATION

NAVAL AIR STATION BRUNSWICK, MAINE

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

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TABLE OF CONTENTS

SECTION			PAGE
1.0	**INTRODUCTION**		**1-1**
	1.1	PILOT TEST OBJECTIVE	1-1
	1.2	WORK PLAN FORMAT	1-1
	1.3	PROJECT ORGANIZATION AND RESPONSIBILITIES	1-1
	1.4	PROJECT SCHEDULE	1-3
2.0	**BACKGROUND INFORMATION**		**2-1**
	2.1	SITE LOCATION AND DESCRIPTION	2-1
	2.2	SITE HISTORY	2-1
	2.3	NAVY EXCHANGE SERVICE STATION PILOT TEST AREA	2-2
	2.3.1	Topography	2-2
	2.3.2	Geology and Hydrogeology	2-2
	2.3.3	Contaminant Presence and Distribution	2-6
	2.4	FOCUSED FEASIBILITY STUDY	2-9
	2.5	CORRECTIVE ACTION PLAN	2-9
	2.6	DENITRIFICATION-BASED BIODEGRADATION PROCESS	2-10
	2.7	DATA QUALITY OBJECTIVES	2-12
	2.7.1	Statement of the Problem	2-12
	2.7.2	Identification of the Decision	2-12
	2.7.3	Inputs to the Decision	2-12
	2.7.4	Definition of the Pilot Test Boundaries	2-12
	2.7.5	Decision Rule	2-13
	2.7.6	Limits on Decision Errors	2-13
	2.7.7	Design for Obtaining Data	2-13
3.0	**FIELD SAMPLING AND ANALYSIS PLAN**		**3-1**
	3.1	INTRODUCTION	3-1
	3.2	FIELD INVESTIGATION ACTIVITIES	3-1
	3.2.1	Mobilization/Demobilization	3-1
	3.2.2	Utility Clearance	3-2
	3.2.3	In-Situ Permeability Testing	3-2
	3.2.4	Baseline Groundwater Sampling and Monitoring	3-3
	3.2.5	Periodic Groundwater Sampling and Monitoring	3-5
	3.2.6	Baseline Soil Sampling	3-6
	3.2.7	Periodic Soil Sampling	3-9
	3.2.8	Mini-Well Installation	3-10
	3.3	DBB PILOT TEST	3-11
	3.3.1	Microbiological and Biogeochemical Monitoring	3-12
	3.3.2	Major Additions, Field Measurements, and Sampling	3-14
	3.3.3	Minor Additions	3-15
	3.4	WELL LOCATION SURVEY	3-16
	3.5	INVESTIGATION-DERIVED WASTE (IDW) CHARACTERIZATION AND DISPOSAL	3-16
	3.6	DECONTAMINATION PROCEDURES	3-17
	3.7	SITE HEALTH AND SAFETY	3-18
4.0	**QUALITY ASSURANCE/QUALITY CONTROL PLAN**		**4-1**
	4.1	QUALITY ASSURANCE OBJECTIVES	4-1
	4.1.1	PARCC Parameters	4-1
	4.1.2	Quality Control Samples	4-3

TABLE OF CONTENTS (cont.)

SECTION		PAGE
4.2	PROJECT ACTION LIMITS AND METHOD DETECTION LIMITS	4-3
4.3	SAMPLE DESIGNATION AND CUSTODY	4-4
4.3.1	Environmental Samples	4-4
4.3.2	Sample Chain-of-Custody	4-5
4.4	CALIBRATION PROCEDURES	4-6
4.5	LABORATORY ANALYSIS	4-6
4.6	DATA REDUCTION, VALIDATION, AND REPORTING	4-6
4.7	INTERNAL QUALITY CONTROL	4-6
4.8	PERFORMANCE AND SYSTEM AUDITS	4-6
4.9	PREVENTATIVE MAINTENANCE	4-7
4.10	DATA ASSESSMENT PROCEDURES	4-7
4.10.1	Representativeness, Accuracy, and Precision	4-7
4.10.2	Analytical Data Review	4-8
4.11	CORRECTIVE ACTION	4-8
4.12	QUALITY ASSURANCE REPORTS/DOCUMENTS	4-8
5.0	**REPORTING**	**5-1**
5.1	LETTER REPORTS	5-1
5.2	PILOT TEST COMPLETION REPORT	5-1
6.0	**REFERENCES**	**6-1**

TABLES

NUMBER	
1-1	Proposed Project Schedule
2-1	Comparison of Microbial Electron Acceptors for Biodegradation of Petroleum Hydrocarbons
3-1	Baseline Soil and Mini-Well Sampling Locations
3-2	Periodic Soil and Mini-Well Sampling Locations
3-3	Field and Quality Control Sample Summary
3-4	Analytical Methods, Sample Container, Preservative, and Holding Time Requirements
4-1	Project Action Limits and Quantitation Limits – Groundwater
4-2	Project Action Limits and Quantitation Limits – Soil

FIGURES

NUMBER	
2-1	Site Location Map
2-2	Site Plan
2-3	Site Plan Showing Known Utility Locations
2-4	Interpreted Depth to Top of Clay Isolines
2-5	Cross Section A-A'
2-6	Cross Section B-B'
2-7	Cross Section C-C'

TABLE OF CONTENTS (cont.)

FIGURES (cont.)

NUMBER

2-8 Cross Section D-D'
2-9 Interpreted Groundwater Flow and Potentiometric Elevations
2-10 Saturated Zone Soil TPH-GRO Concentrations (mg/Kg) following In-Situ Chemical Oxidation Injection
2-11 Dissolved Phase TPH-GRO Concentrations (mg/L) following In-Situ Chemical Oxidation Injection
3-1 Mini-Well Construction Details
3-2 Proposed DBB Pilot Test Study Area

APPENDICES

A SELECTED STANDARD OPERATING PROCEDURES
B FIELD DOCUMENTATION FORMS
C HEALTH AND SAFETY PLAN
D MINI-WELLS DESIGN LETTER REPORT

LIST OF ACRONYMS

ACOE	U.S. Army Corps of Engineers
ARAR	Applicable or Relevant and Appropriate Requirement
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	Contaminant of Concern
DRO	Diesel Range Organics
EPA	U.S. Environmental Protection Agency
EPH	Extractable petroleum hydrocarbon
FFA	Federal Facilities Interagency Agreement
GRO	Gasoline Range Organics
IRP	Installation Restoration Program
MCL	Maximum Contaminant Level
MEDEP	Maine Department of Environmental Protection
MEG	Maximum Exposure Guideline (2000)
mg/kg	milligram per kilogram
mg/L	milligram per liter
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEX	Navy Exchange
NIOSH	National Institute for Occupational Safety and Health
NORTHDIV	Northern Division
OSHA	Occupational Safety and Health Administration
PAH	Polynuclear Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
POTW	Publicly-Owned Treatment Works
PPE	Personnel Protective Equipment
RCRA	Resource Conservation and Recovery Act
SARA	Superfund Amendment and Reauthorization Act
SVOC	Semivolatile Organic Compound
TCLP	Toxic Characteristic Leaching Procedure
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
TSDF	Treatment, Storage, and Disposal Facility
ug/Kg	microgram per kilogram
ug/L	microgram per liter
VOC	Volatile Organic Compound
VPH	Volatile petroleum hydrocarbon

1.0 INTRODUCTION

This Work Plan was prepared under the Comprehensive Long -Term Environmental Action Navy (CLEAN) Contract No. N62472-03-D-0057, Contract Task Order (CTO) 0014. The Scope of Work directs Tetra Tech NUS, Inc. (TtNUS) to perform a denitrification-based biodegradation pilot test at the Navy Exchange (NEX) Service Station located at the Naval Air Station in Brunswick, Maine. This Work Plan presents the objectives and technical approach to completing the pilot study.

1.1 PILOT TEST OBJECTIVE

The objective of the pilot test is to assess the effectiveness of the Geovation Technologies, Inc's Denitrification-Based Biodegradation (DBB™) process to mitigate sorbed-phase petroleum hydrocarbon contamination in the vicinity of the NEX Service Station at Naval Air Station Brunswick (NASB). One objective is to assess whether the site-specific remedial goal of 500 mg/Kg of gasoline range organics (GRO) can be achieved in the saturated overburden unit using the DBB process.

1.2 WORK PLAN FORMAT

Section 1.0 of this Work Plan presents the project organization and communication pathways, personnel responsibilities, and a process for revision to the Work Plan during field activities, if necessary.

Section 2.0 of this Work Plan presents the project planning and project definitions, site history, site location and description, contaminant presence and distribution in the proposed pilot test area, and the data quality objectives.

Section 3.0 presents the descriptions of data collection activities planned for the in-situ anaerobic biodegradation pilot study. These include objective for the field investigation design, descriptions of field investigation and pilot test efforts, sampling procedures, and analytical requirements.

Section 4.0 presents the Quality Assurance/Quality Control (QA/QC) Plan. This section includes the project quality objectives, project action limits, and measurement performance criteria. Also included in Section 4.0 are discussions of: sample collection documentation requirements; the sample identification system; sample handling and custody; analytical method requirements; sampling and analytical quality control; analytical documentation and data management; data validation and verification requirements and procedures; and QA assessment and management efforts.

Section 5.0 identifies the reports that will be produced as the result of the field program and the pilot test.

Section 6.0 presents references cited and used in preparing this Work Plan.

1.3 PROJECT ORGANIZATION AND RESPONSIBILITIES

TtNUS will be responsible for the overall management of the project, including the performance of field activities presented in this Work Plan.

Navy personnel from the Engineering Field Activity Northeast (EFANE) will be responsible for administrative and technical oversight of the program, and project management and coordination with

the state regulatory agency, while the Navy personnel from Naval Air Station Brunswick (NASB) will be responsible for on-site coordination with TtNUS.

Key Navy personnel supporting this project are as follows:

Brian Helland, Remedial Project Manager (RPM)
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Key TtNUS personnel supporting this project are as follows:

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The TtNUS Project Manager (PM) will have the primary responsibility for implementing and managing the investigation, and will also be responsible for notifying regulatory agencies of field activities or schedule modifications.

The Field Operations Leader (FOL) will be responsible for directing on-site field activities and will report directly to the PM. The FOL will coordinate efforts of the field sampling staff, the subcontractors, and the lead technical staff and will be responsible for identifying problem areas and bringing them to the attention of the PM for resolution.

The Project Manager will be responsible for reviewing the sampling program to ensure it is adequate to meet the objectives of the study and to develop the data required to assess the progress of the pilot study.

The Lead Chemist will advise the PM on technical requirements of the chemical data, prepare laboratory specifications for analysis of samples collected, oversee the subcontracted analytical laboratories, and review or oversee the validation of the analytical reports prepared.

The Lead Hydrogeologist will assist in planning the pilot test and advise the PM and FOL regarding the interpretation of the subsurface materials encountered, location of borings and mini-wells to be installed, and assessment of contaminant distribution during various phases of the pilot test. The Lead Hydrogeologist is a Certified Geologist (C.G.) in the State of Maine. Work plans, reports and report comments for subsurface investigation work for the pilot test will be reviewed by the Maine C.G..

The CLEAN Health and Safety Manager is responsible for reviewing health and safety plans for all CLEAN operations, and performs site audits to ensure compliance with program and site health and safety requirements.

The Project Quality Assurance Manager is responsible for QA/QC requirements for the TtNUS CLEAN project. This individual reviews data and deliverable documents, and performs system audits to ensure contract QA/QC goals are met.

A Site Safety Officer (SSO) will be designated prior to field activities and will be responsible for ensuring adherence to the site-specific Health and Safety Plan. The SSO reports directly to the CLEAN Health and Safety Manager and the PM.

In addition to the above personnel, TtNUS program personnel will provide overall support in subcontracting, cost tracking, progress reporting, and supervising the PM. The program personnel include:

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1.4 PROJECT SCHEDULE

A tentative project schedule has been developed and is presented in Table 1-1.

2.0 BACKGROUND INFORMATION

Overviews of the site description, pilot test area, site geology and hydrogeology, and the nature and extent of contamination are presented in this Section.

2.1 SITE LOCATION AND DESCRIPTION

NASB is located in Brunswick, Cumberland County, which is situated near the southern coastal area of Maine (Figure 2-1). NASB is situated just south of the Androscoggin River and is located north of several coves (Harpswell, Buttermilk, and Woodward), which connect with Casco Bay. NASB is located approximately 20 miles northeast of Portland. NASB is an active military base and is owned and operated by the federal government through the Department of the Navy.

The NEX Service Station (Building 538) is located within NASB and is situated just north of the intersection of Second Street and Burbank Avenue (Figure 2-2). The fueling island is situated just south of Building 538, and three underground storage tanks (USTs) are located east of the NEX Service Station. The NEX Service Station is bordered to the west by Second Street and the Public Works Department's vehicle motor pool. The NEX shopping complex (Building 11) is located approximately 100 feet northeast of the three USTs. To the north, Building 538 is adjoined to Building 295, the water pump house with a mounded water tank. The Family Services Center (Building 27) is situated approximately 100 feet southeast of the NEX Service Station, across Burbank Avenue.

Additional descriptions are presented in the *Corrective Action Plan* (EA, 2004) and the *Focused Feasibility Study* (EA, 2004).

2.2 SITE HISTORY

Gasoline odors were detected at the NEX Service Station in 1981. Petroleum product odors were then reported by the occupants of the Family Services Center (Building 27), situated downgradient of the NEX Service Station, in 1983. Periodic complaints concerning petroleum product odors ensued. Reportedly, there has been a history of problems associated with the petroleum product bulk storage at the NEX Service Station. Petroleum product releases appear to have been related to corroded steel product lines that were in use from 1975 through early 1992. There have been indications that additional gasoline releases may have occurred after the installation of the existing fiberglass USTs and product line system, which occurred in 1992 and 1993; however, these indications have not been confirmed (*Focused Feasibility Study* [FFS], EA 2004).

In 1987, NASB was placed on the National Priorities List by the U.S. Environmental Protection Agency (EPA) and is currently participating in the Navy's Installation Restoration Program.

Past remedial actions have included the installation of a groundwater recovery system in 1981 or 1984 to address gasoline odors in Building 25 and 27 (Building 25 has been demolished and removed). This recovery system was decommissioned during 1993. A soil vapor extraction/aquifer air sparing (SVE/AAS) system was installed in 1993 and operated continuously until March 2002. An estimated 11,000 pounds of petroleum hydrocarbons was removed by the SVE/AAS system. Other past response actions included the excavation and removal of approximately 400 tons of petroleum product-contaminated soil during replacement of the three steel USTs in 1992. Also in 1992, approximately 40 tons of petroleum product-contaminated soil were removed during the replacement of three buried, corroded steel product lines (FFS, EA, 2004).

While the SVE/AAS system had been effective in removing petroleum hydrocarbons, it appeared to be ineffective in addressing the residual sorbed-phase petroleum hydrocarbons in the saturated overburden unit. . Petroleum hydrocarbon removal had approached asymptotic conditions. Therefore, another remediation technology was considered and tested (FFS, EA, 2004). An in-situ chemical oxidation (ISCO) pilot test was performed during April and May of 2002 through the direct injection of hydrogen peroxide and an iron catalyst solution. Based on baseline sampling (March 2002) and post-application sampling (May and June 2002) results, it was determined that partial mobilization of sorbed-phase GRO occurred resulting in increased dissolved-phase GRO concentrations (by one to two orders of magnitude). Evaluation of the results concluded that the ISCO process' effectiveness would be limited by the excessive mass of sorbed-phase contamination present at test area, and that the high injection pressures would mobilize some of the contaminant mass, rendering the technology largely ineffective. The FFS determined that ISCO using hydrogen peroxide would not be a cost-effective option and that likely alterations of the subsurface geochemical conditions would render subsequent ISCO injections less effective.

A limited baseline biodegradation evaluation was performed in June 2003 to evaluate the site-specific biogeochemical conditions. The results of the study indicated that anaerobic and reducing conditions were dominant within the plume, the microbial populations were discernable in the source areas, and the presence of ammonium indicated that anaerobic processes via denitrification were occurring. These indications favored the anaerobic degradation of the petroleum hydrocarbons through the denitrification process. As a result, denitrification-based biodegradation was evaluated in the *Focused Feasibility Study* (EA 2004) and presented in the *Corrective Action Plan* (EA 2004) as the recommended remedial action.

2.3 NAVY EXCHANGE SERVICE STATION PILOT TEST AREA

Information concerning the NEX Service Station's topography, geology and hydrogeology, and extent of petroleum hydrocarbon contamination presented in either the *Focused Feasibility Study* or the *Corrective Action Plan* are presented as summaries or verbatim (as appropriate) in this section of the Work Plan.

2.3.1 Topography

Topography of the NEX Service Station area is generally flat, but gently slopes to the south-southwest towards the intersection of Burbank Avenue and Second Street. A small, steeply graded hill (approximately 8 feet total height) is situated north of the NEX Service Station, where the pump house and the water tank (Building 295) are located. On and directly adjacent to the NEX Service Station grounds are buried utilities and piping including water, storm sewer, sanitary sewer, natural gas, electronic data (fiber-optic and other), and steam. Several storm sewer and sanitary sewer lines traverse the southern portion of the NEX Service Station grounds. A water main extends across Second Street to a fire hydrant located at the southwestern corner of Service Station grounds, and a 1-inch water line reportedly runs from the Burbank Avenue water main due east of the former pump dispensers into the center of the NEX Service Station. Additionally, electrical service lines are located both overhead and below grade within the vicinity of the Service Station (Figure 2-3).

2.3.2 Geology and Hydrogeology

This section is provided verbatim from Section 2.1 of the *Corrective Action Plan* (EA 2004), to provide the most comprehensive descriptions of site geology and hydrogeology for planning purposes. Descriptions of the subsurface physical features, including geology and hydrogeology, are based primarily on the findings of monitoring well gauging and direct-push sampling investigations conducted by EA in March, May, and June of 2002 (EA 2002), as well as the June 2003 limited direct-push

investigation conducted at Building 27 (EA 2003a). Additional findings from previous investigations have been referenced, as appropriate (Figures 2-4 through 2-11).

From the *Corrective Action Plan*:

"Site Geology

Previously collected geologic and soil data indicate that unconsolidated, fine-grained sedimentary deposits comprise the shallow overburden geology below the NEX Service Station and Building 27. These deposits primarily consist of glacial outwash overlying the marine clay deposits of the Presumpscot Formation. The overlying outwash deposits primarily consist of fine-grained sands with varying amounts of medium and very fine sand, silt, and mica. The overlying outwash deposits are also characterized by thin lenses of finer-grained, poorly sorted deposits within the body of the unit and at the transitional contact with the underlying clay. The Presumpscot Formation is composed of stratified, water-laden clay, with trace amounts of silt, sand, and fine gravel (E.C. Jordan 1990), and is characterized by a gray to dark blue/gray color with variable thickness. The clay is reported to extend to a depth of approximately 93.5 ft below the NEX Service Station site, based on a geotechnical boring advanced adjacent to the NEX Service Station in 1974 (ERM 1992). This geotechnical boring also confirmed that the clay is underlain by a thin, poorly sorted till unit of variable thickness that directly overlies bedrock, which was encountered at approximately 95.5 ft below the NEX Service Station site.

Based on the subsurface investigation data collected at the NEX Service Station site as part of the ISCO-related direct-push sampling investigations conducted by EA in March, May, and June of 2002, and at Building 27 in June 2003, two unconsolidated units and two sub-units have been defined that characterize the site geology, including the following:

- Sand unit
- Silt sub-unit
- Interbedded sub-unit
- Clay unit.

These unconsolidated overburden units encountered beneath the site are briefly described as follows in general descending stratigraphic order:

- ***Sand Unit***—A moderately sorted, brown, tan and gray, fine to very fine-grained, micaceous sand with trace to little silt, and trace amounts of medium to coarse sand and fine gravel. This unit was encountered at all data points and is interpreted to be a continuous unit throughout the site. This unit, and the two sub-units described below, are largely characterized by the impacted soil and groundwater associated with the NEX Service Station.

- ***Silt Sub-Unit***—This sub-unit is contained within the body of the sand unit and at the transitional contact with the underlying clay unit. Where present, these thin lenses consist of brown to tan silt with little to some very fine sand, as well as trace amounts of clay and mica. This sub-unit occurs as a thin lens (less than 2-ft thick) within the body of the sand unit, and as a transitional unit at the contact with the underlying clay unit.

- ***Interbedded Sub-Unit***—This sub-unit is contained within the body of the sand unit and at the transitional contact with the underlying clay unit. Where present, these lenses consist of brown to tan fine-grained sand interbedded with thin seams of gray silt, and tan to gray clay, which appear as a varved/rhythmite glaciolacustrine sequence. This sub-unit occurs as a lens approximately 6-ft thick within the body of the sand unit, and as a transitional unit at the contact with the underlying clay unit. This sub-unit appears to occur only along the eastern and southern portions of the site, and corresponds with the shallow occurrence of the Presumpscot Clay (Figure 3) *[Figure 2-4 of Work Plan]*.

- ***Clay Unit***—A gray to bluish-gray marine clay with trace to some silt, which is referred to regionally as the Presumpscot Formation. This unit exhibits moderate plasticity and is interpreted to be a continuous unit throughout the site. Figure 3 *[Figure 2-4 of Work Plan]* depicts the depth to clay and corresponding saturated zone thickness (ft) as interpreted from the log of soil boring forms from previous investigations conducted in 2002 and 2003. The depth to clay is shallow along the eastern boundary of the site and increases in depth toward the west along Burbank Avenue, creating a trough that extends from the location of the existing gasoline USTs south, toward and beyond the foundation of Building 27. Due to its low permeability, this unit acts as a local aquitard that prevents groundwater and contaminant migration. The geometry of this unit appears to have a controlling influence on the lateral and vertical migration of total petroleum hydrocarbon (TPH)-gasoline range organics (GROs) downgradient of the NEX site."

"Based on the subsurface investigation data recently collected at the site during the ISCO-related direct-push sampling investigations conducted by EA in March, May, and June 2002, and the limited direct-push investigation conducted in 2003 at Building 27, 4 geologic cross-sections (A-A' through D-D') have been developed for the site, as shown on Figures 4 through 7*[Figures 2-5 through 2-8 of Work Plan]*. Cross-sections A-A' and D-D' trend north-south through the central axis of the two saturated zone source areas and show the distribution of geologic units along the eastern and western portions of the NEX Service Station site, respectively. Cross-sections B-B' and C-C' trend east to west, and show the distribution of geologic units along the northern and southern portions of the NEX Service Station site, respectively."

The four geologic cross-sections described in the <u>Corrective Action Plan</u> are:

- ***"Cross-Section A-A'***—Cross-section A-A' trends from north to south, from just south of the existing gasoline USTs toward Building 27 through the central axis of the UST-related source area. This cross-section shows that the sand unit varies in thickness across the transect, and is thicker to the north near the gasoline USTs. However, the sand unit thins out south of the northwest corner of Building 27, which corresponds with the shallow occurrence of the Presumpscot Clay shown on Figure 3 *[Figure 2-4 of Work Plan]*. Cross-section A-A' also shows the extent of the petroleum-impacted saturated zone soil, which generally extends from the high water table down to the top of the clay unit and is extensive throughout the UST-related source area from the gasoline USTs south to the northwest corner of Building 27.

- ***Cross-Section B-B'***—Cross-section B-B' trends from east to west, parallel to Burbank Avenue, from just south of the gasoline USTs toward the area just south of the fueling islands. This cross-section shows that the sand unit varies in thickness across the transect, and is thickest near the geographic center of the site. In addition, the cross-section shows two distinct troughs created by the shallow occurrence and steep rise of the top of clay to the east and again to the west near Second Street. These two troughs correspond with the occurrence of

petroleum-impacted saturated zone soil associated with the UST-related and fueling island source areas.

- ***Cross-Section C-C'***—Cross-section C-C' trends from east to west, south of Burbank Avenue and parallel to the northern foundation wall of Building 27. This cross-section shows that the sand unit varies in thickness across the transect, and is thickest to the west. In addition, this cross-section shows the shallow occurrence and steep rise of the clay to the east, near direct-push soil borings SDP-8 and SDP-9. Cross-section C-C' also shows the extent of the petroleum-impacted saturated zone soil, which extends from the water table down to the top of the clay unit, most notably at direct-push soil boring DP-19, which is upgradient and adjacent to Building 27.

- ***Cross-Section D-D'***—Cross-section D-D' trends from north to south through the central axis of the fueling island source area, originating just south of the fueling islands. This cross-section shows that the sand unit varies in thickness across the transect, and is thicker to the north, just south of the fueling islands. Cross-section D-D' also shows the extent of petroleum-impacted saturated zone soil, which extends from the water table down to the top of the clay unit and is extensive throughout the saturated zone in the fueling island source area."

The hydrogeology and groundwater flow as presented in the *Corrective Action Plan* are as follow:

"Site Hydrogeology and Groundwater Flow Patterns

Historically, groundwater contour data have shown a prominent flow pattern to the southwest across the NEX Service Station site. This prominent flow pattern is shown on Figure 8 *[Figure 2-9 of Work Plan]*, which was contoured to represent the most recently available groundwater gauging data at the site (11 June 2003). These data are presented and further discussed in the FFS (EA 2003a). The depth to groundwater at the site in June 2003 ranged from approximately 3.05 ft bgs (57.15 ft MSL) to approximately 8.05 ft bgs (58.21 ft MSL). Historically, seasonal fluctuations of the water table of up to several feet are common at the NEX Service Station, and the shallow groundwater table typically exhibits a shallow hydraulic gradient of approximately 0.010-0.011 ft/ft.

Historically, the saturated thickness of the water table in the sand unit has ranged from approximately less than 1 ft along the eastern sections of the NEX Service Station site to approximately 16 ft near the geographic center of the site at the fueling islands, as per data from previous direct-push investigations (EA 2002, 2003a). The saturated thickness is equal to or less than 1 ft in the eastern portion of the site and increases to the west, which corresponds with the shallow occurrence and steep rise of the top of clay to the east (EA 2003a). The saturated zone within the sand unit beneath the site is unconfined, and is bound by the underlying low permeability clay unit, which is considered to be a natural aquitard for the groundwater flow system and for the purposes of site remediation.

Hydraulic conductivity has been measured at the site based on slug test data collected from monitoring wells MW-4 and MW-5 (ERM 1992). The average hydraulic conductivity for the saturated zone within the sand unit, as calculated from hydraulic conductivity data for the shallow sand unit presented in the Final Supplemental Remedial Investigation Report for NAS Brunswick (E.C. Jordan 1991), was estimated to be 6.3×10^{-3} cm/sec. The hydraulic conductivity of the clay unit has been measured at 8.6×10^{-6} cm/sec."

2.3.3 Contaminant Presenc and Distribution

This section is provided verbatim from Section 2.2 of the *Corrective Action Plan* (EA 2004), to provide the most comprehensive descriptions of the source areas and the nature and extent of petroleum hydrocarbon contamination at the NEX Service Station for planning purposes. Descriptions of the presence and distribution of petroleum hydrocarbon, specifically the gasoline range organics (GRO), in soil and groundwater are based on various direct-push sampling investigations conducted by EA during 2002, and from pre-and post-in-situ chemical oxidation (ISCO) direct-push sampling performed in June 2003.

From Section 2.2 of the *Corrective Action Plan* (EA 2004):

> "This section provides a brief description of the current status of the nature and extent of soil and groundwater impacts present at the NEX Service Station based on previously completed sampling and remedial activities. This discussion primarily focuses on the nature and extent of sorbed-phase and dissolved-phase TPH-GRO impacts, as TPH-GRO is considered to be the primary contaminant of concern. Two separate and distinct sorbed-phase source areas have been identified at the NEX, including the: (1) fueling island source area, and (2) UST-related source area, both of which are likely related to gasoline releases associated with the former gasoline product lines and the USTs (prior to replacement), respectively. The baseline and post-ISCO saturated zone soil sampling data (EA 2002) indicate that significantly-impacted saturated zone soils are present below and to the southwest of the fueling island area and southwest of the UST area and near Building 27. The nature and extent of the sorbed-phase and dissolved-phase contamination at the NEX Service Station site are further detailed in the FFS (EA 2003a).
>
> #### 2.2.1 Fueling Island Source Area
>
> A separate residual source area with significant petroleum-impacted saturated zone soil is located directly south and downgradient of the existing fueling island area. The existence of this separate source area associated with the fueling islands is supported by analytical data from the ISCO-related direct-push investigations conducted in March, May, and June 2002 (EA 2002). The interpreted saturated zone soil TPH-GRO concentration isopleths for the fueling island residual source area are provided on Figure 9 *[Figure 2-10 of Work Plan]*. As indicated by the concentration isopleths, the interpreted residual source area (i.e., saturated zone soils with TPH-GRO concentrations in excess of 500 mg/kg) is likely to extend from below the fueling islands south-southwest toward the intersection of Burbank Avenue and Second Street.
>
> The downgradient limit of the fueling island source area appears to be located under Burbank Avenue, southwest of monitoring well MW-NASB-225. It was not possible to install direct-push borings below the fueling island canopy because the exact locations of existing product lines and electrical/data lines are not known. However, since the most likely source for petroleum hydrocarbon contamination south of the fueling islands has been identified as historical releases from the former product lines, and potential overfills during vehicle refueling, the interpreted source area concentration isopleths include the area directly below the current fueling islands. This interpretation will ultimately be confirmed as part of the recommended remedial action, discussed in Section 3. This location is considered to represent the northern extent of the fueling island source area. The eastern and western extents of the fueling island source area are well defined, based on direct-push soil borings installed during May and June 2002 as well as previously completed direct-push soil vapor and groundwater investigations (EA 1997).

The interpreted vertical extents of petroleum-impacted saturated zone soils associated with the fueling island source area are shown on geologic cross-sections B-B' and D-D' (Figures 5 and 7) *[Figures 2-6 and 2-7 of Work Plan]*, respectively. As indicated by cross-section B-B' (which passes through the center of the fueling island source area parallel to Burbank Avenue) and cross-section D-D' (which passes through the center of the fueling island source area in the direction of groundwater flow), both the field photoionization detector readings and subsequent analytical data indicate that contaminated saturated zone soil is present in the fueling island source area from the phreatic zone to the top of the marine clay layer (approximately 15-20 ft bgs).

2.2.2 Underground Storage Tank-Related Residual Source Area

The UST-related residual source area extends across Burbank Avenue as far south as the north foundation wall of Building 27 (and possibly below), and extends several feet along the western foundation wall of the building, as shown on Figure 9 *[Figure 2-10 of Work Plan]*.

The August 1999 direct-push investigation (EA 2000) identified the residual source of dissolved-phase petroleum hydrocarbons at the NEX Service Station to be associated with saturated zone soil adjacent to the southwest side of the existing UST area. The results of the baseline and post-ISCO direct-push sampling programs confirmed that significant petroleum-impacted saturated zone soil is located in this area; however, recent data indicated that the saturated zone soil concentrations are at least an order of magnitude greater than previously reported (i.e. approximately 5,800 mg/kg of TPH-GRO as compared to a concentration of 530 mg/kg of TPH-GRO). The recently completed direct-push investigations indicate that the extent of the petroleum-impacted source zone (i.e., saturated zone soil concentrations in excess of 500 mg/kg) extends from the southwest side of the existing UST area across Burbank Avenue to the northern and western foundation walls of Building 27. The highest TPH-GRO concentrations reported for saturated zone soil (8,830 mg/kg) and for groundwater (50 mg/L) were observed at 2003 direct-push location B27-DP1 and post-ISCO direct-push boring DP-19, respectively, both are located within approximately 15 ft of the northwest corner of Building 27.

Post-ISCO and 2003 direct-push soil sampling data provided on Figure 9 *[Figure 2-10 of Work Plan]* demonstrate separation between the saturated-soil source area associated with the former UST release and the source area associated with the fueling islands. The distinction between the two release areas is further evidenced by the dissolved-phase analytical data provided on Figure 10 *[Figure 2-11 of Work Plan]*.

As indicated in the geologic cross-sections, the source area contamination appears to include saturated zone soil from the groundwater interface (approximately 6-8 ft bgs) to the marine clay layer (approximately 20 ft bgs). There was no apparent vertical concentration trend, with nearly uniform petroleum-impacted soil concentrations reported from the groundwater interface to the top of the marine clay layer at most direct-push locations.

2.2.3 Dissolved-Phase Contamination

This subsection provides a brief summary of dissolved-phase impacts at the NEX Service Station site. The interpreted extent of petroleum-impacted groundwater is based primarily on the March, May, and June 2002 direct-push investigations, and the June 2003 limited direct-push investigation, and is supported by relevant analytical data collected prior to 2002.

The interpreted dissolved-phase TPH-GRO concentration isopleths are provided on Figure 10. **A comparison of the residual saturated zone soil source areas (Figure 9 *[Figure 2-10 of Work Plan]*) to the dissolved-phase concentration isopleths indicate that impacted groundwater is directly related to the contaminant mass present in saturated zone soil.** Petroleum mass estimates indicate that the mass of residual gasoline-related compounds associated with saturated zone soil in the fueling island and UST-related residual source areas is approximately 10,640 lb. The estimated mass of residual gasoline-related compounds present in groundwater is estimated at 45 lb, which is less than 1 percent of the total mass. **Groundwater impacts are believed to be the result of diffusion-related concentrations associated with surrounding saturated zone soil contamination, which serves as an ongoing source for dissolved-phase petroleum hydrocarbons.** Groundwater monitoring data indicate limited potential for offsite migration of dissolved-phase contaminants as the groundwater plume has not been increasing with time.

Based on the relative mass of dissolved-phase contaminants versus sorbed-phase contamination, and the correlation of dissolved-phase contamination to the residual sorbed-phase source areas, it is apparent that remediation (i.e., via natural attenuation) of contaminated groundwater at the NEX Service Station can be completed only after successful removal of sorbed-phase petroleum hydrocarbons from the fueling island and UST-related source areas.

2.2.4 Nature of Contamination

Petroleum contamination at the NEX Service Station appears to consist primarily of residual, weathered gasoline constituents, resulting from leaking product lines during the period 1980-1992. Additional gasoline releases may have occurred since installation of the new fiberglass UST system in 1993; however, insufficient information is currently available to evaluate the petroleum bulk storage history during the period of 1993-2002. Minor releases of petroleum to groundwater appear to have occurred since 1997, possibly due to installation of subsurface sparge points, which mobilized sorbed-phase petroleum, or possibly due to minor undocumented surface spills. Other than gasoline range hydrocarbons (TPH-GRO), additional potential contaminants of concern associated with historical gasoline releases are lead and methyl tertiary-butyl ether.

Based on existing data and as discussed in the Environmental Site Evaluation Summary Report (EA 2002) and FFS (EA 2003a), lead and methyl tertiary-butyl ether do not appear to be a major concern for site soil or groundwater. The low detection frequency for lead at the NEX Service Station, and the relatively low reported concentrations which were within typical background levels, suggest that historic gasoline releases occurred following the phase-out of leaded gasoline (approximately 1980) in the Brunswick, Maine area. It is believed that residual contamination at the NEX Service Station consists of weathered gasoline, the majority of which is associated with saturated zone soil in the fueling island and UST-related source areas. Exceedances of the most stringent Maine Department of Environmental Protection (MEDEP) cleanup goals for TPH-GRO and several specific gasoline-related volatile organic compounds are typically reported within or adjacent to these residual source areas. The primary contaminants of concern at the NEX Service Station include TPH-GRO and benzene, toluene, ethylbenzene, and total xylene constituents.

The estimated mass of petroleum hydrocarbons in saturated zone soil within the fueling island and UST-related source areas is currently estimated to be approximately 10,640 lb, of which approximately 3,300 lb (31 percent) are estimated to be present in the fueling island source area and approximately 7,340 lb (69 percent) are estimated to be present in the UST-related source

area. Calculations for this estimate are provided in Appendix C of the Environmental Site Evaluation Summary Report (EA 2002)."

2.4 FOCUSED FEASIBILITY STUDY

A *Focused Feasibility Study* (EA 2004) was prepared by EA Engineering, Science, and Technology, Inc. to develop and evaluate remedial alternatives that address petroleum hydrocarbon contamination present as residuals in the sorbed-phase and dissolved-phase media at the NEX Service Station. The remedial alternatives were assembled based on information developed during previous site investigations and remedial/response activities at the site, and to address specific contamination associated with the NEX Service Station. Remedial alternatives were developed to address two separate goals (where practicable):

1. Immediate remediation of petroleum hydrocarbon contamination present at the northwest corner of the Family Services Center (Building 27) and the elimination of potential vapor intrusion into the building.

2. Remedial action and monitoring goals to address the residual sorbed-phase and dissolved-phase hydrocarbon contaminants at the NEX Service Station.

The FFS also summarized the results of the ISCO pilot test performed in 2002, and the results of a limited baseline biodegradation investigation completed during 2003. The FFS concluded that ISCO using hydrogen peroxide would not be a cost-effective technology for the site. The baseline biodegradation investigation evaluated the biogeochemical conditions at the NEX Service Station that could support anaerobic biodegradation. The investigation included the collection of groundwater samples and the analysis for: indigenous microbial population, availability of electron acceptors, growth nutrients, and biogeochemical parameters. The FFS concluded that the site-specific data indicated favorable conditions for anaerobic biodegradation.

Five remedial alternatives were considered including: soil vapor extraction/aquifer air sparging, in-situ chemical oxidation, excavation, denitrification-based bioremediation, and denitrification-based bioremediation and selective excavation.

The last alternative, denitrification-based bioremediation and selective excavation was selected as the most aggressive and cost-effective treatment of saturated and vadose-zone soil contaminated by sorbed-phase petroleum hydrocarbons.

2.5 CORRECTIVE ACTION PLAN

The *Corrective Action Plan* (CAP) (EA 2004) was developed to support the Navy's overall strategy to address residual sorbed-phase and dissolved-phase petroleum hydrocarbon contamination associated with the NEX Service Station. The CAP was developed based on the conclusions and recommendations of the *Focused Feasibility Study* (EA 2004) and the findings and conclusions of the *Environmental Site Evaluation Summary Report* (EA 2002).

The purpose of the CAP was to detail the activities associated with the FFS' recommended remedial alternative for implementation at the NEX Service Station to mitigate contamination in saturated soil. The proposed remedial action includes DBB treatment of residual saturated zone sorbed-phase and dissolved-phase petroleum hydrocarbon contamination at the site, and selective removal of vadose zone

soil in conjunction with the tank removals to remediate soil above the water table. This proposed remedial action will be implemented to achieve two Remedial Action Objectives (RAOs):

1. Short-term remediation of petroleum hydrocarbon contamination present at the northwest corner of the Family Services Center (Building 27) and the elimination of potential vapor intrusion into the building.

2. Long-term remedial action and monitoring goals to address the residual sorbed-phase and dissolved-phase hydrocarbon contaminants at the NEX Service Station.

The CAP presents a proposed pilot test to evaluate the effectiveness of the DBB process and its ability to achieve the site-specific clean-up goal of 500 mg/Kg GRO in saturated soil in one portion of the UST-related residual source area.

2.6 DENITRIFICATION-BASED BIODEGRADATION PROCESS

The degradation of organic compounds by microorganisms occurs in the natural environment. The degradation process breaks down complex organic compounds to produce materials and energy that are used by the microorganisms for growth and reproduction. Bioremediation utilizes biodegradation processes to decompose toxic chemicals into simpler and less-toxic or non-toxic components. Biodegradation may be mediated through either aerobic or anaerobic processes by various microorganisms using available electron donors and receptors present in the environment. Biodegradation activity in the subsurface can be stimulated through the addition of electron acceptors while electron donors are already present as environmental contaminants. Table 2-1 presents a list of electron acceptors that can be used by various microorganisms to degrade petroleum hydrocarbons.

Table 2-1 provides a summary of microbial degradation processes including aerobic respiration and anaerobic metabolic processes (i.e., denitrification; manganese, iron, and sulfate reduction; and methanogenesis). During biodegradation, any of these metabolic pathways may contribute to the overall mineralization of contaminants. Facultative bacteria (i.e., organisms able to metabolize hydrocarbons in both aerobic and anaerobic environments) typically utilize available electron acceptors preferentially according to energy available per mole, beginning with oxygen (aerobic respiration) and proceeding in order through nitrate reduction, iron reduction, and sulfate reduction. In oxygen-depleted environments, methanogenic bacteria may utilize carbon dioxide as an electron acceptor, resulting in the production of methane gas (FFS, EA 2004).

The Denitrification-Based Bioremediation™ process to be evaluated in the proposed pilot test is a patented anaerobic biodegradation process owned by Geovation Technologies, Inc. of Florida, New York. DBB consists of the injection of nitrate-based reagents that provide electron acceptors and nutrients to promote the anaerobic degradation of organic compounds in soil and groundwater. Denitrification occurs when nitrate is used as an electron acceptor for the microbial metabolic processes and degradation of petroleum hydrocarbons. The byproducts of denitrification of petroleum hydrocarbons include carbon dioxide, water, and inert nitrogen gas. As presented in the FFS, the June 2003 assessment of the biodegradation potential and microbial analyses indicate that current site conditions are favorable for anaerobic biodegradation of petroleum hydrocarbon contaminants including gasoline components (i.e. GRO).

As presented in Table 2-1, denitrification offers relatively a high Gibbs Free Energy value, in comparison with other biodegradation processes. Based on the stoichiometry, it is evident that the greater the number of electron acceptors present, the greater the mass of hydrocarbons that can degraded.

Comparison of the solubility values indicates that nitrates are highly soluble and more moles can be applied into groundwater than the other electron acceptors. DBB, using the proprietary N-Blend nitrate-based reagent, can provide much higher concentrations of electron acceptors than other compounds. Therefore denitrification is more likely to mitigate large residual hydrocarbon masses because of nitrate solubility (>600,000 mg/L). The solubility of nitrate also allows for subsurface diffusive flux that would be sufficient to transfer the nitrate-based reagent electron acceptor to otherwise inaccessible areas, such as contamination located below building foundations or subsurface utilities (i.e., in the vicinity of Building 27). Diffusion of nitrate-based electron acceptor solutions has been found to exceed advective forces in certain instances.

As presented in Table 2-1, the Gibbs Free Energy values for aerobic respiration and denitrification are similar, both being greater than the other biodegradation processes presented, and would therefore be preferred for microbial metabolic processes. Both oxygen and nitrate are excellent electron acceptors that may be used for biodegradation. However, the solubility of dissolved oxygen (6-9 mg/L) is relatively low when compared with nitrate's (>600,000 mg/L) and may restrict aerobic biodegradation at sites where significant residual hydrocarbon mass is present (i.e., the NEX Service Station), or where remedial target locations are not readily accessible, such as below building foundations (i.e. Building 27).

At sites with elevated sorbed-phase or dissolved-phase petroleum hydrocarbons mass, the available subsurface dissolved oxygen may be quickly depleted because of the stoichiometric demand for electron acceptors. Maintaining the dissolved oxygen concentrations may be difficult due to its limited solubility. Nitrate can be introduced and maintained at much higher concentrations than oxygen, providing more electron acceptors. Nitrate introduced at high concentrations can establish a strong diffusive mass flux so that the nitrate-based electron acceptor reagent can be dispersed to portions of the treatment area where injection points cannot be installed (i.e., adjacent to or under below building foundations and utility lines).

Due to the greater available metabolic energy associated with denitrification relative to other anaerobic metabolic processes, facultative bacteria preferentially utilize nitrate as an electron acceptor in the absence of oxygen or when insufficient oxygen is available for substrate (i.e., petroleum hydrocarbon) degradation. During June 2003, water quality parameters measurements indicated that the sorbed-phase contaminant source area and locations immediately downgradient of the NEX Service Station had reduced oxygen concentrations relative to upgradient sampling locations (i.e., monitoring wells MW-NASB-23). Within and downgradient of the sorbed-phase contaminant source area, the dissolved oxygen concentrations were in the 1 mg/L range. These measurements are typical for anaerobic sites, where the oxygen demand posed by the residual petroleum contamination had nearly depleted the available dissolved oxygen. Based on water quality parameters measured at upgradient monitoring well MW-NASB-23, the background dissolved oxygen concentration at the NEX is estimated to be greater than 4-5 mg/L (FFS, EA 2004).

Because the dissolved oxygen has been essentially been depleted within the remedial target area, the FFS concluded that denitrification would be established as the preferred metabolic pathway by existing facultative bacteria. The available water quality parameter data and the microbial analyses results compiled during June 2003 suggest that facultative bacteria are active at the site. Redox and pH measurements collected during well purging in June 2003 are also indicative of anaerobic conditions under which iron reduction was occurring. The depleted oxygen conditions and presence of an established facultative microbial population indicate that conditions are favorable for DBB at the NEX Service Station.

DBB is considered to be an innovative remedial technology and the performance of the pilot test would assess the effectiveness of the treatment prior to designing a full-scale treatment program for the

remainder of the petroleum hydrocarbon contamination. The CAP indicated that priority would be given to the area immediately upgradient of (and below) the northwest foundation corner of Building 27 during DBB treatment.

2.7 DATA QUALITY OBJECTIVES

The data quality objectives (DQOs) for the pilot test were developed in accordance with the EPA Guidance for Data Quality Objectives (EPA G4 document). The G4 document suggests seven steps be followed to develop project DQOs.

The intended use of the data resulting from pilot test is the primary determining factor in defining the DQOs for that data. To be certain that the data are consistent with the goals of the pilot test, the seven steps of defining DQOs are presented in this section.

2.7.1 Statement of the Problem

The effectiveness of the Geovation Technologies, Inc's Denitrification-Based Biodegradation™ process to reduce sorbed-phase petroleum hydrocarbon contamination in the vicinity of the NEX Service Station at NASB to the site-specific remediation goal of 500 mg/Kg GRO is unknown. This pilot test investigation will focus on the GRO presence and distribution in the pilot test area before and after the pilot test.

2.7.2 Identification of the Decision

After the completion of this pilot test, the effectiveness of DBB on GRO-contaminated soil will be determined and the decision to proceed to a full-scale remediation will be made.

2.7.3 Inputs to the Decision

Inputs to the decision are the elements used in the decision process. Inputs to the decision as stated in Section 2.8.2 are as follow:

- Baseline saturated soil and groundwater GRO concentrations in the pilot test area.
- Baseline biogeochemical conditions in the pilot test area.
- Periodic saturated soil and groundwater GRO concentrations in the pilot test area after addition of nitrate-based reagents.
- Periodic biogeochemical conditions in the pilot test area after addition of nitrate-based reagents.

GRO concentrations will be used to determine achievement of the site-specific clean-up goal of 500 mg/Kg. Biogeochemical parameters will be used to assess the status of microbial community activity.

2.7.4 Definition of the Pilot Test Boundaries

The pilot test boundaries encompass one portion of the interpreted UST-related residual source area located south of the NEX Service Station, adjacent to the Family Services Center. The target depth shall

extend from the top of the mean high water table (approximately 5 - 6 feet below ground surface [bgs]) to the top of clay (approximately 15 – 20 feet bgs).

2.7.5 Decision Rule

The decision rule is a clear statement defining the requirements of the pilot test based on the possible outcomes. For this Work Plan, the decision rule shall be if reduction of sorbed-phase GRO concentration to 500 mg/Kg is achieved, then full-scale implementation using DBB for the remainder of the residual source areas will be viable. If reduction of GRO does not achieve the 500 mg/Kg GRO goal, then the data will be evaluated to assess whether additional nitrate reagent applications may be required or the pilot test should be terminated.

2.7.6 Limits on Decision Errors

Biogeochemical data collected during June 2003 indicate conditions that are favorable to biodegradation using nitrate. Key decisions for the successful implementation of the in-situ anaerobic degradation is the application of appropriate doses of the nitrate-based reagent to promote growth of the appropriate microbial populations. Field measurements will be made to ascertain the abundance of the microbial community and their activity, and the allocation of appropriate reagent doses. If the reagent dose is biased low, there may be insufficient microbial growth and activity. If the reagent dose is biased high, unexpended reagent may migrate away from the pilot test area. The decision errors may be minimized by periodic gauging of microbial population activity and adjusting the nitrate reagent doses to be applied.

2.7.7 Design for Obtaining Data

The DQO process presented in the G4 document describes the use of various statistical approaches for developing a database. These approaches are based on contaminant distributions and outputs of the previous steps. A statistical approach was not used for development of the sampling plan. Rather, as detailed in Section 3, this Work Plan is intended to assess the GRO concentrations only within the pilot test area. It is anticipated that with the reduction of residual GRO in saturated soil, a concomitant reduction of GRO in groundwater concentrations will likely occur. This pilot test was designed based on previously acquired data and the expectation that current site conditions are favorable for denitrification-based biodegradation. Specifics of the data collected are described in the Quality Assurance/Quality Control Plan, presented in Section 4 of this Work Plan.

3.0 FIELD SAMPLING AND ANALYSIS PLAN

This section presents a description of the field investigation activities that are planned for the DBB pilot test at the NEX Service Station.

Several field tasks were completed after the *Draft Work Plan* was reviewed by the MEDEP and review comments had been resolved, in order to accelerate the project schedule so that nitrate reagent applications could be implemented before unfavorable seasonal conditions occurred. For the activities already completed, the *Final Work Plan* text reflects how work was actually completed on site.

3.1 INTRODUCTION

The objective of the field investigation is to implement and monitor a DBB pilot test. This includes conducting an in-situ permeability test, baseline and periodic soil and groundwater sampling, and mini-wells installation. The overall goal is to demonstrate the effectiveness of the DBB technology and determine whether the site-specific remedial goal of 500 mg/Kg in sorbed-phase saturated zone soil can be attained. The following sections detail the sampling activities that comprise the DBB pilot test as described under this Work Plan.

The pilot test shall be implemented by the technology owner, Geovations Technology, Inc., which is a subcontractor to TtNUS. TtNUS shall provide for oversight of the Geovation activities. TtNUS shall perform all field investigation activities itemized in Section 3.2, with the exception of the DBB pilot test. For the pilot test, Geovation shall perform the microbiological and biogeochemical monitoring (see Section 3.3.1) and the Major Addition events (Section 3.3.2) of N-Blend nitrate reagent. TtNUS shall perform the Minor Addition Events (Section 3.3.3).

3.2 FIELD INVESTIGATION ACTIVITIES

The field investigation activities consist of the following subtasks:

- Mobilization
- Utility Clearance
- In-situ Permeability Testing
- Baseline Groundwater Sampling and Monitoring
- Periodic Groundwater Sampling and Monitoring
- Baseline Soil Sampling
- Periodic Soil Sampling
- Mini-Wells Installation
- DBB Pilot Test
- Sample location survey
- IDW characterization and disposal
- Demobilization

3.2.1 Mobilization/Demobilization

As part of mobilization activities, technical specifications for drilling, surveying, and sample analysis subcontracts shall be prepared and issued. Required field equipment and supplies shall be ordered and

mobilized to the Site. Field team members shall review this Work Plan, applicable Standard Operating Procedures (SOPs, included as Appendix A), applicable Field Documentation Forms (Appendix B), the Health and Safety Plan (Appendix C), and applicable subcontract specifications. A field team orientation meeting shall be conducted prior to initiating the fieldwork to familiarize the field team and subcontractor personnel with the Site's health and safety requirements and the scope of the field activities. TtNUS and subcontractor mobilizations shall be coordinated with the Naval Air Station's Pass Office a minimum of 1 week in advance of the proposed field activities initiation.

3.2.2 Utility Clearance

TtNUS and the NASB shall be responsible for obtaining clearance of all underground utilities at all drilling locations prior to mobilizing drilling equipment. No subsurface investigation shall be performed without underground utility clearances, which must be obtained at least 72 hours prior to beginning onsite work. The following procedure was implemented to obtain utility clearance:

- TtNUS staked the area to be investigated with white grade stakes.
- TtNUS notified Maine Dig Safe at least 72 hours prior to beginning onsite work.
- TtNUS received a ticket number along with a date active for this request.
- TtNUS provided the Dig Safe ticket number, the date active, the number of borings and depth below ground surface to be investigated, the date work shall begin, and a figure clearly marking the area of the subsurface investigation to the appropriate NASB personal (Mr. Anthony Williams and Mr. Blaise Horsman).
- Once this information was received at NASB, the appropriate NASB personnel shall provided the signature(s) of approval for work to proceed.

Based on the review of available drawings and files and inspection of actual features (i.e., number of wells, access hatches to existing SVE and ISCO treatment infrastructure) in the pilot test area, discrepancies were noted.

A utility clearance subcontractor (Hager-Richter Geoscience of Salem New Hampshire was employed by TtNUS to assess and evaluate the pilot test area during August 2004. Two complementary geophysical survey methods, precision utility location (PUL) and ground penetrating radar (GPR) were used to evaluate the pilot test area. Results of the utility clearance survey are presented in the *Mini-Wells Design Letter Report* (TtNUS, September 15, 2004), which is included in Appendix D and in Figure 2-3 of the Work Plan. The data developed was used to select locations for drilling and mini-wells.

3.2.3 In-Situ Permeability Testing

The objective of this task was to determine the in-situ permeability (hydraulic conductivity) of the soil in the proposed pilot test area. This test was performed prior to direct-push technology (DPT) soil sampling and mini-well installation. Data generated was used to design the mini-wells to be installed for application of the N-Blend solution during the DBB pilot test.

The in-situ permeability tests was performed at seven existing monitoring wells and mini-wells located at the proposed test area. The wells to be tested was determined in the field based on the physical condition of the monitoring wells. Both "slug in" and slug out" tests were performed to estimate the

hydraulic conductivity of the overburden materials. The hydraulic conductivity test results were evaluated along with the utility clearance survey results to aid the design of the mini-wells (for reagent application wells) to be used for adding the nitrate-based amendments. A 0.7-inch diameter electronic transducer and data logger were used to record the changes in groundwater level in the monitoring wells during the slug test. The slug tests were continued until static levels in the wells were reached or for a period of 1 hour. The slug and pressure transducer were decontaminated between wells to prevent cross-contamination.

In-situ permeability tests were performed in the following wells located within or adjacent to the proposed pilot test area:

- MW-SDP-5
- MW-B-27-DP2
- MW-DP9
- MW-B-27-DP4
- MW-NASB-226 (replacing MW-NASB-225 [dry])

Both MW-NASB-24 and MW-NASB-25 were determined to be unsuitable for hydraulic conductivity testing because water levels did not recover after the slug removal, which indicated that the wells were in poor communication with the aquifer. MW-DP19 was unusable as it was filled with soil.

The data collected were evaluated using Hvorslev's method rather than the Bower and Rice method because the tops of the well screens extended above the water table.

Results of the hydraulic conductivity testing are presented in the *Mini-Wells Design Letter Report* (TtNUS, September 15, 2004), which is included in Appendix D.

3.2.4 Baseline Groundwater Sampling and Monitoring

The objective of the baseline groundwater sampling and monitoring program is to establish a set of baseline groundwater conditions prior to the DBB pilot test. Groundwater samples were collected from 10 existing monitoring and mini-wells (MW-DP1, MW-DP-2, MW-B-27-DP4, MW-DP9, MW-DP13, , MW-SDP5, MW-NASB24, MW-NASB-25, MW-NASB-26, and MW-NASB-23) for chemical analysis. The locations of these wells are depicted in Figure 1-2. Baseline sampling locations and analytical parameters of interest are identified in Table 3-1.

All wells were sampled during the baseline groundwater monitoring sampling event following the EPA Region 1 procedure for *Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells* (EPA SOP No. GW 001) (Appendix A).

- Peristaltic pumps and dedicated ¼-inch inner diameter [I.D.] Teflon-lined tubing shall be used to purge the wells. This shall involve starting the pumps at their lowest settings and slowly increasing the pumping rates until discharge occurs. Wells shall be purged at flow rates between 100 and 400 mL/min.

- The pump shall be operated at the lowest setting that shall minimize drawdown to a maximum of 0.3 feet. If drawdown exceeds 0.3 feet, then purging shall continue at 100 mL/min (or the lowest possible setting above 100 mL/min that allows water to flow out of the well).

- If while purging at the lowest setting the drawdown exceeds 0.3 feet and continues dropping until the screen interval becomes exposed, the well shall be evacuated dry. A grab sample shall then be collected after the well has recovered sufficiently to allow collection of the appropriate volume needed for the sample analyses.

- The water level, pumping rate, turbidity, DO, ORP, specific conductance, temperature, pH, and observations shall be recorded every 3 to 5 minutes (or as appropriate). The groundwater parameters shall be measured using a Horiba U-22 multi-parameter meter along with a separate turbidity meter. Stabilization shall be considered to be achieved when three consecutive readings, taken at 3 to 5-minute intervals, are within the following limits:

    - Turbidity (10 percent for values greater than 5 NTU)
    - Dissolved oxygen (10 percent)
    - Specific conductance (3 percent)
    - Temperature (3 percent)
    - pH (+/- 0.1 unit)
    - Oxidation-reduction potential (ORP) (+/-10 millivolts)

- Regardless of the method used to purge the well, groundwater samples shall be obtained from the sample tubing filled with water to the sample point and free of air bubbles or air pockets to minimize changes in the water chemistry upon contact with the atmosphere.

During the August 2004 baseline groundwater sampling event, samples were submitted for the analysis of:

- Gasoline Range Organics
- BTEX/MTBE
- Nitrates/Nitrites
- Inorganic Geochemical Parameters (including Fe, Mn, K, Mg, Ca, hardness), Total Inorganic Carbon (TIC), and ammonia.

All chemical analyses were performed by a laboratory approved by the State of Maine.

Quality assurance/quality control (QA/QC) samples were collected including field duplicates, laboratory QCs, and trip blanks. Table 3-3 presents the field and quality control sample summary. Table 3-4 presents the analytical methods, sample container types, preservative requirements, and the maximum holding times for the associated analyses. A "Low Flow" Groundwater Sample Log Sheet for Liquid phase was completed for each groundwater sample collected (Appendix B). Information recorded include that specified for the EPA low-flow sampling procedure and type of analysis performed.

Three new monitoring wells (MW-300, MW-301, and MW-302) were installed during September 2004 (see section 3.2.8). The supplemental monitoring wells are located in the downgradient portion of the plume or outside of the plume and will be used to monitor potential migration of nitrates or other groundwater contaminants outside of the pilot test area. Baseline sampling was performed during October 2004 for these wells and samples were submitted for the analysis of:

- Gasoline Range Organics

- BTEX/MTBE
- Nitrates/Nitrites

3.2.5 Periodic Groundwater Sampling and Monitoring

The objective of the periodic groundwater sampling and monitoring program is to monitor the in-situ biodegradation process and health of the biological community. The periodic groundwater sampling is expected to be performed at approximately 6 months, 12 months, and 18 months after the start of the DBB pilot test. The locations of these wells are depicted in Figure 3.1. Periodic sampling locations and analytical parameters of interest are identified in Table 3-2.

Groundwater samples shall be collected from a total of 10 wells as follows:

- Two wells located in the DBB pilot test plume area (DB-10 and MW-300 (which replaced MW-DP-19)
- One well located downgradient of the DBB pilot test plume area (MW-301, which replaced MW-NASB-25), and
- Seven out of the 12 mini-wells installed during the baseline soil sampling event.

The seven mini-wells to be sampled during the periodic groundwater sampling event shall be chosen based on the baseline soil and groundwater analytical results. These sample locations may also be modified based on actual field conditions.

For all wells to be sampled during the periodic groundwater monitoring sampling events, the EPA Region 1 procedure for *Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells* (EPA SOP No. GW 001) shall be followed as discussed in Section 3.2.4 (Appendix A).

During the periodic groundwater sampling events samples shall be sent for the analyses of:

- Gasoline Range Organics
- BTEX/MTBE
- Ammonia

All chemical analyses shall be performed by a laboratory that is approved by the State of Maine.

Quality assurance/quality control (QA/QC) samples shall also be collected as part of the soil investigation including field duplicates, laboratory QCs, and trip blanks. Table 3-3 presents the field and quality control sample summary. Table 3-4 presents the analytical methods, sample container types, preservative requirements, and the maximum holding times for the associated analyses. A "Low Flow" Groundwater Sample Log Sheet for Liquid Phase shall be completed for each groundwater sample collected (Appendix B). Information recorded shall include that specified for the EPA low-flow sampling procedure and type of analysis to be performed.

3.2.6 Baseline Soil Sampling

The objective of the baseline soil sampling program is to establish a set of baseline residual petroleum hydrocarbon contamination conditions in soil prior to the DBB pilot test.

During September 2004, soil samples were collected from 7 of the 12 mini-well boring locations (DB-01 through DB-12). These 12 mini-well boring locations were distributed in two lines aligned parallel with existing subsurface utility lines. Additionally, three of the five mini-well boring locations (DB-13 through DB-17), along the foundation footing of Building 27, were also be sampled. These three additional mini-well boring locations were spaced 10 to 15 feet on center near the foundation footing. The locations of these mini-well boring are depicted in Figure 3-1. The baseline sampling locations and analytical parameters of interest are identified in Table 3-1.

Soil samples were collected from the upper two depth intervals below the water table in all soil borings using a 3.0-inch I.D. sampler with a 4-foot disposable plastic liner sleeve. Soil borings DB-01 through DB-17 were completed as mini-wells.

Soil samples were also collected from three new monitoring well locations: MW-300, MW-301, and MW-302 (see Section 3.2.8 for additional details). A reference boring SB-01 was installed to provide baseline data for a location that would not be subjected to direct nitrate addition (such as the DB mini-wells).

Two samples were typically collected from each of the 13 borings, and one from SB-01 for a total of 27 soil samples.

A TtNUS drilling subcontractor used a DPT rig to advance samplers into the subsurface, retrieve the samplers, extrude the soil core in an acetate liner, and slice open the liner. Soil samples were collected according to TtNUS Standard Operating Procedure (SOP) SA-1.3 (Appendix A) as described below. The TtNUS field geologist determined which soil borings were sampled based on the highest concentration of organic vapors as determined by the FID readings, or from areas showing visual or olfactory evidence of petroleum hydrocarbon contamination. The TtNUS field geologist representative performed the following activities during soil sampling:

- Identifying the sample depth interval, and collecting soils for laboratory analyses.
- Screening each soil sample using a photo-ionization detector (PID).
- Determining the amount of soil sloughed in the top of the sampler.
- Classifying soil samples according to the Unified Soil Classification System (TtNUS SOP No. GH-1.5), noting the depth of change in each strata and any other pertinent visual observations (i.e., discolorations, odors, residual product).
- Decontaminating TtNUS soil sampling equipment prior to each use (See Section 3.6).

Soil Sampling for GRO Analysis:

Two samples from each soil boring were selected for laboratory analysis. The samples submitted for GRO analysis were collected directly from the disposable plastic liner sleeve from areas indicating the highest concentration of organic vapors as determined by the FID readings, or from areas showing visual or olfactory evidence of contamination, as determined by the TtNUS geologist. The samples were preserved with methanol immediately after collection. The following procedures were used to fill each of the vials required for GRO analysis:

- Label a pre-tare weighted 40-ml amber VOC vial with the sample location number;
- Collect a grab soil core (about 10 g), with a 10-ml pre-cut syringe. Extrude the soil sample into the 40-ml VOC vial containing 10-mL of methanol. The soil must be immersed in the methanol; recollect the sample using a smaller volume if necessary.
- Avoid touching the thread of the vial neck or spilling methanol. Cap the vial and shake it to mix the preservative with the sample, and
- Weigh the VOC preserved sample and record the value in the VOC soil sample collection/preservation log (Appendix B).

During the baseline soil sampling event, samples were sent for the analysis of:

- Gasoline Range Organics

Analysis was performed by a laboratory that is approved by the State of Maine.

Quality assurance/quality control (QA/QC) samples shall also be collected as part of the soil investigation including field duplicates, rinsate (equipment) blanks, laboratory QCs, and trip blanks. Table 3-3 presents the field and quality control sample summary. Table 3-4 presents the analytical methods, sample container types, preservative requirements, and the maximum holding times for the associated analyses.

All soil samples were identified in accordance with the sample location identification system presented in Section 4.3.1 of this Work Plan. Soil samples were handled and delivered in accordance with the chain-of-custody procedures detailed in Section 4.3.2 of this Work Plan. Required data were recorded on the sample log sheet, including sample device used, sampling personnel, date and time of sample, analyses collected, and other information as listed in the Sample Log Sheet Solid Phase (Appendix B).

Soil Sampling for VPH Analysis:

Based on Maine DEP comments to the *Draft Work Plan*, the MEDEP suggested that another analytical method be used to supplement the GRO analysis to better characterize the gasoline components present during the baseline and periodic sampling events. Navy proposed the use of the Massachusetts Department of Environmental Protection's Volatile Petroleum Hydrocarbon (VPH) Method [May 2004, rev. 1.1], because it could provide a more definitive identification of petroleum hydrocarbons as aliphatics [C5-C8, C9-C12] and aromatics [C9-C10]. VPH analysis will allow for future evaluation of the DBB process' effectiveness on hydrocarbon ranges of gasoline components.

Samples were collected during September 2004 using the DPT drill rig from adjacent to two previously mapped areas with elevated GRO presence (MW-SDP-5 and B27-DP1). Soil samples were collected from two intervals at each of the DB-10 and MW-300 locations, which were the situated near MW-SDP-5 and B27-DP1, respectively.

During the baseline soil sampling event, samples were sent for the analysis of:

- Volatile Petroleum Hydrocarbon (Massachusetts method)

Top of Clay sampling:

The MEDEP suggested collecting samples from the top of the marine clay unit to assess potential presence of petroleum hydrocarbons in this geologic layer and to assess the potential effectiveness of the DBB process in addressing petroleum hydrocarbons. Navy proposed the collection of two samples from the upper foot of the top of clay at two previously mapped locations with elevated GRO presence (MW-SDP-5 and B27-DP1).

Soil samples were collected from two intervals at each of the DB-10 and MW-300 locations, which are situated near MW-SDP-5 and B27-DP1, respectively.

During the baseline soil sampling event, samples were sent for the analysis of:

- Gasoline Range Organics

Soil Sampling for 8260B Analysis:

Immediately before the start of the September 2004 DPT drilling and soil sampling program, preliminary pilot test results for another DBB pilot test (at Groton, Connecticut) became available to Geovation that identified potential limitations of the GRO and VPH analytical methods to identify petroleum hydrocarbon contamination from in-situ biodegradation treatment processes. When in-situ biodegradation treatment occurs, it appears that biogenic compounds (i.e., biomass) and biodegradation metabolites of petroleum hydrocarbons could be detected by the GRO and VPH methods, resulting in bias high or false positive detection of petroleum hydrocarbons. Based on the potential interferences, Navy determined that it would be appropriate to have some of the soil samples analyzed using EPA Method 8260B (GC/MS method) to identify specific VOCs and gasoline components (as tentatively identified compounds). Therefore baseline soil 8260B results could be compared with the periodic sampling results to demonstrate the degree the petroleum (gasoline range) hydrocarbons that are being degraded.

Soil samples obtained from DB-01, DB-03, DB-05, DB-09, DB-10, DB-15, and MW-300 that were sent to the analytical laboratory for GRO analysis were also analyzed for VOCs and tentatively identified compounds (TICs) by EPA Method 8260B.

During the baseline soil sampling event, samples were sent for the analysis of:

- Volatile organic compounds and TICs(Method 8260B)

3.2.7 Periodic Soil Sampling

The objective of the periodic soil sampling rounds shall be to collect soil samples for the analysis of GROs and VPH (from selected boreholes) to provide indicators of the biodegradation process. The periodic soil sampling is expected to be preformed at approximately 6 months, 12 months, and 18 months after the start of the DBB™ pilot test. Selected samples will be analyzed for VOC and TICs by Method 8260B to identify whether specific gasoline hydrocarbons are being degraded. Based on an evaluation of the baseline results, the VPH analysis may be replaced by the 8260B analysis.

A DPT rig shall be used to acquire 26 soil samples from 13 soil boring locations (two samples per boring) during this sampling event. The periodic soil samples shall be collected in proximity of the 13 boring locations (DB-01 through DB-19, and MW-300 through MW-301) that were sampled during the baseline soil sampling event. The locations of these mini-well boring locations are depicted in Figure 3.1. The periodic sampling locations and analytical parameters of interest are identified in Table 3-2.

Periodic soil boring locations may change based on the baseline soil and groundwater analytical results. These sample locations may also be modified based on actual field conditions. The TtNUS Standard Operating Procedure (SOP) SA-1.3 shall be followed for all soil samples to be collected during the periodic soil sampling events, as discussed in Section 3.2.6 (Appendix A).

During the periodic soil sampling events, all samples shall be sent for the analysis of:

- Gasoline Range Organics

GRO analysis shall be performed by a laboratory that is approved by the State of Maine.

To assess DBB effectiveness on various gasoline hydrocarbon compounds and residuals that may be present in the top of clay, samples shall be collected in the vicinity of DB-10 and MW-300 for the analysis of:

- Volatile Petroleum Hydrocarbon (soil samples)
- Gasoline Range Organics (top of clay samples)

Selected samples from eight boring locations (one sample per location) may also be analyzed for:

- Volatile organic compounds and TICs (Method 8260B)

Quality assurance/quality control (QA/QC) samples shall also be collected as part of the soil investigation including field duplicates, rinsate (equipment) blanks, laboratory QCs, and trip blanks. Table 3-3 presents the field and quality control sample summary. Table 3-4 presents the analytical methods, sample container types, preservative requirements, and the maximum holding times for the associated analyses.

All soil samples shall be identified in accordance with the sample location identification system presented in Section 4.3.1 of this Work Plan. Soil samples shall be handled and delivered in accordance with the chain-of-custody procedures detailed in Section 4.3.2 of this Work Plan. Required data shall be recorded on the sample log sheet, including sample device used, sampling personnel, date and time of sample, analyses collected, and other information as listed in the Sample Log Sheet Solid Phase (Appendix B).

3.2.8 Mini-Well Installation

This section details the mini-well construction and well development procedures that were followed during the field investigation. TtNUS subcontracted with a drilling company to advance 20 DPT soil borings (detailed previously in Sections 3.2.6 and 3.2.7). All of these soil borings were completed as a 1.0-inch inner diameter monitoring wells (MW-DB01 through MW-DB17, and MW-300 to MW-301) located in and downgradient of the DBB™ pilot test plume area. The wells were installed into the saturated overburden with residual GRO petroleum hydrocarbon contamination. The locations of DPT soil borings and 1.0-inch monitoring wells are shown on Figure 3-1. Actual well locations were determined based on the results of the in-situ permeability testing, location of subsurface utilities, and the Geovation's empirical experience with nitrate reagent applications.

The array installed during September 2004 consists of three lines of application mini-wells, rather than the grid array proposed originally in the *Draft Work Plan*. Details are provided in the *Mini-Wells Design Letter Report* (Appendix D)

All mini-wells were constructed according to the following guidelines:

- Mini-well screen and casing shall be constructed of 1.0-inch I.D., non-glued, flush-threaded Schedule 40. Well screens shall be equipped with a threaded PVC end plug. Each mini-well shall be installed in separate DPT borings.

- Mini-well screens shall range in length depending on the saturated thickness of the contaminated sand unit to be determined during soil sampling. Each well screen shall be machine slotted (0.010-inch slot size) surrounded by silica sand (20-40 grade) to 3.25-inch outer diameter (O.D.). The top of the well screen shall be up to 3 feet BGS to allow room for placement of sand filter pack, bentonite seal, and concrete surface seal, as described below.

- A sand filter pack consisting of 20-40 grade silica sand pack shall be placed in the annular space around the well screen to a height of approximately 1 foot above the screen.

- A seal consisting of a 1-foot layer (minimum) of bentonite pellets shall be placed above the filter pack to approximately 0.5 feet below the base of the protective well cover.

- Mini-wells shall be completed with a flush-to-grade metal protective well cover marked "monitoring well" centered over the well. The well shall be capped with a lockable expansion cap ("J-cap").

- A concrete surface seal (Quickcrete® or equivalent) shall be placed to a radius of approximately 0.5-feet around the protective cover. The seal shall be flush-with-grade and extend around the protective well cover to a depth of approximately 0.5 feet bgs.

- Mini-wells shall be developed as described below.

- Standard Operating Procedures for DPT soil sampling and well installation are addressed in TtNUS SOP SA-2.5 (Appendix A). Mini-well construction details shall be documented by the TtNUS field geologist on a Well Construction Log Sheet (Appendix B). A typical schematic of a mini-well construction diagram is depicted in Figure 3-1.

Well Development

The TtNUS geologist/engineer developed all new 1.0-inch diameter groundwater mini-wells (MW-DB1 through MW-DB19) to remove fines from around the well screens. These wells were developed using a Wattera pump until the water was visually clear. If a well was not completely developed after 2 hours, the FOL notified the TtNUS Project Manager. The TtNUS Project Manager shall consult with technical advisors to determine a course of action for continued well development.

Development water was containerized and staged on site until waste characterization samples are collected and laboratory analysis is completed. Subsequent to the receipt of waste characterization results, development water shall be shipped off site for proper disposal according to the procedures outlined in Section 3.4.2 of this Work Plan. Well development details were documented by TtNUS personnel on a well development log sheet (Appendix B).

3.3 DBB PILOT TEST

The objective of the pilot test is to assess the effectiveness of Geovation's DBB process to mitigate sorbed-phase petroleum hydrocarbon contamination in saturated zone soil in the vicinity of the NEX Service Station at NASB such that the site-specific remedial goal of 500 mg/Kg GRO can be achieved. This section details the field measurements and sampling, and the nitrate-based reagent applications to stimulate microbial population growth and microbial biodegradation activities.

Geovations has been subcontracted by TtNUS to perform the baseline monitoring of biogeochemical conditions and molecular analysis, to perform additions of the N-blend reagent into the mini-wells during the pilot test duration, and to assess the degree of biodegradation. TtNUS shall perform baseline and periodic soil and groundwater sampling to assess whether the DBB process can achieve the 500 mg/Kg GRO goal.

For the pilot study, the area to be treated is depicted in Figure 3-2 (same as Figure 11 of the *Corrective Action Plan*). This area is approximately bounded by Burbank Avenue to the north and by the northwestern corner of Building 27 to the south. The test area footprint corresponds to the lower half of one of the two residual source areas delineated during previous investigations.

Twelve addition wells (DB-01 to DB-12) and existing sparging wells (AS-6, AS-7, and AS-8) shall be used to introduce Geovation's N-Blend, a proprietary nitrate-based electron acceptor reagent, into the test portion of the residual source area. Five new mini-wells ((DB-13 to DB-17)installed next to Building 27's foundation shall also be treated.

Based on discussions with Geovation, the N-Blend applications shall be performed during 10 Major Addition events during a 60-week period (or approximately once every 6 weeks). As DBB is an in-situ bioremediation technology, not a chemical-oxidation process, there may be weather, temperature and other site-specific conditions (i.e., ground and groundwater temperatures) that create lag times prior to the establishment of optimal treatment conditions and treatment cycles in the subsurface for the microbial population. Lower doses of the N-Blend reagent may be added during four Minor Addition Events during the start of pilot test to ensure a more successful increase in the microbial population and to allow adjustments to site-specific conditions that may limit the initial microbial population growth.

Nitrate is a state-regulated groundwater pollutant. Therefore, approval by the MEDEP is required prior to applying N-Blend solution at NEX Service Station.

Prior to the pilot test initiation, the test area perimeter shall be cordoned off using a high visibility safety fence (bright orange polyethylene, 4 feet high) to limit access. Placards shall be installed to warn against entry into the pilot test area, and appropriate base contact information shall be included. All mini-wells to be used for reagent addition,shall be marked with colored fiberglass rods to facilitate their location during winter conditions.

3.3.1 Microbiological and Biogeochemical Monitoring

This section details the field monitoring and sampling program that shall be implemented to monitor the progress of the pilot test by the DBB pilot test subcontractor (Geovation).

Two tiers of DBB-related monitoring activities shall be conducted over the course of the pilot test: routine monitoring and in-field/real time targeted monitoring of nitrate and key field parameters. The collection of field instrument readings and groundwater samples for laboratory analyses are typically coordinated together. A number of groundwater monitoring wells or treatment points shall be selected to provide representative coverage of locations both interior and exterior to the treatment area. For the pilot test, up to eight wells/sampling points shall be used to monitor DBB-related parameters.

Subsequently, representative groundwater samples shall be collected from some wells for laboratory analyses using low-flow, low-volume sampling techniques to transfer groundwater directly into laboratory glassware. Groundwater samples shall be analyzed for biogeochemical, microscopy, and molecular analyses.

The field monitoring and sampling shall be performed prior to the application of N-Blend reagent during the Major Addition events and possibly during the Minor Addition events (see Section 3.3.2).

Field Monitoring - The primary objective of the routine pre-treatment (in-field) monitoring activities is to quickly screen subsurface conditions to assess available nitrate and the relative microbial demand for nitrate and other electron acceptors prior to adding N-Blend to the subsurface. The in-field monitoring data shall provide means for the real-time modification of the amounts and concentrations of N-Blend to be applied in each treatment point. In addition, these sampling data shall be used to evaluate changes in subsurface environmental and microbiological conditions over time for the longer term planning and optimization of the DBB program to enhance the rate of biodegradation of gasoline-related hydrocarbons in groundwater and in particular sorbed-phase hydrocarbons present in the aquifer media.

First, the depth to the water-level interface at each location is measured and recorded to calculate the volume of water in each well. Downhole field instruments are used to measure and record dissolved oxygen (DO) and redox potential (redox). Low-flow, low-volume sampling techniques are then utilized to purge the well or treatment point using Wattera inertial pumps and dedicated tubing. A small volume of groundwater is collected from the subsurface and additional field instruments are used to obtain measurements of pH, temperature, nitrates, conductivity, and total dissolved solids (TDS). All information shall be recorded in logsheets provided by Geovation.

Routine Monitoring - The routine microbiological and biogeochemical monitoring program shall be used to evaluate changes in microbial populations and microbial activity in response to N-Blend treatments over time.

i. Biogeochemical Analyses

Geovation's routine DBB-related monitoring shall include low method detection limit (MDL) analyses of fixed-nitrogen species (nitrate, nitrite, ammonium) and phosphate species (orthophosphate, complex phosphate) related to the DBB program. The purpose of monitoring these parameters is to assess changes in response to N-Blend treatments over time and to measure available nitrate (nitrate/nitrite), and microbial waste products/nutrients (ammonium).

Samples shall be routinely collected for low-MDL analysis of these parameters using modified SW-846 methods designed to obtain lower detection limits within the range of 1-15 ug/L. These low-MDL analyses shall be conducted by a Geovation contractor in a research laboratory at Southampton University. Geovation shall also routinely obtain field measurements (per Section 3.3.1) of nitrate, ORP (redox potential or Eh), DO, pH and other field parameters as noted above to document changes in groundwater conditions in response to treatment.

The baseline groundwater samples (Section 3.2.4 - Fe, Mn, K, Mg, Ca, hardness, and carbonate alkalinity or TIC) to be collected by TtNUS shall be used by Geovation to assess geochemical conditions. Iron and manganese concentrations levels are affected by both microbial reduction (e.g., Fe[III] → Fe[II]) and microbial oxidation (e.g., Fe[II] → Fe[III] processes. Hence, analysis for total iron and manganese, which shall generally measure the soluble species, i.e., Fe[II] and Mn[II]), provides insight into the biogeochemical conditions and overall redox state in groundwater. Analysis for potassium, magnesium, and calcium provides an assessment of the inorganic (cation) geochemistry of these metals in site groundwater for purposes of understanding the native water quality (hard vs. soft water) and for fine-tuning the formulation of the N-blend accordingly. The purpose for hardness and bicarbonate alkalinity analysis is to monitor the presence of inorganic ("mineralized") carbon. A better alternative would be to obtain total inorganic carbon (TIC) data from which concentrations of the prevalent carbon species (i.e., CO_2, HCO_3^-, $CO3^{-2}$) may be calculated. The TIC analysis is being evaluated as a possible replacement for the hardness and bicarbonate alkalinity.

These sampling data shall be used to evaluate changes in subsurface environmental and microbiological conditions over time for the longer term planning and optimization of the DBB program to enhance the rate of biodegradation of gasoline-related hydrocarbons in groundwater and in particular sorbed-phase hydrocarbons present in the aquifer media.

ii. Microscopy Analyses

Microbial populations in site groundwater samples shall be quantified via epi-fluorescent light microscopy throughout the project. Geovation shall combine epi-fluorescent light microscopy with digital imaging and automated digital image analysis/counting in Geovation's microbiology laboratory to provide quantitative measurements of the total microbial populations present in groundwater samples. These methods are considered vastly superior to the use of "plate counting" and other indirect methods of estimating microbial populations. Groundwater samples shall be collected by Geovation and/or TtNUS directly into sterile vials containing buffered formaldehyde solution as a preservative. In the laboratory, representative aliquots of the preserved samples shall be doped with a dispersing agent and stained with 4',6-diamidino-2-phenylindole (DAPI). As DAPI selectively stains double-stranded (i.e., intact) DNA, it is useful to illuminate the live microorganisms present in the sample at the time of collection. Accordingly, this methodology provides consistent means for directly assessing active microbial populations in ground water over time in response to bioremediation treatment activities. The use of a state-of-the-art digital imaging and automated digital image analysis/counting system shall provide more accurate and reproducible counting data as well as providing means of archiving images (and data) for further analysis and interpretation if warranted.

Selected samples may also be examined using transmitted light, phase-contrast and darkfield microscopy techniques. These techniques are useful to examine qualitative aspects of the microbial conditions in samples, as well as to investigate biofilms, filamentous fungi and yeasts and "grazers" such as heliozoans, rotifers and ciliate protozoans that may be present in some samples.

iii. Molecular Analyses

Relatively infrequent and selective sampling shall be performed for molecular analyses by Microbial Insights of Rockford, Tennessee. Overall, the main utility of the molecular analyses described above is to characterize the response of the microbial community to the DBB program.

Denaturing-gradient gel electrophoresis (DGGE) and DNA sequencing shall be conducted to provide in-depth characterization of the microbial consortia in site groundwater before and during DBB treatment activities. DGGE shall be used to profile bacteria, archaea and fungi present in the samples. Prior work at other DBB sites has revealed the growth of robust and diverse microbial consortia comprised of microorganisms from the bacterial, archael, and fungal domains. Findings have included identification of *Pseudomonas* spp. (bacteria), many of which are well-known hydrocarbon degraders (and denitrifyers) as well as hydrocarbon-degrading, nitrate-respiring fungi. The *Archaea* are much less understood at the present time; however, DGGE data from prior DBB programs has shown abundant and numerous archaeal species as well.

Other molecular analyses that may be performed include the use of phospholipid fatty-acid (PLFA) assays and enzyme-specific gene probes. PLFA assays were previously conducted at the site in 2003, and additional post-treatment PLFA analyses may provide useful information such as the assessment of total biomass for comparison the microbial population data determined from microscopy. In addition, PLFA analyses provide means for the characterization of qualitative aspects of the microbial community that may be useful for monitoring the response of the microbial community to the DBB treatments.

Another potentially useful analysis is an enzyme-specific gene probe for Benzyl Succinate Synthase (BssA). BssA is an enzyme involved in the anaerobic degradation of aromatic hydrocarbons (e.g., toluene). The BssA enzyme mediates what is believed to be the first "universal" step in the "activation" of aromatic hydrocarbons by anaerobic microorganisms for subsequent degradation. Broad classes of anaerobic bacteria have been shown to utilize BssA including nitrate-, manganese-, iron- and sulfate-reducing bacteria. BssA mediates the addition of fumarate to the methyl group on methyl-substituted aromatics to form benzylsuccinate (hence the enzyme being benzylsuccinate synthase). Accordingly, the analysis of BssA activity over time may provide a means for the direct assessment of the anaerobic biodegradation of the gasoline-related aromatic hydrocarbons.

3.3.2 Major Additions, Field Measurements, and Sampling

The DBB pilot test program shall include the applications of the proprietary N-Blend nitrate and nutrient solution by Geovation personnel (Major Additions) and smaller N-Blend additions applied to the subsurface by TtNUS personnel with training and support from Geovation (Minor Additions). The typical scope of field activities for each Major Addition event shall include:

- The recording of field instrument data
- Collection of groundwater samples for laboratory analysis, and
- The application of N-Blend to subsurface.

The collection of field instrument readings and groundwater samples shall be performed as described in Section 3.3.1 for up to eight wells or sampling points prior to N-Blend addition.

The goal of each of the ten Major Addition events is the application of up to 300 gallons of N-Blend reagent distributed into the saturated soil zone of the pilot test area. Less N-Blend may be applied based on factors including site-specific hydrogeology (e.g., seepage rates), weather and the results of DBB-related monitoring (e.g., nitrate levels). The N-Blend may be applied via two different methodologies and the amount modified based on the practical application rates that may be realized at the pilot test area. Up to 300 gallons of N-Blend product shall be transported to the site in Geovation's truck-mounted "skid rig". The first method of N-Blend application is direct application from the skid rig into treatment wells. The second method consists of refilling a delayed distribution system that has the capability to apply a small amount of N-Blend to a sub-set of the treatment wells over an approximate 1 month time period. Up to 825 gallons of additional N-Blend shall be staged at a secure on-site location to be designated by the Navy for use in the Minor Addition events (see Section 3.3.3).

The direct application of N-Blend from the skid rig generally consists of the application of between 1 to 25 gallons at each treatment point (monitoring wells are occasionally utilized). The amount of N-Blend to be applied at each location is determined from a series of related mass-balance calculations that are tied to the horizontal and vertical distribution of hydrocarbons as best as can be estimated from the available field and laboratory data. In general, treatment points located in the upgradient portions of the treatment typically receive a greater proportion of the N-Blend product.

The delayed distribution of N-Blend may consist of either manual additions using 5-gallon carboys or an automated system that can dispense small amounts of N-Blend into one to five treatment points. The manual method would involve the use of a number 5-gallon carboys with valves set to slowly deliver N-Blend into individual treatment points over a period of minutes to hours. The automated delivery system(s) would consist of a series of 5-gallon stainless-steel canisters plumbed together to dispense N-Blend by controlled volume displacement with compressed inert gas. The automated systems (if used) would be placed in secure (i.e., lockable) above-ground enclosures and connected to treatment points via a series of small, shallow trenches. Small-diameter plastic tubing would be buried below the ground surface from the system enclosure to the selected treatment points. The automated systems would only be set up and operated in such fashion with the prior approval of TtNUS and the Navy.

Automated N-Blend additions are controlled with a programmable logic controller (PLC) set to periodically open a valve to dispense small amounts of N-Blend into the selected treatment points. The automated systems could operate unattended for time periods of up to about 1 month. If the automated systems are used at the site, each Major Addition event would include refilling the empty canisters and conducting routine system operation and maintenance. The use of these automated delivery systems would be particularly advantageous during periods of winter-weather operations and/or if the total N-Blend application rates for the Major Addition treatment events are limited by site-specific conditions (i.e., slow percolation rates of N-Blend into the subsurface).

3.3.3 Minor Additions

Based on both Geovation's practical experience and empirical observations from prior DBB programs, it would be advantageous to build up the populations of denitrifying microorganisms in the subsurface by performing a series of Minor Addition of N-Blend during the initial period of the pilot test treatment program. The Minor Addition of N-Blend may occur prior to conducting most (if not all) of the Major Addition events or may be used to provide supplemental N-Blend treatment in between the Major Addition events to help maintain robust microbial activity during the most intensive period of DBB-related biodegradation as determined from project-related biogeochemical and microbiological monitoring. The

objective of the Minor Addition is to apply small amounts of N-Blend periodically to selected treatment points as well as to both optimize the DBB process and minimize nitrate losses to areas outside and/or downgradient of the treatment area. After evaluation of the baseline groundwater sampling results (biogeochemical, microscopy, and molecular analysis), the sequencing of the Major and Minor Addition events shall be determined.

The Minor Additions shall consist of the direct application of from ≤1 to ± 5 gallons of N-Blend to each treatment point from N-Blend stored in either 275-gallon tanks at a Navy maintained location on-site or off-site in a larger number of smaller carboys under the control of TtNUS. Field instrument readings and ground-water sampling may be performed as described above, as needed. The Minor Addition events shall be performed by TtNUS personnel with training, equipment and technical support to be provided by Geovation.

3.4 WELL LOCATION SURVEY

The horizontal location and vertical elevation of each new mini-well shall be surveyed relative to the Maine State Plane Coordinate system NAD 1927. The survey accuracy shall be 0.01 feet for elevation and 0.1 feet for horizontal location. At each well, the elevation of ground surface and the top of the well casing shall be determined. In addition, three existing monitoring wells (to be determined), and the north-west corner of the existing Family Services Center, Building 27, shall also be surveyed.

3.5 INVESTIGATION-DERIVED WASTE (IDW) CHARACTERIZATION AND DISPOSAL

IDW shall be generated throughout the pilot test program and shall consist of soil drilling cuttings contaminated by petroleum hydrocarbons (GRO of up to 40 mg/Kg), well development and purge water (with up to 40 mg/L GRO), decontamination liquids (i.e., rinse water), and solid waste (i.e., used personal protective equipment [PPE] and spent sampling materials and supplies).

Soil IDW – IDW soils generated during sampling activities shall be placed in separate 55-gallon, open-head steel drums, sealed, labeled according to NASB procedures, and shall be temporarily stored on site at a staging area to be designated by NASB.

TtNUS shall arrange for the transport and off-site disposal of drums containing contaminated soil. The IDW Subcontractor shall be responsible for transportation, waste characterization, and disposal in conformance with all applicable, local, state and federal laws and regulations. The drums shall be sampled for laboratory analysis of waste-disposal parameters as discussed in the IDW Technical Specification.

TtNUS shall comply with the following NASB requirements for the management of contaminated soil that may contain hazardous wastes:

- All wastes that are potentially hazardous shall be tested prior to disposal utilizing the Toxicity Characteristic Leaching Procedure (TCLP) in accordance with 40 CFR 261 and the Maine Hazardous Waste Management Rules Chapter 850.

- Authorized NASB Hazardous Waste (HW) personnel must sign all HW manifests. Manifests, Land Disposal Restriction Bans, and analytical data shall be presented 24 hours in advance of the intended shipping date. All HW must be shipped off site within 80 days from the date waste

is first placed in any container unless other arrangements are approved by the Hazardous Waste Manager prior to project initiation.

- If analysis shows the contaminated soil is non-hazardous, then a TtNUS subcontractor shall provide for removal and disposal at a licensed solid waste disposal facility. If analytical results indicate that no analytes exceed the Maine Remedial Action Guidelines, then the soil shall be considered to be non-hazardous and non-contaminated.

Liquid IDW – Liquid IDW generated during well development shall consist primarily of groundwater containing petroleum hydrocarbons and other VOCs (i.e., MTBE). The well development and purge water may be sent offsite for disposal. One disposal method is to use the treatment system in building 50, which is designed to treat extracted groundwater containing VOCs (same as the IDW). TtNUS will coordinate with Navy on the use of this method. As approved by NASB, the well development and purge water shall be discharged into the sanitary sewer system. The base sanitary system would be able to treat VOCs in the liquid IDW. The storm water system is currently receiving groundwater originating from the NEX Service Station Area and the pilot test area. A foundation drain located on the northern perimeter of Building 27 (Family Services Center) intercepts and discharges the captured groundwater to the storm water system. The storm water drain system discharges into a series of detention ponds, where the VOCs would be volatilized and ultimately photolyzed in the atmosphere.

PPE and Disposable IDW - Any PPE and disposable supplies generated during work shall be decontaminated and stored in plastic bags for disposal at the end of each work day. The bags shall be placed in an industrial dumpster at a location to be determined by the Navy.

3.6 DECONTAMINATION PROCEDURES

All non-disposable sampling equipment that comes in contact with the sample medium shall be decontaminated to prevent cross-contamination between sampling points. This includes equipment such as stainless steel bowls, scoops, etc. Water level indicators shall be sprayed with 2-propanol, wiped with clean paper towel, and rinsed with deionized water in between every well interval.

All downhole drilling, sampling, and testing equipment and tools shall be free of paint or any petroleum-based greases/lubricants prior to drilling. The back end of the drilling rig shall be high-pressure steam cleaned on Site prior to beginning soil boring and monitoring well installation activities, between boring well locations, any time the drilling rig leaves the project Site, and at the conclusion of the drilling program.

Standard Operating Procedures for decontamination procedures are addressed in the TtNUS SOP SA-7.1 (Appendix A). The following decontamination sequence shall be employed:

- Remove gross contamination by scrubbing with potable water
- Scrub with potable water/liquinox
- Rinse with potable water
- Rinse with deionized water
- Rinse with 2-propanol
- Rinse with deionized water
- Air dry (to extent possible)
- Wrap with aluminum foil, dull side toward equipment.

3.7 SITE HEALTH AND SAFETY

All field activities shall be performed by in accordance with the Health and Safety Plan [HASP] (TtNUS, July 2004) for the DBB pilot test, which is presented in Appendix C to this Work Plan. Project personnel that shall be performing work on site shall review the pertinent sections of the HASP prior to work performance. The Site Safety Office shall review health and safety requirements at the start each task with the appropriate on-site personnel.

4.0 QUALITY ASSURANCE/QUALITY CONTROL PLAN

This section provides technical guidelines and procedures for maintaining an appropriate level of quality for data collected during fieldwork performed. This section references the TtNUS Standard Operating Procedures (SOPs) for specific protocols for procedures discussed in Section 3.0.

Pertinent SOPs for fieldwork are included in this work plan as Appendix A. These SOPs include, but are not limited to:

SOP	DESCRIPTION
CT-04	Sample Nomenclature
CT-05	Database Records and Quality Assurance
GH-1.5	Borehole and Sample Logging
ME-15	Photovac Microfid Handheld Flame Ionization Detector
SA-1.3	Soil Sampling
SA-6.1	Non-Radiological Sample Handling
SA-6.3	Field Documentation
SA-7.1	Decontamination of Field Equipment and Waste Handling
GW 001	U.S. EPA Region 1 Low Stress (Low Flow) Purging and Sampling Procedure For the Collection of Groundwater Samples From Monitoring Wells

Pertinent field forms used to document field activities, visual observations and sample collection are provided in Appendix B.

4.1 QUALITY ASSURANCE OBJECTIVES

The main objective of this pilot test is to implement and monitor DBB treatment. Achieving this objective requires that the data collected from the field conform to an appropriate level of quality. The quality of a data set is measured by certain characteristics of the data, namely the precision accuracy, representativeness, completeness, and comparability (PARCC) parameters. Some of the parameters are expressed quantitatively, while others are expressed qualitatively. The PARCC goals for a particular project are determined by the intended use of the data, defined as a part of the Data Quality Objectives (DQOs). DQOs are discussed in Section 2.8; the PARCC parameters are discussed below.

4.1.1 PARCC Parameters

The PARCC goals for the work covered by this quality assurance plan are discussed in the following sections.

4.1.1.1 Precision and Accuracy

Field and laboratory precision and accuracy performance can affect the attainment of project objectives, particularly when compliance with established criteria is based on laboratory analysis of environmental samples.

Field sampling precision and accuracy are not easily measured. Field contamination, sample preservation, and sample handling will affect precision and accuracy. By following the appropriate TtNUS SOP, precision and accuracy errors associated with field activities can be minimized. Field duplicates and blanks (field and rinsate) will be used to estimate field sampling precision and accuracy for samples submitted for laboratory analysis.

Field duplicate and field quality control blank analyses results will be used to review the laboratory-analyzed results and determine the usability of the data with respect to its intended use.

4.1.1.2 Representativeness

Representativeness describes the degree to which analytical data accurately and precisely define the population being measured. Several elements of the sampling and sample handling process must be controlled to maximize the representativeness of the analytical data (appropriate number of samples collected, physical state of the samples, Site-specific factors, sampling equipment, containers, sample preservation and storage, holding times, sample identity, and chain-of-custody will be defined to ensure that the samples analyzed represent the population being measured). The sampling program is designed to provide analytical data that are representative of the existing contaminant levels.

Representativeness of data is also affected by sampling techniques. Errors or cross-contamination during the sampling could affect the laboratory analytical results. However, every effort will be made during sample collection to minimize the introduction of errors or cross-contamination by following the sample techniques described in Section 3.0, and the TtNUS SOPs included in Appendix A.

4.1.1.3 Completeness

Completeness describes the amount of data generated that meets the objectives for precision, accuracy, and representativeness versus the amount of data expected to be obtained. For relatively clean, homogeneous matrices (such as water), 100 percent completeness is expected. However, as matrix complexity and heterogeneity increase (such as for soil), completeness may decrease. Where analysis is precluded or where data quality objectives are compromised, effects on the overall investigation must be considered. Whether or not 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.

The sampling and analysis program for the Site is sufficiently broad in scope to prevent a single data point or parameter from jeopardizing attainment of the study objectives. Critical data points may not be evaluated until all the analytical results are evaluated. Additionally, several sampling points, in aggregate, may be considered to be critical either by location or by analysis. A subsequent sampling event may be necessary if it becomes apparent that the data for a specific medium are of insufficient quality, either with respect to the number of samples or based on an individual analysis.

For the purposes of this effort, a data point will be determined to contribute to the completeness of the data set if the information provided is meaningful, useful, and contributes to the project objectives.

4.1.1.4 Comparability

One of the objectives of the sampling effort is to provide analytical data that are characterized by a level of quality that is comparable between sampling points. By specifying the use of standard analytical

procedures (as well as standardizing field sampling procedures by employing TtNUS SOPs), the potential for variables to affect the final data quality will be effectively minimized. Analytical methods for this work are presented in Tables 3-4 and SOPs appear in Appendix A.

4.1.2 Quality Control Samples

QC samples to be used during the sampling effort are identified below, and include field duplicates or replicates, laboratory duplicates or replicates, rinsate blanks, field blanks, and source blanks. Each type of field quality control sample defined below will undergo the same preservation, holding times, etc., as the field samples. Table 3-3 presents a summary of the QC samples to be collected during this sampling event.

4.1.2.1 Field Duplicates

Field duplicates will be submitted at the rate of one for every ten samples per matrix. Field personnel will note on the sample summary form and in the logbook which samples are field duplicates. Duplicate samples will be shipped blind to the laboratories, and shipping paperwork will be completed accordingly.

Field duplicates are collected by mixing a double or triple portion of the required volume of sample and dividing it into two sample containers. Field duplicates provide precision information regarding homogeneity, handling, shipping, storing, preparation, and analysis.

4.1.2.2 Rinsate Blanks

Rinsate blanks are obtained under representative field conditions by running analyte-free deionized water through sample collection equipment after decontamination, immediately before sampling and placing it in the appropriate sample containers for analysis. These samples are used to assess the effectiveness of decontamination procedures. Rinsate blanks are prepared at the rate deemed adequate to assure effective decontamination. For this project, rinsate blanks will be collected at the rate of one per two days of sampling.

4.1.2.3 Field Blanks

Field blanks will consist of the source water used in decontamination (includes analyte-free deionized water, potable water from each source, and other waters used in decontamination operations). Field blanks will be prepared at the rate of one per source of water per sampling event.

4.1.2.4 Matrix Spike/Matrix Spike Duplicates (Lab QCs)

A matrix spike sample will be identified by field teams at a frequency of 1 in 20 field samples (per matrix) collected. Samples for matrix spike analyses and laboratory duplicate analysis are collected in triplicate volumes for aqueous organics (three containers for each analyte group), and duplicate volumes for aqueous metals (two containers). Soil matrix spikes will be collected in double volumes.

4.2 PROJECT ACTION LIMITS AND METHOD DETECTION LIMITS

The action limits and method detection limits for this project are listed in Table 4-1.

The project action limit for soil GRO is the site-specific clean-up goal of 500 mg/Kg.

The project action limits for groundwater GRO (assuming stringent), BTEX VOCs, and MTBE are based on the *Procedural Guidelines for Establishing Action Levels and Remediation Goals for the Remediation of Oil Contaminated Soil and Ground Water in Maine*, Appendices B and C, Maine Department of Environmental Protection, Revised March 13, 2000.

The project action limits selected for nitrate, nitrite, and ammonium are based on the Safe Drinking Water Act Maximum Contaminant Levels (MCLs) and the State of Maine's Maximum Exposure Guidelines (MEGs). Although MCLs and MEGs are not applicable or relevant and appropriate requirements, these guidelines are used to establish analytical quantitation limits for the pilot test.

Project action limits selected for iron, manganese, potassium, magnesium, and calcium are equivalent to the EPA's CLP program contract required detection limits (CRDL). There are no promulgated regulations governing these analytes. However, the CRDL are used to establish analytical quantitation limits for the pilot test.

Often times, actual sample conditions will dictate the quantitation limit (QL), which may be lower or higher than those listed. When the laboratory identifies chemicals below the QL, the concentration will be reported as approximate. For this reason, some analytes may be reported below the QL and reported as approximate values.

4.3 SAMPLE DESIGNATION AND CUSTODY

This section describes the sample designation and chain-of-custody requirements for all environmental and quality control samples.

4.3.1 Environmental Samples

Each sample collected will be assigned a unique sample tracking number that will be used to catalog the results. The sample tracking number will consist of alpha-numeric characters identifying the Site, sample medium, location, and depth. Any other pertinent information regarding sample identification will be recorded on the sample logsheets or in the field logbooks.

The alpha-numeric coding to be used in the sample system is detailed below and in the subsequent definitions.

AAA	-	AA	- (NNN)	-	(NNNN)
(Site ID)	-	(Medium)	- (Location)	-	(Depth)

Site identifier: "NEX" for Navy Exchange Service Station

Medium identifier: "SO" for soil samples collected from soil borings,
"GW" for groundwater samples collected from wells;

Sample location identifier: For soil samples each sample location will be assigned a DB identifier along with its corresponding consecutive number in order of advancement, using 00-series identifiers (e.g. -DB01, -DB02, etc.). For groundwater samples each sample will be assigned its corresponding soil sample location identifier with the addition of a MW at the beginning (e.g. -MWDB01, MWDB02, etc.)

Depth: For soil borings, this portion of the sample tracking number will represent the depth in feet below ground surface from which the sample was collected, e.g., for soil samples collected from 2 to 4 feet below ground surface, this portion of the sample tracking number will be "0204", and samples collected from 04 to 08 feet below ground surface, the portion of the tracking number will be "0408", etc. The depth identifier does not apply to groundwater samples.

Examples:

A soil sample collected from boring location DB1 at a depth of 2 to 4 feet will be identified as NEX-SO-DB1-0204. The corresponding groundwater sample ID will be NEX-GW-MWDB1.

Quality Control (QC) Samples

Field quality control (QC) samples will use the same coding system as for environmental samples. Field QC sample types are described in Section 4.1.2.

Blind field duplicate samples will be designated such that the location designation will be replaced with a chronological number. The sample log sheet will note which sample location the duplicate was collected from:

Duplicates: NEX-GW-DUP01 or for soil - NEX-SO-DUP01.

Field blanks will be designated such that they can clearly be identified as field blanks. The designation must be able to be referenced to the source, i.e. DIUF water, potable water (PTW), etc., using the field sample data forms.

Field Blanks: NEX-DIUF-FB01or NEX-PTW-FB01.

Rinsate blanks will be designated such that the location designation will be replaced with a chronological number as follows:

Rinsate Blanks: NEX-RB01 or NEX-RB02.

Matrix spike samples have no separate sample identifier codes, but are noted on the chain-of-custody record and sample logsheet.

4.3.2 Sample Chain-of-Custody

Custody of samples must be maintained and documented at all times. To ensure the integrity of a sample from collection through analysis, an accurate written record is necessary to trace the possession and handling of the sample. This documentation is referred to as the "chain-of-custody" form. Chain-of-custody begins when samples are collected in the field, and is maintained by storing the samples in secure areas until custody can be passed on. A chain-of-custody form (Appendix B) that lists each sample, the analytical parameters, and the persons who are responsible for their integrity will accompany all samples.

Samples will be placed on ice and attended by TtNUS personnel or placed in locked vehicles or designated storage areas until analysis or shipment to an off-Site laboratory. Chain-of-custody procedures are described in further detail in the SOPs.

4.4 CALIBRATION PROCEDURES

Field equipment normally requiring calibration (i.e. screening instruments) will be calibrated and operated in accordance with the manufacturer's instructions and manuals. A calibration log (Appendix B) will be kept to document the periodic calibration results for each field instrument.

Calibration procedures for laboratory equipment used in the analysis of environmental samples will be performed in accordance with the Laboratory's QC plan.

4.5 LABORATORY ANALYSIS

Samples will be analyzed for various parameters as described in previous sections and in Table 3-3.

A laboratory previously approved by the State of Maine will analyze the environmental samples collected for laboratory analysis during the pilot test program. Standard EPA and Standard Methods procedures will be employed, as listed in Table 3-4.

4.6 DATA REDUCTION, VALIDATION, AND REPORTING

Laboratory analytical data will be reviewed by qualified TtNUS technical staff, according to EPA-equivalent "Tier I" protocols. A data review memorandum will be prepared and submitted to the Project Manager as a part of that activity. Data review procedures are described in Section 4.10.

Field data will be periodically reviewed by technical lead personnel and the TtNUS PM to ensure that the data collected are well documented, clearly described, and are appropriate for the investigation and its ultimate use.

4.7 INTERNAL QUALITY CONTROL

Section 4.1.2 discussed the types and frequency of quality control samples that will be prepared during the field investigation activities for those samples that undergo laboratory analysis. The quantities of various types of QC samples are shown in Table 3-3. Laboratory analysis will follow the QC criteria described in the analytical procedures.

4.8 PERFORMANCE AND SYSTEM AUDITS

System audits will be performed as appropriate to ensure that the work is being implemented in accordance with the approved project SOPs and in an overall satisfactory manner.

- The TtNUS FOL will supervise the field operations. The FOL will perform a daily check to ensure that the equipment are properly decontaminated, samples are collected and handled properly, and the fieldwork is accurately and neatly documented.

- The data reviewer(s) will review the data to ensure they were obtained through the approved methodology, and that the appropriate level of QC effort and reporting were conducted. The data review effort will be supervised by the TtNUS CLEAN Quality Assurance Manager or designee.

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

4.9 PREVENTATIVE MAINTENANCE

TtNUS has established a maintenance program for field equipment owned by TtNUS 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 maintains an inventory of the equipment by model and serial number, quantity, and condition. Each item of equipment is signed out when in use and its operating condition and cleanliness is checked upon return.

- The equipment manager conducts routine checks on the status of equipment and is responsible for stocking spare parts and for 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 ensure that the equipment is tested, cleaned, charged, and calibrated in accordance with the manufacturer's instructions before being taken to the job Site.

- While the equipment is in the field, the FOL or designee is responsible for the equipment, maintains calibration records, and performs maintenance operations and checks.

In many instances, rental equipment and instruments will be used in the field. The rental firms will be responsible for the proper care, maintenance, and repair of these items, and for tracking and documenting equipment and instrument maintenance and repairs. TtNUS will be responsible for the instrument calibration and documentation prior to use in the field.

4.10 DATA ASSESSMENT PROCEDURES

The following paragraphs describe the procedures used to evaluate data prior to inclusion in report deliverables.

4.10.1 Representativeness, Accuracy, and Precision

All laboratory data generated in the investigation will be assessed for representativeness, accuracy, and precision, as described in Section 4.1. The completeness of the data will also be assessed by comparing the acquired data to the project objectives to see that these objectives are being addressed and met.

Qualified TtNUS personnel will conduct the PARCC parameter assessment. Determining if the data are consistent with known or anticipated chemical conditions and accepted principles will assess the representativeness of the data.

Field measurements will be checked for completeness of procedures and documentation of procedures and results.

Precision and accuracy will be determined using duplicate samples, and blank and spiked samples, respectively. PARCC parameters are addressed in more detail in Section 4.1.

4.10.2 Analytical Data Review

An analytical data review process that includes the following tasks will be carried out:

- Check data for completeness to determine if all samples were analyzed and reported for the parameters requested in the chain-of-custody form.
- Check data report for accuracy of sample identification, sample location, collection date, and units.
- Organize the data tables by sample matrix, sample location, and calculate and report the average of field duplicate results. Consolidate results of two sample dilutions into one set of results.
- Check large positive hits against the raw data to avoid false positive results.
- Submit the data review results with a summary of problems and resolutions in writing.

4.11 CORRECTIVE ACTION

The QA program will enable problems to be identified, controlled, and corrected. Potential problems may involve non-conformance with the SOPs and/or analytical procedures established for the project, or other unforeseen difficulties. Any person identifying an unacceptable condition will notify the FOL and the PM. The PM, with the assistance of the Quality Assurance Manager and the project QA/QC officer, will be responsible for developing and initiating appropriate corrective action and verifying that the corrective action has been effective.

Corrective actions may include re-sampling and/or re-analysis of samples or modifying project procedures. If warranted by the severity of the problem (for example, if a change in the approved work plan is required), the Navy will be notified in writing and their approval will be obtained prior to implementing any change. Additional work that depends on a nonconforming activity will not be performed until the source of the problem has been addressed.

4.12 QUALITY ASSURANCE REPORTS/DOCUMENTS

A bound/weatherproof field logbook will be maintained by the FOL. The FOL or designee will record all information related to sampling or field activities. This information may include sampling time, weather conditions, unusual events, field measurements, photograph description, etc. The Site logbook maintained by the FOL will contain a summary of the day's activities and will reference other field logbooks when applicable.

At the completion of field activities, the FOL will submit to the PM all field records, data, field logbooks, chain-of-custody receipts, sample log sheets, etc. The PM will ensure that these materials are entered into the project file. Examples of all applicable field forms are included contained in Appendix B.

5.0 REPORTING

Reports will be prepared periodically to present the results of field investigation and pilot test progress.

5.1 LETTER REPORTS

The purpose of the letter reports is to provide the status or progress for the field activities and pilot test progress. No major comments are expected and only minor comments are anticipated. Suggested changes or recommendations will be discussed via electronic mail or telephone, and the changes or recommendations will be incorporated into the *Draft Pilot Test Completion Report* (Section 5.2), as appropriate. Only one version of each letter report will be prepared and distributed.

TtNUS will prepare the following letter reports:

- Results of baseline biogeochemical sampling – This letter report will summarize the baseline sampling and evaluation of biological activity and geochemical conditions at the pilot test work prior to any in-situ treatment. The letter report will summarize, as appropriate, the work performed, field measurements, laboratory analysis, tabulated analytical results, graphics, interpretation of results, and recommendations for the pilot test.

- Mini-well design and installation – This letter report will incorporate the findings from the utility clearance and the in-situ permeability testing. The proposed spacing and design of the mini-wells will be presented. This letter will also include tabulated results and graphics.

- Baseline groundwater and soil sampling – This letter report will provide summaries of work performed, field measurements, sample stations, samples collected, tabulated results and graphics, and evaluations of data.

- Rounds 1 and 2 periodic groundwater and soil sampling - These letter reports will provide summaries of work performed, field measurements, sample stations, samples collected, tabulated results and graphics, and evaluations of data. Each periodic letter report will compare that round's results with the baseline results. As appropriate, recommendations will be included. The Round 3 sampling results will be incorporated into the *Draft Pilot Test Completion Report*.

5.2 PILOT TEST COMPLETION REPORT

TtNUS will prepare *Draft Pilot Test Completion Report* that presents: the pilot test objectives, summary of petroleum hydrocarbon contamination at NEX Service Station, a description of the DBB process, mini-wells design and installation, the pilot test program, sampling and analysis performed, summaries of the stations sampled and samples collected, summaries of the baseline and periodic monitoring results, evaluation of results, conclusions, and recommendations. The draft report will evaluate the data through summaries and tabulation of chemical data compared with the site-specific remediation goals of 500 mg/Kg of GRO in soil. This report will be supported by maps, tables, tabulated analytical data, tabulated field measurements, figures, and photographs, as appropriate.

The *Draft Pilot Test Completion Report* will be published and distributed for review and comment. Upon receipt of review comments, a Response to Comments shall be distributed within 30 calendar days. Comments resolution are expected to be completed by conference calls or electronic mail. A *Final Pilot*

Test Completion Report will be completed and distributed within 20 calendar days after all comments have been resolved.

6.0 REFERENCES

Bouwer, Herman and R. C. Rice, 1976. A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells, Water Resources Research, Vol. 12, No. 3, 1976.

EA Engineering, Science, Technology, Inc., 2004. Corrective Action Plan for the Navy Exchange Service Station, Naval Air Station, Brunswick, Maine. April 2004.

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Maine Department of Environmental Protection, 2000. Procedural Guidelines for Establishing Action Levels and Remediation Goals for the Remediation of Oil Contaminated Soil and Ground Water in Maine, Revised March 13, 2000.

U.S. Environmental Protection Agency, 1996. Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells (EPA SOP No. GW 001, Revision 2). July 30, 1996.

TABLES

TABLE 1-1

PROPOSED PROJECT SCHEDULE
WORK PLAN
NAVY EXCHANGE SERVICE STATION
NAVAL AIR STATION, BRUNSWICK, MAINE

ACTIVITY	PLANNED START	PLANNED END
WORK PLANS		
Internal Draft Work Plan prep.	06/07/04	07/02/04
Submit Internal Draft Work Plan	07/02/04	07/02/04
Navy comments	07/06/04	07/12/04
Draft Work Plan prep.	07/13/04	07/26/04
Submit Draft Work Plan	07/26/04	07/26/04
MEDEP Review Period	07/27/04	08/23/04
Response to Comments	08/24/04	09/20/04
Final Work Plan prep.	09/21/04	10/04/04
Submit Final Work Plan	10/04/04	11/22/04
SUBCONTRACT PROCUREMENT		
Spec. prep., procurement	06/08/04	07/19/04
Subcontract tracking & management	06/08/04	02/13/06
FIELD INVESTIGATIONS		
Mobilization	08/23/04	09/17/04
Utility Clearance	08/23/04	08/23/04
In-Situ Perm. Testing	08/24/04	08/25/04
Baseline GW Sampling	08/25/04	08/27/04
Design mini-wells	08/26/04	09/14/04
Baseline Soil Sampling & Mini-Well Install.	09/27/04	09/30/04
Round 1 Soil and GW Sampling	03/28/05	03/30/05
Round 2 Soil and GW Sampling	10/03/05	10/05/05
Round 3 Soil and GW Sampling	03/27/06	03/29/06
DBB Pilot Test		
Application 1 (1)	10/25/04	10/27/04
Minor Addition 1 (1)	11/15/04	11/15/04
Application 2 (1)	12/06/04	12/08/04
Minor Addition 2 (1)	12/24/04	12/24/04
Application 3 (1)	01/17/05	01/19/05
Minor Addition 3 (1)	02/07/05	02/07/05
Application 4 (1)	02/28/05	03/02/05
Minor Addition 4 (1)	03/21/05	03/21/05
Application 5	04/11/05	04/12/05
Application 6	05/23/05	05/24/05

TABLE 1-1

PROPOSED PROJECT SCHEDULE
WORK PLAN
NAVY EXCHANGE SERVICE STATION
NAVAL AIR STATION, BRUNSWICK, MAINE
PAGE 2 OF 3

ACTIVITY	PLANNED START	PLANNED END
Application 8	08/16/05	08/17/05
Application 9	09/26/05	09/27/05
Application 10	11/07/05	11/08/05
Well Location Survey	11/02/04	11/02/04
Drilling Waste and IDW Disposal		
Post Baseline Event	10/22/04	10/22/04
Post Round 1 sampling	03/31/05	03/31/05
Post Round 2 sampling	10/06/05	10/06/05
Post Round 3 sampling	03/30/06	03/30/06
LABORATORY ANALYSIS		
Microscopy, Biogeochemical, and Molecular Analysis	08/30/04	10/01/04
Sample Analysis - Baseline	10/22/04	11/18/04
Sample Analysis - Round 1 (2)	03/31/05	04/06/05
Sample Analysis - Round 2	10/06/05	11/02/05
Sample Analysis - Round 3	03/30/06	04/26/06
DATA MANAGEMENT		
Data Validation - Baseline	11/19/04	12/30/04
Data Validation - Round 1	04/07/05	04/13/05
Data Validation - Round 2	11/03/05	12/07/05
Data Validation - Round 3	04/27/06	05/31/06
DATA EVALUATION AND REPORTING		
Letter Reports	08/26/04	01/12/06
Baseline Biological Sampling Results LR prep.	10/04/04	10/15/04
Submit Baseline Biological Sampling Results LR	10/15/04	10/15/04
Mini-Well Design and Installation LR prep.	08/26/04	09/14/04
Submit Mini-Well Design and Installation LR	09/15/04	09/15/04
Baseline Sampling LR prep.	12/31/04	02/03/05
Submit Baseline Sampling LR	02/04/05	02/04/05
Round 1 Sampling LR prep.	04/14/05	04/28/05
Submit Round 1 Sampling LR	04/29/05	04/29/05

TABLE 1-1

PROPOSED PROJECT SCHEDULE
WORK PLAN
NAVY EXCHANGE SERVICE STATION
NAVAL AIR STATION, BRUNSWICK, MAINE

ACTIVITY	PLANNED START	PLANNED END
Submit Round 2 Sampling LR	01/12/06	01/12/06
DATA EVALUATION AND REPORTING		
Internal Draft Pilot Test Comp. Report prep.	06/01/06	07/12/06
Submit Internal Draft Pilot Test Comp. Report	07/13/06	07/13/06
Navy Review & Comments	07/14/06	07/27/06
Draft Pilot Test Comp. Report prep.	07/28/06	08/10/06
Submit Draft Pilot Test Comp. Report	08/11/06	08/11/06
MEDEP Review Period	08/14/06	09/08/06
Response to Comments Prep.	09/11/06	10/06/06
Submit Response to Comments	10/09/06	10/09/06
Final Pilot Test Comp. Report Prep.	10/10/06	10/30/06
Submit Final Pilot Test Comp. Report	10/31/06	10/31/06

Notes:

1) Actual sequence of Major and Minor Additions at start will be determined based on the baseline sampling results and assessment of biogeochemical, microscopy, and molecular analyses.
2) Rapid turnaround (48-hour) will be requested of the analytical laboratories.

TABLE 2-1

COMPARISON OF MICROBIAL ELECTRON ACCEPTORS FOR BIODEGRADATION OF PETROLEUM HYDROCARBONS
WORK PLAN
NAVY EXCHANGE SERVICE STATION
NAVAL AIR STATION, BRUNSWICK, MAINE

Electron Acceptor	Biodegradation Process	Gibbs Free Energy (KJ/mole) CH_2O	Eh (mV)	Solubility (mg/L)	Idealized Stoichiometry of Bioremediation Processes of Petroleum Hydrocarbons
Oxygen	Aerobic	-475	800	6-9	$1.5\ O_2^- + \text{-CH-} + H^+ \rightarrow CO_2 + H_2O$
Nitrate (NO_3)	Denitrification	-448	750	>600,000	$NO_3^- + \text{-CH-} + H^+ \rightarrow CO_2 + H_2O + ½N_2$
Manganese [IV]	Manganese Reduction	-349	500	Insoluble mineral	$½Mn(IV) + \text{-CH-} + H^+ \rightarrow ½Mn(II) + HCO_3 + 6H^+$
Iron [III]	Iron Reduction	-114	-70	Insoluble mineral	$1/2\ Fe(III) + \text{-CH-} + 3H_2O \rightarrow ½Fe(II) + HCO_3 + 6H^+$
Sulfate (SO_4)	Sulfate reduction	-77	-210	1,300	$SO_4^{-2} + \text{-CH-} + 5H^+ \rightarrow CO2 + 2H_2O + H_2S$
Carbon dioxide	Methanogenesis	-58	-250	1,900	$CO_2 + 8H^+ \rightarrow CH_4 + 2H_2O$

Source: Geovation Technologies, Inc. (2003).

TABLE 3-1

BASELINE SOIL AND MINI-WELL SAMPLING LOCATIONS
WORK PLAN
NAVY EXCHANGE SERVICE STATION
NAVAL AIR STATION, BRUNSWICK, MAINE

Mini-Well or Boring ID	Location	Groundwater	Soil (1)	Top of Clay (2)
DB01	Line 1 - DBB Pilot Test Area	NA	GRO, 8260B	NA
DB02	"	NA	NA	NA
DB03	"	NA	GRO, 8260B	NA
DB04	"	NA	NA	NA
DB05	"	NA	GRO, 8260B	NA
DB06	"	NA	NA	NA
DB07	"	NA	NA	NA
DB08	"	NA	GRO	NA
DB09	Line 2 - DBB Pilot Test Area	NA	GRO, 8260B	NA
DB10	"	NA	GRO, VPH, 8260B	GRO
DB11	"	NA	NA	NA
DB12	"	NA	GRO	NA
DB13	Line 3 – Near Bldg. 27's Foundation Footing	NA	GRO	NA
DB14	"	NA	NA	NA
DB15	"	NA	GRO, 8260B	NA
DB16	"	NA	NA	NA
DB17	"	NA	GRO	NA
MW300	Near former B27-DP1 location	GRO, BTEX/MTBE, N/N	GRO, VPH, 8260B	GRO
MW-301	MW-NASB-25 replacement	GRO, BTEX/MTBE, N/N	GRO	NA
MW-302	New downgradient mid-point monitoring well	GRO, BTEX/MTBE, N/N	GRO	NA
SB-1	New soil boring location	NA	GRO	NA
MW-DP01	Upgradient of DBB Pilot Test Area	GRO, BTEX/MTBE, N/N, A, IGP	NA	NA
MW-DP02	Upgradient of DBB Pilot Test Area	GRO, BTEX/MTBE, N/N, A, IGP	NA	NA
MW-NASB23	Upgradient of DBB Pilot Test Area	GRO, BTEX/MTBE, N/N, A, IGP	NA	NA
MW-DP09	Upgradient of DBB Pilot Test Area	GRO, BTEX/MTBE, N/N, A, IGP	NA	NA
MW-DP13	Upgradient of DBB Pilot Test Area	GRO, BTEX/MTBE, N/N, A, IGP	NA	NA
B27-DP4	Downgradient of DBB Pilot Test Area	GRO, BTEX/MTBE, N/N, A, IGP	NA	NA
MW-SDP5	DBB Pilot Test Area	GRO, BTEX/MTBE, N/N, A, IGP	NA	NA
MW-NASB24	Cross-Gradient of DBB Pilot Test Area	GRO, BTEX/MTBE, N/N, A, IGP	NA	NA
MW-NASB25	Downgradient of DBB Pilot Test Area	GRO, BTEX/MTBE, N/N, A, IGP	NA	NA
MW-NASB26	Upgradient of DBB Pilot Test Area	GRO, BTEX/MTBE, N/N, A, IGP	NA	NA

TABLE 3-1 (cont.)

BASELINE SOIL AND MINI-WELL SAMPLING LOCATIONS
WORK PLAN
NAVY EXCHANGE SERVICE STATION
NAVAL AIR STATION, BRUNSWICK, MAINE
PAGE 2 OF 2

Notes:

1. GRO analysis to be used to compare with Maine standards
   VPH analysis to better define groups (ranges by C) of hydrocarbons present
   8260B analysis to identify specific petroleum hydrocarbon constituents, for comparison with GRO results
2. Top of clay samples collected to assess potential gasoline hydrocarbon sorption into a low permeability unit

Abbr.:

A – ammonia/ammonium
BTEX - benzene, toluene, ethylbenzene, and xylene
GRO - gasoline range organics, by Maine HETL Modified Method 4.2.17
IGP - pilot test inorganic geochemical parameters [Fe, Mn, K, P, Mg, Ca, hardness, alkalinity or Total Inorganic Carbon]
MTBE - methyl tert butyl ether
N/N - nitrate/nitrite
VPH – volatile petroleum hydrocarbon (Massachusetts method)
8260B – SW-846 GC/MS VOCs method & TICs

TABLE 3-2

PERIODIC SOIL AND MINI-WELL SAMPLING LOCATIONS
WORK PLAN
NAVY EXCHANGE SERVICE STATION
NAVAL AIR STATION, BRUNSWICK, MAINE

Mini-Well or Boring ID	Location	Groundwater [1]	Soil [2]	Top of Clay
DB01	Line 1 - DBB Pilot Test Area	GRO, BTEX/MTBE, A (TBD)	GRO, VPH, 8260B (TBD)	NA
DB02	"	"	"	NA
DB03	"	"	"	NA
DB04	"	"	"	NA
DB05	"	"	"	NA
DB06	"	"	"	NA
DB07	"	"	"	NA
DB08	"	"	"	NA
DB09	Line 2 - DBB Pilot Test Area	"	"	NA
DB10	"	"	GRO, VPH, 8260B	GRO
DB11	"	"	GRO, VPH, 8260B (TBD)	NA
DB12	"	"	"	NA
DB13	Line 3 – Near Bldg. 27's Foundation Footing	"	"	NA
DB14	"	"	"	NA
DB15	"	"	"	NA
DB16	"	"	"	NA
DB17	"	"	"	NA
MW300	Near former B27-DP1 location	"	GRO, VPH, 8260B	GRO
MW-301	MW-NASB-25 replacement	"	NA	NA
MW-302	New downgradient mid-point monitoring well	"	NA	NA
SB-1	New soil boring location	"	GRO (TBD)	NA
MW-DP01	Upgradient of DBB Pilot Test Area	"	NA	NA
MW-DP02	Upgradient of DBB Pilot Test Area	"	NA	NA
MW-NASB23	Upgradient of DBB Pilot Test Area	"	NA	NA
MW-DP13	Upgradient of DBB Pilot Test Area	"	NA	NA
B27-DP4	Downgradient of DBB Pilot Test Area	"	NA	NA
MW-NASB26	Upgradient of DBB Pilot Test Area		NA	NA

TABLE 3-2 (cont.)

PERIODIC SOIL AND MINI-WELL SAMPLING LOCATIONS
WORK PLAN
NAVY EXCHANGE SERVICE STATION
NAVAL AIR STATION, BRUNSWICK, MAINE
PAGE 2 OF 2

Notes:

1. The monitoring wells to be sampled for GRO and BTEX/MTBE analyses shall be selected based on the results of the baseline or previous sampling results. Up to 10 wells are scheduled to be sampled. The analytical methods to be used will be determined after evaluation of the baseline sampling data.

2. The soil samples to be collected for chemical analyses shall be selected based on the results of the baseline or previous sampling results. Up to 13 boreholes are scheduled to be sampled. The analytical methods to be used will be determined after evaluation of the baseline sampling data.

Abbr.:

A – ammonia
BTEX - benzene, toluene, ethylbenzene, and xylene
GRO - gasoline range organics, by Maine method 4.2.17
IGP - pilot test inorganic geochemical parameters [Fe, Mn, K, P, Mg, Ca, hardness, alkalinity or Total Inorganic Carbon]
MTBE - methyl tert butyl ether
N/N - nitrate/nitrite
VPH – volatile petroleum hydrocarbon (Massachusetts method)
8260B – SW-846 GC/MS VOCs method

TABLE 3-3

FIELD AND QUALITY CONTROL SAMPLE SUMMARY
WORK PLAN
NAVY EXCHANGE SERVICE STATION
NAVAL AIR STATION, BRUNSWICK, MAINE

SAMPLE TYPE	ANALYSIS	FIELD SAMPLES	RINSATE (EQUIPMENT) BLANKS(1)	FIELD DUPLICATES(2)	FIELD BLANKS(3)	TRIP BLANKS(4)	Lab QCs(5)	TOTAL (w/o Lab QC)
Baseline Groundwater Samples	GRO (Maine)	10	1	1	1	1	1	14
	BTEX/MTBE	10	1	1	1	1	1	14
	Nitrates/Nitrites	10	1	1	1	0	1	13
	Ammonia	10	1	1	1	0	1	13
	Total Inorganic Carbon	10	1	1	1	0	1	13
	Inorganic Geochemical Parameters(6)	10	1	1	1	0	1	13
Periodic Groundwater Sampling	GRO (Maine)	10	1	1	1	1	1	14
	BTEX/MTBE	10	1	1	1	1	1	14
	Ammonia	10	1	1	1	0	1	13
Baseline Soil Sampling	GRO (Maine)	26	3	3	3	3	2	38
	VPH (Mass.)	4	1	1	1	1	1	8
	VOCs by 8260B	8	1	1	1	1	1	12
Periodic Soil Sampling (7)	GRO (Maine)	26	3	3	3	3	2	38 (7)
	VPH (Mass.) TBD	4	1	1	1	1	1	8 (7)
	VOCs by 8260B	8	1	1	1	1	1	12 (7)

Notes:

(1) Collect 1 rinsate blank per 10 field samples.
(2) Collect 1 duplicate per 10 field samples.
(3) Collect 1 field blank per water source (e.g. decontamination rinse water [one per lot number]).
(4) Collect 1 trip blank per 10 GRO samples
(5) Collect 1 Lab QC per 20 samples
(6) Inorganic Geochemical Parameters Include Fe, Mn, K, Mg, Ca, hardness, carbonate alkalinity.
(7) Three periodic events planned; the totals represent quantities per event. The actual number of samples to be collected is to be determined.

Abbr:

BTEX - benzene, toluene, ethylbenzene, and xylene
GRO - gasoline range organics, by Maine 4.2.17
MTBE - methyl tert butyl ether
TBD – to be determined
VPH – volatile petroleum hydrocarbons, MA method
VOCs – volatile organic compounds

TABLE 3-4

ANALYTICAL METHODS, SAMPLE CONTAINER, PRESERVATIVE, AND HOLDING TIME REQUIREMENTS
WORK PLAN
NAVY EXCHANGE SERVICE STATION
NAVAL AIR STATION, BRUNSWICK, MAINE

SAMPLE MEDIUM	ANALYSIS	SAMPLE CONTAINER[1]	SAMPLE PRESERVATIVE [2]	RINSATE SAMPLE CONTAINER	HOLDING TIME
Baseline Groundwater Sampling	GRO Maine HETL Method 4.2.17	(2) 40 mL VOA vials	HCl to pH < 2	(2) 40 mL VOA vials	14 days
	BTEX/MTBE by EPA 8260B	(3) 40 mL VOA vials	HCl to pH < 2	(3) 40 mL VOA vials	14 days
	Nitrate, Nitrite by EPA 353.2	(1) 250 mL poly	Ice only	(1) 250 mL poly	24 hours
	Total Inorganic Carbon by EPA 415.1	(2) 40 mL VOA vials	HCl or H_2SO_4 to pH < 2	(2) 40 mL VOA vials	28 days
	Fe, Mn, K, Mg, Ca by EPA 6010B; hardness by Standard Method 2340B	(1) 250 mL poly	HNO_3 to pH < 2	(1) 250 mL poly	180 days
	Ammonia by EPA 350.2/350.1	(1) 1 L poly	H_2SO_4 to pH < 2	(1) 1 L poly	24 hours
Periodic Groundwater Sampling	GRO by Maine HETL Modified Method 4.2.17	(2) 40 mL VOA vials	HCl to pH < 2	(2) 40 mL VOA vials	14 days
	BTEX/MTBE by EPA 8260B	(3) 40 mL VOA vials	HCl to pH < 2	(3) 40 mL VOA vials	14 days
	Ammonia by EPA 350.2	(1) 1 L poly	Ice only	(1) 1 L poly	24 hours
Baseline Soil Sampling	GRO by Maine HETL Method 4.2.17	(2) 40 mL VOA vials for 10 g soil	10 mL MeOH	(2) 40 mL VOA vials	14 days
	VPH by MADEP Method, May, 2004	(2) 40 mL VOA vials for 15 g soil	15 mL MeOH	(2) 40 mL VOA vials	28 days
	VOCs by 8260B Modified	(2) 40 mL VOA vials for 10 g soil	10 mL MeOH	(2) 40 mL VOA vials	14 days
Periodic Soil Sampling	GRO by Maine HETL Method 4.2.17	(2) 40 mL VOA vials for 10 g soil	10 mL MeOH	(2) 40 mL VOA vials	14 days
	VPH by MADEP Method, May, 2004	(2) 40 mL VOA vials for 15 g soil	15 mL MeOH	(2) 40 mL VOA vials	28 days
	VOCs by 8260B Modified	(2) 40 mL vials for 10 g soil	10 mL MeOH	(2) 40 mL vials	14 days

TABLE 3-4 (cont.)

ANALYTICAL METHODS, SAMPLE CONTAINER, PRESERVATIVE, AND HOLDING TIME REQUIREMENTS
WORK PLAN
NAVY EXCHANGE SERVICE STATION
NAVAL AIR STATION, BRUNSWICK, MAINE
PAGE 2 OF 2

Notes:

(1) Triple volume needed for organic laboratory QC, and double volume needed for metal laboratory QC, at a rate of one per 20 field samples. Also, actual volumes and bottle requirements needed for all analyses will be verified with the selected analytical laboratory prior to initiation of sampling event.

(2) All soil, groundwater, aqueous rinsate blanks, filed blank samples will be stored and shipped at 4 degrees C +/- 2 celcius degrees.

Abbr:

BTEX - benzene, toluene, ethylbenzene, and xylene
GRO - gasoline range organics, by Maine 4.2.17
MTBE - methyl tert butyl ether
VOC – volatile organic compound
VPH - volatile petroleum hydrocarbons, MA method

HCl - hydrochloric acid
HNO_3 - nitric acid
H_2SO_4 - sulfuric acid
MeOH - methanol

g – gram
L -liter

TABLE 4-1

PROJECT ACTION LIMITS AND QUANTITATION LIMITS – GROUNDWATER
WORK PLAN
NAVY EXCHANGE SERVICE STATION
NAVAL AIR STATION, BRUNSWICK, MAINE

ANALYTES	CAS NUMBER	PROJECT ACTION LIMIT	PROJECT QUANTITATION LIMIT	Achievable Laboratory Limits	
				MDLs (ug/kg)	QLs (ug/kg)
Benzene	71-43-2	5 ug/L (1)	2.5 ug/L	TBD	2.5
Ethyl Benzene	100-41-4	35 ug/L (2)	2.5 ug/L	TBD	2.5
Toluene	108-88-3	500 ug/L (2)	2.5 ug/L	TBD	2.5
Xylene	1330-20-7	10,000 ug/L (2)	2.5 ug/L	TBD	2.5
MTBE	1634-64-4	25 ug/L (1)	2.5 ug/L	TBD	2.5
Nitrate as Nitrogen	NA	10 mg/L (2)	0.5 mg/L	TBD	0.5
Nitrite as Nitrogen	14-797-65-0	10 mg/L (2)	0.5 mg/L	TBD	0.5
Ammonium	NA	1.0 mg/L (2)	0.5 mg/L	TBD	0.5
Alkalinity as Calcium Carbonate	NA		10	TBD	10
Total Inorganic Carbon	NA				
Fe	7439-89-6	100 ug/L (3)	100 ug/L	TBD	10
Mn	7439-96-5	15 ug/L (3)	15 ug/L	TBD	10
K	7440-09-7	5000 ug/L (3)	5000 ug/L	TBD	10
Mg	7439-95-4	5000 ug/L (3)	5000 ug/L	TBD	10
Ca	7440-70-2	500 ug/L (3)	500 ug/L	TBD	10
Gasoline Range Organics	NA	50 ug/L (1)	12.5 ug/L	TBD	12.5

Notes:

1. *Procedural Guidelines for Establishing Action Levels and Remediation Goals for the Remediation of Oil* Contaminated Soil and Groundwater in Maine, Maine DEP, Appendix B, Revised March 13, 2000.
2. Maximum Contaminant Level or Maine Maximum Exposure Guideline
3. EPA CLP contract required quantitation limit; these analytes are no contaminants of concern, but are used as relative indicators of geochemical conditions.

TABLE 4-2

PROJECT ACTION LIMITS AND QUANTITATION LIMITS – SOIL
WORK PLAN
NAVY EXCHANGE SERVICE STATION
NAVAL AIR STATION, BRUNSWICK, MAINE

ANALYTE	CAS NUMBER	PROJECT ACTION LIMIT	PROJECT QUANTITATION LIMIT	Achievable Laboratory Limits	
				MDLs (ug/kg)	QLs (ug/kg)
Gasoline Range Organics	NA	500 mg/Kg (1)	2.5 mg/Kg	TBD	TBD
VPH by MA Method	NA	MDLs	C_9-C_{12} Aliphatics 2.6 mg/kg C_5-C_8 Aliphatics 10 mg/kg C_9-C_{10} Aromatics 2.6 mg/kg Target Compounds 1.3 mg/kg		
VOCs by 8260B	NA	MDLs	5 ug/kg*		

Notes:

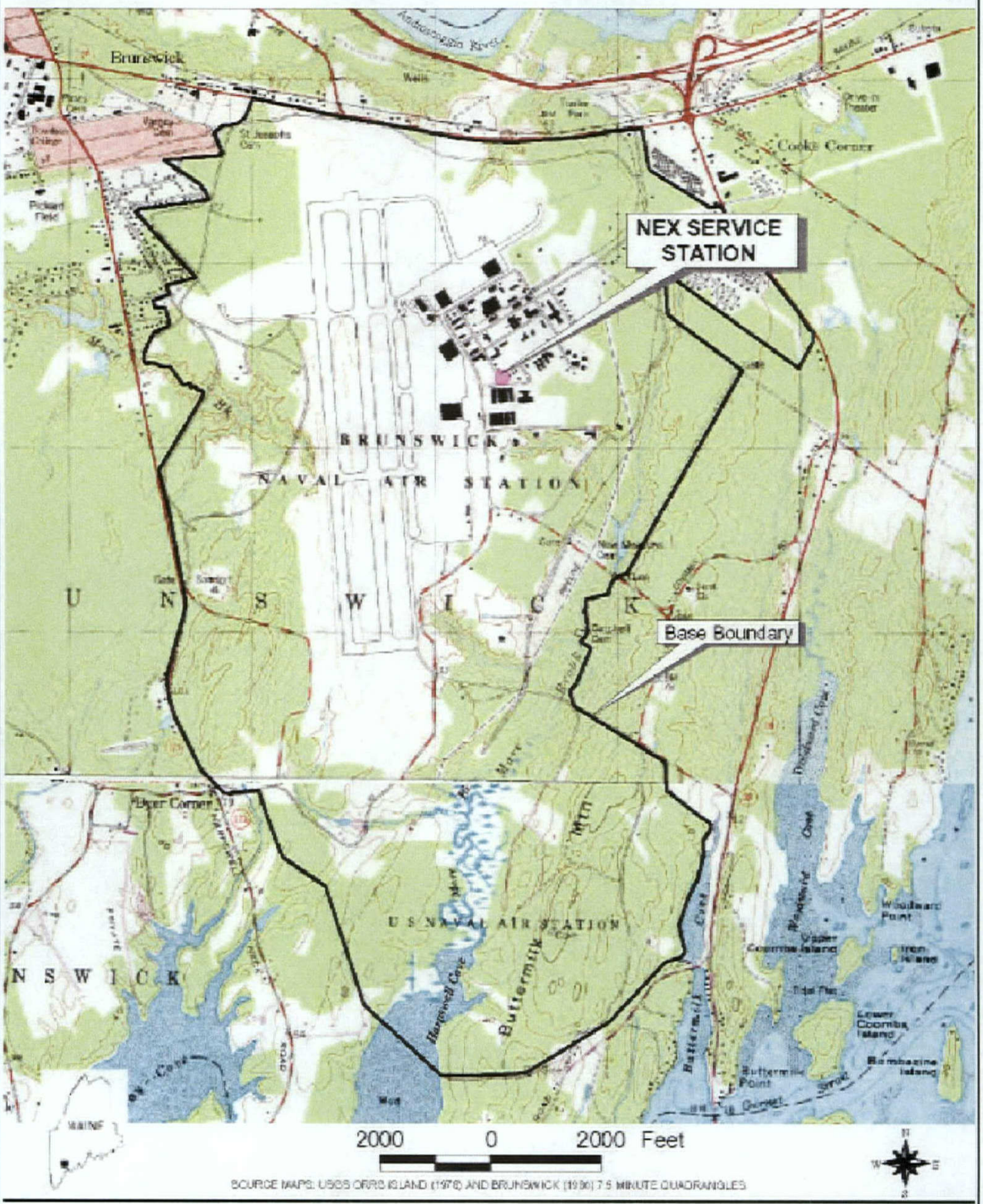
1. Based on Site-specific action level.

Abbr:

NA = Not Applicable
GRO - Gasoline Range Organics

TBD - To be determined
VOCs – volatile organic compounds
VPH – volatile petroleum hydrocarbons, Massachusetts Method
* - Except for ketones, which are 10 ug/kg

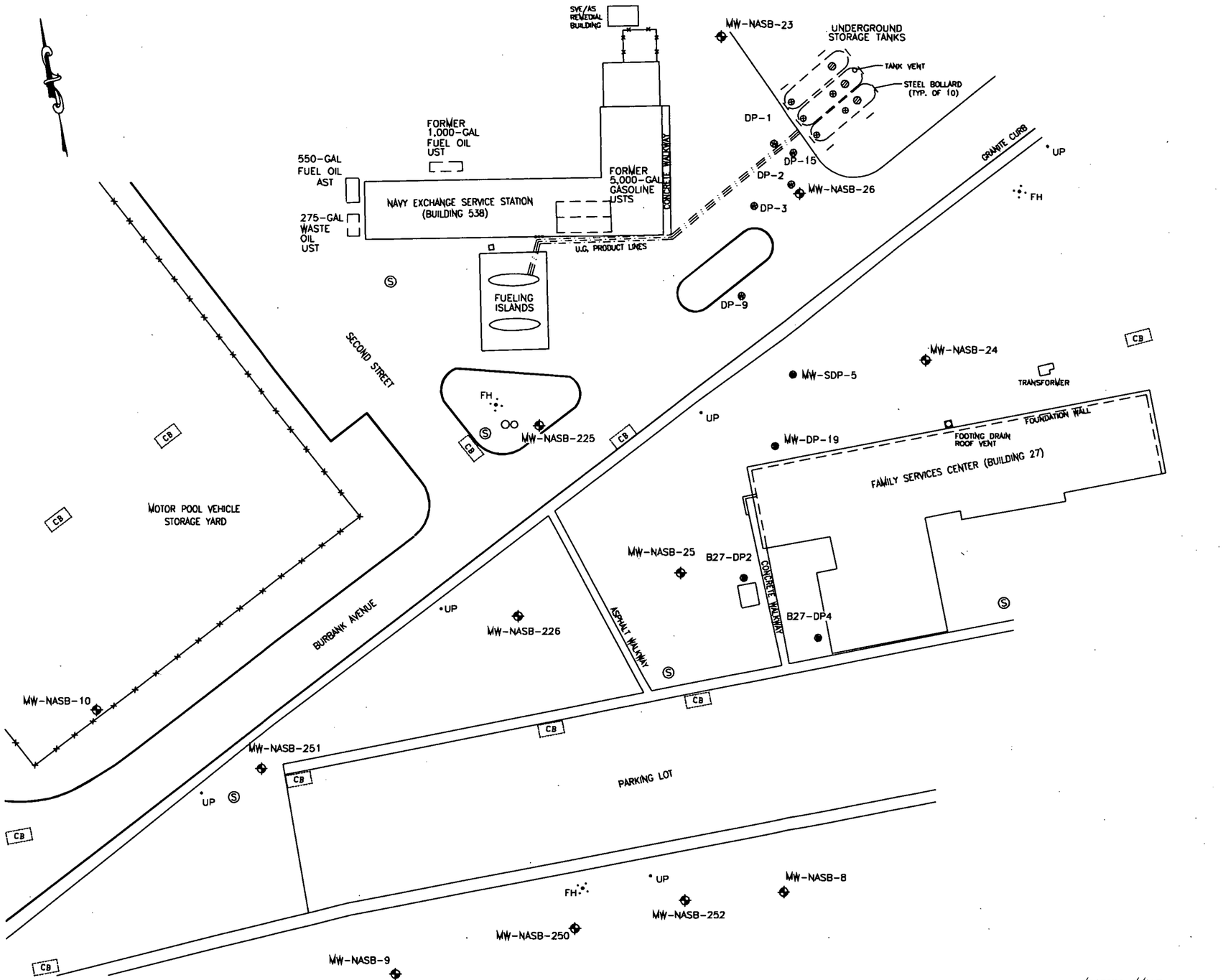
FIGURES



TETRA TECH NUS, INC.

SITE LOCATION MAP
NAVY EXCHANGE SERVICE STATION
US NAVY NAVFAC EFANE
NAVAL AIR STATION, BRUNSWICK, MAINE

SCALE	AS NOTED
FILE	DWG\4590\0411\FIG_2-1.DWG
REV	0
DATE	06/30/04
FIGURE NUMBER	2-1



LEGEND

MW-NASB-24	MONITORING WELL (POTENTIOMETRIC SURFACE ELEVATION, FT MSL) (ND = NOT DATA) (NS = NOT SURVEYED)
B27-DP2	DIRECT-PUSH SOIL BORING (LOCATION CONFIRMED BY SURVEY) (POTENTIOMETRIC SURFACE ELEVATION, FT MSL)
DP-15	DIRECT-PUSH SOIL BORING COMPLETED AS 1.5-IN FLUSH MOUNT MONITORING WELL (POTENTIOMETRIC SURFACE ELEVATION, FT MSL)
FH	FIRE HYDRANT WITH BOLLARDS
UP	UTILITY POLE
CB	STORM WATER CATCH BASIN
S	SEWER MANHOLE
	EXISTING CHAIN LINK FENCE
	UNDERGROUND STRUCTURE

NOTES:

1. BASE MAP DEVELOPED FROM ERM-NEW ENGLAND, INC. SITE PLAN DATED 24 JUNE 1992 AND SURVEYS PERFORMED BY CORNERSTONE PROFESSIONAL LAND SURVEYING, INC., 20 MAY 1994, 19 JULY 1995, MAY 1997, AND 7 NOVEMBER 2001.

2. BASE MAP UPDATED AND VERIFIED BASED ON SURVEY COMPLETED 11 JUNE 2003 BY BRIAN SMITH SURVEYORS, INC.

SOURCE:

CORRECTIVE ACTION PLAN, NAVY EXCHANGE SERVIE STATION, NAVAL AIR STATION, BRUNSWICK, MAINE; EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC. - MARCH 2004.

TETRA TECH NUS, INC.

SITE PLAN
NAVAL EXCHANGE SERVICE STATION
US NAVY NAVFAC EFANE
NAVAL AIR STATION, BRUNSWICK, MAINE

FILE DWG\4590\0411\FIG_2-2.DWG	SCALE AS NOTED
FIGURE NUMBER 2-2	REV 1 / DATE 11/24/04

NAVY EXCHANGE SERVICE STATION (BUILDING 538)

U.G. PRODUCT LINES

FUELING ISLANDS

1" WATER LINE

MW-NASB-26

SVE-3

SVE-2

DP-9 (58.76)

FH

AS-10

AS-9

AS-8

MW-NASB-24

MW-SDP-5 (58.62)

AS-7

TRANSFORMER

CB

10" RCP

SECOND STREET

SVE-9

FH

SVE-10

6" WATER LINE

MW-NASB-225

SVE-11

15" RCP

SVE-8

CB

8" AC WATER LINE

UP

AS-6

MW-DP-19 (58.21)

FOOTING DRAIN ROOF VENT

FOUNDATION WALL

UTILITY CONNECTIONS (POWER, GAS, TELEPHONE, CABLE)

AS-13

AS-12

AS-11

FAMILY SERVICES CENTER (BUILDING 27)

16" VC

BURBANK AVENUE

B27-DP2 (57.61)

MW-NASB-25

CONCRETE WALKWAY

B27-DP4 (57.15)

UP

MW-NASB-226

ASPHALT WALKWAY

15" PVC

CB

PARKING LOT

N

APPROX.

LEGEND

— —	APPROXIMATE AREA OF INTEREST
—E—	ELECTRIC LINE
—W—	WATER LINE
—S—	SEWER LINE
—SVE—	SVE SYSTEM
—LAN—	LAN LINE
—AS—	AIR SPARGE LINE
—?—	UNKNOWN LINE

SCALE (feet)

0 30 60

SOURCE:

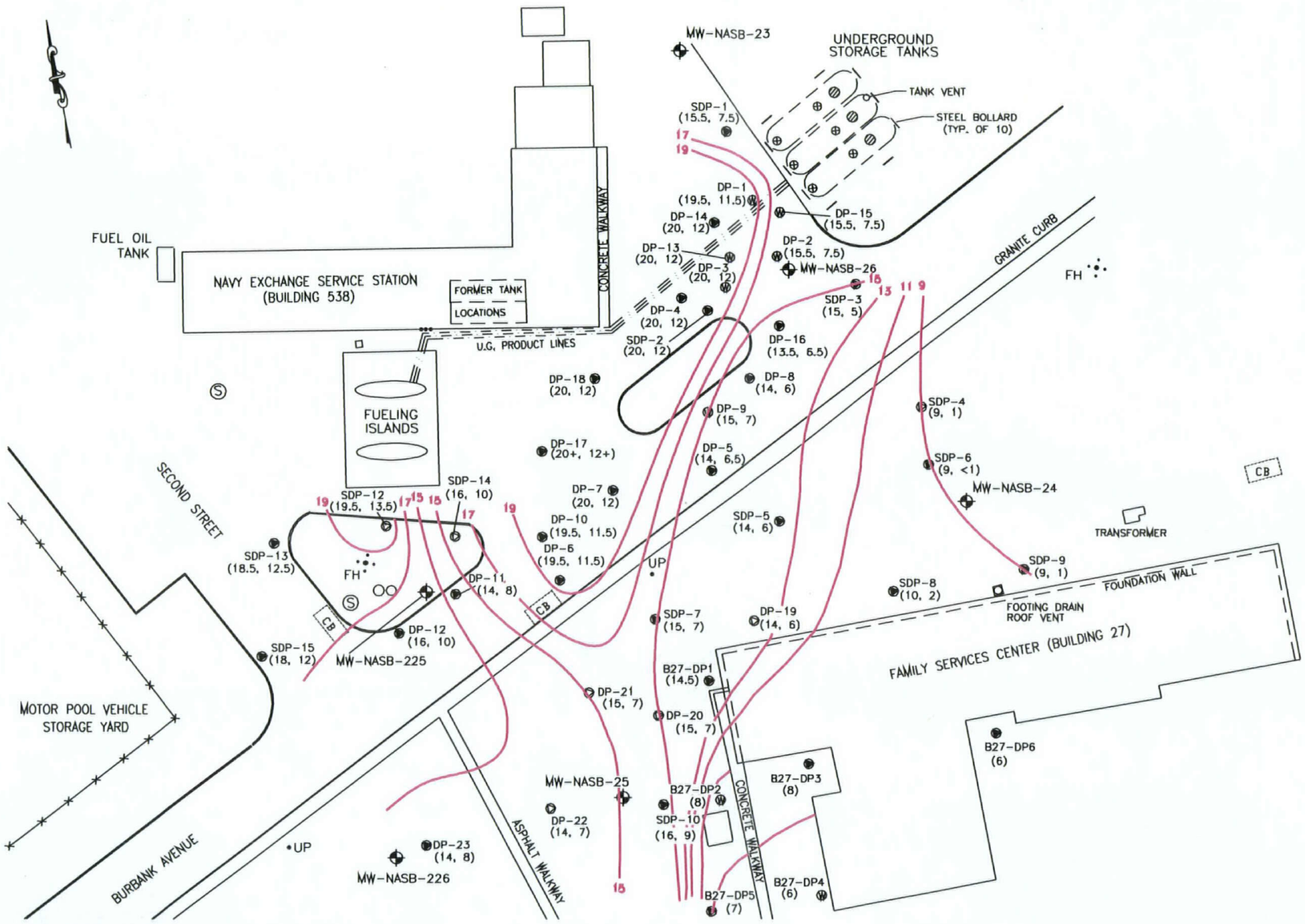
FIGURE 2, GEOPHYSICAL SURVEY. UTILITY CLEARANCE SERVICES, NAVY EXCHANGE SERVICE STATION, NAS BRUNSWICK, ME. HAGER-RICHTER GEOSCIENCE, INC. SEPT. 2004.

TETRA TECH NUS, INC.

SITE PLAN WITH UTILITY LOCATIONS
NAVAL EXCHANGE SERVICE STATION
US NAVY NAVFAC EFANE
NAVAL AIR STATION, BRUNSWICK, MAINE

FILE	SCALE
DWG\4590\3511\SITE_PLAN_UTIL.DWG	AS NOTED

FIGURE NUMBER	REV	DATE
2-3	2	11/11/04



LEGEND

- SDP-4 (9, 1) — DIRECT-PUSH LOCATION (DEPTH TO TOP OF CLAY [FT BGS], THICKNESS OF SATURATED ZONE [FT])
- 9 — DEPTH TO TOP OF CLAY ISOLINE (FT)
- MONITORING WELL
- FH — FIRE HYDRANT
- UP — UTILITY POLE
- CB — STORM WATER CATCH BASIN
- MANHOLE
- EXISTING CHAIN LINK FENCE

NOTES:

1. DEPTH TO CLAY (FT) AND THICKNESS OF SATURATED ZONE (FT) INTERPRETED FROM LOG OF SOIL BORING FOR EACH LOCATION.

2. BASE MAP DEVELOPED FROM ERM-NEW ENGLAND, INC. SITE PLAN DATED 24 JUNE 1992 AND SURVEYS PERFORMED BY CORNERSTONE PROFESSIONAL LAND SURVEYING, INC., 20 MAY 1994, 19 JULY 1995, MAY 1997, AND 7 NOVEMBER 2001.

3. BASE MAP UPDATED AND VERIFIED BASED ON SURVEY COMPLETED 11 JUNE 2003 BY BRIAN SMITH SURVEYORS, INC.

SOURCE:

CORRECTIVE ACTION PLAN, NAVY EXCHANGE SERVIE STATION, NAVAL AIR STATION, BRUNSWICK, MAINE; EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC. MARCH 2004.

GRAPHIC SCALE

0' 40' 80'

TETRA TECH NUS, INC.

INTERPRETED DEPTH TO TOP OF CLAY ISOLINES
NAVAL EXCHANGE SERVICE STATION
US NAVY NAVFAC EFANE
NAVAL AIR STATION, BRUNSWICK, MAINE

FILE	SCALE
DWG\04590\0411\FIG_2-4.DWG	AS NOTED

FIGURE NUMBER	REV	DATE
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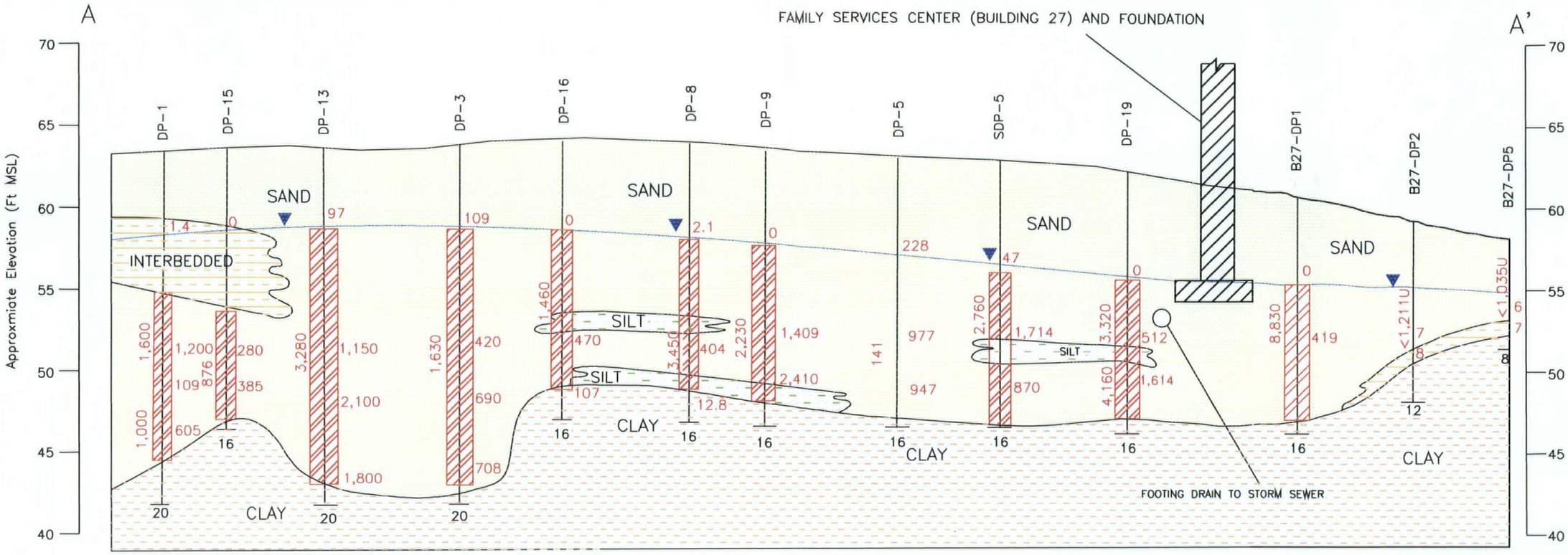


LEGEND

- SAND: BROWN/TAN/GREY FINE TO VERY FINE SAND WITH TRACE TO LITTLE SILT AND MICA; TRACE MEDIUM/COARSE SAND AND FINE GRAVEL
- SILT: BROWN/TAN SILT WITH LITTLE TO SOME VERY FINE SAND; TRACE CLAY AND MICA; WET
- CLAY: GREY MARINE CLAY WITH TRACE TO SOME CIL, PLASTIC; WET
- INTERBEDDED: BROWN/TAN FINE SAND INTERBEDDED WITH THIN SEAMS OF (1) GREY SILT WITH TRACE TO SOME CLAY, AND/OR (2) TAN/GREY CLAY WITH TRACE TO SOME SILT; VARVED/RHYTHMITE SEQUENCES COMMON
- IMPACTED SOIL: DEFINED BY TPH-GRO CONCENTRATION GREATER THAN 500 mg/kg

DP-5 — Direct-Push Sampling Location

DP designation denotes post-ISCO direct-push sampling locations (May 2002)
SDP designation denotes supplemental post-ISCO direct-push sampling locations (June 2002)

B27 designation denotes June 2003 direct-push sampling locations

228 — Water Table

977

Analytical Results (TPH-GRO soil) 141

Measured PID Headspace Monitoring Results, in ppm.

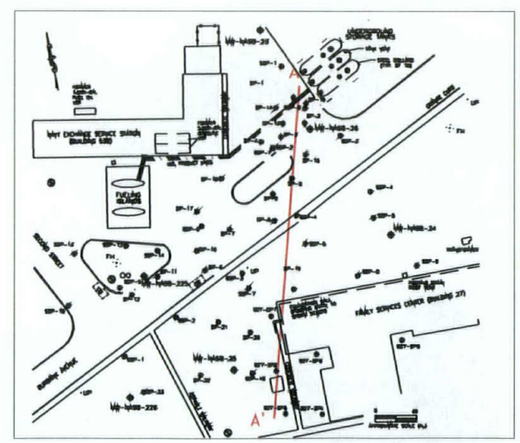
947 — End of Boring

16 — Total Depth of Boring

GRAPHIC SCALE

0' 40' 80'

VERTICAL EXAGGERATION = 5X



NOTES:

1. WATER TABLE ELEVATIONS APPROXIMATED SOIL BORING FOR EACH LOCATION.
2. CONTACTS BETWEEN BORING ARE INFERRED.
3. DEPTHS AND DESCRIPTIONS OF STRATIGRAPHIC DATA INTERPRETED FROM SOIL BORING RECORDS.
4. THE DIRECT-PUSH SAMPLING LOCATIONS PROJECTED ONTO THIS CROSS-SECTION ARE APPROXIMATED.
5. DEPTHS OF FOUNDATIONS AND FOOTING DRAIN AT THE FAMILY SERVICES BUILDING ARE APPROXIMATED.
6. PID HEADSPACE MONITORING RESULTS ARE SHOWN IN RED TEXT AND ARE MEASURED IN PARTS PER MILLION (ppm).

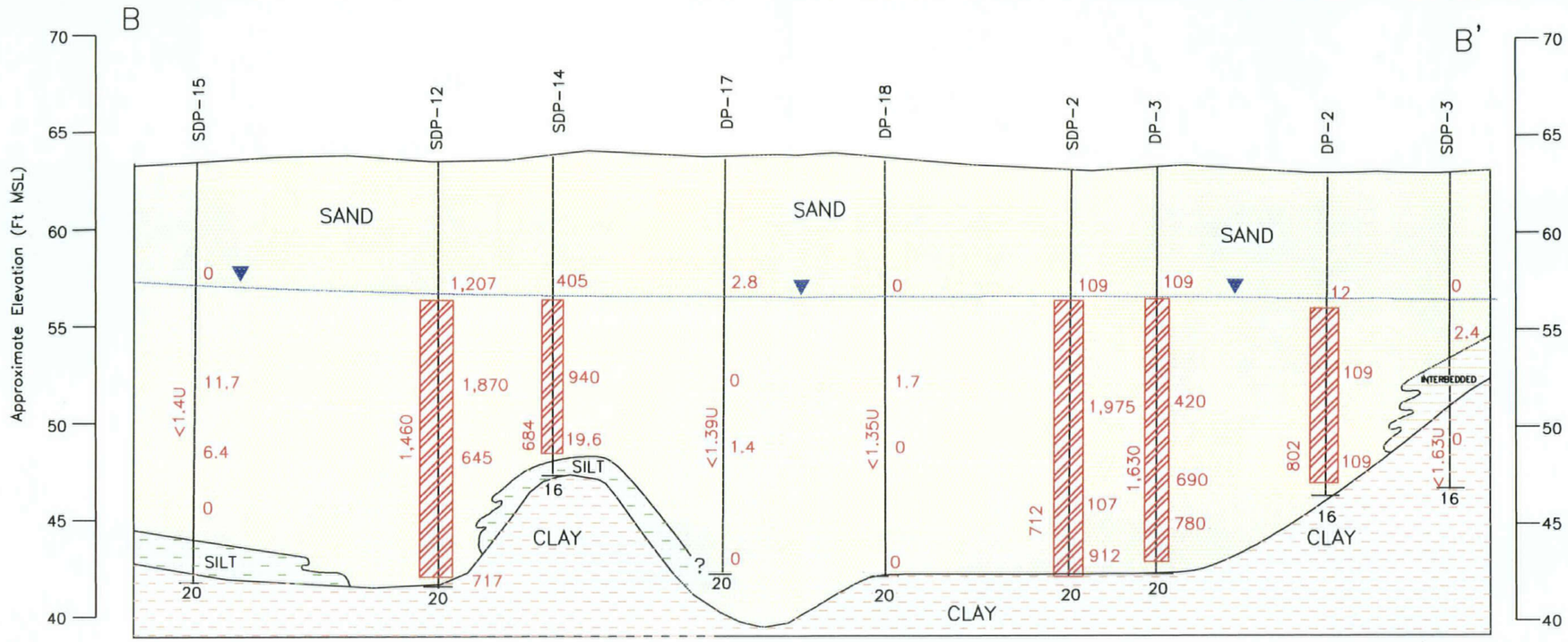
SOURCE:

CORRECTIVE ACTION PLAN, NAVY EXCHANGE SERVIE STATION, NAVAL AIR STATION, BRUNSWICK, MAINE; EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC. MARCH 2004.

TETRA TECH NUS, INC.

CROSS-SECTION A-A'
NAVAL EXCHANGE SERVICE STATION
US NAVY NAVFAC EFANE
NAVAL AIR STATION, BRUNSWICK, MAINE

FILE	SCALE
DWG\4590\0411\FIG_2-5.DWG	AS NOTED
FIGURE NUMBER 2-5	REV 1 / DATE 11/24/04



LEGEND

- SAND: BROWN/TAN/GREY FINE TO VERY FINE SAND WITH TRACE TO LITTLE SILT AND MICA; TRACE MEDIUM/COARSE SAND AND FINE GRAVEL
- SILT: BROWN/TAN SILT WITH LITTLE TO SOME VERY FINE SAND; TRACE CLAY AND MICA; WET
- CLAY: GREY MARINE CLAY WITH TRACE TO SOME CIL, PLASTIC; WET
- INTERBEDDED: BROWN/TAN FINE SAND INTERBEDDED WITH THIN SEAMS OF (1) GREY SILT WITH TRACE TO SOME CLAY, AND/OR (2) TAN/GREY CLAY WITH TRACE TO SOME SILT; VARVED/RHYTHMITE SEQUENCES COMMON
- IMPACTED SOIL: DEFINED BY TPH-GRO CONCENTRATION GREATER THAN 500 mg/kg

DP-2 — Direct-Push Sampling Location
DP designation denotes post-ISCO direct-push sampling locations (May 2002)
SDP designation denotes supplemental post-ISCO direct-push sampling locations (June 2002)

Ground Surface

12 — Water Table

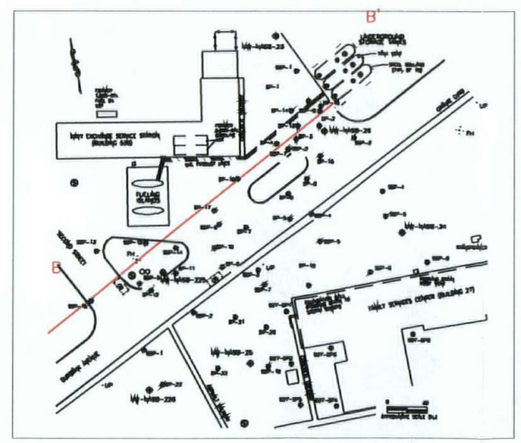
Analytical Results (TPH-GRO soil)

802 — 109 — PID Headspace Monitoring Results, in ppm.

109

16 — End of Boring
Total Depth of Boring

GRAPHIC SCALE
0' 40' 80'
VERTICAL EXAGGERATION = 5X



NOTES:

1. WATER TABLE ELEVATIONS APPROXIMATED SOIL BORING FOR EACH LOCATION.
2. CONTACTS BETWEEEN BORING ARE INFERRED.
3. DEPTHS AND DESCRIPTIONS OF STRATIGRAPHIC DATA INTERPRETED FROM SOIL BORING RECORDS.
4. THE DIRECT-PUSH SAMPLING LOCATIONS PROJECTED ONTO THIS CROSS-SECTION ARE APPROXIMATED.
5. PID HEADSPACE MONITORING RESULTS ARE SHOWN IN RED TEXT AND ARE MEASURED IN PARTS PER MILLION (ppm).

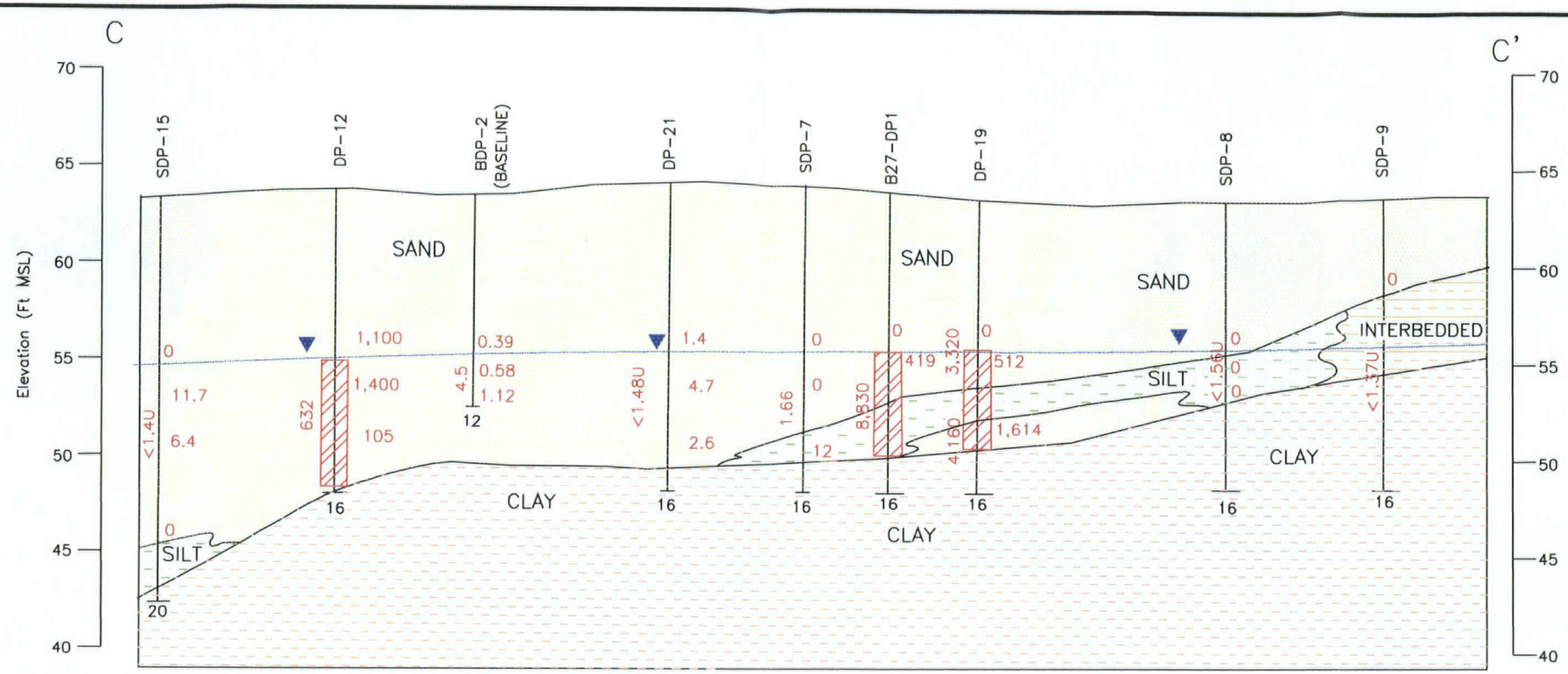
SOURCE:

CORRECTIVE ACTION PLAN, NAVY EXCHANGE SERVIE STATION, NAVAL AIR STATION, BRUNSWICK, MAINE; EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC. MARCH 2004.

TETRA TECH NUS, INC.

CROSS-SECTION B-B'
NAVAL EXCHANGE SERVICE STATION
US NAVY NAVFAC EFANE
NAVAL AIR STATION, BRUNSWICK, MAINE

FILE	SCALE
DWG\4590\0411\FIG_2-6.DWG	AS NOTED
FIGURE NUMBER 2-6	REV 1 / DATE 11/24/04



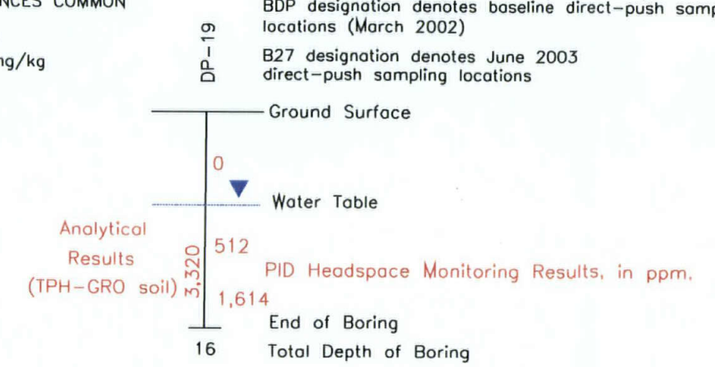
LEGEND

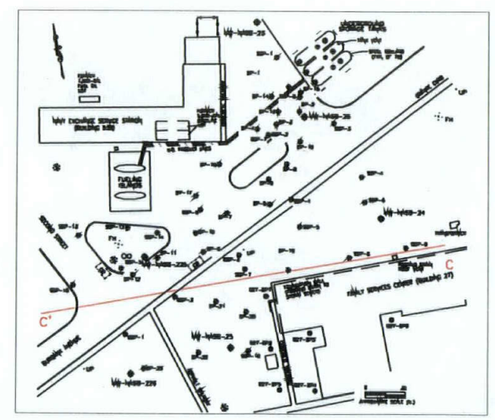
- SAND: BROWN/TAN/GREY FINE TO VERY FINE SAND WITH TRACE TO LITTLE SILT AND MICA; TRACE MEDIUM/COARSE SAND AND FINE GRAVEL
- SILT: BROWN/TAN SILT WITH LITTLE TO SOME VERY FINE SAND; TRACE CLAY AND MICA; WET
- CLAY: GREY MARINE CLAY WITH TRACE TO SOME CIL, PLASTIC; WET
- INTERBEDDED: BROWN/TAN FINE SAND INTERBEDDED WITH THIN SEAMS OF (1) GREY SILT WITH TRACE TO SOME CLAY, AND/OR (2) TAN/GREY CLAY WITH TRACE TO SOME SILT; VARVED/RHYTHMITE SEQUENCES COMMON
- IMPACTED SOIL: DEFINED BY TPH-GRO CONCENTRATION GREATER THAN 500 mg/kg

Direct-Push Sampling Location

DP designation denotes post-ISCO direct-push sampling locations (May 2002)
SDP designation denotes supplemental post-ISCO direct-push sampling locations (June 2002)
BDP designation denotes baseline direct-push sampling locations (March 2002)

B27 designation denotes June 2003 direct-push sampling locations





NOTES:

1. WATER TABLE ELEVATIONS APPROXIMATED SOIL BORING FOR EACH LOCATION.
2. CONTACTS BETWEEEN BORING ARE INFERRED.
3. DEPTHS AND DESCRIPTIONS OF STRATIGRAPHIC DATA INTERPRETED FROM SOIL BORING RECORDS.
4. THE DIRECT-PUSH SAMPLING LOCATIONS PROJECTED ONTO THIS CROSS-SECTION ARE APPROXIMATED.
5. PID HEADSPACE MONITORING RESULTS ARE SHOWN IN RED TEXT AND ARE MEASURED IN PARTS PER MILLION (ppm).

SOURCE:

CORRECTIVE ACTION PLAN, NAVY EXCHANGE SERVIE STATION, NAVAL AIR STATION, BRUNSWICK, MAINE; EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC. MARCH 2004.

GRAPHIC SCALE

0' 40' 80'

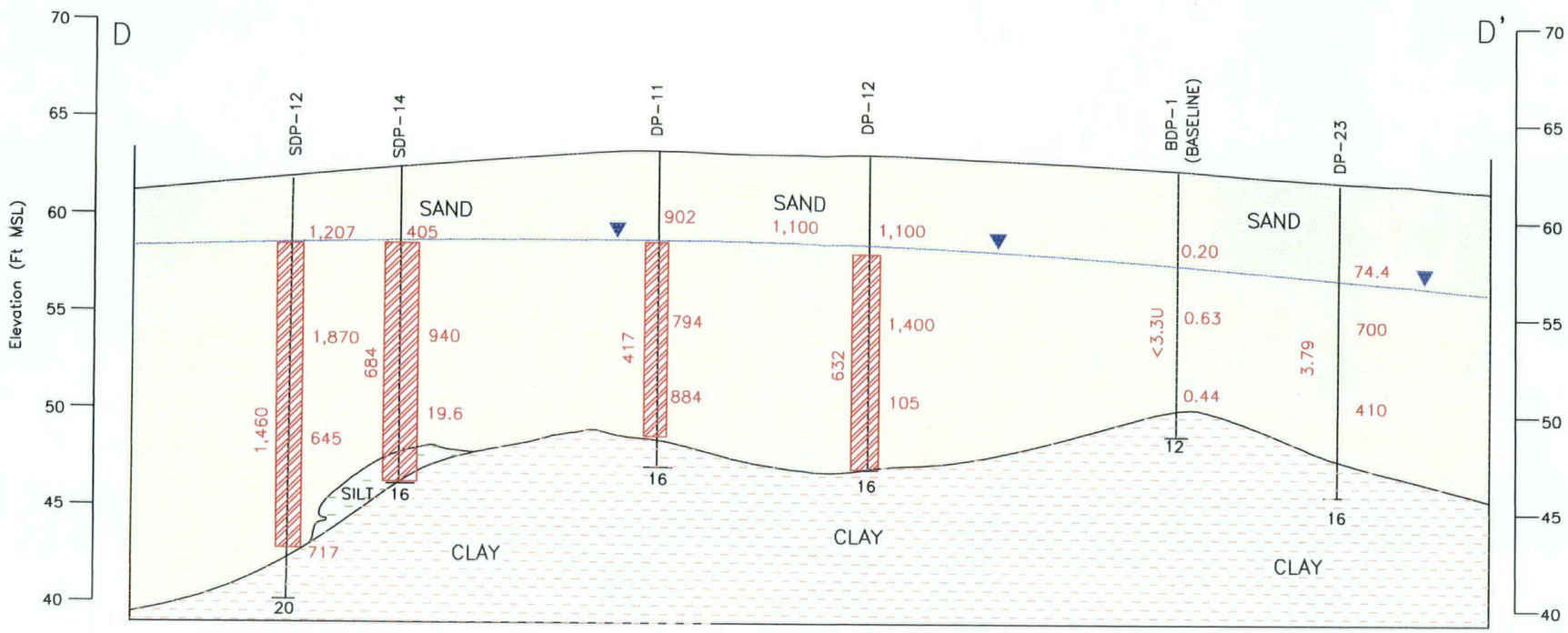
VERTICAL EXAGGERATION = 5X

TETRA TECH NUS, INC.

CROSS-SECTION C-C'
NAVAL EXCHANGE SERVICE STATION
US NAVY NAVFAC EFANE
NAVAL AIR STATION, BRUNSWICK, MAINE

FILE	SCALE
DWG\4590\0411\FIG_2-7.DWG	AS NOTED

FIGURE NUMBER	REV	DATE
2-7	1	11/24/04



LEGEND

SAND: BROWN/TAN/GREY FINE TO VERY FINE SAND WITH TRACE TO LITTLE SILT AND MICA; TRACE MEDIUM/COARSE SAND AND FINE GRAVEL

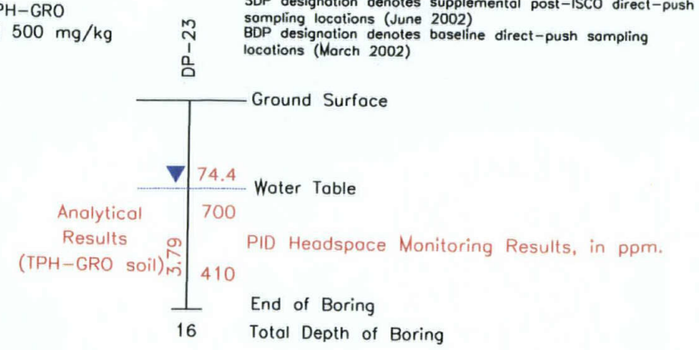
SILT: BROWN/TAN SILT WITH LITTLE TO SOME VERY FINE SAND; TRACE CLAY AND MICA; WET

CLAY: GREY MARINE CLAY WITH TRACE TO SOME CIL, PLASTIC; WET

IMPACTED SOIL: DEFINED BY TPH-GRO CONCENTRATION GREATER THAN 500 mg/kg

Monitoring Well/Direct-Push Sampling Location

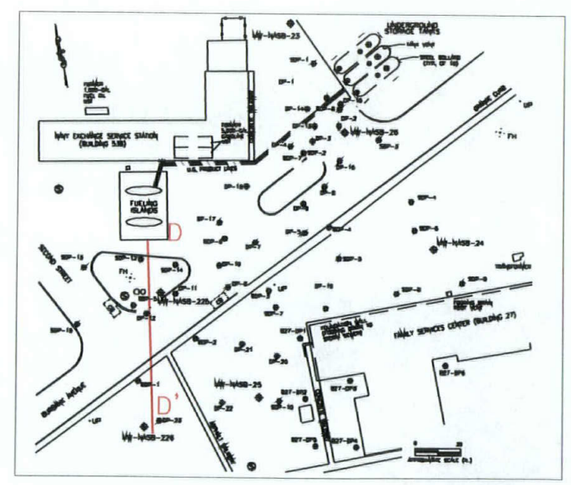
DP designation denotes post-ISCO direct-push sampling locations (May 2002)
SDP designation denotes supplemental post-ISCO direct-push sampling locations (June 2002)
BDP designation denotes baseline direct-push sampling locations (March 2002)



GRAPHIC SCALE

0' 40' 80'

VERTICAL EXAGGERATION = 5X



NOTES:

1. WATER TABLE ELEVATIONS APPROXIMATED SOIL BORING FOR EACH LOCATION.
2. CONTACTS BETWEEEN BORING ARE INFERRED.
3. DEPTHS AND DESCRIPTIONS OF STRATIGRAPHIC DATA INTERPRETED FROM SOIL BORING RECORDS.
4. THE DIRECT-PUSH SAMPLING LOCATIONS PROJECTED ONTO THIS CROSS-SECTION ARE APPROXIMATED.
5. PID HEADSPACE MONITORING RESULTS ARE SHOWN IN RED TEXT AND ARE MEASURED IN PARTS PER MILLION (ppm).

SOURCE:

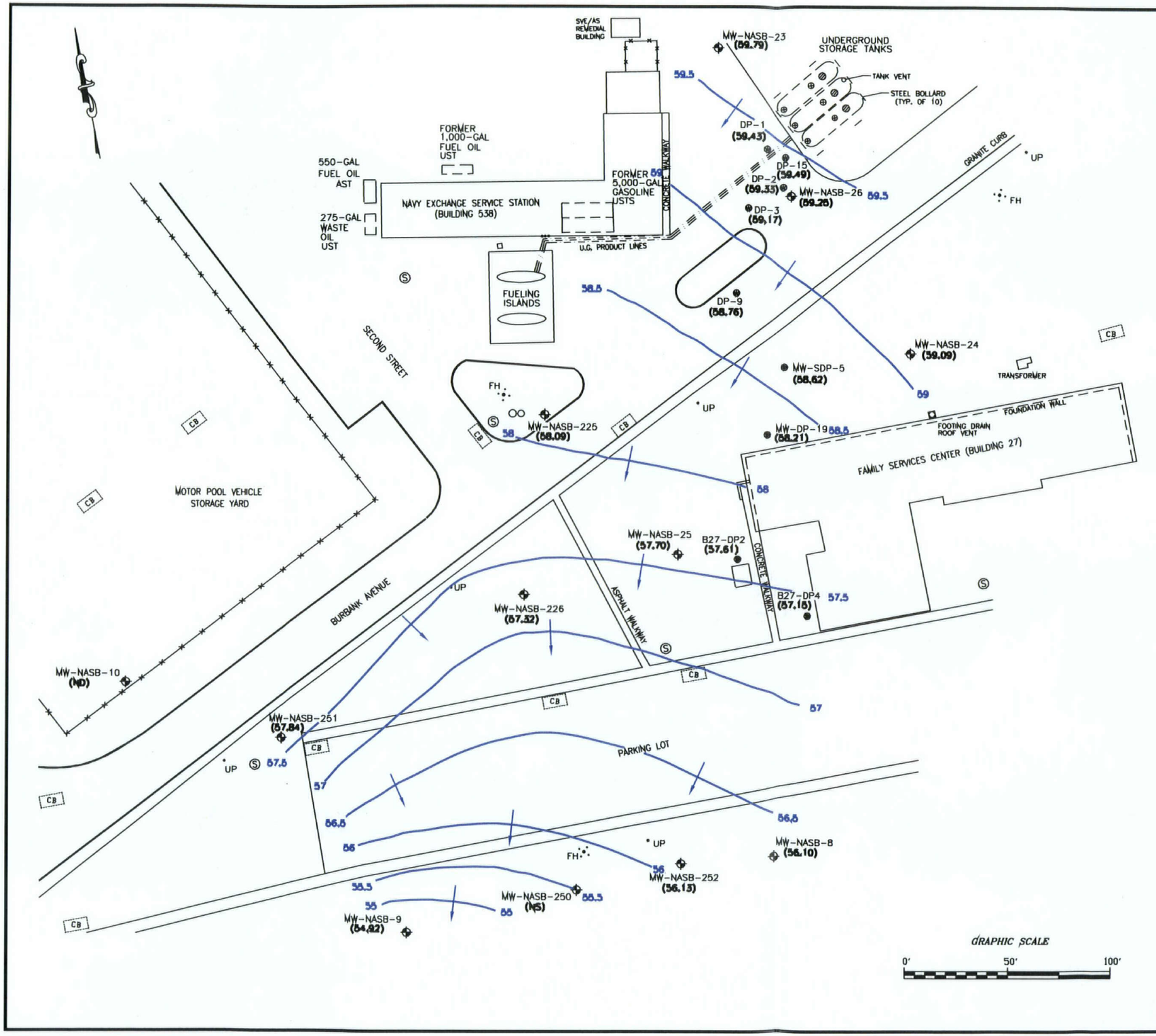
CORRECTIVE ACTION PLAN, NAVY EXCHANGE SERVIE STATION, NAVAL AIR STATION, BRUNSWICK, MAINE; EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC. MARCH 2004.

TETRA TECH NUS, INC.

CROSS-SECTION D-D'
NAVAL EXCHANGE SERVICE STATION
US NAVY NAVFAC EFANE
NAVAL AIR STATION, BRUNSWICK, MAINE

FILE	SCALE
DWG\4590\0411\FIG_2-8.DWG	AS NOTED

FIGURE NUMBER	REV	DATE
2-8	1	11/24/04



LEGEND

MW-NASB-24 (58.86)	MONITORING WELL (POTENTIOMETRIC SURFACE ELEVATION, FT MSL) (ND = NOT DATA) (NS = NOT SURVEYED)
B27-DP2 (57.61)	DIRECT-PUSH SOIL BORING (LOCATION CONFIRMED BY SURVEY) (POTENTIOMETRIC SURFACE ELEVATION, FT MSL)
DP-15 (59.49)	DIRECT-PUSH SOIL BORING COMPLETED AS 1.5-IN FLUSH MOUNT MONITORING WELL (POTENTIOMETRIC SURFACE ELEVATION, FT MSL)
FH	FIRE HYDRANT WITH BOLLARDS
UP	UTILITY POLE
CB	STORM WATER CATCH BASIN
S	SEWER MANHOLE
	EXISTING CHAIN LINK FENCE
	UNDERGROUND STRUCTURE
59	INTERPRETED POTENTIOMETRIC SURFACE (CONTOUR INTERVAL = 0.5 FT)
	INTERPRETED DIRECTION OF GROUNDWATER FLOW

NOTES:

1. BASE MAP DEVELOPED FROM ERM-NEW ENGLAND, INC. SITE PLAN DATED 24 JUNE 1992 AND SURVEYS PERFORMED BY CORNERSTONE PROFESSIONAL LAND SURVEYING, INC., 20 MAY 1994, 19 JULY 1995, MAY 1997, AND 7 NOVEMBER 2001.

2. BASE MAP UPDATED AND VERIFIED BASED ON SURVEY COMPLETED 11 JUNE 2003 BY BRIAN SMITH SURVEYORS, INC.

SOURCE:

CORRECTIVE ACTION PLAN, NAVY EXCHANGE SERVIE STATION, NAVAL AIR STATION, BRUNSWICK, MAINE; EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC. MARCH 2004.

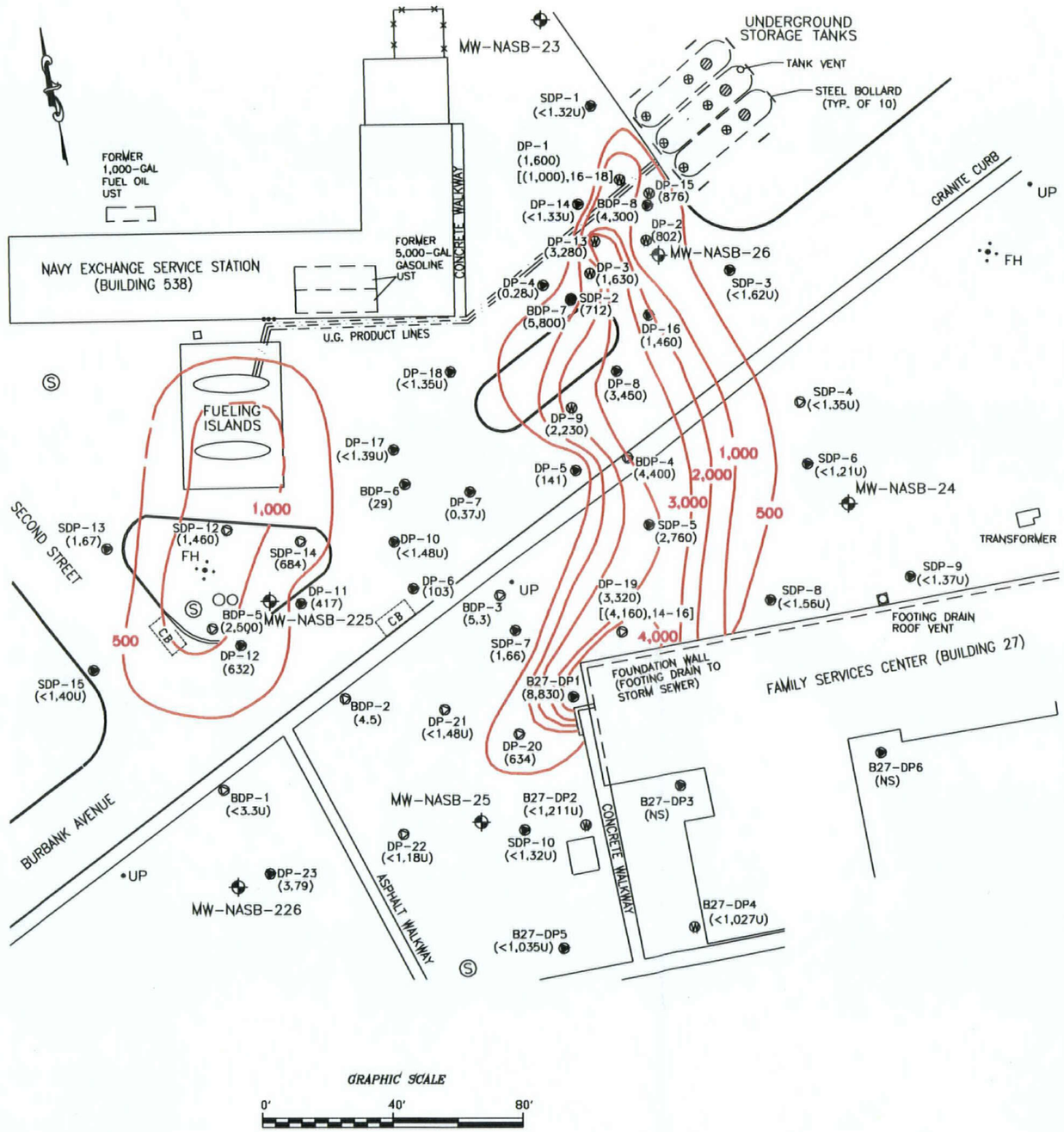
GRAPHIC SCALE

0' 50' 100'

TETRA TECH NUS, INC.

INTERPRETED GROUNDWATER FLOW AND POTENTIOMETRIC ELEVATIONS
NAVAL EXCHANGE SERVICE STATION
US NAVY NAVFAC EFANE
NAVAL AIR STATION, BRUNSWICK, MAINE

FILE	SCALE
DWG\4590\0411\FIG_2-9.DWG	AS NOTED
FIGURE NUMBER 2-9	REV 1 / DATE 11/24/04



LEGEND

- MONITORING WELL
- FH — FIRE HYDRANT WITH BOLLARDS
- UP — UTILITY POLE
- CB — STORMWATER CATCH BASIN
- MANHOLE
- EXISTING CHAIN LINK FENCE
- UNDERGROUND STRUCTURE
- DIRECT-PUSH SOIL BORING (LOCATION CONFIRMED BY SURVEY)
- DIRECT-PUSH SOIL BORING (LOCATION BASED ON FIELD NOTES)
- DIRECT-PUSH SOIL BORING COMPLETED AS 1.5-IN FLUSH MOUNT MONITORING WELL
- DP-1 (1,600) [(1,000),16-18] — (TPH-GRO CONCENTRATION, MG/KG) NS = NOT SAMPLED NOTE: UNLESS OTHERWISE NOTED, SOIL SAMPLING INTERVAL IS 8-12 FT BGS. [TPH-GRO CONCENTRATION AT 16-18 FT BGS]
- 500 — TOTAL SORBED-PHASE TPH-GRO CONCENTRATION ISOPLETH (MG/KG) (DASHED WHERE INFERRED)

B27 = LIMITED DIRECT-PUSH INVESTIGATION AT BUILDING 27 (9-10 JUNE 2003).
BDP = BASELINE DIRECT-PUSH SOIL BORING (20 MARCH 2002).
DP = POST-ISCO DIRECT PUSH SOIL BORING (22-24 MAY 2002).
SDP = POST-ISCO SUPPLEMENTAL DIRECT-PUSH SOIL BORING (18-20 JUNE 2002).

NOTES:

1. BASE MAP DEVELOPED FROM ERM-NEW ENGLAND, INC. SITE PLAN DATED 24 JUNE 1992 AND SURVEYS PERFORMED BY CORNERSTONE PROFESSIONAL LAND SURVEYING, INC., 20 MAY 1994, 19 JULY 1995, MAY 1997, AND 7 NOVEMBER 2001.

2. BASE MAP UPDATED AND VERIFIED BASED ON SURVEY COMPLETED 11 JUNE 2003 BY BRIAN SMITH SURVEYORS, INC.

3. BASELINE DIRECT-PUSH POINTS MAY OVER-REPRESENT CURRENT SATURATED ZONE TPH-GRO CONCENTRATIONS. TPH-GRO CONCENTRATION ISOPLETHS WERE DEVELOPED PRIMARILY BASED ON POST-ISCO DIRECT-PUSH DATA (i.e., DP AND SDP SOIL BORINGS).

4. 1-IN. FLUSH MOUNTED MICRO-WELLS WERE INSTALLED AT POST-ISCO DIRECT-PUSH SOIL BORING LOCATION DP-19 AND POST-ISCO SUPPLEMENTAL DIRECT-PUSH SOIL BORING LOCATION SDP-5 ON 10 JUNE 2003.

5. NEWLY INSTALLED MICRO-WELLS (AT LOCATIONS DP-19 AND SPD-5) AND ALL B27 DIRECT-PUSH SOIL BORINGS (B27-DP1 THROUGH B27-DP6) WERE SURVEYED BY BRIAN SMITH SURVEYORS ON 10 JUNE 2003.

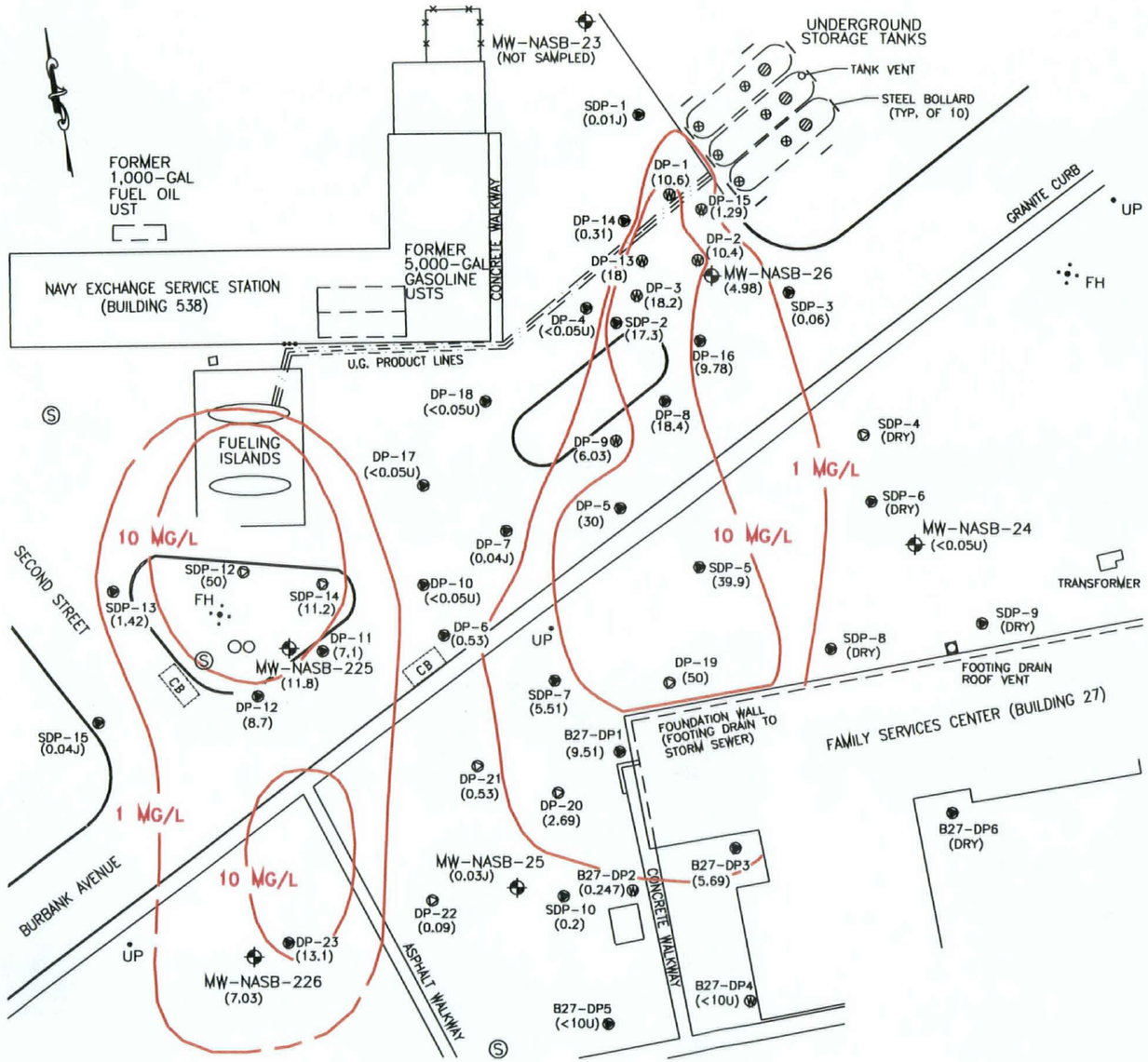
SOURCE:

CORRECTIVE ACTION PLAN, NAVY EXCHANGE SERVIE STATION, NAVAL AIR STATION, BRUNSWICK, MAINE; EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC. MARCH 2004.

TETRA TECH NUS, INC.

SATURATED ZONE SOIL TPH-GRO CONCENTRATIONS (MG/KG)
FOLLOWING IN-SITU CHEMICAL OXIDATION INJECTION
NAVAL EXCHANGE SERVICE STATION
US NAVY NAVFAC EFANE
NAVAL AIR STATION, BRUNSWICK, MAINE

FILE	SCALE
DWG\4590\0411\FIG_2-10.DWG	AS NOTED
FIGURE NUMBER 2-10	REV 1 / DATE 11/24/04



GRAPHIC SCALE

0' 40' 80'

LEGEND

- MONITORING WELL
- FH — FIRE HYDRANT WITH BOLLARDS
- UP — UTILITY POLE
- CB — STORMWATER CATCH BASIN
- MANHOLE
- EXISTING CHAIN LINK FENCE
- UNDERGROUND STRUCTURE
- DIRECT-PUSH SOIL BORING (LOCATION CONFIRMED BY SURVEY)
- DIRECT-PUSH SOIL BORING (LOCATION BASED ON FIELD NOTES)
- DIRECT-PUSH SOIL BORING COMPLETED AS 1.5-IN. FLUSH MOUNT MONITORING WELL
- B27 = LIMITED DIRECT-PUSH INVESTIGATION AT BUILDING 27 (9-10 JUNE 2003).
- DP = POST-ISCO DIRECT PUSH SOIL BORING (22-24 MAY 2002).
- SDP = POST-ISCO SUPPLEMENTAL DIRECT-PUSH SOIL BORING (18-20 JUNE 2002).
- 1 MG/L — TOTAL DISSOLVED-PHASE TPH-GRO CONCENTRATION ISOPLETH (MG/L) (DASHED WHERE INFERRED)

NOTES:

1. BASE MAP DEVELOPED FROM ERM-NEW ENGLAND, INC. SITE PLAN DATED 24 JUNE 1992 AND SURVEYS PERFORMED BY CORNERSTONE PROFESSIONAL LAND SURVEYING, INC., 20 MAY 1994, 19 JULY 1995, MAY 1997, AND 7 NOVEMBER 2001.

2. BASE MAP UPDATED AND VERIFIED BASED ON SURVEY COMPLETED 18 JUNE 2003 BY BRIAN SMITH SURVEYORS, INC.

3. 1-IN. FLUSH MOUNTED MICRO-WELLS WERE INSTALLED AT POST-ISCO DIRECT-PUSH SOIL BORING LOCATION DP-19 AND POST-ISCO SUPPLEMENTAL DIRECT-PUSH SOIL BORING LOCATION SDP-5 ON 10 JUNE 2003.

4. NEWLY INSTALLED MICRO-WELLS (AT LOCATIONS DP-19 AND SPD-5) AND ALL B27 DIRECT-PUSH SOIL BORINGS (B27-DP1 THROUGH B27-DP6) WERE SURVEYED BY BRIAN SMITH SURVEYORS ON 10 JUNE 2003.

SOURCE:

CORRECTIVE ACTION PLAN, NAVY EXCHANGE SERVIE STATION, NAVAL AIR STATION, BRUNSWICK, MAINE; EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC. MARCH 2004.

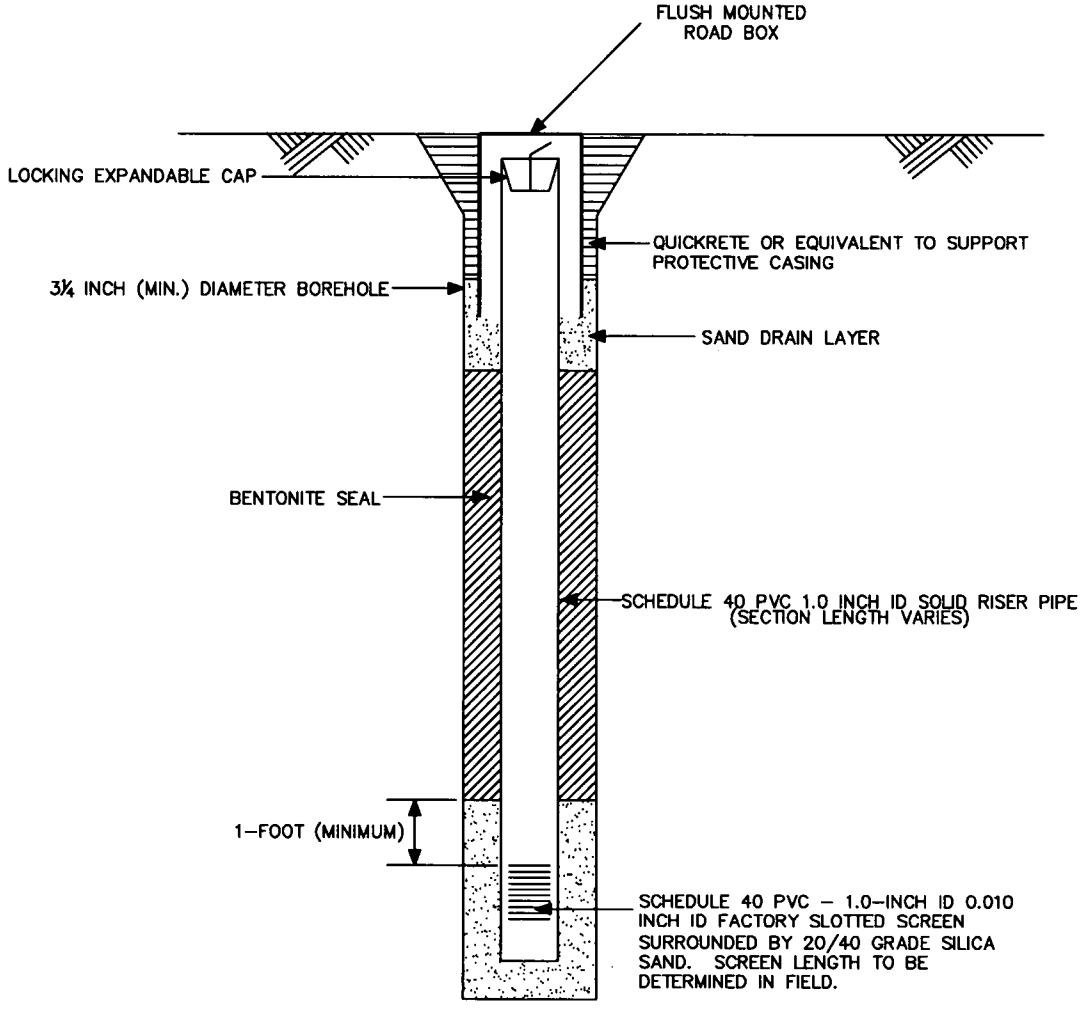
TETRA TECH NUS, INC.

DISSOLVED-PHASE TPH-GRO CONCENTRATIONS (MG/L)
FOLLOWING IN-SITU CHEMICAL OXIDATION INJECTION
NAVAL EXCHANGE SERVICE STATION
US NAVY NAVFAC EFANE
NAVAL AIR STATION, BRUNSWICK, MAINE

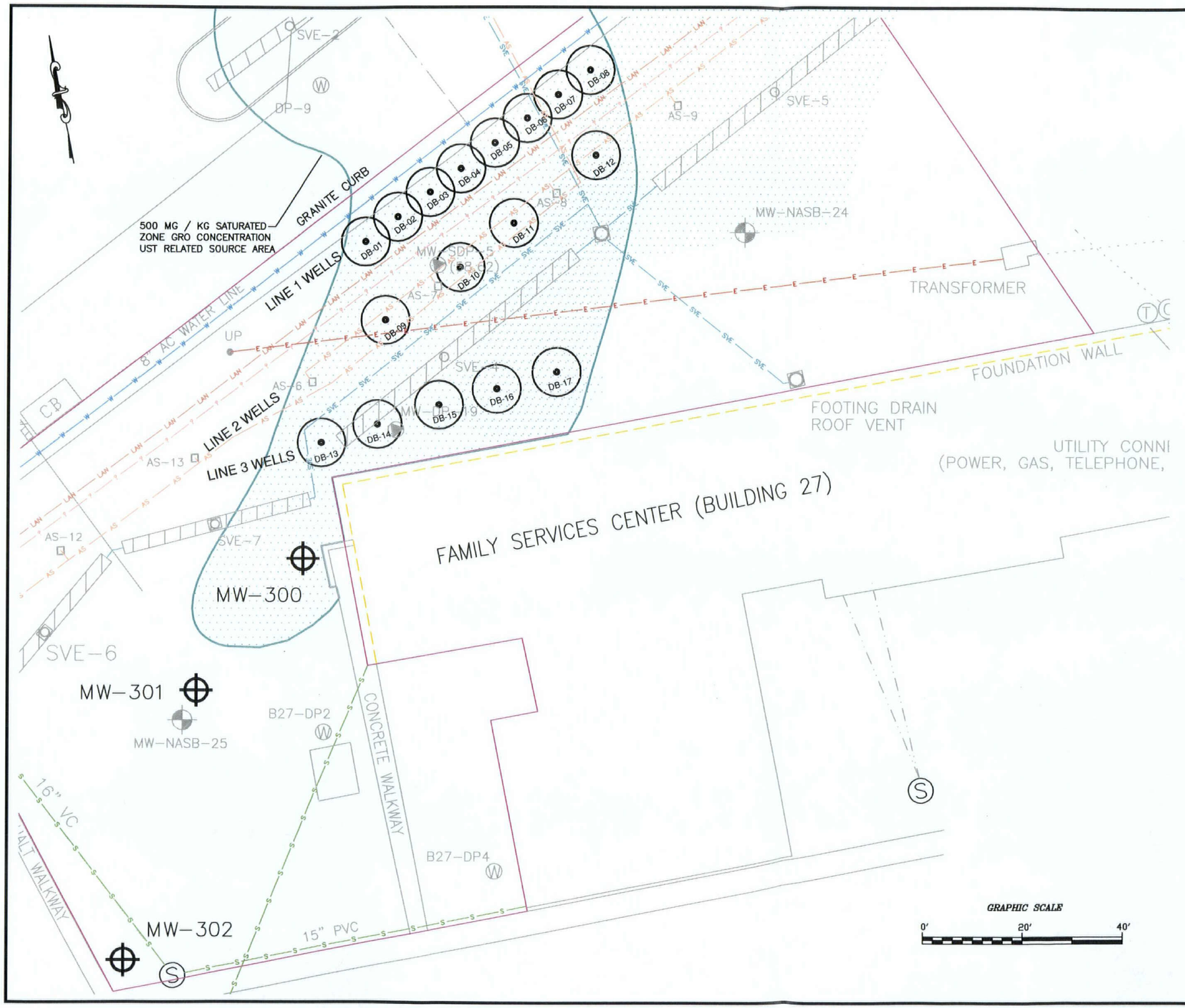
FILE	SCALE
DWG\4590\0411\FIG_2-11.DWG	AS NOTED

FIGURE NUMBER	REV	DATE
2-11	1	11/24/04

MINI- WELL



TETRA TECH NUS, INC	MINI WELL CONSTRUCTION DETAILS NAVY EXCHANGE SERVICE STATION US NAVY NAVFAC EFANE NAVAL AIR STATION, BRUNSWICK, MAINE	SCALE: AS NOTED FILE: DWG\4590\0411\FIG_3–1.DWG REV: 0 DATE: 06/30/0 FIGURE NUMBER: 3–1



LEGEND

- MONITORING WELL
- FH — FIRE HYDRANT WITH BOLLARDS
- UP — UTILITY POLE
- CB — STORM WATER CATCH BASIN
- MANHOLE
- EXISTING CHAIN LINK FENCE
- UNDERGROUND STRUCTURE
- APPROXIMATE AREA OF INTEREST
- E — ELECTRIC LINE
- W — WATER LINE
- S — SEWER LINE
- SVE — SVE SYSTEM
- LAN — LAN LINE
- AS — AIR SPARGE LINE
- ? — UNKNOWN LINE
- PROPOSED NBLEND APPLICATION WELL DB SERIES
- PROPOSED MONITORING WELL
- DBB PILOT TEST AREA

NOTES:

1. BASE MAP DEVELOPED FROM ERM-NEW ENGLAND, INC. SITE PLAN DATED 24 JUNE 1992 AND SURVEYS PERFORMED BY CORNERSTONE PROFESSIONAL LAND SURVEYING, INC., 20 MAY 1994, 19 JULY 1995, MAY 1997, AND 7 NOVEMBER 2001.
2. BASE MAP UPDATED AND VERIFIED BASED ON SURVEY COMPLETED 11 JUNE 2003 BY BRIAN SMITH SURVEYORS, INC.
3. SOIL VAPOR EXTRACTION/AIR SPARGING SYSTEM COMPONENTS NOT SHOWN.
4. UTILITIES SHOWN FOR REFERENCE PURPOSE ONLY. ACTUAL LOCATIONS MUST BE FIELD VERIFIED.
5. PROPOSED WELL LOCATIONS TO BE IN SUBSTANTIAL COMPLIANCE WITH PLAN BUT LOCATIONS MAY CHANGE DUE TO ACTUAL UTILITY AND/OR OTHER OBSTRUCTIONS FOUND IN THE FIELD.

SOURCE:

FOCUSED FEASIBILITY STUDY, NAVY EXCHANGE SERVIE STATION, NAVAL AIR STATION, BRUNSWICK, MAINE; EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC. APRIL 2004.

GEOPHYSICAL SURVEY, HAGER-RICHTER GEOSCIENCE, INC., SALEM, NEW HAMPSHIRE, AUGUST 2004.

TETRA TECH NUS, INC.

PROPOSED DBB PILOT TEST STUDY AREA
NAVAL EXCHANGE SERVICE STATION
US NAVY NAVFAC EFANE
NAVAL AIR STATION, BRUNSWICK, MAINE

FILE	SCALE
DWG\4590\3511\WELL_LOC_PROP.DWG	AS NOTED

FIGURE NUMBER	REV	DATE
3-2	2	11/11/04

APPENDIX A

SELECTED STANDARD OPERATING PROCEDURES

TABLE OF CONTENTS

SECTION **PAGE**

1.0 PURPOSE 2

2.0 SCOPE 2

3.0 GLOSSARY 2

4.0 RESPONSIBILITIES 2

5.0 PROCEDURES 2

5.1 INTRODUCTION 2
5.2 SAMPLE IDENTIFICATION FIELD REQUIREMENTS 3
5.3 EXAMPLE SAMPLE FIELD DESIGNATIONS 4
5.4 EXAMPLES OF SAMPLE NOMENCLATURE 5
5.5 FIELD QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) SAMPLE NOMENCLATURE) 6
5.6 EXAMPLES OF FIELD QA/QC SAMPLE NOMENCLATURE 6

6.0 DEVIATIONS 6

1.0 PURPOSE

The purpose of this document is to specify a consistent sample nomenclature system that will facilitate subsequent data management in a cost-effective manner. The sample nomenclature system has been devised such that the following objectives can be attained:

- Sorting of data by matrix.
- Sorting of data by depth.
- Maintenance of consistency (field, laboratory, and data base sample numbers).
- Accommodation of all project-specific requirements.
- Accommodation of laboratory sample number length constraints (maximum of 20 characters).

2.0 SCOPE

The methods described in this procedure shall be used consistently for all projects requiring electronic data.

3.0 GLOSSARY

None.

4.0 RESPONSIBILITIES

Program Manager - It shall be the responsibility of the Program Manager (or designee) to inform contract-specific Project Managers of the existence and requirements of this Standard Operating Procedure.

Project Manager - It shall be the responsibility of the Project Manager to determine the applicability of this Standard Operating Procedure based on: (1) program-specific requirements, and (2) project size and objectives. It shall be the responsibility of the Project Manager (or designee) to ensure that the sample nomenclature is thoroughly specified in the relevant project planning document (e.g., sampling and analysis plan) and is consistent with this Standard Operating Procedure if relevant. It shall be the responsibility of the project manager to ensure that the Field Operations Leader is familiar with the sample nomenclature system.

Field Operations Leader - It shall be the responsibility of the Field Operations Leader to ensure that all field technicians or sampling personnel are thoroughly familiar with this Standard Operating Procedure and the project-specific sample nomenclature system. It shall be the responsibility of the Field Operations Leader to ensure that the sample nomenclature system is used during all project-specific sampling efforts.

5.0 PROCEDURES

5.1 Introduction

The sample identification (ID) system can consist of as few as 8 but not more than 20 distinct alpha-numeric characters. The sample ID will be provided to the laboratory on the sample labels and chain-of-custody forms. The basic sample ID provided to the lab has three segments and shall be as follows where "A" indicates "alpha," and "N" indicates "numeric":

A or N 3- or 4-Characters	AAA 2- or 3-Characters	A or N 3- to 6-Characters
Site Identifier	Sample Type	Sample Location

Additional segments may be added as needed. For example:

(1) Soil and Sediment Sample ID

A or N 3- or 4-Characters	AAA 2- or 3-Characters	A or N 3- to 6-Characters	NNNN 4-Characters
Site Identifier	Sample Type	Sample Location	Sample Depth

(2) Aqueous (groundwater or surface water) Sample ID

A or N 3- or 4-Characters	AAA 2- or 3-Characters	A or N 3- to 6-Characters	NN 2-Characters	-A
Site Identifier	Sample type	Sample Location	Round Number	Filtered Sample only

(3) Biota Sample ID

A or N 3- or 4-Characters	AAA 2- or 3-Characters	A or N 3- to 6-Characters	AA 2-Characters	NNN 3-Characters
Site Identifier	Sample Type	Sample Location	Species Identifier	Sample Group Number

5.2 Sample Identification Field Requirements

The various fields in the sample ID will include but are not limited to the following:

- Site Identifier
- Sample Type
- Sample Location
- Sample Depth
- Sampling Round Number
- Filtered
- Species Identifier
- Sample Group Number

The site identifier must be a three- or four-character field (numeric characters, alpha characters, or a mixture of alpha and numeric characters may be used). A site number is necessary since many facilities/sites have multiple individual sites, SWMUs, operable units, etc. Several examples are presented in Section 5.3 of this SOP.

The sample type must be a two- or three-character alpha field. Suggested codes are provided in Section 5.3 of this SOP.

The sample location must be at least a three-character field but may have up to six-characters (alpha, numeric, or a mixture). The six-characters may be useful in identifying a monitoring well to be sampled or describing a grid location.

The sample depth field is used to note the depth below ground surface (bgs) at which a soil or sediment sample is collected. The first two numbers of the four-number code specify the top interval, and the third and fourth specify the bottom interval in feet bgs of the sample. If the sample depth is equal to or greater than 100, then only the top interval would be represented and the sampling depth would be truncated to

three-characters. The depths will be noted in whole numbers only; further detail, if needed, will be recorded on the sample log sheet, boring log, logbook, etc.

A two-digit round number will be used to track the number of aqueous samples taken from a particular aqueous sample location. The first sample collected from a location will be assigned the round identifier 01, the second 02, etc. This applies to both existing and proposed monitoring wells and surface water locations.

Aqueous samples that are field filtered (dissolved analysis) will be identified with an "-F" in the last field segment. No entry in this segment signifies an unfiltered (total) sample.

The species identifier must be a two-character alpha field. Several suggested codes are provided in Section 5.3 of this SOP.

The three digit sample group number will be used to track the number of biota sample groups (a particular group size may be determined by sample technique, media type, the number of individual caught, weight issues, time, etc.) by species and location. The first sample group of a particular species collected from a given location will be assigned the sample group number 001 and the second sample group of the same species collected from the same location will be assigned the sample group number 002.

5.3 Example Sample Field Designations

Examples of each of the fields are as follows:

Site Identifier - Examples of site numbers/designations are as follows:

A01 - Area of Concern Number 1
125 - Solid Waste Management Unit Number 125
000 - Base or Facility Wide Sample (e.g., upgradient well)
BBG - Base Background

The examples cited are only suggestions. Each Project Manager (or designee) must designate appropriate (and consistent) site designations for their individual project.

Sample Type - Examples of sample types are as follows:

AH - Ash Sample
AS - Air Sample
BM - Building Material Sample
BSB - Biota Sample Full Body
BSF - Biota Sample Fillet
CP - Composite Sample
CS - Chip Sample
DS - Drum Sample
DU - Dust Sample
FP - Free Product
IDW - Investigation Derived Waste Sample
LT - Leachate Sample
MW - Monitoring Well Groundwater Sample
OF - Outfall Sample
RW - Residential Well Sample
SB - Soil Boring Sample
SD - Sediment Sample
SC - Scrape Sample

SG - Soil Gas Sample
SL - Sludge Sample
SP - Seep Sample
SS - Surface Soil Sample
ST - Storm Sewer Water Sample
SW - Surface Water Sample
TP - Test Pit Sample
TW - Temporary Well Sample
WC - Well Construction Material Sample
WP - Wipe Sample
WS - Waste/Solid Sample
WW - Wastewater Sample

Sample Location - Examples of the location field are as follows:

001 - Monitoring Well 1
N32E92 - Grid location 32 North and 92 East
D096 - Investigation derived waste drum number 96

Species Identifier - Examples of species identifier are as follows:

BC - Blue Crab
GB - Blue Gill
CO - Corn
SB - Soybean

5.4 Examples of Sample Nomenclature

The first round monitoring well groundwater sample collected from existing monitoring well 001 at SWMU 16 for a filtered sample would be designated as 016MW00101-F.

The second round monitoring well groundwater sample collected from existing monitoring well C20P2 at Site 23 for an unfiltered sample would be designated as 023MWC20P202.

The second surface water sample collected from point 01 at SWMU 130 for an unfiltered sample would be designated as 130SW00102.

A surface soil sample collected from grid location 32 North and 92 East at Site 32 at the 0- to 2-foot interval would be designated as 032SSN32E920002.

A subsurface soil sample from soil boring 03 at SWMU 32 at an interval of 4 to 5 feet bgs would be designated as 032SB0030405.

A sediment sample collected at SWMU 19 from 0 to 6 inches at location 14 would be designated as 019SD0140001. The sample data sheet would reflect the precise depth at which this sample was collected.

During biota sampling for full body analysis the first time a minnow trap was checked at grid location A25 of SWMU 1415 three small blue gills were captured, collected and designated with the sample ID of 1415BSBA25BG001. The second time blue gill were collected at the same location (grid location A25 at SWMU 1415) the sample ID designation given was 1415BSBA25BG002.

Note: No dash (-) or spacing is used between the segments with the exception of the filtered segment. The "F" used for a filtered aqueous sample is preceded by a dash "-F".

5.5 Field Quality Assurance/Quality Control (QA/QC) Sample Nomenclature)

Field QA/QC will be designated using a different coding system. The QC code will consist of a three- to four-segment alpha-numeric code that identifies the sample QC type, the date the sample was collected, and the number of this type of QC sample collected on that date.

AA	NNNNNN	NN	-F
QC Type	Date	Sequence Number (per day)	Filtered (aqueous only, if needed)

The QC types are identified as:

TB = Trip Blank
RB = Rinsate Blank (Equipment Blank)
FD = Field Duplicate
AB = Ambient Conditions Blank
WB = Source Water Blank

The sampling time recorded on the Chain-of-Custody Form, labels, and tags for duplicate samples will be 0000 so that the samples are "blind" to the laboratory. Notes detailing the sample number, time, date, and type will be recorded on the routine sample log sheets and will document the location of the duplicate sample (sample log sheets are not provided to the laboratory). Documentation for all other QC types (TB, RB, AB, and WB) will be recorded on the QC Sample Log sheet (see SOP on Field Documentation).

5.6 Examples of Field QA/QC Sample Nomenclature

The first duplicate of the day for a filtered ground water sample collected on June 3, 2000 would be designated as FD06030001-F.

The third duplicate of the day taken of a subsurface soil sample collected on November 17, 2003 would be designated as FD11170303.

The first trip blank associated with samples collected on October 12, 2000 would be designated as TB10120001.

The only rinsate blank collected on November 17, 2001 would be designated as RB11170101.

6.0 DEVIATIONS

Any deviation from this SOP must be addressed in detail in the site specific planning documents.

TABLE OF CONTENTS

SECTION **PAGE**

1.0 PURPOSE 2

2.0 SCOPE 2

3.0 GLOSSARY 2

4.0 RESPONSIBILITIES 2

5.0 PROCEDURES 2

5.1 PRELIMINARY EVALUATION 3
5.2 FIELD INSPECTION 3
5.3 WATER LEVEL (HYDRAULIC HEAD) MEASUREMENTS 4
5.3.1 General 4
5.3.2 Water Level Measuring Techniques 5
5.3.3 Methods 5
5.3.4 Water Level Measuring Devices 6
5.3.5 Data Recording 6
5.3.6 Specific Quality Control Procedures for Water Level Measuring Devices 7
5.4 EQUIPMENT DECONTAMINATION 7
5.5 HEALTH AND SAFETY CONSIDERATIONS 7

6.0 RECORDS 7

ATTACHMENTS

A MONITOIRNG WELL INSPECTON SHEET 8
B GROUNDWATER LEVEL MEASUREMENT SHEET 9

1.0 PURPOSE

The purpose of this procedure is to provide reference information regarding the proper methods for evaluating the physical condition and project utility of existing monitoring wells and determining water levels.

2.0 SCOPE

The procedures described herein are applicable to all existing monitoring wells and, for the most part, are independent of construction materials and methods.

3.0 GLOSSARY

Hydraulic Head - The height to which water will rise in a well.

Water Table - A surface in an unconfined aquifer where groundwater pressure is equal to atmospheric pressure (i.e., the pressure head is zero).

4.0 RESPONSIBILITIES

Site Geologist/Hydrogeologist - Has overall responsibility for the evaluation of existing wells, obtaining water level measurements and developing groundwater contour maps. The site geologist/hydrogeologist (in concurrence with the Project Manager) shall specify the reference point from which water levels are measured (usually a specific point on the upper edge of the inner well casing), the number and location of data points which shall be used for constructing a contour map, and how many complete sets of water levels are required to adequately define groundwater flow directions (e.g., if there are seasonal variations).

Field Personnel - Must have a basic familiarity with the equipment and procedures involved in obtaining water levels and must be aware of any project-specific requirements or objectives.

5.0 PROCEDURES

Accurate, valid and useful groundwater monitoring requires that four important conditions be met:

- Proper characterization of site hydrogeology.
- Proper design of the groundwater monitoring program, including adequate numbers of wells installed at appropriate locations and depths.
- Satisfactory methods of groundwater sampling and analysis to meet the project data quality objectives (DQOs).
- The assurance that specific monitoring well samples are representative of water quality conditions in the monitored interval.

To insure that these conditions are met, adequate descriptions of subsurface geology, well construction methods and well testing results must be available. The following steps will help to insure that the required data are available to permit an evaluation of the utility of existing monitoring wells for collecting additional samples.

5.1 Preliminary Evaluation

A necessary first step in evaluating existing monitoring well data is the study and review of the original work plan for monitoring well installation (if available). This helps to familiarize the site geologist/hydrogeologist with site-specific condition, and will promote an understanding of the original purpose of the monitoring wells.

The next step of the evaluation should involve a review of all available information concerning borehole drilling and well construction. This will allow interpretation of groundwater flow conditions and area geology, and will help to establish consistency between hydraulic properties of the well and physical features of the well or formation. The physical features which should be identified and detailed, if available, include:

- The well identification number, permit number and location by referenced coordinates, the distance from prominent site features, or the location of the well on a map.
- The installation dates, drilling methods, well development methods, past sampling dates, and drilling contractors.
- The depth to bedrock -- where rock cores were not taken, auger refusal, drive casing refusal or penetration test results (blow counts for split-barrel sampling) may be used to estimate bedrock interface.
- The soil profile and stratigraphy.
- The borehole depth and diameter.
- The elevation of the top of the protective casing, the top of the well riser, and the ground surface.
- The total depth of the well.
- The type of well materials, screen type, slot size, and length, and the elevation/depths of the screen, interval, and/or monitored interval.
- The elevation/depths of the tops and bottom of the filter pack and well seals and the type and size.

5.2 Field Inspection

During the onsite inspection of existing monitoring wells, features to be noted include:

- The condition of the protective casing, cap and lock.
- The condition of the cement seal surrounding the protective casing.
- The presence of depressions or standing water around the casing.
- The presence of and condition of dedicated sampling equipment.
- The presence of a survey mark on the inner well casing.

If the protective casing, cap and lock have been damaged or the cement collar appears deteriorated, or if there are any depressions around the well casing capable of holding water, surface water may have infiltrated into the well. This may invalidate previous sampling results unless the time when leakage started can be precisely determined.

The routine physical inspection must be followed by a more detailed investigation to identify other potential routes of contamination or sampling equipment malfunction. Any of these occurrences may invalidate

previously-collected water quality data. If the monitoring well is to be used in the future, considerations shown in the steps described above should be rectified to rehabilitate the well.

After disconnecting any wires, cables or electrical sources, remove the lock and open the cap. Check for the presence of organic vapors with a photoionization detector (PID) or flame-ionization detector (FID) to determine the appropriate worker safety level. The following information should be noted:

- Cap function.
- Physical characteristics and composition of the inner casing or riser, including inner diameter and annular space.
- Presence of grout between the riser and outer protective casing and the existence of drain holes in the protective casing.
- Presence of a riser cap, method of attachment to casing, and venting of the riser.
- Presence of dedicated sampling equipment; if possible, remove such equipment and inspect size, materials of construction and condition.

The final step of the field inspection is to confirm previous hydraulic or physical property data and to obtain data not previously available. This includes the determination of static water levels, total well depth and well obstruction. This may be accomplished using a weighted tape measure which can also be used to check for sediment (the weight will advance slowly if sediment is present, and the presence of sediment on the weight upon removal should be noted). If sediment is present and/or the well has not been sampled in 12 or more months, it should be redeveloped before sampling.

Lastly, as a final step, the location, condition and expected water quality of the wells should be reviewed in light of their usefulness for the intended purpose of the investigation.

See Attachment A, Monitoring Well Inspection Sheet.

5.3 Water Level (Hydraulic Head) Measurements

5.3.1 General

Groundwater level measurements can be made in monitoring wells, private or public water wells, piezometers, open boreholes, or test pits (after stabilization). Groundwater measurements should generally not be made in boreholes with drilling rods or auger flights present. If groundwater sampling activities are to occur, groundwater level measurements shall take place prior to well purging or sampling.

All groundwater level measurements shall be made to the nearest 0.01 foot, and recorded in the site geologist/hydrogeologist's field notebook or on the Groundwater Level Measurement Sheet (Attachment B), along with the date and time of the reading. The total depth of the well shall be measured and recorded, if not already known. Weather changes that occur over the period of time during which water levels are being taken, such as precipitation and barometric pressure changes, should be noted.

In measuring groundwater levels, there shall be a clearly-established reference point of known elevation, which is normally identified by a mark on the upper edge of the inner well casing. To be useful, the reference point should be tied in with an established USGS benchmark or other properly surveyed elevation datum. An arbitrary datum could be used for an isolated group of wells, if necessary.

Cascading water within a borehole or steel well casings can cause false readings with some types of sounding devices (chalked line, electrical). Oil layers may also cause problems in determining the true water level in a well. Special devices (interface probes) are available for measuring the thickness of oil layers and true depth to groundwater, if required.

Water level readings shall be taken regularly, as required by the site geologist/hydrogeologist. Monitoring wells or open-cased boreholes that are subject to tidal fluctuations should be read in conjunction with a tidal chart (or preferably in conjunction with readings of a tide staff or tide level recorder installed in the adjacent water body); the frequency of such readings shall be established by the site hydrogeologist. All water level measurements at a site used to develop a groundwater contour map shall be made in the shortest practical time to minimize affects due to weather changes.

5.3.2 Water Level Measuring Techniques

There are several methods for determining standing or changing water levels in boreholes and monitoring wells. Certain methods have particular advantages and disadvantages depending upon well conditions. A general description of these methods is presented, along with a listing of various advantages and disadvantages of each technique. An effective technique shall be selected for the particular site conditions by the site geologist/hydrogeologist.

In most instances, preparation of accurate potentiometric surface maps require that static water level measurements be obtained to a precision of 0.01 feet. To obtain such measurements in individual accessible wells, electrical water level indicator methods have been found to be best, and thus should be utilized. Other, less precise methods, such as the popper or bell sound, or bailer line methods, should be avoided. When a large number of (or continuous) readings are required, time-consuming individual readings are not usually feasible. In such cases, it is best to use a pressure transducer.

5.3.3 Methods

Water levels can be measured by several different techniques, but the same steps shall be followed in each case. The proper sequence is as follows:

1. Check operation of recording equipment above ground. Prior to opening the well, don personal protective equipment, as required. Never remove an air-tight lock (such as a J-plug) with your face over the well. Pressure changes within the well may explosively force the cap off once loosened.

2. Record all information specified below in the geologist/hydrogeologist's field notebook or on the Groundwater Level Measurement Sheet (Attachment B):

   - Well number.
   - Water level (to the nearest 0.01 foot). Water levels shall be taken from the surveyed reference mark on the top edge of the inner well casing. If the J-plug was on the well very tightly, it may take several minutes for the water level to stabilize.
   - Time and day of the measurement.
   - Thickness of free product if present.

Water level measuring devices with permanently marked intervals shall be used. The devices shall be free of kinks or folds which will affect the ability of the equipment to hang straight in the well pipe.

5.3.4 Water Level Measuring Devices

Electric Water Level Indicators

These are the most commonly used devices and consist of a spool of small-diameter cable and a weighted probe attached to the end. When the probe comes in contact with the water, an electrical circuit is closed and a meter, light, and/or buzzer attached to the spool will signal the contact.

There are a number of commercial electric sounders available, none of which is entirely reliable under all conditions likely to occur in a contaminated monitoring well. In conditions where there is oil on the water, groundwater with high specific conductance, water cascading into the well, steel well casing, or a turbulent water surface in the well, measuring with an electric sounder may be difficult.

For accurate readings, the probe shall be lowered slowly into the well adjacent to the survey mark on the inner well casing. The electric tape is read (to the nearest 0.01 ft.) at the measuring point and recorded where contact with the water surface was indicated.

Popper or Bell Sounder

A bell- or cup-shaped weight that is hollow on the bottom is attached to a measuring tape and lowered into the well. A "plopping" or "popping" sound is made when the weight strikes the surface of the water. An accurate reading can be determined by lifting and lowering the weight in short strokes, and reading the tape when the weight strikes the water. This method is not sufficiently accurate to obtain water levels to 0.01 feet, and thus is more appropriate for obtaining only approximate water levels quickly.

Pressure Transducer

Pressure transducers can be lowered into a well or borehole to measure the pressure of water and therefore the water elevation above the transducer. The transducer is wired into a recorder at the surface to record changes in water level with time. The recorder digitizes the information and can provide a printout or transfer the information to a computer for evaluation (using a well drawdown/recovery model). The pressure transducer should be initially calibrated with another water level measurement technique to ensure accuracy. This technique is very useful for hydraulic conductivity testing in highly permeable material where repeated, accurate water level measurements are required in a very short period of time. A sensitive transducer element is required to measure water levels to 0.01 foot accuracy.

Borehole Geophysics

Approximate water levels can be determined during geophysical logging of the borehole (although this is not the primary purpose for geophysical logging and such logging is not cost effective if used only for this purpose). Several logging techniques will indicate water level. Commonly-used logs which will indicate saturated/unsaturated conditions include the spontaneous potential (SP) log and the neutron log.

5.3.5 Data Recording

Water level measurements, time, data, and weather conditions shall be recorded in the geologist/hydrogeologist's field notebook or on the Groundwater Level Measurement Sheet. All water level measurements shall be measured from a known reference point. The reference point is generally a marked point on the upper edge of the inner well casing that has been surveyed for an elevation. The exact reference point shall be marked with permanent ink on the casing since the top of the casing may not be entirely level. It is important to note changes in weather conditions because changes in the barometric pressure may affect the water level within the well.

5.3.6 Specific Quality Control Procedures for Water Level Measuring Devices

All groundwater level measurement devices must be cleaned before and after each use to prevent cross contamination of wells. Manufacturer's instructions for cleaning the device shall be strictly followed. Some devices used to measure groundwater levels may need to be calibrated. These devices shall be calibrated to 0.01 foot accuracy and any adjustments/corrections shall be recorded in the field logbook/notebook. After the corrections/adjustments are made to the measuring device and entered in the field logbook/notebook, the corrected readings shall be entered onto the Groundwater Level Measurement Sheet (Attachment B). Elevations will be entered on the sheet when they become available.

5.4 Equipment Decontamination

Equipment used for water level measurements provide a mechanism for potentially cross contaminating wells. Therefore, all portions of a device which project down the well casing must be decontaminated prior to advancing to the next well. Decontamination procedures vary based on the project objectives but must be defined prior to conducting any field activities including the collection of water level data. Consult the project planning documents and SA-7.1 Decontamination of Field Equipment.

5.5 Health and Safety Considerations

Groundwater contaminated by volatile organic compounds may release toxic vapors into the air space inside the well pipe. The release of this air when the well is initially opened is a health/safety hazard which must be considered. Initial monitoring of the well headspace and breathing zone concentrations using a PID or FID shall be performed to determine required levels of protection. Under certain conditions, air-tight well caps may explosively fly off the well when the pressure is relieved. Never stand directly over a well when uncapping it.

6.0 RECORDS

A record of all field procedures, tests and observations must be recorded in the site logbook or designated field notebook. Entries in the log/notebook should include the individuals participating in the field effort, and the date and time. The use of annotated sketches may help to supplement the evaluation.

ATTACHMENT A
MONITORING WELL INSPECTION SHEET

Monitoring Well Inspection Sheet

Project Name: _____ Date: _____

Location: _____ Time: _____

Tidally Influenced: Y / N Personnel: _____

Field Measurements				
Well ID	PID Reading PPM	Depth to Water *	Total Depth *	Flush Mt./ Stick-up

Well Construction Details (Taken from construction logs)		
Total Depth *	Ground Elev.	Top/Btm Screen *

Check List:

Riser Pipe Material:
Riser Notched for Surveyors:
Well ID Tag In-place:
Well security:
Photo taken:

Condition of Well:

Protective Case:
Riser:
Well Pad:
Other:

Presence/Evidence of:

Standing Water Around Well:
Existing Sampling Equipment:
Sediment build-up in Well Btm:

Comments:

** = Measurements are from the top of the inner case to the nearest 0.01'*

ATTACHMENT B
GROUNDWATER LEVEL MESUREMENT SHEET

Tetra Tech NUS, Inc.

GROUNDWATER LEVEL MEASUREMENT SHEET

Project Name: _____ **Project No.:** _____
Location: _____ **Personnel:** _____
Weather Conditions: _____ **Measuring Device:** _____
Tidally Influenced: Yes ___ No ___ **Remarks:** _____

Well or Piezometer Number	Date	Time	Elevation of Reference Point (feet)*	Water Level Indicator Reading (feet)*	Thickness of Free Product (feet)*	Comments

* All measurements to the nearest 0.01 foot, from surveyed mark (unless noted)

Page ____ of ____

TABLE OF CONTENTS

SECTION **PAGE**

1.0 PURPOSE **2**

2.0 SCOPE **2**

3.0 GLOSSARY **2**

4.0 RESPONSIBILITIES **3**

5.0 PROCEDURES **3**

5.1 BURIED UTILITIES 3
5.2 OVERHEAD POWER LINES 5

6.0 UNDERGROUND LOCATING TECHNIQUES **5**

6.1 GEOPHYSICAL METHODS 5
6.2 PASSIVE DETECTION SURVEYS 6
6.3 INTRUSIVE DETECTION SURVEYS 6

7.0 INTRUSIVE ACTIVITIES SUMMARY **7**

8.0 REFERENCES **8**

ATTACHMENTS

1 Listing of Underground Utility Clearance Resources 9
2 Frost Line Penetration Depths by Geographic Location 11
3 Utility Clearance Form 12
4 OSHA Letter of Interpretation 13

1.0 PURPOSE

Utilities such as electric service lines, natural or propane gas lines, water and sewage lines, telecommunications, and steam lines are very often in the immediate vicinity of work locations. Contact with underground or overhead utilities can have serious consequences including employee injury/fatality, property and equipment damage, substantial financial impacts, and loss of utility service to users.

The purpose of this procedure is to provide minimum requirements and technical guidelines regarding the appropriate procedures to be followed when performing subsurface and overhead utility locating services. It is the policy of Tetra Tech NUS, Inc. (TtNUS) to provide a safe and healthful work environment for the protection of our employees. The purpose of this Standard Operating Procedure (SOP) is to aid in achieving the objectives of this policy, to present the acceptable procedures pertaining to utility locating and excavation clearance activities, and to present requirements and restrictions relevant to these types of activities. This SOP must be reviewed by any employee potentially involved with underground or overhead utility locating and avoidance activities.

2.0 SCOPE

This procedure applies to all TtNUS field activities where there may be potential contact with underground or overhead utilities. This procedure provides a description of the principles of operation, instrumentation, applicability, and implementability of typical methods used to determine the presence and avoidance of contact with utility services. This procedure is intended to assist with work planning and scheduling, resource planning, field implementation, and subcontractor procurement. Utility locating and excavation clearance requires site-specific information prior to the initiation of any such activities on a specific project. This SOP is not intended to provide a detailed description of methodology and instrument operation. Specialized expertise during both planning and execution of several of the methods presented may also be required.

3.0 GLOSSARY

Electromagnetic Induction (EMI) Survey - A geophysical exploration method whereby electromagnetic fields are induced in the ground and the resultant secondary electromagnetic fields are detected as a measure of ground conductivity.

Magnetometer – A device used for precise and sensitive measurements of magnetic fields.

Magnetic Survey – A geophysical survey method that depends on detection of magnetic anomalies caused by the presence of buried ferromagnetic objects.

Metal Detection – A geophysical survey method that is based on electromagnetic coupling caused by underground conductive objects.

Vertical Gradiometer – A magnetometer equipped with two sensors that are vertically separated by a fixed distance. It is best suited to map near surface features and is less susceptible to deep geologic features.

Ground Penetrating Radar – Ground Penetrating Radar (GPR) involves specialized radar equipment whereby a signal is sent into the ground via a transmitter. Some portion of the signal will be reflected from the subsurface material, which is then recorded with a receiver and electronically converted into a graphic picture.

4.0 RESPONSIBILITIES

Project Manager (PM)/Task Order Manager (TOM) - Responsible for ensuring that all field activities are conducted in accordance with this procedure.

Site Manager (SM)/Field Operations Leader (FOL) - Responsible for the onsite verification that all field activities are performed in compliance with approved SOPs or as otherwise directed by the approved project plan(s).

Site Health & Safety Officer (SHSO) – Responsible to provide technical assistance and verify full compliance with this SOP. The SHSO is also responsible for reporting any deficiencies to the Corporate Health and Safety Manager (HSM) and to the PM/TOM.

Health & Safety Manager (HSM) – Responsible for preparing, implementing, and modifying corporate health and safety policy and this SOP.

Site Personnel – Responsible for performing their work activities in accordance with this SOP and the TtNUS Health and Safety Policy.

5.0 PROCEDURES

This procedure addresses the requirements and technical procedures that must be performed to minimize the potential for contact with underground and overhead utility services. These procedures are addressed individually from a buried and overhead standpoint.

5.1 Buried Utilities

Buried utilities present a heightened concern because their location is not typically obvious by visual observation, and it is common that their presence and/or location is unknown or incorrectly known on client properties. This procedure must be followed prior to beginning any subsurface probing or excavation that might potentially be in the vicinity of underground utility services. In addition, the Utility Clearance Form (Attachment 3) must be completed for every location or cluster of locations where intrusive activities will occur.

Where the positive identification and de-energizing of underground utilities cannot be obtained and confirmed using the following steps, the PM/TOM is responsible for arranging for the procurement of a qualified, experienced, utility locating subcontractor who will accomplish the utility location and demarcation duties specified herein.

1. A comprehensive review must be made of any available property maps, blue lines, or as-builts prior to site activities. Interviews with local personnel familiar with the area should be performed to provide additional information concerning the location of potential underground utilities. Information regarding utility locations shall be added to project maps upon completion of this exercise.

2., A visual site inspection must be performed to compare the site plan information to actual field conditions. Any findings must be documented and the site plan/maps revised. The area(s) of proposed excavation or other subsurface activities must be marked at the site in white paint or pin flags to identify those locations of the proposed intrusive activities. The site inspection should focus on locating surface indications of potential underground utilities. Items of interest include the presence of nearby area lights, telephone service, drainage grates, fire hydrants, electrical service vaults/panels, asphalt/concrete scares and patches, and topographical depressions. Note the location of any emergency shut off switches. Any additional information regarding utility

locations shall be added to project maps upon completion of this exercise and returned to the PM/TOM.

3. If the planned work is to be conducted on private property (e.g., military installations, manufacturing facilities, etc.) the FOL must identify and contact appropriate facility personnel (e.g., public works or facility engineering) before any intrusive work begins to inquire about (and comply with) property owner requirements. It is important to note that private property owners may require several days to several weeks advance notice prior to locating utilities.

4. If the work location is on public property, the state agency that performs utility clearances must be notified (see Attachment 1). State "one-call" services must be notified prior to commencing fieldwork per their requirements. Most one-call services require, by law, 48- to 72-hour advance notice prior to beginning any excavation. Such services typically assign a "ticket" number to the particular site. This ticket number must be recorded for future reference and is valid for a specific period of time, but may be extended by contacting the service again. The utility service will notify utility representatives who then mark their respective lines within the specified time frame. It should be noted that most military installations own their own utilities but may lease service and maintenance from area providers. Given this situation, "one call" systems may still be required to provide location services on military installations.

5. Utilities must be identified and their locations plainly marked using pin flags, spray paint, or other accepted means. The location of all utilities must be noted on a field sketch for future inclusion on project maps. Utility locations are to be identified using the following industry-standard color code scheme, unless the property owner or utility locator service uses a different color code:

white	excavation/subsurface investigation location
red	electrical
yellow	gas, oil, steam
orange	telephone, communications
blue	water, irrigation, slurry
green	sewer, drain

6. Where utility locations are not confirmed with a high degree of confidence through drawings, schematics, location services, etc., the work area must be thoroughly investigated prior to beginning the excavation. In these situations, utilities must be identified using safe and effective methods such as passive and intrusive surveys, or the use of non-conductive hand tools. Also, in situations where such hand tools are used, they should always be used in conjunction with suitable detection equipment, such as the items described in Section 6.0 of this SOP. Each method has advantages and disadvantages including complexity, applicability, and price. It also should be noted that in some states, initial excavation is required by hand to a specified depth.

7. At each location where trenching or excavating will occur using a backhoe or other heavy equipment, and where utility identifications and locations cannot be confirmed prior to groundbreaking, the soil must be probed using a device such as a tile probe which is made of non-conductive material such as fiberglass. If these efforts are not successful in clearing the excavation area of suspect utilities, hand shoveling must be performed for the perimeter of the intended excavation.

8. All utilities uncovered or undermined during excavation must be structurally supported to prevent potential damage. Unless necessary as an emergency corrective measure, TtNUS shall not make any repairs or modifications to existing utility lines without prior permission of the utility owner, property owner, and Corporate HSM. All repairs require that the line be locked-out/tagged-out prior to work.

5.2 Overhead Power Lines

If it is necessary to work within the minimum clearance distance of an overhead power line, the overhead line must be de-energized and grounded, or re-routed by the utility company or a registered electrician. If protective measures such as guarding, isolating, or insulating are provided, these precautions must be adequate to prevent employees from contacting such lines directly with any part of their body or indirectly though conductive materials, tools, or equipment.

The following table provides the required minimum clearances for working in proximity to overhead power lines.

Nominal Voltage	Minimum Clearance
0 -50 kV	10 feet, or one mast length; whichever is greater
50+ kV	10 feet plus 4 inches for every 10 kV over 50 kV or 1.5 mast lengths; whichever is greater

6.0 UNDERGROUND LOCATING TECHNIQUES

A variety of supplemental utility locating approaches are available and can be applied when additional assurance is needed. The selection of the appropriate method(s) to employ is site-specific and should be tailored to the anticipated conditions, site and project constraints, and personnel capabilities.

6.1 Geophysical Methods

Geophysical methods include electromagnetic induction, magnetics, and ground penetrating radar. Additional details concerning the design and implementation of electromagnetic induction, magnetics, and ground penetrating radar surveys can be found in one or more of the TtNUS SOPs included in the References (Section 8.0).

Electromagnetic Induction

Electromagnetic Induction (EMI) line locators operate either by locating a background signal or by locating a signal introduced into the utility line using a transmitter. A utility line acts like a radio antenna, producing electrons, which can be picked up with a radiofrequency receiver. Electrical current carrying conductors have a 60HZ signal associated with them. This signal occurs in all power lines regardless of voltage. Utilities in close proximity to power lines or used as grounds may also have a 60HZ signal, which can be picked up with an EM receiver. A typical example of this type of geophysical equipment is an EM-61.

EMI locators specifically designed for utility locating use a special signal that is either indirectly induced onto a utility line by placing the transmitter above the line or directly induced using an induction clamp. The clamp induces a signal on the specific utility and is the preferred method of tracing since there is little chance of the resulting signals being interfered with. A good example of this type of equipment is the Schonstedt® MAC-51B locator. The MAC-51B performs inductively traced surveys, simple magnetic locating, and traced nonmetallic surveys.

When access can be gained inside a conduit to be traced, a flexible insulated trace wire can be used. This is very useful for non-metallic conduits but is limited by the availability of gaining access inside the pipe.

Magnetics

Magnetic locators operate by detecting the relative amounts of buried ferrous metal. They are incapable of locating or identifying nonferrous utility lines but can be very useful for locating underground storage tanks (UST's), steel utility lines, and buried electrical lines. A typical example of this type of equipment is the Schonstedt® GA-52Cx locator. The GA-52Cx is capable of locating 4-inch steel pipe up to 8 feet deep.

Non-ferrous lines are often located by using a typical plumbing tool (snake) fed through the line. A signal is then introduced to the snake that is then traced.

Ground Penetrating Radar

Ground Penetrating Radar (GPR) involves specialized radar equipment whereby a signal is sent into the ground via a transmitter. Some portion of the signal will be reflected from the subsurface material, which is then recorded with a receiver and electronically converted into a graphic picture. In general, an object which is harder than the surrounding soil will reflect a stronger signal. Utilities, tunnels, UST's, and footings will reflect a stronger signal than the surrounding soil. Although this surface detection method may determine the location of a utility, this method does not specifically identify utilities (i.e., water vs. gas, electrical vs. telephone); hence, verification may be necessary using other methods. This method is somewhat limited when used in areas with clay soil types or with a high water table.

6.2 Passive Detection Surveys

Acoustic Surveys

Acoustic location methods are generally most applicable to waterlines or gas lines. A highly sensitive Acoustic Receiver listens for background sounds of water flowing (at joints, leaks, etc.) or to sounds introduced into the water main using a transducer. Acoustics may also be applicable to determine the location of plastic gas lines.

Thermal Imaging

Thermal (i.e., infrared) imaging is a passive method for detecting the heat emitted by an object. Electronics in the infrared camera convert subtle heat differentials into a visual image on the viewfinder or a monitor. The operator does not look for an exact temperature; rather they look for heat anomalies (either elevated or suppressed temperatures) characteristic of a potential utility line.

The thermal fingerprint of underground utilities results from differences in temperature between the atmosphere and the fluid present in a pipe or the heat generated by electrical resistance. In addition, infrared scanners may be capable of detecting differences in the compaction, temperature and moisture content of underground utility trenches. High-performance thermal imagery can detect temperature differences to hundredths of a degree.

6.3 Intrusive Detection Surveys

Vacuum Excavation

Vacuum excavation is used to physically expose utility services. The process involves removing the surface material over approximately a 1' x 1' area at the site location. The air-vacuum process proceeds with the simultaneous action of compressed air-jets to loosen soil and vacuum extraction of the resulting

debris. This process ensures the integrity of the utility line during the excavation process, as no hammers, blades, or heavy mechanical equipment comes into contact with the utility line, eliminating the risk of damage to utilities. The process continues until the utility is uncovered. Vacuum excavation can be used at the proposed site location to excavate below the "utility window" which is usually 8 feet.

Hand Excavation

When the identification and location of underground utilities cannot be positively confirmed through document reviews and/or other methods, borings and excavations may be cleared via the use of non-conductive hand tools. This should always be done in conjunction with the use of detection equipment. This would be required for all locations where there is a potential to impact buried utilities. The minimum hand-excavation depth that must be reached is to be determined considering the geographical location of the work site. This approach recognizes that the placement of buried utilities is influenced by frost line depths that vary by geographical region. Attachment 2 presents frost line depths for the regions of the contiguous United States. At a minimum, hand excavation depths must be at least to the frost line depth (see Attachment 2) plus two (2) feet, but never less than 4 feet below ground surface (bgs). For hand excavation, the hole created must be reamed large enough to be at least the diameter of the drill rig auger or bit prior to drilling. For soil gas surveys, the survey probe shall be placed as close as possible to the cleared hand excavation. It is important to note that a post-hole digger must not be used in this type of hand excavation activity.

Tile Probe Surveys

For some soil types, site conditions, and excavation requirements, non-conductive tile probes may be used. A tile probe is a "T"-handled rod of varying lengths that can be pushed into the soil to determine if any obstructions exist at that location. Tile probes constructed of fiberglass or other nonconductive material are readily-available from numerous vendors. Tile probes must be performed to the same depth requirements as previously specified. As with other types of hand excavating activities, the use of a non-conductive tile probe, should always be in conjunction with suitable utility locating detection equipment.

7.0 INTRUSIVE ACTIVITIES SUMMARY

The following list summarizes the activities that must be performed prior to beginning subsurface activities:

1. Map and mark all subsurface locations and excavation boundaries using white paint or markers specified by the client or property owner.

2. Notify the property owner and/or client that the locations are marked. At this point, drawings of locations or excavation boundaries shall be provided to the property owner and/or client so they may initiate (if applicable) utility clearance.

   Note: Drawings with confirmed locations should be provided to the property owner and/or client as soon as possible to reduce potential time delays.

3. Notify "One Call" service. If possible, arrange for an appointment to show the One Call representative the surface locations or excavation boundaries in person. This will provide a better location designation to the utilities they represent. You should have additional drawings should you need to provide plot plans to the One Call service.

4. Implement supplemental utility detection techniques as necessary and appropriate to conform utility locations or the absence thereof.

5. Complete Attachment 3, Utility Clearance Form. This form should be completed for each excavation location. In situations where multiple subsurface locations exist within the close proximity of one another, one form may be used for multiple locations provided those locations are noted on the Utility Clearance Form. Upon completion, the Utility Clearance Form and revised/annotated utility location map becomes part of the project file.

8.0 REFERENCES

OSHA Letter of Interpretation, Mr. Joseph Caldwell, Attachment 4
OSHA 29 CFR 1926(b)(2)
OSHA 29 CFR 1926(b)(3)
TtNUS Utility Locating and Clearance Policy
TtNUS SOP GH-3.1; Resistivity and Electromagnetic Induction
TtNUS SOP GH-3.2; Magnetic and Metal Detection Surveys
TtNUS SOP GH-3.4; Ground-penetrating Radar Surveys

ATTACHMENT 1
LISTING OF UNDERGROUND UTILITY CLEARANCE RESOURCES

American Public Works Association
2345 Grand Boulevard, Suite 500, Kansas City, MO 64108-2625
Phone (816) 472-6100 • Fax (816) 472-1610
Web www.apwa.net • E-mail apwa@apwa.net

ONE-CALL SYSTEMS INTERNATIONAL CONDENSED DIRECTORY

Alabama
Alabama One-Call
1-800-292-8525

Alaska
Locate Call Center of Alaska, Inc.
1-800-478-3121

Arizona
Arizona Blue Stake
1-800-782-5348

Arkansas
Arkansas One Call System, Inc.
1-800-482-8998

California
Underground Service Alert North
1-800-227-2600
Underground Service Alert of Southern California
1-800-227-2600

Colorado
Utility Notification Center of Colorado
1-800-922-1987

Connecticut
Call Before You Dig
1-800-922-4455

Delaware
Miss Utility of Delmarva
1-800-282-8555

Florida
Sunshine State One-Call of Florida, Inc.
1-800-432-4770

Georgia
Underground Protection Center, Inc.
1-800-282-7411

Hawaii
Underground Service Alert North
1-800-227-2600

Idaho
Dig Line Inc.
1-800-342-1585
Kootenai County One-Call
1-800-428-4950
Shoshone - Benewah One-Call
1-800-398-3285

Illinois
JULIE, Inc.
1-800-892-0123
Digger (Chicago Utility Alert Network)
312-744-7000

Indiana
Indiana Underground Plant Protection Service
1-800-382-5544

Iowa
Iowa One-Call
1-800-292-8989

Kansas
Kansas One-Call System, Inc.
1-800-344-7233

Kentucky
Kentucky Underground Protection Inc.
1-800-752-6007

Louisiana
Louisiana One Call System, Inc.
1-800-272-3020

Maine
Dig Safe System, Inc.
1-888-344-7233

Maryland
Miss Utility
1-800-257-7777
Miss Utility of Delmarva
1-800-282-8555

Massachusetts
Dig Safe System, Inc.
1-888-344-7233

Michigan
Miss Dig System, Inc.
1-800-482-7171

Minnesota
Gopher State One Call
1-800-252-1166

Mississippi
Mississippi One-Call System, Inc
1-800-227-6477

Missouri
Missouri One-Call System, Inc.
1-800-344-7483

Montana
Utilities Underground Protection Center
1-800-424-5555
Montana One Call Center
1-800-551-8344

Nebraska
Diggers Hotline of Nebraska
1-800-331-5666

Nevada
Underground Service Alert North
1-800-227-2600

New Hampshire
Dig Safe System, Inc.
1-888-344-7233

New Jersey
New Jersey One Call
1-800-272-1000

New Mexico
New Mexico One Call System, Inc.
1-800-321-2537
Las Cruces- Dona Ana Blue Stakes
1-888-526-0400

New York
Dig Safely New York
1-800-962-7962
New York City- Long Island One Call Center
1-800-272-4480

North Carolina
The North Carolina One-Call Center, Inc.
1-800-632-4949

North Dakota
North Dakota One-Call
1-800-795-0555

Ohio
Ohio Utilities Protection Service
1-800-362-2764
Oil & Gas Producers Underground Protect'n Svc
1-800-925-0988

Oklahoma
Call Okie
1-800-522-6543

Oregon
Oregon Utility Notification Center/One Call Concepts
1-800-332-2344

Pennsylvania
Pennsylvania One Call System, Inc.
1-800-242-1776

Rhode Island
Dig Safe System, Inc.
1-888-344-7233

South Carolina
Palmetto Utility Protection Service Inc.
1-888-721-7877

South Dakota
South Dakota One Call
1-800-781-7474

Tennessee
Tennessee One-Call System, Inc.
1-800-351-1111

ATTACHMENT 1 (Continued)

Texas
Texas One Call System
1-800-245-4545
Texas Excavation Safety System, Inc.
1-800-344-8377
Lone Star Notification Center
1-800-669-8344

Utah
Blue Stakes of Utah
1-800-662-4111

Vermont
Dig Safe System, Inc.
1-888-344-7233

Virginia
Miss Utility of Virginia
1-800-552-7001
Miss Utility (Northern Virginia)
1-800-257-7777

Washington
Utilities Underground Location Center
1-800-424-5555
Northwest Utility Notification Center
1-800-553-4344
Inland Empire Utility Coordinating Council
509-456-8000

West Virginia
Miss Utility of West Virginia, Inc.
1-800-245-4848

Wisconsin
Diggers Hotline, Inc.
1-800-242-8511

Wyoming
Wyoming One-Call System, Inc.
1-800-348-1030
Call Before You Dig of Wyoming
1-800-849-2476

District of Columbia
Miss Utility
1-800-257-7777

Alberta
Alberta One-Call Corporation
1-800-242-3447

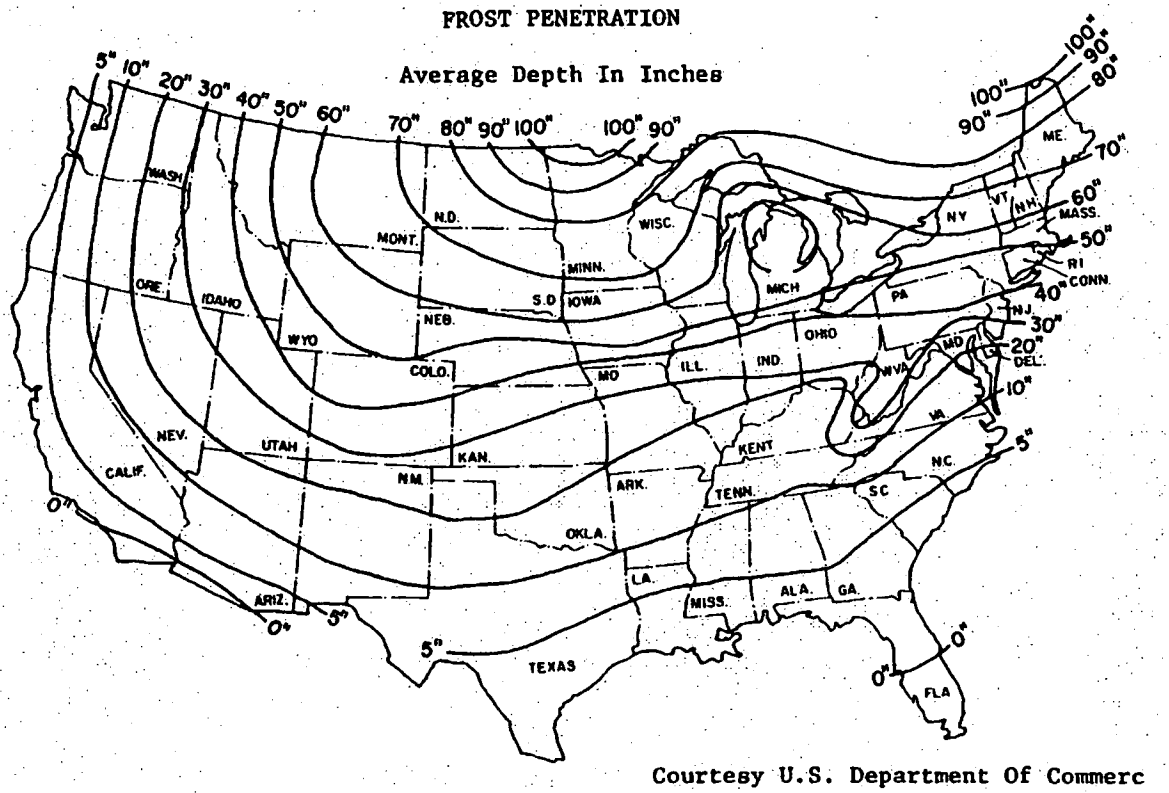
British Columbia
BC One Call
1-800-474-6886

Ontario
Ontario One-Call System
1-800-400-2255

Quebec
Info-Excavation
1-800-663-9228

ATTACHMENT 2

FROST LINE PENETRATION DEPTHS BY GEOGRAPHIC LOCATION



Courtesy U.S. Department Of Commerc

ATTACHMENT 3
UTILITY CLEARANCE FORM

Client: _____ Project Name: _____

Project No.: _____ Completed By: _____

Location Name: _____ Work Date: _____

Excavation Method/Overhead Equipment: _____

1. Underground Utilities — Circle One

a)	Review of existing maps?	yes	no	N/A
b)	Interview local personnel?	yes	no	N/A
c)	Site visit and inspection?	yes	no	N/A
d)	Excavation areas marked in the field?	yes	no	N/A
e)	Utilities located in the field?	yes	no	N/A
f)	Located utilities marked/added to site maps?	yes	no	N/A
g)	Client contact notified Name _____ Telephone: _____ Date: _____	yes	no	N/A
g)	State One-Call agency called? Caller: _____ Ticket Number: _____ Date: _____	yes	no	N/A
h)	Geophysical survey performed? Survey performed by: _____ Method: _____ Date: _____	yes	no	N/A
i)	Hand excavation performed (with concurrent use of utility detection device)? Completed by: _____ Total depth: _____ feet Date: _____	yes	no	N/A
j)	Trench/excavation probed? Probing completed by: _____ Depth/frequency: _____ Date: _____	yes	no	N/A

2. Overhead Utilities — Present Absent

a)	Determination of nominal voltage	yes	no	N/A
b)	Marked on site maps	yes	no	N/A
c)	Necessary to lockout/insulate/re-route	yes	no	N/A
d)	Document procedures used to lockout/insulate/re-route	yes	no	N/A
e)	Minimum acceptable clearance (SOP Section 5.2): _____			

3. Notes:

_____

_____

_____

Approval:

_____ _____

Site Manager/Field Operations Leader Date

c: PM/Project File
Program File

ATTACHMENT 4
OSHA LETTER OF INTERPRETATION

Mr. Joseph Caldwell
Consultant
Governmental Liaison
Pipeline Safety Regulations
211 Wilson Boulevard
Suite 700
Arlington, Virginia 22201

Re: Use of hydro-vacuum or non-conductive hand tools to locate underground utilities.

Dear Mr. Caldwell:

In a letter dated July 7, 2003, we responded to your inquiry of September 18, 2002, regarding the use of hydro-vacuum equipment to locate underground utilities by excavation. After our letter to you was posted on the OSHA website, we received numerous inquiries that make it apparent that aspects of our July 7 letter are being misunderstood. In addition, a number of industry stakeholders, including the National Utility Contractors Association (NUCA), have provided new information regarding equipment that is available for this work.

To clarify these issues, we are withdrawing our July 7 letter and issuing this replacement response to your inquiry.

Question: Section 1926.651 contains several requirements that relate to the safety of employees engaged in excavation work. Specifically, paragraphs (b)(2) and (b)(3) relate in part to the safety of the means used to locate underground utility installations that, if damaged during an uncovering operation, could pose serious hazards to employees.

Under these provisions, what constitutes an acceptable method of uncovering underground utility lines, and further, would the use of hydro-vacuum excavation be acceptable under the standard?

Answer

Background

Two sections of 29 CFR 1926 Subpart P (Excavations), 1926.651(Specific excavation requirements), govern methods for uncovering underground utility installations. Specifically, paragraph (b)(2) states:

> When utility companies or owners cannot respond to a request to locate underground utility installations within 24 hours * * * or cannot establish the exact location of these installations, the employer may proceed, provided the employer does so with caution, and provided detection equipment or other acceptable means to locate utility installations are used. (emphasis added).

Paragraph (b)(3) provides:

ATTACHMENT 4 (Continued)

> When excavation operations approach the estimated location of underground installations, the exact location of the installations shall be determined by safe and acceptable means. (emphasis added).

Therefore, "acceptable means" must be used where the location of the underground utilities have not been identified by the utility companies and detection equipment is not used.

Subpart P does not contain a definition of either "other acceptable means" or "safe and acceptable means." The preambles to both the proposed rule and the final rule discussed the rationale behind the wording at issue. For example, the preamble to the proposed rule, 52 Fed. Reg. 12301 (April 15, 1987), noted that a 1972 version of this standard contained language that specified "careful probing or hand digging" as the means to uncover utilities. The preamble then noted that an amendment to the 1972 standard later deleted that language "to allow other, *equally effective means* of locating such installations." The preamble continued that in the 1987 proposed rule, OSHA again proposed using language in section (b)(3) that would provide another example of an acceptable method of uncovering utilities that could be used *where the utilities have not been marked and detection equipment is not being used* – "probing with hand-held tools." This method was rejected in the final version of 29 CFR 1926. As OSHA explained in the preamble to the final rule, 54 Fed. Reg. 45916 (October 31, 1989):

> OSHA received two comments * * * and input from ACCSH [OSHA's Advisory Committee on Construction Safety and Health] * * * on this provision. All commenters recommended dropping 'such as probing with hand-held tools' from the proposed provision, because this could create a hazard to employees by damaging the installation or its insulation.

In other words, the commenters objected to the use of hand tools being used unless detection equipment was used in conjunction with them. OSHA then concluded its discussion relative to this provision by agreeing with the commentators and ultimately not including any examples of "acceptable means" in the final provision.

Non-conductive hand tools are permitted

This raises the question of whether the standard permits the use of hand tools alone -- without also using detection equipment. NUCA and other industry stakeholders have recently informed us that non-conductive hand tools that are appropriate to be used to locate underground utilities are now commonly available.

Such tools, such as a "shooter" (which has a non-conductive handle and a snub nose) and non-conductive or insulated probes were not discussed in the rulemaking. Since they were not considered at that time, they were not part of the class of equipment that was thought to be unsafe for this purpose. Therefore, we conclude that the use of these types of hand tools, when used with appropriate caution, is an "acceptable means" for locating underground utilities.

ATTACHMENT 4 (Continued)

Hydro-vacuum excavation

It is our understanding that some hydro-vacuum excavation equipment can be adjusted to use a minimum amount of water and suction pressure. When appropriately adjusted so that the equipment will not damage underground utilities (especially utilities that are particularly vulnerable to damage, such as electrical lines), use of such equipment would be considered a "acceptable means" of locating underground utilities. However, if the equipment cannot be sufficiently adjusted, then this method would not be acceptable under the standard.

Other technologies

We are not suggesting that these are the only devices that would be "acceptable means" under the standard. Industry stakeholders have informed us that there are other types of special excavation equipment designed for safely locating utilities as well.

We apologize for any confusion our July 7 letter may have caused. If you have further concerns or questions, please feel free to contact us again by fax at: U.S. Department of Labor, OSHA, Directorate of Construction, Office of Construction Standards and Compliance Assistance, fax # 202-693-1689. You can also contact us by mail at the above office, Room N3468, 200 Constitution Avenue, N.W., Washington, D.C. 20210, although there will be a delay in our receiving correspondence by mail.

Sincerely,

Russell B. Swanson, Director
Directorate of Construction

NOTE: OSHA requirements are set by statute, standards and regulations. Our interpretation letters explain these requirements and how they apply to particular circumstances, but they cannot create additional employer obligations. This letter constitutes OSHA=s interpretation of the requirements discussed. Note that our enforcement guidance may be affected by changes to OSHA rules. Also, from time to time we update our guidance in response to new information. To keep apprised of such developments, you can consult OSHA's website at http://www.osha.gov.

TABLE OF CONTENTS

SECTION **PAGE**

1.0 PURPOSE **2**

2.0 SCOPE **2**

3.0 GLOSSARY **2**

4.0 RESPONSIBILITIES **2**

5.0 PROCEDURES **3**

5.1 GENERAL 3
5.2 USE AND DOCUMENTATION OF RESULTS 3
5.3 PRINCIPLES OF OPERATION 3
5.4 CALIBRATION 10
5.5 ROUTINE MAINTENANCE 11
5.5.1 Battery Charging 11
5.5.2 Emptying the Hydrogen Cylinder 12
5.5.3 Replacing the Sample Inlet Filter 12
5.6 TROUBLESHOOTING 13
5.6.1 MicroFID Fault Messages 13
5.7 TRANSPORTING MICROFID 18

6.0 SHIPPING **18**

7.0 REFERENCES **18**

FIGURES

NUMBER **PAGE**

5-1 DOCUMENTATION OF FIELD CALIBRATION 4
5-2 DIRECT-READING INSTRUMENT RESPONSE DATA 5
5-3 BORING LOG 7
5-4 TEST PIT LOG 8
6-1 EXAMPLE OF A HAZARDOUS AIRBILL FOR HYDROGEN 19
6-2 EXAMPLE OF A HAZARDOUS AIRBILL FOR METHANE IN AIR 20

1.0 PURPOSE

To establish procedures for the use, calibration, maintenance, troubleshooting, and shipment of the Photovac MicroFID handheld flame ionization detector.

2.0 SCOPE

Applies to all Brown & Root Environmental personnel who operate the MicroFID instrument during the performance of their work.

3.0 GLOSSARY

None.

4.0 RESPONSIBILITIES

Office Managers - Office Managers are responsible for ensuring that personnel under their direction who may use this device are first provided with adequate training and information.

Project Managers - Project Managers are responsible for ensuring that appropriate health and safety requirements and resources are addressed for their assigned projects.

Health and Safety Manager (HSM) - The HSM shall ensure that appropriate training is available to users of the Photovac MicroFID instrument.

Equipment Manager - The Equipment Manager shall ensure that all air monitoring instrumentation slated for field activities has been operationally checked out, fully charged, and calibrated prior to issuance for field service. Maintenance deficiencies identified by the Equipment Manager will require those instruments to be pulled from service until repairs can be facilitated.

Field Operations Leader (FOL)/Field Team Leader (FTL) - The FOL/FTL shall ensure all field team members using monitoring instruments as part of their assigned duties are adequately trained in their proper operation and limitations. The FOL/FTL shall ensure that the air monitoring instruments are employed as directed by site guidance documents (i.e., Work Plan, Health and Safety Plan, etc.). Additionally, the FOL/FTL shall ensure that the appropriate documentation and recordkeeping requirements are fulfilled including Documentation of Calibration and Direct Reading Instrument Response Data Sheets for air monitoring activities. On projects where a dedicated SSO is not assigned, the FOL/FTL is responsible for assuming the duties of that position.

Health and Safety Officer (HSO) - The HSO is responsible for determining air monitoring requirements for the site activities, and providing direction for air monitoring during specific site activities. This identification of types of air monitoring and direction for use are indicated within the Site-Specific Health and Safety Plan (HASP).

Site Safety Officer (SSO) - The SSO shall ensure the instruments identified are employed in the manner directed by the HSO and action levels employed as contingencies marks for the application of engineering controls, personal protective equipment (PPE) use, and administrative controls are employed as directed. Additionally, he/she shall ensure the instruments are properly maintained and calibrated prior to use in the field. The SSO during specific air monitoring applications including STEL and TWA mode measurements will be responsible for operation and application of this specialty air monitoring employment duty. The

SSO is also responsible for addressing relevant Hazard Communication requirements (e.g., MSDS, chemical inventories, labeling, training, etc.) on each assigned project.

5.0 PROCEDURES

5.1 General

Direct-reading instruments such as a flame ionization detector are typically used to monitor for airborne releases that could present an inhalation threat to personnel, and to screen and bias environmental samples. Proper use of these instruments by trained, qualified personnel is essential to the validity of any acquired results. Also essential is that the devices are properly calibrated according to manufacturers instructions (and the specifications of this SOP), and that users of the instrument properly document results.

5.2 Use and Documentation of Results

As with any direct-reading instrument, understanding not only how - but when to use this instrument is essential to gathering relevant and valid data. This device will only respond to volatile organics in air that are combustible. Inappropriate instrument selection, use, or interpretation of instrument results by an unqualified user not only can yield inaccurate results, but could place personnel at risk of exposure to hazardous agents. Only personnel who are properly trained and authorized to use this device will be permitted to operate it.

It is essential that instrument operators understand and comply with the requirements to document results. This includes the need to document calibration results as well as operational readings. Calibration results must be recorded using Figure 5-1. Operational results can be recorded in several ways, including:

- Direct-Reading Instrument Response Data (Figure 5-2) - preferred method
- Boring Log Forms (Figure 5-3)
- Test Pit Log Forms (Figure 5-4)
- Log book entries

When using direct-reading instruments, it is important to monitor the air near the source of potential releases (e.g., drilling boreholes, tank entrances, drum openings, etc.) and at worker breathing zone areas. All readings should be recorded, including readings noted where background levels were not exceeded.

5.3 Principles of Operation

The MicroFID is a flame ionization detector used for the measurement of combustible organic compounds in air at parts per million levels. Permanent air gases (argon, carbon dioxide, nitrogen, oxygen, water vapor, etc.) are not ionized by the flame.

When the MicroFID is turned on, the display prompts you to turn on the hydrogen. The internal pump draws sample air in through MicroFID's inlet. This sample air provides the oxygen necessary for combustion in the hydrogen-fueled flame. When the proper ratio of hydrogen to air is present in the combustion chamber, the flame is automatically started with a glow plug. A thermocouple is used to monitor the status of the flame. When the sample passes through the flame the combustible organic compounds in the sample will be ionized. After the compounds have been ionized, they are subjected to

FIGURE 5-1

DOCUMENTATION OF FIELD CALIBRATION

SITE NAME: _____ PROJECT NO.: _____

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

FIGURE 5-2

DIRECT-READING INSTRUMENT RESPONSE DATA

SITE NAME: _____

PROJECT NO.: _____

PAGE OF

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

FIGURE 5-2 (Continued)

SITE NAME: _____

PROJECT NO.: _____

PAGE _____ OF ____

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

FIGURE 5-3

BORING LOG

Page ___ of ___

PROJECT NAME: _____ BORING NUMBER: _____
PROJECT NUMBER: _____ DATE: _____
DRILLING COMPANY: _____ GEOLOGIST: _____
DRILLING RIG: _____ DRILLER: _____

Sample No. and 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: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated response read.

Drilling Area Background (ppm): [ ]

Remarks: _____

Converted to Well: Yes _____ No _____ Well I.D. #: _____

FIGURE 5-4

Page ___ of ___

TEST PIT LOG

PROJECT NAME: _____ TEST PIT NUMBER: _____
PROJECT NUMBER: _____ DATE: _____
LOCATION: _____ GEOLOGIST: _____

Depth (Ft.)	Lithology Change (Depth/Ft.)	MATERIAL DESCRIPTION Soil/Waste Characteristics (lithology, density, color, etc.)	USCS	Remarks	PID/FID READING Source (ppm)	BZ (ppm)

TEST PIT CROSS SECTION AND / OR PLAN VIEW

REMARKS: _____

PHOTO LOG: _____

a continuous electric field between the repeller electrode at the jet and the collector electrode. The ions in the electric field generate a current which is proportional to the concentration of the ionized molecules in the ionization chamber. An electrometer circuit converts the current to a voltage that is then fed to the microprocessor which interprets the current in units of ppm. After the sample passes through the flame and has become ionized, it is vented from the detector through a flame arrestor. The flame arrestor prevents the flame from igniting any flammable gases present in the working atmosphere.

MicroFID is strictly an organic compound detector. It does not respond to inorganic compounds. MicroFID's sensitivity is highly dependent on chemical structure and bonding characteristics. The combustion efficiency of a compound determines its sensitivity. Simple saturated hydrocarbons (methane, ethane, etc.) posses high combustion efficiencies and are among the compounds that produce the highest MicroFID response. Organic fuels (acetylene, refined petroleum products), burn easily and are also extremely well detected.

The presence of substituted functional groups (amino, hydroxyl, halogens) on a simple hydrocarbon reduces its combustion efficiency and the MicroFID's sensitivity to the compound. For example, methanol and chloromethane are detectable with MicroFID, but not at the same sensitivity as methane. The number of carbon atoms can also affect the instrument's sensitivity due to substitution. For example, MicroFID is more sensitive to n-butanol than it is to methanol. For additional information regarding response factors of the MicroFID, consult the manufacturer's of the User's Manual.

Beginning Operation

The MicroFID can be operated without the activation of the flame to print or review logged data. In this way, the hydrogen fuel is conserved.

MicroFID will attempt to ignite the flame once the flow of hydrogen gas has been started. If the MicroFID has not been used for a while, it is possible that the gas supply lines are filled with air. If the flame cannot be started, MicroFID will begin a 30 second purge cycle. During the purge cycle it will flush the gas supply lines with hydrogen. After the purge cycle, it will attempt to light the flame again. If it fails again, another purge cycle will be performed and MicroFID will try a third time to ignite the flame. The following steps summarize proper start-up procedures.

1. Turn the instrument on by pressing the front of the On/Off switch. When the instrument is powered up, the version number and creation date of the instrument software are displayed. Press ENTER.

2. You will be prompted to start the flame. If you do not want to start the flame, use the ARROW keys to select "No Flame Needed" and press ENTER. To start the flame, use the ARROW keys to select Start Flame and press ENTER.

3. If you selected "Start Flame," MicroFID will prompt you to turn on the hydrogen. Turn the shut-off valve counterclockwise to start the flow of hydrogen and press ENTER.

4. The pump will start and MicroFID will then ignite the flame. You will hear a small pop when the flame has been ignited. Once the flame has been started the message "Detector flame has been started OK" will be displayed followed by the default display.

The default display provides the following information: instrument status, current detected concentration, event name (if the datalogger is on), time, and date. If an event name is longer than three characters, the bottom line of the display will scroll through the information.

The instrument status appears at the left of the upper line of the display and on the Print and Graph outputs. Each status has a priority assigned to it. If more than one status is in effect, then the status with the highest priority is displayed until the condition is corrected or until the option is turned off.

5.4 Calibration

The calibration (CAL) key is used to calibrate MicroFID. Before beginning calibration, ensure that you have a reliable source of both zero air and calibration gas. To document calibration efforts, field personnel will record information on the Documentation of Field Calibration Form (Figure 5-1), or the same information in the calibration/maintenance log book assigned to an instrument. A brief description of the functions under the CAL key are as follows:

1. When you press the CAL key you will first be prompted to select a Cal Memory. Each Cal Memory stores a unique zero point, sensitivity setting, response factor and alarm level.

2. You will then be prompted to enter a response factor. Refer to the manufacturer's User's Manual for a list of response factors. If the compound is not listed in that reference, or if you are measuring gas mixtures, enter a value of 1.00. The concentration detected by MicroFID will be multiplied by the response factor before it is displayed and logged.

3. Next select Low Range or High Range operation. Use Low Range if you are sampling concentrations between 0.5 and 2000 ppm (methane equivalents). Use High Range if you are sampling concentrations between 10 and 50,000 ppm (methane equivalents).

4. You will now be prompted to connect a supply of zero air. You may use ambient air or, for best results, use a clean Tedlar bag filled with zero grade air. In most cases, ambient air will be used provided calibration is performed in an area in which interfering airborne contaminants are not present. If using ambient air, press <ENTER> to being zeroing.

5. If you are using a charcoal filter to clean ambient air, connect the filter by loading the Teflon ferrules into the nut (the ferrules and the nut are supplied with the filter). Connect the nut to MicroFID's inlet. Do not tighten the nut. Remove the charcoal filter from its plastic bag and insert it into the nut. Finger tighten the nut onto the inlet. If the filter is not secure, ensure you have inserted the tube far enough into the nut. Do not over-tighten the fitting. Press <ENTER> and the MicroFID will set its zero point. NOTE: The charcoal filter does not filter methane or ethane. If these compounds are present, use a gas bag with a supply of commercial zero air.

6. If you are using a Tedlar bag filled with zero air, connect the bag to the inlet. Open the bag and press <ENTER>. MicroFID will set its zero point.

7. After MicroFID has set its zero point, you can then enter the concentration of the calibration gas (span gas), and then connect the Tedlar bag adapter to the inlet. Open the bag and press <ENTER>. MicroFID sets its sensitivity. Note: You must have a supply of calibration gas ready before calibrating MicroFID. When calibrating MicroFID, ensure the instrument is level. If MicroFID is tilted from side to side, gravity will affect the flame height and cause erroneous readings.

8. When MicroFID's display reverts to normal, it is calibrated and ready for use. Remove the Tedlar bag from the inlet.

9. Press the ALARM key and enter the alarm level for the selected CAL memory.

5.5 Routine Maintenance

5.5.1 Battery Charging

A fully charged battery will power the MicroFID for approximately 15 hours. If the instrument is to be used for more than 15 hours, carry a spare battery pack. Battery life is reduced if the instrument is turned off and then on again repeatedly.

When the instrument status displays "LoBat," the battery pack requires changing. When the "LoBat" status is displayed, you have a few minutes of operation left. MicroFID will turn itself off before the battery pack becomes critically low.

To remove the battery pack:

1. Stop the flow of hydrogen gas by turning the hydrogen shut-off valve fully clockwise. Turn the instrument off by pressing the On/Off switch twice.

2. Use the MicroFID multi-tool to loosen the two captive screws in the bottom of the battery pack.

3. A retainer at the rear of the instrument helps secure the battery pack to the instrument. Free the battery pack from the instrument.

4. Connect the charged battery pack to the retainer at the rear of the instrument.

5. Retighten the two captive screws and the bottom of the battery pack.

To charge the battery pack:

1. Ensure the correct plug is installed on the line cord of the battery charger.

2. Plug the charger into the jack located on the front of the battery pack.

3. Plug the charger into an AC outlet. The LED, on the battery pack indicates the charge state. Red indicates the battery is being charged. Green indicates the battery is fully charged and ready for use. It is normal for a fully charged battery to indicate it is charging (red light) when first plugged in. The LED will turn green as the battery charges.

4. When the battery pack is charged remove the charger, first from the wall outlet then from the battery pack.

Charging a fully discharged battery pack will take approximately 8 hours. Leaving the charger connected to a charged battery pack will not harm the battery or the charger in any way. If a battery pack is to be left indefinitely, leave it connected to the charger so that it will be fully charged and ready for operation.

5.5.2 Emptying the Hydrogen Cylinder

When you transport the MicroFID, you should empty the internal hydrogen cylinder and then refill it when you arrive at your destination.

To empty the cylinder:

1. Take the instrument outdoors, or to a well-ventilated area, at least 25 feet from any potential sources of ignition.

2. Turn the MicroFID off and open the hydrogen shut-off valve.

3. Remove the battery pack as described above.

4. Locate the purge outlet. It is located on the underside of the instrument.

5. Use the MicroFID multi-tool to turn the screws counterclockwise. Loosen the screw but do not remove it.

6. Leave the instrument so that the purge outlet is facing up. If the purge outlet is facing down, hydrogen will vent into MicroFID's case.

7. If the cylinder is full, it will take approximately 15 minutes to empty.

8. Watch the Contents gauge. When the cylinder is empty, close the purge outlet. Use the MicroFID multi-tool to turn the screw clockwise.

9. Replace the battery pack as discussed above.

5.5.3 Replacing the Sample Inlet Filter

MicroFID is equipped with a combined dust and water filter to reduce detector contamination. As the filter collects dust, MicroFID's inlet flow rate and sensitivity decrease. The filter will not allow water to pass through, but the filter will not stop gases and vapors.

Replace the filter on a weekly basis, or more frequently if MicroFID is used in a dusty or wet environment. You must replace the filter if MicroFID has been exposed to liquid water. The pump will sound labored when the filter requires replacement.

1. Turn off the instrument and unscrew the filter housing from the detector housing. Be careful not to lose the o-ring seal.

2. Remove the Teflon/Polypropylene filter and install the new filter. Place the filter in the filter housing with the Teflon side facing down into the filter housing and the mesh side facing the MicroFID. Handle the filter disk only by the edges. The mesh may be damaged or contaminated by excessive handling. Use forceps if possible.

3. Replace the filter housing.

4. Calibrate the CAL Memories that you are using before continuing operation.

5.6 Troubleshooting

This section provides guidance for troubleshooting the MicroFID. If problems are not corrected through these troubleshooting methods, contact the Photovac Service Department.

5.6.1 MicroFID Fault Messages

When the "Check" status is displayed, MicroFID's operation is compromised. Press the <TUTOR> key for a two-line description of the fault. One exception is the flame out fault. When a flame out fault occurs, the instrument status changes to "NoFlm."

Fault: Detector flame has gone out.

Cause: The hydrogen gas has run out.

Action: Ensure the shut-off valve is open. Check the hydrogen contents gauge on the side of the instrument and refill the hydrogen cylinder if necessary. Ensure the cylinder purge outlet has been closed.

Cause: Oxygen supply is deficient (Note: This is a Level B PPE condition).

Action: Ensure there is an adequate supply of oxygen. If you are sampling very high concentrations it is possible you are sampling above the flame out concentration. The flame out concentration for methane is approximately 52,000 ppm (5.2 percent methane in air).

A minimum of 17 percent oxygen is required to start the hydrogen flame. The oxygen is supplied from the sample as it is drawn in by the pump. A minimum of 10 percent oxygen is required to maintain the hydrogen flame.

Flame out also may occur when sampling enclosed or confined spaces where vapors and gases cannot escape. Watch for indications of increased flame height such as erratic readings or sudden high concentrations followed by a flame out fault.

If you will be using the MicroFID in a highly contaminated area where it is possible that the oxygen content will fall below 10 percent, watch for indication of reduced flame height such as lowered detection limits or a flame out fault.

Cause: High concentrations of flammable gases (gases within their flammable range) are present. High concentrations of flammable gases can act as an additional fuel source. When this happens, the flame height may increase beyond the confines of the combustion chamber. The hydrogen supply will then be cut-off and the flame will go out. Monitor LEL conditions and observe action levels specified in the Health and Safety Plan.

Action: Move to a location where there is an adequate supply of air and restart the flame. See the information above. Watch for indications of increased flame height such as erratic readings or sudden height concentrations followed by a flame out fault.

Cause: Exhaust port is blocked.

Action: At low temperatures, water vapor, a by-product of the hydrogen flame, may condense at the exhaust port. At sub-zero temperatures the water will freeze and obstruct the exhaust port. If the exhaust port becomes obstructed, pump operation will be inhibited. Flame out may also result. Operate the MicroFID within the operating temperature range 41 to 105 degrees Fahrenheit. In the event that the flame arrestor becomes clogged, contact the Photovac Service Department.

Cause: Sample line is blocked.

Action: Ensure the sample line is not obstructed in any way. If you are using the long sample probe, ensure flow is maintained through the entire length of tubing.

Cause: Inlet filter is plugged.

Action: Replace the inlet filter.

Fault: Signal from zero gas is too high.

Cause: Contamination of sample line or fittings before the detector.

Action: Clean or replace the sample line of the inlet filter.

Cause: Span gas is used instead of zero gas.

Action: Ensure clean gas is used to zero the MicroFID. Mark the calibration and zero gas Tedlar bags clearly.

Cause: Ambient air is contaminated.

Action: If you are unsure about the quality of the ambient air, use a charcoal filter or a supply of commercial zero grade air.

Cause: Hydrogen supply is contaminated.

Action: Hydrogen may react with the carbon element of the steel tank to produce methane. This will only occur if the cylinder is in poor condition and if the hydrogen has a high moisture content. Replace the hydrogen tank. Empty and refill the MicroFID internal cylinder with fresh hydrogen.

Fault: Signal from the calibration gas is too small

Cause: Calibration gas and zero air are switched.

Action: Ensure calibration gas is used to calibrate the MicroFID. Mark the calibration and zero gas Tedlar bags clearly. Ensure the calibration gas is of a reliable concentration.

Fault: Detector field voltage is low.

Cause: Internal fault in electronics.

Action: Contact the Photovac Service Department.

Problem: No instrument response detected, yet compounds are known to be present.

Cause: MicroFID has not been calibrated properly.

Action: Ensure calibration gas is of a reliable concentration and then calibrate the instrument. After the instrument has been calibrated, sample the Tedlar bag of calibration gas. A reading equivalent to the calibration gas should be displayed. If not, contact the Photovac Service Department.

Action: When calibrating the MicroFID, ensure the instrument is level. If the MicroFID is tilted side to side, gravity can affect the flame height and cause erroneous readings. If the sampling location is difficult to reach without tilting the instrument, use the long sample probe.

Cause: Background contamination from the hydrogen.

Action: It is possible that the hydrogen has become contaminated and is contributing a high background signal. If the hydrogen supply tank is more than 6 months old it should be replaced with a new cylinder. When ordering hydrogen, specify ultra-high purity (99.999 percent pure). Empty the MicroFID hydrogen cylinder (as described in Section 5.5.2 of this SOP) and then refill with hydrogen from the new cylinder.

Problem: **Date and time settings are not retained.**

Cause: MicroFID has not been used for 3 months or more and the internal battery (not the external battery pack) has been discharged.

Action: Turn MicroFID on and allow it to run until a "LoBat" status appears. This will take approximately 15 hours. Remove the battery pack and recharge it overnight. Repeat this procedure for 3 or 4 days. While MicroFID is running the internal battery is charging.

Problem: **Cannot fill the internal hydrogen cylinder to 1800 psi.**

Cause: Supply tank has less than 1800 psi of pressure. You can only fill the internal cylinder to a pressure of less than or equal to the tank pressure.

Action: Fill the internal cylinder to the pressure of the tank or replace the tank with a full one.

Cause: The hydrogen purge outlet is open.

Action: Close the outlet and fill the cylinder.

Cause: There is a problem with the refill adapter.

Action: Contact the Photovac Service Department

Problem: **Instrument status shows "Over."**

Cause: Rapid change in signal level. The detector electronics have been momentarily saturated.

Action: Wait a few seconds for the status to return to "Ready."

Cause: The detector has become saturated.

Action: Move the MicroFID to a location where it can sample clean air. Sample zero air until the reading stabilizes around "0." If you were using Low Range, switch to High Range. Calibrate the CAL Memory you were using when the "Over" status appeared.

Problem: **Display contrast bars are on or display is blank.**

Cause: Battery pack is critically low.

Action: Recharge the battery pack or connect the MicroFID to the battery charger.

Cause: The battery pack is not connected to the instrument properly.

Action: Ensure the battery pack has been aligned correctly. Ensure the battery pack is secured by the retainer at the rear of the instrument.

Problem: **Sample flow rate varies from 600 ml/min. +/-10 percent.**

Cause: Inlet filter has not been installed.

Action: Install an inlet filter.

Cause: Inlet filter has not been properly tightened onto the detector cap.

Action: Finger-tighten the filter cap.

Cause: Inlet filter is plugged.

Action: Replace the inlet filter.

Cause: Pump has been damaged.

Action: Contact the Photovac Service Department

Cause: Exhaust port is blocked.

Action: At low temperatures, water vapor (a by-product of the hydrogen flame) may condense at the exhaust port. At sub-zero temperatures the water will freeze and obstruct the exhaust port. If the exhaust port becomes obstructed, pump operation will be inhibited. Flame out may also result. Operate the MicroFID within the operating temperature range 41 to 105 degrees Fahrenheit. In the event that the flame arrestor becomes clogged, contact the Photovac Service Department.

Problem: **Flame will not ignite.**

Cause: The hydrogen gas has run out.

Action: Ensure the shut-off valve is open. Check the hydrogen contents gauge on the side of the instrument and refill the hydrogen cylinder if necessary. Ensure the hydrogen purge outlet is closed.

Cause: Oxygen supply is deficient.

Action: Ensure there is an adequate supply of oxygen. Do not attempt to ignite the flame in a location where there is the suspicion of encountering greater than 10,000 ppm methane or the equivalent concentration of a flammable gas. Move to a location where there are lower concentrations, start the flame and then begin sampling higher concentrations. Monitor for LEL conditions, following action levels specified in the Health and Safety Plan. If the flame goes out while you are sampling very high concentrations, it is possible you are sampling above the flame out concentration. The flame out concentration of methane is approximately 52,000 ppm (5.2 percent methane in air). A minimum of 17 percent oxygen is required to start the hydrogen flame. Oxygen is supplied from the sample as it is drawn in by the pump. A minimum or 10 percent oxygen is required to maintain the hydrogen flame.

Cause: Exhaust port is blocked.

Action: At low temperatures, water vapor (a by-product of the hydrogen flame) may condense at the exhaust port. At sub-zero temperatures the water will freeze and obstruct the exhaust port. If the exhaust port becomes obstructed, pump operation will be inhibited. Flame out may also result. Operate the MicroFID within the operating temperature range 41 to 105 degrees Fahrenheit. In the event that the flame arrestor becomes clogged, contact the Photovac Service Department.

Cause: Hydrogen supply lines are full of air.

Action: If MicroFID has not been operated for some time, it is possible that the hydrogen supply lines contain air. Fill the hydrogen cylinder and then open the hydrogen shut-off valve. Allow the hydrogen to purge the system for about 5 minutes and then turn MicroFID on and start the flame.

Cause: Hydrogen lines are blocked.

Action: Contact the Photovac Service Department.

Problem: **Liquid has been aspirated.**

Cause: MicroFID has been exposed to a solvent that can pass through the Teflon/Polypropylene filter.

Action: Contact the Photovac Service Department.

5.7 Transporting MicroFID

When you transport MicroFID, you should empty the internal hydrogen cylinder and then refill it when you arrive at your destination (see Section 5.5.2 of this SOP). If you are traveling by passenger aircraft, you **must** empty the hydrogen cylinder. You cannot transport MicroFID by passenger aircraft with hydrogen in the cylinder.

The MicroFID can be shipped to sites. However, if shipment is to be performed while the cylinder still contains hydrogen, a Hazardous Materials Airbill must be filled out and the package must be properly marked and labeled. Examples of various completed forms are provided as Figures 6-1 and 6-2.

6.0 SHIPPING

The Photovac may be shipped as cargo or carried on as luggage providing there is no hydrogen fuel source or calibration gas cylinder accompanying the kit. **Only personnel who have been properly trained are permitted to offer a hazardous material for shipment.** The "Shipping Hazardous Materials" course offered by Tetra Tech NUS is considered acceptable training for this purpose. Specific instructions on packaging, labeling, and otherwise preparing a hazardous material shipment are presented in the Student Manual that accompanies the course. If shipping or transporting the hydrogen fuel source, a Hazardous Materials (or Dangerous Goods) Airbill such as the example in Figure 6-1 must be completed. When shipping or transporting the calibration gas, a separate Airbill (such as the one illustrated in Figure 6-2) must be prepared.

7.0 REFERENCES

MicroFID Handheld Flame Ionization Detector User's Manual, 1995.

Student Manual from "Shipping Hazardous Materials" course, Tetra Tech NUS, 1999.

FIGURE 6-1

EXAMPLE HAZARDOUS AIRBILL FOR HYDROGEN

FedEx. *Dangerous Goods Airbill*

288/300
7180827

Sender's Copy
RETAIN FOR 1 YEAR
RETAIN THIS COPY FOR YOUR RECORDS

The World On Time.

1 From (please print and press hard)

Date ______ Sender's FedEx Account Number ______

Sender's Name ______ Phone ( )

Company ______

Address ______ Dept./Floor/Suite/Room

City ______ State ______ ZIP ______

2 Your Internal Billing Reference Information

3 To (please print and press hard)

Recipient's Name: TOM PATTON Phone (412) 262 4583

Company: TETRA TECH NUS

Address: SPRING RUN RD EXT STE 140 B 1 (We Cannot Deliver to P.O. Boxes or P.O. ZIP Codes) Dept./Floor/Suite/Room

☐ Check here if residence

City: CORAOPOLIS State: PA ZIP: 15108

For HOLD at FedEx Location check here: ☐ Hold Weekday ☐ Hold Saturday

For WEEKEND Delivery check here: ☐ Saturday Delivery ☐ NEW Sunday Delivery

4a Express Package Service (Packages under 150 lbs.)
☐ FedEx Priority Overnight ☐ FedEx Standard Overnight
☐ FedEx 2Day ☐ FedEx Express Saver

4b Express Freight Service (Packages over 150 lbs.)
☐ FedEx Overnight Freight ☐ FedEx 2Day Freight ☐ FedEx Express Saver Freight

(Call for delivery schedule. Some restrictions apply. See back for detailed descriptions of freight services.)

Questions? Call 1-800-Go-FedEx® (800)463-3339

5 Packaging
☒ Other Packaging
Dangerous Goods cannot be shipped in FedEx packaging.

6 Special Handling
☒ Dangerous Goods as per attached Shipper's Declaration ☒ Cargo Aircraft Only

7 Payment
☐ Sender ☐ Recipient ☐ Third Party ☐ Credit Card ☐ Cash/Check

FedEx Account No. ______

Credit Card No. ______ Exp. Date ______

Total Packages | Total Weight | Total Declared Value $ .00 | Total Charges $

Signature Release Unavailable

FedEx Tracking Number: 807286973876 Form I.D. No. 0204

355

Page 1 of 1 Pages

Two completed and signed copies of this Declaration must be handed to the operator.

WARNING

Failure to comply in all respects with the applicable Dangerous Goods Regulations may be in breach of the applicable law, subject to legal penalties. This Declaration must not, in any circumstances, be completed and/or signed by a consolidator, a forwarder or an IATA cargo agent.

TRANSPORT DETAILS

This shipment is within the limitations prescribed for: (delete non-applicable) XXXXXXXXX | CARGO AIRCRAFT ONLY

Airport of Departure: ______

Airport of Destination: ______

Shipment type: (delete non-applicable) NON-RADIOACTIVE | XXXXXXXXXX

NATURE AND QUANTITY OF DANGEROUS GOODS

Proper Shipping Name	Class or Division	UN or I.D. No.	Packing Group	Subsidiary Risk	Quantity and Type of Packaging	Packing Inst.	Authorization
Hydrogen Compressed	2.1	UN 1049			1 Plastic Box X 1.0 Kg	200	

Additional Handling Information

Prepared for AIR TRANSPORT according to: (Customer MUST check one) ☐ 49 CFR ☒ ICAO / IATA

I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name and are classified, packaged, marked, and labelled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations.

Name/Title of Signatory

Place and Date

Signature (see warning above)

Emergency Telephone Number (Required for US Origin or Destination Shipments): 1-800-535-5053 Infotrac

IF ACCEPTABLE FOR PASSENGER AIRCRAFT, THIS SHIPMENT CONTAINS RADIOACTIVE MATERIAL INTENDED FOR USE IN, OR INCIDENT TO, RESEARCH, MEDICAL DIAGNOSIS, OR TREATMENT.

FIGURE 6-2

EXAMPLE HAZARDOUS AIRBILL FOR METHANE IN AIR

FedEx *Dangerous Goods Airbill* — Sender's Copy — RETAIN FOR 1 YEAR — RETAIN THIS COPY FOR YOUR RECORDS — *The World On Time*

6/300 7181160

1 From (please print and press hard)

Date _____ Sender's FedEx Account Number _____

Sender's Name _____ Phone ( ) _____

Company _____

Address _____ Dept./Floor/Suite/Room

City _____ State _____ ZIP _____

2 Your Internal Billing Reference Information (Optional) (First 24 characters will appear on invoice)

3 To (please print and press hard)

Recipient's Name Tom Patton Phone (412) 262-4583

Company Tetra Tech NUS

Address Spring Run Road Extension, Suite 140 (We Cannot Deliver to P.O. Boxes or P.O. ZIP Codes) Dept./Floor/Suite/Room

☐ Check here if residence (Extra charge applies for FedEx Express Saver)

City Coraopolis State PA ZIP 15108

For HOLD at FedEx Location check here: ☐ Hold Weekday ☐ Hold Saturday

For WEEKEND Delivery check here: ☐ Saturday Delivery ☐ NEW Sunday Delivery

4a Express Package Service Packages under 150 lbs. Delivery commitments may be later in some areas.

☐ FedEx Priority Overnight ☐ FedEx Standard Overnight ☐ FedEx 2Day ☐ FedEx Express Saver

4b Express Freight Service Packages over 150 lbs. Delivery commitments may be later in some areas.

☐ FedEx Overnight Freight ☐ FedEx 2Day Freight ☐ FedEx Express Saver Freight (Up to 3 business days)

(Call for delivery schedule. Some restrictions apply. See back for detailed descriptions of freight services.)

Questions? Call 1•800•Go•FedEx® (800)463-3339

5 Packaging

☒ Other Packaging

Dangerous Goods cannot be shipped in FedEx packaging.

6 Special Handling

☒ Dangerous Goods as per attached Shipper's Declaration ☐ Cargo Aircraft Only

7 Payment

Bill to: ☐ Sender ☐ Recipient ☐ Third Party ☐ Credit Card ☐ Cash/Check

FedEx Account No. _____

Credit Card No. _____ Exp. Date _____

Total Packages	Total Weight	Total Declared Value*	Total Charges
		$ .00	$

Signature Release Unavailable

PART #154251 • Rev. Date 4/98 ©1994-99 FedEx • PRINTED IN U.S.A.

FedEx Tracking Number 807286974806 Form I.D. No. 0204 355

Page 1 of 1 Pages

Two completed and signed copies of this Declaration must be handed to the operator.

WARNING

Failure to comply in all respects with the applicable Dangerous Goods Regulations may be in breach of the applicable law, subject to legal penalties. This Declaration must not, in any circumstances, be completed and/or signed by a consolidator, a forwarder or an IATA cargo agent.

TRANSPORT DETAILS

This shipment is within the limitations prescribed for: (delete non-applicable) PASSENGER AND CARGO AIRCRAFT / CARGO AIRCRAFT ONLY

Airport of Departure:

Airport of Destination:

Shipment type: (delete non-applicable) NON-RADIOACTIVE ~~RADIOACTIVE~~

NATURE AND QUANTITY OF DANGEROUS GOODS

Dangerous Goods Identification

Proper Shipping Name	Class or Division	UN or I.D. No.	Packing Group	Subsidiary Risk	Quantity and Type of Packaging	Packing Inst.	Authorization
Compressed Gas N.O.S. (mixture Nitrogen and Oxygen)	2.2	UN 1956			1 Plastic box x 0.56 Kg	200	

Additional Handling Information

Prepared for AIR TRANSPORT according to: (Customer MUST check one) ☐ 49 CFR ☒ ICAO / IATA

I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name and are classified, packaged, marked, and labelled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations.

Name/Title of Signatory

Place and Date

Signature (see warning above)

Emergency Telephone Number (Required for US Origin or Destination Shipments) 1-800-535-5053 InfoTRAC

IF ACCEPTABLE FOR PASSENGER AIRCRAFT, THIS SHIPMENT CONTAINS RADIOACTIVE MATERIAL INTENDED FOR USE IN, OR INCIDENT TO, RESEARCH, MEDICAL DIAGNOSIS, OR TREATMENT.

TABLE OF CONTENTS

SECTION **PAGE**

1.0 PURPOSE **2**

2.0 SCOPE **2**

3.0 GLOSSARY **2**

4.0 RESPONSIBILITIES **3**

5.0 PROCEDURES **3**

5.1 OVERVIEW 3
5.2 SOIL SAMPLE COLLECTION 4
5.2.1 Procedure for Collecting Soil Samples for Volatile Organic Compounds 4
5.2.2 Procedure for Collecting Non-Volatile Soil Samples 6
5.2.3 Procedure for Collecting Undisturbed Soil Samples (ASTM D1587-83) 6
5.3 SURFACE SOIL SAMPLING 7
5.4 NEAR-SURFACE SOIL SAMPLING 7
5.5 SUBSURFACE SOIL SAMPLING WITH A HAND AUGER 8
5.6 SUBSURFACE SOIL SAMPLING WITH A SPLIT-BARREL SAMPLER (ASTM D1586-84) 9
5.7 SUBSURFACE SOL SAMPLING USING DIRECT PUSH TECHNOLOGY 10
5.8 EXCAVATION AND SAMPLING OF TEST PITS AND TRENCHES 10
5.8.1 Applicability 10
5.8.2 Test Pit and Trench Excavation 10
5.8.3 Sampling in Test Pits and Trenches 12
5.8.4 Backfilling of Trenches and Test Pits 15
5.9 RECORDS 15

6.0 REFERENCES **16**

ATTACHMENTS

A SOIL & SEDIMENT SAMPLE LOG SHEET 17
B SPLIT-SPOON SAMPLER 18
C TEST PIT LOG 19
D REMOTE SAMPLE HOLDER FOR TEST PIT/TRENCH SAMPLING 20

1.0 PURPOSE

This procedure discusses the methods used to collect surface, near surface, and subsurface soil samples. Additionally, it describes the method for sampling of test pits and trenches to determine subsurface soil and rock conditions, and recover small-volume or bulk samples.

2.0 SCOPE

This procedure is applicable to the collection of surface, near surface and subsurface soils for laboratory testing, which are exposed through hand digging, hand augering, drilling, or machine excavating at hazardous substance sites.

3.0 GLOSSARY

Composite Sample - A composite sample exists as a combination of more than one sample at various locations and/or depths and times, which is homogenized and treated as one sample. This type of sample is usually collected when determination of an average waste concentration for a specific area is required. Composite samples are not to be collected for volatile organics analysis.

Grab Sample - One sample collected at one location and at one specific time.

Non-Volatile Sample - A non-volatile sample includes all other chemical parameters (e.g., semivolatiles, pesticides/PCBs, metals, etc.) and those engineering parameters that do not require undisturbed soil for their analysis.

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

Thin-Walled Tube Sampler - A thin-walled metal tube (also called a Shelby tube) used to recover relatively undisturbed soil samples. These tubes are available in various sizes, ranging from 2 to 5 inches outside diameter (OD) and from 18 to 54 inches in length.

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

Test Pit and Trench - Open, shallow excavations, typically rectangular (if a test pit) or longitudinal (if a trench), excavated to determine the shallow subsurface conditions for engineering, geological, and soil chemistry exploration and/or sampling purposes. These pits are excavated manually or by machine (e.g., backhoe, clamshell, trencher excavator, or bulldozer).

Confined Space - As stipulated in 29 CFR 1910.146, a confined space means a space that: 1) is large enough and so configured that an employee can bodily enter and perform assigned work; 2) has limited or restricted means for entry or exit (for example tanks, vessels, silos, storage bins, hoppers, vaults, pits, and excavations); and 3) is not designed for continuous employee occupancy. TtNUS considers all confined space as permit-required confined spaces.

4.0 RESPONSIBILITIES

Project Manager - The Project Manager is responsible for determining sampling objectives, as well as, the field procedures used in the collection of soil samples. Additionally, in consultation with other project personnel (geologist, hydrogeologist, etc.), the Project Manager establishes the need for test pits or trenches, and determines their approximate locations and dimensions.

Site Safety Officer (SSO) - The SSO (or a qualified designee) is responsible for providing the technical support necessary to implement the project Health and Safety Plan. This will include (but not be limited to) performing air quality monitoring during sampling, boring and excavation activities, and to ensure that workers and offsite (downwind) individuals are not exposed to hazardous levels of airborne contaminants. The SSO/designee may also be required to advise the FOL on other safety-related matters regarding boring, excavation and sampling, such as mitigative measures to address potential hazards from unstable trench walls, puncturing of drums or other hazardous objects, etc.

Field Operations Leader (FOL) - The FOL is responsible for finalizing the location of surface, near surface, and subsurface (hand and machine borings, test pits/trenches) soil samples. He/she is ultimately responsible for the sampling and backfilling of boreholes, test pits and trenches, and for adherence to OSHA regulations during these operations.

Project Geologist/Sampler - The project geologist/sampler is responsible for the proper acquisition of soil samples and the completion of all required paperwork (i.e., sample log sheets, field notebook, boring logs, test pit logs, container labels, custody seals, and chain-of-custody forms).

Competent Person - A Competent Person, as defined in 29 CFR 1929.650 of Subpart P - Excavations, means one who is capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

5.0 PROCEDURES

5.1 Overview

Soil sampling is an important adjunct to groundwater monitoring. Sampling of the soil horizons above the groundwater table can detect contaminants before they have migrated into the water table, and can establish the amount of contamination sorbed on aquifer solids that have the potential of contributing to groundwater contamination.

Soil types can vary considerably on a hazardous waste site. These variations, along with vegetation, can affect the rate of contaminant migration through the soil. It is important, therefore, that a detailed record be maintained during the sampling operations, particularly noting the location, depth, and such characteristics as grain size, color, and odor. Subsurface conditions are often stable on a daily basis and may demonstrate only slight seasonal variation especially with respect to temperature, available oxygen and light penetration. Changes in any of these conditions can radically alter the rate of chemical reactions or the associated microbiological community, thus further altering specific site conditions. As a result, samples must be kept at their at-depth temperature or lower, protected from direct light, sealed tightly in approved glass containers, and be analyzed as soon as possible.

The physical properties of the soil, its grain size, cohesiveness, associated moisture, and such factors as depth to bedrock and water table, will limit the depth from which samples can be collected and the method required to collect them. Often this information on soil properties can be obtained from published soil surveys available through the U.S. Geological Surveys and other government or farm agencies. It is the

intent of this procedure to present the most commonly employed soil sampling methods used at hazardous waste sites.

5.2 Soil Sample Collection

5.2.1 Procedure for Collecting Soil Samples for Volatile Organic Compounds

The above described traditional sampling techniques, used for the collection of soil samples for volatile organic analysis, have recently been evaluated by the scientific community and determined to be ineffective in producing accurate results (biased low) due to the loss of volatile organics in the sampling stages and microbial degradation of aromatic volatiles. One of the newly adopted sampling procedures for collecting soil samples includes the field preservation of samples with methanol or sodium bisulfate to minimize volatilization and biodegradation. These preservation methods may be performed either in the field or laboratory, depending on the sampling methodology employed.

Soil samples to be preserved by the laboratory are currently being performed using method SW-846, 5035. Laboratories are currently performing low level analyses (sodium bisulfate preservation) and high level analyses (methanol preservation) depending on the end users needs.

It should be noted that a major disadvantage of the methanol preservation method is that the laboratory reporting limits will be higher than conventional testing. The reporting levels using the new method for most analytes are 0.5 µg/g for GC/MS and 0.05 µg/g for GC methods.

The alternative preservation method for collecting soil samples is with sodium bisulfate. This method is more complex to perform in the field and therefore is not preferred for field crews. It should also be noted that currently, not all laboratories have the capabilities to perform this analysis. The advantage to this method is that the reporting limits (0.001 µg/g for GC/PID or GC/ELCD, or 0.010 for GC/MS) are lower than those described above.

The following procedures outline the necessary steps for collecting soil samples to be preserved at the laboratory, and for collecting soil samples to be preserved in the field with methanol or sodium bisulfate.

5.2.1.1 Soil Samples to be Preserved at the Laboratory

Soil samples collected for volatile organics that are to be preserved at the laboratory will be obtained using a hermetically sealed sample vial such as an EnCore™ sampler. Each sample will be obtained using a reusable sampling handle provided with the EnCore™ sampler. The sample is collected by pushing the EnCore™ sampler directly into the soil, ensuring that the sampler is packed tight with soil, leaving zero headspace. Using this type of sampling device eliminates the need for field preservation and the shipping restrictions associated with preservatives. A complete set of instructions is included with each Encore™ sampler shipment by the manufacturer.

Once the sample is collected, it should be placed on ice immediately and shipped to the laboratory within 48 hours (following the chain-of-custody and documentation procedures outlined in SOP SA-6.1). Samples must be preserved by the laboratory within 48 hours of sample collection.

If the lower detection limits are necessary, an option would be to collect several EnCore™ samplers at a given sample location. Send all samplers to the laboratory and the laboratory can perform the required preservation and analyses.

5.2.1.2 Soil Samples to be Preserved in the Field

Soil samples preserved in the field may be prepared for analyses using both the low-level (sodium bisulfate preservation) method and medium-level (methanol preservation) method.

Methanol Preservation (Medium Level):

Soil samples to be preserved in the field with methanol will utilize 40-60 mL glass vials with septum lids. Each sample bottle will be filled with 25 mL of demonstrated analyte-free purge and trap grade methanol. Bottles may be prespiked with methanol in the laboratory or prepared in the field.

Soil will be collected with the use of a decontaminated (or disposable), small-diameter coring device such as a disposable tube/plunger-type syringe with the tip cut off. The outside diameter of the coring device must be smaller than the inside diameter of the sample bottle neck.

A small electronic balance or manual scale will be necessary for measuring the volume of soil to be added to the methanol preserved sample bottle. Calibration of the scale should be performed prior to use and intermittently throughout the day according to the manufacturers requirements.

The sample should be collected by pulling the plunger back and inserting the syringe into the soil to be sampled. The top several inches of soil should be removed before collecting the sample. Approximately 10 grams $\pm$2g (8-12 grams) of soil should be collected. The sample should be weighed and adjusted until obtaining the required amount of sample. The sample weight should be recorded to the nearest 0.01 gram in the field logbook and/or sample log sheet. The soil should then be extruded into the methanol preserved sample bottle taking care not to contact the sample container with the syringe. The threads of the bottle and cap must be free of soil particles.

After capping the bottle, swirl the sample (do not shake) in the methanol and break up the soil such that all of the soil is covered with methanol. Place the sample on ice immediately and prepare for shipment to the laboratory as described in SOP SA-6.1.

Sodium Bisulfate Preservation (Low Level):

Samples to be preserved using the sodium bisulfate method are to be prepared as follows:

Add 1 gram of sodium bisulfate to 5 mL of laboratory grade deionized water in a 40-60 mL glass vial with septum lid. Bottles may be prespiked in the laboratory or prepared in the field. The soil sample should be collected in a manner as described above and added to the sample container. The sample should be weighed to the nearest 0.01 gram as described above and recorded in the field logbook or sample log sheet.

Care should be taken when adding the soil to the sodium bisulfate solution. A chemical reaction of soils containing carbonates (limestone) may cause the sample to effervesce or the vial to possibly explode.

When preparing samples using the sodium bisulfate preservation method, duplicate samples must be collected using the methanol preservation method on a one for one sample basis. The reason for this is because it is necessary for the laboratory to perform both the low level and medium level analyses. Place the sample on ice immediately and prepare for shipment to the laboratory as described in SOP SA-6.1.

If the lower detection limits are necessary, an option to field preserving with sodium bisulfate would be to collect 3 EnCore™ samplers at a given sample location. Send all samplers to the laboratory and the laboratory can perform the required preservation and analyses.

5.2.2 Procedure for Collecting Non-Volatile Soil Samples

Non-volatile soil samples may be collected as either grab or composite samples. The non-volatile soil sample is thoroughly mixed in a stainless steel or disposable, inert plastic tray, using a stainless steel trowel or other approved tool, then transferred into the appropriate sample container(s). Head space is permitted in a non-volatile soil sample container to allow for sample expansion.

5.2.3 Procedure for Collecting Undisturbed Soil Samples (ASTM D1587-83)

When it is necessary to acquire undisturbed samples of soil for purposes of engineering parameter analysis (e.g., permeability), a thin-walled, seamless tube sampler (Shelby tube) will be employed. The following method will be used:

1. Remove all surface debris (e.g., vegetation, roots, twigs, etc.) from the specific sampling location and drill and clean out the borehole to the sampling depth, being careful to minimize the chance for disturbance of the material to be sampled. In saturated material, withdraw the drill bit slowly to prevent loosening of the soil around the borehole and to maintain the water level in the hole at or above groundwater level.

2. The use of bottom discharge bits or jetting through an open-tube sampler to clean out the borehole shall not be allowed. Use of any side-discharge bits is permitted.

3. 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 into the borehole, check to ensure that the sampler head contains a check valve. The check valve is necessary to keep water in the rods from pushing the sample out the tube sampler during sample withdrawal and to maintain a suction within the tube to help retain the sample.

4. 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're 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 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.

5. Upon removal of the sampling 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. Clean filler must be placed in voids at either end of the tube prior to sealing with wax. Place plastic caps on the ends of the sample tube, tape the caps in place, and dip the ends in wax.

6. Affix label(s) to the tube as required and record sample number, depth, penetration, and recovery length on the label. Mark the "up" direction on the side of the tube with indelible ink, and mark the end of the sample. Complete Chain-of-Custody (see SOP SA-6.3) and other required forms (including Attachment A of this SOP). 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 Dennison 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 need for acquiring an undisturbed sample.

5.3 Surface Soil Sampling

The simplest, most direct method of collecting surface soil samples (most commonly collected to a depth of 6 inches) for subsequent analysis is by use of a stainless steel trowel. Surface soils are considered 0-12 inches bgs.

In general, the following equipment is necessary for obtaining surface soil samples:

- Stainless steel or pre-cleaned disposable trowel.
- Real-time air monitoring instrument (e.g., PID, FID, etc.).
- Latex gloves.
- Required Personal Protective Equipment (PPE).
- Required paperwork (see SOP SA-6.3 and Attachment A of this SOP).
- Required decontamination equipment.
- Required sample container(s).
- Wooden stakes or pin flags.
- Sealable polyethylene bags (i.e., Ziploc® baggies).
- Heavy duty cooler.
- Ice.
- Chain-of-custody records and custody seals.

When acquiring surface soil samples, the following procedure shall be used:

1. Carefully remove vegetation, roots, twigs, litter, etc., to expose an adequate soil surface area to accommodate sample volume requirements.

2. Using a decontaminated stainless steel trowel, follow the procedure cited in Section 5.2.1 for collecting a volatile soil sample. Surface soil samples for volatile organic analysis should be collected from 6-12 inches bgs only.

3. Thoroughly mix (in-situ) a sufficient amount of soil to fill the remaining sample containers and transfer the sample into those containers utilizing the same stainless steel trowel employed above. Cap and securely tighten all sample containers.

4. Affix a sample label to each container. Be sure to fill out each label carefully and clearly, addressing all the categories described in SOP SA-6.3.

5. Proceed with the handling and processing of each sample container as described in SOP SA-6.2.

5.4 Near-Surface Soil Sampling

Collection of samples from near the surface (depth of 6-18 inches) can be accomplished with tools such as shovels and stainless steel or pre-cleaned disposable trowels.

The following equipment is necessary to collect near surface soil samples:

- Clean shovel.
- The equipment listed under Section 5.3 of this procedure.
- Hand auger.

To obtain near-surface soil samples, the following protocol shall be observed:

1. With a clean shovel, make a series of vertical cuts to the depth required in the soil to form a square approximately 1 foot by 1 foot.

2. Lever out the formed plug and scrape the bottom of the freshly dug hole with a decontaminated stainless steel or pre-cleaned disposable trowel to remove any loose soil.

3. Follow steps 2 through 5 listed under Section 5.3 of this procedure.

5.5 Subsurface Soil Sampling With a Hand Auger

A hand augering system generally consists of a variety of all stainless steel bucket bits (i.e., cylinders 6-1/2" long, and 2-3/4", 3-1/4", and 4" in diameter), a series of extension rods (available in 2', 3', 4' and 5' lengths), and a cross handle. A larger diameter bucket bit is commonly used to bore a hole to the desired sampling depth and then withdrawn. In turn, the larger diameter bit is replaced with a smaller diameter bit, lowered down the hole, and slowly turned into the soil at the completion depth (approximately 6 inches). The apparatus is then withdrawn and the soil sample collected.

The hand auger can be used in a wide variety of soil conditions. It can be used to sample soil both from the surface, or to depths in excess of 12 feet. However, the presence of rock layers and the collapse of the borehole normally contribute to its limiting factors.

To accomplish soil sampling using a hand augering system, the following equipment is required:

- Complete hand auger assembly (variety of bucket bit sizes).
- Stainless steel mixing bowls.
- The equipment listed under Section 5.3 of this procedure.

To obtain soil samples using a hand auger, the following procedure shall be followed:

1. Attach a properly decontaminated bucket bit to a clean extension rod and further attach the cross handle to the extension rod.

2. Clear the area to be sampled of any surface debris (vegetation, twigs, rocks, litter, etc.).

3. Begin augering (periodically removing accumulated soils from the bucket bit) and add additional rod extensions as necessary. Also, note (in a field notebook, boring log, and/or on standardized data sheets) any changes in the color, texture or odor of the soil.

4. After reaching the desired depth, slowly and carefully withdraw the apparatus from the borehole.

5. Remove the soiled bucket bit from the rod extension and replace it with another properly decontaminated bucket bit. The bucket bit used for sampling is commonly smaller in diameter than the bucket bit employed to initiate the borehole.

6. Carefully lower the apparatus down the borehole. Care must be taken to avoid scraping the borehole sides.

7. Slowly turn the apparatus until the bucket bit is advanced approximately 6 inches.

8. Discard the top of the core (approximately 1"), which represents any loose material collected by the bucket bit before penetrating the sample material.

9. Fill volatile sample container(s), using a properly decontaminated stainless steel trowel, with sample material directly from the bucket bit. Refer to Section 5.2.1 of this procedure.

10. Utilizing the above trowel, remove the remaining sample material from the bucket bit and place into a properly decontaminated stainless steel mixing bowl and thoroughly homogenize the sample material prior to filling the remaining sample containers. Refer to Section 5.2.2 of this procedure.

11. Follow steps 4 and 5 listed under Section 5.3 of this procedure.

5.6 Subsurface Soil Sampling With a Split-Barrel Sampler (ASTM D1586-84)

Split-barrel (split-spoon) samplers consist of a heavy carbon steel or stainless steel sampling tube that can be split into two equal halves to reveal the soil sample (see Attachment B). A drive head is attached to the upper end of the tube and serves as a point of attachment for the drill rod. A removable tapered nosepiece/drive shoe attaches to the lower end of the tube and facilitates cutting. A basket-like sample retainer can be fitted to the lower end of the split tube to hold loose, dry soil samples in the tube when the sampler is removed from the drill hole. This split-barrel sampler is made to be attached to a drill rod and forced into the ground by means of a 140-lb. or larger casing driver.

Split-barrel samplers are used to collect soil samples from a wide variety of soil types and from depths greater than those attainable with other soil sampling equipment.

The following equipment is used for obtaining split-barrel samples:

- Drilling equipment (provided by subcontractor).
- Split-barrel samplers (O.D. 2 inches, I.D. 1-3/8 inches, either 20 inches or 26 inches long); Larger O.D. samplers are available if a larger volume of sample is needed.
- Drive weight assembly, 140-lb. weight, driving head and guide permitting free fall of 30 inches.
- Stainless steel mixing bowls.
- Equipment listed under Section 5.3 of this procedure.

The following steps shall be followed to obtain split-barrel samples:

1. Remove the drive head and nosepiece, and open the sampler to reveal the soil sample. Immediately scan the sample core with a real-time air monitoring instrument (e.g., FID, PID, etc.). Carefully separate the soil core, with a decontaminated stainless steel knife or trowel, at about 6-inch intervals while scanning the center of the core for elevated readings. Also scan stained soil, soil lenses, and anomalies (if present), and record readings.

2. Collect the volatile sample from the center of the core where elevated readings occurred. If no elevated readings where encountered the sample material should still be collected from the core's

center (this area represents the least disturbed area with minimal atmospheric contact). Refer to Section 5.2.1 of this procedure.

3. Using the same trowel, remove remaining sample material from the split-barrel sampler (except for the small portion of disturbed soil usually found at the top of the core sample) and place the soil into a decontaminated stainless steel mixing bowl. Thoroughly homogenize the sample material prior to filling the remaining sample containers. Refer to Section 5.2.2 of this procedure.

4. Follow steps 4 and 5 listed under Section 5.3 of this procedure.

5.7 Subsurface Sol Sampling Using Direct Push Technology

Subsurface soil samples can be collected to depths of 40+ feet using direct push technology (DPT). DPT equipment, responsibilities, and procedures are described in SOP SA-2.5.

5.8 Excavation and Sampling of Test Pits and Trenches

5.8.1 Applicability

This subsection presents routine test pit or trench excavation techniques and specialized techniques that are applicable under certain conditions.

During the excavation of trenches or pits at hazardous waste sites, several health and safety concerns arise which control the method of excavation. No personnel shall enter any test pit or excavation over 4 feet deep except as a last resort, and then only under direct supervision of a Competent Person (as defined in 29 CFR 1929.650 of Subpart P - Excavations). Whenever possible, all required chemical and lithological samples should be collected using the excavator bucket or other remote sampling apparatus. If entrance is still required, all test pits or excavations must be stabilized by bracing the pit sides using specifically designed wooden or steel support structures. Personnel entering the excavation may be exposed to toxic or explosive gases and oxygen-deficient environments. Any entry may constitute a Confined Space and must be done in conformance with all applicable regulations. In these cases, substantial air monitoring is required before entry, and appropriate respiratory gear and protective clothing is mandatory. There must be at least two persons present at the immediate site before entry by one of the investigators. The reader shall refer to OSHA regulations 29 CFR 1926, 29 CFR 1910.120, 29 CFR 1910.134, and 29 CFR 1910.146.

Excavations are generally not practical where a depth of more than about 15 feet is desired, and they are usually limited to a few feet below the water table. In some cases, a pumping system may be required to control water levels within the pit, providing that pumped water can be adequately stored or disposed. If data on soils at depths greater than 15 feet are required, the data are usually obtained through test borings instead of test pits.

In addition, hazardous wastes may be brought to the surface by excavation equipment. This material, whether removed from the site or returned to the subsurface, must be properly handled according to any and all applicable federal, state, and local regulations.

5.8.2 Test Pit and Trench Excavation

These procedures describe the methods for excavating and logging test pits and trenches excavated to determine subsurface soil and rock conditions. Test pit operations shall be logged and documented (see Attachment C).

Test pits and trenches may be excavated by hand or by power equipment to permit detailed description of the nature and contamination of the in-situ materials. The size of the excavation will depend primarily on the following:

- The purpose and extent of the exploration.
- The space required for efficient excavation.
- The chemicals of concern.
- The economics and efficiency of available equipment.

Test pits normally have a cross section that is 4 to 10 feet square; test trenches are usually 3 to 6 feet wide and may be extended for any length required to reveal conditions along a specific line. The following table, which is based on equipment efficiencies, gives a rough guide for design consideration:

Equipment	Typical Widths, in Feet
Trenching machine	2
Backhoe	2-6
Track dozer	10
Track loader	10
Excavator	10
Scraper	20

The lateral limits of excavation of trenches and the position of test pits shall be carefully marked on area base maps. If precise positioning is required to indicate the location of highly hazardous waste materials, nearby utilities, or dangerous conditions, the limits of the excavation shall be surveyed. Also, if precise determination of the depth of buried materials is needed for design or environmental assessment purposes, the elevation of the ground surface at the test pit or trench location shall also be determined by survey. If the test pit/trench will not be surveyed immediately, it shall be backfilled and its position identified with stakes placed in the ground at the margin of the excavation for later surveying.

The construction of test pits and trenches shall be planned and designed in advance as much as possible. However, field conditions may necessitate revisions to the initial plans. The final depth and construction method shall be determined by the field geologist. The actual layout of each test pit, temporary staging area, and spoils pile will be predicated based on site conditions and wind direction at the time the test pit is made. Prior to excavation, the area can be surveyed by magnetometer or metal detector to identify the presence of underground utilities or drums.

As mentioned previously, no personnel shall enter any test pit or excavation except as a last resort, and then only under direct supervision of a Competent Person. If entrance is still required, Occupational Safety and Health Administration (OSHA) requirements must be met (e.g., walls must be braced with wooden or steel braces, ladders must be in the hole at all times, and a temporary guardrail must be placed along the surface of the hole before entry). It is emphasized that the project data needs should be structured such that required samples can be collected without requiring entrance into the excavation. For example, samples of leachate, groundwater, or sidewall soils can be taken with telescoping poles, etc.

Dewatering may be required to assure the stability of the side walls, to prevent the bottom of the pit from heaving, and to keep the excavation dry. This is an important consideration for excavations in cohesionless material below the groundwater table. Liquids removed as a result of dewatering operations must be handled as potentially contaminated materials. Procedures for the collection and disposal of such materials should be discussed in the site-specific project plans.

5.8.3 Sampling in Test Pits and Trenches

5.8.3.1 General

Test pits and trenches are usually logged as they are excavated. Records of each test pit/trench will be made as presented in Attachment C. These records include plan and profile sketches of the test pit/trench showing materials encountered, their depth and distribution in the pit/trench, and sample locations. These records also include safety and sample screening information.

Entry of test pits by personnel is extremely dangerous, shall be avoided unless absolutely necessary, and can occur only after all applicable Health and Safety and OSHA requirements have been met.

The final depth and type of samples obtained from each test pit will be determined at the time the test pit is excavated. Sufficient samples are usually obtained and analyzed to quantify contaminant distribution as a function of depth for each test pit. Additional samples of each waste phase and any fluids encountered in each test pit may also be collected.

In some cases, samples of soil may be extracted from the test pit for reasons other than waste sampling and chemical analysis, for instance, to obtain geotechnical information. Such information would include soil types, stratigraphy, strength, etc., and could therefore entail the collection of disturbed (grab or bulk) or relatively undisturbed (hand-carved or pushed/driven) samples, which can be tested for geotechnical properties. The purposes of such explorations are very similar to those of shallow exploratory or test borings, but often test pits offer a faster, more cost-effective method of sampling than installing borings.

5.8.3.2 Sampling Equipment

The following equipment is needed for obtaining samples for chemical or geotechnical analysis from test pits and trenches:

- Backhoe or other excavating machinery.
- Shovels, picks, hand augers, and stainless steel trowels/disposable trowels.
- Sample container - bucket with locking lid for large samples; appropriate bottleware for chemical or geotechnical analysis samples.
- Polyethylene bags for enclosing sample containers; buckets.
- Remote sampler consisting of 10-foot sections of steel conduit (1-inch-diameter), hose clamps and right angle adapter for conduit (see Attachment D).

5.8.3.3 Sampling Methods

The methods discussed in this section refer to test pit sampling from grade level. If test pit entry is required, see Section 5.8.3.4.

- Excavate trench or pit in several depth increments. After each increment, the operator will wait while the sampler inspects the test pit from grade level to decide if conditions are appropriate for sampling. (Monitoring of volatiles by the SSO will also be used to evaluate the need for sampling.) Practical depth increments range from 2 to 4 feet.

- The backhoe operator, who will have the best view of the test pit, will immediately cease digging if:

  - Any fluid phase or groundwater seepage is encountered in the test pit.
  - Any drums, other potential waste containers, obstructions or utility lines are encountered.
  - Distinct changes of material are encountered.

This action is necessary to permit proper sampling of the test pit and to prevent a breach of safety protocol. Depending upon the conditions encountered, it may be required to excavate more slowly and carefully with the backhoe.

For obtaining test pit samples from grade level, the following procedure shall be followed:

- Remove loose material to the greatest extent possible with backhoe.

- Secure walls of pit if necessary. (There is seldom any need to enter a pit or trench which would justify the expense of shoring the walls. All observations and samples should be taken from the ground surface.)

- Samples of the test pit material are to be obtained either directly from the backhoe bucket or from the material once it has been deposited on the ground. The sampler or Field Operations Leader directs the backhoe operator to remove material from the selected depth or location within the test pit/trench. The bucket is brought to the surface and moved away from the pit. The sampler and/or SSO then approaches the bucket and monitors its contents with a photoionization or flame ionization detector. The sample is collected from the center of the bucket or pile and placed in sample containers using a decontaminated stainless steel trowel or disposable spatula.

- If a composite sample is desired, several depths or locations within the pit/trench are selected and a bucket is filled from each area. It is preferable to send individual sample bottles filled from each bucket to the laboratory for compositing under the more controlled laboratory conditions. However, if compositing in the field is required, each sample container shall be filled from materials that have been transferred into a mixing bucket and homogenized. Note that homogenization/compositing is not applicable for samples to be subjected to volatile organic analysis.

- Using the remote sampler shown in Attachment D, samples can be taken at the desired depth from the side wall or bottom of the pit. The face of the pit/trench shall first be scraped (using a long-handled shovel or hoe) to remove the smeared zone that has contacted the backhoe bucket. The sample shall then be collected directly into the sample jar, by scraping with the jar edge, eliminating the need to utilize samplers and minimizing the likelihood of cross-contamination. The sample jar is then capped, removed from the assembly, and packaged for shipment.

- Complete documentation as described in SOP SA-6.3 and Attachment C of this SOP.

5.8.3.4 <u>In-Pit Sampling</u>

Under rare conditions, personnel may be required to enter the test pit/trench. This is necessary only when soil conditions preclude obtaining suitable samples from the backhoe bucket (e.g., excessive mixing of soils or wastes within the test pit/trench) or when samples from relatively small discrete zones within the test pit are required. This approach may also be necessary to sample any seepage occurring at discrete levels or zones in the test pit that are not accessible with remote samplers.

In general, personnel shall sample and log pits and trenches from the ground surface, except as provided for by the following criteria:

- There is no practical alternative means of obtaining such data.
- The Site Safety Officer and Competent Person determines that such action can be accomplished without breaching site safety protocol. This determination will be based on actual monitoring of the pit/trench after it is dug (including, at a minimum, measurements of volatile organics, explosive gases and available oxygen).
- A Company-designated Competent Person determines that the pit/trench is stable or is made stable (by grading the sidewalls or using shoring) prior to entrance of any personnel. OSHA requirements must be strictly observed.

If these conditions are satisfied, one person will enter the pit/trench. On potentially hazardous waste sites, this individual will be dressed in safety gear as required by the conditions in the pit. He/she will be affixed to a safety rope and continuously monitored while in the pit.

A second individual will be fully dressed in protective clothing including a self-contained breathing device and on standby during all pit entry operations. The individual entering the pit will remain therein for as brief a period as practical, commensurate with performance of his/her work. After removing the smeared zone, samples shall be obtained with a decontaminated trowel or spoon. As an added precaution, it is advisable to keep the backhoe bucket in the test pit when personnel are working below grade. Such personnel can either stand in or near the bucket while performing sample operations. In the event of a cave-in they can either be lifted clear in the bucket, or at least climb up on the backhoe arm to reach safety.

5.8.3.5 Geotechnical Sampling

In addition to the equipment described in Section 5.8.3.2, the following equipment is needed for geotechnical sampling:

- Soil sampling equipment, similar to that used in shallow drilled boring (i.e., open tube samplers), which can be pushed or driven into the floor of the test pit.
- Suitable driving (i.e., a sledge hammer) or pushing (i.e., the backhoe bucket) equipment which is used to advance the sampler into the soil.
- Knives, spatulas, and other suitable devices for trimming hand-carved samples.
- Suitable containers (bags, jars, tubes, boxes, etc.), labels, wax, etc. for holding and safely transporting collected soil samples.
- Geotechnical equipment (pocket penetrometer, torvane, etc.) for field testing collected soil samples for classification and strength properties.

Disturbed grab or bulk geotechnical soil samples may be collected for most soils in the same manner as comparable soil samples for chemical analysis. These collected samples may be stored in jars or plastic-lined sacks (larger samples), which will preserve their moisture content. Smaller samples of this type are usually tested for their index properties to aid in soil identification and classification, while larger bulk samples are usually required to perform compaction tests.

Relatively undisturbed samples are usually extracted in cohesive soils using open tube samplers, and such samples are then tested in a geotechnical laboratory for their strength, permeability and/or compressibility. The techniques for extracting and preserving such samples are similar to those used in performing Shelby tube sampling in borings, except that the sampler is advanced by hand or backhoe,

rather than by a drill rig. Also, the sampler may be extracted from the test pit by excavation around the sampler when it is difficult to pull it out of the ground. If this excavation requires entry of the test pit, the requirements described in Section 5.8.3.4 of this procedure must be followed. The open tube sampler shall be pushed or driven vertically into the floor or steps excavated in the test pit at the desired sampling elevations. Extracting tube samples horizontally from the walls of the test pit is not appropriate, because the sample will not have the correct orientation.

A sledge hammer or the backhoe may be used to drive or push the sampler or tube into the ground. Place a piece of wood over the top of the sampler or sampling tube to prevent damage during driving/pushing of the sample. Pushing the sampler with a constant thrust is always preferable to driving it with repeated blows, thus minimizing disturbance to the sample. If the sample cannot be extracted by rotating it at least two revolutions (to shear off the sample at the bottom), hand-excavate to remove the soil from around the sides of the sampler. If hand-excavation requires entry of the test pit, the requirements in Section 5.8.3.4 of this procedure must be followed. Prepare, label, pack and transport the sample in the required manner, as described in SOP SA-6.3 and SA-6.1.

5.8.4 Backfilling of Trenches and Test Pits

All test pits and excavations must be either backfilled, covered, or otherwise protected at the end of each day. No excavations shall remain open during non-working hours unless adequately covered or otherwise protected.

Before backfilling, the onsite crew shall photograph all significant features exposed by the test pit and trench and shall include in the photograph a scale to show dimensions. Photographs of test pits shall be marked to include site number, test pit number, depth, description of feature, and date of photograph. In addition, a geologic description of each photograph shall be entered in the site logbook. All photographs shall be indexed and maintained as part of the project file for future reference.

After inspection, backfill material shall be returned to the pit under the direction of the FOL.

If a low permeability layer is penetrated (resulting in groundwater flow from an upper contaminated flow zone into a lower uncontaminated flow zone), backfill material must represent original conditions or be impermeable. Backfill could consist of a soil-bentonite mix prepared in a proportion specified by the FOL (representing a permeability equal to or less than original conditions). Backfill can be covered by "clean" soil and graded to the original land contour. Revegetation of the disturbed area may also be required.

5.9 Records

The appropriate sample log sheet (see Attachment A of this SOP) must be completed by the site geologist/sampler. All soil sampling locations should be documented by tying in the location of two or more nearby permanent landmarks (building, telephone pole, fence, etc.) or obtaining GPS coordinates; and shall be noted on the appropriate sample log sheet, site map, or field notebook. Surveying may also be necessary, depending on the project requirements.

Test pit logs (see Attachment C of this SOP) shall contain a sketch of pit conditions. In addition, at least one photograph with a scale for comparison shall be taken of each pit. Included in the photograph shall be a card showing the test pit number. Boreholes, test pits and trenches shall be logged by the field geologist in accordance with SOP GH-1.5.

Other data to be recorded in the field logbook include the following:

- Name and location of job.
- Date of boring and excavation.

- Approximate surface elevation.
- Total depth of boring and excavation.
- Dimensions of pit.
- Method of sample acquisition.
- Type and size of samples.
- Soil and rock descriptions.
- Photographs.
- Groundwater levels.
- Organic gas or methane levels.
- Other pertinent information, such as waste material encountered.

6.0 REFERENCES

American Society for Testing and Materials, 1987. ASTM Standards D1587-83 and D1586-84. ASTM Annual Book of Standards. ASTM. Philadelphia, Pennsylvania. Volume 4.08.

NUS Corporation, 1986. Hazardous Material Handling Training Manual.

NUS Corporation and CH2M Hill, August, 1987. Compendium of Field Operation Methods. Prepared for the U.S. EPA.

OSHA, Excavation, Trenching and Shoring 29 CFR 1926.650-653.

OSHA, Confined Space Entry 29 CFR 1910.146.

ATTACHMENT A
SOIL & SEDIMENT SAMPLE LOG SHEET

Tetra Tech NUS, Inc.

SOIL & SEDIMENT SAMPLE LOG SHEET

Page___ of ___

Project Site Name: _____
Project No.: _____

[] Surface Soil
[] Subsurface Soil
[] Sediment
[] Other: _____
[] QA Sample Type: _____

Sample ID No.: _____
Sample Location: _____
Sampled By: _____
C.O.C. No.: _____

Type of Sample:
[] Low Concentration
[] High Concentration

GRAB SAMPLE DATA

Date:	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Time:			
Method:			
Monitor Reading (ppm):			

COMPOSITE SAMPLE DATA

Date:	Time	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings (Range in ppm):				

SAMPLE COLLECTION INFORMATION

Analysis	Container Requirements	Collected	Other

OBSERVATIONS / NOTES:

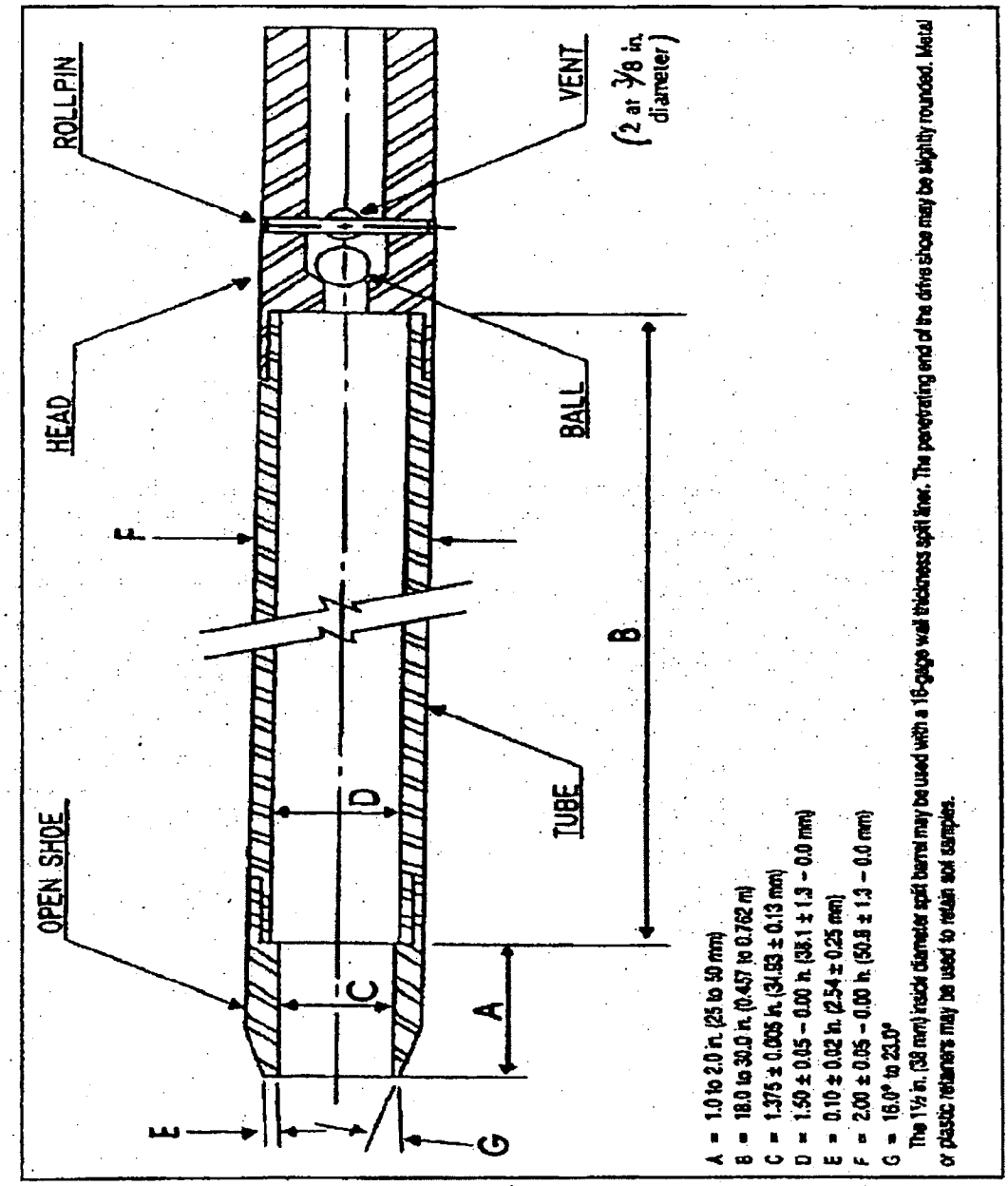
MAP:

Circle if Applicable:

MS/MSD	Duplicate ID No.:

Signature(s):

ATTACHMENT B
SPLIT-SPOON SAMPLER



ATTACHMENT C
TEST PIT LOG

Tetra Tech NUS, Inc.

TEST PIT LOG

Page ___ of ___

PROJECT NAME: _____ TEST PIT No.: _____
PROJECT NUMBER: _____ DATE: _____
LOCATION: _____ GEOLOGIST: _____

Depth (Ft.)	Lithology Change (Depth/Ft.)	MATERIAL DESCRIPTION Soil/Waste Characteristics (lithology, density, color, etc.)	USCS	Remarks	PID/FID READING Outside Pit	PID/FID READING In Pit

TEST PIT CROSS SECTION AND / OR PLAN VIEW

REMARKS: _____

PHOTO LOG: _____

ATTACHMENT D
REMOTE SAMPLE HOLDER FOR TEST PIT/TRENCH SAMPLING

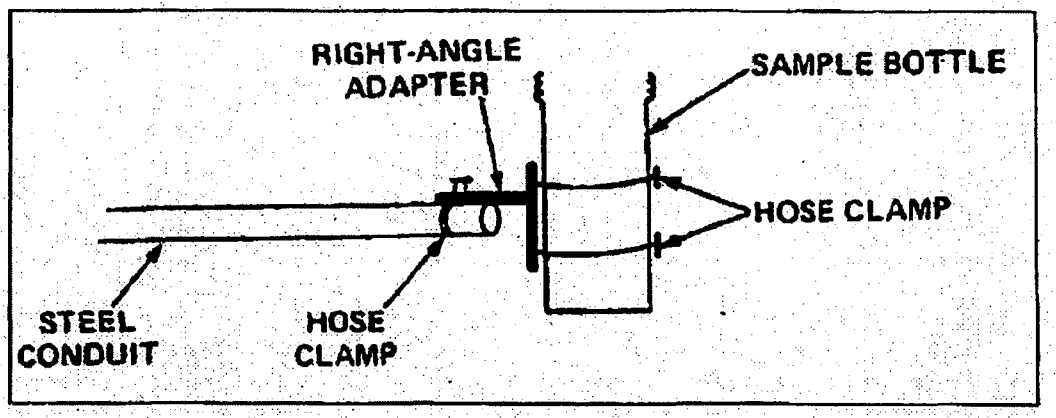


TABLE OF CONTENTS

SECTION **PAGE**

1.0 PURPOSE 2

2.0 SCOPE 2

3.0 GLOSSARY 2

4.0 RESPONSIBILITIES 2

5.0 SOIL SAMPLING PROCEDURES 3

5.1 GENERAL 3
5.2 SAMPLING EQUIPMENT 3
5.3 DPT SAMPLING METHODOLOGY 3

6.0 GROUNDWATER SAMPLING PROCEDURES 4

6.1 GENERAL 4
6.2 SAMPLING EQUIPMENT 4
6.3 DPT TEMPORARY WELL POINT INSTALLATION AND SAMPLING METHODOLOGY 5

7.0 RECORDS 5

ATTACHMENTS

1 SAFE WORK PERMIT 6

1.0 PURPOSE

The purpose of this procedure is to provide general reference information on Direct Push Technology (DPT). DPT is designed to collect soil, groundwater, and soil gas samples without using conventional drilling techniques. The advantage of using DPT over conventional drilling includes the generation of little or no drill cuttings, sampling in locations with difficult accessibility, reduced overhead clearance requirements, no fluid introduction during probing, and typical lower costs per sample than with conventional techniques. Disadvantages include a maximum penetration depth of approximately 15 to 40 feet in dense soils (although it may be as much as 60 to 80 feet in certain types of geological environments), reduced capability of obtaining accurate water-level measurements, and the inability to install permanent groundwater monitoring wells. The methods and equipment described herein are for collection of surface and subsurface soil samples and groundwater samples. Soil gas sampling is discussed in SOP SA-2.4.

2.0 SCOPE

This procedure provides information on proper sampling equipment and techniques for DPT. Review of the information contained herein will facilitate planning of the field sampling effort by describing standard sampling techniques. The techniques described shall be followed whenever applicable, noting that site-specific conditions or project-specific plans may require adjustments in methodology.

3.0 GLOSSARY

Direct Push Technology (DPT) - DPT refers to sampling tools and sensors that are driven directly into the ground without the use of conventional drilling equipment. DPT typically utilizes hydraulic pressure and/or percussion hammers to advance the sampling tools. A primary advantage of DPT over conventional drilling techniques is that DPT results in the generation of little or no investigation derived waste.

Geoprobe® - Geoprobe® is a manufacturer of a hydraulically-powered, percussion/probing machines utilizing DPT to collect subsurface environmental samples. Geoprobe® relies on a relatively small amount of static weight (vehicle) combined with percussion as the energy for advancement of a tool string. The Geoprobe® equipment can be mounted in a multitude of vehicles for access to all types of environmental sites.

HydroPunch™ - HydroPunch™ is a manufacturer of stainless steel and Teflon® sampling tools that are capable of collecting representative groundwater and/or soil samples without requiring the installation of a groundwater monitoring well or conventional soil boring. HydroPunch™ is an example of DPT sampling equipment.

Flame Ionization Detector (FID) - A portable instrument for the measurement of many combustible organic compounds and a few inorganic compounds in air at parts-per million levels. The basis for the detection is the ionization of gaseous species utilizing a flame as the energizing source.

Photo Ionization Detector (PID) - A portable instrument for the measurement of many combustible organic compounds and a few inorganic compounds in air at parts-per million levels. The basis for the detection is the ionization of gaseous species utilizing ultraviolet radiation as the energizing source.

4.0 RESPONSIBILITIES

Project Manager - The Project Manager is responsible for selecting and/or reviewing the appropriate DPT drilling procedure required to support the project objectives.

Field Operations Leader (FOL)- The FOL is primarily responsible for performing the DPT in accordance with the project-specific plan.

5.0 SOIL SAMPLING PROCEDURES

5.1 General

The common methodology for the investigation of the vadose zone is soil boring drilling and soil sampling. However, drilling soil borings can be very expensive. Generally the advantage of DPT for subsurface soil sampling is the reduced cost of disposal of drilling cuttings and shorter sampling times.

5.2 Sampling Equipment

Equipment needed for conducting DPT drilling for subsurface soil sampling includes, but is not limited to, the following:

- Geoprobe® Sampling Kit
- Cut-resistant gloves
- 4-foot x 1.5-inch diameter macrocore sampler
- Probe sampling adapters
- Roto-hammer with 1.5-inch bit
- Disposable acetate liners for soil macrocore sampler
- Cast aluminum or steel drive points
- Geoprobe® AT-660 Series Large Bore Soil Sampler, or equivalent
- Standard decontamination equipment and solutions

For health and safety equipment and procedures, follow the direction provided in the Safe Work Permit in Attachment 1, or the more detailed directions provided in the project's Health and Safety Plan.

5.3 DPT Sampling Methodology

There are several methods for the collection of soil samples using DPT drilling. The most common method is discussed in the following section. Variations of the following method may be conducted upon approval of the Project Manager in accordance with the project-specific plan.

- Macrocore samplers fitted with detachable aluminum or steel drive points are driven into the ground using hydraulic pressure. If there is concrete or pavement over a sampling location, a Roto-hammer is used to drill a minimum 1.5-inch diameter hole through the surface material. A Roto-hammer may also be used if very dense soils are encountered.

- The sampler is advanced continuously in 4-foot intervals or less if desired. No soil cuttings are generated because the soil which is not collected in the sampler is displaced within the formation.

- The sampler is retracted from the hole, and the 4-foot continuous sample is removed from the outer coring tube. The sample is contained within an inner acetate liner.

- Attach the metal trough from the Geoprobe® Sampling Kit firmly to the tail gate of a vehicle. If a vehicle with a tail gate is not available, secure the trough on another suitable surface.

- Place the acetate liner containing the soils in the trough.

- While wearing cut-resistant gloves (constructed of leather or other suitable material), cut the acetate liner through its entire length using the double-bladed knife that accompanies the Geoprobe® Sampling Kit. Then remove the strip of acetate from the trough to gain access to the collected soils. Do not attempt to cut the acetate liner while holding it in your hand.

- Field screen the sample with an FID or PID, and observe/examine the sample (according to SOP GH-1.3). If appropriate, transfer the sample to sample bottles for laboratory analysis. If additional volume is required, push an additional boring adjacent to the first and composite/mix the same interval. Field compositing is usually not acceptable for sample requiring volatile organics analysis.

- Once sampling has been completed, the hole is backfilled with bentonite chips or bentonite cement grout, depending upon project requirements. Asphalt or concrete patch is used to cap holes through paved or concrete areas. All holes should be finished smooth to existing grade.

- In the event the direct push van/truck cannot be driven to a remote location or a sampling location with difficult accessibility, sampling probes may be advanced and sampled manually or with air/electric operated equipment (e.g., jack hammer).

- Sampling equipment is decontaminated prior to collecting the next sample.

6.0 GROUNDWATER SAMPLING PROCEDURES

6.1 General

The most common methodology for the investigation of groundwater is the installation and sampling of permanent monitoring wells. If only groundwater screening is required, the installation and sampling of temporary well points may be performed. The advantage of temporary well point installation using DPT is reduced cost due to no or minimal disposal of drilling cuttings and well construction materials, and shorter installation/times sampling.

Two disadvantages of DPT drilling for well point installation are:

- In aquifers with low yields, well points may have to be sampled without purging or development.
- If volume requirements are high, this method can be time consuming for low yield aquifers.

6.2 Sampling Equipment

Equipment needed for temporary well installation and sampling using DPT includes, but is not limited, to the following:

- 2-foot x 1-inch diameter mill-slotted (0.005 to 0.02-inch) well point
- Connecting rods
- Roto-hammer with 1.5-inch bit
- Mechanical jack
- 1/4-inch OD polyethylene tubing
- 3/8-inch OD polyethylene tubing
- Peristaltic pump
- Standard decontamination equipment and solutions

6.3 DPT Temporary Well Point Installation and Sampling Methodology

There are several methods for the installation and sampling of temporary well points using DPT. The most common methodology is discussed below. Variations of the following method may be conducted upon approval of the Project Manager in accordance with the project specific plan.

- A 2-foot x 1-inch diameter mill-slotted (0.005 to 0.02-inch) well point attached to connecting rods is driven into the ground to the desired depth using a rotary electric hammer or other direct push drill rig. If there is concrete or pavement over a sampling location, a Roto-hammer or electric coring machine is used to drill a hole through the surface material.

- The well point will be allowed to equilibrate for at least 15 minutes, after which a measurement of the static water level will be taken. The initial measurement of the water level will be used to assess the amount of water which is present in the well point and to determine the amount of silt and sand infiltration that may have occurred.

- The well point will be developed using a peristaltic pump and polyethylene tubing to remove silt and sand which may have entered the well point. The well point is developed by inserting polyethylene tubing to the bottom of the well point and lifting and lowering the tubing slightly while the pump is operating. The pump will be operated at a maximum rate of approximately 2 liters per minute. After removal of sediment from the bottom of the well point, the well point will be vigorously pumped at maximum capacity until discharge water is visibly clear and no further sediments are being generated. Measurements of pH, specific conductance, temperature, and turbidity shall be recorded every 5 to 10 minutes during the purging process. After two consistent readings of pH, specific conductance, temperature and turbidity (±10 percent), the well may be sampled.

- A sample will be collected using the peristaltic pump set at the same or reduced speed as during well development. Samples (with the exception of the samples to be analyzed for volatile organic compounds, VOCs) will be collected directly from the pump discharge. Sample containers for VOCs will be filled by (first shutting off the pump) crimping the discharge end of the sample tubing when filled, removing the inlet end of the sample tubing from the well, suspending the inlet tubing above the vial, and allowing water to fill each vial by gravity flow.

- Once the groundwater sample has been collected, the connecting rods and well point will be removed from the hole with the direct push rig hydraulics. The hole will be backfilled with bentonite chips or bentonite cement grout, depending upon project requirements. Asphalt or concrete patch will be used to cap holes through paved or concrete areas. All holes will be finished smooth to existing grade.

- In the event the direct push van/truck cannot be driven to a remote location or sampling location with difficult accessibility, sampling probes may be advanced and sampled manually or with air/electric-operated equipment (e.g., jack hammer).

- Decontaminate the equipment before moving to the next location.

7.0 RECORDS

A record of all field procedures, tests, and observations must be recorded in the field logbook, boring logs, and sample log sheets, as needed. Entries should include all pertinent data regarding the investigation. The use of sketches and field landmarks will help to supplement the investigation and evaluation.

ATTACHMENT 1
SAFE WORK PERMIT FOR DPT OPERATIONS

Permit No. _____ Date: _____ Time: From _____ to _____

SECTION I: General Job Scope

I. Work limited to the following (description, area, equipment used): **Monitoring well drilling and installation through direct push technology**

II. Required Monitoring Instruments: _____

III. Field Crew: _____

IV. On-site Inspection conducted ☐ Yes ☐ No Initials of Inspector _____ _____ TtNUS

SECTION II: General Safety Requirements (To be filled in by permit issuer)

V. Protective equipment required

Level D ☒ Level B ☐
Level C ☐ Level A ☐
Detailed on Reverse

Respiratory equipment required

Full face APR ☐ Escape Pack ☐
Half face APR ☐ SCBA ☐
SKA-PAC SAR ☐ Bottle Trailer ☐
Skid Rig ☐ None ☒

Level D Minimum Requirements: Sleeved shirt and long pants, safety footwear, and work gloves. Safety glasses, hard hats, and hearing protection will be worn when working near or sampling in the vicinity of the DPT rig.

Modifications/Exceptions.

VI. Chemicals of Concern | Action Level(s) | Response Measures

VII. Additional Safety Equipment/Procedures

Hard-hat	☒ Yes	☐ No	Hearing Protection (Plugs/Muffs)	☒ Yes	☐ No
Safety Glasses	☒ Yes	☐ No	Safety belt/harness	☐ Yes	☒ No
Chemical/splash goggles	☐ Yes	☒ No	Radio	☐ Yes	☒ No
Splash Shield	☐ Yes	☒ No	Barricades	☒ Yes	☐ No
Splash suits/coveralls	☐ Yes	☐ No	Gloves (Type - _____)	☐ Yes	☐ No
Steel toe Work shoes or boots	☒ Yes	☐ No	Work/warming regimen	☐ Yes	☐ No

Modifications/Exceptions: Reflective vests for high traffic areas.

VIII. Procedure review with permit acceptors

	Yes	NA		Yes	NA
Safety shower/eyewash (Location & Use)	☐	☒	Emergency alarms	☐	☐
Daily tail gate meetings	☒	☐	Evacuation routes	☐	☐
Contractor tools/equipment/PPE inspected	☐	☐	Assembly points	☐	☐

IX. Site Preparation

Utility Clearances obtained for areas of subsurface investigation	☐ Yes	☐ No
Physical hazards removed or blockaded	☐ Yes	☐ No
Site control boundaries demarcated/signage	☐ Yes	☐ No

X. Equipment Preparation

	Yes	NA
Equipment drained/depressurized	☐	☒
Equipment purged/cleaned	☐	☒
Isolation checklist completed	☐	☒
Electrical lockout required/field switch tested	☐	☒
Blinds/misalignments/blocks & bleeds in place	☐	☒
Hazardous materials on walls/behind liners considered	☐	☒

XI. Additional Permits required (Hot work, confined space entry). ☐ Yes ☐ No

If yes, complete permit required or contact Health Sciences, Pittsburgh Office

XII. Special instructions, precautions:

_____

Permit Issued by: _____ Permit Accepted by: _____

TABLE OF CONTENTS

SECTION **PAGE**

1.0 PURPOSE 2

2.0 SCOPE 2

3.0 GLOSSARY 2

4.0 RESPONSIBILITIES 3

5.0 PROCEDURES 3

5.1 SAMPLE CONTAINERS 3
5.2 SAMPLE PRESERVATION 3
5.2.1 Overview 4
5.2.2 Preparation and Addition of Reagents 4
5.3 FIELD FILTRATION 5
5.4 SAMPLE PACKAGING AND SHIPPING 6
5.4.1 Environmental Samples 6

6.0 REFERENCES 7

ATTACHMENTS

A GENERAL SAMPLE CONTAINER AND PRESERVATION REQUIREMENTS 8
B ADDITIONAL REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES 9

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide information on sample preservation, packaging, and shipping procedures to be used in handling environmental samples submitted for chemical constituent, biological, or geotechnical analysis. Sample chain-of-custody procedures and other aspects of field documentation are addressed in SOP SA-6.3. Sample identification is addressed in SOP CT-04.

2.0 SCOPE

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

3.0 GLOSSARY

Hazardous Material - A substance or material which has been determined by the Secretary of Transportation to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and which has been so designated. Under 49 CFR, the term includes hazardous substances, hazardous wastes, marine pollutants, and elevated temperature materials, as well as materials designated as hazardous under the provisions of §172.101 and §172.102 and materials that meet the defining criteria for hazard classes and divisions in Part 173. With slight modifications, IATA has adopted DOT "hazardous materials" as IATA "Dangerous Goods."

Hazardous Waste - Any substance listed in 40 CFR, Subpart D (ÿ261.30 et seq.), or otherwise characterized as ignitable, corrosive, reactive, or toxic (as defined by Toxicity Characteristic Leaching Procedure, TCLP, analysis) as specified under 40 CFR, Subpart C (ÿ261.20 et seq.), that would be subject to manifest requirements specified in 40 CFR 262. Such substances are defined and regulated by EPA.

Marking - A descriptive name, identification number, instructions, cautions, weight, specification or UN marks, or combination thereof required on outer packaging of hazardous materials.

n.o.i - Not otherwise indicated (may be used interchangeably with n.o.s.).

n.o.s. - Not otherwise specified.

Packaging - A receptacle and any other components or materials necessary for compliance with the minimum packaging requirements of 49 CFR 174, including containers (other than freight containers or overpacks), portable tanks, cargo tanks, tank cars, and multi-unit tank-car tanks to perform a containment function in conformance with the minimum packaging requirements of 49 CFR 173.24(a) & (b).

Placard - Color-coded, pictorial sign which depicts the hazard class symbol and name and which is placed on the side of a vehicle transporting certain hazardous materials.

Common Preservatives:

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

Other Preservatives

- Zinc Acetate
- Sodium Thiosulfate - $Na_2S_2O_3$

Normality (N) - Concentration of a solution expressed as equivalent per liter, an equivalent being the amount of a substance containing 1 gram-atom of replaceable hydrogen or its equivalent.

Reportable Quantity (RQ) - For the purposes of this SOP, means the quantity specified in column 3 of the Appendix to DOT 49 CFR §172.101 for any material identified in column 1 of the appendix. A spill greater than the amount specified must be reported to the National Response Center.

Sample - A sample is physical evidence collected from a facility or the environment, which is representative of conditions at the location and time of collection.

4.0 RESPONSIBILITIES

Field Operations Leader - Directly responsible for the bottling, preservation, labeling, packaging, shipping, and custody of samples up to and including release to the shipper.

Field Samplers - Responsible for initiating the Chain-of-Custody Record (per SOP SA-6.3), implementing the packaging and shipping requirements, and maintaining custody of samples until they are relinquished to another custodian or to the shipper.

5.0 PROCEDURES

Sample identification, labeling, documentation, and chain-of-custody are addressed by SOP SA-6.3.

5.1 Sample Containers

Different types of chemicals react differently with sample containers made of various materials. For example, trace metals adsorb more strongly to glass than to plastic, whereas many organic chemicals may dissolve various types of plastic containers. Attachments A and B show proper containers (as well as other information) per 40 CFR 136. In general, the sample container shall allow approximately 5-10 percent air space ("ullage") to allow for expansion/vaporization if the sample warms during transport. However, for collection of volatile organic compounds, head space shall be omitted. The analytical laboratory will generally provide certified-clean containers for samples to be analyzed for chemical constituents. Shelby tubes or other sample containers are generally provided by the driller for samples requiring geotechnical analysis. Sufficient lead time shall be allowed for a delivery of sample container orders. Therefore, it is critical to use the correct container to maintain the integrity of the sample prior to analysis.

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

5.2 Sample Preservation

Many water and soil samples are unstable and therefore require preservation to prevent changes in either the concentration or the physical condition of the constituent(s) requiring analysis. Although complete and irreversible preservation of samples is not possible, preservation does retard the chemical and biological

changes that inevitably take place after the sample is collected. Preservation techniques are usually limited to pH control, chemical addition(s), and refrigeration/ freezing (certain biological samples only).

5.2.1 Overview

The preservation techniques to be used for various analytes are listed in Attachments A and B. Reagents required for sample preservation will either be added to the sample containers by the laboratory prior to their shipment to the field or be added in the field (in a clean environment). Only high purity reagents shall be used for preservation. In general, aqueous samples of low-concentration organics (or soil samples of low- or medium-concentration organics) are cooled to 4°C. Medium-concentration aqueous samples, high-hazard organic samples, and some gas samples are typically not preserved. Low-concentration aqueous samples for metals are acidified with HNO_3, whereas medium-concentration and high-hazard aqueous metal samples are not preserved. Low- or medium-concentration soil samples for metals are cooled to 4°C, whereas high-hazard samples are not cooled.

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

The FOL is responsible for ensuring that an accurate Chemical Inventory is created and maintained for all hazardous chemicals brought to the work site (see Section 5 of the TtNUS Health and Safety Guidance Manual). Furthermore, the FOL must ensure that a corresponding Material Safety Data Sheet (MSDS) is collected for every substance entered on the site Chemical Inventory, and that all persons using/handling/ disposing of these substances review the appropriate MSDS for substances they will work with. The Chemical Inventory and the MSDSs must be maintained at each work site in a location and manner where they are readily-accessible to all personnel.

5.2.2 Preparation and Addition of Reagents

Addition of the following acids or bases may be specified for sample preservation; these reagents shall be analytical reagent (AR) grade or purer and shall be diluted to the required concentration with deionized water before field sampling commences. To avoid uncontrolled reactions, be sure to Add Acid to water (not vice versa). A dilutions guide is provided below.

Acid/Base	Dilution	Concentration	Estimated Amount Requir d for Preservation
Hydrochloric Acid (HCl)	1 part concentrated HCl: 1 part double-distilled, deionized water	6N	5-10 mL
Sulfuric Acid (H_2SO_4)	1 part concentrated H_2SO_4: 1 part double-distilled, deionized water	18N	2 - 5 mL
Nitric Acid (HNO_3)	Undiluted concentrated HNO_3	16N	2 - 5 mL
Sodium Hydroxide (NaOH)	400 grams solid NaOH dissolved in 870 mL double-distilled, deionized water; yields 1 liter of solution	10N	2 mL

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

- Pour off 5-10 mL of sample into a dedicated, clean container. Use some of this sample to check the initial sample pH using wide range (0-14) pH paper. Never dip the pH paper into the sample; always apply a drop of sample to the pH paper using a clean stirring rod or pipette.

- Add about one-half of the estimated preservative required to the original sample bottle. Cap and invert gently several times to mix. Check pH (as described above) using medium range pH paper (pH 0-6 or pH 7.5-14, as applicable).

- Cap sample bottle and seal securely.

Additional considerations are discussed below:

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

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

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

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

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

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

- Sodium thiosulfate must be added to remove residual chlorine from a sample. To test the sample for residual chlorine use a field test kit specially made for this purpose.

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

  Continue with proper acidification of the sample as described above.

For biological samples, 10% buffered formalin or isopropanol may also be required for preservation. Questions regarding preservation requirements should be resolved through communication with the laboratory before sampling begins.

5.3 Field Filtration

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

- The sample shall be filtered through a non-metallic, 0.45-micron membrane filter, immediately after collection. The filtration system shall consist of dedicated filter canister, dedicated tubing, and a peristaltic pump with pressure or vacuum pumping squeeze action (since the sample is filtered by mechanical peristalsis, the sample travels only through the tubing).

- To perform filtration, thread the tubing through the peristaltic pump head. Attach the filter canister to the discharge end of the silicon tubing (note flow direction arrow); attach the aqueous sample container to the intake end of the silicon tubing. Turn the peristaltic pump on and perform filtration. Run approximately 100 ml of sample through the filter and discard prior to sample collection.

- Continue by preserving the filtrate (contained in the filter canister), as applicable and generally described above.

5.4 Sample Packaging and Shipping

Only employees who have successfully completed the TtNUS "Shipping Hazardous Materials" training course are authorized to package and ship hazardous substances. These trained individuals are responsible for performing shipping duties in accordance with this training.

Samples collected for shipment from a site shall be classified as either environmental or hazardous material samples. Samples from drums containing materials other than Investigative Derived Waste (IDW) and samples obtained from waste piles or bulk storage tanks are generally shipped as hazardous materials. 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 transport and laboratory personnel receiving the samples (special precautions are used by the shipper and at laboratories when hazardous materials are received.)

Detailed procedures for packaging environmental samples are outlined in the remainder of this section.

5.4.1 Environmental Samples

Environmental samples are packaged as follows:

- Place properly identified sample container, with lid securely fastened, in a plastic bag (e.g. Ziploc baggie), and seal the bag.

- Place sample in a cooler constructed of sturdy material which has been lined with a large, plastic bag (e.g. "garbage" bag). Drain plugs on coolers must be taped shut.

- Pack with enough cushioning materials such as bubble wrap (shoulders of bottles must be iced if required) to minimize the possibility of the container breaking.

- If cooling is required (see Attachments A and B), place ice around sample container shoulders, and on top of packing material (minimum of 8 pounds of ice for a medium-size cooler).

- Seal (i.e., tape or tie top in knot) large liner bag.

- The original (top, signed copy) of the COC form shall be placed inside a large Ziploc-type bag and taped inside the lid of the shipping cooler. If multiple coolers are sent but are included on one COC form, the COC form should be sent with the cooler containing the vials for VOC analysis. The COC form should then state how many coolers are included with that shipment.

- Close and seal outside of cooler as described in SOP SA-6.3. Signed custody seals must be used.

Coolers must be marked as containing "Environmental Samples." The appropriate side of the container must be marked "This End Up" and arrows placed appropriately. No DOT marking or labeling is required; there are no DOT restrictions on mode of transportation.

6.0 REFERENCES

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

International Air Transport Association (latest issue). Dangerous Goods Regulations, Montreal, Quebec, Canada.

U.S. Department of Transportation (latest issue). Hazardous Materials Regulations, 49 CFR 171-177.

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

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

ATTACHMENT A

GENERAL SAMPLE CONTAINER AND PRESERVATION REQUIREMENTS

Sample Type and Concentration		Container[1]	Sample Size	Preservation[2]	Holding Time[2]
WATER					
Organics (GC&GC/MS)	VOC Low	Borosilicate glass	2 x 40 mL	Cool to 4°C HCl to ≤ 2	14 days[9]
	Extractables (Low SVOCs and pesticide/PCBs)	Amber glass	2x2 L or 4x1 L	Cool to 4°C	7 days to extraction; 40 days after extraction
	Extractables (Medium SVOCs and pesticide/PCBs)	Amber glass	2x2 L or 4x1 L	None	7 days to extraction; 40 days after extraction
Inorganics	Metals Low	High-density polyethylene	1 L	HNO_3 to pH ≤2	6 months (Hg-28 days)
	Medium	Wide-mouth glass	16 oz.	None	6 months
	Cyanide Low	High-density polyethylene	1 L	NaOH to pH>12	14 days
	Cyanide Medium	Wide-mouth glass	16 oz.	None	14 days
Organic/ Inorganic	High Hazard	Wide-mouth glass	8 oz.	None	14 days
SOIL					
Organics (GC&GC/MS)	VOC	EnCore Sampler	(3) 5 g Samplers	Cool to 4°C	48 hours to lab preservation
	Extractables (Low SVOCs and pesticides/PCBs)	Wide-mouth glass	8 oz.	Cool to 4°C	14 days to extraction; 40 days after extraction
	Extractables (Medium SVOCs and pesticides/PCBs)	Wide-mouth glass	8 oz.	Cool to 4°C	14 days to extraction; 40 days after extraction
Inorganics	Low/Medium	Wide-mouth glass	8 oz.	Cool to 4°C	6 months (Hg - 28 days) Cyanide (14 days)
Organic/Inorganic	High Hazard	Wide-mouth glass	8 oz.	None	NA
Dioxin/Furan	All	Wide-mouth glass	4 oz.	None	35 days until extraction; 40 days after extraction
TCLP	All	Wide-mouth glass	8 oz.	None	7 days until preparation; analysis as per fraction
AIR					
Volatile Organics	Low/Medium	Charcoal tube -- 7 cm long, 6 mm OD, 4 mm ID	100 L air	Cool to 4°C	5 days recommended

1 All glass containers should have Teflon cap liners or septa.
2 See Attachment E. Preservation and maximum holding time allowances per 40 CFR 136.

ATTACHMENT B

ADDITIONAL REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES

Parameter Number/Name	Container[1]	Preservation[2][3]	Maximum Holding Time[4]
INORGANIC TESTS:			
Acidity	P, G	Cool, 4°C	14 days
Alkalinity	P, G	Cool, 4°C	14 days
Ammonia - Nitrogen	P, G	Cool, 4°C; H_2SO_4 to pH 2	28 days
Biochemical Oxygen Demand (BOD)	P, G	Cool, 4°C	48 hours
Bromide	P, G	None required	28 days
Chemical Oxygen Demand (COD)	P, G	Cool, 4°C; H_2SO_4 to pH 2	28 days
Chloride	P, G	None required	28 days
Chlorine, Total Residual	P, G	None required	Analyze immediately
Color	P, G	Cool, 4°C	48 hours
Cyanide, Total and Amenable to Chlorination	P, G	Cool, 4°C; NaOH to pH 12; 0.6 g ascorbic acid[5]	14 days[6]
Fluoride	P	None required	28 days
Hardness	P, G	HNO_3 to pH 2; H_2SO_4 to pH 2	6 months
Total Kjeldahl and Organic Nitrogen	P, G	Cool, 4°C; H_2SO_4 to pH 2	28 days
Nitrate - Nitrogen	P, G	None required	48 hours
Nitrate-Nitrite - Nitrogen	P, G	Cool, 4°C; H_2SO_4 to pH 2	28 days
Nitrite - Nitrogen	P, G	Cool, 4°C	48 hours
Oil & Grease	G	Cool, 4°C; H_2SO_4 to pH 2	28 days
Total Organic Carbon (TOC)	P, G	Cool, 4°C; HCl or H_2SO_4 to pH 2	28 days
Orthophosphate	P, G	Filter immediately; Cool, 4°C	48 hours
Oxygen, Dissolved-Probe	G Bottle & top	None required	Analyze immediately
Oxygen, Dissolved-Winkler	G Bottle & top	Fix on site and store in dark	8 hours
Phenols	G	Cool, 4°C; H_2SO_4 to pH 2	28 days
Phosphorus, Total	P, G	Cool, 4°C; H_2SO_4 to pH 2	28 days
Residue, Total	P, G	Cool, 4°C	7 days
Residue, Filterable (TDS)	P, G	Cool, 4°C	7 days
Residue, Nonfilterable (TSS)	P, G	Cool, 4°C	7 days
Residue, Settleable	P, G	Cool, 4°C	48 hours
Residue, Volatile (Ash Content)	P, G	Cool, 4°C	7 days
Silica	P	Cool, 4°C	28 days
Specific Conductance	P, G	Cool, 4°C	28 days
Sulfate	P, G	Cool, 4°C	28 days

ATTACHMENT B
ADDITIONAL REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES
PAGE TWO

Parameter Number/Name	Container[1]	Preservation[2][3]	Maximum Holding Time[4]
INORGANIC TESTS (Cont'd):			
Sulfide	P, G	Cool, 4°C; add zinc acetate plus sodium hydroxide to pH 9	7 days
Sulfite	P, G	None required	Analyze immediately
Turbidity	P, G	Cool, 4°C	48 hours
METALS:[7]			
Chromium VI (Hexachrome)	P, G	Cool, 4°C	24 hours
Mercury (Hg)	P, G	HNO_3 to pH 2	28 days
Metals, except Chromium VI and Mercury	P, G	HNO_3 to pH 2	6 months
ORGANIC TESTS:[8]			
Purgeable Halocarbons	G, Teflon-lined septum	Cool, 4°C; 0.008% $Na_2S_2O_3$[5]	14 days
Purgeable Aromatic Hydrocarbons	G, Teflon-lined septum	Cool, 4°C; 0.008% $Na_2S_2O_3$[5] HCl to pH 2 [9]	14 days
Acrolein and Acrylonitrile	G, Teflon-lined septum	Cool, 4°C; 0.008% $Na_2S_2O_3$[5] adjust pH to 4-5 [10]	14 days
Phenols[11]	G, Teflon-lined cap	Cool, 4°C; 0.008% $Na_2S_2O_3$[5]	7 days until extraction; 40 days after extraction
Benzidines[11],[12]	G, Teflon-lined cap	Cool, 4°C; 0.008% $Na_2S_2O_3$[5]	7 days until extraction[13]
Phthalate esters[11]	G, Teflon-lined cap	Cool, 4°C	7 days until extraction; 40 days after extraction
Nitrosamines[11],[14]	G, Teflon-lined cap	Cool, 4°C; store in dark; 0.008% $Na_2S_2O_3$[5]	7 days until extraction; 40 days after extraction
PCBs[11]	G, Teflon-lined cap	Cool, 4°C	7 days until extraction; 40 days after extraction
Nitroaromatics & Isophorone[11]	G, Teflon-lined cap	Cool, 4°C; 0.008% $Na_2S_2O_3$[5]; store in dark	7 days until extraction; 40 days after extraction
Polynuclear Aromatic Hydrocarbons (PAHs)[11],[14]	G, Teflon-lined cap	Cool, 4°C; 0.008% $Na_2S_2O_3$[5]; store in dark	7 days until extraction; 40 days after extraction
Haloethers[11]	G, Teflon-lined cap	Cool, 4°C; 0.008% $Na_2S_2O_3$[5]	7 days until extraction; 40 days after extraction
Dioxin/Furan (TCDD/TCDF)[11]	G, Teflon-lined cap	Cool, 4°C; 0.008% $Na_2S_2O_3$[5]	7 days until extraction; 40 days after extraction

ATTACHMENT B
ADDITIONAL REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES
PAGE THREE

(1) Polyethylene (P): generally 500 ml or Glass (G): generally 1L.
(2) Sample preservation should be performed immediately upon sample collection. For composite chemical samples each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining at 4°C until compositing and sample splitting is completed.
(3) When any sample is to be shipped by common carrier or sent through the United States Mail, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172).
(4) Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid. Samples may be held for longer periods only if the permittee, or monitoring laboratory, has data on file to show that the specific types of samples under study are stable for the longer periods, and has received a variance from the Regional Administrator.
(5) Should only be used in the presence of residual chlorine.
(6) Maximum holding time is 24 hours when sulfide is present. Optionally, all samples may be tested with lead acetate paper before pH adjustments are made to determine if sulfide is present. If sulfide is present, it can be removed by the addition of cadmium nitrate powder until a negative spot test is obtained. The sample is filtered and then NaOH is added to pH 12.
(7) Samples should be filtered immediately on site before adding preservative for dissolved metals.
(8) Guidance applies to samples to be analyzed by GC, LC, or GC/MS for specific compounds.
(9) Sample receiving no pH adjustment must be analyzed within 7 days of sampling.
(10) The pH adjustment is not required if acrolein will not be measured. Samples for acrolein receiving no pH adjustment must be analyzed within 3 days of sampling.
(11) When the extractable analytes of concern fall within a single chemical category, the specified preservative and maximum holding times should be observed for optimum safeguard of sample integrity. When the analytes of concern fall within two or more chemical categories, the sample may be preserved by cooling to 4°C, reducing residual chlorine with 0.008% sodium thiosulfate, storing in the dark, and adjusting the pH to 6-9; samples preserved in this manner may be held for 7 days before extraction and for 40 days after extraction. Exceptions to this optional preservation and holding time procedure are noted in footnote 5 (re: the requirement for thiosulfate reduction of residual chlorine) and footnotes 12, 13 (re: the analysis of benzidine).
(12) If 1,2-diphenylthydrazine is likely to be present, adjust the pH of the sample to 4.0±0.2 to prevent rearrangement to benzidine.
(13) Extracts may be stored up to 7 days before analysis if storage is conducted under an inert (oxidant-free) atmosphere.
(14) For the analysis of diphenylnitrosamine, add 0.008% $Na_2S_2O_3$ and adjust pH to 7-10 with NaOH within 24 hours of sampling.
(15) The pH adjustment may be performed upon receipt at the laboratory and may be omitted if the samples are extracted within 72 hours of collection. For the analysis of aldrin, add 0.008% $Na_2S_2O_3$.

TABLE OF CONTENTS

SECTION **PAGE**

1.0 PURPOSE 2

2.0 SCOPE 2

3.0 GLOSSARY 2

4.0 RESPONSIBILITIES 2

5.0 PROCEDURES 2

5.1 SITE LOGBOOK 2
5.1.1 General 2
5.1.2 Photographs 3
5.2 FIELD NOTEBOOKS 3
5.3 FIELD FORMS 4
5.3.1 Sample Collection, Labeling, Shipment, Request for Analysis, and Field Test Results 4
5.3.2 Hydrogeological and Geotechnical Forms 5
5.3.3 Equipment Calibration and Maintenance Form 6
5.4 FIELD REPORTS 6
5.4.1 Daily Activities Report 6
5.4.2 Weekly Status Reports 7

6.0 LISTING OF TETRA TECH NUS FIELD FORMS FOUND ON THE TTNUS INTRANET SITE. HTTP://INTRANET.TTNUS.COM CLICK ON FIELD LOG SHEETS 7

ATTACHMENTS

A TYPICAL SITE LOGBOOK ENTRY 9
B SAMPLE LABEL 10
C CHAIN-OF-CUSTODY RECORD FORM 11
D CHAIN-OF-CUSTODY SEAL 12

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to identify and designate the field data record forms, logs and reports generally initiated and maintained for documenting Tetra Tech NUS field activities.

2.0 SCOPE

Documents presented within this procedure (or equivalents) shall be used for all Tetra Tech NUS field activities, as applicable. Other or additional documents may be required by specific client contracts or project planning documents.

3.0 GLOSSARY

None

4.0 RESPONSIBILITIES

Project Manager (PM) - The Project Manager is responsible for obtaining hardbound, controlled-distribution logbooks (from the appropriate source), as needed. In addition, the Project Manager is responsible for placing all field documentation used in site activities (i.e., records, field reports, sample data sheets, field notebooks, and the site logbook) in the project's central file upon the completion of field work.

Field Operations Leader (FOL) - The Field Operations Leader is responsible for ensuring that the site logbook, notebooks, and all appropriate and current forms and field reports illustrated in this guideline (and any additional forms required by the contract) are correctly used, accurately filled out, and completed in the required time-frame.

5.0 PROCEDURES

5.1 Site Logbook

5.1.1 General

The site logbook is a hard-bound, paginated, controlled-distribution record book in which all major onsite activities are documented. At a minimum, the following activities/events shall be recorded or referenced (daily) in the site logbook:

- All field personnel present
- Arrival/departure of site visitors
- Time and date of H&S training
- Arrival/departure of equipment
- Time and date of equipment calibration
- Start and/or completion of borehole, trench, monitoring well installation, etc.
- Daily onsite activities performed each day
- Sample pickup information
- Health and Safety issues (level of protection observed, etc.)
- Weather conditions

A site logbook shall be maintained for each project. The site logbook shall be initiated at the start of the first onsite activity (e.g., site visit or initial reconnaissance survey). Entries are to be made for every day

that onsite activities take place which involve Tetra Tech NUS or subcontractor personnel. Upon completion of the fieldwork, the site logbook must become part of the project's central file.

The following information must be recorded on the cover of each site logbook:

- Project name
- Tetra Tech NUS project number
- Sequential book number
- Start date
- End date

Information recorded daily in the site logbook need not be duplicated in other field notebooks (see Section 5.2), but must summarize the contents of these other notebooks and refer to specific page locations in these notebooks for detailed information (where applicable). An example of a typical site logbook entry is shown in Attachment A.

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 field notebook in which the measurements are recorded (see Attachment A).

All logbook, notebook, and log sheet entries shall be made in indelible ink (black pen is preferred). No erasures are permitted. If an incorrect entry is made, the entry shall be crossed out with a single strike mark, and initialed and dated. At the completion of entries by any individual, the logbook pages used must be signed and dated. The site logbook must also be signed by the Field Operations Leader at the end of each day.

5.1.2 Photographs

When movies, slides, or photographs are taken of a site or any monitoring location, they must be numbered sequentially to correspond to logbook/notebook entries. The name of the photographer, date, time, site location, site description, and weather conditions must be entered in the logbook/notebook 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/notebook. If possible, such techniques shall be avoided, since they can adversely affect the accuracy of photographs. Chain-of-custody procedures depend upon the subject matter, type of camera (digital or film), and the processing it requires. Film used for aerial photography, confidential information, or criminal investigation require chain-of-custody procedures. Once processed, the slides of photographic prints shall be consecutively numbered and labeled according to the logbook/notebook descriptions. The site photographs and associated negatives and/or digitally saved images to compact disks must be docketed into the project's central file.

5.2 Field Notebooks

Key field team personnel may maintain a separate dedicated field notebook to document the pertinent field activities conducted directly under their supervision. For example, on large projects with multiple investigative sites and varying operating conditions, the Health and Safety Officer may elect to maintain a separate field notebook. Where several drill rigs are in operation simultaneously, each site geologist assigned to oversee a rig must maintain a field notebook.

5.3 Field Forms

All Tetra Tech NUS field forms (see list in Section 6.0 of this SOP) can be found on the company's intranet site (http://intranet.ttnus.com) under Field Log Sheets. Forms may be altered or revised for project-specific needs contingent upon client approval. Care must be taken to ensure that all essential information can be documented. Guidelines for completing these forms can be found in the related sampling SOP.

5.3.1 Sample Collection, Labeling, Shipment, Request for Analysis, and Field Test Results

5.3.1.1 Sample Log Sheet

Sample Log Sheets are used to record specified types of data while sampling. The data recorded on these sheets are useful in describing the sample as well as pointing out any problems, difficulties, or irregularities encountered during sampling. A log sheet must be completed for each sample obtained, including field quality control (QC) samples.

5.3.1.2 Sample Label

A typical sample label is illustrated in Attachment B. Adhesive labels must be completed and applied to every sample container. Sample labels can usually be obtained from the appropriate Program source electronically generated in-house, or are supplied from the laboratory subcontractor.

5.3.1.3 Chain-of-Custody Record Form

The Chain-of-Custody (COC) Record is a multi-part form that is initiated as samples are acquired and accompanies a sample (or group of samples) as they are transferred from person to person. This form must be used for any samples collected for chemical or geotechnical analysis whether the analyses are performed on site or off site. One carbonless copy of the completed COC form is retained by the field crew, one copy is sent to the Project Manager (or designee), while the original is sent to the laboratory. The original (top, signed copy) of the COC form shall be placed inside a large Ziploc-type bag and taped inside the lid of the shipping cooler. If multiple coolers are sent but are included on one COC form, the COC form should be sent with the cooler containing vials for VOC analysis or the cooler with the air bill attached. The air bill should then state how many coolers are included with that shipment. An example of a Chain-of-Custody Record form is provided as Attachment C. Once the samples are received at the laboratory, the sample cooler and contents are checked and any problems are noted on the enclosed COC form (any discrepancies between the sample labels and COC form and any other problems that are noted are resolved through communication between the laboratory point-of-contact and the Tetra Tech NUS Project Manager). The COC form is signed and copied. The laboratory will retain the copy while the original becomes part of the samples' corresponding analytical data package.

5.3.1.4 Chain-of-Custody Seal

Attachment D is an example of a custody seal. The Custody seal is an adhesive-backed label. It is part of a chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field and sealed in coolers for transport to the laboratory. The COC seals are signed and dated by the sampler(s) and affixed across the lid and body of each cooler (front and back) containing environmental samples (see SOP SA-6.1). COC seals may be available from the laboratory; these seals may also be purchased from a supplier.

5.3.1.5 Geochemical Parameters Log Sheets

Field Analytical Log Sheets are used to record geochemical and/or natural attenuation field test results.

5.3.2 Hydrogeological and Geotechnical Forms

5.3.2.1 Groundwater Level Measurement Sheet

A Groundwater Level Measurement Sheet must be filled out for each round of water level measurements made at a site.

5.3.2.2 Data Sheet for Pumping Test

During the performance of a pumping test (or an in-situ hydraulic conductivity test), a large amount of data must be recorded, often within a short time period. The Pumping Test Data Sheet facilitates this task by standardizing the data collection format for the pumping well and observation wells, and allowing the time interval for collection to be laid out in advance.

5.3.2.3 Packer Test Report Form

A Packer Test Report Form must be completed for each well upon which a packer test is conducted.

5.3.2.4 Boring Log

During the progress of each boring, a log of the materials encountered, operation and driving of casing, and location of samples must be kept. The Summary Log of Boring, or Boring Log is used for this purpose and must be completed for each soil boring performed. In addition, if volatile organics are monitored on cores, samples, cuttings from the borehole, or breathing zone, (using a PID or FID), these readings must be entered on the boring log at the appropriate depth. The "Remarks" column can be used to subsequently enter the laboratory sample number, the concentration of key analytical results, or other pertinent information. This feature allows direct comparison of contaminant concentrations with soil characteristics.

5.3.2.5 Monitoring Well Construction Details Form

A Monitoring Well Construction Details Form must be completed for every monitoring well, piezometer, or temporary well point installed. This form contains specific information on length and type of well riser pipe and screen, backfill, filter pack, annular seal and grout characteristics, and surface seal characteristics. This information is important in evaluating the performance of the monitoring well, particularly in areas where water levels show temporal variation, or where there are multiple (immiscible) phases of contaminants. Depending on the type of monitoring well (in overburden or bedrock, stick-up or flush mount), different forms are used.

5.3.2.6 Test Pit Log

When a test pit or trench is constructed for investigative or sampling purposes, a Test Pit Log must be filled out by the responsible field geologist or sampling technician.

5.3.2.7 Miscellaneous Monitoring Well Forms

Monitoring Well Materials Certificate of Conformance should be used as the project directs to document all materials utilized during each monitoring well installation.

The Monitoring Well Development Record should be used as the project directs to document all well development activities.

5.3.2.8 Miscellaneous Field Forms - QA and Checklists

Container Sample and Inspection Sheet should be used as the project directs each time a container (drum, tank, etc.) is sampled and/or inspected.

QA Sample Log Sheet should be used at the project directs each time a QA sample is colleted, such as Rinsate Blank, Source Blank, etc.

Field Task Modification Request (FTMR) will be prepared for all deviations from the project planning documents. The FOL is responsible for initiating the FTMRs. Copies of all FTMRs will be maintained with the onsite planning documents and originals will be placed in the final evidence file.

The Field Project Daily Activities Check List and Field Project Pre-Mobilization Checklist should be used during both the planning and field effort to assure that all necessary tasks are planned for and completed. These two forms are not a requirement but a useful tool for most field work.

5.3.3 Equipment Calibration and Maintenance Form

The calibration or standardization of monitoring, measuring or test equipment is necessary to assure the proper operation and response of the equipment, to document the accuracy, precision or sensitivity of the measurement, and determine if correction should be applied to the readings. Some items of equipment require frequent calibration, others infrequent. Some are calibrated by the manufacturer, others by the user.

Each instrument requiring calibration has its own Equipment Calibration Log which documents that the manufacturer's instructions were followed for calibration of the equipment, including frequency and type of standard or calibration device. An Equipment Calibration Log must be maintained for each electronic measuring device used in the field; entries must be made for each day the equipment is used or in accordance with the manufacturer's recommendations.

5.4 Field Reports

The primary means of recording onsite activities is the site logbook. Other field notebooks may also be maintained. These logbooks and notebooks (and supporting forms) contain detailed information required for data interpretation or documentation, but are not easily useful for tracking and reporting of progress. Furthermore, the field logbook/notebooks remain onsite for extended periods of time and are thus not accessible for timely review by project management.

5.4.1 Daily Activities Report

To provide timely oversight of onsite contractors, Daily Activities Reports are completed and submitted as described below.

5.4.1.1 Description

The Daily Activities Report (DAR) documents the activities and progress for each day's field work. This report must be filled out on a daily basis whenever there are drilling, test pitting, well construction, or other related activities occurring which involve subcontractor personnel. These sheets summarize the work performed and form the basis of payment to subcontractors. The DAR form can be found on the TtNUS intranet site.

5.4.1.2 Responsibilities

It is the responsibility of the rig geologist to complete the DAR and obtain the driller's signature acknowledging that the times and quantities of material entered are correct.

5.4.1.3 Submittal and Approval

At the end of the shift, the rig geologist must submit the Daily Activities Report to the Field Operations Leader (FOL) for review and filing. The Daily Activities Report is not a formal report and thus requires no further approval. The DAR reports are retained by the FOL for use in preparing the site logbook and in preparing weekly status reports for submission to the Project Manager.

5.4.2 Weekly Status Reports

To facilitate timely review by project management, photocopies of logbook/notebook entries may be made for internal use.

It should be noted that in addition to summaries described herein, other summary reports may also be contractually required.

All Tetra Tech NUS field forms can be found on the company's intranet site at http://intranet.ttnus.com under Field Log Sheets.

6.0 LISTING OF TETRA TECH NUS FIELD FORMS FOUND ON THE TTNUS INTRANET SITE. HTTP://INTRANET.TTNUS.COM CLICK ON FIELD LOG SHEETS

Groundwater Sample Log Sheet
Surface Water Sample Log Sheet
Soil/Sediment Sample Log Sheet
Container Sample and Inspection Sheet
Geochemical Parameters (Natural Attenuation)
Groundwater Level Measurement Sheet
Pumping Test Data Sheet
Packer Test Report Form
Boring Log
Monitoring Well Construction Bedrock Flush Mount
Monitoring Well Construction Bedrock Open Hole
Monitoring Well Construction Bedrock Stick Up
Monitoring Well Construction Confining Layer
Monitoring Well Construction Overburden Flush Mount
Monitoring Well Construction Overburden Stick Up
Test Pit Log
Monitoring Well Materials Certificate of Conformance
Monitoring Well Development Record

Daily Activities Record
Field Task Modification Request
Hydraulic Conductivity Test Data Sheet
Low Flow Purge Data Sheet
QA Sample Log Sheet
Equipment Calibration Log
Field Project Daily Activities Checklist
Field Project Pre-Mobilization Checklist

ATTACHMENT A
TYPICAL SITE LOGBOOK ENTRY

START TIME: _____ DATE: _____

SITE LEADER: _____

PERSONNEL:

TtNUS	DRILLER	SITE VISITORS
_____	_____	_____
_____	_____	_____
_____	_____	_____

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 off site, gate locked.

_____

Field Operations Leader

ATTACHMENT B

Tetra Tech NUS, Inc. 661 Andersen Drive Pittsburgh, 15220 (412)921-7090	Project: Site: Location:		
Sample No:			Matrix:
Date:	Time:	Preserve:	
Analysis:			
Sampled by:	Laboratory:		

ATTACHMENT C

TETRA TECH NUS, INC. CHAIN OF CUSTODY | NUMBER 3413 | PAGE ___ OF ___

PROJECT NO:	FACILITY:	PROJECT MANAGER	PHONE NUMBER	LABORATORY NAME AND CONTACT:
SAMPLERS (SIGNATURE)		FIELD OPERATIONS LEADER	PHONE NUMBER	ADDRESS
		CARRIER/WAYBILL NUMBER		CITY, STATE

STANDARD TAT ☐
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

DATE YEAR	TIME	SAMPLE ID	LOCATION ID	TOP DEPTH (FT)	BOTTOM DEPTH (FT)	MATRIX (GW, SO, SW, SD, QC, ETC.)	COLLECTION METHOD GRAP (G) COMP (C)	No. OF CONTAINERS	CONTAINER TYPE PLASTIC (P) or GLASS (G) / PRESERVATIVE USED / TYPE OF ANALYSIS								COMMENTS

1. RELINQUISHED BY	DATE	TIME	1. RECEIVED BY	DATE	TIME
2. RELINQUISHED BY	DATE	TIME	2. RECEIVED BY	DATE	TIME
3. RELINQUISHED BY	DATE	TIME	3. RECEIVED BY	DATE	TIME

COMMENTS

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE) YELLOW (FIELD COPY) PINK (FILE COPY)

4/02R
FORM NO. TtNUS-001

ATTACHMENT D

CHAIN-OF-CUSTODY SEAL

CUSTODY SEAL	**CUSTODY SEAL**
Date	**Date**
Signature	**Signature**

TABLE OF CONTENTS

SECTION **PAGE**

1.0 PURPOSE **2**

2.0 SCOPE **2**

3.0 GLOSSARY **2**

4.0 RESPONSIBILITIES **3**

5.0 PROCEDURES **3**

5.1 DECONTAMINATION DESIGN/CONSTRUCTIONS CONSIDERATIONS 3
5.1.1 Temporary Decontamination Pads 3
5.1.2 Decontamination Activities at Drill Rigs/DPT Units 4
5.1.3 Decontamination Activities at Remote Sample Locations 5
5.2 EQUIPMENT DECONTAMINATION PROCEDURES 5
5.2.1 Monitoring Well Sampling Equipment 5
5.2.2 Down-Hole Drilling Equipment 6
5.2.3 Soil/Sediment Sampling Equipment 6
5.3 CONTACT WASTE/MATERIALS 7
5.3.1 Decontamination Solutions 7
5.4 DECONTAMINATION EVALUATION 7

1.0 PURPOSE

Decontamination is the process of removing and/or neutralizing site contaminants that have contacted and/or accumulated on equipment. The objective/purpose of this SOP is intended to protect site personnel, general public, and the sample integrity through the prevention of cross contamination onto unaffected persons or areas. It is further intended through this procedure to provide guidelines regarding the appropriate procedures to be followed when decontaminating drilling equipment, monitoring well materials, chemical sampling equipment and field analytical equipment.

2.0 SCOPE

This procedure applies to all equipment including drilling equipment, heavy equipment, monitoring well materials, as well as chemical sampling and field analytical equipment decontamination that may be used to provide access/acquire environmental samples. Where technologically and economically feasible, single use sealed disposable equipment will be employed to minimize the potential for cross contamination. This procedure also provides general reference information on the control of contaminated materials.

3.0 GLOSSARY

Acid - For decontamination of equipment when sampling for trace levels of inorganics, a 10% solution of nitric acid in deionized water should be used. Due to the leaching ability of nitric acid, it should not be used on stainless steel.

Alconox/Liquinox - A brand of phosphate-free laboratory-grade detergent.

Decontamination Solution - Is a solution selected/identified within the Health and Safety Plan or Project-Specific Quality Assurance Plan. The solution is selected and employed as directed by the project chemist/health and safety professional.

Deionized Water (DI) - Deionized water is tap water that has been treated by passing through a standard deionizing resin column. This water may also pass through additional filtering media to attain various levels of analyte-free status. The DI water should meet CAP and NCCLS specifications for reagent grade, Type I water.

Potable Water - Tap water used from any municipal water treatment system. Use of an untreated potable water supply is not an acceptable substitute for tap water.

Pressure Washing - Employs high pressure pumps and nozzle configuration to create a high pressure spray of potable water. High pressure spray is employed to remove solids.

Solvent - The solvent of choice is pesticide-grade Isopropanol. Use of other solvents (methanol, acetone, pesticide-grade hexane, or petroleum ether) may be required for particular projects or for a particular purpose (e.g. for the removal of concentrated waste) and must be justified in the project planning documents. As an example, it may be necessary to use hexane when analyzing for trace levels of pesticides, PCBs, or fuels. In addition, because many of these solvents are not miscible in water, the equipment should be air dried prior to use. Solvents should not be used on PVC equipment or well construction materials.

Steam Pressure Washing - This method employs a high pressure spray of heated potable water. This method through the application of heat provides for the removal of various organic/inorganic compounds.

4.0 RESPONSIBILITIES

Project Manager - Responsible for ensuring that all field activities are conducted in accordance with approved project plan(s) requirements.

Field Operations Leader (FOL) - Responsible for the onsite verification that all field activities are performed in compliance with approved Standards Operating Procedures or as otherwise dictated by the approved project plan(s).

Site Health and Safety Officer (SHSO) - The SHSO exercises shared responsibility with the FOL concerning decontamination effectiveness. All equipment arriving on-site (as part of the equipment inspection), leaving the site, moving between locations are required to go through a decontamination evaluation. This is accomplished through visual examination and/or instrument screening to determine the effectiveness of the decontamination process. Failure to meet these objectives are sufficient to restrict equipment from entering the site/exiting the site/ or moving to a new location on the site until the objectives are successfully completed.

5.0 PROCEDURES

The process of decontamination is accomplished through the removal of contaminants, neutralization of contaminants, or the isolation of contaminants. In order to accomplish this activity a level of preparation is required. This includes site preparation, equipment selection, and evaluation of the process. Site contaminant types, concentrations, media types, are primary drivers in the selection of the types of decontamination as well as where it will be conducted. For purposes of this SOP discussion will be provided concerning general environmental investigation procedures.

The decontamination processes are typically employed at:

- Temporary Decontamination Pads/Facilities
- Sample Locations
- Centralized Decontamination Pad/Facilities
- Combination of some or all of the above

The following discussion represents recommended site preparation in support of the decontamination process.

5.1 Decontamination Design/Constructions Considerations

5.1.1 Temporary Decontamination Pads

Temporary decontamination pads are constructed at satellite locations in support of temporary work sites. These structures are generally constructed to support the decontamination of heavy equipment such as drill rigs and earth moving equipment but can be employed for smaller articles.

The purpose of the decontamination pad is to contain wash waters and potentially contaminated soils generated during decontamination procedures. Therefore, construction of these pads should take into account the following considerations

- Site Location – The site selected should be within a reasonable distance from the work site but should avoid:

  - Pedestrian/Vehicle thoroughfares
  - Areas where control/custody cannot be maintained
  - Areas where a potential releases may be compounded through access to storm water transport systems, streams or other potentially sensitive areas.
  - Areas potentially contaminated.

- Pad – The pad should be constructed to provide the following characteristics

  - Size – The size of the pad should be sufficient to accept the equipment to be decontaminated as well as permitting free movement around the equipment by the personnel conducting the decontamination.

  - Slope – An adequate slope will be constructed to permit the collection of the water and potentially contaminated soils within a trough or sump constructed at one end. The collection point for wash waters should be of adequate distance that the decontamination workers do not have to walk through the wash waters while completing their tasks.

  - Sidewalls – The sidewalls should be a minimum of 6-inches in height to provide adequate containment for wash waters and soils. If splash represents a potential problem, splash guards should be constructed to control overspray. Sidewalls maybe constructed of wood, inflatables, sand bags, etc. to permit containment.

  - Liner – Depending on the types of equipment and the decontamination method the liner should be of sufficient thickness to provide a puncture resistant barrier between the decontamination operation and the unprotected environment. Care should be taken to examine the surface area prior to placing the liner to remove sharp articles (sticks, stones, debris) that could puncture the liner. Liners are intended to form an impermeable barrier. The thickness may vary from a minimum recommended thickness of 10 mil to 30 mil. Achieving the desired thickness maybe achieved through layering lighter constructed materials. It should be noted that various materials (rubber, polyethylene sheeting) become slippery when wet. To minimize this potential hazard associated with a sloped liner a light coating of sand maybe applied to provide traction as necessary.

  - Wash/drying Racks – Auger flights, drill/drive rods require racks positioned off of the ground to permit these articles to be washed, drained, and dried while secured from falling during this process. A minimum ground clearance of 2-feet is recommended.

  - Maintenance – The work area should be periodically cleared of standing water, soils, and debris. This action will aid in eliminating slip, trip, and fall hazards. In addition, these articles will reduce potential backsplash and cross contamination. Hoses should be gathered when not in use to eliminate potential tripping hazards.

5.1.2 Decontamination Activities at Drill Rigs/DPT Units

During subsurface sampling activities including drilling and direct push activities decontamination of drive rods, Macro Core Samplers, split spoons, etc. are typically conducted at an area adjacent to the operation. Decontamination is generally accomplished using a soap/water wash and rinse utilizing buckets and brushes. This area requires sufficient preparation to accomplish the decontamination objectives.

Buckets shall be placed within mortar tubs or similar secondary containment tubs to prevent splash and spills from reaching unprotected media. Drying racks will be employed as directed for temporary pads to permit parts to dry and be evaluated prior to use/re-use.

5.1.3 Decontamination Activities at Remote Sample Locations

When sampling at remote locations sampling devices such as trowels, pumps/tubing should be evacuated of potentially contaminated media to the extent possible. This equipment should be wrapped in plastic for transport to the temporary/centralized decontamination location for final cleaning and disposition.

5.2 Equipment Decontamination Procedures

The following represents procedures to be employed for the decontamination of equipment that may have contacted and/or accumulated contamination through site investigation activities.

5.2.1 Monitoring Well Sampling Equipment

5.2.1.1 Groundwater sampling pumps – This includes pumps inserted into the monitoring well such as Bladder pumps, Whale pumps, Redi-Flo, reusable bailers, etc.

1) Evacuate to the extent possible, any purge water within the pump.

2) Scrub using soap and water and/or steam clean the outside of the pump and tubing, where applicable.

3) Insert the pump and tubing into a clean container of soapy water. Pump a sufficient amount of soapy water through the pump to flush any residual purge water. Once flushed, circulate soapy water through the pump to ensure the internal components are thoroughly flushed.

4) Remove the pump and tubing from the container, rinse external components using tap water. Insert the pump and tubing into a clean container of tap water. Pump a sufficient amount of tap water through the pump to evacuate all of the soapy water (until clear).

5) Rinse equipment with pesticide grade isopropanol

6) Repeat item #4 using deionized water through the hose to flush out the tap water and solvent residue as applicable*.

7) Drain residual deionized water to the extent possible, allow components to air dry.

8) Wrap pump in aluminum foil or a clear clean plastic bag for storage.

5.2.1.2 Electronic Water Level Indicators/Sounders/Tapes

During water level measurements, rinsing with the extracted tape and probe with deionized water and wiping the surface of the extracted tape is acceptable. However, periodic full decontamination should be conducted as indicated below.

---

* - The solvent should be employed when samples contain oil, grease, PAHs, PCBs, and other hard to remove materials. If these are not of primary concern, the solvent step may be omitted. In addition, do not rinse PE, PVC, and associated tubing with solvents.

1) Wash with soap and water
2) Rinse with tap water
3) Rinse with deionized water

N te: In situations where oil, grease, free product, other hard to remove materials are encountered probes and exposed tapes should be washed in hot soapy water.

5.2.1.3 Miscellaneous Equipment

Miscellaneous equipment including analytical equipment (water quality testing equipment) should be cleaned per manufacturer's instructions. This generally includes wiping down the sensor housing and rinsing with tap and deionized water.

Coolers/Shipping Containers employed to ship samples are received from the lab in a variety of conditions from marginal to extremely poor. Coolers should be evaluated prior to use for

- Structural integrity – Coolers missing handles or having breaks within the outer housing should be removed and not used. Notify the laboratory that the risk of shipping samples will not be attempted and request a replacement unit.

- Cleanliness – As per protocol only volatile organic samples are accompanied by a trip blank. If a cooler's cleanliness is in question (visibly dirty/stained) or associated with noticeable odors it should be decontaminated prior to use.

  1) Wash with soap and water
  2) Rinse with tap water
  3) Dry

If these measures fail to clean the cooler to an acceptable level, remove the unit from use as a shipping container and notify the laboratory to provide a replacement unit.

5.2.2 Down-Hole Drilling Equipment

This includes any portion of the drill rig that is over the borehole including auger flights, drill stems, rods, and associated tooling that would extend over the borehole. This procedure is to be employed prior to initiating the drilling/sampling activity, then between locations.

1) Remove all soils to the extent possible using shovels, scrapers, etc. to remove loose soils.
2) Through a combination of scrubbing using soap and water and/or steam cleaning remove visible dirt/soils.
3) Rinse with tap water.
4) Rinse equipment with pesticide grade isopropanol
5) To the extent possible allow components to air dry.
6) Wrap or cover equipment in clear plastic until it is time to be used.

5.2.3 Soil/Sediment Sampling Equipment

This consists of soil sampling equipment including but not limited to hand augers, stainless steel trowels/spoons, bowls, dredges, scoops, split spoons, Macro Core samplers, etc.

1) Remove all soils to the extent possible.

2) Through a combination of scrubbing using soap and water and/or steam cleaning remove visible dirt/soils.

3) Rinse with tap water.

4) Rinse equipment with pesticide grade isopropanol

5) Rinse with deionized water

6) To the extent possible allow components to air dry.

7) If the device is to be used immediately, screen with a PID/FID to insure all solvents (if they were used) and trace contaminants have been adequately removed.

8) Once these devices have been dried wrap in aluminum foil for storage until it is time to be used.

5.3 Contact Waste/Materials

During the course of field investigations disposable/single use equipment becomes contaminated. These items include tubing, trowels, PPE (gloves, overboots, splash suits, etc.) broken sample containers.

With the exception of the broken glass, single use articles should be cleaned (washed and rinsed) of visible materials and disposed of as normal refuse. The exception to this rule is that extremely soiled materials that cannot be cleaned should be containerized for disposal in accordance with applicable federal state and local regulations.

5.3.1 Decontamination Solutions

All waste decontamination solutions and rinses must be assumed to contain the hazardous chemicals associated with the site unless there are analytical or other data to the contrary. The waste solution volumes could vary from a few gallons to several hundred gallons in cases where large equipment required cleaning.

Containerized waste rinse solutions are best stored in 55-gallon drums (or equivalent containers) that can be sealed until ultimate disposal at an approved facility. These containers must be appropriately labeled.

5.4 Decontamination Evaluation

Determining the effectiveness of the decontamination process will be accomplished in the following manner

- Visual Evaluation – A visual evaluation will be conducted to insure the removal of particulate matter. This will be done to insure that the washing/rinsing process is working as intended.

- Instrument Screening – A PID and/or an FID should be used to evaluate the presence of the contaminants or solvents used in the cleaning process. The air intake of the instrument should be passed over the article to be evaluated. A positive detection requires a repeat the decontamination process. It should be noted that the instrument scan is only viable if the contaminants are detectable within the instruments capabilities.

- Rinsate Blanks – It is recommended that Rinsate samples be collected to
  - Evaluate the decontamination procedure representing different equipment applications (pumps versus drilling equipment) and different decontamination applications.
  - Single use disposable equipment – The number of samples should represent different types of equipment as well as different Lot Numbers of single use articles.

The collection and the frequency of collection of rinsate samples are as follows:

- Per decontamination method
- Per disposable article/Batch number of disposable articles

It is recommended that an initial rinsate sample be collected early in the project to ensure that the decontamination process is functioning properly and in an effort to avoid using a contaminated batch of single use articles. It is recommended that a follow up sample be collected during the execution of the project to insure those conditions do not change. Lastly, rinsate samples collection may be driven by types of and/or contaminant levels. Hard to remove contaminants, oils/greases, some PAHs/PCBs, etc. may also support the collection of additional rinsates due to the obvious challenges to the decontamination process. This is a field consideration to be determined by the FOL.

APPENDIX B

FIELD DOCUMENTATION FORMS

TETRA TECH NUS, INC.

ANALYTICAL SERVICE
Packing List/Chain-of-Custody

Case No. _____ Page ____ of ____

Subcontract No. _____

Project No.	Laboratory Name:	Container Type	Container Type	Container Type	Container Type	Container Typ
Sampler Signatures	Date Shipped / Carrier Airbill No. / No. of Coolers	Analysis	Analysis	Analysis	Analysis	Analysis

Sample Number	Matrix	Date/Time	Sample Location	Tag Number(s)	QC	Preservative	Preservative	Preservative	Preservative	Preservative

Relinquished By: (Signature)	Date/Time	Received By: (Signature)	Shipment for Case Complete? YES NO	Remarks
Relinquished By: (Signature)	Date/Time	Received for Laboratory By:	Date/Time	

TtNUS Form 0022

BORING LOG FOR:
PROJECT NO.: N4590-0516
LOGGED BY:
DRILLED BY (Company/Driller):
GRD. SURFACE ELEVATION:

TRANSCRIBED BY:
ELEVATION FROM:

BORING NO.:
START DATE:
COMPLETION: DATE:
MON. WELL NO.:
CHECKED BY:

DEPTH (FEET)	BLOWS PER 6"	SAMP REC. / SAMP LENG.	SAMPLING TIME & SAMPLE NO. (QA/QC STATUS)	DEPTH MAT'L CHG./ WELL PROF'L	SOIL DENSITY/ CONSIS. or ROCK HARD.	CLR	MATERIAL CLASSIFICATION	USCS or ROCK BRKN	REMARKS (moisture condition; odors; geological classification; rock weathering; etc.)	FIELD SCREENING DATA *METHOD* = [FID, (PPM)]

TYPE OF DRILLING RIG:
METHOD OF ADVANCING BORING:
METHOD OF SOIL SAMPLING:
METHOD OF ROCK CORING:
GROUNDWATER LEVELS:
OTHER OBSERVATIONS:

BORING NO.:

Tetra Tech NUS, Inc.

TtNUS Form 0018

TETRA TECH NUS, INC.

FIELD INSTRUMENT CALIBRATION LOG

INSTRUMENT NAME: _____ MODEL No.: _____

SERIAL No.: _____ DECAL No.: _____ TETRA TECH NUS CHARGE No. _____

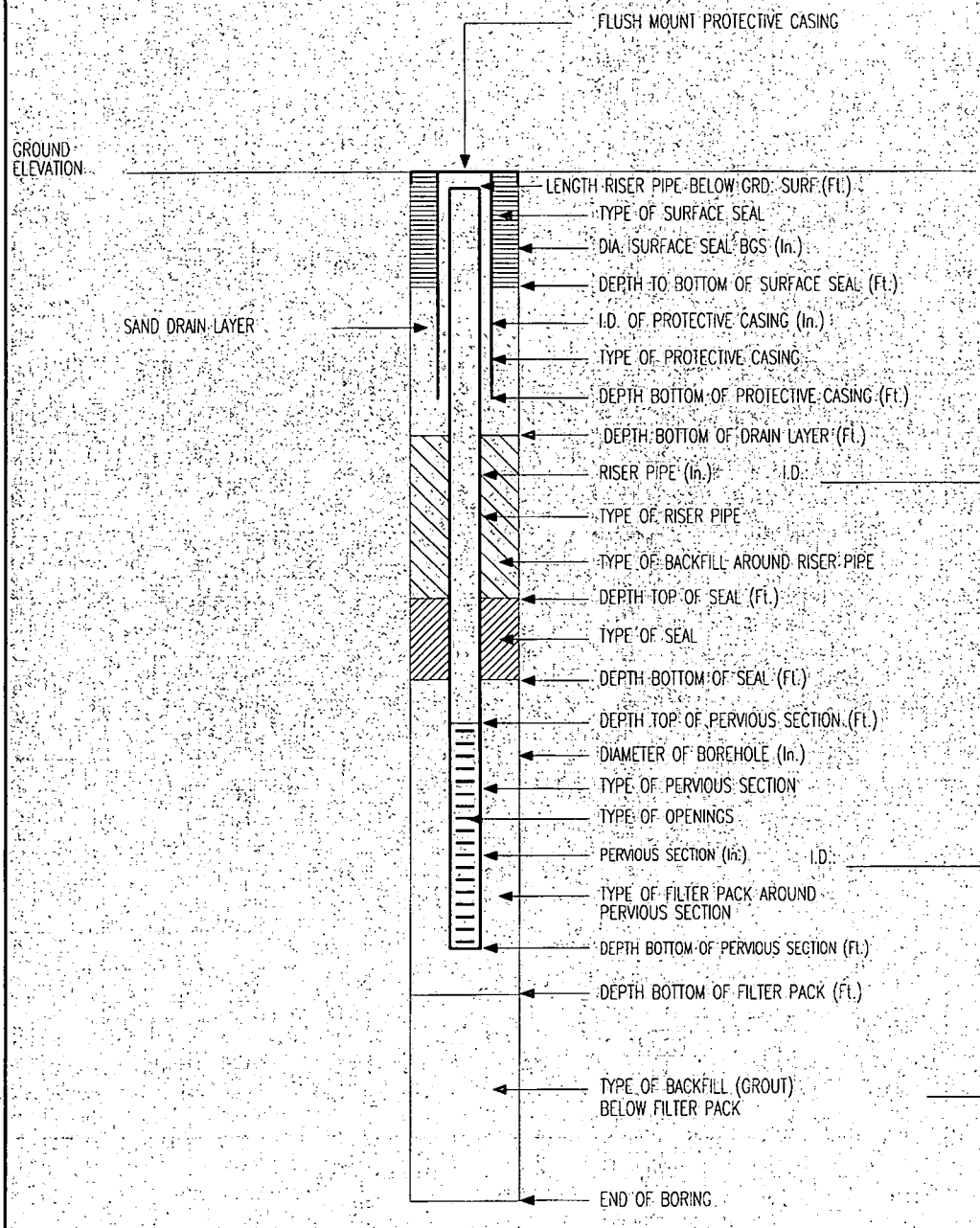
CALIBRATION DATE	INITIAL READING	PROCEDURE	FINAL READING	SIGNATURE	COMMENTS

TtNUS Form 0007

FLUSH MOUNT MONITORING WELL CONSTRUCTION LOG

TETRA TECH NUS INC.

PROJECT NAME:	Navy Exchange Service Station	PROJECT NO:	N4590-0516
PROJECT LOCATION:	Naval Air Station, Brunswick, Maine	WELL NO:	
CLIENT:	EFA Northest of the NAVFAC	BORING NO:	
CONTRACTOR:	TtNUS	DRILLER:	
LOGGED BY:		DATE:	
CHECKED BY:		DATE:	
BORING LOCATION:			
PAGE:	1 OF 1		



GENERAL NOTE:

1. Entry of 0.00 for Ground Elevation Indicates that Surveyed Ground Elevation is NOT Available.

TtNUS Form 0058

TETRA TECH NUS, INC.

FIELD MODIFICATION RECORD

Site Name: _____ Location: _____

Project Number: _____ Task Assignment: _____

To: _____ Location: _____ Date: _____

Description: _____

_____

_____

_____

Reason for Change: _____

_____

_____

Recommended Action: _____

_____

_____

Field Operations Leader (Signature): _____ Date: _____

Disposition/Action: _____

_____

_____

Project Manager (Signature): _____ Date: _____

Distribution:

Program Manager:	_____	Others as Required:
Project Manager:	_____	_____
Quality Assurance Officer:	_____	_____
Field Operations Leader:	_____	_____
Project File:	_____	_____

TtNUS Form 0003

TETRA TECH NUS, INC.

FIELD INSTRUMENT CALIBRATION LOG

INSTRUMENT NAME: FID MODEL No.: _____

SERIAL No.: _____ DECAL No.: _____ TETRA TECH NUS CHARGE No. N4590-0515/0516

CALIBRATION DATE	INITIAL READING	PROCEDURE	FINAL READING	SIGNATURE	COMMENTS

TtNUS Form 0007

TETRA TECH NUS, INC.

GROUNDWATER LEVEL MEASUREMENT

SITE INFORMATION

Site Name: _____

Project Number: _____

Personnel: _____

Date: _____

Municipality: _____

County: _____

State: _____

Street or Map Location: _____

(If Off-Site): _____

WEATHER CONDITIONS AND EQUIPMENT

Temperature Range: _____

Precipitation: _____

Barometric Pressure: _____

Tidally-Influenced [ ] Yes [ ] No

Equipment No.: _____

Equipment Number: _____

Latest Calibration Date: _____

Well or Piezometer Number	Date/Time	Elevation of Reference Point (Feet)*	Water Level Indicator Reading (Feet)*	Adjusted Depth (Feet)*	Groundwater Elevation (Feet)*

TtNUS Form 0010

* measured made to 0.00 feet

TETRA TECH NUS, INC.

HORIBA U-10 WATER QUALITY CHECKER

Serial No.: _____ Model No.: _____ Decal No.: _____

Site Name: _____ Job No.: _____ Buffer Lot No.: _____

Instrument is calibrated in accordance with Manufacturer's Instructions

Calibration Date	Initial Readings						Final Readings						Signature	Comments
	pH=4.0	Cond. m/cm	Turbidity NTUs	D.O. mg/l	Temp. (°C)	Salinity	pH=4.0	Cond. m/cm	Turbidity NTUs	D.O. mg/l	Temp. (°C)	Salinity		

TtNUS Form 0023

TETRA TECH NUS, INC.

PHOTOIONIZATION DETECTOR FIELD CALIBRATION LOG

Serial No.: _____ Model No.: _____ Decal No.: _____

Site Name/Location: _____ Tetra Tech NUS Charge No.: _____

CALIBRATION DATE	STANDARD GAS-ISOBUTYLENE	CALIBRATION READING Isobutylene Equiv. (ppm)	CALIBRATION CHECK Isobutylene Equiv. (ppm)	SIGNATURE	COMMENTS
	Lot # _____ Conc. = _____ ppm				
	Lot # _____ Conc. = _____ ppm				
	Lot # _____ Conc. = _____ ppm				
	Lot # _____ Conc. = _____ ppm				
	Lot # _____ Conc. = _____ ppm				
	Lot # _____ Conc. = _____ ppm				
	Lot # _____ Conc. = _____ ppm				
	Lot # _____ Conc. = _____ ppm				
	Lot # _____ Conc. = _____ ppm				

TtNUS Form 0006

TETRA TECH NUS, INC.

RECORD OF FIELD WORK ORIENTATION

SITE: _____ JOB No.: _____

WORK ASSIGNMENT No.: _____

TASK OR ACTIVITY: _____ DATE OF ORIENTATION: _____

PERSONNEL ATTENDING	TRAINERS	FOL	PROJECT MGR.
1.	1.	1.	1.
2.	2.		
3.	3.		
4.			
5.			
6.			
7.			

VERIFICATIONS (CHECK AND INITIAL BY ATTENDEES)

	WORK PLAN REVIEWED	SAP/QAPP REVIEWED	SOGs REVIEWED	SITE/EQUIP. SECURITY REVIEWED	EQUIPMENT OPERATION	H&S PLAN REVIEWED	PURCHASING	INITIALS
1.								
2.								
3.								
4.								
5.								
6.								
7.								

RETURN ORIGINAL TO THE QUALITY ASSURANCE OFFICER

Copies to: PROJECT FILE: _____

PROJECT MANAGER: _____

PROGRAM MANAGER: _____

TtNUS Form 0029

TETRA TECH NUS, INC.

PROJECT NAME: _____ RIG NUMBER & TYPE _____

PROJECT NUMBER: _____ DATE: _____

LOCATION: _____ INSPECTED BY: _____

	ITEM	√	COMMENTS
1	Number of Emergency shutdown switches_____ All personnel knowledgeable of their location (s). Switches have been tested prior to commencement of drilling operations		
2	Steel cables are not frayed		
3	Ropes are not frayed		
4	Hydraulic fluids, and lubricants are not leaking		
5	Equipment with proper guards in place (chains to secure high-power air lines in the event of a break)		
6	Use of improper tools, pins, or other devices in poor condition		
7	Using worn air or hydraulic lines		
8	Cleaning-up the work site		
9	Storing fuels or other fluids in proper containers		
10	Hard hats, safety eyewear, steel toe/shank boots, hearing protection, Gloves, tyvek worn by driller/helper		
11	Proper protection equipment required by the Health & Safety Plan		
12	Decontamination Equipment		
13	Vehicle warning alarms (horn, mast, and back-up alarms)		
14	Fire extinguishers; fully charged and accessible		
15	Electrical wiring and switches		
16	Documentation of each driller's compliance with OSHA Health & Safety Training requirements		

TtNUS Form 0056

The FOL and SSO can request demonstration that the equipment is functioning properly.

TETRA TECH NUS, INC.

SAMPLE LOG SHEET - "LOW FLOW" GROUNDWATER

Site Name: _____
Sample ID: _____

Tetra Tech NUS Charge No. _____
QC: _____(If applicable)

Sample Method: _____
Depth Sampled: _____Feet Screened Interval Depth _____feet
Sample Date & Time: __/___ /___ _____hours _____/Dup
Sampler(s): _____
Data Recorded By: _____ Signature: _____
Notes: _____

H&S Survey Meter _____ PPM Field Instrument Group A/B/C/D
Pre-pump insertion WL _____ ft Post - pump insertion WL _____ft

Analysis	Bottle Lot #	Analysis	Bottle Lot #	Analysis	Bottle Lot #

Clock Time 24hr	Water Depth below MP ft	Pump Dial 1	Purge Rate ml/min	Cumm. Volume Purged liters	Temp °C	Spec. Cond. 2 uS/cm	pH	ORP/Eh3 mv	DO mg/L	Turbidity NTU	Comments

TtNUS Form 0009

1. Pump dial setting (for example: hertz, cycle/min, etc.)
2. Siemens per cm (same as umhos/cm) at 25 °C.
3. Oxidation reduction potential (stand in for Eh).

TETRA TECH NUS, INC.

SAMPLE LOG SHEET - SOLID PHASE

Site Name: _____
Sample ID: _____

Tetra Tech NUS Charge No. _____
QC Information: _____(if applicable)

Sample Method: _____
Depth Sampled: _____feet
Sample Date & Time: ____/____/____ _____hours Dup_____hours
Sampler(s): _____

Data Recorded By: _____
Signature

PID/OVA Monitor Reading: _____ ppm

TYPE OF SAMPLE: (Check all that apply)

_____ Soil
_____ Sediment
_____ Lagoon/Pond
_____ Grab
_____ Trip Blank*
_____ Rinsate Blank*
_____ Field Duplicate collected
_____ Other (Specify): _____

Description: (Sand, Clay, Muck, Peat, Dry, Moist, Wet, Etc.)

SAMPLE DATA/REMARKS: _____

ANALYSIS	BOTTLE LOT No.	NOTES/SKETCH:

TtNUS Form 0005

TETRA TECH NUS, INC.

SAMPLE LOG SHEET - LIQUID PHASE

Site Name: _____

Tetra Tech NUS Charge No.

Sample ID: _____ QC Information: _____ (if applicable)

Sample Method/Device: _____

Depth Sampled: _____ feet Total Depth _____ feet (SW Only)

Sample Date & Time: ____/____/____ _____ hours

Sampler(s): _____

Recorded By: _____
Signature

TYPE OF SAMPLE: (Check all that apply)

- _____ Groundwater
- _____ Surface Water
- _____ Residential Supply
- _____ Grab
- _____ Composite
- _____ Trip Blank*
- _____ Rinsate Blank*
- _____ Field Duplicate Collected
- _____ Other (Specify): _____

*include sample source & lot No.

WELL PURGE DATA:

Well Depth	feet	Purge Start	hrs
Inside Diameter	Inches	Purge Stop Time	hrs
Water Level	feet	Total Gallons Purged	
Well Volume	gal.	Purge Method	

Color: _____ Turbidity: CLR/SL CLDY/CLDY/OPAQ

Micro Tip/OVA Monitor Reading: ppm

Sampling/Purge Data:

Vol. #	Temp °C	pH	Spec. Cond.	DO
0				
1				
3				
4				

ANALYSIS	BOTTLE LOT NO.	TRAFFIC REPORT NO.		COMMENTS
		ORGANIC	INORGANIC	

TtNUS Form 0004

TETRA TECH NUS, INC.

SAMPLE COLLECTION SUMMARY RECORD

PROJECT NAME: Navy Exchange Service Station

TETRA TECH NUS CHARGE NUMBER: N4590-0515/0516

SAMPLING EVENT:_____ CASE NO.: _____ DAS NO.:_____

DATE	TIME	SAMPLE LOCATION	FIELD QC							COMMENTS

TtNUS Form 0012

TETRA TECH NUS, INC.

SITE ENTRY LOG

Site Name: _____ Date: _____

Location: _____ Project Number: _____

NAME	REPRESENTING	TIME IN (HOURS)	TIME OUT (HOURS)	INITIALS

TtNUS Form 0002

TETRA TECH NUS, INC.

VEHICLE RENTAL LOG

Date Received: _____ Date Returned: _____

Job Number/Task: _____ Vehicle License Number: _____

Vendor: _____ Date Notified for Pick-up: _____

Gas Out: (Circle One) ¼ ½ ¾ F Gas In: ¼ ½ ¾ F

Ending Odometer: _____ (Round off tenths to Nearest Mile)

Beginning Odometer: _____

Total Miles Driven: _____

FUEL AND OIL PURCHASES

DATE	GALLONS OF FUEL	QUARTS OF OIL	COMBINED COST FUEL AND OIL
			$
			$
			$
			$
			$
TOTALS:			$

DATE	DESCRIPTION OF MAINTENANCE/OTHER OPERATING EXPENSES	COST
	Totals Maintenance and Other	

Note all operating failures on reverse side. This form to be submitted to Motor Vehicle Coordinator upon vehicle return.

I certify that the above information is true and correct to the best of my knowledge		
Motor Vehicle Operator	Phone:	Date:

TtNUS Form 0055

TETRA TECH NUS, INC.

VOC SOIL SAMPLE COLLECTION/PRESERVATION LOG SHEET

Sample Container Lot # _____ Preserved in the field Date: _____

			LOW CONCENTRATION VOC				HIGH CONCENTRATION				LAB
Sample #	Bottle Letter	Vial ID Number	Volatile Free Water	Tare Weight Vial + 5 ml H_2O (g)	Final Weight Vial + H_2O + Sample (g)	Soil Sample Weight (g)	Methanol (mL)	Tare Weight Vial + Pres. (g)	Final Weight (g)	Soil Sample Weight (g)	Final Weight Vial + Pres. + Sample (g)

TtNUS Form 0040

Note: Tare weight = vial, preservative, cap and magnetic stirrer, if applicable

Laboratory Analysts Initials: _____ Date: _____

TETRA TECH NUS, INC.

WELL DEVELOPMENT DATA SHEET **Well No.:** _____

PROJECT: _____ DATE: _____

PROJECT NO.: _____ WEATHER: _____

SAMPLE ID: _____ PERSONNEL: _____

Well Screen Depth: _____ / _____ ft. bgs

H&S Monitoring Instrument Reading _____

Pump Type/Material: _____

Pump Intake Depth: _____

Total Purge Volume = _____(gal)

Data Recorded By: _____

Time	Water Level ft below top PVC	Volume mL	Flow Rate mL/min	Temp °C	pH	Sp Cond mS/cm	DO mg/L	Turbidity NTU	Comments

TtNUS Form 0013

Page ___ of___

APPENDIX C

HEALTH AND SAFETY PLAN
DBB PILOT TEST, NEX, NAVAL AIR STATION, BRUNSWICK MAINE
TtNUS, JUNE 2004

Revision 0
July 2004

Health and Safety Plan
for
Denitrification-Based Biodegradation Pilot Test
Navy Exchange Service Station
at
Naval Air Station
Brunswick, Maine

Engineering Field Activity Northeast
Naval Facilities Engineering Command

Contract Number N62472-03-D-0057
Contract Task Order 0014

July 2004

HEALTH AND SAFETY PLAN
FOR
DENITRIFICATION-BASED BIODEGRADATION
PILOT TEST
NAVY EXCHANGE SERVICE STATION
AT
NAVAL AIR STATION
BRUNSWICK, MAINE

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Engineering Field Activity Northeast
Environmental Branch, Code 18
Naval Facilities Engineering Command
10 Industrial Highway, Mail Stop No. 82
Lester, Pennsylvania 19113-2090

Submitted by:
Tetra Tech NUS, Inc.
600 Clark Avenue, Suite 3
King of Prussia, Pennsylvania 19406-1433

CONTRACT NO. N62472-03-D-057
Contract Task Order 0014

JULY 2004

PREPARED UNDER THE SUPERVISION OF:

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TETRA TECH NUS, INC.
PITTSBURGH, PENNSYLVANIA

TABLE OF CONTENTS

SECTION		PAGE
1.0	**INTRODUCTION**	**1-1**
1.1	KEY PROJECT PERSONNEL AND ORGANIZATION	1-2
1.2	SITE INFORMATION AND PERSONNEL ASSIGNMENTS	1-4
2.0	**EMERGENCY ACTION PLAN**	**2-1**
2.1	INTRODUCTION	2-1
2.2	PRE-EMERGENCY PLANNING – RECOGNITION AND PREVENTION	2-2
2.2.1	General Practices – Pre-Emergency Planning	2-2
2.3	SAFE DISTANCES AND PLACES OF REFUGE / EMERGENCY ALERTING AND ACTION / RESPONSE PROCEDURES	2-4
2.3.1	Critical Operations	2-4
2.4	DECONTAMINATION PROCEDURES/EMERGENCY MEDICAL TREATMENT	2-5
2.4.1	Non-Life Threatening Medical Incident	2-5
2.4.2	Life Threatening	2-5
2.4.3	Emergency Medical Treatment	2-5
2.4.4	Mishap Report/Injury/Illness Procedure	2-8
2.5	EMERGENCY CONTACTS	2-8
2.6	PPE AND EMERGENCY EQUIPMENT	2-11
3.0	**SITE BACKGROUND**	**3-1**
3.1	SITE HISTORY AND CURRENT OPERATIONS	3-1
3.2	HISTORY OF INVESTIGATION AREAS	3-1
4.0	**SCOPE OF WORK**	**4-1**
5.0	**TASKS/HAZARDS/ASSOCIATED CONTROL MEASURES SUMMARY**	**5-1**
5.1	MOBILIZATION/DEMOBILIZATION	5-1
5.2	IN-SITU PERMEABILITY TESTING	5-1
5.3	MONITORING WELL INSTALLATION AND SOIL SAMPLING VIA DIRECT PUSH TECHNOLOGY	5-2
5.3.1	Before Conducting DPT Operations	5-2
5.3.2	During DPT Operations	5-3
5.3.3	After DPT Operations	5-3
5.4	MONITORING WELL DEVELOPMENT / SAMPLING	5-3
5.4.1	Monitoring Well Devleopment	5-3
5.4.2	Monitoring Well Groundwater Sampling (Baseline and Periodic)	5-4
5.5	GEOGRAPHICAL SURVEYING	5-5
5.6	DECONTAMINATION	5-5
5.6.1	Heavy Equipment	5-5
5.6.2	Sampling Equipment	5-6
5.7	DBB PILOT TESTING	5-6
5.8	INVESTIGATIVE DERIVED WASTE MANAGEMENT	5-7
5.9	GENERAL SAFE WORK PRACTICES	5-8

TABLE OF CONTENTS CONTINUED

SECTION **PAGE**

6.0 HAZARD ASSESSMENT 6-1
6.1 CHEMICAL HAZARDS 6-1
6.1.1 Exposure Potential 6-1
6.2 PHYSICAL HAZARDS 6-1
6.3 NATURAL HAZARDS 6-2
6.3.1 Insect/Animal Bites and Stings, Poisonous Plants, etc. 6-2
6.3.2 Inclement Weather 6-4

7.0 AIR MONITORING 7-1
7.1 INSTRUMENTS AND USE 7-1
7.1.1 Photoionization Detector (PID) or Flame Ionization Detector (FID) 7-2
7.1.2 Hazard Monitoring Frequency 7-2
7.2 INSTRUMENT MAINTENANCE AND CALIBRATION 7-2

8.0 TRAINING/MEDICAL SURVEILLANCE REQUIREMENTS 8-1
8.1 INTRODUCTORY/REFRESHER/SUPERVISORY TRAINING 8-1
8.1.1 Requirements for Tetra Tech NUS, Inc. and Subcontractor Personnel 8-1
8.2 SITE-SPECIFIC TRAINING 8-1
8.3 MEDICAL SURVEILLANCE REQUIREMENTS 8-2
8.3.1 Medical Surveillance Requirements for TtNUS and Subcontractor Personnel 8-2
8.3.2 Requirements for Field Personnel 8-2
8.4 SUBCONTRACTOR EXCEPTION 8-2

9.0 SPILL PREVENTION AND CONTAINMENT PROGRAM 9-1
9.1 SCOPE AND APPLICATION 9-1
9.2 POTENTIAL SPILL AREAS 9-1
9.3 CONTAINMENT AREAS 9-1
9.3.1 IDW 9-2
9.3.2 Flammable/POL Storage 9-2
9.4 MATERIALS HANDLING 9-3
9.5 LEAK AND SPILL DETECTION 9-3
9.6 PERSONNEL TRAINING AND SPILL PREVENTION 9-3
9.7 SPILL PREVENTION AND CONTAINMENT EQUIPMENT 9-3
9.8 SPILL CONTROL PLAN 9-4

TABLE OF CONTENTS CONTINUED

SECTION **PAGE**

10.0 SITE OPERATIONS AND CONTROL 10-1
10.1 WORK ZONES 10-1
10.1.1 Exclusion Zone 10-1
10.1.2 Contamination Reduction Zone 10-2
10.1.3 Support Zone 10-3
10.2 SAFE WORK PERMITS 10-3
10.3 SITE MAP 10-5
10.4 BUDDY SYSTEM 10-5
10.5 MATERIAL SAFETY DATA SHEET (MSDS) REQUIREMENTS 10-5
10.6 COMMUNICATION 10-5
10.7 SITE VISITORS 10-6
10.8 SITE SECURITY 10-7
10.9 SANITATION AND BREAK AREAS 10-8
10.9.1 TOILETS 10-8
10.9.2 POTABLE WATER 10-8
10.9.3 SHOWERS AND CHANG ROOMS 10-9
10.9.4 BREAK AREAS 10-9

11.0 CONFINED SPACE ENTRY 11-1

12.0 MATERIALS AND DOCUMENTS 12-1
12.1 MATERIALS TO BE POSTED AT THE SITE 12-1

13.0 GLOSSARY 13-

ATTACHMENTS

ATTACHMENT I - INJURY/ILLNESS PROCEDURE AND REPORT FORM
ATTACHMENT II – TtNUS SOP UTILITY LOCATING AND EXCAVATION CLEARANCE
ATTACHMENT III – EQUIPMENT INSPECTION CHECKLIST
ATTACHMENT IV – SAFE WORK PERMITS
ATTACHMENT V – MEDICAL DATA SHEET
ATTACHMENT VI – HEARING CONSERVATION PROGRAM

TABLES

NUMBER		PAGE
2-1	Emergency Contacts	2-9
5-1	Tasks/Hazards/Control Measures Compendium	5-10
6-1	Chemical, Physical, and Toxicological Data	6-5
6-2	Heat Strain Symptoms	6-10
7-1	Monitoring Instrument Action Levels	7-1

FIGURES

NUMBER		PAGE
2-1	Emergency Response Protocol	2-6
2-2	Map to Hospital	2-10
7-1	Documentation of Field Calibration	7-3
8-1	Site-Specific Training Documentation	8-4
10-1	Safe Work Permit	10-4

1.0 INTRODUCTION

The objective of this Health and Safety Plan (HASP) is to specify the minimum safety and health practices and procedures to Tech NUS (TtNUS) and subcontractor personnel conducting denitrification-based biodegradation (DBB) pilot test activities at the Navy Exchange (NEX) Service Station at Naval Air Station (NAS) Brunswick, Maine.

Authorization: This Health and Safety Plan (HASP) has been completed under the authorization of:

Contract: Comprehensive Long Term Environmental Action – Navy (CLEAN) – Southern Division Naval Facilities Engineering Command

Contract Number: N62472-03-D-0057

Contract Task Order Number (CTO): 0014

Statement of Work/Application: This HASP will support the following activities:

- Mobilization/demobilization
- In-situ permeability testing (conductivity testing in existing and newly-installed monitoring wells)
- Sample location survey
- DBB Pilot Testing
- Baseline and periodic soil and groundwater sampling
- Installation of mini-wells via Direct Push Technology (DPT) and well development
- IDW Management (collection, characterization, and disposal)

NOTE: The DBB Pilot Testing task will be performed by a subcontractor, who is the owner of the technology that will be used. The subcontractor is therefore expected to be familiar with the specific tasks and operations that will be involved in this activity and to effectively accomplish hazard recognition, evaluation, and control, and also will be expected to address OSHA HAZWOPER and other requirements as they apply to the nature of their work.

See Sections 4.0 and 5.0 of this HASP or the Work Plan for more detailed descriptions of the tasks to be performed.

Compliance: The elements of this HASP are intended to be in compliance with the requirements established by:

- OSHA 29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response" (HAZWOPER)
- Applicable sections of 29 CFR 1926 "Safety and Health Regulations for Construction."
- Tetra Tech NUS Health and Safety Program

This HASP must be accompanied by the Tetra Tech NUS, Inc. Health and Safety Guidance Manual (TtNUS HSGM). The Guidance Manual provides additional information in the areas of program support, standard operating procedures, and safe work practices.

Modifications/Changes: This HASP has been prepared using the latest available information regarding known or suspected chemical contaminants and potential and foreseeable physical hazards associated with the planned work at the NEX Service Station area of NAS Brunswick. The following conditions are considered sufficient basis for review and possible changes to this document

- The addition or modification of activities/tasks outside of those specified in Section 4.0, Scope of Work.
- New information becomes available through the course of the investigation or from outside sources.

All changes to this HASP will be requested through the Project Manager (PM) to the Tetra Tech NUS Health and Safety Manager (HSM). It is the responsibility of the PM to notify all affected personnel of all changes to this HASP.

1.1 KEY PROJECT PERSONNEL AND ORGANIZATION

This section defines responsibilities for site safety and health for TtNUS and subcontractor employees conducting environmental sampling and other field activities. Personnel assigned to these positions shall exercise the primary responsibility for on site health and safety. These persons will be the primary point of contact for any questions regarding the safety and health procedures and the selected control measures.

- The TtNUS PM is responsible for the overall direction of health and safety for this project.

- The PHSO is responsible for the development of this HASP in accordance with applicable OSHA regulations as specified in Section 1.0 and to serve as technical support.

- The TtNUS Field Operations Leader (FOL) is responsible for implementation of the HASP with the assistance of an appointed SHSO. The FOL manages field activities, executes the work plan, and enforces safety procedures as applicable to the work plan.

- The SHSO supports site activities by advising the FOL on all aspects of health and safety on site as they may pertain to regulatory requirements or task related hazards. These duties may include:

  - Verify training and medical status of on-site personnel in relation to site activities.
  - Assist and represent TtNUS coordinating emergency services (if needed)
  - Provide elements site-specific training for on site personnel.
  - Coordinating health and safety activities
  - Selecting, applying, inspecting, and maintaining personal protective equipment
  - Establishing work zones and control points
  - Implementing air monitoring procedures
  - Implementing hazard communication, respiratory protection, and other associated safety and health programs

- Compliance with the requirements stipulated in this HASP is monitored by the SHSO and coordinated through the TtNUS CLEAN HSM.

- TtNUS and Subcontractor employees are responsible for:

  - Following direction provided in this HASP, HSGM, and as provided under the direction of the SHSO and/or FOL.
  - Reporting unsafe conditions to the FOL and/or SHSO.

Note: In some cases one person may be designated responsibilities for more than one position. For example, on this project the FOL may also be responsible for the SHSO duties. This action will be performed only as credentials, experience, and availability permits.

1.2 SITE INFORMATION AND PERSONNEL ASSIGNMENTS

Site Name: NEX Service Station
NAS Brunswick
Address: Brunswick, Maine

Client Contact: Brian Helland (RPM)
Phone Number: (610) 595 - 0567
Site Contact: Tony Williams
Phone Number: (207) 921 – 1719

Purpose of Site Visit: Denitrification-Based Pilot Testing for remediation of Gasoline Range Organics.

Proposed Dates of Work: July 2004 until complete

Project Team:

TtNUS Personnel:	Discipline/Tasks Assigned:	Telephone Number
Liyang Chu	Project Manager (PM)	(978) 658-7899
Craig Sanchez	Field Operations Leader (FOL)	(978) 658-7899
Matthew M. Soltis, CIH, CSP	Health and Safety Manager (HSM)	(412) 921-8912
Thomas M. Dickson, CSP	Project Health and Safety Officer (HSM)	(412) 921-8457
Chuck Race/Lucy Guzman	Site Health and Safety Officer (SHSO)	(978) 658-7899

Non-TtNUS Personnel:	Affiliation/Discipline/Tasks Assigned
Geovations Technology, Inc.	DBB Pilot Test Subcontractor
TBD	DPT Subcontractor
TBD	Surveyor

Hazard Assessment (for purpose of 29 CFR 1910.132) for HASP preparation has been conducted by:

Matthew M. Soltis, CIH, CSP

2.0 EMERGENCY ACTION PLAN

2.1 INTRODUCTION

This section of the HASP is part of a preplanning effort to direct and guide field personnel in the event of an emergency. The first measure in accomplishing this objective is to define, what is and is not, an emergency.

An emergency as defined in 1910.120 is:

> *An occurrence or condition that can or has resulted in an uncontrolled release of a hazardous substance or potential safety hazard (i.e., fire, explosion, chemical exposure) associated with that release.*

An incidental release as defined in 1910.120 is:

> *The releases of a hazardous substance that can be absorbed, neutralized, or otherwise controlled and will not result in potential safety hazard (i.e., fire, explosion, chemical exposure) are not considered emergency responses.*

Based on the above definitions, TtNUS will provide through on-site resources initial incident response measures for incidents such as:

- Initial fire-fighting support and prevention
- Initial spill control and containment measures and prevention
- Removal of personnel from emergency situations
- Provision of initial medical support for injury/illness requiring only first-aid level support
- Provision of site control and security measures as necessary

Incidents and conditions above this level of participation are and will be considered emergencies. These events are considered beyond the capabilities of field personnel and above available resources to provide emergency response safely. The emergency response agencies listed in this plan are capable of providing the most effective response, and as such, will be designated as the primary responders in the event of an emergency. These agencies are located within a reasonable distance from the area of site operations, which ensures adequate emergency response time.

This Emergency Action Plan (EAP) conforms to the requirements of 29 CFR 1910.38(a), as allowed in 29 CFR 1910.120(l)(1)(ii).

The FOL and/or the SHSO are responsible for this EAPs implementation. Any and all questions should be directed to them for clarification.

2.2 PRE-EMERGENCY PLANNING – RECOGNITION AND PREVENTION

The primary focus of this section is the ability to recognize and control factors that could contribute to an incident/emergency situation and/or condition. Situations and/or conditions recognized that could lead to an incident/emergency situation include

Physical Hazards

- DPT activities
  - Struck by – Movement in and around operating equipment; pressurized systems
  - Noise
  - Injury caused by unsafe lifting or carrying activities
  - Contact with overhead or underground energized sources

See Section 6.2 Physical Hazards, Table 5-1 Monitoring Well Installation, and Section 9.0 Site Control for identified control measures to minimize or eliminate these hazards.

2.2.1 General Practices – Pre-Emergency Planning

To further minimize and eliminate these potential emergency situations, emergency planning activities associated with this project, the following responsibilities are assigned to the FOL and/or the SHSO:

- The FOL and/or the SHSO will coordinate response actions with NAS Brunswick Emergency Services personnel to ensure that TtNUS emergency action activities are compatible with facility emergency response procedures. This will serve as the initial review of the Emergency Action Plan.

- Establish and maintain information at the project staging area (Support Zone) for easy access in the event of an emergency. This information includes the following:
  - Chemical Inventory (for substances used on-site), with Material Safety Data Sheets.
  - On-site personnel medical records (medical data sheets).
  - A logbook identifying personnel on-site each day.
  - Emergency notification phone numbers and maps to the hospital in site vehicles

Note: It is the responsibility of the TtNUS FOL and/or the SHSO to ensure that this information is available and present at the site.

- **Identifying a chain of command for emergency action** – The FOL and/or the SHSO will serve as Incident Commander in the event of an on-site incident. He or she will remain in this position unless the incident progresses to an emergency situation. Once emergency response crews arrive, he or she will relinquish command to the responding agency.

- **Educating site workers** - Educating site workers to the potential emergency situations that may exist and the associated control measures will be critical in early recognition and prevention. This will be accomplished through
  - Site specific training
  - Use and application of the Safe Work Permit System (See Section 10.2)
  - Daily Tool Box Meetings
  - Previewing work areas to identify, barricade, or remove physical hazards where identified.

- **Provide the necessary emergency action equipment** to control potential emergencies (i.e., safety cans for flammable liquid storage, spill containment equipment, PPE, and emergency equipment such as portable fire extinguishers).

- **Evaluate operations** to ensure that necessary measures are taken to control and/or minimize the impact of emergency situations/conditions. This includes actions such as, but not limited to, securing the necessary permits and clearances such as Utility and Excavation Clearances; ensuring equipment and resources are at the ready for response to incidental measures; ensuring that personnel are adequately trained in the provisions of this HASP and this Emergency Action Plan; enforcing the use and application of prescribed PPE and safe work practices, where and as applicable.

Field Crew shall:

- Identify, remove, or barricade physical hazards within the estimated work area identified by the FOL and/or the SHSO.
- Follow the guidelines for control of emergency conditions
- Report any potential emergency situation to the FOL and/or the SHSO.

2.3 SAFE DISTANCES AND PLACES OF REFUGE/EMERGENCY ALERTING AND ACTION/RESPONSE PROCEDURES

TtNUS and subcontractor personnel may be working in close proximity to each other at the site. As a result, hand signals, two-way radio communications, voice commands, line of sight communication, and/or cell phones will be sufficient to alert site personnel of an emergency. If an emergency warranting evacuation occurs, the following procedures are to be initiated:

- Initiate the evacuation via radio communications, hand signals, voice commands, line of sight communication, or cell phones.

- Non-essential personnel will report to the designated refuge point, designated personnel will initiate incidental response procedures to control the situation. In support of this activity, the FOL will identify 2-person teams who will be designated to respond and initiate incidental response measures. The same 2-person team may serve multiple position (fire, spill response, etc.). The identified personnel will familiarize themselves with the applicable emergency action procedures and equipment to insure they are prepared for incidental response.

- Describe to the FOL (FOL will serve as the Incident Coordinator) pertinent incident details.

In the event that site personnel cannot mitigate the hazardous situation, the FOL and SHSO will enact emergency notification procedures to secure additional assistance in the following manner:

- Dial 911 (outside services) and call other pertinent emergency contacts listed in Table 2-1 and report the incident. Give the emergency operator the location of the emergency, the type of emergency, the number of injured, and a brief description of the incident. Stay on the phone and follow the instructions given by the operator. The operator will then notify and dispatch the proper emergency response agencies.

2.3.1 Critical Operations

There are no operations being conducted under this scope of work that are considered critical and would require an individual or individuals to man during an emergency. Therefore in the event of an emergency all personnel will cease all operations and report to the safe place of refuge.

2.4 DECONTAMINATION PROCEDURES/EMERGENCY MEDICAL TREATMENT

During an evacuation, decontamination procedures will be performed only if doing so does not further jeopardize the welfare of site workers. However, it is unlikely that an emergency would occur which would require workers to evacuate the site without first performing decontamination procedures. Decontamination of medical incidents/emergencies will proceed in the following manner.

2.4.1 Non-Life Threatening Medical Incident (Bruises, Cuts, Scrapes, Etc.)

The area of clothing or suit penetration will be isolated from the decontamination procedure by removing the protective garments or clothing surrounding the area of the injury and applying a light gauze wrap and plastic cover. Decontamination for unaffected areas will proceed as per Table 5-1 of this HASP.

2.4.2 Life Threatening

- Engage Emergency Notification Sequence
- Notify off-site response agencies.
- If it will not endanger the injured individual (i.e., spinal cord injury, etc.) remove any outer PPE. Removal may require the use of bandage scissors to remove the outer garments.
- Begin life saving techniques as appropriate (CPR, cooling or warming regimens, etc.).
- Cover the injured in a blanket to prevent the onset of shock.
- Follow instructions provided in Figure 2-1 and Attachment I.

Note: One person from the field team will accompany the injured to the hospital with his/her medical data sheet, appropriate MSDSs (if applicable), a copy of this HASP, and the incident forms. This person will collect as much information as possible, and transfer that information to the HSM and WorkCare as per the Incident Response Protocol provided in Figure 2-1. All other personnel will engage site control/site security measures.

2.4.3 Emergency Medical Treatment

Only personnel having current training and certification will be permitted to offer First-Aid/CPR assistance. It should also be noted all first aid shall be administered voluntarily. All First-Aid provided will incorporate the following protective measures:

FIGURE 2-1
EMERGENCY RESPONSE PROTOCOL

The purpose of this protocol is to provide guidance for the medical management of injury situations.

In the event of a personnel injury or accident:

- Rescue, when necessary, employing proper equipment and methods.
- Give attention to emergency health problems -- breathing, cardiac function, bleeding, and shock.
- Transfer the victim to the medical facility designated in this HASP by suitable and appropriate conveyance (i.e. ambulance for serious events)
- Obtain as much exposure history as possible (a Potential Exposure report is attached).
- If the injured person is a Tetra Tech NUS employee, call the medical facility and advise them that the patient(s) is/are being sent and that they can anticipate a call from the WorkCare physician. WorkCare will contact the medical facility and request specific testing which may be appropriate. WorkCare physicians will monitor the care of the victim. Site officers and personnel should not attempt to get this information, as this activity leads to confusion and misunderstanding.
- Call WorkCare at 1-800-455-6155 and enter Extension 109 or follow the voice prompt for after hours and weekend notification and be prepared to provide:
  - Any known information about the nature of the injury.
  - As much of the exposure history as was feasible to determine in the time allowed.
  - Name and phone number of the medical facility to which the victim(s) has/have been taken.
  - Name(s) of the involved Tetra Tech NUS, Inc. employee(s).
  - Name and phone number of an informed site officer who will be responsible for further investigations.
  - Fax appropriate information to WorkCare at (714) 456-2154.
  - Contact Corporate Health and Safety Department (Matt Soltis) and Human Resources (Marilyn Duffy) at 1-800-245-2730.

As data is gathered and the scenario becomes more clearly defined, this information should be forwarded to WorkCare.

WorkCare will compile the results of data and provide a summary report of the incident. A copy of this report will be placed in each victim's medical file in addition to being distributed to appropriately designated company officials.

Each involved worker will receive a letter describing the incident but deleting any personal or individual comments. A personalized letter describing the individual findings/results will accompany this generalized summary. A copy of the personal letter will be filed in the continuing medical file maintained by WorkCare.

FIGURE 2-1 (continued)
WORKCARE

POTENTIAL EXPOSURE REPORT

Name: _____ Date of Exposure: _____

Social Security No.: _____ Age: _____ Sex: _____

Client Contact: _____ Phone No.: _____

Company Name: _____

I. Exposing Agent

Name of Product or Chemicals (if known): _____

_____

Characteristics (if the name is not known)

Solid Liquid Gas Fume Mist Vapor

II. Dose Determinants

What was individual doing? _____

How long did individual work in area before signs/symptoms developed? _____

Was protective gear being used? If yes, what was the PPE? _____

Was their skin contact? _____

Was the exposing agent inhaled? _____

Were other persons exposed? If yes, did they experience symptoms? _____

III. Signs and Symptoms (check off appropriate symptoms)

Immediately With Exposure:

Burning of eyes, nose, or throat
Tearing
Headache Dizziness
Cough
Shortness of Breath
Chest Tightness / Pressure
Nausea / Vomiting
Weakness

Delayed Symptoms:

Weakness
Nausea / Vomiting
Shortness of Breath
Cough
Loss of Appetite
Abdominal Pain
Headache
Numbness / Tingling

IV. Present Status of Symptoms (check off appropriate symptoms)

Burning of eyes, nose, or throat
Tearing
Headache
Cough
Shortness of Breath
Chest Tightness / Pressure
Cyanosis
Nausea / Vomiting
Dizziness
Weakness
Loss of Appetite
Abdominal Pain
Numbness / Tingling

Have symptoms: (please check off appropriate response and give duration of symptoms)

Improved: _____ Worsened: _____ Remained Unchanged: _____

V. Treatment of Symptoms (check off appropriate response)

None: _____ Self-Medicated: _____ Physician Treated: _____

Emergency medical treatment will be initiated under the following guarded restrictions:

- Take the necessary precautions to prevent direct contact with the injured person's body fluids. This may be accomplished through the employment of the following measures:
  - Use surgeons gloves when handling cuts, abrasions, bites, punctures, etc. or any part of the injured person. The use of safety glasses and surgeons masks is recommended, if there is the potential for uncontrolled spread of body fluids. The PHSO will be immediately notified in event that personnel providing emergency first-aid come into contact with body fluids or other potentially infectious tissues.
  - Should Cardio-Pulmonary Resuscitation (CPR) be required, use a CPR Micro-Shield mouthpiece when administering CPR to prevent contact with the injured person's body fluids.

In order to engage these protective measures the FOL shall insure that these items are part of their first-aid kit.

2.4.4 Mishap Report/Injury/Illness Procedure

The SHSO upon insuring care for the injured party, securing damaged equipment, and/or controlling property damage will engage an investigation of the incident to gather as much information as possible. This includes as a minimum answering the questions Who? What? Where? When? Why? and How?. This information will then be communicated to the NAS Brunswick Client Contact – Mr. Brian Helland Fields, the PM, and the HSM. The Tetra Tech NUS, Inc. Injury/Illness Procedure is provided in Attachment I and IA, respectively, and must be completed and submitted in accordance with the instructions in that procedure.

2.5 EMERGENCY CONTACTS

Prior to performing work at the site, all personnel will be thoroughly briefed on the emergency procedures to be followed in the event of an incident. A mobile/cellular phone shall be available on site. It will be the responsibility of the FOL and/or the SHSO to test or otherwise insure that the signal strength is sufficient to contact emergency services. If it is not, then a different provider, two way radios, or other supported means of communication will be utilized. Table 2-1 provides a list of emergency contacts and their corresponding telephone numbers. This table must be posted on site where it is readily available to all site personnel or provided to site personnel.

TABLE 2-1

EMERGENCY CONTACTS
NAS BRUNSWICK, MAINE

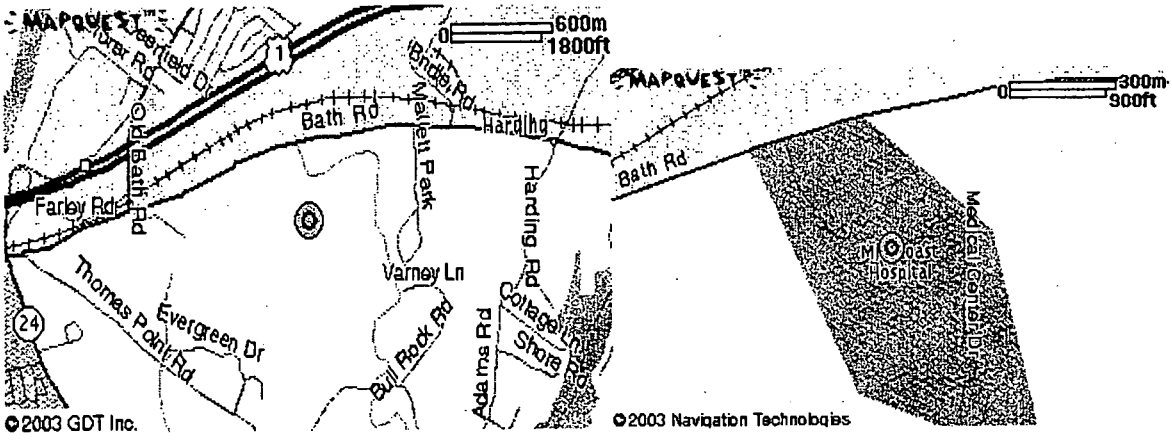
AGENCY	TELEPHONE
EMERGENCY	**911**
Ambulance service: Base Clinic (**Note**: Base Clinic can provide limited first responder emergency care)	(207) 921-3333
Primary Hospital: Mid Coast Hospital 123 Medical Center Drive, Brunswick, ME 04011	911 or (207) 729 - 0181
Alternate Hospital: Parkview Hospital 329 Maine St Brunswick, ME 04011	911 or (207) 373 - 2000
Chemtrec	(800) 424 - 9300
National Response Center	(800) 424 - 8802
Dig Safe System, Inc.	(888) 344 - 7233
Northern New England Poison Center	(800) 222 - 1222
Client Contact, Brian Helland, RPM	(610) 595 - 0567
Base Security: Nola Hitchcock	(207) 921 – 2457
Base Safety Office: John Bond	(207) 921 - 1319
Base Fire Department: Don Barter	(207) 921 - 1676
Project Manager, Liyang Chu	(978) 658 - 7899
Project Health and Safety Officer, Tom Dickson, CSP	(412) 921 - 8457
CLEAN Health and Safety Manager, Matthew M. Soltis, CIH, CSP	(412) 921 - 8912

Figure 2-2

Route to Hospital

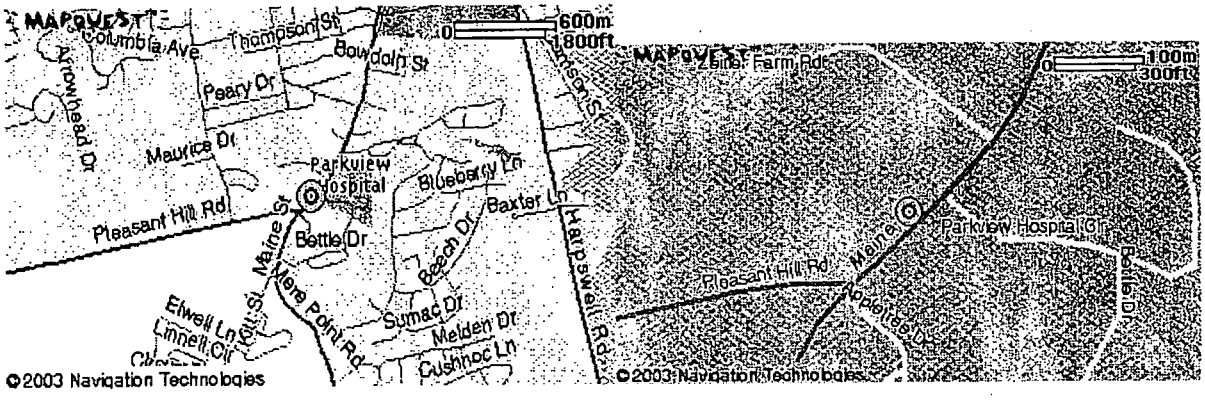
Directions to Mid Coast Hospital:

- From Cooks Corner, turn Right (East) on Old Bath Road/ME - 24. Travel approximately 4 miles
- Turn right (South) onto Medical Center Drive. Travel 0.4 miles.
- Hospital is at 123 Medical Center Drive



Directions to Parkview Hospital:

- From Cooks Corner, turn Left (West) on Bath Rd./ME – 24. Travel approximately 2 miles
- Turn slight Right onto Main Street/ME – 24 West. Travel 0.1 mile
- Turn Left onto Cleveland Street. Travel 0.1 mile.
- Hospital is at 329 Main Street



2.6 PPE AND EMERGENCY EQUIPMENT

The following equipment will be maintained on-site and be immediately accessible to support incidental response measures

First-aid kit(s) – The SHSO will determine the number of kits necessary based on the number of segregated operations.

Eye wash units (or bottles of disposable eyewash solution) - The SHSO will determine the number of units are necessary based on the number of segregated operations. Currently, at a minimum eye wash units are required at the monitoring well installation (handling Portland Cement during well construction which is caustic) and at groundwater sampling operations which handle corrosives (preservatives) as part of the sampling function. The SHSO will make a determination if any additional units are required based on the nature of the operation.

Fire extinguishers (strategically placed) will be maintained onsite and be immediately available for use in the event of an emergency. Again as above the SHSO will make a determination as to how many units are required based on activities requiring this support.

Spill Prevention Equipment – See Section 9.2 and 9.7 for additional details.

3.0 SITE BACKGROUND

3.1 SITE HISTORY AND CURRENT OPERATIONS

NASB is located in Brunswick, Cumberland County, which is situated near the southern coastal area of Maine. NASB is situated just south of the Androscoggin River and is located north of several coves (Harpswell, Buttermilk, and Woodward), which connect with Casco Bay. NASB is located approximately 20 miles northeast of Portland. NASB is an active military base and is owned and operated by the federal government through the Department of the Navy.

The NEX Service Station (Building 538) is located within NASB and is situated just north of the intersection of Second Street and Burbank Avenue. The fueling island is situated just south of Building 538, and three underground storage tanks (USTs) are located east of the NEX Service Station. The NEX Service Station is bordered to the west by Second Street and the Public Works Department's vehicle motor pool. The NEX shopping complex (Building 11) is located approximately 100 feet northeast of the three USTs. To the north, Building 538 is adjoined to Building 295, the water pump house with a mounded water tank. The Family Services Center (Building 27) is situated approximately 100 feet southeast of the NEX Service Station, across Burbank Avenue.

3.2 HISTORY OF INVESTIGATION AREAS

Gasoline odors were detected at the NEX Service Station in 1981. Petroleum product odors were then reported by the occupants of the Family Services Center (Building 27), situated downgradient of the NEX Service Station, in 1983. Periodic complaints concerning petroleum product odors ensued. Reportedly, there has been a history of problems associated with the petroleum product bulk storage at the NEX Service Station. Petroleum product releases appear to have been related to corrode steel product lines that were in use from 1975 through early 1992. There have been indications that additional gasoline releases may have occurred after the installation of the existing fiberglass USTs and product line system between 1992 and 1993; however, these indications have not been confirmed.

In 1987, NASB was placed on the National Priorities List by the U.S. Environmental Protection Agency (EPA) and is currently participating in the Navy's Installation Restoration Program.

Past remedial actions have included the installation of a groundwater recovery system to address gasoline odors in Building 25 and 27 (Building 25 has been demolished and removed). This recovery system was decommissioned during 1993. A soil vapor extraction/aquifer air sparing (SVE/AAS) system was installed and operated continuously from 1993 until March 2002. Other past response actions included the

excavation and removal of approximately 400 tons of petroleum product-contaminated soil during replacement of three steel USTs in 1992. Also in 1992, approximately 40 tons of petroleum product-contaminated soil were removed during the replacement of three buried, corroded steel product lines. Several remediation pilot tests have also been performed, with limited success.

Based on previous DPT sampling activities at this site, total petroleum hydrocarbons/gasoline range organics (TPH-GRO) are considered to be the primary contaminant of concern. Two separate and distinct source areas have been identified at the NEX, including the fueling island source area and the UST-related source area.

In 2004, this site went through a Corrective Action Plan (CAP) process. As a result, there were two proposed remedial actions:

1. Short-term remediation of petroleum hydrocarbon contamination present at the northwest corner of the Family Services Center (Building 27) and the elimination of potential vapor intrusion into the building.
2. Long-term remedial action and monitoring goals to address hydrocarbon contaminants at the NEX Service Station.

This DBB pilot test is being performed to assess its effectiveness prior to designing a full-scale treatment program for the remainder of the petroleum hydrocarbon contamination. The CAP indicated that priority would be given to the area immediately upgradient of (and below) the northwest foundation corner of Building 27 during DBB treatment.

Petroleum contamination at the NEX Service Station appears to consist primarily of residual, weathered gasoline constituents, resulting from leaking product lines during 1980-1992. However, at the time of the preparation of this HASP, insufficient information was available on the concentrations of TPH-GRO that may be expected to be encountered at the two source areas. As additional information becomes available, it will be evaluated and this HASP may be modified (if/as necessary).

4.0 SCOPE OF WORK

The following subsections discuss the specific tasks that are to be conducted as part of this scope of work as identified by CTO 0014. Only the tasks mentioned below are addressed by this HASP. Any additions or modifications to this task listing will be considered a change in scope review and possible modification of this HASP. The PM is responsible for notifying the HSM in the event of any such task additions or modifications.

- Mobilization/demobilization
- In-situ permeability testing (conductivity testing in existing and newly-installed monitoring wells)
- Sample location survey
- Installation of mini-wells via Direct Push Technology (DPT) and well development
- DBB Pilot Testing
- Baseline and periodic soil and groundwater sampling
- IDW Management (collection, characterization, and disposal)
- Decontamination

For more detailed description of the associated tasks, refer to the Work Plan (WP).

5.0 TASKS/HAZARDS/ASSOCIATED CONTROL MEASURES

Table 5-1 serves as one of the primary portions of this site specific HASP. This table is intended to summarize the recognized hazards, hazard evaluation methods, and recommended control measures necessary to minimize potential for exposure or injuries related to those hazards. The table also assists field team members in determining which personal protective equipment (PPE) and decontamination procedures are to be used as well as appropriate air monitoring techniques and action levels.

Safe Work Permits will be issued for all activities (See Section 10.2). The FOL and/or the SHSO will use the elements defined in Table 5-1 as the primary reference. The FOL and/or the SHSO completing the Safe Work Permit will add additional site-specific information as warranted.

The following text provides a summary description of the tasks to be conducted and are the basis for the hazard assessment.

5.1 MOBILIZATION/DEMOBILIZATION

This task includes, but not limited to, the following

- The procurement and shipping of equipment, and materials for the field investigation.
- Review of planning documents (i.e., HASP, Sampling and Analysis Plan, Work Plan, Quality Assurance Plan, etc.)
- Site Reconnaissance to include site characterization, site preparation, arrange for site access, securing the necessary utility clearances and isolate physical hazards, where applicable.
- Secure, construct, or equip decontamination facilities to support the field activities.

Physical Hazards – The hazard types associated with this task are considered primarily to be Physical hazards – Lifting, strains/sprains, lacerations achieved during unpacking of equipment and during site preparation (i.e., cutting open boxes, lifting equipment, locating sample points).

Chemical Hazards - It is not anticipated that personnel will be exposed to chemical hazards during this task. The FOL and/or the SHSO will establish the site-specific Hazard Communications Program to address potential chemical hazards of chemicals brought on-site. See Section 5.0 of the HSGM.

5.2 IN-SITU PERMEABILITY TESTING

This testing will be performed at up to seven existing monitoring wells and mini-wells at the proposed testing area. The objective of this testing will be to determine the in-situ permeability (i.e., hydraulic

conductivity) of the soils and overburden materials. This will be accomplished via slug testing and through the use of 0.7" diameter electronic transducer and data logger.

Physical Hazards – Lifting, strains/sprains, insect bites, contact with poisonous plants, exposure to the elements.

Chemical Hazards – Contact with GRO-contaminated media (groundwater).

5.3 MONITORING WELL INSTALLATION AND SOIL SAMPLING VIA DIRECT PUSH TECHNOLOGY (DPT)

There have been several employee hand cut injuries reported that have resulted from improperly obtaining soil samples from DPT operations. To prevent a recurrence of these types of injuries, soil sampling from DPT operations **must** involve the use a GeoProbe Sampling Kit and the concurrent use of cut-resistant gloves.

The following Safe Work Practices are to be followed when working in or around DPT operations.

5.3.1 Before Conducting DPT Operations

- Identify all underground utilities and buried structures before drilling. Follow the TtNUS SOP on Utility Locating and Excavation Clearance Standard Operating Procedure (see Attachment II).

- The SSO (or designee) will inspect all DPT rigs prior to the acceptance of the equipment at the site and prior to its first use. Any repairs or deficiencies identified during this pre-inspection will be corrected prior to use. The inspection will be accomplished using the Equipment Inspection Checklist provided in Attachment III. Additional inspections will be performed at least once every 10-day shift or following repairs.

- The work area around the point of operation will be graded to the extent possible to remove any trip hazards near or surrounding operating equipment.

- The DPT helper will establish an equipment staging and lay-down plan. The purpose of this is to keep the work area clear of clutter and slips, trips, and fall hazards.

- All potentially contaminated tooling will be wrapped in polyethylene sheeting for storage and transport to the centrally located decontamination unit.

5.3.2 During DPT Operations

- Minimize contact to the extent possible with contaminated tooling and environmental media.
- Support functions (sampling and screening stations) will be maintained a minimum distance from the rig of the height of the mast plus five feet.
- Only qualified operators and knowledgeable ground crew personnel will participate in the operation of the DPT rig.
- In order to minimize potentials for injury from lifting hazards, multiple personnel should move heavy tooling, where necessary.
- Only personnel absolutely essential to the work activity will be allowed in the exclusion zone. Site visitors will be restricted from work areas and will be escorted at all times.

5.3.3 After DPT Operations

- All equipment used within the exclusion zone will undergo a complete decontamination and evaluation by the SSO to determined cleanliness prior to moving to the next location, exiting the site, or prior to down time for maintenance.
- All motorized equipment will be fueled prior to the commencement of the day's activities. During fueling operations all equipment will be shutdown and bonded to the fuel provider.
- When not in use all rigs will be shutdown, emergency brakes set, and wheels chocked.
- All areas subjected to subsurface investigative methods will be restored to equal or better condition than original to remove any contamination brought to the surface and to remove any physical hazards. In situations where these hazards cannot be removed these areas will be barricaded to minimize the impact on field crews working in the area.

5.4 MONITORING WELL DEVELOPMENT/SAMPLING

5.4.1 Monitoring Well Development

The development of the monitoring wells is intended to remove debris associated with installation and to condition the sand pack to facilitate contact with the surrounding aquifer. Monitoring well development is typically accomplished using surge blocks and pumps to force water in and out of the sand pack and

formation. Removal of the debris flushed through the surging action is typically accomplished using 1" inch Whale Pumps with 12-volt battery. Development entails the removal of specified water volumes as well as any debris.

Physical Hazards – Lifting, strains/sprains, insect bites, contact with poisonous plants, exposure to the elements.

Chemical Hazards – Contact with GRO-contaminated media (groundwater).

5.4.2 Monitoring Well Groundwater Sampling (Baseline and Periodic)

The monitoring wells will be sampled using peristaltic pumps and dedicated ¼" Teflon-lined tubing to purge the wells. Field measurements will be taken of water level, pumping rate, DO, ORP, pH, temperature, specific conductance, and turbidity. These measurements will be taken at the start of purging and every 3 to 5 minutes (as appropriate). All tubing used for sampling will be dedicated and disposed of after the sample has been collected. Ground water samples will be taken from the dedicated well tubing.

Physical Hazards – Lifting, strains/sprains, insect bites, contact with poisonous plants, exposure to the elements.

Chemical Hazards – Chemical exposure with GRO-contaminated media (groundwater) via:

- Direct contact - Splash - Contaminant exposure based on direct interaction with contaminated media through possible splash.

- Inhalation – Some wells due to chemical contaminants or biological degradation may build gases within the headspace. When a field crew member opens the well they maybe exposed to vapors/gases coming out of the well as well as be exposed to the pressure related hazard. To control exposure we limit the proximity of the technician to the well head as well as the amount of time he or she remains there.

- Ingestion – Due to handling of equipment, sample media, and improper work hygiene could result in the ingestion of identified site contaminants.

- Sample preservatives/decontamination solutions – Certain chemicals will be brought on-site in support of this field investigation effort. The chemical hazard classes include corrosives and flammable liquids.

See Section 6.1 for potential health effect information due to chemical exposure. See also the Site Specific Hazard Communication Program for controlling hazards as it pertains to chemical substances brought on-site.

5.5 GEOGRAPHICAL SURVEYING

This activity is generally non-intrusive in nature. Vertical elevations and horizontal locations will be taken from the ground surface at well and soil sampling locations.

Physical Hazards associated with this task includes

- Traffic hazards – These sites are located within very active industrial areas. This hazard may be exacerbated depending on where the surveyors must carry their control points from.
- Trips and Falls – This hazard is considered due to uneven ground (curb sides, hill sides) and potentially slippery surfaces.

5.6 DECONTAMINATION

The equipment involved in the field activities for well installation and sampling will be decontaminated prior to, during and after the completion of on-site activities.

5.6.1 Heavy Equipment

Heavy equipment decontamination will be accomplished using a pressure washer and/or steam cleaner within an established temporary decontamination pad.
Procedural steps are as follows

1. Remove gross (visible) materials using scrapers, shovels as necessary (soils, etc.)
2. Use the pressure washer/steam cleaner remove remaining visible debris.
3. As necessary, follow up with scrub brushes with Alconox or Liquinox detergent wash.
4. Potable water rinse using pressure washer/steam cleaner as necessary
5. Solvent rinse (Isopropanol) – This application will only pertain to the sample collecting media.
6. DI water rinse
7. Air dry

5.6.2 Sampling Equipment

All non-dedicated sampling equipment (i.e. stainless-steel hand augers, trowels, bowls) will be decontaminated prior to the initiation of field sampling, between sample locations, and at the completion of the field activities. The following decontamination steps will be taken.

1. Remove heavy materials (soils, etc.)
2. Alconox or Liquinox detergent wash
3. Potable water rinse
4. Solvent rinse (Isopropanol)
5. DI water rinse
6. Air dry

All dedicated sampling and PPE equipment will be rinse to remove gross contamination and then disposed of.

Physical Hazards associated with this activity include

- Water cuts/lacerations/burns – One of the most severe hazards associated with decontamination operations is associated with the water pressure generated by the pressure washers. This hazard is compounded by the elevated temperatures associated with high pressure steam cleaners. An Incident has occurred where a person has placed the pressure wand on their boot and accidentally compressed the trigger resulting in burns and water lacerations of the foot.
- Noise – Operating level of the pressure washer/steam cleaners typically operate at 94-97 dBA when engaged.

Chemical Hazards associated with this activity include

- Exposure to contaminated media - Negligible
- Exposure to decontamination solvents - Negligible

5.7 DBB PILOT TESTING

This patented, anaerobic biodegradation process involves the injection of nitrate-based reagents to promote the degradation of organic compounds (including aromatics such as those associated with GRO) in soil and groundwater. The byproducts of this process include carbon dioxide, nitrogen gas, and water. This will be accomplished by adding the proprietary product "Geovation N-Blend" nitrate and nutrient solution. This is a nitrogen-based reagent which will be added into existing mini-wells, and into the

additional new mini-wells installed as part of this project. The handling and dispensing of this product during the DBB pilot test and during ten Major Additions will be performed by the license holder of this proprietary technology (Geovation Technologies, Inc.). This will involve the introduction of up to 300 gallons of the N-Blend product for each of the major treatment tasks. These large quantities will be delivered in bulk by Geovation via skid rig, and directly applied from the skid rig into the selected treatment wells. A second application method involves refilling a delayed distribution system that can "meter out" the N-Blend over an approximate one-month time frame. This second method may involve either manual additions using 5-gallon carboys or an automated system using 5-gallon stainless steel canisters that are plumbed together. **(Note: If the automated system is used, some shallow excavation tasks may become necessary as part of the system installation. In that event, this HASP will be modified to address excavation safety issues).**

Smaller N-Blend applications ("minor additions") will be performed by TtNUS personnel, who have been trained by the license-holding firm. This training will include appropriate attention to health and safety matters, including addressing OSHA Hazard Communication requirements. This will involve manual, direct application of 1 to 5 gallons of the N-Blend product to selected DBB treatment injection points.

Physical Hazards – Lifting, strains/sprains, insect bites, contact with poisonous plants, exposure to the elements.

Chemical Hazards – Contact with N-Blend product and/or GRO-contaminated media (groundwater).

5.8 INVESTIGATIVE DERIVED WASTE MANAGEMENT

This task includes the containerization, labeling, staging, monitoring, characterization, and final deposition of investigative derived wastes. These are as follows:

Containerization – Materials generated including soils, purge and development waters, and decontamination fluids shall be collected and containerized in 55-gallon drums and then staged in a temporary storage facility.

Labeling – All containers will be labeled as to their contents.

Staging – All drums will be staged on pallets (maximum 4 drums to a pallet) with lid retention ring bolt accessible on the outside as well as the label. Pallet rows will maintain a minimum of 4 feet between rows for access and monitoring for leaks. Containers will be separated according to media and site.

Monitoring – During staging site personnel will examine containers to ensure they are not leaking.

Characterization – Collection of samples from IDW containers in order that contents can be characterized for proper transportation and disposal.

Final Deposition – Waste materials will be separated as determined through sampling and disposed of through pre-determined routes.

Physical Hazards associated with this IDW activity include:

- Caught between pinches and compressions. This occurs primarily when moving containers to transport vehicles and when staging the drums on pallets. The prevalent hazard is recognized when moving the drums and hands get caught between drums.

- Lifting – Drums of water can weigh upwards of 475 lbs. Drums of wet soil can weigh up to 750 lbs.

Chemical Hazards would involve contact with (presumed diluted) site contaminants. However, given the nature of GRO contaminants, exposure to concentrations that could represent a health concern are considered to be unlikely.

5.9 GENERAL SAFE WORK PRACTICES

In addition to the task-specific safe work practices identified in Table 5-1 to be employed to minimize task specific hazards, the following general safe work practices will be employed. These safe work practices establish a pattern of general precautions and measures for reducing risks associated with hazardous site operations.

- Refrain from eating, drinking, chewing gum or tobacco, taking medication, or smoking in contaminated or potentially contaminated areas or where the possibility for the transfer of contamination exists.

- Wash hands and face thoroughly upon leaving a contaminated or suspected contaminated area. This is especially critical between breaks and prior to lunch and associated hand to mouth activities.

- Avoid contact with potentially contaminated substances by walking around puddles, pools, mud, or other such areas. Avoid, whenever possible, kneeling on the ground or leaning or sitting on equipment. Do not place monitoring equipment on potentially contaminated surfaces.

- Be familiar with and adhere to all instructions provided within this site-specific HASP.
- Be aware of the location of the nearest telephone and all emergency telephone numbers. See Section 2.0, Table 2-1.
- Attend briefings on anticipated hazards, equipment requirements, Safe Work Permits, emergency procedures, and communication methods before going on site.
- Plan and mark entrance, exit, and emergency escape routes. See Section 2.0.
- Rehearse unfamiliar operations prior to implementation.
- Use the "buddy system".
- Maintain visual contact with each other and with other on-site team members by remaining in close proximity in order to assist each other in case of emergency.
- Establish appropriate Safety Zones including Support, Contamination Reduction, and Exclusion Zones.
- Minimize the number of personnel and equipment in contaminated areas (such as the Exclusion Zone). Non-essential vehicles and equipment should remain within the Support Zone.
- Establish appropriate decontamination procedures for leaving the site.
- Immediately report all injuries, illnesses, and unsafe conditions, practices, and equipment to the Site Health and Safety Officer (SHSO).
- Matches and lighters are restricted from entering in the Exclusion Zone or Contamination Reduction Zone. Smoking will only be permitted in specified areas at Site 4.
- Observe coworkers for signs of toxic exposure and heat or cold stress.

TABLE 5-1
TASKS/HAZARDS/CONTROL MEASURES
HEALTH AND SAFETY PLAN
NAVY EXCHANGE SERVICE STATION
NAVAL AIR STATION, BRUNSWICK, MAINE

Task/Operation/ Location	Anticipated Hazards	Recommended Control Measures	Hazard Monitoring - Types and Action Levels	Personal Protective Equipm nt *(Items in italics are deemed optional as conditions or the FOL or SHSO dictate.)*	Decontamination Procedures
Mobilization/ Demobilization This activity includes, but not limited to: - Equipment Preparation and Inspection - Resource acquisition and unpacking of supplies - Site clearance and preparation – Utility clearances, etc. - Construct decontamination and IDW operation and storage facilities, as applicable.	***Chemical hazards:*** 1) Exposure to identified site contaminants are not anticipated. However, potential exposure to chemicals brought on-site should be considered. ***Physical hazards:*** 2) Lifting (strain/muscle pulls) 3) Cuts and lacerations 4) Pinches and compressions/Struck by 5) Slips, trips, and falls 6) Heavy equipment hazards (swinging booms, hydraulic lines, etc.) 7) Vehicular and foot traffic ***Natural hazards:*** 8) Ambient temperature extremes (heat/cold stress) 9) Insect and animal bites 10)Inclement weather	***Chemical hazards:*** 1) The on-site Hazard Communication Program (Section 5.0 TtNUS Health and Safety Guidance Manual) will be followed. All chemicals brought onto the site by Tetra Tech NUS and subcontractor personnel will be inventoried with each applicable chemical having an MSDS on site, on file. This effort shall include • Accurate Chemical Inventory List (Entries will match chemicals brought on-site, as the names appear on the MSDS and the label) This list, which also includes quantities and storage locations will be maintained in a centralized location and made available upon request. • MSDS's will be maintained in a central location, accessible to all personnel. • All containers will have labels specifying the following information: - Chemical Identity (As it appears on the label, MSDS, and Chemical Inventory List) - Appropriate Warning (i.e., Eye and skin irritation, flammable, etc.) - Manufacturer's Name Address and Phone Number All personnel will be required to review the appropriate MSDS's if they are not familiar with the hazards of the chemicals to be used, prior to the use of a specified chemical substance. Information on hazards and PPE will be communicated on the Safe Work Permit for this task. Any specific provisions recommended by the MSDS shall be in place (i.e., eye wash, fire extinguisher, specified PPE, etc.) prior to using the chemical substance. ***Physical hazards:*** 2) Lifting **Hazards** – During mobilization/demobilization personnel are required to handle equipment, supplies, and resources in preparation for site activities. This hazard becomes more predominant in the early morning hours (prior to muscles becoming limber) and later in the day (as a result of fatigue). The following provisions shall be instituted in order to minimize hazards of this nature: • Use machinery or multiple personnel for heavy lifts, where possible. • Use proper lifting techniques - Lift with your legs, not your back, bend your knees move as close to the load as possible, and ensure good hand holds are obtainable. - Minimize the horizontal distance to the center of the lift to your center of gravity. - Minimize turning and twisting when lifting as the lower back is especially vulnerable at this time. - Break lifts into steps if the vertical distance (from the start point to the placement of the lift) is excessive. - Plan your lifts – Place heavy items on shelves between the waist and chest; lighter items on higher shelves. - Periods of high frequency lifts or extended duration lifts should provide sufficient breaks to guard against fatigue and injury. Other considerations associated with lifting injuries and muscle strains include • Area available to maneuver the lift. • Area of the lift – Work place clutter, slippery surfaces • Your Overall physical condition 3) Cuts **and lacerations** – To prevent cuts and lacerations associated with unpacking or packing equipment and supplies, during site preparation (clearing access routes), the following provisions are required: - Always cut away from yourself and others, then, if a knife slips, you will not impale yourself or others. - Do not place items to be cut in your hand or on your knee. - Change out blades as necessary to maintain a sharp cutting edge. Many accidents result from struggling with dull cutting instruments. If hand tools (brush hooks, machetes, etc.) are used to gain access to sample locations, the following precautions are recommended: - Insure handles are of good construction (no cracks, splinters, loose heads/cutting apparatus. - Insure all cutting tools are maintained. Blades shall be sharp without nicks and gouges in the blade. 4) **Pinches/Compressions/Struck By** - Do not modify tooling without manufacturer's expressed permission. - Keep any machine guarding in place, avoid moving parts. - Use tools or equipment where necessary to avoid placing hands in areas vulnerable to pinch points. - Adjust machine guarding as necessary to minimize distance between guards and point of operation. - When staging equipment, insure all stacked loads, shelving, are adequately secure to avoid creating a hazard from falling objects. 5) **Preview work locations for unstable/uneven terrain**. - Cover, guard and barricade all open pits, ditches, and floor opening as necessary. - Ruts, roots, tools, and other tripping hazards should be eliminated to minimize trips and falls. - Maintain a clutter free work area. - As part of site control efforts construct fences or other means of demarcation (i.e. signs and postings) to control and isolate traffic in the work area. Means of demarcation shall also be constructed isolating resource and/or staging areas. - Work areas greater than 6-feet above ground surface shall employ acceptable engineered fall protection (i.e. handrails and platforms) or accepted fall protection harnesses. 6) **Heavy Equipment Hazards** - All equipment will be - Inspected in accordance with OSHA and manufacturer's design. - All equipment inspection will be documented on an Equipment Inspection Checklist as provided in (See Attachment III). - Operated by knowledgeable operators and ground crew. 7) **Vehicular and Foot Traffic Hazards** - As part of site preparation activities and zone construction, when preparing traffic and equipment considerations are to include the following: - Establish safe zones of approach (i.e. Boom or mast + 5 feet). - The mast must be lowered when moving the rig. - Foot and vehicular traffic routes shall be well defined. - Heavy equipment patterns shall be isolated using fences or other suitable barricades from pedestrian pathways. - Bumpers or other suitable traffic stops shall be placed in areas where it is desired that traffic approaching a drop offs or unprotected banks. - All self-propelled equipment with restricted vision moving backwards shall be equipped with back up warning systems. - The FOL and/or the SHSO as a precautionary measure to remove or demarcate physical hazards shall preview traffic routes (foot and vehicular) before the commitment of personnel and resources. ***Natural hazards:*** 8) **Ambient Temperature Extremes** - Wear appropriate clothing for weather conditions. Provide acceptable shelter and liquids for field crews. Additional information regarding heat and cold stress is provided in Section 4.0 of the TtNUS Health and Safety Guidance Manual. 9) **Insect/Animal Bites and Stings** - - Wear light colored clothes. This will allow easier detection of ticks and insects crawling on your body. It will also assist in heat stress control. - Tape pant legs to work boots to block direct access. This is especially critical when clearing or entering heavy brush and wooded areas. - Do not stick your hand anywhere where you can't see. - When opening existing well heads be cautious of bees and spiders as these are preferred nesting locations. - Use repellents – Follow manufacturer's recommendations for use. Permanone should be applied liberally to the clothing, but not the skin as it may cause irritation. Concentrate on areas where ticks and other insects may access your body such as pant cuffs, shirt to pants, and collars. Repellants containing DEET should be applied directly to the skin. - If you leave your workboots at the trailer or office over your break make sure you shake them out before sticking your feet in them. 10) **Inclement Weather** - Suspend or terminate operations until directed otherwise by SHSO. See Section 4.0 of the TtNUS Health and Safety Guidance Manual for additional information concerning natural hazards.	Visual observation of work practices by the FOL and/or the SHSO to minimize potential physical hazards (i.e., improper lifting, unsecured loads, cutting practices, etc.). Monitoring for chemical hazards are not required during this activity.	Level D - (Minimum Requirements) - *Standard* field attire (Sleeved shirt; long pants) - Safety shoes (Steel toe/shank) - *Snake chaps(for remote and unmaintained areas)* - *Safety glasses (for moving through brush and when involved in activities that could result in flying projectiles such as hammering or chopping and clearing brush)* - *Hardhat (when overhead hazards exists, or identified as a operation requirement)* - *Reflective vest for high traffic areas* - *Hearing protection for high noise areas (At the direction of the FOL and/or the SHSO).* As site conditions may change, the following equipment will be maintained during all on-site activities as prescribed in Section 2.0 of this HASP - Fire Extinguishers - First-aid kit ***Note:*** *The FOL and/or the SHSO will determine the number of fire extinguishers and first-aid kits to be made available based on the number of operations to be conducted at any given time.*	Not required. Good personal hygiene practices should be employed prior to breaks lunch or other period when hand to mouth contact occurs. This will minimize potential ingestion exposures.

TABLE 5-1 (cont.)
TASKS/HAZARDS/CONTROL MEASURES
HEALTH AND SAFETY PLAN
NAVY EXCHANGE SERVICE STATION
NAVAL AIR STATION, BRUNSWICK, MAINE
PAGE 2 OF 8

Task/ Operation/ Location	Anticipated Hazards	Recommended Control Measures	Hazard Monitoring - Types and Action Levels	Personal Protective Equipment *(Items in italics are deemed optional as conditions or the FOL or SHSO dictate.)*	Decontamination Procedures
In-situ Permeability Testing This activity involves conductivity testing to determine permeability of the soils and overburden materials. This will involve slug testing and the use of electronic transducer and data logging devices.	***Chemical hazards:*** 1) Site contaminants of concern that may be encountered in this task include Gasoline Range Organics, and BTEX components of gasoline. Further information on these contaminants are presented in Section 6.1. ***Physical hazards:*** 2) Lifting (strain/muscle pulls) 3) Pinches and compressions/Struck by 4) Slips, trips, and falls ***Natural hazards:*** 5) Ambient temperature extremes (heat/cold stress) 6) Insect and animal bites 7) Inclement weather	***Chemical hazards:*** 1) Safe work practices will be employed as the first line of defense. As a general rule, avoid contact with contaminated media (water, soils, etc.) as a universal control measure. In addition, good work hygiene practices include avoiding hand-to-mouth contact to the extent possible, washing hands and face or using hygienic wipes to remove potential contaminants from hands and face prior to breaks or lunch or other hand to mouth activities. Subsurface media will be scanned with a PID or FID to determined potential source concentration and to monitor for inhalation exposure concerns. The greatest potential for contact exists when opening a well that has been sealed and may have gases present in the confined headspace. As a precaution, approach and sample as follows: At arms length, open the well and step away (upwind). Let the well off gas for a few minutes, while you prepare your equipment. Airborne concentrations will recede and you can continue with your task. To protect against dermal contact exposure concerns, wear specified PPE. ***Physical hazards:*** 2) Lifting **Hazards** –The following provisions shall be instituted in order to minimize hazards of this nature: • Use machinery or multiple personnel for heavy lifts, where possible. • Use proper lifting techniques - Lift with your legs, not your back, bend your knees move as close to the load as possible, and ensure good hand holds are obtainable. - Minimize the horizontal distance to the center of the lift to your center of gravity. - Minimize turning and twisting when lifting as the lower back is especially vulnerable at this time. - Break lifts into steps if the vertical distance (from the start point to the placement of the lift) is excessive. - Plan your lifts – Place heavy items on shelves between the waist and chest; lighter items on higher shelves. - Periods of high frequency lifts or extended duration lifts should provide sufficient breaks to guard against fatigue and injury. Other considerations associated with lifting injuries and muscle strains include • Area available to maneuver the lift. • Area of the lift – Work place clutter, slippery surfaces • Your Overall physical condition 3) **Pinches/Compressions/Struck By** - Do not modify tooling without manufacturer's expressed permission. - Keep any machine guarding in place, avoid moving parts. - Use tools or equipment where necessary to avoid placing hands in areas vulnerable to pinch points. 4) **Preview work locations for unstable/uneven terrain.** - Cover, guard and barricade all open pits, ditches, and floor opening as necessary. - Ruts, roots, tools, and other tripping hazards should be eliminated to minimize trips and falls. - Maintain a clutter free work area. - As part of site control efforts construct fences or other means of demarcation (i.e. signs and postings) to control and isolate traffic in the work area. Means of demarcation shall also be constructed isolating resource and/or staging areas. - Work areas greater than 6-feet above ground surface shall employ acceptable engineered fall protection (i.e. handrails and platforms) or accepted fall protection harnesses. ***Natural hazards:*** 5) **Ambient Temperature Extremes** - Wear appropriate clothing for weather conditions. Provide acceptable shelter and liquids for field crews. Additional information regarding heat and cold stress is provided in Section 4.0 of the TtNUS Health and Safety Guidance Manual. 6) **Insect/Animal Bites and Stings** - - Wear light colored clothes. This will allow easier detection of ticks and insects crawling on your body. It will also assist in heat stress control. - Tape pant legs to work boots to block direct access. This is especially critical when clearing or entering heavy brush and wooded areas. - Do not stick your hand anywhere where you can't see. - When opening existing well heads be cautious of bees and spiders as these are preferred nesting locations. - Use repellents – Follow manufacturer's recommendations for use. Permanone should be applied liberally to the clothing, but not the skin as it may cause irritation. Concentrate on areas where ticks and other insects may access your body such as pant cuffs, shirt to pants, and collars. Repellants containing DEET should be applied directly to the skin. - If you leave your workboots at the trailer or office over your break make sure you shake them out before sticking your feet in them. 7) **Inclement Weather** - Suspend or terminate operations until directed otherwise by SHSO. See Section 4.0 of the TtNUS Health and Safety Guidance Manual for additional information concerning natural hazards.	1) Monitoring shall be conducted to qualify and quantify estimated source concentrations of on-site contaminants in support of the prescribed worker protection levels. Monitoring shall be conducted using Photoionization Detector (PID) with 10.2eV lamp strength (or higher), or with an FID. <5 ppm sustained in potential source areas (e.g., well head) - continue to work; monitor breathing zone areas. > 5 ppm sustained in the workers breathing zone – Retreat to unaffected (upwind) area. Work may resume if/when background levels are regained in the breathing zone. If desired, SHSO may pull Draeger 0.5/c tube. If specified color change is not observed (indicating that benzene is not present), work may resume up to readings of 50 ppm on the PID/FID in the breathing zone. In this instance, repeat Draeger tube testing periodically. If Dreager testing indicates the presence of benzene at any time, do not resume work and contact the PHSO. Failure of these concentrations to diminish will require an upgrade in the level of protection and therefore a modification of this HASP. Monitoring shall be conducted upon the initial opening of each existing well, and periodically during permeability testing activities. Monitoring shall also be conducted at the sampler's location to in the same prescribed frequency when handling samples.	Level D - (Minimum Requirements) - Standard field attire (Sleeved shirt; long pants) - Safety shoes (Steel toe/shank) - Surgeon's-style nitrile gloves - *Snake chaps(for remote and unmaintained areas)* - Safety glasses with side shields - *Hardhat (when overhead hazards exists, or identified as a operation requirement)* - *Reflective vest for high traffic areas* As site conditions may change, the following equipment will be maintained during all on-site activities as prescribed in Section 2.0 of this HASP - Fire Extinguishers - First-aid kit ***Note:*** *The FOL and/or the SHSO will determine the number of fire extinguishers and first-aid kits to be made available based on the number of operations to be conducted at any given time.*	Remove and dispose of gloves. Good personal hygiene practices should be employed prior to breaks lunch or other period when hand to mouth contact occurs. This will minimize potential ingestion exposures.

TABLE 5-1 (cont.)
TASKS/HAZARDS/CONTROL MEASURES
HEALTH AND SAFETY PLAN
NAVY EXCHANGE SERVICE STATION
NAVAL AIR STATION, BRUNSWICK, MAINE
PAGE 3 OF 8

Task/Operati n/ Location	Anticipated Hazards	Recommended Control Measures	Hazard Monitoring - Type and Action Levels	Personal Protective Equipment *(Items in italics are deemed optional as conditions or the FOL or SHSO dictate.)*	Decontamination Proc dures
Mini-monitoring Well Installation via DPT This task also includes the well development, subtasks.	***Chemical hazards:*** 1) Site contaminants of concern that may be encountered in this task include Gasoline Range Organics, and BTEX components of gasoline. Further information on these contaminants are presented in Section 6.1. 2) Transfer of contamination into clean areas or onto persons ***Physical hazards:*** 3) Heavy equipment hazards (pinch/compressions points) 4) Noise in excess of 85 dBA 5) Energized systems (contact with underground or overhead utilities) 6) Lifting (strain/muscle pulls) 7) Slips, trips, and falls 8) Cuts and lacerations 9) Vehicular and foot traffic For further information on these physical hazards, see Section 6.2 of this HASP or Section 4.0 of the HSGM. ***Natural hazards:*** 10) Inclement weather 11) Insect bites	***Chemical hazards:*** 1) Safe work practices will be employed as the first line of defense. As a general rule, avoid contact with contaminated media (water, soils, etc.) as a universal control measure. In addition, good work hygiene practices include avoiding hand-to-mouth contact to the extent possible, washing hands and face or using hygienic wipes to remove potential contaminants from hands and face prior to breaks or lunch or other hand to mouth activities. Subsurface media will be scanned with a PID or FID to determined potential source concentration and to monitor for inhalation exposure concerns. To protect against dermal contact exposure concerns, wear specified PPE. 2) Transfer **of Contamination into Clean Areas or onto Persons** - Restrict the cross use of equipment and supplies between locations and activities without first going through a suitable decontamination. Work practices including establishing a rigid decontamination procedure will be employed for all equipment between locations and between clean and potentially dirty work. This provision along with dedicated sampling equipment will insure materials are not carried and deposited in unaffected areas. ***Physical hazards:*** 3) **Heavy Equipment Hazards** - All equipment will be: - Inspected in accordance with Federal safety and transportation guidelines, OSHA (1926.600.601.602), and manufacturer's design, as applicable. All inspections will be documented using the Equipment Inspection Checklist (for Drill Rigs) found in (See Attachment III) of this HASP. - Operated and supported by knowledgeable operators and ground crew. - Used within safe work zones, with routes of approach clearly demarcated. All personnel not directly supporting this operation will remain at least 35 feet from the point of operation or the height of the mast plus 5-feet (whichever is greater). See Section 10.1.1 of this HASP. This will be the area identified as the exclusion zone. - Any self-propelled equipment used shall be equipped with movement warning systems. - All personnel will be instructed in the location and operations of the emergency shut-off device(s). This device will be tested initially (and then periodically) to ensure its operational status. - One person (usually the driller) will be designated as the Emergency Shut Off Device Operator. - Areas will be inspected prior to the movement of the direct push rig and support vehicles to eliminate physical hazards. This will be the responsibility of the FOL and/or SHSO. - See additional safe work procedures for drilling in Section 5.9 of this HASP as well as in Section 4.0 of the HSGM. 4) **Noise in Excess of 85 dBA** - Hearing protection will be used during all subsurface activities using the direct push rig or when noise levels are >85 dBA. (during operation). Previous accumulated data indicates an average 8 hour exposure is approximately 87-92 dBA... Controlling this hazard shall be accomplished employing two separate approaches as follows: - Boundaries will be established to limit the affect of the noise hazard. The height of the mast + 5 feet or 35 feet whichever is greater will remove personnel far enough from the noise source as not to present a noise exposure concern. - Hearing protection 5) **Energized Systems** - All drilling activities will proceed in accordance with the Utility Locating and Excavation Clearance SOP in Attachment II of this HASP. All utility clearances will be obtained in writing, and locations identified and marked, prior to activities. If it is not obtainable/unknown or you location infringes within 3-feet of an underground utility advancement must proceed by hand until past the utility. The hand dug hole must at least represent the same diameter of the mechanized tooling that will be used. Obtain appropriate utility clearance prior to breaking ground from Dig Safe and on-base authority (as appropriate). 6) **Lifting Hazards** - Use machinery or multiple personnel for heavy lifts. Use proper lifting techniques as described in Table 5-1 for mobilization/demobilization. Drill stems, auger flights, and well construction supplies are some of the common material that are handled and because of their weight will present a lifting strain hazard associated with this activity. 7) **Slips, Trips, and Falls** - Preview work locations for unstable/uneven terrain. - Cover, guard and barricade all open pits, ditches, and floor opening as necessary. - Ruts, roots, tools, and other tripping hazards should be eliminated to minimize trips and falls. - Maintain a clutter free work area. - As part of site control efforts construct fences or other means of demarcation (i.e. signs and postings) to control and isolate traffic in the work area. Means of demarcation shall also be constructed isolating resource and/or staging areas. 8) **Cuts and Lacerations** - To prevent cuts and lacerations, the following provisions are required: - Use GeoProbe Sampling Kit and cut-resistant gloves to obtain soil samples from DPT flights. - Always cut away from yourself and others, then, if a knife slips, you will not impale yourself or others. - Do not place items to be cut in your hand or on your knee. - Change out blades as necessary to maintain a sharp cutting edge. Many accidents result from struggling with dull cutting attachments. - Wear cut-resistant gloves (leather or heavy cotton) 9) **Vehicular and Foot Traffic Hazards** - Use traffic-warning signs, flag persons, and high visibility vests as determined by the SHSO when working along traffic thoroughfares. In addition, use physical barricades, when working within normal traffic flow patterns/traffic lanes. ***Natural hazards:*** 10) **Inclement Weather** – To minimize hazards of this nature, the following provisions shall be employed: - Wear appropriate clothing for weather conditions. - Provide acceptable shelter and replacement liquids for field crews as relief from excessive ambient temperatures. - Under conditions of elevated levels of PPE, periods of acclimatization, excessive ambient temperature extremes, or if you believe someone is suffering from a heat/cold related disorder, it may be necessary to conduct heat/cold stress monitoring. - Electrical storms/high winds - Suspend or terminate operations until directed otherwise by SHSO. Follow the provisions as specified in Section 4.0 of the Tetra Tech NUS, Inc. Health and Safety Guidance Manual regarding the identification and evaluation of heat/cold stress related conditions. 11) **Insect bites**. See Multi-media sampling for protective measures. These hazards are not anticipated to be as predominant during this activity or in this area.	1) Monitoring shall be conducted to qualify and quantify estimated source concentrations of on-site contaminants in support of the prescribed worker protection levels. Monitoring shall be conducted using Photoionization Detector (PID) with 10.2eV lamp strength (or higher), or with an FID. <5 ppm sustained in potential source areas (e.g., well head) - continue to work; monitor breathing zone areas. > 5 ppm sustained in the workers breathing zone – Retreat to unaffected (upwind) area. Work may resume if/when background levels are regained in the breathing zone. If desired, SHSO may pull Draeger 0.5/c tube. If specified color change is not observed (indicating that benzene is not present), work may resume up to readings of 50 ppm on the PID/FID in the breathing zone. In this instance, repeat Draeger tube testing periodically. If Draeger testing indicates the presence of benzene at any time, do not resume work and contact the PHSO. Failure of these concentrations to diminish will require an upgrade in the level of protection and therefore a modification of this HASP. Monitoring shall be conducted periodically during mini-well installation activities. Monitoring shall also be conducted at the sampler's location to in the same prescribed frequency when handling samples. Noise monitoring may be conducted at the discretion of the PHSO and/or the SHSO. Action Level - >85 dBA Require participation in the Project Hearing Conservation Program. As a general rule of thumb, if you have to raise your voice to communicate with someone who is within arm's length of you, then noise levels are probably over 85 dBA and hearing protection should be used.	All mini-well installation activities will be initiated in Level D protection, as follows: **Driller and Driller Helper** - Standard field attire including sleeved shirt and long pants - Safety shoes (Steel toe/shank) - Safety glasses - Nitrile inner gloves, leather or cotton work outer gloves - Hearing protection - Hard hat - *Impermeable boot covers* Sampler/Oversight Personnel - Use GeoProbe Sampling Kit and cut-resistant gloves to obtain soil samples - Standard field dress (long pants, Sleeved shirts) - Steel toe safety shoes or work boots - Hard hat (when within 35-feet of the DPT rig) - Safety Glasses(when within 35-feet of the DPT rig or when sampling) - Nitrile surgeon style inner gloves for sampling - Hearing protection(when within 35-feet of an operating DPT rig) - Impermeable boot covers - Reflective vest for traffic areas **Upgrades to Level C and B protection** are not anticipated. The following equipment will also be maintained during all on-site activities - Fire Extinguishers - First-aid Kit **Note:** The Safe Work Permit(s) for this task (See Attachment IV of this HASP) will be issued at the beginning of each day to address the tasks planned for that day. As part of this task, additional PPE may be assigned to reflect site-specific conditions or special considerations or conditions associated with any identified task.	**Personnel Decontamination** will consist of a soap/water wash and rinse for reusable and non-reusable outer protective equipment (boots, gloves, impermeable apron, as applicable. Disposable items will be removed, properly discarded, and maintained/controlled as IDW. The sequential procedure is as follows: Stage 1: Equipment drop Decontamination personnel will clean hand tools as necessary. Stage 2: Soap/water wash and rinse of outer boots as applicable and gloves Stage 3: Soap/water wash and rinse of the impermeable apron, as applicable. Stage 4: Disposable PPE will be removed and bagged. Stage 5: Wash face and hands Note: For remote locations away from the centralized decontamination unit - Bag and/or wrap all disposable and reusable equipment, respectively for transport back to the decontamination unit. - Hygienic wipes may be used for cleaning hands and face **Equipment Decontamination** - All heavy and sampling equipment decontamination will take place at a centralized decontamination pad utilizing a steam cleaner or pressure washer as prescribed in Table 5-1 for that task. Heavy equipment will have the wheels and tires cleaned along with any loose debris removed, prior to transporting to the central decontamination area. All site vehicles will have restricted access to exclusion zones. Vehicles will have their wheels/tires cleaned or sprayed off as applicable as not to track mud onto the roadways servicing this installation. Roadways shall be cleared of any debris resulting from the onsite activity. The FOL or the SHSO will be responsible for evaluating equipment arriving on-site, leaving the site, and between locations. No equipment will be authorized access, exit, or movement to another location without this evaluation.

TABLE 5-1 (cont.)
TASKS/HAZARDS/CONTROL MEASURES
HEALTH AND SAFETY PLAN
NAVY EXCHANGE SERVICE STATION
NAVAL AIR STATION, BRUNSWICK, MAINE
PAGE 4 OF 8

Task/Operation /Location	Anticipated Hazards	Recommended Control Measures	Hazard Monitoring - Type and Action Levels	Personal Protective Equipment *(Items in italics are deemed optional as conditions or the FOL or SHSO dictate.)*	D contamination Procedures
Multi-media sampling, including - Baseline and periodic soil and groundwater sampling. Note: Any sampling performed concurrently with DPT operations must also observe the precautions, requirements, and restrictions specified in the Table 5-1 entry for Mini-monitoring well installation.	***Chemical hazards:*** 1) Site contaminants of concern that may be encountered in this task include Gasoline Range Organics, and BTEX components of gasoline. Further information on these contaminants are presented in Section 6.1. Sample preservatives provided by the analytical laboratory. 2) Transfer of contamination into clean areas. ***Physical hazards:*** 3) Slip, trip, and fall hazards 4) Strain/muscle pulls from manual lifting 5) Cuts and Lacerations 6) Ambient temperature extremes (heat/cold stress) 7) Site Characterization ***Natural hazards:*** 8) Animal and insect bites and encounters 9) Inclement weather	***Chemical hazards:*** 1) Safe work practices will be employed as the first line of defense. As a general rule, avoid contact with contaminated media (water, soils, etc.) as a universal control measure. In addition, good work hygiene practices include avoiding hand-to-mouth contact to the extent possible, washing hands and face or using hygienic wipes to remove potential contaminants from hands and face prior to breaks or lunch or other hand to mouth activities. Subsurface media will be scanned with a PID or FID to determined potential source concentration and to monitor for inhalation exposure concerns. The greatest potential for contact exists when opening a well that has been sealed and may have gases present in the confined headspace. As a precaution, approach and sample as follows: At arms length, open the well and step away (upwind). Let the well off gas for a few minutes, while you prepare your equipment. Airborne concentrations will recede and you can continue with your task. To protect against dermal contact exposure concerns, wear specified PPE. Obtain and familiarize yourself with manufacturer's MSDS for any sample preservatives used on-site (e.g., methanol). Restrict the use of these substances to only well-ventilated areas, such as outdoors. Use appropriate PPE as identified on MSDS for the product used. All chemicals used must be listed on the Chemical Inventory for the site, and site activities must be consistent with the Hazard Communication Program provided in Section 5.0 of the TtNUS Health and Safety Guidance Manual. 2) Transfer **of Contamination into Clean Areas** - Decontaminate all equipment and supplies between sampling locations and prior to leaving the site. See decontamination of heavy and sampling equipment for direction in this task. In addition, the bulk of sampling equipment (i.e., tubing, trowels are disposable therefore dedicated). In addition, Rinsate samples will be collected 1/20 samples to evaluate the decontamination procedure and to evaluate dedicated equipment. 3) Slip, **Trip, and Fall Hazards** – These hazards shall be minimized by adherence to the practices listed below. This includes - Maintain proper housekeeping in all work areas. - Preview and inspect work areas to identify and eliminate slip, trip, or fall hazards. - Cover, guard, barricade, and or place warning postings over/at holes or openings that personnel may fall or step into. - For traversing steep, slippery, or sloped terrain establish rope ladders to control ascent and descent to sampling areas or use alternative pathways. - Use lifeline to sample along waters edge - Use multiple persons and pack small loads to remote locations. 4) **Strain/Muscle Pulls from Manual Lifting** - Use machinery or multiple personnel for heavy lifts. Use proper lifting techniques (See Lifting Mobilization/Demobilization, Page 1 of 6, Table 5-1). 5) **Cuts and Lacerations** – Employ the following measures to reduce and/or eliminate the potential for cuts and lacerations - For collecting soil samples from DPT rig, use GeoProbe sampling kit and wear cut-resistant gloves - Select and secure the most favorable route to monitoring wells and sampling locations. - Previewing pathways - Where possible, remove or demarcate the physical hazards. - When cutting items - always use a sharp knife and always cut away from your body. Do not place items to be cut in your opposite hand or on your knee. - Carry all glassware and items that present a potential for cuts, lacerations, or impalement such as machetes or brush hooks in protective packaging or sheathed to avoid breakage or exposure in the event of a slip, trip, and/or fall. 6) **Ambient Temperature Extremes (Heat/Cold Stress)** - Wear appropriate clothing for weather conditions. Provide acceptable shelter and liquids for field crews. Additional information regarding heat/cold stress is provided in Section 4.0 of the Health and Safety Guidance Manual. Care should be exercised when working outdoors due to harmful effects of the sun. To reduce the potential for sunburn and melanoma the following measures should be observed: - Wear a hat that shades the face, neck, and ears. - Apply sunscreen with a SPF of 15 or higher liberally on any exposed skin at least 15 minutes before going outside, then at least every two hours, more if you are sweating a lot. - Plan/provide suitable equipment to offer shade to avoid the midday sun since the sun's ultraviolet rays are most intense between 10 A.M. and 4 P.M. and can damage your skin even on hazy days. - Wear wrap-around sunglasses to protect the eyes and delicate skin around them. 7) **Site Characterization** - Work areas will be surveyed prior to committing personnel or resources. The survey will be conducted by the FOL and/or the SHSO. The purpose is to identify physical and natural hazards that may impact the proposed work area. These hazards are to be identified, barricaded, or eliminated to the extent possible to minimize potential effect to field crew. 8) **Insect/Animal Bites and Stings** - This is not considered a predominant hazard as these activities are to be conducted in well maintained areas. To combat the potential impact of natural hazards, the following actions are recommended Insects and spiders - Wear light color clothes. This will allow easier detection of ticks and insects crawling on your body. It will also assist in heat stress control. - Tape pant legs to work boots to block direct access. This is especially critical when clearing or entering heavy brush and wooded areas. - Do not stick your hand anywhere where you can't see. - When opening existing well heads be cautious of bees and spiders as these are preferred nesting locations. - Use repellents – Follow manufacturer's recommendations for use. Permanone should be applied liberally to the clothing, but not the skin as it may cause irritation. Apply insect repellants containing DEET directly to skin. Concentrate on areas where ticks and other insects may access your body such as pant cuffs, shirt to pants, and collars. - If you leave your workboots at the trailer or office over your break make sure you shake them out before sticking your feet in them. 9) **Suspend** or terminate operations during electrical storms. Return to work when directed by the FOL and/or the SHSO.	Monitoring shall be conducted to qualify and quantify estimated source concentrations of on-site contaminants in support of the prescribed worker protection levels. Monitoring shall be conducted using Photoionization Detector (PID) with 10.2eV lamp strength (or higher), or with an FID. <5 ppm sustained in potential source areas (e.g., well head) - continue to work; monitor breathing zone areas. > 5 ppm sustained in the workers breathing zone – Retreat to unaffected (upwind) area. Work may resume if/when background levels are regained in the breathing zone. If desired, SHSO may pull Draeger 0.5/c tube. If specified color change is not observed (indicating that benzene is not present), work may resume up to readings of 50 ppm on the PID/FID in the breathing zone. In this instance, repeat Draeger tube testing periodically. If Draeger testing indicates the presence of benzene at any time, do not resume work and contact the PHSO. Failure of these concentrations to diminish will require an upgrade in the level of protection and a modification of this HASP. Noise monitoring maybe conducted at the discretion of the PHSO and/or the SHSO. Action Level - >85 dBA Require participation in the Project Hearing Conservation Program. As a general rule of thumb, if you have to raise your voice to communicate with someone who is within arm's length of you, then noise levels are probably over 85 dBA and hearing protection should be used.	Level D protection will be utilized for the following sampling activities - Standard field dress (long pants, Sleeved shirts) - Hardhat - Steel toe safety shoes or work boots - Safety Glasses - Nitrile surgeon style inner gloves - Cut-resistant glove when hand cutting (use Geo Probe sampling kit when collecting soil samples from DPT operations) - *Hearing protection* (when within the height of the mast + 5-feet or 35-feet whichever is greater) - *Impermeable boot covers* - *Reflective vest for traffic areas* Protective Measures as specified for drilling and soil boring will be employed for all subsurface soil sampling at the drill rig. **Upgrades to Level C and B protection** are not anticipated. **Note:** The Safe Work Permit(s) for this task (See Attachment IV) will be issued at the beginning of each day to address the tasks planned for that day. As part of this task, additional PPE may be assigned to reflect site-specific conditions or special considerations or conditions associated with any identified task.	**Personnel Decontamination** Upon completion of the sampling - Dedicated trowels, tubing, PPE will be rinsed and bagged for disposal. - Handi-Wipes or similar product will be used to clean hands, prior to moving to the next location. **Equipment Decontamination** Decontamination of equipment (sampling and hand tools) will proceed as indicated in Table 5-1 of this HASP and/or the Workplan.

TABLE 5-1 (cont.)
TASKS/HAZARDS/CONTROL MEASURES
HEALTH AND SAFETY PLAN
NAVY EXCHANGE SERVICE STATION
NAVAL AIR STATION, BRUNSWICK, MAINE
PAGE 5 OF 8

Tasks/Operation /Locations	Anticipated Hazards	Recommended Control Measures	Hazard Monitoring - Type And Action Levels	Personal Protective Equipment *(Items In Italics Are Deemed Optional As Conditions Or The FOL Or the SSO Dictate.)*	Decontamination Proc dures
Sample Location Surveying	***Chemical hazards:*** Significant exposure to site contaminants is not anticipated during this task. ***Physical hazards:*** 1) Slips, trips, and falls 2) Struck by 3) Traffic hazards ***Natural hazards:*** 4) Inclement weather *5)* Insect/animal bites or stings, poisonous plants, etc.	***Physical hazards:*** 1) Preview work locations and site lines for uneven and unstable terrain. Clear vegetation as necessary. Establish temporary means for traversing hazardous terrain (i.e., rope ladders, etc.) as necessary. A review of accident/injury statistics associated with land surveying identifies slips, trips, and falls as the number one injury cause, followed by cuts and lacerations, and animal/insect bites. 2) If hand tools (brush hooks, machetes, etc.) are necessary to clear and carry lines and bench marks to the area of operation the following precautions are recommended: - Ensure handles are of good construction (no cracks, splinters, loose heads/cutting apparatus. - Ensure all cutting tools are maintained. Blades shall be sharp without nicks and gouges in the blade. - All hand tools (brush hooks, machetes, etc.) with cutting blades shall be provided with a sheath to protect individuals, when not in use. - All personnel will maintain a 10-foot perimeter around persons clearing brush. **Note:** It is not anticipated that trees >2-inch girth will be required to be dropped as part of this operation or that significant amount of clearing will be required. Therefore the use of chainsaws and chippers is not anticipated. Note: Where possible it is recommended that heavy equipment (tractors and brush hogs or similar equipment) be used to clear grid lines and lines of site. 3) Vehicular traffic hazards - Wear high visibility vests when working in traffic patterns. - Provide signage in areas where traffic patterns will be altered (Survey crew working; lane restriction, etc.). ***Natural hazards:*** 4) Electrical storms or high winds - Suspend or terminate operations until directed otherwise by SHSO. Harmful effects of the Sun - Care should be exercised when working outdoors due to harmful effects of the sun. To reduce the potential for sunburn and melanoma the following measures should be employed - Wear a hat that shades the face, neck, and ears. - Apply sunscreen with a SPF of 15 or higher liberally on any exposed skin at least 15 minutes before going outside, then at least every two hours, more if you are sweating a lot. - To the extent possible, plan/provide suitable equipment to offer shade to avoid the midday sun since the sun's ultraviolet rays are most intense between 10 A.M. and 4 P.M. and can damage your skin even on hazy days. - Wear wrap-around sunglasses to protect the eyes and delicate skin around them. 5) **Insect/**Animal **Bites and Stings** - This is not considered a predominant hazard as these activities are to be conducted in maintained areas. To combat the potential impact of natural hazards, the following actions are recommended Insects and spiders - Wear light color clothes. This will allow easier detection of ticks and insects crawling on your body. It will also assist in heat stress control. - Tape pant legs to work boots to block direct access. This is especially critical when clearing or entering heavy brush and wooded areas. - Use repellents – Follow manufacturer's recommendations for use. Permanone should be applied liberally to the clothing, but not the skin as it may cause irritation. Apply repellants containing DEET directly on skin surfaces. Concentrate on areas where ticks and other insects may access your body such as pant cuffs, shirt to pants, and collars. - Upon exiting the high brush and wooded areas perform a close body inspection to remove any ticks or other insects that have attached to your clothing or skin. - Do not stick your hand anywhere where you can't see. - When opening existing well heads be cautious of bees and spiders as these are preferred nesting locations. See Section 4.0 of the TtNUS Health and Safety Guidance Manual for additional information concerning natural hazards.	Air monitoring is not required given the unlikelihood that airborne contaminants will be present. The potential for exposure to site contaminants during this activity is considered minimal.	Surveying activities shall be performed in Level D protection Level D Protection consists of the following: - Standard field dress including sleeved shirt and long pants - Shoes rugged lug sole for traction - Work gloves shall be worn when clearing brush. - *Safety glasses, hard hats (if working near machinery, overhead hazards, or clearing brush)* - *Snake chaps for heavily wooded area where encounters are likely.* - *Tyvek coveralls may be worn to provide additional protection against poisonous plants and insects, particularly ticks.* - *Reflective or blaze orange vests should be worn when working along traffic thoroughfares.* **Note:** The Safe Work Permit(s) for this task (See Attachment IV) will be issued at the beginning of each day to address the tasks planned for that day. As part of this task, additional PPE may be assigned to reflect site-specific conditions or special considerations or conditions associated with any identified task.	**Personnel Decontamination** A structured decontamination is not required as the likelihood of encountering contaminated media is considered remote. However, survey parties should inspect themselves and one another for the presence of ticks when exiting wooded areas, grassy fields, etc. This action will be employed to stop the transfer of these insects into vehicles, homes, and offices. In addition, early detection shall provide for early removal.

TABLE 5-1 (cont.)
TASKS/HAZARDS/CONTROL MEASURES
HEALTH AND SAFETY PLAN
NAVY EXCHANGE SERVICE STATION
NAVAL AIR STATION, BRUNSWICK, MAINE
PAGE 6 OF 8

Tasks/Op ration/ Locations	Anticipated Hazards	Recommended Control Measures	Hazard Monitoring - Type and Action Levels	Personal Protective Equipment *(Items in italics are deemed optional as conditions or the FOL or SHSO dictate.)*	Decontamination Proc dur s
Decontamination of Heavy Equipment Decontamination of sampling equipment. It is anticipated that this activity will take place at a temporary centralized location. Gross contamination will be removed to the extent possible at the site. Contaminated tooling then will be wrapped in polyethylene sheeting for transport to the centralized location for a full decontamination and evaluation.	***Chemical hazards:*** 1) It is not anticipated that previously identified contaminants of concern will be encountered during this task in sufficient concentrations that would represent an exposure concern. Further information on these contaminants are presented in Section 6.1. 2) Decontamination fluids - Liquinox (detergent); isopropanol (decontamination solvent) ***Physical hazards:*** 3) Lifting (strain/muscle pulls) 4) Noise in excess of 85 dBA 5) Flying projectiles 6) Falling hazards 7) Slips, trips, and falls ***Natural hazards:*** 8) Inclement weather	1) and 2) Employ protective equipment to minimize contact with site contaminants and hazardous decontamination fluids. Control potential non-occupational exposures through good work hygiene practices (i.e., avoid hand to mouth contact; wash hands and face before breaks and lunch; minimize contact with contaminated media). Obtain and familiarize yourself with manufacturer's MSDS for any decontamination fluids used on-site. Solvents may only be used in well-ventilated areas, such as outdoors. Use appropriate PPE as identified on MSDS or within this HASP. All chemicals used must be listed on the Chemical Inventory for the site, and site activities must be consistent with the Hazard Communication Program provided in Section 5.0 of the TtNUS Health and Safety Guidance Manual. 3) Use multiple persons where necessary for lifting and handling heavy equipment for decontamination purposes. - Employ proper lifting techniques as described in Table 5-1, Mobilization/Demobilization. 4) Wear hearing protection when operating the pressure washer and/or steam cleaner. Sound pressure levels measured during the operation of similar pieces of equipment indicate a range of 87 to 93 dBA. 5) Use eye and face protective equipment when operating the pressure washer and/or steam cleaner. Restrict nonessential personnel from the area. In addition to minimize hazards associated with this operation (flying projectiles, water lacerations and burns), the following controls will be implemented - Do not point the wand at persons or place against any part of your body. - Thermostat control will be in place and operational to control the temperature levels of the water where applicable. - Inspect hoses and fittings for structural defects - Construct deflection screens as necessary to control overspray and to guard against dispersion of contaminants. 6) Ensure wash and drying racks are of suitable construction to prevent heavier items such as auger flights and drill rods from falling and striking someone during the decontamination process. 7) The decontamination pad should be constructed to contain wash waters generated during decontamination procedures. Temporary decontamination pads are usually 10-30 mil polyethylene or polyvinyl chloride tarp construction. Although these items when used as a liner offer containment, they also present a slipping hazard. When these temporary liners are employed, it is recommended that a light coating of sand be spread over the walking surface to provide traction. - In addition, adequate slope should be provided to the pad to permit drainage away from the object being cleaned. The collection point for wash waters should be of adequate distance that the decontamination workers do not have to walk through the wash waters while completing their tasks. - Hoses should be gathered when not in use to eliminate potential tripping hazards. 8) Suspend or terminate operations until directed otherwise by SHSO.	Use visual observation and real-time monitoring instrumentation to ensure all equipment has been properly cleaned of contamination and dried. Monitoring instrumentation will be employed to determine If contaminants and all of the decontamination solvent (isopropanol, where use is applicable) has been removed through the rinse process. Any positive indication/results greater than background require the article that has been decontaminated to be re-rinsed and scanned again. If necessary this process should be repeated until no measurable indication of contaminants and/or the decontamination solvent exists.	For Heavy Equipment This applies to pressure washing and/or steam cleaning operations and soap/water wash and rinse procedures. Level D Minimum requirements: - Hard hat with splash shield - Standard field attire (Long sleeve shirt; long pants) - Safety shoes (Steel toe/shank) - Chemical resistant boot covers - Nitrile or neoprene gloves - Safety glasses underneath a splash shield - Hearing protection (plugs or muffs) - *Hooded PVC Rainsuits or PE or PVC coated Tyvek.* Impermeable aprons may be used instead of coveralls if they offer adequate protection against overspray and back splash. **For sampling equipment** (trowels, split spoons,, etc.), the following PPE is required **Note**: Consult MSDS for PPE guidance. Otherwise, observe the following. Level D Minimum requirements - - *Standard field attire (Long sleeve shirt; long pants)* - *Safety shoes (Steel toe/shank)* - *Nitrile outer gloves over nitrile inner gloves* - *Safety glasses* - *Impermeable apron* **Note:** The Safe Work Permit(s) for this task (See Attachment IV) will be issued at the beginning of each day to address the tasks planned for that day. As part of this task, additional PPE may be assigned to reflect site-specific conditions or special considerations or conditions associated with any identified task.	**Personnel Decontamination** will consist of a soap/water wash and rinse for reusable and non-reusable outer protective equipment (boots, gloves, PE or PVC splash suits, as applicable). The sequential procedure is as follows: Stage 1: Equipment drop, remove outer protective wrapping; personnel will wash hand tools and pass hand equipment through as necessary. Stage 2: Soap/water wash and rinse of outer boots and gloves Stage 3: Soap/water wash and rinse of the outer splash suit or apron as applicable Stage 4: Disposable PPE will be removed and bagged. Stage 5: Wash face and hands **Equipment Decontamination** - All heavy equipment decontamination will take place at a centralized decontamination pad utilizing a steam cleaner or pressure washer. Heavy equipment will have the wheels and tires cleaned along with any loose debris removed, prior to transporting to the central decontamination area. **Sampling Equipment Decontamination** Sampling equipment will be decontaminated as per the requirements indicated within the Work Plan. All equipment used in the exclusion zone will require a complete decontamination between locations and prior to removal from the site. The FOL or the SHSO will be responsible for evaluating equipment arriving on-site, leaving the site, and between locations. No equipment will be authorized access, exit, or movement to another location without this evaluation.

TABLE 5-1 (cont.)
TASKS/HAZARDS/CONTROL MEASURES
HEALTH AND SAFETY PLAN
NAVY EXCHANGE SERVICE STATION
NAVAL AIR STATION, BRUNSWICK, MAINE
PAGE 7 OF 8

Task/Operation /Location	Anticipated Hazards	Recommended Control Measures	Hazard Monitoring - Type and Action Levels	Personal Protective Equipment *(Items in italics are deemed optional as conditions or the FOL or SHSO dictate.)*	Decontamination Proc dures
Denitrification-based biodegradation testing It is anticipated that this task will be initiated and largely performed by employees of Geovation Technologies. However, a potential exists that some TtNUS employees will be trained and tasked to participate in this task. Note: Depending on the results of the permeability testing task, one of two DBB pilot testing approaches may be used: 1) Major additions approach: Involve subcontractor delivering bulk (up to 300 gal.) of N-Blend and dispensing it into the wells directly from the skid rig supply. If this approach is selected, TtNUS personnel will not directly participate. 2) Minor additions approach: Involves the use of delayed distribution system consisting of 5-gallon stainless steel containers plumbed together to "meter out" the N-Blend product over a more prolonged time period. If this approach is selected, TtNUS personnel may be expected to directly participate (following receipt of training)/ Also, if the Minor Additions approach is selected, the creation of some shallow excavations may become necessary. In that event, this HASP will need to be modified to address excavation safety issues.	***Chemical hazards:*** 1) Site contaminants of concern that may be encountered in this task include Gasoline Range Organics, and BTEX components of gasoline. Further information on these contaminants are presented in Section 6.1. 2) Hazards associated with contact with subcontractor's additive product, "Geovation N-Blend". 3) Transfer of contamination into clean areas. ***Physical hazards:*** 4) Heavy equipment hazards (pinch/compressions points) 5) Noise in excess of 85 dBA 6) Slip, trip, and fall hazards 7) Strain/muscle pulls from manual lifting 8) Cuts and Lacerations 9) Ambient temperature extremes (heat/cold stress) ***Natural hazards:*** 10) Animal and insect bites and encounters 11) Inclement weather	***Chemical hazards:*** 1) Safe work practices will be employed as the first line of defense. As a general rule, avoid contact with contaminated media (water, soils, etc.) as a universal control measure. In addition, good work hygiene practices include avoiding hand-to-mouth contact to the extent possible, washing hands and face or using hygienic wipes to remove potential contaminants from hands and face prior to breaks or lunch or other hand to mouth activities. Subsurface media will be scanned with a PID or FID to determined potential source concentration and to monitor for inhalation exposure concerns. The greatest potential for contact with airborne concentrations of site contaminants exists when opening a well that has been sealed and may have gases present in the confined headspace. As a precaution, approach as follows: At arms length, open the well and step away (upwind). Let the well off-gas for a few minutes, while you prepare your equipment. Airborne concentrations will recede and you can continue with your task. To protect against dermal contact exposure concerns, wear specified PPE. 2) Chemical hazards associated with subcontractors "N-Blend" product were not known at the time of HASP preparation. Any TtNUS employees tasked to participate in any tasks that involve dispensing or otherwise handling this product must first be provided with a copy of the manufacturer's MSDS and training by Geovations. 3) Transfer of Contamination into Clean Areas - Decontaminate all equipment and supplies prior to leaving the site. See decontamination of heavy equipment (such as the Skid Rig) for direction in this task. ***Physical hazards:*** 4) **Heavy** Equipment **Hazards** - All equipment will be: - Inspected in accordance with Federal safety and transportation guidelines, OSHA (1926.600.601.602), and manufacturer's design, as applicable. All inspections will be documented using the Equipment Inspection Checklist (for Drill Rigs) found in (See Attachment III) of this HASP. - Operated and supported by knowledgeable operators and ground crew. - Used within safe work zones, with routes of approach clearly demarcated. All personnel not directly supporting this operation will remain at least 35 feet from any operating heavy equipment. - Any self-propelled equipment used shall be equipped with movement warning systems. 5) **Noise in Excess of 85 dBA** - Hearing protection will be used during all heavy equipment operations or when noise levels are >85 dBA. (during operation). Controlling this hazard shall be accomplished employing two separate approaches as follows: - Boundaries will be established to limit the affect of the noise hazard (35 foot area around operating heavy equipment). - Hearing protection 6) **Slip, Trip, and Fall Hazards** – These hazards shall be minimized by adherence to the practices listed below. This includes - Maintain proper housekeeping in all work areas. - Preview and inspect work areas to identify and eliminate slip, trip, or fall hazards. - For traversing steep, slippery, or sloped terrain establish rope ladders to control ascent and descent to sampling areas or use alternative pathways. 7) **Strain/Muscle Pulls from Manual Lifting** - Use machinery or multiple personnel for heavy lifts. Use proper lifting techniques (See Lifting Mobilization/Demobilization, task, Table 5-1). **8) Cuts and Lacerations – When cutting items - always use a sharp knife and always cut away from your body. Do not place items to be cut in your opposite hand or on your knee.** **9) Ambient Temperature Extremes (Heat/Cold Stress) - Wear appropriate clothing for weather conditions. Provide acceptable shelter and liquids for field crews. Additional information regarding heat/cold stress is provided in Section 4.0 of the Health and Safety Guidance Manual. Care should be exercised when working outdoors due to harmful effects of the sun. To reduce the potential for sunburn and melanoma the following measures should be observed:** - Wear a hat that shades the face, neck, and ears. - Apply sunscreen with a SPF of 15 or higher liberally on any exposed skin at least 15 minutes before going outside, then at least every two hours, more if you are sweating a lot. - Plan/provide suitable equipment to offer shade to avoid the midday sun since the sun's ultraviolet rays are most intense between 10 A.M. and 4 P.M. and can damage your skin even on hazy days. - Wear wrap-around sunglasses to protect the eyes and delicate skin around them. 10) **Insect/Animal Bites and Stings** - To combat the potential impact of natural hazards, the following actions are recommended - Wear light color clothes. This will allow easier detection of ticks and insects crawling on your body. It will also assist in heat stress control. - Tape pant legs to work boots to block direct access. This is especially critical when clearing or entering heavy brush and wooded areas. - Do not stick your hand anywhere where you can't see. - When opening existing well heads be cautious of bees and spiders as these are preferred nesting locations. - Use repellents – Follow manufacturer's recommendations for use. Permanone should be applied liberally to the clothing, but not the skin as it may cause irritation. Apply insect repellants containing DEET directly to skin. Concentrate on areas where ticks and other insects may access your body such as pant cuffs, shirt to pants, and collars. - If you leave your workboots at the trailer or office over your break make sure you shake them out before sticking your feet in them. 11) **Suspend** or terminate operations during electrical storms. Return to work when directed by the FOL and/or the SHSO.	Monitoring shall be conducted to qualify and quantify estimated source concentrations of on-site contaminants in support of the prescribed worker protection levels. Monitoring shall be conducted using Photoionization Detector (PID) with 10.2eV lamp strength (or higher), or with an FID. <5 ppm sustained in potential source areas (e.g., well head) - continue to work; monitor breathing zone areas. > 5 ppm sustained in the workers breathing zone – Retreat to unaffected (upwind) area. Work may resume if/when background levels are regained in the breathing zone. If desired, SHSO may pull Draeger 0.5/c tubes. If specified color change is not observed (indicating that benzene is not present), work may resume up to readings of 50 ppm on the PID/FID in the breathing zone. In this instance, repeat Draeger tube testing periodically. If Draeger testing indicates the presence of benzene at any time, do not resume work and contact the PHSO. Failure of these concentrations to diminish will require an upgrade in the level of protection and a modification of this HASP. Noise monitoring maybe conducted at the discretion of the PHSO and/or the SHSO. Action Level - >85 dBA Require participation in the Project Hearing Conservation Program. As a general rule of thumb, if you have to raise your voice to communicate with someone who is within arm's length of you, then noise levels are probably over 85 dBA and hearing protection should be used.	Level D protection will be utilized for the following sampling activities - Observe PPE specifications in N-Blend MSDS - Standard field dress (long pants, Sleeved shirts) - *Hardhat* - Steel toe safety shoes or work boots - Safety Glasses - Nitrile surgeon style inner gloves - Cut-resistant glove when hand cutting - *Hearing protection* (Skid Rig operator and nearby persons) - *Impermeable boot covers* - *Reflective vest for traffic areas* **Upgrades to Level C and B protection** are not anticipated. **Note:** The Safe Work Permit(s) for this task (See Attachment IV) will be issued at the beginning of each day to address the tasks planned for that day. As part of this task, additional PPE may be assigned to reflect site-specific conditions or special considerations or conditions associated with any identified task.	**Personnel Decontamination** Wash and rinse any reusable PPE Remove disposable PPE, double-bag, manage as IDW Wash hands and face

TABLE 5-1 (c nt.)
TASKS/HAZARDS/CONTROL MEASURES
HEALTH AND SAFETY PLAN
NAVY EXCHANGE SERVICE STATION
NAVAL AIR STATION, BRUNSWICK, MAINE
PAGE 8 OF 8

Tasks/Operation Locations	Anticipated Hazards	Recommended Control Measures	Hazard Monitoring - Type And Action Levels	Personal Protective Equipment *(Items In Italics Are Deemed Optional As Conditions Or The FOL Or the SHSO Dictate.)*	Decontamination Procedures
IDW Management and Handling This activity includes the following tasks: - Containerization - Labelling - Staging - Monitoring of IDW generated in support of site activities.	***Chemical hazards:*** The only anticipated chemical hazard associated with IDW management is the potential for a spill. In situations such as that the spill containment program identified in Section 9.0 of this HASP will be employed. ***Physical hazards:*** 1) Strains and sprains 2) Back injuries 3) Compressions 4) Loading bulk transport containers	***Chemical hazards:*** It is not anticipated that chemical hazards will be significant during this operation, as the IDW will be in sealed containers. It is anticipated that the IDW will represent a limited chemical hazard, if the container is breached. Control measures in this case will represent PPE and good work hygiene practices to control potential exposures during the implementation of the Spill Containment Program (See Section 9.0 of this HASP). ***Physical hazards:*** 1 & 2) **Strains and sprains (lifting hazards)/Back Injuries** – The predominant hazard associated with this activity is the movement of full or partially full 55-gallon drums of soils and/or water. To minimize hazards of this nature the following provisions shall be incorporated as applicable: - Use machinery (preferred method) or multiple personnel for heavy lifts - Use proper lifting techniques a. Lift with your legs, not your back, bend your knees move as close to the load as possible, and ensure good hand holds are available. b. Minimize the horizontal distance to the center of the lift to your center of gravity. c. Minimize turning and twisting when lifting as the lower back is especially vulnerable at this time. d. Break lifts into steps if the vertical distance (from the start point to the placement of the lift) is excessive. e. Plan your lifts – Place heavy items on shelves between the waist and chest; lighter items on higher shelves. f. Periods of high frequency lifts or extended duration lifts should provide sufficient breaks to guard against fatigue and injury. In determining whether you can lift or move an item several factors must be considered, these are as follows: - Area available to maneuver the lift. - Area of the lift – Work place clutter, slippery surfaces, rough terrain - Overall physical condition 3) **Compressions** – Another hazard frequently associated with this task is the compression of hands and fingers when placing the containers on pallets. This typically occurs when rolling and lowering the container in its place. To combat this hazard, the following provision shall be employed: Material handling devices shall be used for moving drums within the satellite storage area. This includes drum dollies with pneumatic tires, drum grapplers, etc. to handle drums of IDW. These pieces of equipment are engineered to allow placement of these containers while keeping hands from pinch/compression points. **Reminder:** The drums you are attempting to move, lift and/or relocate may weigh on the average of - 55-Gallon container of purge or decontamination waters = 475 lbs. (including the container) - 55-Gallon container of soils (moist) = 750 lbs. (including the container) Satellite Storage Area – Emphasis has been placed on the physical surroundings and how they can influence the potential hazards associated with material handling aspects of this task. To further reduce material handling hazards, support spill containment and control, and sampling when necessary, the IDW storage area should be structured as follows: - Maximum 4-drums to a pallet with retaining ring bolt and label on the outside for easy access/reference. - Maintain a minimum of 4-feet between each row of pallets. This is the minimum distance necessary to wheel drums on a drum dolly - If the site is not secured, the satellite storage area shall be fenced and signs placed indicating the following: a. Primary Point of Contact (Preferably someone at the Base, and make sure they know they been identified as the Primary Point of Contact). b. Phone Number c. Emergency Contact (If different from the Primary) - Provide a Drum/Container Inventory to the Primary Point of Contact and to Emergency Services, if they deem it necessary. The inventory should contain: a. Each drum shall be assigned a unique identification number. This number shall be placed on the label and drum shell using a paint marker (Note: Do not paint the number on the lid as these have a tendency to get exchanged from time to time.) b. Types of waste materials (Subsurface soils, drill cuttings; purge/development waters, etc.) c. Volumes (Full or level associated with the container after completion of the project location) d. Where it was derived from (IDW should be separated by SWMU and media) e. Dates (For all filled containers and at the completion of work for that area or SWMU) f. Contact – For more information Note: All drums should be labeled with the same information.	None Required, unless spill containment provisions are invoked. Then monitoring will proceed as described in the activity associated with the task when the materials were generated such as Soil boring or well installation.	Level D - (Minimum Requirements) - Standard field attire (Sleeved shirt; long pants) - Safety shoes (Steel toe/shank) - Leather or canvas work gloves - *Safety glasses (When utilizing cables or slings to move the containers)* - *Hardhat (when overhead hazards exists, or identified as a operation requirement)* PPE changes may be made with the implementation of the Spill Containment Program. This represents the only anticipated modification to this level of protection.	Not required, unless the implementation of the Spill Containment Program is required due to a spill and/or release. At that point the decontamination procedures for those activities such as soil borings and/or well installation. The reference reflects the tasks conducted when the materials were generated.

6.0 HAZARD ASSESSMENT

This section provides information regarding the chemical, physical, and natural hazards that may be present or otherwise encountered during proposed site activities.

6.1 CHEMICAL HAZARDS

Based on the known site history and on the results of previous investigations at this site, the primary contamination has been categorized as TPH-GRO. From an occupational exposure potential, the principal substances of concern include gasoline, and the hazardous constituents commonly associated with gasoline. That is: benzene; toluene: ethyl benzene; and xylenes (BTEX). Of these, the substance with the greatest toxicological concerns is benzene.

At the time of this HASP preparation, information pertaining to the specific concentrations of gasoline and BTEX that may be encountered was not available. Therefore, the controls and precautions specified in this HASP are based on recognizing benzene as having the controlling toxicity. That is, monitoring instruments, instrument action levels, PPE, and other controls specified in this plan have been selected to be protective of exposure to benzene. When additional information becomes available, the PM will be responsible for communicating it to the HSM so that it can be reviewed to determine if any modifications to this HASP are warranted. Information on these substances of concern is presented in Table 6-1.

6.1.1 Exposure Potential

Exposure to TPH-GRO, and its hazardous constituents (i.e., gasoline and BTEX) can occur through inhalation, direct skin contact, or ingestion. These exposure routes will be monitored and controlled through the use of real-time direct reading air monitoring instrumentation, PPE, and the observance of site restrictions and good personal hygiene practices.

6.2 PHYSICAL HAZARDS

Through the task-specific hazard assessment process, the following physical hazards may be present during the performance of the site activities.

- Slips, trips, and falls
- Cuts (or other injuries associated with hand tool use)
- Lifting (strain/muscle pulls)

- Ambient temperature extremes (cold and heat stress)
- Pinches and compressions
- Heavy equipment hazards (rotating equipment, hydraulic lines, etc.)
- Energized systems (contact with underground or overhead utilities)
- Vehicular and foot traffic
- Noise in excess of 85 dBA
- Flying projectiles

Each of these physical hazards is discussed in greater detail in Section 4.0 of the TtNUS Health and Safety Guidance Manual. Additionally, information concerning the control measures for these hazards are discussed in Table 5-1 of this HASP.

6.3 NATURAL HAZARDS

6.3.1 Insect/Animal Bites and Stings, Poisonous Plants, etc.

Most site activities will be performed in maintained areas or near buildings. However, during warm months (spring through early fall), tick-borne Lyme Disease may pose a potential health hazard. The longer a disease carrying tick remains attached to the body, the greater the potential for contracting the disease. When working in high grass or other potential tick infested areas, the practice of wearing long sleeved shirts and long pants (tucked into boots) as well as performing frequent body checks will prevent long term attachment. Site first aid kits should be equipped with medical forceps and rubbing alcohol to assist in tick removal. For information regarding tick removal procedures and symptoms of exposure consult the Health and Safety Guidance Manual.

Insect bites and stings are difficult to control given the climate and environmental setting of NAS Brunswick. In particular, the summer of 2003 and the spring of 2004 has had significant rainfall that has resulted in an increased number of mosquitoes that may carry pathogenic diseases. In an effort to minimize this hazard the following control measures will be implemented where possible.

- Commercially available bug sprays and repellents will be used whenever possible – Pesticides analytical screening includes chlordane, endrin, lindane, methoxychlor, toxaphene and heptachlor. Commercially available repellants may be used. Products such as Permanone should not be applied directly to the skin due to potential irritation. This product should be applied only over clothing articles, and they reportedly remain effective through 2 or 3 launderings. Apply all insect repellants as per manufacturers instructions.

- Where possible, loose-fitting and light-colored clothing with long sleeves should be worn. This will also aid in insect control by providing a barrier between the field person and the insects and to provide easy recognition of crawling insects against the lighter background. Pant legs should be secured to the work-boots using duct tape to prevent access by ticks. Mosquito nets are also recommended for use when commercially available repellents are not permitted.

- Clothing/limited body checks for ticks and other crawling insects should be conducted upon exiting heavily vegetated areas. Workers should perform a more detailed check of themselves when showering in the evening. Ticks prefer moist areas of the body (arm-pits, genitals, etc.) and will migrate to those locations. It should be noted that over the last three years in situations where ticks have bitten and attached themselves it has been 2 cases attached to the back in the shoulder region with one case attached to the abdomen.

- If site personnel (through completion of Medical Data Sheets), suffer allergic reactions to bee and other insect stings and bites will be required to supply their Doctor recommended antidotes.

Mosquito-Borne Illness

Mosquitoes may carry diseases including St. Louis Encephalitis, Eastern Equine Encephalitis, La Crosse Encephalitis and West Nile Virus. Mosquitoes become infected after biting infected birds. The symptoms for mosquito-borne illnesses may include headache, moderate to high fever, stiff neck and confusion. In serious cases coma, seizures or paralysis can result. Symptoms usually appear between 5 to 15 days after exposure to infected mosquitoes. Mosquito-borne illnesses may be mild or serious and can lead to death.

Precautions include:

- Limit outdoor activities during peak mosquito times – at dusk and dawn.
- Avoid standing water
- Wear long-sleeved shirts and long pants whenever you are outdoors.
- Apply insect repellent according to manufacturers instruction to exposed skin. An effective repellent will contain 20% to 30% DEET (N,N-diethyl-meta-toluamide). Avoid products containing more than 30% DEET.
- Spray clothing with repellents containing permethrin or DEET, mosquitoes may bite through thin clothing.

6.3.2 Inclement Weather

All of the project tasks under this Scope of Work will be performed outdoors. As a result, inclement weather (electrical storms, high winds, etc.) may be encountered. In the event that adverse weather conditions arise, the FOL and/or the SHSO will be responsible for temporarily suspending or terminating activities until hazardous conditions no longer exist. In the event of severe weather conditions, report to a safe location with suitable shelter (preferably in a facility building recognized as a safe haven or shelter) for the weather conditions that result in termination of site activities. In the event of an electrical storm, immediate stop site activities and report to a safe location such as a building. If moving to a safe location is not feasible, stay in site vehicles.

Temperature extremes are considered inclement weather. Steps should be taken to the extent possible protect site personnel from the effects of heat stress and the sun. Control measures include:

- Watch for signs of heat stress/exhaustion. Work should be discontinued if a worker demonstrates any of the symptoms indicated in Table 6-1.
- Provide fluid replacement
- Provide adequate number of breaks within a cooler environment.

Care should be exercised when working outdoors due to harmful effects of the sun. To reduce the potential for sunburn and melanoma the following measures should be employed

- Wear a hat that shades the face, neck, and ears.
- Apply sunscreen with a SPF of 15 or higher liberally on any exposed skin at least 15 minutes before going outside, then at least every two hours, more if you are sweating a lot.
- Plan/provide suitable equipment to offer shade to avoid the midday sun since the sun's ultraviolet rays are most intense between 10 A.M. and 4 P.M. and can damage your skin even on hazy days. Portable canopies over the sample station are an example of this.
- Wear wrap-around sunglasses to protect the eyes and delicate skin around them.

TABLE 6-1

CHEMICAL, PHYSICAL, AND TOXICOLOGICAL DATA

NEX SERVICE STATION, NAS BRUNSWICK

Substance	Air Monitoring/Sampling Information		Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
Benzene 71-43-2	PID: I.P 9.24 eV, 100% response with PID and 10.2 eV lamp. FID: 150% relative response ratio with FID.	Air sample using charcoal tube; carbon disulfide desorption; Sampling and analytical protocol in accordance with OSHA 07 or NIOSH Method #1500.	OSHA: 1 ppm TWA[8] ACGIH: 0.5 ppm TWA[8] 2.5 ppm STEL Skin notation NIOSH: 0.1 ppm TWA[8] 1 ppm STEL IDLH: 500 ppm	Inadequate - Odor threshold 34-199 ppm. OSHA accepts the use of air-purifying respirators with organic vapor cartridge up to 10 ppm despite the inadequate warning properties providing cartridges are changed at the beginning of each shift. **Recommended gloves:** Butyl/neoprene blend - >8.00 hrs; Silver shield as a liner - >8.00 hrs; Viton - >8.00 hrs	**Boiling Pt:** 176°F; 80°C **Melting Pt:** 42°F; 5.5°C **Solubility:** 0.07% **Flash Pt:** 12°F; -11°C **LEL/LFL:** 1.3% **UEL/UFL:** 7.9% **Vapor Density:** 2.77 **Vapor Pressure:** 75 mmHg **Specific Gravity:** 0.88 **Incompatibilities:** Strong oxidizers, fluorides, perchlorates, and acids **Appearance and Odor:** Colorless to a light yellow liquid with an aromatic odor	Overexposure may result in irritation to the eyes, nose, throat, and respiratory system. CNS effects include giddiness, lightheadedness, headaches, staggered gait, fatigue, and lassitude and depression. Additional effects may include nausea. Long duration exposures may result in respiratory collapse. Regulated as an OSHA carcinogen. May cause damage to the blood forming organs and may cause a form of cancer called leukemia.

TABLE 6-1

CHEMICAL, PHYSICAL, AND TOXICOLOGICAL DATA

NEX SERVICE STATION, NAS BRUNSWICK

Substance	Air Monitoring/Sampling Information		Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
Ethylbenzene 100-41-4	PID: I.P 8.76, 116% response with PID and 10.2 eV lamp. FID: 100% response with FID.	Air sample using charcoal tube; carbon disulfide desorption; GC/FID detection. Sampling and analytical protocol in accordance with OSHA Method #07 or NIOSH Method #1501 Aromatic Hydrocarbon.	OSHA: 100 ppm TWA[8] ACGIH & NIOSH: 100 ppm TWA[8] 125 ppm STEL IDLH: 800 ppm	Adequate - Can use air-purifying respirator with organic vapor cartridge up to 1,000 ppm. **Recommended gloves:** Neoprene or nitrile w/ silver shield when potential for saturation; Teflon >3.00 hrs	**Boiling Pt:** 277°F; 136°C **Melting Pt:** -139°F; -95°C **Solubility:** 0.01% **Flash Pt:** 55°F; 13°C **LEL/LFL:** 1.0% **UEL/UFL:** 6.7% **Vapor Density:** 3.66 **Vapor Pressure:** 10 mmHg @ 79°F; 26°C **Specific Gravity:** 0.87 **Incompatibilities:** Strong oxidizers **Appearance and odor:** Colorless liquid with an aromatic odor. Odor Threshold of 0.092-0.60.	Regulated primarily because of its potential to irritate the eyes and respiratory system. In addition, effects of overexposure may include headaches, narcotic effects, CNS changes (i.e., coordination impairment, impaired reflexes, tremoring) difficulty in breathing, possible chemical pneumonia, and potentially respiratory failure or coma.

TABLE 6-1

CHEMICAL, PHYSICAL, AND TOXICOLOGICAL DATA

NEX SERVICE STATION, NAS BRUNSWICK

Substance	Air Monitoring/Sampling Information		Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
Toluene 108-88-3	PID: I.P 8.82 eV, 100% response with PID and 10.2 eV lamp. FID: 110% response with FID.	Air sample using charcoal tube; carbon disulfide desorption. Sampling and analytical protocol shall precede in accordance with OSHA Method #07, or NIOSH Method #1500.	OSHA: 200 ppm TWA[8] 300ppm (Ceiling) ACGIH: 50 ppm TWA[8] Skin notation NIOSH: 100 ppm TWA[8] 150 ppm STEL IDLH: 500 ppm	Adequate - Odor threshold 1.6 ppm is considered good. Can use air-purifying respirator with organic vapor cartridge up to 1,000 ppm. **Recommended gloves:** Teflon >15.00 hrs; Viton >16.00 hrs; silver shield >6,00 hrs; supported nitrile (Useable time limit 0.5 hr, complete submersion for the nitrile selection); PV alcohol >25.00 hrs	**Boiling Pt:** 232°F; 111°C **Melting Pt:** -139°F; -95°C **Solubility:** 0.05% (61°F;16° C) **Flash Pt:** 40°F; 4°C **LEL/LFL:** 1.2% **UEL/UFL:** 7.1% **Vapor Density:** 3.14 **Vapor Pressure:** 20 mmHg @ 65°F; 18°C **Specific Gravity:** 0.87 **Incompatibilities:** Strong oxidizers **Appearance and odor:** Colorless liquid with a sweet pungent aromatic odor.	Overexposure to this substance may result in mild to moderate irritation at all points of contact, and CNS changes including euphoria, confusion, nervousness, and possibly paresthesia characterized by an abnormal burning sensation, pricking, or numbness. At 200-500 ppm exposure has resulted in headaches, nausea, eye irritation, loss of appetite, bad taste, impair coordination, fatigue, and weariness. Chronically, toluene overexposure may result in dermatitis, liver, and kidney damage.

TABLE 6-1

CHEMICAL, PHYSICAL, AND TOXICOLOGICAL DATA

NEX SERVICE STATION, NAS BRUNSWICK

Substance	Air Monitoring/Sampling Information		Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
Xylene All isomers o-,m-, p- 1330-20-7	PID: I.P. 8.56 eV, 112% response with PID and 10.2 eV lamp. FID: 111% response with FID.	Air sample using charcoal tube; carbon disulfide desorption; GC/FID detection. Sampling and analytical protocol shall proceed in accordance with OSHA 07, or NIOSH Method 1500.	OSHA: 100ppm TWA[8] ACGIH & NIOSH: 100 ppm TWA[8] 150 ppm STEL IDLH: 900 ppm	Adequate - Odor thresholds for the following isomers: 0.6 m-; 5.4 p-; 20 o- ppm. Can use air-purifying respirator with organic vapor cartridge up to 1,000 ppm concentrations. **Recommended gloves:** PV Alcohol >12.67 hrs; Viton >8.00 hrs; CPE >1.00 hr; Butyl 0.87 hrs; Nitrile is acceptable for limited operations and contact (>0.20 hrs)	**Boiling Pt:** 269-281°F; 132-138°C **Melting Pt:** -13o/-54m/56p° F; -25o/-48m/13p °C **Solubility:** 0.02 % **Flash Pt:** 81-90°F;27-32°C **LEL/LFL:** 0.9% **UEL/UFL:** 7.0% **Vapor Density:** 3.66 **Vapor Pressure:** 7-9 mmHg @ 70°F; 21°C **Specific Gravity:** 0.86-0.88 **Incompatibilities:** Strong oxidizers and strong acids **Appearance and odor:** Colorless liquid with an aromatic odor.	Effects may of overexposure include irritation at all points of contact, CNS changes (i.e. dizziness, excitement, drowsiness, incoherent, staggering gait), difficulty in breathing, pulmonary edema, and possibly respiratory failure. Chronic effects may include dermatitis and cornea vacuolization.

TABLE 6-1

CHEMICAL, PHYSICAL, AND TOXICOLOGICAL DATA

NEX SERVICE STATION, NAS BRUNSWICK

Substance	Air Monitoring/Sampling Information		Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
Gasoline 8006-61-9	Relative response ratios for the components of gasoline range from 100 - 200% for PID and FID detection.	See components for measurement considerations.	OSHA: No PEL established. ACGIH : 300 ppm TWA[8] 500 ppm STEL NIOSH: Reduce to lowest feasible concentration.	**Respiratory Protection:** Odor threshold 0.7 ppm, adequate air purifying respirator with organic vapor cartridges up to 100 ppm. **Recommended Gloves:** Nitrile >6.00 hrs; PV alcohol >6.00 hrs; Viton/neoprene >8.00 hrs	**Boiling Pt:** 102°F; 39°C **Melting Pt:** Not available **Solubility:** Negligible **Flash Pt:** -50°F; -45°C **LEL/LFL:** 1.4% **UEL/UFL:** 7.6% **Vapor Density:** ~5 **Vapor Pressure:** 38-300 mmHg (varies seasonally) **Specific Gravity:** 0.74 @ 20/20°C **Incompatibilities:** Strong oxidizers, peroxides, strong acids, and perchlorates **Appearance and Odor:** Colorless liquid with gasoline odor.	Overexposure to this substance may result in irritation to the eyes, skin, and mucous membranes. Systemically, headache, fatigue, blurred vision, dizziness, slurred speech, confusion, possible convulsion, and chemical pneumonia (aspiration). Prolonged or chronic exposures may result in possible liver or kidney damage. Components of this substance have been determined to be confirmed human carcinogens.

Tabl 6-2

Heat Strain Symptoms

STOP WORK if Any Worker Demonstrates Any Of The Following

Heart Rate	Sustained (several minutes) heart rate minus worker's age > of 180 beats per minute (bpm) measured at any time.
Body Core Temperature	> 101.3°F (38.5° C)
Recovery Heart Rate	> 110 bpm (Measured 1 minute after peak work effort)
Other symptoms	Sudden and sever fatigue, nausea, dizziness, or headache

Individuals May Be At Greater Risk of Heat Stress If:

Profuse sweating is sustained over hours
Weight loss over a shift is > 1.5% of beginning body weight
24-hour urinary sodium excretion is less than 50 nmoles

7.0 AIR MONITORING

Air monitoring will be performed to evaluate worker breathing zone areas and source areas for the presence of airborne releases. The air monitoring requirements presented in this HASP were selected based on the available information pertaining to site contamination and historical site usage. As previously mentioned, the contaminants of concern at this site include Gasoline Range Organics (GRO), and the hazardous ingredients of gasoline: benzene, ethyl benzene, toluene, and xylenes (BTEX). Specific information on concentrations that may be present in site media were not available at the time of this HASP preparation. If/when more information becomes available, this HASP will be subject to review and possible modification.

7.1 INSTRUMENTS AND USE

Based on the properties of GRO and BTEX, the use of either a photoionization detector or a flame ionization detector will be acceptable at this site. Either instrument is highly responsive to all of these volatile organic substances. Instruments will be used primarily to monitor source points and worker breathing zone areas, while observing instrument action levels. Action levels are discussed in Table 5-1 as they may apply to a specific task or location, and are generally described in Table 7-1, below:

Table 7-1
Monitoring Instrument Action Levels

Instrument	Responsiveness to GRO and BTEX	Action Level for NEX Service Station Site (Based on Benzene)	Response Measures to be Observed if Action Level is Exceeded
PID (with 10.2 eV probe)	100 – 116%	5 ppm for 5 minutes/day in worker breathing zone	Retreat upwind to unaffected area. Resume work if/when Background levels are regained.
		Pull Draeger tube Benzene 0.5/c.	If brownish yellow stain appears, retreat and resume work only if/when background levels are regained.
			If stain does not appear, resume work and observe 50 ppm BZ action level for PID/FID.
FID	100 – 150%	Same as specified for PID	Same as specified above for PID.

7.1.1 Photoionization Detector (PID) or Flame Ionization Detector (FID)

For this site, either a PID (using a lamp energy of 10.2 eV or higher) or an FID may be used to monitor for the presence the volatile organic inhalable hazard concerns that may exist. Both devices are adequately responsive to the identified contaminants of concern. The selected instrument is to be used to monitor potential source areas (boreholes, monitoring wells, workers breathing zones, etc.) during site activities.

Prior to the commencement of any field activities, the background levels of the site must be determined and noted. Daily background readings will be taken away from any areas of potential contamination. These readings, any influencing conditions (i.e., weather, temperature, humidity) and site location must be documented in the field operations logbook or other site documentation (e.g., sample log sheet).

7.1.2 Hazard Monitoring Frequency

Table 5-1 presents the frequencies that hazard monitoring will be performed as well as the action levels which will initiate the use of elevated levels of protection. The SHSO may decide to increases these frequencies based on instrument responses and site observations. The frequency at which monitoring is performed will not be reduced without the prior consent of the PHSO or HSM.

7.2 INSTRUMENT MAINTENANCE AND CALIBRATION

Hazard monitoring instruments will be maintained and pre-field calibrated by the Tetra Tech NUS Equipment Manager and/or rental service employed. Operational checks and field calibration are to be performed on the instruments in accordance with manufacturer recommendations, but generally at least once each day prior to their use. The PID must be field calibrated daily and an additional field calibration must be performed at the end of each day to determine any significant instrument drift). These operational checks and calibration efforts will be performed in a manner that complies with the employees' health and safety training, and with the manufacturer's recommendations and standard operating procedures. All calibration efforts must be documented. Figure 7-1 is provided for documenting these calibration activities. This information may instead be recorded in a field operations logbook, provided that the information specified in Figure 7-1 is recorded. This required information includes the following:

- Date calibration was performed
- Individual calibrating the instrument
- Instrument name, model, and serial number
- Any relevant instrument settings and resultant readings (before and after) calibration
- Identification of the calibration standard (lot no., source concentration, supplier)
- Any relevant comments or remarks

FIGURE 7-1
DOCUMENTATION OF FIELD CALIBRATION

SITE NAME: NAS Brunswick

PROJECT NO.: CTO 0014

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

8.0 TRAINING/MEDICAL SURVEILLANCE REQUIREMENTS

8.1 INTRODUCTORY/REFRESHER/SUPERVISORY TRAINING

This section specifies health and safety training and medical surveillance requirements for both Tetra Tech NUS and subcontractor personnel participating in on site activities.

8.1.1 Requirements For Tetra Tech NUS, Inc. and Subcontractor Personnel

Tetra Tech NUS and subcontractor personnel who will engage in field associated activities as described in this HASP must have:

- Completed 40 hours of introductory hazardous waste site training or equivalent work experience as defined in OSHA Standard 29 CFR 1910.120(e).
- Completed 8-Hour Refresher Training, if the identified persons had introductory training more than 12 months prior to site work.
- Completed 8-hour Supervisory training in accordance with 29 CFR 1910.120(e)(4), if their assigned function will involve the supervision of subordinate personnel.

Documentation of introductory training or equivalent work experience, supervisory, and refresher training as well as site-specific training will be maintained at the site. Copies of certificates or other official documentation will be used to fulfill this requirement.

8.2 SITE-SPECIFIC TRAINING

Tetra Tech NUS will provide site-specific training to Tetra Tech NUS employees and subcontractor personnel who will perform work on this project.

Figure 8-1 will be used to document the provision and content of the project-specific and associated training. Site personnel will be required to sign this form prior to commencement of site activities.

TtNUS will conduct a pre-activities training session prior to initiating site work. Additionally, a brief meeting will be held daily to discuss operations planned for that day. At the end of the workday, a short meeting may be held to discuss the operations completed and any problems encountered. This activity will be supported through the use of a Safe Work Permit System (See Section 10.2).

8.3 MEDICAL SURVEILLANCE

8.3.1 Medical Surveillance Requirements for Tetra Tech NUS and Subcontractor Personnel

Tetra Tech NUS and subcontractor personnel participating in project field activities will have had a physical examination. Physical examinations shall meet the minimum requirements of paragraph (f) of OSHA 29 CFR 1910.120. The physical examinations will be performed to ensure that personnel are medically qualified to perform hazardous waste site work using respiratory protection.

Documentation for medical clearances will be maintained at the job site and made available, as necessary. Subcontractor personnel may use an alternative documentation for this purpose. The "Subcontractor Medical Approval Form" can be used to satisfy this requirement, or a letter from an officer of the company. The letter should state that the persons listed in the letter participate in a medical surveillance program meeting the requirements contained in paragraph (f) of Title 29 of the Code of Federal Regulations (CFR), Part 1910.120, entitled "Hazardous Waste Operations and Emergency Response." The letter should further state the following:

- The persons listed have had physical examinations under this program within the frequency as determined sufficient by their occupational health care provider
- Date of the exam
- The persons identified have been cleared, by a licensed physician, to perform hazardous waste site work and to wear positive- and negative- pressure respiratory protection.

A sample Subcontractor Medical Approval Form and form letter have been provided to eligible subcontractors in the Bid Specification package.

8.3.2 Requirements for Field Personnel

Each field team member, including subcontractors and visitors, entering the exclusion zone(s) shall be required to complete and submit a copy of the Medical Data Sheet that is available in Attachment V of this HASP. This shall be provided to the SHSO, prior to participating in site activities. The purpose of this document is to provide site personnel and emergency responders with additional information that may be necessary in order to administer medical attention.

8.4 SUBCONTRACTOR EXCEPTION

If through the execution of their contract elements the subcontractor will not enter the exclusion zone and there is no potential for exposure to site contaminants, subcontractor personnel may be exempt from the

training and medical surveillance requirements with the exception of Section 8.2. Examples of subcontractors who may qualify as exempt from training and medical surveillance requirements may include surveyors who perform surveying activities in site perimeter areas or areas were there is no potential for exposure to site contaminants and support or restoration services. **Use of this Subcontractor Exception is strictly limited to the authority of the CLEAN Health and Safety Manager.**

FIGURE 8-1

SITE-SPECIFIC TRAINING DOCUMENTATION

My signature below indicates that I am aware of the potential hazardous nature of performing investigation activities at the NAS Brunswick located in Brunswick, Maine, and that I have received site-specific training which included the elements presented below:

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

My signature below indicates that I have been given the opportunity to ask questions and that my questions have been answered to my satisfaction, and that the dates of my training and medical surveillance indicated below are accurate.

Name (Printed and Signature)	Site-Specific Training Date	40-Hour Training (Date)	8-Hour Refresher Training (Date)	8-Hour Supervisory Training (Date)	Medical Exam

9.0 SPILL PREVENTION AND CONTAINMENT PROGRAM

9.1 SCOPE AND APPLICATION

This program applies to the single or aggregate accumulation of bulk storage materials (over 55-gallons). As the classification of certain materials such as IDW is unknown, these materials will be treated as hazardous, pending laboratory certification to the contrary. The types of materials for which this program will apply are as follows:

- Investigative Derived Wastes (IDW) such as decontamination fluids, soil cuttings, and purge and well development waters
- Resource Storage – Limited fuel and lubricant storage

The spill containment and control will be engaged any time there is a release of the above-identified materials from a containment system or vessel. This spill containment program will be engaged in order to minimize associated hazards.

9.2 POTENTIAL SPILL AREAS

Potential spill areas will be periodically monitored in an ongoing attempt to prevent and control further potential contamination of the environment. Currently, limited areas are vulnerable to this hazard including:

- Resource deployment
- IDW Waste transfer
- Central staging

It is anticipated that the IDW generated as a result of this scope of work will be containerized, labeled, and staged to await further analyses. The results of these analyses will determine the method of disposal.

9.3 CONTAINMENT AREAS

In order to facilitate leak and spill inspection and response, and to minimize potential hazards which may impact the integrity of the storage containers, the staging area for these substances will be structured as follows:

9.3.1 IDW

- 55 Gallon Drums (United Nations 1A2 configurations) – Maximum 4 Drums to a Pallet; labels and the retaining ring bolt and nut on the outside of each drum to facilitate easy access; Minimum 4-feet between each row of pallets. The decision to construct a bermed and lined area will be the decision of project management .

- Storage Tank – Polyethylene Construction – Tank shall be placed into a bermed enclosure of sufficient size to accommodate 110% of anticipated volume (Largest container plus 10% for rainwater and container displacement).

Regardless of container types selected, the staging area will be identified as a Satellite Storage Area with proper signage, points of contact in the event of an emergency, alternate contacts, and identification of stored material (i.e., Purge or decontamination waters, soil cuttings, etc.).

An Inventory Log will be maintained by the FOL regarding types of IDW and volumes generated. An updated Inventory List will be provided by the FOL to the designated Emergency Response Agency or Base Contact during days off and between shifts or phases of operations.

9.3.2 Flammable/POL Storage

Flammable Storage [i.e., fuels, decontamination solvents (isopropanol), sample preservatives (methanol)] and Petroleum/oil/lubricants (POL) will require proper dispensing containers and necessary storage for cumulative volumes in excess of 25 gallons. Storage and dispensing will comply with the following requirements:

- The fuels, which will be stored and dispensed from portable containers, will utilize safety cans.
- Portable hand held storage containers will be labeled per Hazard Communication requirements.
- Larger volumes stored for fueling equipment will be stored in approved mobile Above Ground Storage Tanks with secondary containment capable of holding the tank volume plus 10%.
- Portable flammable liquid storage tanks will be properly grounded and will have bonding capabilities for the transfer of loading and off-loading of its contents.
- Dispensing locations will be supported by a Fire Extinguisher positioned no closer than 50 feet from the storage tank, properly mounted and identified.
- The storage location will be well marked with proper signage, protective bumper poles and will have straight through access/egress for vehicles.

9.4 MATERIALS HANDLING

To minimize the hazards associated with moving drums and containers (i.e, lifting, pinch and compression points) material handling will be supported in the following manner:

- A drum cart with pneumatic tires will be required, if drums are used for IDW storage. This cart will be used to relocate drums within the staging and satellite storage location.

- In addition, a mechanized means such as a suitably equipped skid loader or back-hoe will be provided to move IDW containers from the field location to the staging and satellite storage location. This piece of equipment will also be used in site clearance and restoration as deemed appropriate and necessary.

Other means of material handling will be evaluated by the SHSO based on their ability to minimize or eliminate material handling hazards.

9.5 LEAK AND SPILL DETECTION

To establish an early detection of potential spills or leaks, a periodic walk-around by the personnel staging or disposing of drums or in the Resource Deployment area will be conducted during working hours to visually determine that storage vessels are not leaking. If a leak is detected, the FOL will be notified and the Spill Containment/Control Response Plan as specified in Section 9.8 will be engaged. Inspections will be documented in the project logbook.

9.6 PERSONNEL TRAINING AND SPILL PREVENTION

Personnel will be instructed in the procedures for incipient spill prevention, containment, and collection of hazardous materials in the site-specific training. The FOL and/or the SHSO will serve as the Spill Response Coordinators for this operation, should the need arise. Personnel through the course of this project will be drilled as part of testing the EAP.

9.7 SPILL PREVENTION AND CONTAINMENT EQUIPMENT

The following represents the minimum equipment that will always be maintained at the staging areas the purpose of supporting this Spill Containment/Control Plan.

- Sand, clean fill, vermiculite, or other non combustible absorbent (Oil-dry)

- Extra Drums (55-gallon U.N. 1A2) should the need to transfer material from leaking containers arise.
- Pumps (Gas or Electric necessary for transferring liquids from leaking containers)/tubing
- Shovels, rakes, and brooms
- Container labels
- Personal Protective Equipment
  - Nitrile outer gloves
  - Splash Shield
  - Impermeable over-boots
  - Rain suit

9.8 SPILL CONTAINMENT/CONTROL RESPONSE PLAN

This section describes the procedures the Tetra Tech NUS field personnel will employ upon the detection of a spill or leak.

- Notify the SHSO or FOL immediately upon detection of a leak or spill. Activate emergency alerting procedures for that area to remove non-essential personnel.

- Employ the personal protective equipment stored at the staging area. Take immediate actions to stop the leak or spill by plugging or patching the container or raising the leak to the highest point in the vessel. Spread the absorbent material in the area of the spill, covering it completely.

- Transfer the material to a new vessel; collect and containerize the absorbent material. Label the new container appropriately. Await analyses for treatment and disposal options.

- Re-containerize spills, including 2-inch of top cover (if over soils) impacted by the spill. Await test results for treatment or disposal options.

It is not anticipated that a spill will occur that the field crew cannot handle. Should this occur, notification of the appropriate Emergency Response agencies will be carried out by the FOL or SSO in accordance with the procedures specified in Section 2.0 of this HASP.

10.0 SITE OPERATIONS AND CONTROL

Site operations and control will be facilitated through the use of established work zones and security and control of those zones. These activities will minimize the impact and spread of contaminants brought to the surface through subsurface investigative methods as well as protect personnel and visitors within these zones during ongoing operations.

10.1 WORK ZONES

Tetra Tech NUS will delineate and use work zones in conjunction with decontamination procedures to prevent the spread of contaminants to other areas of the site. A three-zone approach will be used for work at this site; an Exclusion Zone, a Contamination Reduction Zone, and a Support Zone. These will be used to control access to the work areas, restricting the general public, avoiding potentials to spread any contaminants, and to protect individuals who are not cleared to enter by way of training and/or medical surveillance qualifications.

10.1.1 Exclusion Zone

An Exclusion Zone will be established at each sampling point/monitoring well location. The purpose of the exclusion zone is to define the area where a more rigorous protocol for workers within what is determined to be an impact area. The impact area is that area which could be adversely impacted by either chemical or physical hazards. Exclusion zone size and dimensions will vary based on activities. Impact areas dimensions will be influenced by the following considerations:

- Physical and topographical features of the site
- Weather conditions
- Field and analytical measurements of air and environmental contaminants
- Air dispersion calculations
- Potential for explosion and dispersion
- Physical, chemical and toxicological properties of the contaminants being investigated
- Tasks to be conducted
- Decontamination procedures
- Potential for exposure

As conditions change the dimensions of the exclusion zone will change. However, the following dimensions represent a starting point from which the exclusion zones will be expanded:

- DPT – Soil boring/Monitoring Well Installation. The exclusion zone for this activity will be set at the height of the mast, plus five feet surrounding the point of operation, or 25-feet, whichever is greater.

- Monitoring well development and sampling. The exclusion zone for this activity will be set at 10-feet surrounding the well head and discharge collection container.

- Decontamination operation. The exclusion zone for this activity will be set at 25 feet surrounding the heavy equipment decontamination area.

- Investigative Derived Waste (IDW) area will be constructed and barricaded. Only authorized personnel will be allowed access.

Exclusion zones shall remain marked until the SHSO has evaluated the restoration effort and has authorized changing the zone status.

Exclusion zones will be marked using barrier tape, traffic cones and/or drive poles. Signs will be posted to inform and direct site personnel and site visitors.

10.1.2 Contamination Reduction Zone

The contamination reduction zone may be split to represent two separate functions. The first function will be a control/supply point for supporting exclusion zone activities. The second function, which may take place a sufficient distance from the exclusion zone is the decontamination of personnel and heavy equipment.

In order to move from the exclusion zone to a separate location the following activities will be used:

- As samplers move from location to another location during sampling activities, dedicated sampling devices and PPE will be washed of gross contamination, removed, separated, and bagged. Personnel will use hygienic wipes, such as Handy Wipes, as necessary for personnel decontamination until they can access the centralized decontamination unit. At the first available opportunity personnel will wash their face and hands. This is critical prior to breaks and lunch when contamination can be transferred to the mouth through hand to mouth contact.

- Muddy over-boots and gloves may be required to go through a gross contamination wash at the exclusion zone. These items will then be cleaned thoroughly at the centralized decontamination unit.

- Potentially contaminated tooling along with PPE will be wrapped, when necessary, for transport to the decontamination area. These items will be disposed of as general refuse.

- Upon completion of the assigned tasks the personnel will move through the central decontamination area to clean reusable PPE and field equipment. Based on ambient conditions medical evaluations may take place at the termination point of the decontamination line. These evaluations will include pulse rate, oral temperature, breathing rate to evaluate physiological demands on site personnel. As stated earlier, these evaluations will be based on ambient conditions and acclimation periods.

10.1.3 Support Zone

The Support Zone will consist of a field trailer, storage, lay-down areas, or some other uncontaminated, controlled point. The Support Zone for this project will include a staging area where site vehicles can be parked, equipment will be unloaded, and where food and drink containers will be maintained. The support zones will be established in clean areas of the site.

10.2 SAFE WORK PERMITS

All work conducted in support of this project will be performed using Safe Work Permits to guide and direct field crews on a task by task basis. An example of the Safe Work Permit is provided in Figure 10-1. The daily meetings conducted by the FOL/SHSO will further support these work permits. The use of these permits will ensure that site-specific considerations and changing conditions are incorporated into the planning effort. Safe Work Permits will require the signatures of either the FOL or the SHSO. Personnel engaged in on-site activities must be made aware of the elements indicating levels of protection and precautionary measures to be used.

The use of these permits will establish and provide for reviewing protective measures and hazards associated with each operation. This HASP will be used as the primary reference for selecting levels of protection and control measures.

FIGURE 10-1
SAFE WORK PERMIT

Permit No. _____ Date: _____ Time: From _____ to _____

SECTION I: General Job Scope (To be filled in by person performing work)

I. Work limited to the following (description, area, equipment used): _____

II. Names: _____

III. Onsite Inspection conducted ☐ Yes ☐ No Initials of Inspector _____ _____
TtNUS

SECTION II: General Safety Requirements (To be filled in by permit issuer)

IV. Protective equipment required
Level D ☐ Level B ☐
Level C ☐ Level A ☐

Respiratory equipment required
Yes ☐ See Reverse
No ☐

Modifications/Exceptions: _____

V. Chemicals of Concern | Action Level(s) | Response Measures

FOL and/or SHSO: Each item below must be checked Yes, No or NA in all remaining sections (VI through IX)

VI. Additional Safety Equipment/Procedures

Hardhat	☐ Yes	☐ No	Hearing Protection	☐ Yes	☐ No
Safety Glasses	☐ Yes	☐ No	Safety belt/harness	☐ Yes	☐ No
Chemical/splash goggles	☐ Yes	☐ No	Radio	☐ Yes	☐ No
Splash Shield	☐ Yes	☐ No	Barricades	☐ Yes	☐ No
Splash suits/coveralls	☐ Yes	☐ No	Gloves (Type)_____	☐ Yes	☐ No
Steel toe/shank	☐ Yes	☐ No	Work/rest regimen	☐ Yes	☐ No
Workboots.	☐ Yes	☐ No			

Modifications/Exceptions: _____

VII. Procedure review with permit acceptors

	Yes	NA		Yes	NA
Safety shower/eyewash (Location & Use)	☐	☐	Emergency alarms	☐	☐
Procedure for safe job completion	☐	☐	Evacuation routes	☐	☐
Contractor tools/equipment inspected	☐	☐	Assembly points	☐	☐

VIII. Site Preparation

	Yes	NA
Utility Locating and Excavation Clearance completed	☐	☐
Vehicle and Foot Traffic Routes Cleared and Established	☐	☐
Physical Hazards Barricaded and Isolated	☐	☐
Emergency Equipment Staged	☐	☐

IX. Additional Permits required (Hot work, confined space entry, excavation etc.)..... ☐ Yes ☐ No
If yes, contact Health Science, Pittsburgh, PA Office

X. Special instructions, precautions: _____

Permit Issued by: _____ Permit Accepted by: _____
Job Completed by: _____ Date: _____

Upon completion of the work for which the Safe Work Permit was assigned, the Safe Work Permit will be turned into the FOL or the SHSO. Concerns, complaints, and suggestions may be made on the reverse of the Safe Work Permit for consideration by the FOL and/or the SHSO. Permits turned in with suggestions, difficulties, or complaints will be forwarded to the PHSO for review.

The Safe Work Permit and the HASP will serve as the primary reference for work place evaluations and audits conducted to determine if the task is being conducted under the direction conveyed by the HASP and the Safe Work Permit.

10.3 SITE MAP

Once the areas of contamination, access routes, topography, dispersion routes are determined, a site map will be generated and adjusted as site conditions change. This map will be posted to illustrate up-to-date information of contaminants and adjustment of zones and access points. This map will be posted at the field support trailer.

10.4 BUDDY SYSTEM

Personnel engaged in on-site activities will practice the "buddy system" to ensure the safety of the personnel involved in this operation.

10.5 MATERIAL SAFETY DATA SHEET (MSDS) REQUIREMENTS

Tetra Tech NUS and subcontractor personnel will provide MSDSs for all chemicals brought on-site. The contents of these documents will be reviewed by the SHSO for content and accuracy. The SHSO will review these documents with the user(s) of the chemical substances prior to any actual use or application or the substances on-site as necessary. The MSDSs will be maintained in a central location (i.e., temporary office) and will be available for anyone to review upon request. The SHSO will be responsible for implementing a site-specific Hazard Communication Program (See Section 5.0 of the TtNUS Health and Safety Guidance Manual). This includes collection of MSDSs, creation and maintenance of an accurate Chemical Inventory Listing, addressing container labeling and personnel training issues, and other aspects of Hazard Communication.

10.6 COMMUNICATION

It is anticipated that site personnel will be working in close proximity during proposed field activities. In the event that site personnel are in isolated areas or are separated by significant distances, a supported

means of communication between field crews will be utilized. Two-way radio communication devices, if needed, will be used only with NAS Brunswick approval.

External communications will be accomplished utilizing telephones at predetermined and approved locations or through cellular phones. External communication will primarily be used for the purpose of resource and emergency resource communications. Prior to the commencement of site activities, the FOL will determine and arrange for telephone communications, if it is determined a cellular means will not be used.

10.7 SITE VISITORS

All site visitors are required to gain initial access to the base by coordinating with the TtNUS PM or designee and following established base access procedures.

Once access to the base is obtained, personnel who require access to Tetra Tech NUS work sites (areas of ongoing operations) will be required to obtain permission from the FOL and the Base Contact. Upon gaining access to the work site, site visitors wishing to observe operations in progress will be required to meet the minimum requirements as stipulated below.

- Site visitors will be routed to the FOL, who will sign them into the field logbook. Information to be recorded in the logbook will include the individuals name (proper identification required), who they represent, and the purpose for the visit. The FOL is responsible for ensuring that site visitors are always escorted while on site.

- Site visitors will be required to produce the necessary information supporting clearance on to the site. This includes information attesting to applicable training (40-hours of HAZWOPER training required for Southern Division Navy Personnel), and medical surveillance as stipulated in Section 8.3, of this document. In addition, to enter the sites operational zones during planned activities, visitors will be required to first go through site-specific training covering the topics stipulated in Section 8.2 of this HASP.

Once the site visitors have completed the above items they will be permitted to enter the site and applicable operational areas. Visitors are required to observe the protective equipment and site restrictions in effect at the work areas visited. Any visitors not meeting the requirements as stipulated in this plan for site clearance will not be permitted to enter the site operational zones during planned activities. Any incidence of unauthorized site visitation will cause on-site activities to be terminated until

that visitor can be removed. Removal of unauthorized visitors will be accomplished with support form the Base Contact, if necessary. At a minimum, the Base Contact will be notified of any unauthorized visitors.

10.8 SITE SECURITY

As this activity will take place at a Navy facility, the first line of security will be provided by the base gate restricting the general public. The second line of security will take place at the work site referring interested parties to the FOL and Base Contact.

Security at the work areas will be accomplished using field personnel. This is a multiple person operation, involving multiple operational zones. Tetra Tech NUS personnel will retain complete control over active operational zones.

The Base Contact will serve as the focal point for base personnel and interested parties and will serve as the primary enforcement contact.

10.9 SANITATION AND BREAK AREAS

This section will address the following items:

- Toilets
- Potable water
- Showers and change rooms
- Break Areas

10.9.1 Toilets

One toilet will be provided for every 20 people. All toilets will be unisex and will have locking doors. The toilet provided will either be a chemical toilet and service provider or the flush toilet readily accessible at a predetermined approved location.

10.9.2 Potable Water

Potable water as well as electrolyte balance sports drinks such as Gatorade will be provided to the field crews for fluid replacement, as it is necessary under conditions of ambient temperature extremes. Storage and dispensing will proceed as follows:

- All containers will be clean and replenished daily.

- All containers will clearly marked as to their contents (Potable Water – Drinking Water Only; Gatorade, etc.).

- Dispensing locations will be placed in identified break areas within the support zone. The most likely location will be at a support vehicle staged near the work area. This will serve as an area for cooling or warming as well as an identified food and drink consumption area.

- If larger containers are used, dispensing cups will be provided.

- The coolers used for storage of potable drinks and cups will be stored in plastic bags away from potentially contaminating materials when not in use.

Fluid intake recommendations may be made based on the medical evaluations conducted at the end of the decontamination process, as necessary based on ambient conditions.

10.9.3 Showers and Change Rooms

Based on this scope and duration of this project shower facilities and locker rooms will not be required.

10.9.4 Break Areas

Given the location and the time of the year structured suitable locations for work breaks and warming/cooling regimens will be necessary. Shelters such as canopies should be provided for protection from the sun as well as to provide a suitable area to permit cooling in this hot environment.

11.0 CONFINED SPACE ENTRY

It is not anticipated, under the proposed scope of work, that confined space and permit-required confined space activities will be conducted. **Therefore, personnel under the provisions of this HASP are not allowed, under any circumstances, to enter confined spaces.**

A confined space is defined as an area which has one or more of the following characteristics:

- Is large enough and so configured that an employee can bodily enter and perform assigned work.
- Has limited or restricted means for entry or exit (for example, tanks, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry).
- Is not designed for continuous employee occupancy.

A Permit-Required Confined Space is one that:

- Contains or has a potential to contain a hazardous atmosphere.
- Contains a material that has the potential to engulf an entrant.
- Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross-section.
- Contains any other recognized, serious, safety or health hazard.

For further information on confined space, consult the Health and Safety Guidance Manual or call the PHSO. If confined space operations are to be performed as part of the scope of work, detailed procedures and training requirements will have to be addressed.

12.0 MATERIALS AND DOCUMENTATION

The TtNUS FOL shall ensure the following materials/documents are taken to the project site and used when required.

- A complete copy of this HASP
- Health and Safety Guidance Manual
- Incident Reports
- Medical Data Sheets
- MSDSs for the chemicals brought onsite, including decon solutions, fuels, grout, sand, sample preservatives, calibration gases, etc.
- A full-size OSHA Job Safety and Health Poster (posted in the site trailers)
- Training/Medical Surveillance Documentation Form (Blank)
- Emergency Reference Information (Section 2.0, extra copy for posting)

12.1 MATERIALS TO BE POSTED OR MAINTAINED AT THE SITE

The following documentation is to be posted or maintained at the site for quick reference purposes. In situations in which posting these documents is not feasible (such as no office trailer), these documents should be separated and immediately accessible.

Chemical Inventory Listing (posted) - This list represents the chemicals brought onsite, including decontamination solutions, sample preservations, fuel, etc. This list should be posted in a central area.

Material Safety Data Sheets (MSDSs) (maintained) - The MSDSs should also be in a central area accessible to site personnel. These documents should match the listings on the chemical inventory list for the substances used onsite. It is acceptable to have these documents within a central folder and the chemical inventory as the table of contents.

Th OSHA Job Safety & Health Protection Poster (posted) - This poster, as directed by 29 CFR 1903.2 (a)(1), should be conspicuously posted in places where notices to employees are normally posted. Each FOL shall ensure that this poster is not defaced, altered, or covered by other material.

Site Clearance (maintained) - This list is found within the training section of the HASP (See Figure 8-2). This list identifies the site personnel, dates of training (including site-specific training), and medical surveillance. The lists indicates not only clearance but also status. If personnel do not meet these requirements, they do not enter the site while site personnel are engaged in activities.

Emergency Phone Numbers and Directions to the Hospital(s) (posted) - This list of numbers and directions will be maintained at the phone communications point and in each site vehicle.

Medical Data Sheets/Cards (maintained) - Medical Data Sheets will be completed by onsite personnel and filed in a central location. The Medical Data Sheet will accompany any injury or illness requiring medical attention to the medical facility. A copy of this sheet or a wallet card will be given to personnel to carry.

Hearing Conservation Standard (29 CFR 1910.95) (posted) - This standard will be posted any time hearing protection or other noise abatement procedures are used.

Personnel Monitoring (maintained) - Results generated through personnel sampling (levels of airborne toxins, noise levels, etc.) will be posted to inform individuals of the results of that effort.

Placards and Labels (maintained) - Where chemical inventories have been separated because of quantities and incompatibilities, these areas will be conspicuously marked using Department of Transportation (DOT) placards and acceptable (Hazard Communication 29 CFR 1910.1200(f)) labels.

The purpose, as stated above, is to allow site personnel quick access to this information. Variations concerning location and methods of presentation are acceptable as long as the objection is accomplished.

13.0 GLOSSARY

ACGIH	American Conference of Governmental Industrial Hygienists
CFR	Code of Federal Regulations
CIH	Certified Industrial Hygienist
CNS	Central Nervous System
CRZ	Contamination Reduction Zone
CSP	Certified Safety Professional
DOD	Department of Defense
DOT	Department of Transportation
EPA	Environmental Protection Agency
eV	electron Volts
FOL	Field Operations Leader
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
HSM	Health and Safety Manager
NIOSH	National Institute Occupational Safety and Health
OSHA	Occupational Safety and Health Administration (U.S. Department of Labor)
PEL	Permissible Exposure Limit
PHSO	Project Health and Safety Officer
PID	Photo Ionization Detector
PM	Project Manager
PPE	Personal Protective Equipment
SOP	Standard Operating Procedure
SHSO	Site Health and Safety Officer
STEL	Short Term Exposure Limit
TBD	To Be Determined
TtNUS	Tetra Tech NUS, Inc.
TWA	Time Weighted Average
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compounds
WP	Work Plan

ATTACHMENT I

INJURY/ILLNESS PROCEDURE AND REPORT FORM

benefits paid are regulated by the state worker's compensation boards and vary from state to state. Corporate Administration in Pasadena is responsible for administering the Company's worker's compensation program. The following is a general explanation of worker's compensation provided in the event that you become injured or develop an illness as a result of your employment with Tetra Tech or any of its subsidiaries. Please be aware that the term used for worker's compensation varies from state to state.

WHO IS COVERED:

All employees of Tetra Tech, whether they are on a full-time, part-time or temporary status, working in an office or in the field, are entitled to worker's compensation benefits from the first day of work. All employees must follow the above injury/illness reporting procedures. If you are working out-of-state and away from your home office, you are still eligible for worker's compensation benefits.

Consultants, independent contractors, and employees of subcontractors and employees from temporary employment agencies are not covered by Tetra Tech's Worker's Compensation plan.

WHAT IS COVERED:

If you are injured or develop an illness caused by your employment, worker's compensation benefits are available to you subject to the laws of the state you work in. Injuries do not have to be serious; even injuries treated by first aid practices are covered and must be reported.

TETRA TECH, INC.

ACCIDENT AND ILLNESS INVESTIGATION REPORT

To: _____
Subsidiary Health and Safety Representative

cc: _____
Workers Compensation Administrator

Project name: _____

Project number: _____

Prepared by: _____

Position: _____

Office: _____

Telephone number: _____

Fax number: _____

Information Regarding Injured or Ill Employee

Name: _____

Home address: _____

_____

Home telephone number: _____

Occupation (regular job title): _____

Department: _____

Office: _____

Gender: M ☐ F ☐ No. of dependents: _____

Marital status: _____

Date of birth: _____

Social security number: _____

Date of Accident: _____

Time Employee Began Work: _____

Time of Accident: _____ a.m. ☐ p.m. ☐

☐ Check if time cannot be determined

Location of Incident

Street address: _____

City, state, and zip code: _____

County: _____

Was place of accident or exposure on employer's premises? Yes ☐ No ☐

Information About the Incident

What was the employee doing just before the incident occurred? Describe the activity as well as the tools, equipment, or material the employee was using. Be specific. Examples: "Climbing a ladder while carrying roofing materials"; "Spraying chlorine from hand sprayer"; "Daily computer key-entry"

What Happened? Describe how the injury occurred. Examples: "When ladder slipped on wet floor, worker fell 20 feet"; "Worker was sprayed with chlorine when gasket broke during replacement"; "Worker developed soreness in wrist over time"

This form contains information relating to employee health and must be used in a manner that protects the confidentiality of the employee to the extent possible while the information is being used for occupational safety and health purposes.

TETRA TECH, INC.

ACCIDENT AND ILLNESS INVESTIGATION REPORT (Continued)

Information About the Incident (Continued)

What was the injury or illness? Describe the part(s) of the body affected and how it was affected. Be more specific than "hurt," "pain," or "sore." Examples "Strained back"; "Chemical burn, right hand"; "Carpal tunnel syndrome, left wrist"

Describe the Object or Substance that Directly Harmed the Employee: Examples: "Concrete floor"; "Chlorine"; "Radial arm saw." If this question does not apply to the incident, write "Not applicable."

Did the employee die? Yes ☐ No ☐ Date of death: _____

Was employee performing regular job duties? Yes ☐ No ☐

Was safety equipment provided? Yes ☐ No ☐ Was safety equipment used? Yes ☐ No ☐

Note: Attach any police reports or related diagrams to this report.

Witness (Attach additional sheets for other witnesses.)

Name: _____

Company: _____

Street address: _____

City: _____ State: _____ Zip code: _____

Telephone number: _____

Medical Treatment Required? ☐ Yes ☐ No ☐ First aid only

Name of physician or health care professional: _____

If treatment was provided away from the work site, provide the information below.

Facility name: _____

Street address: _____

City: _____ State: _____ Zip code: _____

Telephone number: _____

Was the employee treated in an emergency room? ☐ Yes ☐ No

Was the employee hospitalized over night as an in-patient? ☐ Yes ☐ No

This form contains information relating to employee health and must be used in a manner that protects the confidentiality of the employee to the extent possible while the information is being used for occupational safety and health purposes.

TETRA TECH, INC.

ACCIDENT AND ILLNESS INVESTIGATION REPORT (Continued)

Corrective Action(s) Taken by Unit Reporting the Accident:

Corrective Action Still to be Taken (by whom and when):

Name of Tetra Tech employee the injury or illness was first reported to: _____

Date of Report: _____ **Time of Report:** _____

I have reviewed this investigation report and agree, to the best of my recollection, with its contents.

_____ _____
Printed Name of Injured Employee Telephone Number

_____ _____
Signature of Injured Employee Date

The signatures provided below indicate that appropriate personnel have been notified of the incident.

Title	Printed Name	Signature	Telephone Number	Date
Office Manager				
Project Manager				
Site Safety Coordinator or Office Health and Safety Representative				

This form contains information relating to employee health and must be used in a manner that protects the confidentiality of the employee to the extent possible while the information is being used for occupational safety and health purposes.

TETRA TECH, INC.

ACCIDENT AND ILLNESS INVESTIGATION REPORT (Continued)

To Be Completed by the Subsidiary Health and Safety Representative

Classification of Incident:

☐ Injury ☐ Illness

Result of Incident:

☐ First aid only

☐ Days away from work

☐ Remained at work but incident resulted in job transfer or work restriction

☐ Incident involved days away and job transfer or work restriction

☐ Medical treatment only

No. of days away from work _____

Date employee left work _____

Date employee returned to work _____

No. of days placed on restriction or job transfer: _____

OSHA Recordable Case Number _____

To Be Completed by Human Resources

Social security number: _____

Date of hire: _____ Hire date for current job: _____

Wage information: $_____ per ☐ Hour ☐ Day ☐ Week ☐ Month

Position at time of hire: _____

Current position: _____ Shift hours: _____

State in which employee was hired: _____

Status: ☐ Full-time ☐ Part-time Hours per week: _____ Days per week: _____

Temporary job end date: _____

To Be Completed during Report to Workers Compensation Carrier

Date reported: _____ Reported by: _____

Confirmation number: _____

Name of contact: _____

Field office of claims adjuster: _____

This form contains information relating to employee health and must be used in a manner that protects the confidentiality of the employee to the extent possible while the information is being used for occupational safety and health purposes.

ATTACHMENT II

STANDARD OPERATING PROCEDURE
FOR
UTILITY LOCATING AND EXCAVATION CLEARANCE

TABLE OF CONTENTS

SECTION **PAGE**

1.0 PURPOSE **2**

2.0 SCOPE **2**

3.0 GLOSSARY **2**

4.0 RESPONSIBILITIES **3**

5.0 PROCEDURES **3**

5.1 BURIED UTILITIES 3
5.2 OVERHEAD POWER LINES 5

6.0 UNDERGROUND LOCATING TECHNIQUES **5**

6.1 GEOPHYSICAL METHODS 5
6.2 PASSIVE DETECTION SURVEYS 6
6.3 INTRUSIVE DETECTION SURVEYS 6

7.0 INTRUSIVE ACTIVITIES SUMMARY **7**

8.0 REFERENCES **8**

ATTACHMENTS

1 Listing of Underground Utility Clearance Resources 9
2 Frost Line Penetration Depths by Geographic Location 11
3 Utility Clearance Form 12
4 OSHA Letter of Interpretation 13

1.0 PURPOSE

Utilities such as electric service lines, natural or propane gas lines, water and sewage lines, telecommunications, and steam lines are very often in the immediate vicinity of work locations. Contact with underground or overhead utilities can have serious consequences including employee injury/fatality, property and equipment damage, substantial financial impacts, and loss of utility service to users.

The purpose of this procedure is to provide minimum requirements and technical guidelines regarding the appropriate procedures to be followed when performing subsurface and overhead utility locating services. It is the policy of Tetra Tech NUS, Inc. (TtNUS) to provide a safe and healthful work environment for the protection of our employees. The purpose of this Standard Operating Procedure (SOP) is to aid in achieving the objectives of this policy, to present the acceptable procedures pertaining to utility locating and excavation clearance activities, and to present requirements and restrictions relevant to these types of activities. This SOP must be reviewed by any employee potentially involved with underground or overhead utility locating and avoidance activities.

2.0 SCOPE

This procedure applies to all TtNUS field activities where there may be potential contact with underground or overhead utilities. This procedure provides a description of the principles of operation, instrumentation, applicability, and implementability of typical methods used to determine the presence and avoidance of contact with utility services. This procedure is intended to assist with work planning and scheduling, resource planning, field implementation, and subcontractor procurement. Utility locating and excavation clearance requires site-specific information prior to the initiation of any such activities on a specific project. This SOP is not intended to provide a detailed description of methodology and instrument operation. Specialized expertise during both planning and execution of several of the methods presented may also be required.

3.0 GLOSSARY

Electromagnetic Induction (EMI) Survey - A geophysical exploration method whereby electromagnetic fields are induced in the ground and the resultant secondary electromagnetic fields are detected as a measure of ground conductivity.

Magnetometer – A device used for precise and sensitive measurements of magnetic fields.

Magnetic Survey – A geophysical survey method that depends on detection of magnetic anomalies caused by the presence of buried ferromagnetic objects.

Metal Detection – A geophysical survey method that is based on electromagnetic coupling caused by underground conductive objects.

Vertical Gradiometer – A magnetometer equipped with two sensors that are vertically separated by a fixed distance. It is best suited to map near surface features and is less susceptible to deep geologic features.

Ground Penetrating Radar – Ground Penetrating Radar (GPR) involves specialized radar equipment whereby a signal is sent into the ground via a transmitter. Some portion of the signal will be reflected from the subsurface material, which is then recorded with a receiver and electronically converted into a graphic picture.

4.0 RESPONSIBILITIES

Project Manager (PM)/Task Order Manager (TOM) - Responsible for ensuring that all field activities are conducted in accordance with this procedure.

Site Manager (SM)/Field Operations Leader (FOL) - Responsible for the onsite verification that all field activities are performed in compliance with approved SOPs or as otherwise directed by the approved project plan(s).

Site Health & Safety Officer (SHSO) – Responsible to provide technical assistance and verify full compliance with this SOP. The SHSO is also responsible for reporting any deficiencies to the Corporate Health and Safety Manager (HSM) and to the PM/TOM.

Health & Safety Manager (HSM) – Responsible for preparing, implementing, and modifying corporate health and safety policy and this SOP.

Site Personnel – Responsible for performing their work activities in accordance with this SOP and the TtNUS Health and Safety Policy.

5.0 PROCEDURES

This procedure addresses the requirements and technical procedures that must be performed to minimize the potential for contact with underground and overhead utility services. These procedures are addressed individually from a buried and overhead standpoint.

5.1 Buried Utilities

Buried utilities present a heightened concern because their location is not typically obvious by visual observation, and it is common that their presence and/or location is unknown or incorrectly known on client properties. This procedure must be followed prior to beginning any subsurface probing or excavation that might potentially be in the vicinity of underground utility services. In addition, the Utility Clearance Form (Attachment 3) must be completed for every location or cluster of locations where intrusive activities will occur.

Where the positive identification and de-energizing of underground utilities cannot be obtained and confirmed using the following steps, the PM/TOM is responsible for arranging for the procurement of a qualified, experienced, utility locating subcontractor who will accomplish the utility location and demarcation duties specified herein.

1. A comprehensive review must be made of any available property maps, blue lines, or as-builts prior to site activities. Interviews with local personnel familiar with the area should be performed to provide additional information concerning the location of potential underground utilities. Information regarding utility locations shall be added to project maps upon completion of this exercise.

2. A visual site inspection must be performed to compare the site plan information to actual field conditions. Any findings must be documented and the site plan/maps revised. The area(s) of proposed excavation or other subsurface activities must be marked at the site in white paint or pin flags to identify those locations of the proposed intrusive activities. The site inspection should focus on locating surface indications of potential underground utilities. Items of interest include the presence of nearby area lights, telephone service, drainage grates, fire hydrants, electrical service vaults/panels, asphalt/concrete scares and patches, and topographical depressions. Note the location of any emergency shut off switches. Any additional information regarding utility

locations shall be added to project maps upon completion of this exercise and returned to the PM/TOM.

3. If the planned work is to be conducted on private property (e.g., military installations, manufacturing facilities, etc.) the FOL must identify and contact appropriate facility personnel (e.g., public works or facility engineering) before any intrusive work begins to inquire about (and comply with) property owner requirements. It is important to note that private property owners may require several days to several weeks advance notice prior to locating utilities.

4. If the work location is on public property, the state agency that performs utility clearances must be notified (see Attachment 1). State "one-call" services must be notified prior to commencing fieldwork per their requirements. Most one-call services require, by law, 48- to 72-hour advance notice prior to beginning any excavation. Such services typically assign a "ticket" number to the particular site. This ticket number must be recorded for future reference and is valid for a specific period of time, but may be extended by contacting the service again. The utility service will notify utility representatives who then mark their respective lines within the specified time frame. It should be noted that most military installations own their own utilities but may lease service and maintenance from area providers. Given this situation, "one call" systems may still be required to provide location services on military installations.

5. Utilities must be identified and their locations plainly marked using pin flags, spray paint, or other accepted means. The location of all utilities must be noted on a field sketch for future inclusion on project maps. Utility locations are to be identified using the following industry-standard color code scheme, unless the property owner or utility locator service uses a different color code:

white	excavation/subsurface investigation location
red	electrical
yellow	gas, oil, steam
orange	telephone, communications
blue	water, irrigation, slurry
green	sewer, drain

6. Where utility locations are not confirmed with a high degree of confidence through drawings, schematics, location services, etc., the work area must be thoroughly investigated prior to beginning the excavation. In these situations, utilities must be identified using safe and effective methods such as passive and intrusive surveys, or the use of non-conductive hand tools. Also, in situations where such hand tools are used, they should always be used in conjunction with suitable detection equipment, such as the items described in Section 6.0 of this SOP. Each method has advantages and disadvantages including complexity, applicability, and price. It also should be noted that in some states, initial excavation is required by hand to a specified depth.

7. At each location where trenching or excavating will occur using a backhoe or other heavy equipment, and where utility identifications and locations cannot be confirmed prior to groundbreaking, the soil must be probed using a device such as a tile probe which is made of non-conductive material such as fiberglass. If these efforts are not successful in clearing the excavation area of suspect utilities, hand shoveling must be performed for the perimeter of the intended excavation.

8. All utilities uncovered or undermined during excavation must be structurally supported to prevent potential damage. Unless necessary as an emergency corrective measure, TtNUS shall not make any repairs or modifications to existing utility lines without prior permission of the utility owner, property owner, and Corporate HSM. All repairs require that the line be locked-out/tagged-out prior to work.

5.2 Overhead Power Lines

If it is necessary to work within the minimum clearance distance of an overhead power line, the overhead line must be de-energized and grounded, or re-routed by the utility company or a registered electrician. If protective measures such as guarding, isolating, or insulating are provided, these precautions must be adequate to prevent employees from contacting such lines directly with any part of their body or indirectly though conductive materials, tools, or equipment.

The following table provides the required minimum clearances for working in proximity to overhead power lines.

Nominal Voltage	Minimum Clearance
0 -50 kV	10 feet, or one mast length; whichever is greater
50+ kV	10 feet plus 4 inches for every 10 kV over 50 kV or 1.5 mast lengths; whichever is greater

6.0 UNDERGROUND LOCATING TECHNIQUES

A variety of supplemental utility locating approaches are available and can be applied when additional assurance is needed. The selection of the appropriate method(s) to employ is site-specific and should be tailored to the anticipated conditions, site and project constraints, and personnel capabilities.

6.1 Geophysical Methods

Geophysical methods include electromagnetic induction, magnetics, and ground penetrating radar. Additional details concerning the design and implementation of electromagnetic induction, magnetics, and ground penetrating radar surveys can be found in one or more of the TtNUS SOPs included in the References (Section 8.0).

Electromagnetic Induction

Electromagnetic Induction (EMI) line locators operate either by locating a background signal or by locating a signal introduced into the utility line using a transmitter. A utility line acts like a radio antenna, producing electrons, which can be picked up with a radiofrequency receiver. Electrical current carrying conductors have a 60HZ signal associated with them. This signal occurs in all power lines regardless of voltage. Utilities in close proximity to power lines or used as grounds may also have a 60HZ signal, which can be picked up with an EM receiver. A typical example of this type of geophysical equipment is an EM-61.

EMI locators specifically designed for utility locating use a special signal that is either indirectly induced onto a utility line by placing the transmitter above the line or directly induced using an induction clamp. The clamp induces a signal on the specific utility and is the preferred method of tracing since there is little chance of the resulting signals being interfered with. A good example of this type of equipment is the Schonstedt® MAC-51B locator. The MAC-51B performs inductively traced surveys, simple magnetic locating, and traced nonmetallic surveys.

When access can be gained inside a conduit to be traced, a flexible insulated trace wire can be used. This is very useful for non-metallic conduits but is limited by the availability of gaining access inside the pipe.

Magnetics

Magnetic locators operate by detecting the relative amounts of buried ferrous metal. They are incapable of locating or identifying nonferrous utility lines but can be very useful for locating underground storage tanks (UST's), steel utility lines, and buried electrical lines. A typical example of this type of equipment is the Schonstedt® GA-52Cx locator. The GA-52Cx is capable of locating 4-inch steel pipe up to 8 feet deep.

Non-ferrous lines are often located by using a typical plumbing tool (snake) fed through the line. A signal is then introduced to the snake that is then traced.

Ground Penetrating Radar

Ground Penetrating Radar (GPR) involves specialized radar equipment whereby a signal is sent into the ground via a transmitter. Some portion of the signal will be reflected from the subsurface material, which is then recorded with a receiver and electronically converted into a graphic picture. In general, an object which is harder than the surrounding soil will reflect a stronger signal. Utilities, tunnels, UST's, and footings will reflect a stronger signal than the surrounding soil. Although this surface detection method may determine the location of a utility, this method does not specifically identify utilities (i.e., water vs. gas, electrical vs. telephone); hence, verification may be necessary using other methods. This method is somewhat limited when used in areas with clay soil types or with a high water table.

6.2 Passive Detection Surveys

Acoustic Surveys

Acoustic location methods are generally most applicable to waterlines or gas lines. A highly sensitive Acoustic Receiver listens for background sounds of water flowing (at joints, leaks, etc.) or to sounds introduced into the water main using a transducer. Acoustics may also be applicable to determine the location of plastic gas lines.

Thermal Imaging

Thermal (i.e., infrared) imaging is a passive method for detecting the heat emitted by an object. Electronics in the infrared camera convert subtle heat differentials into a visual image on the viewfinder or a monitor. The operator does not look for an exact temperature; rather they look for heat anomalies (either elevated or suppressed temperatures) characteristic of a potential utility line.

The thermal fingerprint of underground utilities results from differences in temperature between the atmosphere and the fluid present in a pipe or the heat generated by electrical resistance. In addition, infrared scanners may be capable of detecting differences in the compaction, temperature and moisture content of underground utility trenches. High-performance thermal imagery can detect temperature differences to hundredths of a degree.

6.3 Intrusive Detection Surveys

Vacuum Excavation

Vacuum excavation is used to physically expose utility services. The process involves removing the surface material over approximately a 1' x 1' area at the site location. The air-vacuum process proceeds with the simultaneous action of compressed air-jets to loosen soil and vacuum extraction of the resulting

debris. This process ensures the integrity of the utility line during the excavation process, as no hammers, blades, or heavy mechanical equipment comes into contact with the utility line, eliminating the risk of damage to utilities. The process continues until the utility is uncovered. Vacuum excavation can be used at the proposed site location to excavate below the "utility window" which is usually 8 feet.

Hand Excavation

When the identification and location of underground utilities cannot be positively confirmed through document reviews and/or other methods, borings and excavations may be cleared via the use of non-conductive hand tools. This should always be done in conjunction with the use of detection equipment. This would be required for all locations where there is a potential to impact buried utilities. The minimum hand-excavation depth that must be reached is to be determined considering the geographical location of the work site. This approach recognizes that the placement of buried utilities is influenced by frost line depths that vary by geographical region. Attachment 2 presents frost line depths for the regions of the contiguous United States. At a minimum, hand excavation depths must be at least to the frost line depth (see Attachment 2) plus two (2) feet, but never less than 4 feet below ground surface (bgs). For hand excavation, the hole created must be reamed large enough to be at least the diameter of the drill rig auger or bit prior to drilling. For soil gas surveys, the survey probe shall be placed as close as possible to the cleared hand excavation. It is important to note that a post-hole digger must not be used in this type of hand excavation activity.

Tile Probe Surveys

For some soil types, site conditions, and excavation requirements, non-conductive tile probes may be used. A tile probe is a "T"-handled rod of varying lengths that can be pushed into the soil to determine if any obstructions exist at that location. Tile probes constructed of fiberglass or other nonconductive material are readily-available from numerous vendors. Tile probes must be performed to the same depth requirements as previously specified. As with other types of hand excavating activities, the use of a non-conductive tile probe, should always be in conjunction with suitable utility locating detection equipment.

7.0 INTRUSIVE ACTIVITIES SUMMARY

The following list summarizes the activities that must be performed prior to beginning subsurface activities:

1. Map and mark all subsurface locations and excavation boundaries using white paint or markers specified by the client or property owner.

2. Notify the property owner and/or client that the locations are marked. At this point, drawings of locations or excavation boundaries shall be provided to the property owner and/or client so they may initiate (if applicable) utility clearance.

   Note: Drawings with confirmed locations should be provided to the property owner and/or client as soon as possible to reduce potential time delays.

3. Notify "One Call" service. If possible, arrange for an appointment to show the One Call representative the surface locations or excavation boundaries in person. This will provide a better location designation to the utilities they represent. You should have additional drawings should you need to provide plot plans to the One Call service.

4. Implement supplemental utility detection techniques as necessary and appropriate to conform utility locations or the absence thereof.

5. Complete Attachment 3, Utility Clearance Form. This form should be completed for each excavation location. In situations where multiple subsurface locations exist within the close proximity of one another, one form may be used for multiple locations provided those locations are noted on the Utility Clearance Form. Upon completion, the Utility Clearance Form and revised/annotated utility location map becomes part of the project file.

8.0 REFERENCES

OSHA Letter of Interpretation, Mr. Joseph Caldwell, Attachment 4
OSHA 29 CFR 1926(b)(2)
OSHA 29 CFR 1926(b)(3)
TtNUS Utility Locating and Clearance Policy
TtNUS SOP GH-3.1; Resistivity and Electromagnetic Induction
TtNUS SOP GH-3.2; Magnetic and Metal Detection Surveys
TtNUS SOP GH-3.4; Ground-penetrating Radar Surveys

ATTACHMENT 1
LISTING OF UNDERGROUND UTILITY CLEARANCE RESOURCES

American Public Works Association
2345 Grand Boulevard, Suite 500, Kansas City, MO 64108-2625
Phone (816) 472-6100 • Fax (816) 472-1610
Web www.apwa.net • E-mail apwa@apwa.net

ONE-CALL SYSTEMS INTERNATIONAL CONDENSED DIRECTORY

Alabama
Alabama One-Call
1-800-292-8525

Alaska
Locate Call Center of Alaska, Inc.
1-800-478-3121

Arizona
Arizona Blue Stake
1-800-782-5348

Arkansas
Arkansas One Call System, Inc.
1-800-482-8998

California
Underground Service Alert North
1-800-227-2600
Underground Service Alert of Southern California
1-800-227-2600

Colorado
Utility Notification Center of Colorado
1-800-922-1987

Connecticut
Call Before You Dig
1-800-922-4455

Delaware
Miss Utility of Delmarva
1-800-282-8555

Florida
Sunshine State One-Call of Florida, Inc.
1-800-432-4770

Georgia
Underground Protection Center, Inc.
1-800-282-7411

Hawaii
Underground Service Alert North
1-800-227-2600

Idaho
Dig Line Inc.
1-800-342-1585
Kootenai County One-Call
1-800-428-4950
Shoshone - Benewah One-Call
1-800-398-3285

Illinois
JULIE, Inc.
1-800-892-0123
Digger (Chicago Utility Alert Network)
312-744-7000

Indiana
Indiana Underground Plant Protection Service
1-800-382-5544

Iowa
Iowa One-Call
1-800-292-8989

Kansas
Kansas One-Call System, Inc.
1-800-344-7233

Kentucky
Kentucky Underground Protection Inc.
1-800-752-6007

Louisiana
Louisiana One Call System, Inc.
1-800-272-3020

Maine
Dig Safe System, Inc.
1-888-344-7233

Maryland
Miss Utility
1-800-257-7777
Miss Utility of Delmarva
1-800-282-8555

Massachusetts
Dig Safe System, Inc.
1-888-344-7233

Michigan
Miss Dig System, Inc.
1-800-482-7171

Minnesota
Gopher State One Call
1-800-252-1166

Mississippi
Mississippi One-Call System, Inc
1-800-227-6477

Missouri
Missouri One-Call System, Inc.
1-800-344-7483

Montana
Utilities Underground Protection Center
1-800-424-5555
Montana One Call Center
1-800-551-8344

Nebraska
Diggers Hotline of Nebraska
1-800-331-5666

Nevada
Underground Service Alert North
1-800-227-2600

New Hampshire
Dig Safe System, Inc.
1-888-344-7233

New Jersey
New Jersey One Call
1-800-272-1000

New Mexico
New Mexico One Call System, Inc.
1-800-321-2537
Las Cruces- Dona Ana Blue Stakes
1-888-526-0400

New York
Dig Safely New York
1-800-962-7962
New York City- Long Island One Call Center
1-800-272-4480

North Carolina
The North Carolina One-Call Center, Inc.
1-800-632-4949

North Dakota
North Dakota One-Call
1-800-795-0555

Ohio
Ohio Utilities Protection Service
1-800-362-2764
Oil & Gas Producers Underground Protect'n Svc
1-800-925-0988

Oklahoma
Call Okie
1-800-522-6543

Oregon
Oregon Utility Notification Center/One Call Concepts
1-800-332-2344

Pennsylvania
Pennsylvania One Call System, Inc.
1-800-242-1776

Rhode Island
Dig Safe System, Inc.
1-888-344-7233

South Carolina
Palmetto Utility Protection Service Inc.
1-888-721-7877

South Dakota
South Dakota One Call
1-800-781-7474

Tennessee
Tennessee One-Call System, Inc.
1-800-351-1111

ATTACHMENT 1 (Continued)

Texas
Texas One Call System
1-800-245-4545
Texas Excavation Safety System, Inc.
1-800-344-8377
Lone Star Notification Center
1-800-669-8344

Utah
Blue Stakes of Utah
1-800-662-4111

Vermont
Dig Safe System, Inc.
1-888-344-7233

Virginia
Miss Utility of Virginia
1-800-552-7001
Miss Utility (Northern Virginia)
1-800-257-7777

Washington
Utilities Underground Location Center
1-800-424-5555
Northwest Utility Notification Center
1-800-553-4344
Inland Empire Utility Coordinating Council
509-456-8000

West Virginia
Miss Utility of West Virginia, Inc.
1-800-245-4848

Wisconsin
Diggers Hotline, Inc.
1-800-242-8511

Wyoming
Wyoming One-Call System, Inc.
1-800-348-1030
Call Before You Dig of Wyoming
1-800-849-2476

District of Columbia
Miss Utility
1-800-257-7777

Alberta
Alberta One-Call Corporation
1-800-242-3447

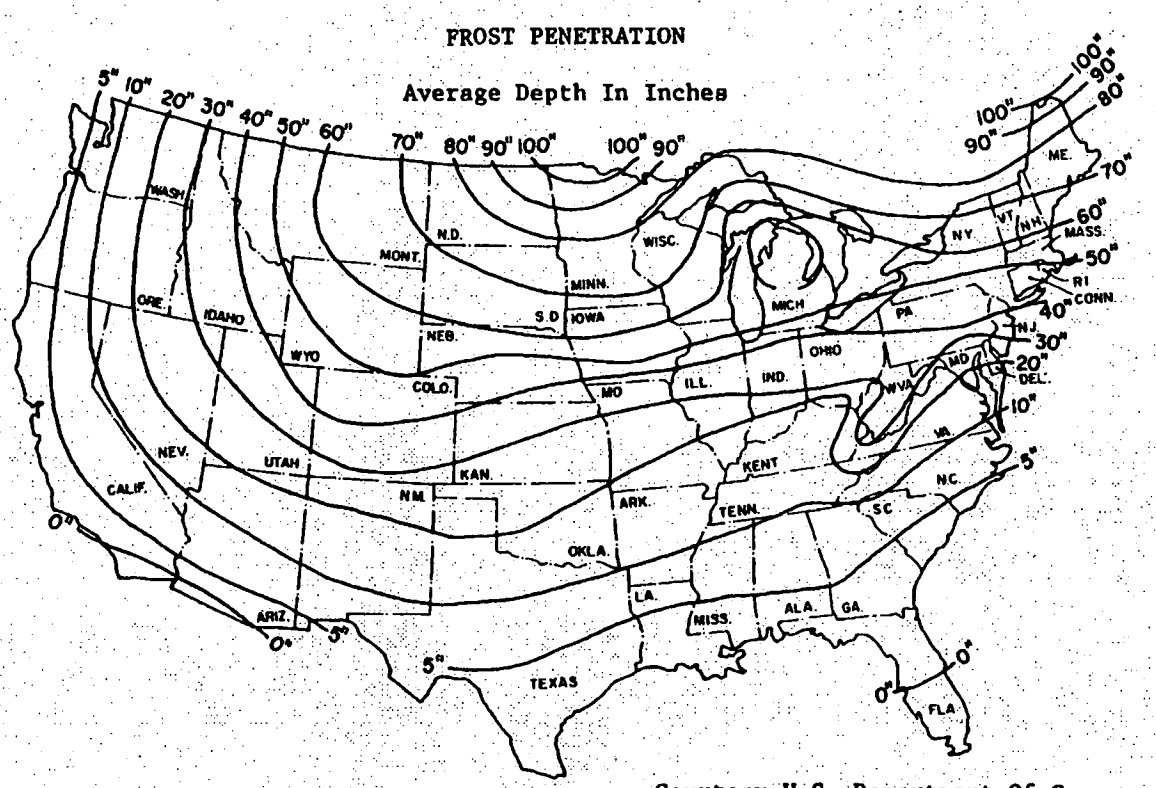
British Columbia
BC One Call
1-800-474-6886

Ontario
Ontario One-Call System
1-800-400-2255

Quebec
Info-Excavation
1-800-663-9228

ATTACHMENT 2

FROST LINE PENETRATION DEPTHS BY GEOGRAPHIC LOCATION



Courtesy U.S. Department Of Commerce

ATTACHMENT 3
UTILITY CLEARANCE FORM

Client: _____ Project Name: _____

Project No.: _____ Completed By: _____

Location Name: _____ Work Date: _____

Excavation Method/Overhead Equipment: _____

1. Underground Utilities — Circle One

a)	Review of existing maps?	yes no N/A
b)	Interview local personnel?	yes no N/A
c)	Site visit and inspection?	yes no N/A
d)	Excavation areas marked in the field?	yes no N/A
e)	Utilities located in the field?	yes no N/A
f)	Located utilities marked/added to site maps?	yes no N/A
g)	Client contact notified Name _____ Telephone: _____ Date: _____	yes no N/A
g)	State One-Call agency called? Caller: _____ Ticket Number: _____ Date: _____	yes no N/A
h)	Geophysical survey performed? Survey performed by: _____ Method: _____ Date: _____	yes no N/A
i)	Hand excavation performed (with concurrent use of utility detection device)? Completed by: _____ Total depth: _____ feet Date: _____	yes no N/A
j)	Trench/excavation probed? Probing completed by: _____ Depth/frequency: _____ Date: _____	yes no N/A

2. Overhead Utilities — Present Absent

a)	Determination of nominal voltage	yes no N/A
b)	Marked on site maps	yes no N/A
c)	Necessary to lockout/insulate/re-route	yes no N/A
d)	Document procedures used to lockout/insulate/re-route	yes no N/A
e)	Minimum acceptable clearance (SOP Section 5.2): _____	

3. Notes:

_____

_____

_____

Approval:

_____ _____

Site Manager/Field Operations Leader Date

c: PM/Project File
Program File

ATTACHMENT 4
OSHA LETTER OF INTERPRETATION

Mr. Joseph Caldwell
Consultant
Governmental Liaison
Pipeline Safety Regulations
211 Wilson Boulevard
Suite 700
Arlington, Virginia 22201

Re: Use of hydro-vacuum or non-conductive hand tools to locate underground utilities.

Dear Mr. Caldwell:

In a letter dated July 7, 2003, we responded to your inquiry of September 18, 2002, regarding the use of hydro-vacuum equipment to locate underground utilities by excavation. After our letter to you was posted on the OSHA website, we received numerous inquiries that make it apparent that aspects of our July 7 letter are being misunderstood. In addition, a number of industry stakeholders, including the National Utility Contractors Association (NUCA), have provided new information regarding equipment that is available for this work.

To clarify these issues, we are withdrawing our July 7 letter and issuing this replacement response to your inquiry.

Question: Section 1926.651 contains several requirements that relate to the safety of employees engaged in excavation work. Specifically, paragraphs (b)(2) and (b)(3) relate in part to the safety of the means used to locate underground utility installations that, if damaged during an uncovering operation, could pose serious hazards to employees.

Under these provisions, what constitutes an acceptable method of uncovering underground utility lines, and further, would the use of hydro-vacuum excavation be acceptable under the standard?

Answer

Background

Two sections of 29 CFR 1926 Subpart P (Excavations), 1926.651(Specific excavation requirements), govern methods for uncovering underground utility installations. Specifically, paragraph (b)(2) states:

> When utility companies or owners cannot respond to a request to locate underground utility installations within 24 hours * * * or cannot establish the exact location of these installations, the employer may proceed, provided the employer does so with caution, and provided detection equipment or other acceptable means to locate utility installations are used. (emphasis added).

Paragraph (b)(3) provides:

ATTACHMENT 4 (Continu d)

> When excavation operations approach the estimated location of underground installations, the exact location of the installations shall be determined by safe and acceptable means. (emphasis added).

Therefore, "acceptable means" must be used where the location of the underground utilities have not been identified by the utility companies and detection equipment is not used.

Subpart P does not contain a definition of either "other acceptable means" or "safe and acceptable means." The preambles to both the proposed rule and the final rule discussed the rationale behind the wording at issue. For example, the preamble to the proposed rule, 52 Fed. Reg. 12301 (April 15, 1987), noted that a 1972 version of this standard contained language that specified "careful probing or hand digging" as the means to uncover utilities. The preamble then noted that an amendment to the 1972 standard later deleted that language "to allow other, *equally effective means* of locating such installations." The preamble continued that in the 1987 proposed rule, OSHA again proposed using language in section (b)(3) that would provide another example of an acceptable method of uncovering utilities that could be used *where the utilities have not been marked and detection equipment is not being used* – "probing with hand-held tools." This method was rejected in the final version of 29 CFR 1926. As OSHA explained in the preamble to the final rule, 54 Fed. Reg. 45916 (October 31, 1989):

> OSHA received two comments * * * and input from ACCSH [OSHA's Advisory Committee on Construction Safety and Health] * * * on this provision. All commenters recommended dropping 'such as probing with hand-held tools' from the proposed provision, because this could create a hazard to employees by damaging the installation or its insulation.

In other words, the commenters objected to the use of hand tools being used unless detection equipment was used in conjunction with them. OSHA then concluded its discussion relative to this provision by agreeing with the commentators and ultimately not including any examples of "acceptable means" in the final provision.

Non-conductive hand tools are permitted

This raises the question of whether the standard permits the use of hand tools alone -- without also using detection equipment. NUCA and other industry stakeholders have recently informed us that non-conductive hand tools that are appropriate to be used to locate underground utilities are now commonly available.

Such tools, such as a "shooter" (which has a non-conductive handle and a snub nose) and non-conductive or insulated probes were not discussed in the rulemaking. Since they were not considered at that time, they were not part of the class of equipment that was thought to be unsafe for this purpose. Therefore, we conclude that the use of these types of hand tools, when used with appropriate caution, is an "acceptable means" for locating underground utilities.

ATTACHMENT 4 (Continued)

Hydro-vacuum excavation

It is our understanding that some hydro-vacuum excavation equipment can be adjusted to use a minimum amount of water and suction pressure. When appropriately adjusted so that the equipment will not damage underground utilities (especially utilities that are particularly vulnerable to damage, such as electrical lines), use of such equipment would be considered a "acceptable means" of locating underground utilities. However, if the equipment cannot be sufficiently adjusted, then this method would not be acceptable under the standard.

Other technologies

We are not suggesting that these are the only devices that would be "acceptable means" under the standard. Industry stakeholders have informed us that there are other types of special excavation equipment designed for safely locating utilities as well.

We apologize for any confusion our July 7 letter may have caused. If you have further concerns or questions, please feel free to contact us again by fax at: U.S. Department of Labor, OSHA, Directorate of Construction, Office of Construction Standards and Compliance Assistance, fax # 202-693-1689. You can also contact us by mail at the above office, Room N3468, 200 Constitution Avenue, N.W., Washington, D.C. 20210, although there will be a delay in our receiving correspondence by mail.

Sincerely,

Russell B. Swanson, Director
Directorate of Construction

NOTE: OSHA requirements are set by statute, standards and regulations. Our interpretation letters explain these requirements and how they apply to particular circumstances, but they cannot create additional employer obligations. This letter constitutes OSHA=s interpretation of the requirements discussed. Note that our enforcement guidance may be affected by changes to OSHA rules. Also, from time to time we update our guidance in response to new information. To keep apprised of such developments, you can consult OSHA's website at http://www.osha.gov.

ATTACHMENT III

EQUIPMENT INSPECTION CHECKLIST

EQUIPMENT INSPECTION FOR DRILL RIGS

COMPANY:_____ **UNIT NO.**_____

FREQUENCY: Inspect at the initiation of the project, after repairs, once every 10-day shift.

Inspection Date: ____/____/____ Time: _____ Equipment Type:_____

(e.g., **Drill Rigs** Hollow Stem, Mud Rotary, Direct Push)

	Good	Need Repair	N/A
Emergency Stop Devices (At points of operation)	☐	☐	☐
Tires (Tread) or tracks	☐	☐	☐
Hoses and belts	☐	☐	☐
Cab, mirrors, safety glass	☐	☐	☐
- Turn signals, lights, brake lights, etc. (front/rear) for equipment approved for highway use?	☐	☐	☐
- Is the equipment equipped with audible back-up alarms and back-up lights?	☐	☐	☐
Horn and gauges	☐	☐	☐
Brake condition (dynamic, park, etc.)	☐	☐	☐
Fire extinguisher (Type/Rating -_____)	☐	☐	☐
Fluid Levels:			
- Engine oil	☐	☐	☐
- Transmission fluid	☐	☐	☐
- Brake fluid	☐	☐	☐
- Cooling system fluid	☐	☐	☐
- Windshield wipers	☐	☐	☐
- Hydraulic oil	☐	☐	☐
Oil leak/lube	☐	☐	☐
Coupling devices and connectors	☐	☐	☐
Exhaust system	☐	☐	☐
Mast condition (Mast Height_____)	☐	☐	☐
Access-ways: Frame, hand holds, ladders, walkways (non-slip surfaces), guardrails?	☐	☐	☐
Steering (standard and emergency)	☐	☐	☐
Power cable and/or hoist cable	☐	☐	☐
➢ Hooks			
- Safety Latch	☐	☐	☐
- Wear in excess of 10% original dimension	☐	☐	☐
- A bend or twist exceeding 10% from the plane of an unbent hook	☐	☐	☐
- Increase in throat opening exceeding 15% from new condition	☐	☐	☐
- Excessive nicks and/or gouges	☐	☐	☐
➢ Wire Rope (Hoist Mechanism)			
- Reduction in Rope diameter (5/16 wire rope>1/64 reduction nominal size -replace) (3/8 to 1/2 wire rope>1/32 reduction nominal size-replace) (9/16 to 3/4 wire rope>3/64 reduction nominal size-replace)	☐	☐	☐
- Number of broken wires (12 randomly broken wires in one rope lay)	☐	☐	☐
- (4 broken wires in one strand)			
- Number of wire rope wraps left on the Running Drum at nominal use (>3 required)	☐	☐	☐
- Lead (primary) sheave is centered on the running drum	☐	☐	☐
- Lubrication of wire rope (adequate?)	☐	☐	☐

	Good	Needs Repaired	N/A
- Number of U-Type (Crosby) Clips (5/16 – 5/8 = 3 clips minimum) (3/4 – 1 inch = 4 clips minimum) (1 1/8 – 1 3/8 inch = 5 clips minimum)	❒	❒	❒
➢ Kinks, bends – Flattened to > 50% diameter	❒	❒	❒
➢ Hemp/Fiber rope (Cathead/Split Spoon Hammer)			
- Minimum ¾;maximum 1inch rope diameter (Inspect for physical damage)	❒	❒	❒
- Rope to hammer is securely fastened	❒	❒	❒

Safety Guards:

	Yes	No
Around rotating apparatus (belts, pulleys, sprockets, spindles, drums, flywheels, chains) all points of operations protected from accidental contact?_____	❒	❒
Hot pipes and surfaces exposed to accidental contact?_____	❒	❒
All emergency shut offs have been identified and communicated to the field crew?_____	❒	❒
Are any structural members bent, rusted, or otherwise show signs of damage?_____	❒	❒
Are fueling cans used with this equipment approved type safety cans?_____	❒	❒
Have the attachments designed for use (as per manufacturer's recommendation) with this equipment been inspected and are considered suitable for use?_____	❒	❒

Cleanliness:

Overall condition (was the decontamination performed prior to arrival on-site considered acceptable)?_____

Where was this equipment used prior to its arrival on site?_____

Site Contaminants of concern at the previous site?_____

Inside debris (coffee cups, soda cans, tools and equipment) blocking free access to foot controls?_____

Flammable solvents stored in the operators cab?_____

Operator Qualifications (as applicable for all heavy equipment):

Does the operator have proper licensing where applicable, (e.g., CDL)?_____

Does the operator, understand the equipment's operating instructions?_____

Is the operator experienced with this equipment? _____

Is the operator 21 years of age or more?_____

ADDITIONAL INSPECTION REQUIRED PRIOR TO USE ON-SITE

	YES	NO
Does equipment emit noise levels above 90 decibels?	❒	❒
If so, has an 8-hour noise dosimetry test been performed?	❒	❒

Results of noise dosimetry:_____

Defects and repairs needed:_____

General Safety Condition: _____

Operator or mechanic signature:_____

Site Health and Safety Officer Signature:_____

Approved for Use: ❒ Yes ❒ No

ATTACHMENT IV

SAFE WORK PERMITS

HEAVY EQUIPMENT DECONTAMINATION
NEX SERVICE STATION, NAS BRUNSWICK

Permit No. _____ Date: _____ Time: From _____ to _____

SECTION I: General Job Scope

I. **Work limited to the following (description, area, equipment used):** Decontamination of heavy equipment and machinery (i.e., DPT rig and tooling, skid rig) will occur using pressure washers and/or steam cleaning units. This will be accomplished at a constructed temporary decontamination pad at the work site. Sampling equipment will be decontaminated using buckets, brushes and spray bottles at the work site or suitable location such as a field trailer.

II. **Primary Hazards:** Potential hazards associated with this task include lifting (strain/muscle pulls lifting heavy drilling equipment); Flying projectiles propelled by the force of the pressure washer/stream cleaner; noise in excess of 85 dBA; Burns/water lacerations; Stacked equipment - falling hazards; slips, trips, and falls – slippery surfaces.

III. **Field Crew:** _____

IV. **On-site Inspection conducted** ☐ Yes ☐ No Initials of Inspector _____ TtNUS _____

Equipment Inspection required ☐ Yes ☐ No Initials of Inspector _____ TtNUS _____

SECTION II: General Safety Requirements (To be filled in by permit issuer)

V. **Protective equipment required**

Level D ☒ Level B ☐
Level C ☐ Level A ☐

Respiratory equipment required

Yes ☐ Specify on the reverse
No ☒

Modifications/Exceptions: None anticipated

VI.

Chemicals of Concern	Hazard Monitoring	Action Level(s)	Response Measures
Liquinox (soap)	None Required	None	Eye irritant/flush with clean water
Residual Contaminants	Post-decon screening	Above background	Repeat decon sequence, rescreen
Methanol (decon solution)	Follow MSDS	Follow MSDS	Follow MSDS

Primary Route of Exposure/Hazard: Soap – Contact - eye irritant; ingestion- nausea possible vomiting, diarrhea;

(Note to FOL and/or SHSO: Each item in Sections VII, VIII, and IX must be checked Yes, No or NA)

VII. **Additional Safety Equipment/Procedures**

Hard-hat	☒ Yes	☐ No	Hearing Protection (Plugs/Muffs)	☒ Yes	☐ No
Safety Glasses	☒ Yes	☐ No	Safety belt/harness	☐ Yes	☒ No
Chemical/splash goggles	☐ Yes	☒ No	Radio/Cellular Phone	☐ Yes	☒ No
Splash Shield	☒ Yes	☐ No	Barricades	☐ Yes	☐ No
Splash suits/coveralls	☐ Yes	☐ No	Gloves (Type – Nitrile,neoprene)	☒ Yes	☐ No
Impermeable apron	☒ Yes	☐ No	Work/rest regimen	☐ Yes	☒ No
Steel toe Work shoes or boots	☒ Yes	☐ No	Chemical Resistant Boot Covers	☒ Yes	☐ No
High Visibility vest	☐ Yes	☒ No	Tape up/use insect repellent	☐ Yes	☐ No
First Aid Kit	☒ Yes	☐ No	Fire Extinguisher	☐ Yes	☐ No
Safety Shower/Eyewash	☐ Yes	☐ No	Other	☐ Yes	☐ No

Modifications/Exceptions: Impermeable aprons to control splashing/overspray. If this is inadequate replace with rainsuit or PE coated Tyvek. Hard hat, splash shield, hearing protection will be worn for pressure washer/steam cleaner operation. Gloves – Nitrile (surgeons style) or Nitrile style outer gloves for deconning sampling (hand) tools, nitrile or neoprene supported gloves for steam cleaner/pressure washer operation. Overboots will be used when working in the temporary decontamination pad.

VIII. **Site Preparation**

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☒
Vehicle and Foot Traffic Routes Established/Traffic Control Barricades/Signs in Place	☐	☐	☐
Physical Hazards Identified and Isolated (Splash and containment barriers)	☐	☐	☐
Emergency Equipment Staged (Spill control, fire extinguishers, first aid kits, etc)	☐	☐	☐

IX. **Additional Permits required** (Hot work, confined space entry, excavation etc.). ☐ Yes ☒ No

If yes, SHSO to complete or contact Health Sciences, Pittsburgh Office (412)921-7090

X. **Special instructions, precautions:** Suspend site activities in the event of inclement weather (storms, high winds, etc.). Employ proper lifting techniques as described on Table 5-1 for Mobilization/Demobilization. Use washing/drying racks to secure heavy tooling/equipment to prevent items from falling during washing and drying. In addition, do NOT point the wand at other people or place it against any part of your body. Accidental compression of the trigger can cause water lacerations or burns. All hoses and fittings will be inspected to insure structural integrity prior to use. For pressure washers or steam cleaners in excess of 3,000 psi, a fan tip of 25° or greater will be used to control potential for water cuts or lacerations. A light coating of sand should be applied to the plastic liner should the surface becomes too slippery to prevent slips. Keep hoses gathered to prevent trips and falls. A site control boundary for this activity is 25-feet surrounding the point of operation. Follow directions provided in the MSDSs for any decontamination solvents/solutions used in the decontamination procedure

Permit Issued by: _____ Permit Accepted by: _____

MOBILIZATION/DEMOBILIZATION
NEX SERVICE STATION, NAS BRUNSWICK

Permit No. _____ Date: _____ Time: From _____ to _____

SECTION I: General Job Scope

I. **Work limited to the following (description, area, equipment used):** Site reconnaissance/characterization, pre-inspection of intended work areas, equipment inspections and staging, arranging for utility clearance, construct decon pad and IDW staging areas, and other preliminary tasks.

II. **Primary Hazards:** Potential hazards associated with this task include lifting (strain/muscle pulls lifting heavy drilling equipment); cuts/lacerations; pinches/compressions; slips, trips, and falls, heavy equipment hazards, temperature extremes, inclement weather, and insect bites.

III. **Field Crew:** _____

IV. **On-site Inspection conducted** ☐ Yes ☐ No Initials of Inspector _____ TtNUS _____
Equipment Inspection required ☒ Yes ☐ No Initials of Inspector _____ TtNUS _____

SECTION II: General Safety Requirements (To be filled in by permit issuer)

V. **Protective equipment required**
Level D ☒ Level B ☐
Level C ☐ Level A ☐

Respiratory equipment required
Yes ☐ Specify on the reverse
No ☒

Modifications/Exceptions: None anticipated

VI.

Chemicals of Concern	Hazard Monitoring	Action Level(s)	Response Measures
None anticipated	None Required	None	Eye irritant/flush with clean water

Primary Route of Exposure/Hazard: None anticipated.

(Note to FOL and/or SHSO: Each item in Sections VII, VIII, and IX must be checked Yes, No or NA)

VII. **Additional Safety Equipment/Procedures**

Hard-hat	☐ Yes	☐ No	Hearing Protection (Plugs/Muffs)	☐ Yes	☐ No
Safety Glasses	☐ Yes	☐ No	Safety belt/harness	☐ Yes	☐ No
Chemical/splash goggles	☐ Yes	☒ No	Radio/Cellular Phone	☐ Yes	☐ No
Splash Shield	☐ Yes	☒ No	Barricades	☐ Yes	☐ No
Splash suits/coveralls	☐ Yes	☒ No	Gloves (Type –_____)	☒ Yes	☐ No
Impermeable apron	☐ Yes	☒ No	Work/rest regimen	☐ Yes	☐ No
Steel toe Work shoes or boots	☒ Yes	☐ No	Chemical Resistant Boot Covers	☐ Yes	☒ No
High Visibility vest	☐ Yes	☒ No	Tape up/use insect repellent	☒ Yes	☐ No
First Aid Kit	☒ Yes	☐ No	Fire Extinguisher	☒ Yes	☐ No
Safety Shower/Eyewash	☐ Yes	☐ No	Other	☐ Yes	☐ No

Modifications/Exceptions: Snake chaps in high grass/brush areas. Safety glasses, hardhat, and hearing protection at SSO discretion. Reflective vests in high traffic areas.

VIII. **Site Preparation**

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☒
Vehicle and Foot Traffic Routes Established/Traffic Control Barricades/Signs in Place	☐	☐	☐
Physical Hazards Identified and Isolated (Splash and containment barriers)	☐	☐	☐
Emergency Equipment Staged (Spill control, fire extinguishers, first aid kits, etc)	☐	☐	☐

IX. **Additional Permits required** (Hot work, confined space entry, excavation etc.). ☐ Yes ☒ No
If yes, SHSO to complete or contact Health Sciences, Pittsburgh Office (412)921-7090

X. **Special instructions, precautions:** Implement site Hazard Communication Program (chemical inventory, MSDS, container labeling, etc.). Suspend site activities in the event of inclement weather (storms, high winds, etc.). Employ proper lifting techniques as described on Table 5-1 for Mobilization/Demobilization.

Permit Issued by: _____ Permit Accepted by: _____

IN-SITU PERMEABILITY TESTING
NEX SERVICE STATION, NAS BRUNSWICK

Permit No. _____ Date: _____ Time: From _____ to _____

SECTION I: General Job Scope

I. **Work limited to the following (description, area, equipment used):** Conductivity testing, slug testing, electronic transducer/data logging, and associated activities to evaluate permeability for DBB task.

II. **Primary Hazards:** Potential exposure to site contaminants, and physical hazards including lifting, pinches and compressions; slips/ trips/ falls; insect and animal bites, and exposure to temperature extremes or inclement weather.

III. **Field Crew:** _____

IV. **On-site Inspection conducted** ☐ Yes ☐ No Initials of Inspector _____ TtNUS _____
Equipment Inspection required ☐ Yes ☒ No Initials of Inspector _____ TtNUS _____

SECTION II: General Safety Requirements (To be filled in by permit issuer)

V. **Protective equipment required**
Level D ☒ Level B ☐
Level C ☐ Level A ☐

Respiratory equipment required
Yes ☐ See Reverse
No ☒

Modifications/Exceptions: If action levels specified below are exceeded and do not subside, contact PHSO.

VI.

Chemicals of Concern	Hazard Monitoring	Action Level(s)	Response Measures
GRO and BTEX	Well opening and periodic	>5ppm in BZ	Retreat to unaffected area

Modifications: >5ppm and Draeger 0.5/c indicates that benzene is not present – continue to work up 50ppm in BZ
If Draeger tube testing indicates benzene is present, stop work and contact PHSO

Primary Route of Exposure/Hazard: Skin contact and inhalation

(Note to FOL and/or SHSO: Each item in Sections VII, VIII, and IX must be checked Yes, No or NA)

VII. **Additional Safety Equipment/Procedures**

Hard-hat	☐ Yes	☐ No	Hearing Protection (Plugs/Muffs)	☐ Yes	☐ No
Safety Glasses	☒ Yes	☐ No	Safety belt/harness	☐ Yes	☐ No
Chemical/splash goggles	☐ Yes	☒ No	Radio/Cellular Phone	☐ Yes	☐ No
Splash Shield	☐ Yes	☒ No	Barricades	☐ Yes	☐ No
Splash suits/coveralls	☐ Yes	☒ No	Gloves (Type – nitrile surgeons)	☒ Yes	☐ No
Impermeable apron	☐ Yes	☒ No	Work/rest regimen	☐ Yes	☒ No
Steel toe Work shoes or boots	☒ Yes	☐ No	Chemical Resistant Boot Covers	☐ Yes	☒ No
High Visibility vest	☐ Yes	☐ No	Tape up/use insect repellent	☒ Yes	☐ No
First Aid Kit	☒ Yes	☐ No	Fire Extinguisher	☒ Yes	☐ No
Safety Shower/Eyewash	☐ Yes	☒ No	Other	☐ Yes	☐ No

Modifications/Exceptions: If overhead hazards or bump hazards or you are working near operating equipment hard hats will be required. If you are working in or near traffic patterns then wear High Visibility Vests. Snake chaps in high grass/brush areas.

VIII. **Site Preparation**

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☐
Vehicle and Foot Traffic Routes Established/Traffic Control Barricades/Signs in Place	☐	☐	☐
Physical Hazards Identified and Isolated	☐	☐	☐
Emergency Equipment Staged (Spill control, fire extinguishers, first aid kits, etc)	☐	☐	☐

IX. **Additional Permits required** (Hot work, confined space entry, excavation etc.). ☐ Yes ☒ No
If yes, SHSO to complete or contact Health Sciences, Pittsburgh Office (412)921-7090

X. **Special instructions, precautions:** Suspend site activities in the event of inclement weather (storms, high winds, etc.). Employ proper lifting techniques as described on Table 5-1 Mob/Demob task.

Permit Issued by: _____ Permit Accepted by: _____

MULTI-MEDIA SAMPLING ACTIVITIES
NEX SERVICE STATION, NAS BRUNSWICK

Permit No._____ Date:_____ Time: From_____ to_____

SECTION I: General Job Scope

I. **Work limited to the following (description, area, equipment used):** Baseline and periodic soil and ground water sampling. Soil sampling collected via DPT must use GeoProbe Sampling Kit, and must also observe requirements specified on DPT Safe Work Permit if performed concurrently and in close proximity to the DPT rig.

II. **Primary Hazards:** Potential hazards associated with this task include contact with contaminated media, injury from improper lifting, cuts and lacerations (cutting tubing), pinches and compressions; and.

III. **Field Crew:** _____

IV. **On-site Inspection conducted** ☐ Yes ☐ No Initials of Inspector _____ TtNUS _____
Equipment Inspection required ☐ Yes ☒ No Initials of Inspector _____ TtNUS _____

SECTION II: General Safety Requirements (To be filled in by permit issuer)

V. **Protective equipment required**
Level D ☒ Level B ☐
Level C ☐ Level A ☐

Respiratory equipment required
Yes ☐ See Reverse
No ☒

Modifications/Exceptions If action levels specified below are exceeded and do not subside, contact PHSO.

VI.

Chemicals of Concern	Hazard Monitoring	Action Level(s)	Response Measures
GRO and BTEX	Well opening and periodic	>5ppm in BZ	Retreat to unaffected area

Modifications: >5ppm and Draeger 0.5/c indicates that benzene is not present – continue to work up 50ppm in BZ
If Draeger tube testing indicates benzene is present, stop work and contact PHSO

Primary Route of Exposure/Hazard: Skin contact and inhalation

(Note to FOL and/or SHSO: Each item in Sections VII, VIII, and IX must be checked Yes, No or NA

VII. **Additional Safety Equipment/Procedures**

Hard-hat	☒ Yes	☐ No	Hearing Protection (Plugs/Muffs)	☒ Yes	☐ No
Safety Glasses	☒ Yes	☐ No	Safety belt/harness	☐ Yes	☒ No
Chemical/splash goggles	☐ Yes	☒ No	Radio/Cellular Phone	☐ Yes	☐ No
Splash Shield	☐ Yes	☐ No	Barricades	☐ Yes	☐ No
Splash suits/coveralls	☐ Yes	☐ No	Gloves (Type – Nitrile surgeons)	☒ Yes	☐ No
Impermeable apron	☐ Yes	☐ No	Work/rest regimen	☐ Yes	☐ No
Steel toe Work shoes or boots	☒ Yes	☐ No	Chemical Resistant Boot Covers	☐ Yes	☐ No
High Visibility vest	☐ Yes	☐ No	Tape up/use insect repellent	☐ Yes	☐ No
First Aid Kit	☒ Yes	☐ No	Fire Extinguisher	☐ Yes	☐ No
Safety Shower/Eyewash	☐ Yes	☐ No	Other	☐ Yes	☐ No

Modifications/Exceptions: Hard hat, hearing protection, and safety glasses when sampling near the DPT rig. Use Geoprobe Sampling Kit and wear cut-resistant (leather/cotton) gloves to obtain soil samples. High Visibility Vests for high traffic areas; Tape up and use insect repellent; for additional insect protection in high grass or brushy areas, SSO may dictate Tyvek coveralls. Spiders and bees prefer well protective casings as nesting areas; When sampling existing wells, stand upwind and open wells and allow to vent/off gas 3-5 minutes while preparing your sampling equipment. Boot covers at SSO discretion..

VIII. **Site Preparation**

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☐
Vehicle and Foot Traffic Routes Cleared and Established	☐	☐	☐
Physical Hazards Barricaded and Isolated	☐	☐	☐
Emergency Equipment Staged	☐	☐	☐

IX. **Additional Permits required** (Hot work, confined space entry, excavation etc.). ☐ Yes ☒ No
If yes, complete permit required or contact Health Sciences, Pittsburgh Office

X. **Special instructions, precautions:** Personal sampling at remote locations will bag contaminated PPE and reusable sampling tools and use hygienic wipes for hands and face until persons can reach the structured decontamination unit. Minimize contact with potentially contaminated media. Suspend site activities in the event of inclement weather (storms, high, winds, etc.). Employ proper lifting techniques as described on Table 5-1 for mobilization/demobilization. For remote locations pack glass ware in hard sided containers to prevent falls breakage of glassware and possible lacerations. Provisions for protection against the sun should be provided to site personnel including shade providing devices requirements for hats, sun block, wrap around sun glasses.

Permit Issued by:_____ Permit Accepted by:_____

MINI-MONITORNG WELL INSTALLATION VIA DPT
NEX SERVICE STATION, NAS BRUNSWICK

Permit No. _____ Date: _____ Time: From _____ to _____

SECTION I: General Job Scope

I. **Work limited to the following (description, area, equipment used):** Installation of mini-monitoring wells using DPT. If soil sampling tasks are to be performed concurrently with well installation, ensure that GeoProbe Sampling Kit is used and samplers are to follow the Multi-Media Sampling Safe Work Permit.

II. **Primary Hazards:** Potential hazards associated with this task include contact with site contaminants, lifting (bags of sand, grout, DPT flights and moving drums), noise, contact with underground or overhead utilities, cuts and lacerations (cutting bags, well riser, etc.), pinches and compressions; pressurized systems (hydraulic lines). Contact with operating or moving vehicles, inclement weather, and natural hazards (insect bites).

III. **Field Crew:** _____

IV. **On-site Inspection conducted** ☐ Yes ☐ No Inspector Initials _____ TtNUS
Equipment Inspection required ☒ Yes ☐ No Inspector Initials _____ TtNUS

SECTION II: General Safety Requirements (To be filled in by permit issuer)

V. **Protective equipment required**
Level D ☒ Level B ☐
Level C ☐ Level A ☐

Respiratory equipment required
Yes ☐ See Reverse
No ☒

Modifications/Exceptions: If action levels specified below are exceeded and do not subside, contact PHSO.

VI.

Chemicals of Concern	Hazard Monitoring	Action Level(s)	Response Measures
GRO and BTEX	Well opening and periodic	>5ppm in BZ	Retreat to unaffected area

Modifications: >5ppm and Draeger 0.5/c indicates that benzene is not present – continue to work up 50ppm in BZ
If Draeger tube testing indicates benzene is present, stop work and contact PHSO

Primary Route of Exposure/Hazard: Skin contact and inhalation

(Note to FOL and/or SHSO: Each item in Sections VII, VIII, and IX must be checked Yes, No or NA

VII. **Additional Safety Equipment/Procedures**

Hard-hat	☒ Yes	☐ No	Hearing Protection (Plugs/Muffs)	☒ Yes	☐ No
Safety Glasses	☒ Yes	☐ No	Safety belt/harness	☐ Yes	☐ No
Chemical/splash goggles	☐ Yes	☒ No	Radio/Cellular Phone	☐ Yes	☐ No
Splash Shield	☐ Yes	☒ No	Barricades	☒ Yes	☐ No
Splash suits/coveralls	☐ Yes	☒ No	Gloves (Type – See Note)	☒ Yes	☐ No
Impermeable apron	☐ Yes	☐ No	Work/rest regimen	☐ Yes	☐ No
Steel toe Work shoes or boots	☒ Yes	☐ No	Chemical Resistant Boot Covers	☐ Yes	☐ No
High Visibility vest	☐ Yes	☐ No	Tape up/use insect repellent	☒ Yes	☐ No
First Aid Kit	☒ Yes	☐ No	Fire Extinguisher	☒ Yes	☐ No
Safety Shower/Eyewash	☐ Yes	☐ No	Other	☐ Yes	☐ No

Modifications/Exceptions: Samplers are to follow SWP for that task. High Visibility Vests for high traffic areas; Tape up and use insect repellent to combat insect bites as necessary; Fire extinguisher for all vehicles in excess of 1-ton; Nitrile or neoprene supported gloves for handling contaminated DPT flights (SSO may also specify and impermeable aprons and/or boot covers), clean nitrile surgeon gloves for handling sampling tools and well screens and risers.

VIII. **Site Preparation**

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☐
Vehicle and Foot Traffic Routes Cleared and Established	☐	☐	☐
Physical Hazards Barricaded and Isolated	☐	☐	☐
Emergency Equipment Staged	☐	☐	☐

IX. **Additional Permits required** (Utility Locating and Excavation Clearance – Attachment II).. ☒ Yes ☐ No
If yes, SHSO complete permit or contact Health Sciences, Pittsburgh Office(412) 921-7090

X. **Special instructions, precautions:** Follow the safe work practices for drilling specified in Section 5.3 of this HASP. Use proper lifting techniques defined in Table 5-1 for mobilization/demobilization. Test all emergency stop devices initially then periodically to ensure operational status. Identify a person on the field crew as the Emergency Stop Operator. Visually ensure all persons are removed from moving DPT tooling areas. Remove jewelry, loose clothing and other potential entanglement hazards. Personnel decontamination will consist of disposing of single use PPE and washing hands and face prior to breaks or meals. Utility clearance will proceed all subsurface installation.

Permit Issued by: _____ Permit Accepted by: _____

SAFE WORK PERMIT
SAMPLE LOCATION SURVEYING ACTIVITIES
NEX SERVICE STATION, NAS BRUNSWICK

Permit No. _____ Date: _____ Time: From _____ to _____

SECTION I: General Job Scope

I. **Work limited to the following (description, area, equipment used):** Geographical surveying of sampling locations.

II. **Primary Hazards:** Potential hazards associated with this task are primarily physical in nature including lifting, cuts and lacerations, slips/ trips/ falls, traffic/struck by hazards, insect and animal bites, and inclement weather.

III. **Field Crew:** _____

IV. **On-site Inspection conducted** ☐ Yes ☐ No Initials of Inspector _____ TtNUS _____
Equipment Inspection required ☒ Yes ☐ No Initials of Inspector _____ TtNUS _____

SECTION II: General Safety Requirements (To be filled in by permit issuer)

V. **Protective equipment required**
Level D ☒ Level B ☐
Level C ☐ Level A ☐

Respiratory equipment required
Yes ☐ See Reverse
No ☒

Modifications/Exceptions: None anticipated

VI. Chemicals of Concern	Hazard Monitoring	Action Level(s)	Response Measures
None anticipated	Not applicable	Not Applicable	Not Applicable

Primary Route of Exposure/Hazard: None

(Note to FOL and/or SHSO: Each item in Sections VII, VIII, and IX must be checked Yes, No or NA

VII. **Additional Safety Equipment/Procedures**(Note to FOL and/or SHSO: Each item must be checked Yes or No)

Hard-hat	☐ Yes	☐ No	Hearing Protection (Plugs/Muffs)	☐ Yes	☒ No
Safety Glasses	☐ Yes	☐ No	Safety belt/harness	☐ Yes	☒ No
Chemical/splash goggles	☐ Yes	☒ No	Radio/Cellular Phone	☐ Yes	☐ No
Splash Shield	☐ Yes	☒ No	Barricades	☐ Yes	☐ No
Splash suits/coveralls	☐ Yes	☒ No	Gloves (Type – Leather/Cotton)	☐ Yes	☐ No
Impermeable apron	☐ Yes	☐ No	Work/rest regimen	☐ Yes	☒ No
Steel toe Work shoes or boots	☒ Yes	☐ No	Chemical Resistant Boot Covers	☐ Yes	☐ No
High Visibility vest	☐ Yes	☐ No	Tape up/use insect repellent	☐ Yes	☐ No
First Aid Kit	☒ Yes	☐ No	Fire Extinguisher	☐ Yes	☐ No
Safety Shower/Eyewash	☐ Yes	☒ No	Other	☐ Yes	☐ No

Modifications/Exceptions: Pant legs are to be taped to work boots to prevent entry under the clothing by ticks and other insects when working in heavy brush and wooded areas. Use insect repellants. Tyvek coveralls may be used in heavy brush to protect against natural hazards (e.g., ticks) and also to make identification easier. If working in areas where snakes are a threat, wear snake chaps to protect against bites. Surveyors working along highways and traffic pathways shall wear high visibility vests to increase visual recognition. Hard hats, safety glasses, leather or cotton work gloves when cutting brush.

VIII. **Site Preparation**

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☒
Vehicle and Foot Traffic Routes Established/Traffic Control Barricades/Signs in Place	☐	☐	☐
Physical Hazards Identified and Isolated	☐	☐	☐
Emergency Equipment Staged (Spill control, fire extinguishers, first aid kits, etc).	☐	☐	☐

IX. **Additional Permits required** (Hot work, confined space entry, excavation etc.). ☐ Yes ☒ No
If yes, SHSO to complete or contact Health Sciences, Pittsburgh Office (412)921-7090

X. **Special instructions, precautions:** Suspend site activities in the event of inclement weather. Employ proper lifting techniques as described on Table 5-1 for Mob/Demob task. Use only sharp tools for cutting brush, and when not in use keep sheaths on cutting blades or otherwise protect them.

Permit Issued by: _____ Permit Accepted by: _____

SAFE WORK PERMIT
IDW MANAGEMENT ACTIVITIES
NEX SERVICE STATION, NAS BRUNSWICK

Permit No. _____ Date: _____ Time: From _____ to _____

SECTION I: General Job Scope

I. **Work limited to the following (description, area, equipment used):** IDW management activities includes containerization, staging, monitoring for leaks of IDW accumulated wastes. Wastes types include soil cutting, purge and decontamination wash waters.

II. **Primary Hazards:** Potential hazards associated with this task are primarily physical in nature including lifting, pinches and compressions; slips, trips, and falls.

III. Field Crew: _____ IV.

On-site Inspection conducted ☐ Yes ☐ No Initials of Inspector _____ TtNUS _____

Equipment Inspection required ☒ Yes ☐ No Initials of Inspector _____ TtNUS _____

SECTION II: General Safety Requirements (To be filled in by permit issuer)

V. **Protective equipment required**

Level D ☒ Level B ☐
Level C ☐ Level A ☐

Respiratory equipment required

Yes ☐ See Reverse
No ☒

Modifications/Exceptions: None anticipated

VI. Chemicals of Concern	Hazard Monitoring	Action Level(s)	Response Measures
None anticipated	Not Applicable	Not Applicable	Not Applicable

Primary Route of Exposure/Hazard: None

(Note to FOL and/or SHSO: Each item in Sections VII, VIII, and IX must be checked Yes, No or NA

VII. **Additional Safety Equipment/Procedures**

Hard-hat	☐ Yes	☐ No	Hearing Protection (Plugs/Muffs)	☐ Yes	☒ No
Safety Glasses	☐ Yes	☐ No	Safety belt/harness	☐ Yes	☒ No
Chemical/splash goggles	☐ Yes	☒ No	Radio/Cellular Phone	☐ Yes	☐ No
Splash Shield	☐ Yes	☒ No	Barricades	☐ Yes	☐ No
Splash suits/coveralls	☐ Yes	☒ No	Gloves (Type – Leather/Cotton)	☒ Yes	☐ No
Impermeable apron	☐ Yes	☒ No	Work/rest regimen	☐ Yes	☐ No
Steel toe Work shoes or boots	☒ Yes	☐ No	Chemical Resistant Boot Covers	☐ Yes	☒ No
High Visibility vest	☐ Yes	☒ No	Tape up/use insect repellent	☐ Yes	☒ No
First Aid Kit	☒ Yes	☐ No	Fire Extinguisher	☒ Yes	☐ No
Safety Shower/Eyewash	☐ Yes	☒ No	Other	☐ Yes	☐ No

Modifications/Exceptions: If you are using pneumatic/electric power to open drums – Safety glasses are required; If power equipment is employed to move drums or you are working near operating equipment hard hats will be required.

VIII. **Site Preparation**

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☒
Vehicle and Foot Traffic Routes Established/Traffic Control Barricades/Signs in Place	☐	☐	☐
Physical Hazards Identified and Isolated	☐	☐	☐
Emergency Equipment Staged (Spill control, fire extinguishers, first aid kits, etc).	☐	☐	☐

IX. **Additional Permits required** (Hot work, confined space entry, excavation etc.). ☐ Yes ☒ No

If yes, SHSO to complete or contact Health Sciences, Pittsburgh Office (412)921-7090

X. **Special instructions, precautions:** Suspend site activities in the event of inclement weather. Employ proper lifting techniques as described on Table 5-1 for Mob/Demob task. When/where possible use heavy equipment to move and place containers. When placing drums – Place the label and retention ring nut on the outside where it is readily visible. Place 4-drums to a pallet. Maintain a minimum distance of 4-feet between pallet rows. An IDW inventory shall be generated to provide the number of drums, contents, and volumes. This inventory should be provided to the facility contact

Permit Issued by: _____ Permit Accepted by: _____

SAFE WORK PERMIT

DENITRIFICATION-BASED BIODEGRADATION (DBB) PILOT TEST ACTIVITIES
NEX SERVICE STATION, NAS BRUNSWICK

Permit No. _____ Date: _____ Time: From _____ to _____

SECTION I: General Job Scope

I. **Work limited to the following (description, area, equipment used):** DBB Major Additions task. Delivery and dispensing of N-Blend directly from skid rig.

II. **Primary Hazards:** Heavy equipment operation hazards, noise, contact with N-Blend product, contact with site contaminants, lifting hazards, natural hazards, inclement weather, slips/trips/falls.

IV. **Field Crew:** _____

IV. **On-site Inspection conducted** ☐ Yes ☐ No Initials of Inspector _____ TtNUS _____
Equipment Inspection required ☒ Yes ☐ No Initials of Inspector _____ TtNUS _____

SECTION II: General Safety Requirements (To be filled in by permit issuer)

V. **Protective equipment required**
Level D ☒ Level B ☐
Level C ☐ Level A ☐

Respiratory equipment required
Yes ☐ See Reverse
No ☒

Modifications/Exceptions: None anticipated

VI.

Chemicals of Concern	Hazard Monitoring	Action Level(s)	Response Measures
N-Blend product	Review and observe MSDS	Review and observe MSDS	Review and observe MSDS
GRO and BTEX	Well opening and periodic	>5ppm in BZ	Retreat to unaffected area

Modifications: >5ppm and Draeger 0.5/c indicates that benzene is not present – continue to work up 50ppm in BZ
If Draeger tube testing indicates benzene is present, stop work and contact PHSO

Primary Route of Exposure/Hazard: Skin contact and inhalation

(Note to FOL and/or SHSO: Each item in Sections VII, VIII, and IX must be checked Yes, No or NA

VII. **Additional Safety Equipment/Procedures**

Hard-hat	☐ Yes	☐ No	Hearing Protection (Plugs/Muffs)	☒ Yes	☐ No
Safety Glasses	☒ Yes	☐ No	Safety belt/harness	☐ Yes	☐ No
Chemical/splash goggles	☐ Yes	☐ No	Radio/Cellular Phone	☐ Yes	☐ No
Splash Shield	☐ Yes	☐ No	Barricades	☐ Yes	☐ No
Splash suits/coveralls	☐ Yes	☐ No	Gloves (Type – nitrile surgeons)	☒ Yes	☐ No
Impermeable apron	☐ Yes	☐ No	Work/rest regimen	☐ Yes	☐ No
Steel toe Work shoes or boots	☒ Yes	☐ No	Chemical Resistant Boot Covers	☐ Yes	☐ No
High Visibility vest	☐ Yes	☐ No	Tape up/use insect repellent	☒ Yes	☐ No
First Aid Kit	☒ Yes	☐ No	Fire Extinguisher	☒ Yes	☐ No
Safety Shower/Eyewash	☐ Yes	☐ No	Other	☐ Yes	☐ No

Modifications/Exceptions: Hard hat and hearing protection in heavy equipment operation areas (e.g., skid rig). Wear cut resistant gloves if hand cutting or handling sharp/rough objects. Reflective vests in high traffic areas. Boot covers at SSO discretion. Review MSDS for N-Blend product prior to handling, and observe all PPE requirements specified. Check appropriate additional boxes above based on MSDS, and review with task participants.

VIII. **Site Preparation**

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☐
Vehicle and Foot Traffic Routes Established/Traffic Control Barricades/Signs in Place	☐	☐	☐
Physical Hazards Identified and Isolated	☐	☐	☐
Emergency Equipment Staged (Spill control, fire extinguishers, first aid kits, etc).	☐	☐	☐

IX. **Additional Permits required** (Hot work, confined space entry, excavation etc.). ☐ Yes ☒ No
If yes, SHSO to complete or contact Health Sciences, Pittsburgh Office (412)921-7090

X. **Special instructions, precautions:** Suspend site activities in the event of inclement weather. Employ proper lifting techniques as described in Table 5-1 (see Mob/Demob task entry). When/where possible use heavy equipment to move and place containers. Review and observe N-Blend MSDS specifications. Review heat stress symptoms in Table 6-2. Use sunscreen as appropriate.

Permit Issued by: _____ Permit Accepted by: _____

ATTACHMENT V

MEDICAL DATA SHEET

MEDICAL DATA SHEET

This brief Medical Data Sheet will be completed by all onsite personnel and visitors who are cleared and will enter defined areas of operation. The medical data sheets will be kept in a central location during the conduct of site operations. This data sheet will accompany any personnel when medical assistance is needed or if transport to hospital facilities is required.

Project: NAS Brunswick; CTO 0014

Name: _____ Home Telephone: _____

Address: _____

_____

Age: _____ Height: _____ Weight: _____

Name of Next Kin: _____

Telephone Numbers: Home: _____ Work: _____ Cell: _____

Address _____

_____

Drug or other Allergies: _____

Particular Sensitivities: _____

Do You Wear Contacts? _____

Provide a Checklist of Previous Illnesses or Overexposure to Hazardous Chemicals Resulting in signs and symptoms of overexposure and/or the necessity for Medical Attention and/or First-aid: _____

_____

Do you have any medical restrictions? _____

Past Medical History/Review of Systems (Check if you have had positive history)

- ☐ Heart Conditions (Chest pains, angina, heart attacks)
- ☐ Gastrointestinal Conditions (Ulcers, liver, GI Bleeding)
- ☐ Pulmonary(Difficulty in breathing, coughing, asthma, pneumonia)
- ☐ Neurological [Headaches, dizziness, strokes (CVA, TIA)]
- ☐ Kidney/Urological Disorder (kidney stones, renal failure)
- ☐ Endocrine (Thyroid, diabetes)
- ☐ Hematological (Clotting, anemia)
- ☐ Cancer
- ☐ Muscular/Skeleton (Arthritis, Fractures, etc.)
- ☐ Other (Recent Illnesses, weight loss, fever, etc.)

Comments: (Please explain positive indications): _____

_____

Immunization History: Last Tetanus Shot or Booster (Date): _____ Pneumonia Vaccination (Date): _____

Flu Vaccination (Date): _____ Other: _____

Name, Address, and Phone Number of personal physician: _____

_____

I am the individual described above. I have read and understand this HASP.

_____ _____

Signature Date

ATTACHMENT VI

HEARING CONSERVATION PROGRAM

SECTION		PAGE

1.0 PURPOSE 1

2.0 SCOPE 1

3.0 RESPONSIBILITIES 1

4.0 MONITORING AND ESTABLISHING HIGH-NOISE AREAS 1

5.0 HEARING PROTECTION 2

6.0 TRAINING PROGRAM 2

7.0 RECORDKEEPING 2

8.0 ATTACHMENT 3

8.1 29 CFR 1910.95 Occupational Noise Exposure 4

8.1.1 Code of Federal Regulations, Subsection 1910.95 5

TETRA TECH NUS, INC.
HEARING CONSERVATION PROGRAM

1.0 PURPOSE

To establish general and site-specific hearing conservation procedures and guidelines.

2.0 SCOPE

Applies to all hazardous waste and other field activities where exposure to high levels of noise may occur. This program is designed to comply with OSHA General Industry Standard 29 CFR 1910.95.

3.0 RESPONSIBILITIES

Project Health and Safety Officer (PHSO) - The PHSO shall ensure that hearing conservation measures are adequately addressed in the Site Specific Health and Safety Plan.

Site Health Safety Officer (SHSO) - The SHSO is responsible for establishing and implementing a hearing conservation program. The SHSO also ensures that adequate procedures are followed to prevent excessive exposure of individuals to high levels of noise.

Project Manager (PM) - The PM will ensure that sufficient information has been provided to the PHSO to prepare adequate procedures for inclusion in the site-specific Health and Safety Plan (HASP). The PM is also ultimately responsible for the effective compliance with these requirements.

4.0 MONITORING AND ESTABLISHING HIGH-NOISE AREAS

4.1 When appropriate, the SHSO, may perform noise surveys on Tetra Tech NUS and Subcontractors operations and work areas by the use of a sound meter and/or dosimetry. All monitoring will be done in accordance with 29 CFR 1910.95. Areas and operations which are expected to reach or exceed 85 decibels (dBA) will be required to adhere to the requirements for this program. Noise monitoring results obtained from previous representative activities may be used.

4.2 The HASP will specify the tasks directing the mandatory use of hearing protection. The FOL and/or SHSO will notify all Tetra Tech NUS and Subcontractor personnel of high noise areas and operations prior to work initiation.

The FOL and/or the SHSO will be responsible for implementation and enforcement of the site-specific Hearing Conservation elements.

4.3 The FOL and/or the SHSO will post or otherwise identify areas of operations which exceed 85 dBA. If significant changes in noise levels occur (such as a shutdown in an operating unit, change in procedures), the noise levels shall be re-evaluated by the SSO to determine if hearing protection will be worn.

5.0 HEARING PROTECTION

Each employee will have the opportunity to choose from a variety of hearing protection devices. Hearing protectors shall be replaced as necessary. The SHSO with the assistance of the PHSO will evaluate the attenuation factors of hearing protection devices and will select appropriate types based on sound level monitoring or personal dosimetry.

6.0 TRAINING PROGRAM

The Health Sciences Department will institute and maintain an initial training program for new employees and provide an annual training program for employees who may be exposed to noise sources 85 dBA or greater. The annual training will be incorporated with the refresher health and safety training curricula. All affected employees will be involved in the program and their participation documented.

6.1 The training program shall include the effects of noise on hearing. It will also include the purpose of hearing protectors; the advantages, disadvantages, and attenuation factors of the various types. Instruction shall also be given on audiometric testing, selection, fitting, use and care of hearing protectors.

6.2 A copy of the OSHA Noise Standard and applicable informational and training material will be available to all employees.

7.0 RECORDKEEPING

Exposure measurements, related records will be kept at the site. Record retention will be done in accordance with the time periods stated in 29 CFR 1910.95 and 1910.20.

8.0 ATTACHMENTS

8.1 29 CFR 1910.95 Occupational Noise Exposure

8.1.1 Code of Federal Regulations, Subsection 1910.95

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ATTACHMENT 8.1

29 CFR 1910.95 OCCUPATIONAL NOISE EXPOSURE

Site:		Type of Audio Monitoring Equipment:		Date:
Employee Name	**Operation**	**Hearing Protection Type Attenuation Factor**	**Noise Levels Measured**	**Duration of Use**

Forward completed table (with backup noise monitoring data) to the Manager, Health Sciences.

TETRA TECH NUS, Inc.
NOISE DOSIMETRY LOG

This attachment is to b completed when noise dosimetry measurements (personal or area) ar collected using noise dosimeters in order to quantify noise levels associated with an operation. Direction to complete this form will be provided wh re applicable in the HASP. It is the responsibility of the SHSO or identified Industrial Hygienist.

Project Name:_____Project Number:_____
Sampler:_____( ) Date of Sample:_____
Sampler's initials below indicate that noise dosimeter(s) was calibrated, and the unit(s) test parameters verified, prior to sampling:

_____ 90 dB Criterion _____ Pre-sample Calibration @ 102 dBA

_____ 5 dB Exchange _____ Post-sample Calibration @ 102 dBA

_____ 80 dB Cut-off Threshold

Calibrator Model:_____Serial Number:_____Primary Calibration Date:_____

Sound Level Meter/Noise Dosimeter Model:_____Dosimeter Identification No._____

Type of Calibration:_____

Worker Sampled:_____S.S. Number:_____

Job Classification:_____

Equipment/Tools used:_____

Job/Task being performed:_____

_____

Type of Hearing Protection Employed:_____Noise Reduction Rating:_____

Representative Exposure: _____ _____ _____

For: _____ _____ _____

_____ _____ _____

Start-time: ___:___ Stop-time: ___:___ Elapsed-time: ___:___

SLM/Noise Dosimeter Operational Check:_____ _____ _____ _____

Lmax._____Lavg._____ Lpk._____ Dose: _____% Projected Dose: _____%

TWA = 16.61 Log 10$\frac{(\text{Dose}+90)}{100}$ =_____ TWA – 7dB – Manufacturer's NRR =

Comments:_____

_____

_____

_____ _____
Supervisor in Charge Industrial Hygienist/Technician

WORKER ACTIVITY LOG ON REVERSE SIDE

WORKER ACTIVITY LOG

TEST HOUR	TASK(S)	Hearing Prot ction*	WORK LOCATION(S)
1			
2			
3			
4			
5			
6			
7			
8			

* Hearing Protection Type – 0-No Hearing Protection; 1-Disposable Plugs; 2-Ear Muffs; 3-Fitted protection; 4-Combination (Plugs and Muffs)

SECTION 1.8.4

TETRA TECH NUS, INC.

SOUND LEVEL MEASUREMENT LOG

This attachment is to be completed whenever sound level measurements are conducted in an area evaluation of noise levels. Direction for sound level measurements and completion of this attachment will be provided as required in the HASP.

★ Noise Source

Indicate reading, location in relationship to the noise source [Distance (increments of 10 feet) and bearing], structures/deflection barriers, and the weighted measurement scale (dBA, dBB, dBC) used during the monitoring.

Project Name:			Project Number:
Date of Survey:	Location of Survey:		Surveyed By:
Sound Level Meter(Type):		Model #:	Serial #:
Calibrator Model:	Serial Number:		Primary Calibration Date:
Calibration Date:		Calibrated By:	
Pre-Calibration Reading:		Post-Calibration Reading:	

Worker/Area Surveyed:_____

_____

_____

_____

Activity Being Conducted:_____

_____

_____

Equipment Used:_____

Duration of Activity:_____

Hearing Protection Used?_____Type:_____NRR:_____

Comments:_____

_____

FR 5322, Feb. 10, 1984; 55 FR 32015, Aug. 6, 1990; 58 FR 35308, June 30, 1993]

§ 1910.95 Occupational noise exposure.

(a) Protection against the effects of noise exposure shall be provided when the sound levels exceed those shown in Table G-16 when measured on the A scale of a standard sound level meter at slow response. When noise levels are determined by octave band analysis, the equivalent A-weighted sound level may be determined as follows:

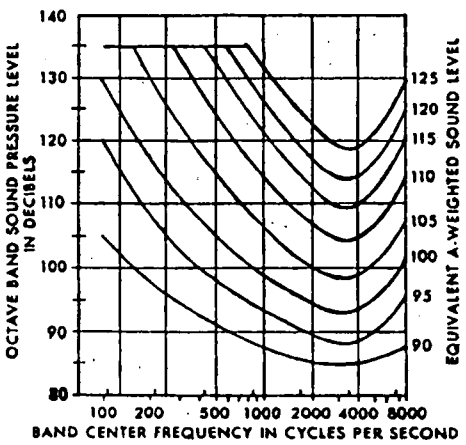


FIGURE G-9

Equivalent sound level contours. Octave band sound pressure levels may be converted to the equivalent A-weighted sound level by plotting them on this graph and noting the A-weighted sound level corresponding to the point of highest penetration into the sound level contours. This equivalent A-weighted sound level, which may differ from the actual A-weighted sound level of the noise, is used to determine exposure limits from Table 1.G-16.

(b)(1) When employees are subjected to sound exceeding those listed in Table G-16, feasible administrative or engineering controls shall be utilized. If such controls fail to reduce sound levels within the levels of Table G-16, personal protective equipment shall be provided and used to reduce sound levels within the levels of the table.

(2) If the variations in noise level involve maxima at intervals of 1 second or less, it is to be considered continuous.

TABLE G-16—PERMISSIBLE NOISE EXPOSURES [1]

Duration per day, hours	Sound level dBA slow response
8	90
6	92
4	95
3	97
2	100
1½	102
1	105
½	110
¼ or less	115

[1] When the daily noise exposure is composed of two or more periods of noise exposure of different levels, their combined effect should be considered, rather than the individual effect of each. If the sum of the following fractions: $C_1/T_1 + C_2/T_2$ C_n/T_n exceeds unity, then, the mixed exposure should be considered to exceed the limit value. *Cn* indicates the total time of exposure at a specified noise level, and *Tn* indicates the total time of exposure permitted at that level.

Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level.

(c) *Hearing conservation program.* (1) The employer shall administer a continuing, effective hearing conservation program, as described in paragraphs (c) through (o) of this section, whenever employee noise exposures equal or exceed an 8-hour time-weighted average sound level (TWA) of 85 decibels measured on the A scale (slow response) or, equivalently, a dose of fifty percent. For purposes of the hearing conservation program, employee noise exposures shall be computed in accordance with appendix A and Table G-16a, and without regard to any attenuation provided by the use of personal protective equipment.

(2) For purposes of paragraphs (c) through (n) of this section, an 8-hour time-weighted average of 85 decibels or a dose of fifty percent shall also be referred to as the action level.

(d) *Monitoring.* (1) When information indicates that any employee's exposure may equal or exceed an 8-hour time-weighted average of 85 decibels, the employer shall develop and implement a monitoring program.

(i) The sampling strategy shall be designed to identify employees for inclusion in the hearing conservation program and to enable the proper selection of hearing protectors.

(ii) Where circumstances such as high worker mobility, significant variations in sound level, or a significant

component of impulse noise make area monitoring generally inappropriate, the employer shall use representative personal sampling to comply with the monitoring requirements of this paragraph unless the employer can show that area sampling produces equivalent results.

(2)(i) All continuous, intermittent and impulsive sound levels from 80 decibels to 130 decibels shall be integrated into the noise measurements.

(ii) Instruments used to measure employee noise exposure shall be calibrated to ensure measurement accuracy.

(3) Monitoring shall be repeated whenever a change in production, process, equipment or controls increases noise exposures to the extent that:

(i) Additional employees may be exposed at or above the action level; or

(ii) The attenuation provided by hearing protectors being used by employees may be rendered inadequate to meet the requirements of paragraph (j) of this section.

(e) *Employee notification.* The employer shall notify each employee exposed at or above an 8-hour time-weighted average of 85 decibels of the results of the monitoring.

(f) *Observation of monitoring.* The employer shall provide affected employees or their representatives with an opportunity to observe any noise measurements conducted pursuant to this section.

(g) *Audiometric testing program.* (1) The employer shall establish and maintain an audiometric testing program as provided in this paragraph by making audiometric testing available to all employees whose exposures equal or exceed an 8-hour time-weighted average of 85 decibels.

(2) The program shall be provided at no cost to employees.

(3) Audiometric tests shall be performed by a licensed or certified audiologist, otolaryngologist, or other physician, or by a technician who is certified by the Council of Accreditation in Occupational Hearing Conservation, or who has satisfactorily demonstrated competence in administering audiometric examinations, obtaining valid audiograms, and properly using, maintaining and checking calibration and proper functioning of the audiometers being used. A technician who operates microprocessor audiometers does not need to be certified. A technician who performs audiometric tests must be responsible to an audiologist, otolaryngologist or physician.

(4) All audiograms obtained pursuant to this section shall meet the requirements of Appendix C: *Audiometric Measuring Instruments.*

(5) *Baseline audiogram.* (i) Within 6 months of an employee's first exposure at or above the action level, the employer shall establish a valid baseline audiogram against which subsequent audiograms can be compared.

(ii) *Mobile test van exception.* Where mobile test vans are used to meet the audiometric testing obligation, the employer shall obtain a valid baseline audiogram within 1 year of an employee's first exposure at or above the action level. Where baseline audiograms are obtained more than 6 months after the employee's first exposure at or above the action level, employees shall wearing hearing protectors for any period exceeding six months after first exposure until the baseline audiogram is obtained.

(iii) Testing to establish a baseline audiogram shall be preceded by at least 14 hours without exposure to workplace noise. Hearing protectors may be used as a substitute for the requirement that baseline audiograms be preceded by 14 hours without exposure to workplace noise.

(iv) The employer shall notify employees of the need to avoid high levels of non-occupational noise exposure during the 14-hour period immediately preceding the audiometric examination.

(6) *Annual audiogram.* At least annually after obtaining the baseline audiogram, the employer shall obtain a new audiogram for each employee exposed at or above an 8-hour time-weighted average of 85 decibels.

(7) *Evaluation of audiogram.* (i) Each employee's annual audiogram shall be compared to that employee's baseline audiogram to determine if the audiogram is valid and if a standard threshold shift as defined in paragraph (g)(10) of this section has oc-

curred. This comparison may be done by a technician.

(ii) If the annual audiogram shows that an employee has suffered a standard threshold shift, the employer may obtain a retest within 30 days and consider the results of the retest as the annual audiogram.

(iii) The audiologist, otolaryngologist, or physician shall review problem audiograms and shall determine whether there is a need for further evaluation. The employer shall provide to the person performing this evaluation the following information:

(A) A copy of the requirements for hearing conservation as set forth in paragraphs (c) through (n) of this section;

(B) The baseline audiogram and most recent audiogram of the employee to be evaluated;

(C) Measurements of background sound pressure levels in the audiometric test room as required in Appendix D: Audiometric Test Rooms.

(D) Records of audiometer calibrations required by paragraph (h)(5) of this section.

(8) *Follow-up procedures.* (i) If a comparison of the annual audiogram to the baseline audiogram indicates a standard threshold shift as defined in paragraph (g)(10) of this section has occurred, the employee shall be informed of this fact in writing, within 21 days of the determination.

(ii) Unless a physician determines that the standard threshold shift is not work related or aggravated by occupational noise exposure, the employer shall ensure that the following steps are taken when a standard threshold shift occurs:

(A) Employees not using hearing protectors shall be fitted with hearing protectors, trained in their use and care, and required to use them.

(B) Employees already using hearing protectors shall be refitted and retrained in the use of hearing protectors and provided with hearing protectors offering greater attenuation if necessary.

(C) The employee shall be referred for a clinical audiological evaluation or an otological examination, as appropriate, if additional testing is necessary or if the employer suspects that a medical pathology of the ear is caused or aggravated by the wearing of hearing protectors.

(D) The employee is informed of the need for an otological examination if a medical pathology of the ear that is unrelated to the use of hearing protectors is suspected.

(iii) If subsequent audiometric testing of an employee whose exposure to noise is less than an 8-hour TWA of 90 decibels indicates that a standard threshold shift is not persistent, the employer:

(A) Shall inform the employee of the new audiometric interpretation; and

(B) May discontinue the required use of hearing protectors for that employee.

(9) *Revised baseline.* An annual audiogram may be substituted for the baseline audiogram when, in the judgment of the audiologist, otolaryngologist or physician who is evaluating the audiogram:

(i) The standard threshold shift revealed by the audiogram is persistent; or

(ii) The hearing threshold shown in the annual audiogram indicates significant improvement over the baseline audiogram.

(10) *Standard threshold shift.* (i) As used in this section, a standard threshold shift is a change in hearing threshold relative to the baseline audiogram of an average of 10 dB or more at 2000, 3000, and 4000 Hz in either ear.

(ii) In determining whether a standard threshold shift has occurred, allowance may be made for the contribution of aging (presbycusis) to the change in hearing level by correcting the annual audiogram according to the procedure described in Appendix F: *Calculation and Application of Age Correction to Audiograms.*

(h) *Audiometric test requirements.* (1) Audiometric tests shall be pure tone, air conduction, hearing threshold examinations, with test frequencies including as a minimum 500, 1000, 2000, 3000, 4000, and 6000 Hz. Tests at each frequency shall be taken separately for each ear.

(2) Audiometric tests shall be conducted with audiometers (including microprocessor audiometers) that

meet the specifications of, and are maintained and used in accordance with, American National Standard Specification for Audiometers, S3.6-1969.

(3) Pulsed-tone and self-recording audiometers, if used, shall meet the requirements specified in Appendix C: *Audiometric Measuring Instruments.*

(4) Audiometric examinations shall be administered in a room meeting the requirements listed in Appendix D: *Audiometric Test Rooms.*

(5) *Audiometer calibration.* (i) The functional operation of the audiometer shall be checked before each day's use by testing a person with known, stable hearing thresholds, and by listening to the audiometer's output to make sure that the output is free from distorted or unwanted sounds. Deviations of 10 decibels or greater require an acoustic calibration.

(ii) Audiometer calibration shall be checked acoustically at least annually in accordance with Appendix E: *Acoustic Calibration of Audiometers.* Test frequencies below 500 Hz and above 6000 Hz may be omitted from this check. Deviations of 15 decibels or greater require an exhaustive calibration.

(iii) An exhaustive calibration shall be performed at least every two years in accordance with sections 4.1.2; 4.1.3.; 4.1.4.3; 4.2; 4.4.1; 4.4.2; 4.4.3; and 4.5 of the American National Standard Specification for Audiometers, S3.6-1969. Test frequencies below 500 Hz and above 6000 Hz may be omitted from this calibration.

(i) *Hearing protectors.* (1) Employers shall make hearing protectors available to all employees exposed to an 8-hour time-weighted average of 85 decibels or greater at no cost to the employees. Hearing protectors shall be replaced as necessary.

(2) Employers shall ensure that hearing protectors are worn:

(i) By an employee who is required by paragraph (b)(1) of this section to wear personal protective equipment; and

(ii) By any employee who is exposed to an 8-hour time-weighted average of 85 decibels or greater, and who:

(A) Has not yet had a baseline audiogram established pursuant to paragraph (g)(5)(ii); or

(B) Has experienced a standard threshold shift.

(3) Employees shall be given the opportunity to select their hearing protectors from a variety of suitable hearing protectors provided by the employer.

(4) The employer shall provide training in the use and care of all hearing protectors provided to employees.

(5) The employer shall ensure proper initial fitting and supervise the correct use of all hearing protectors.

(j) *Hearing protector attenuation.* (1) The employer shall evaluate hearing protector attenuation for the specific noise environments in which the protector will be used. The employer shall use one of the evaluation methods described in Appendix B: *Methods for Estimating the Adequacy of Hearing Protection Attenuation.*

(2) Hearing protectors must attenuate employee exposure at least to an 8-hour time-weighted average of 90 decibels as required by paragraph (b) of this section.

(3) For employees who have experienced a standard threshold shift, hearing protectors must attenuate employee exposure to an 8-hour time-weighted average of 85 decibels or below.

(4) The adequacy of hearing protector attenuation shall be re-evaluated whenever employee noise exposures increase to the extent that the hearing protectors provided may no longer provide adequate attenuation. The employer shall provide more effective hearing protectors where necessary.

(k) *Training program.* (1) The employer shall institute a training program for all employees who are exposed to noise at or above an 8-hour time-weighted average of 85 decibels, and shall ensure employee participation in such program.

(2) The training program shall be repeated annually for each employee included in the hearing conservation program. Information provided in the training program shall be updated to be consistent with changes in protective equipment and work processes.

(3) The employer shall ensure that each employee is informed of the following:

(i) The effects of noise on hearing;

(ii) The purpose of hearing protectors, the advantages, disadvantages, and attenuation of various types, and instructions on selection, fitting, use, and care; and

(iii) The purpose of audiometric testing, and an explanation of the test procedures.

(l) *Access to information and training materials.* (1) The employer shall make available to affected employees or their representatives copies of this standard and shall also post a copy in the workplace.

(2) The employer shall provide to affected employees any informational materials pertaining to the standard that are supplied to the employer by the Assistant Secretary.

(3) The employer shall provide, upon request, all materials related to the employer's training and education program pertaining to this standard to the Assistant Secretary and the Director.

(m) *Recordkeeping*—(1) *Exposure measurements.* The employer shall maintain an accurate record of all employee exposure measurements required by paragraph (d) of this section.

(2) *Audiometric tests.* (i) The employer shall retain all employee audiometric test records obtained pursuant to paragraph (g) of this section:

(ii) This record shall include:

(A) Name and job classification of the employee;

(B) Date of the audiogram;

(C) The examiner's name;

(D) Date of the last acoustic or exhaustive calibration of the audiometer; and

(E) Employee's most recent noise exposure assessment.

(F) The employer shall maintain accurate records of the measurements of the background sound pressure levels in audiometric test rooms.

(3) *Record retention.* The employer shall retain records required in this paragraph (m) for at least the following periods.

(i) Noise exposure measurement records shall be retained for two years.

(ii) Audiometric test records shall be retained for the duration of the affected employee's employment.

(4) *Access to records.* All records required by this section shall be provided upon request to employees, former employees, representatives designated by the individual employee, and the Assistant Secretary. The provisions of 29 CFR 1910.20 (a)-(e) and (g)-(i) apply to access to records under this section.

(5) *Transfer of records.* If the employer ceases to do business, the employer shall transfer to the successor employer all records required to be maintained by this section, and the successor employer shall retain them for the remainder of the period prescribed in paragraph (m) (3) of this section.

(n) *Appendices.* (1) Appendices A, B, C, D, and E to this section are incorporated as part of this section and the contents of these appendices are mandatory.

(2) Appendices F and G to this section are informational and are not intended to create any additional obligations not otherwise imposed or to detract from any existing obligations.

(o) *Exemptions.* Paragraphs (c) through (n) of this section shall not apply to employers engaged in oil and gas well drilling and servicing operations.

(p) *Startup date.* Baseline audiograms required by paragraph (g) of this section shall be completed by March 1, 1984.

(Approved by the Office of Management and Budget under control number 1218-0048)

APPENDIX A TO § 1910.95—NOISE EXPOSURE COMPUTATION

This Appendix is Mandatory

I. Computation of Employee Noise Exposure

(1) Noise dose is computed using Table G-16a as follows:

(i) When the sound level, L, is constant over the entire work shift, the noise dose, D, in percent, is given by: D=100 C/T where C is the total length of the work day, in hours, and T is the reference duration corresponding to the measured sound level, L, as given in Table G-16a or by the formula shown as a footnote to that table.

(ii) When the workshift noise exposure is composed of two or more periods of noise at different levels, the total noise dose over the work day is given by:

$$D=100\ (C_1/T_1+C_2/T_2+\ldots+C_n/T_n),$$

where C_n indicates the total time of exposure at a specific noise level, and T_n indicates the reference duration for that level as given by Table G-16a.

(2) The eight-hour time-weighted average sound level (TWA), in decibels, may be computed from the dose, in percent, by means of the formula: $TWA=16.61\ \log_{10}\ (D/100)+90$. For an eight-hour workshift with the noise level constant over the entire shift, the TWA is equal to the measured sound level.

(3) A table relating dose and TWA is given in Section II.

TABLE G-16a

A-weighted sound level, L (decibel)	Reference duration, T (hour)
80	32
81	27.9
82	24.3
83	21.1
84	18.4
85	16
86	13.9
87	12.1
88	10.6
89	9.2
90	8
91	7.0
92	6.1
93	5.3
94	4.6
95	4
96	3.5
97	3.0
98	2.6
99	2.3
100	2
101	1.7
102	1.5
103	1.3
104	1.1
105	1
106	0.87
107	0.76
108	0.66
109	0.57
110	0.5
111	0.44
112	0.38
113	0.33
114	0.29
115	0.25
116	0.22
117	0.19
118	0.16
119	0.14
120	0.125
121	0.11
122	0.095
123	0.082

TABLE G-16a—Continued

A-weighted sound level, L (decibel)	Reference duration, T (hour)
124	0.072
125	0.063
126	0.054
127	0.047
128	0.041
129	0.036
130	0.031

In the above table the reference duration, T, is computed by

$$T = \frac{8}{2^{(L-90)/5}}$$

where L is the measured A-weighted sound level.

II. Conversion Between "Dose" and "8-Hour Time-Weighted Average" Sound Level

Compliance with paragraphs (c)-(r) of this regulation is determined by the amount of exposure to noise in the workplace. The amount of such exposure is usually measured with an audiodosimeter which gives a readout in terms of "dose." In order to better understand the requirements of the amendment, dosimeter readings can be converted to an "8-hour time-weighted average sound level." (TWA).

In order to convert the reading of a dosimeter into TWA, see Table A-1, below. This table applies to dosimeters that are set by the manufacturer to calculate dose or percent exposure according to the relationships in Table G-16a. So, for example, a dose of 91 percent over an eight hour day results in a TWA of 89.3 dB, and, a dose of 50 percent corresponds to a TWA of 85 dB.

If the dose as read on the dosimeter is less than or greater than the values found in Table A-1, the TWA may be calculated by using the formula: $TWA=16.61\ \log_{10}\ (D/100)+90$ where TWA=8-hour time-weighted average sound level and D=accumulated dose in percent exposure.

TABLE A-1—CONVERSION FROM "PERCENT NOISE EXPOSURE" OR "DOSE" TO "8-HOUR TIME-WEIGHTED AVERAGE SOUND LEVEL" (TWA)

Dose or percent noise exposure	TWA
10	73.4
15	76.3
20	78.4
25	80.0
30	81.3
35	82.4
40	83.4
45	84.2
50	85.0
55	85.7
60	86.3
65	86.9
70	87.4
75	87.9
80	88.4
81	88.5
82	88.6
83	88.7
84	88.7
85	88.8
86	88.9
87	89.0
88	89.1
89	89.2
90	89.2
91	89.3
92	89.4
93	89.5
94	89.6
95	89.6
96	89.7
97	89.8
98	89.9
99	89.9
100	90.0
101	90.1
102	90.1
103	90.2
104	90.3
105	90.4
106	90.4
107	90.5
108	90.6
109	90.6
110	90.7
111	90.8
112	90.8
113	90.9
114	90.9
115	91.1
116	91.1
117	91.1
118	91.2
119	91.3
120	91.3
125	91.6
130	91.9
135	92.2
140	92.4
145	92.7
150	92.9
155	93.2
160	93.4
165	93.6
170	93.8
175	94.0

TABLE A-1—CONVERSION FROM "PERCENT NOISE EXPOSURE" OR "DOSE" TO "8-HOUR TIME-WEIGHTED AVERAGE SOUND LEVEL" (TWA)—Continued

Dose or percent noise exposure	TWA
180	94.2
185	94.4
190	94.6
195	94.8
200	95.0
210	95.4
220	95.7
230	96.0
240	96.3
250	96.6
260	96.9
270	97.2
280	97.4
290	97.7
300	97.9
310	98.2
320	98.4
330	98.6
340	98.8
350	99.0
360	99.2
370	99.4
380	99.6
390	99.8
400	100.0
410	100.2
420	100.4
430	100.5
440	100.7
450	100.8
460	101.0
470	101.2
480	101.3
490	101.5
500	101.6
510	101.8
520	101.9
530	102.0
540	102.2
550	102.3
560	102.4
570	102.6
580	102.7
590	102.8
600	102.9
610	103.0
620	103.2
630	103.3
640	103.4
650	103.5
660	103.6
670	103.7
680	103.8
690	103.9
700	104.0
710	104.1
720	104.2
730	104.3
740	104.4
750	104.5
760	104.6
770	104.7
780	104.8
790	104.9
800	105.0
810	105.1

TABLE A-1—CONVERSION FROM "PERCENT NOISE EXPOSURE" OR "DOSE" TO "8-HOUR TIME-WEIGHTED AVERAGE SOUND LEVEL" (TWA)—Continued

Dose or percent noise exposure	TWA
820	105.2
830	105.3
840	105.4
850	105.4
860	105.5
870	105.6
880	105.7
890	105.8
900	105.8
910	105.9
920	106.0
930	106.1
940	106.2
950	106.2
960	106.3
970	106.4
980	106.5
990	106.5
999	106.6

APPENDIX B TO § 1910.95—METHODS FOR ESTIMATING THE ADEQUACY OF HEARING PROTECTOR ATTENUATION

This Appendix is Mandatory

For employees who have experienced a significant threshold shift, hearing protector attenuation must be sufficient to reduce employee exposure to a TWA of 85 dB. Employers must select one of the following methods by which to estimate the adequacy of hearing protector attenuation.

The most convenient method is the Noise Reduction Rating (NRR) developed by the Environmental Protection Agency (EPA). According to EPA regulation, the NRR must be shown on the hearing protector package. The NRR is then related to an individual worker's noise environment in order to assess the adequacy of the attenuation of a given hearing protector. This appendix describes four methods of using the NRR to determine whether a particular hearing protector provides adequate protection within a given exposure environment. Selection among the four procedures is dependent upon the employer's noise measuring instruments.

Instead of using the NRR, employers may evaluate the adequacy of hearing protector attenuation by using one of the three methods developed by the National Institute for Occupational Safety and Health (NIOSH), which are described in the "List of Personal Hearing Protectors and Attenuation Data," HEW Publication No. 76-120, 1975, pages 21-37. These methods are known as NIOSH methods #1, #2 and #3. The NRR described below is a simplification of NIOSH method #2. The most complex method is NIOSH method #1, which is probably the most accurate method since it uses the largest amount of spectral information from the individual employee's noise environment. As in the case of the NRR method described below, if one of the NIOSH methods is used, the selected method must be applied to an individual's noise environment to assess the adequacy of the attenuation. Employers should be careful to take a sufficient number of measurements in order to achieve a representative sample for each time segment.

NOTE: The employer must remember that calculated attenuation values reflect realistic values only to the extent that the protectors are properly fitted and worn.

When using the NRR to assess hearing protector adequacy, one of the following methods must be used:

(i) When using a dosimeter that is capable of C-weighted measurements:

(A) Obtain the employee's C-weighted dose for the entire workshift, and convert to TWA (see appendix A, II).

(B) Subtract the NRR from the C-weighted TWA to obtain the estimated A-weighted TWA under the ear protector.

(ii) When using a dosimeter that is not capable of C-weighted measurements, the following method may be used:

(A) Convert the A-weigh ed dose to TWA (see appendix A).

(B) Subtract 7 dB from the NRR.

(C) Subtract the remainder from the A-weighted TWA to obtain the estimated A-weighted TWA under the ear protector.

(iii) When using a sound level meter set to the A-weighting network:

(A) Obtain the employee's A-weighted TWA.

(B) Subtract 7 dB from the NRR, and subtract the remainder from the A-weighted TWA to obtain the estimated A-weighted TWA under the ear protector.

(iv) When using a sound level meter set on the C-weighting network:

(A) Obtain a representative sample of the C-weighted sound levels in the employee's environment.

(B) Subtract the NRR from the C-weighted average sound level to obtain the estimated A-weighted TWA under the ear protector.

(v) When using area monitoring procedures and a sound level meter set to the A-weighing network.

(A) Obtain a representative sound level for the area in question.

(B) Subtract 7 dB from the NRR and subtract the remainder from the A-weighted sound level for that area.

(vi) When using area monitoring procedures and a sound level meter set to the C-weighting network:

(A) Obtain a representative sound level for the area in question.

(B) Subtract the NRR from the C-weighted sound level for that area.

Appendix C to § 1910.95—Audiometric Measuring Instruments

This Appendix is Mandatory

1. In the event that pulsed-tone audiometers are used, they shall have a tone on-time of at least 200 milliseconds.

2. Self-recording audiometers shall comply with the following requirements:

(A) The chart upon which the audiogram is traced shall have lines at positions corresponding to all multiples of 10 dB hearing level within the intensity range spanned by the audiometer. The lines shall be equally spaced and shall be separated by at least ¼ inch. Additional increments are optional. The audiogram pen tracings shall not exceed 2 dB in width.

(B) It shall be possible to set the stylus manually at the 10-dB increment lines for calibration purposes.

(C) The slewing rate for the audiometer attenuator shall not be more than 6 dB/sec except that an initial slewing rate greater than 6 dB/sec is permitted at the beginning of each new test frequency, but only until the second subject response.

(D) The audiometer shall remain at each required test frequency for 30 seconds (± 3 seconds). The audiogram shall be clearly marked at each change of frequency and the actual frequency change of the audiometer shall not deviate from the frequency boundaries marked on the audiogram by more than ± 3 seconds.

(E) It must be possible at each test frequency to place a horizontal line segment parallel to the time axis on the audiogram, such that the audiometric tracing crosses the line segment at least six times at that test frequency. At each test frequency the threshold shall be the average of the midpoints of the tracing excursions.

Appendix D to § 1910.95—Audiometric Test Rooms

This Appendix is Mandatory

Rooms used for audiometric testing shall not have background sound pressure levels exceeding those in Table D-1 when measured by equipment conforming at least to the Type 2 requirements of American National Standard Specification for Sound Level Meters, S1.4-1971 (R1976), and to the Class II requirements of American National Standard Specification for Octave, Half-Octave, and Third-Octave Band Filter Sets, S1.11-1971 (R1976).

Table D-1—Maximum Allowable Octave-Band Sound Pressure Levels for Audiometric Test Rooms

Octave-band center frequency (Hz)	500	1000	2000	4000	8000
Sound pressure level (dB)	40	40	47	57	62

Appendix E to § 1910.95—Acoustic Calibration of Audiometers

This Appendix is Mandatory

Audiometer calibration shall be checked acoustically, at least annually, according to the procedures described in this appendix. The equipment necessary to perform these measurements is a sound level meter, octave-band filter set, and a National Bureau of Standards 9A coupler. In making these measurements, the accuracy of the calibrating equipment shall be sufficient to determine that the audiometer is within the tolerances permitted by American Standard Specification for Audiometers, S3.6-1969.

(1) Sound Pressure Output Check

A. Place the earphone coupler over the microphone of the sound level meter and place the earphone on the coupler.

B. Set the audiometer's hearing threshold level (HTL) dial to 70 dB.

C. Measure the sound pressure level of the tones at each test frequency from 500 Hz through 6000 Hz for each earphone.

D. At each frequency the readout on the sound level meter should correspond to the levels in Table E-1 or Table E-2, as appropriate, for the type of earphone, in the column entitled "sound level meter reading."

(2) Linearity Check

A. With the earphone in place, set the frequency to 1000 Hz and the HTL dial on the audiometer to 70 dB.

B. Measure the sound levels in the coupler at each 10-dB decrement from 70 dB to 10 dB, noting the sound level meter reading at each setting.

C. For each 10-dB decrement on the audiometer the sound level meter should indicate a corresponding 10 dB decrease.

D. This measurement may be made electrically with a voltmeter connected to the earphone terminals.

(3) Tolerances

When any of the measured sound levels deviate from the levels in Table E-1 or Table E-2 by ± 3 dB at any test frequency between 500 and 3000 Hz, 4 dB at 4000 Hz, or 5 dB at 6000 Hz, an exhaustive calibra-

tion is advised. An exhaustive calibration is required if the deviations are greater than 15 dB or greater at any test frequency.

TABLE E-1—REFERENCE THRESHOLD LEVELS FOR TELEPHONICS—TDH-39 EARPHONES

Frequency, Hz	Reference threshold level for TDH-39 earphones, dB	Sound level meter reading, dB
500	11.5	81.5
1000	7	77
2000	9	79
3000	10	80
4000	9.5	79.5
6000	15.5	85.5

TABLE E-2—REFERENCE THRESHOLD LEVELS FOR TELEPHONICS—TDH-49 EARPHONES

Frequency, Hz	Reference threshold level for TDH-49 earphones, dB	Sound level meter reading, dB
500	13.5	83.5
1000	7.5	77.5
2000	11	81.5
3000	9.5	79.5
4000	10.5	80.5
6000	13.5	83.5

APPENDIX F TO § 1910.95—CALCULATIONS AND APPLICATION OF AGE CORRECTIONS TO AUDIOGRAMS

This Appendix Is Non-Mandatory

In determining whether a standard threshold shift has occurred, allowance may be made for the contribution of aging to the change in hearing level by adjusting the most recent audiogram. If the employer chooses to adjust the audiogram, the employer shall follow the procedure described below. This procedure and the age correction tables were developed by the National Institute for Occupational Safety and Health in the criteria document entitled "Criteria for a Recommended Standard . . . Occupational Exposure to Noise," ((HSM)-11001).

For each audiometric test frequency:

(I) Determine from Tables F-1 or F-2 the age correction values for the employee by:

(A) Finding the age at which the most recent audiogram was taken and recording the corresponding values of age corrections at 1000 Hz through 6000 Hz;

(B) Finding the age at which the baseline audiogram was taken and recording the corresponding values of age corrections at 1000 Hz through 6000 Hz.

(II) Subtract the values found in step (I)(B) from the value found in step (I)(A).

(III) The differences calculated in step (II) represented that portion of the change in hearing that may be due to aging.

EXAMPLE: Employee is a 32-year-old male. The audiometric history for his right ear is shown in decibels below.

Employee's age	Audiometric test frequency (Hz)				
	1000	2000	3000	4000	6000
26	10	5	5	10	5
*27	0	0	0	5	5
28	0	0	0	10	5
29	5	0	5	15	5
30	0	5	10	20	10
31	5	10	20	15	15
*32	5	10	10	25	20

The audiogram at age 27 is considered the baseline since it shows the best hearing threshold levels. Asterisks have been used to identify the baseline and most recent audiogram. A threshold shift of 20 dB exists at 4000 Hz between the audiograms taken at ages 27 and 32.

(The threshold shift is computed by subtracting the hearing threshold at age 27, which was 5, from the hearing threshold at age 32, which is 25). A recent audiogram has confirmed this shift. The contribution of aging to this change in hearing may be estimated in the following manner:

Go to Table F-1 and find the age correction values (in dB) for 4000 Hz at age 27 and age 32.

	Frequency (Hz)				
	1000	2000	3000	4000	6000
Age 32	6	5	7	10	14
Age 27	5	4	6	7	11
Difference	1	1	1	3	3

The difference represents the amount of hearing loss that may be attributed to aging in the time period between the baseline audiogram and the most recent audiogram. In this example, the difference at 4000 Hz is 3 dB. This value is subtracted from the hearing level at 4000 Hz, which in the most recent audiogram is 25, yielding 22 after adjustment. Then the hearing threshold in the baseline audiogram at 4000 Hz (5) is subtracted from the adjusted annual audio-

ATTACHMENT VII

FIRE EXTINGUISHER USE AND INSPECTION

FIRE EXTINGUISHER

USE AND INSPECTION

Fire Extinguisher Use and Inspection procedures will be conducted in support of the activities to be conducted at NAS Brunswick, Maine. The following text is intended to provide general instruction to the field personnel charged with this responsibility.

Fire Extinguisher Use

All personnel trained in incidental response measures may be required to use and operate a fire extinguisher in response to an incipient stage fire. Therefore, the following instruction is provided and will be conveyed to all field personnel as part of site-specific training.

To use a portable fire extinguisher, the user should be familiar with the operation of the specific fire extinguisher located in the workplace. The following procedure will properly extinguish a small fire.

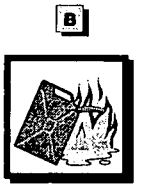
1) IDENTIFY THE TYPE OF FIRE (CLASS A, B, C, D).

CLASSES OF FIRE/FIRE EXTINGUISHER IDENTIFICATION

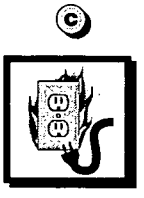
Fire is divided into four classes for easy identification and extinguishment. The type of fuel or ignition source will determine the type of extinguishing medium required.

Class A - Ordinary combustibles (wood, paper, rubber, plastic, and cloth). Extinguishers suitable for Class A fires should be identified by a triangle containing the letter "A." If colored, the triangle is green.

Class B - Flammable liquids, gases, and greases. Extinguishers suitable for Class B fires should be identified by a square containing the letter "B." If colored, the square is red. <u>This type of extinguisher is effective on small petroleum product fires</u>.



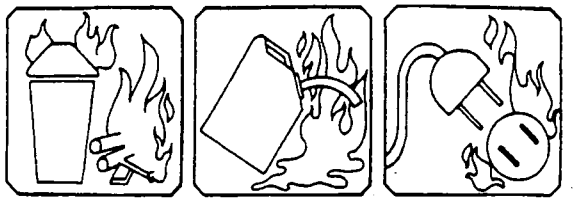
Class C - Electrically energized systems. Extinguishers suitable for Class C fires should be identified by a circle containing the letter "C." If colored, the circle is blue.



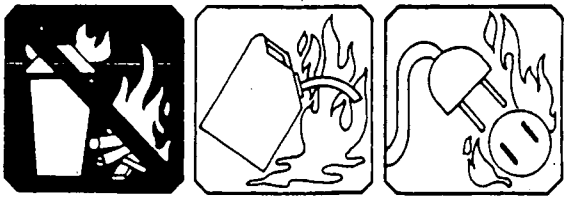
Class D - Combustible metals (sodium, magnesium, phosphorus). Extinguishers suitable for fires involving metals should be identified by a five-pointed star containing the letter "D." If colored, the star is yellow.

<u>Note: Water and other extinguishing media, such as carbon dioxide and dry chemicals, are ineffective on metal fires.</u>

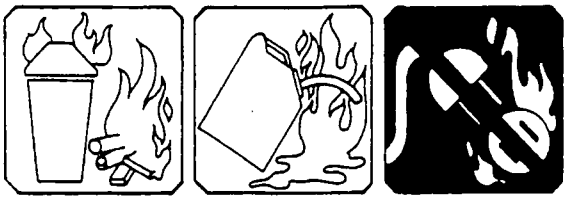
New NFPA Markings



Class A, B, C



Class B, C



Class A, B

Class A

Mutli-class (ABC) Fire extinguishers will be provided for use on site. If you will buy a Fire Extinguisher, this is the type recommended. Size or rating recommended is 2 1/2 to 5 lbs.

1. Determine whether the extinguisher is adequate for this fire.

Rating number – The rating number assigned to a fire extinguisher is based on the capabilities of that fire class, for example
Class 5 A – Will provide extinguishing capabilities equal to that of 5 gallons of water.
Class 20 B - Will provide extinguishing capabilities equal to 20 square feet of flammable liquid burning.

Class C & D are not rated as to their limitations.

2. If adequate, hold the extinguisher upright and pull the ring pin.
3. Stand back 10 feet and aim at base of fire. Be careful not to spread burning material with pressurized extinguishing material.
4. Squeeze lever; sweep extinguisher in a side-to-side motion.

Portable Fire Extinguisher Placement/Mounting

Portable Fire Extinguishers will be placed/mounted in clear view in the areas where flammable materials are stored and/or dispensed. Mounting and placement of fire extinguishers will follow the following requirements

Fixed Locations (Flammable Storage)

- Extinguisher location will be marked by a red painted post or signage to indicate extinguisher location
- The travel distance to access a fire extinguisher shall be no greater than 50 feet.
- The fire extinguisher will be mounted at a maximum height of four feet.

Mobile Locations (Drill Rigs, Support Vehicles)

All vehicles carrying fuel containers or used in the dispensing of fuel will carry at a minimum a 5 pound rated fire extinguisher.

Portable Fire Extinguisher Inspection

All fire extinguishers used in support of this field effort will be inspected on the following frequencies:

- A certified provider will perform maintenance checks of fire extinguishers at least once a year. A tag attached to the neck of the fire extinguisher will indicate documentation of the maintenance check.

- All fire extinguishers will have a current hydrostatic inspection. For the type of extinguishers selected for use at NAS Brunswick hydrostatic inspections are required every 12 years.

- All fire extinguishers will be inspected monthly. The monthly inspection will cover the following
  - Are the fire extinguisher(s) placed in their designated location(s)?
  - Is the location conspicuously marked (Top 18 inches of the mounting pole to be painted red)?
  - Is the access impeding travel to the fire extinguisher blocked or restricted in any way?
  - Has the fire extinguisher been partially or completely discharged?

- Is there signs of obvious physical damage?
- Does the fire extinguisher shows sufficient pressure and are all of the tamper indicators are in place?

This inspection shall be documented on the attached tag provided by the maintenance/hydrostatic inspection service.

FIRE EXTINGUISHER CHECKLIST

NAS BRUNSWICK, MAINE

Proj ct Name:_____	CTO ___	**Date of Inspection:**_____
Fire Extinguisher Identification Number:_____		**Fire Extinguisher Location:** _____

Measurement Criteria	**Yes**	**No**	**N/A**	**Needs R paired**
Are the fire extinguisher(s) placed in their designated location(s)?				
Is the location conspicuously marked (Top 18 inches of the mounting pole to be painted red)?				
Is the access impeding travel to the fire extinguisher blocked or restricted in any way?				
Has the fire extinguisher been partially or completely discharged?				
Is there signs of obvious physical damage?				
Does the fire extinguisher shows sufficient pressure and are all of the tamper indicators are in place?				

Project Name:_____	CTO ___	**Date of Inspection:**_____
Fire Extinguisher Identification Number:_____		**Fire Extinguisher Location:** _____

Measurement Criteria	**Yes**	**No**	**N/A**	**Needs Repaired**
Are the fire extinguisher(s) placed in their designated location(s)?				
Is the location conspicuously marked (Top 18 inches of the mounting pole to be painted red)?				
Is the access impeding travel to the fire extinguisher blocked or restricted in any way?				
Has the fire extinguisher been partially or completely discharged?				
Is there signs of obvious physical damage?				
Does the fire extinguisher shows sufficient pressure and are all of the tamper indicators are in place?				

APPENDIX D

MINI-WELLS DESIGN LETTER REPORT

TETRA TECH NUS, INC.
55 Jonspin Road • Wilmington, MA 01887-1020
Tel 978.658.7899 • Fax 978.658.7870 • www.tetratech.com

C-NAVY-09-04-1749W

September 15, 2004

Project Number N4590

Ms. Claudia Sait
Bureau of Remediation and Waste Management
Maine Department of Environmental Protection
17 State House Station
Augusta, Maine 04333-0017

Reference: CLEAN Contract No. N62472-03-D-0057
Contract Task Order No. 014

Subject: Mini-Wells Design Letter Report
For Denitrification-Based Biodegradation Pilot Test
Navy Exchange Service Station
Naval Air Station, Brunswick, Maine

Dear Ms. Sait:

As requested by Mr. Brian Helland of the Engineering Field Activity Northeast (EFANE), please find enclosed two paper copies of the Mini-Wells Design Letter Report for the DBB pilot test to be performed at the Navy Exchange Service Station for the Department of Environmental Protection's (DEP) review. Electronic versions of the response to comments will be sent separately.

Should you have any questions, please do not hesitate to contact me. Comments should be forwarded to Mr. Brian Helland.

Very truly yours,

Liyang Chu
Project Manager

LC/rp

Enclosures

c: B. Helland, EFANE (w/encl.)
T. Williams, NASB (w/encl.)
J. Trepanowski/G. Glenn, TtNUS (w/encl.)
C. Race, TtNUS (w/encl.)
File: N4590-3.2 (w/encl.)

MINI-WELLS DESIGN LETTER REPORT
DBB PILOT TEST
NAVAL EXCHANGE SERVICE STATION
NAVAL AIR STATION, BRUNSWICK, MAINE
September 15, 2004

1.0 INTRODUCTION

Tetra Tech NUS, Inc. (TtNUS) has prepared this letter report for the Navy Exchange (NEX) Service Station Site located at the Naval Air Station (NAS) in Brunswick, Maine. This report was prepared for Engineering Field Activity Northeast Naval Facilities Engineering Command under Contract Number N62472-03-D-0057, Contract Task Order 014. The purpose of this letter report is to summarize the results of field activities completed during August 2004 and to provide the conceptual design of the application wells array to be used during the pilot test. The field activities were performed in accordance with the *Draft Work Plan for Denitrification-Based Biodegradation Pilot Test* (TtNUS, July 2004) and changes are noted in this report.

2.0 HYDRAULIC CONDUCTIVITY (IN-SITU PERMEABILITY) TESTING

Hydraulic conductivity testing (K) was performed using the slug test method on August 18, 2004. Slug test graphs and calculations are provided as Attachment 1. Slug-in tests using water were performed in 0.75-inch ID wells: MW-B27-DP2, MW-B27-DP4, MW-SDP-5, and MW-DP9. Slug-out tests could not be performed due to the lack of clearance around the transducer cable in these 0.75-inch ID wells. MW-DP-19 was unusable because there was at least two feet of soil in the well. Monitoring well MW-NASB-225 was dry and was replaced by MW-NASB-226, a 2-inch inner diameter (ID) well, where both slug-in and slug-out tests were performed using a solid cylinder. Groundwater levels at both MW-NASB-24 and MW-NASB-25 did not recover after installing the slug. These well are screened into the underlying silt/clay and it is likely the borehole walls are smeared with silt and clay.

All slug test time recovery data was recorded at 1 second intervals using an In-Situ Troll® 5 pounds per square inch (psi) pressure transducer with an accuracy of 0.003 feet (ft). Each test was started a few seconds prior to installation of the slug. The data was downloaded to a spreadsheet and elapsed time and head (H)/max slug displacement (H^o) calculated. The corrected elapsed time and H/H^o data were graphed and a best-fit line drawn through the points. K values were calculated using Hvorslev's method. The Bouwer and Rice method was not applicable because the top of the well screens extend above the water table.

The K values ranged from 1 ft/day (3.57×10^{-4} cm/sec) at MW-SPD5 to approximately 62 ft/day (2.17×10^{-02} cm/sec) at MW-NASB-226; most of the K values were in the 10^{-3} to 10^{-2} cm/sec range. The geometric mean was 11.8 ft/day (4.1×10^{-3} cm/sec). The geometric mean K compares favorably to that reported in the *Final Supplemental Remedial Investigation Report for NAS Brunswick* (E.C.Jordan, 1991), which was estimated to be 6.3×10^{-3} cm/sec. The hydraulic gradient (i) across the pilot test area is approximately 0.01 (ft/ft) measured perpendicular to the 58.5 and 59 ft potentiometric contours (Figure 2-9 – *Draft Work Plan*). Using the geometric mean K and the effective porosity as 0.25, the groundwater seepage velocity, calculated using $V = Ki/n$, is estimated to be 0.5 ft/day.

3.0 UTILITY SURVEY

Underground utilities at the Site south of Burbank Avenue were surveyed on August 19, 2004 by a TtNUS subcontractor, Hager-Richter Geoscience (Salem, New Hampshire). The survey determined the horizontal locations of subsurface utilities in the pilot test area, which are depicted in Figure 1. The pilot test area is bounded by Burbank Street to the north, Building 27 and its parking lot to the south, the

asphalt path between the parking lot and Burbank Street to the west, and the transformer along the north side of Building 27. The utility location survey was conducted using two complementary geophysical methods: precision utility location (PUL) and ground penetrating radar (GPR). The PUL survey was conducted using a precision electromagnetic pipe and cable locator, Radiodetection RD400 series. The GPR survey was conducted using a Sensors & Software Smart Cart Noggin Plus digital subsurface imaging radar system. The system includes a survey wheel that triggers the recording of the data at fixed intervals, thereby increasing the accuracy of the locations of features detected along the survey lines. A 250 MHz antenna was used for this project.

Apparent GPR signal penetrations in areas surveyed was approximately 5-7 feet. The utility location survey detected all of the expected utilities although their locations differed somewhat from plans prepared by previous contractors. The location of the soil vapor extraction trench segment immediately west of Building 27 detected using GPR deviated from that shown on previous plans. In addition, two subsurface utility lines not shown in previous plans were detected. A 4-inch PVC drain line that extends from Building 27 to a catch basin in the parking lot southwest of Building 27 was detected and an unknown utility that runs parallel to the LAN communication line parallel to Burbank Avenue was also detected.

4.0 PILOT TEST APPLICATION WELLS CONFIGURATION

Information developed by the hydraulic conductivity testing and the utility survey were reviewed and used by Geovation Technologies, Inc. (Geovation) to refine the distribution of application wells required for the Denitrification-Based Bioremediation (DBB) pilot test. Given hydraulic conductivity values (10^{-2} to 10^{-3} cm/sec) and estimated groundwater velocities in the 0.5 ft/day range, it was determined that a grid array of addition wells was no longer appropriate. Geovation's past experience at other DBB treatment sites with relatively fast-moving ground water was that downgradient dispersion of N-blend tended to be much greater and lateral dispersion much less pronounced relative to less permeable geologic media. Another factor considered in the design of the well array was the numerous subsurface utility lines present in the pilot test area.

The new proposed array will consist of three lines of application wells within the pilot test area. The application wells are labeled with the "DB-" prefix on Figure 1. Seventeen (17) new 1-in. diameter PVC mini-wells will be installed to facilitate applications of the "N-Blend" nitrate and nutrient solution for the DBB pilot test. Three lines of application wells are planned as shown on Figure 1. Line 1 will consist of eight (8) closely-spaced wells parallel to Burbank Avenue. Line 2 will be located further south and will consist of four (4) new mini-wells installed between existing air sparging wells AS-6 and AS-8 (two each on either side of AS-7). Line 3 will consist of five (5) new mini-wells spaced 10-15-ft apart in a line oriented roughly parallel to the west face of Building 27.

Review of the construction logs for existing air sparging wells AS-6, AS-7 and AS-8 indicates that they are suitable for use in applying the N-Blend. Accordingly, AS-6, AS-7 and AS-8 will be incorporated in the DBB pilot test as part of treatment Line 2.

In addition, Geovation proposes to apply N-Blend into existing mini-wells DP-1, DP-2, and DP-15, which are located upgradient of the pilot test area and north of Burbank Avenue (Figure 2). It is expected that a significant subsurface bloom of motile denitrifiers (e.g., *Pseudomonas* spp.) will develop in response to the N-Blend applications. Using these upgradient wells in the DBB pilot program will help to establish a steady flux of adapted denitrifiers into the pilot test area to treat the sorbed mass upgradient of and within the pilot test zone. This should enhance the overall cost/benefit of the pilot program as well.

The layout of the tightly spaced linear arrays of points (e.g., ±7.5-ft for Line 1) and the overall configuration of the three linear rows of treatment wells was selected to provide for greater overlap of the lateral dispersion of N-blend so as to create a moving "curtain" of DBB-nutrient rich groundwater through the treatment zone. In general, grid patterns of evenly spaced treatment points are preferred in relatively low-permeability, fine-grained formations whereas linear arrays of tightly spaced points oriented roughly orthogonal to the plume axis are preferred in relatively high-permeability, coarse-grained formations. In addition, the presence of numerous utilities, including sensitive telecommunications line, would make the installation of an idealized grid pattern difficult if not impractical at the site. The presence of the utilities also presents restrictions on the orientations of the lines of treatment points such that they are not ideally oriented orthogonal to the plume axis.

The next phase of the DBB design will involve (a) the selection of the vertical screened intervals and (b) the determination of the amounts and concentrations of N-blend to be applied into each treatment point. Geovation plans to modify 5-in. diameter flush mount casings so as to allow the installation of plastic tubing to facilitate a wider range of N-blend application methods. Efforts will be made to enable the application of N-blend over longer time periods (several hours to days versus minutes) so as to slow down the rate of downgradient N-blend dispersion given the rapid groundwater flow rates in the pilot test area. As described in the *Draft Work Plan*, the delayed distribution of N-Blend may utilize either manually operated or automated liquid dispensing systems that include 5-gallon stainless-steel canisters that are plumbed so as to dispense N-Blend by controlled volume displacement with compressed inert gas (argon).

The volume and concentration of N-Blend additions will be designed to correlate with the horizontal and vertical distribution of petroleum hydrocarbons. Data from the existing boring logs, geologic cross-sections and the observed PID readings and sorbed-phase GRO data from prior direct-push sampling will be used to determine the N-Blend loadings. Given the rapid ground-water flow rates at the site, the treatment points located furthest upgradient (i.e., Line 1) will receive a greater proportion of the N-Blend reagent than the wells located further downgradient.

5.0 SUPPLEMENTAL MONITORING WELLS

Three new monitoring wells are also proposed. MW-300 will be located near the northwestern corner of Building 27, which is the approximate location of boring B-27-DP1. This boring previously had the highest detected soil GRO concentration (8,830 mg/Kg). MW-301 will be used to replace MW-NASB-25, which was determined to be poor communication with the aquifer during the August 2004 hydraulic conductivity testing and would be unsuitable for long-term monitoring and sampling. MW-302 will be installed downgradient of MW-NASB-25 and MW-301, and will be used to monitor for potential nitrate and GRO migration outside the pilot test area. During the August 2004 groundwater sampling event, strong gasoline-like odors were noted in MW-NASB-25, which may be an indicator that the GRO plume has expanded since 2003. Therefore, MW-302 will be used to assess this situation.

These new wells will also be sampled prior to the start of the N-Blend addition to provide supplemental baseline groundwater data. These wells will be sampled for GRO, BTEX/MBTE, and nitrate/nitrite.

6.0 BASELINE AND PERIODIC SOIL SAMPLING

Based on the new distribution of mini-wells (lines vs. grid), the baseline soil sampling program has been modified. Soil samples will be collected from 4 borings in Line 1, 4 borings in line 2, and 3 borings in Line

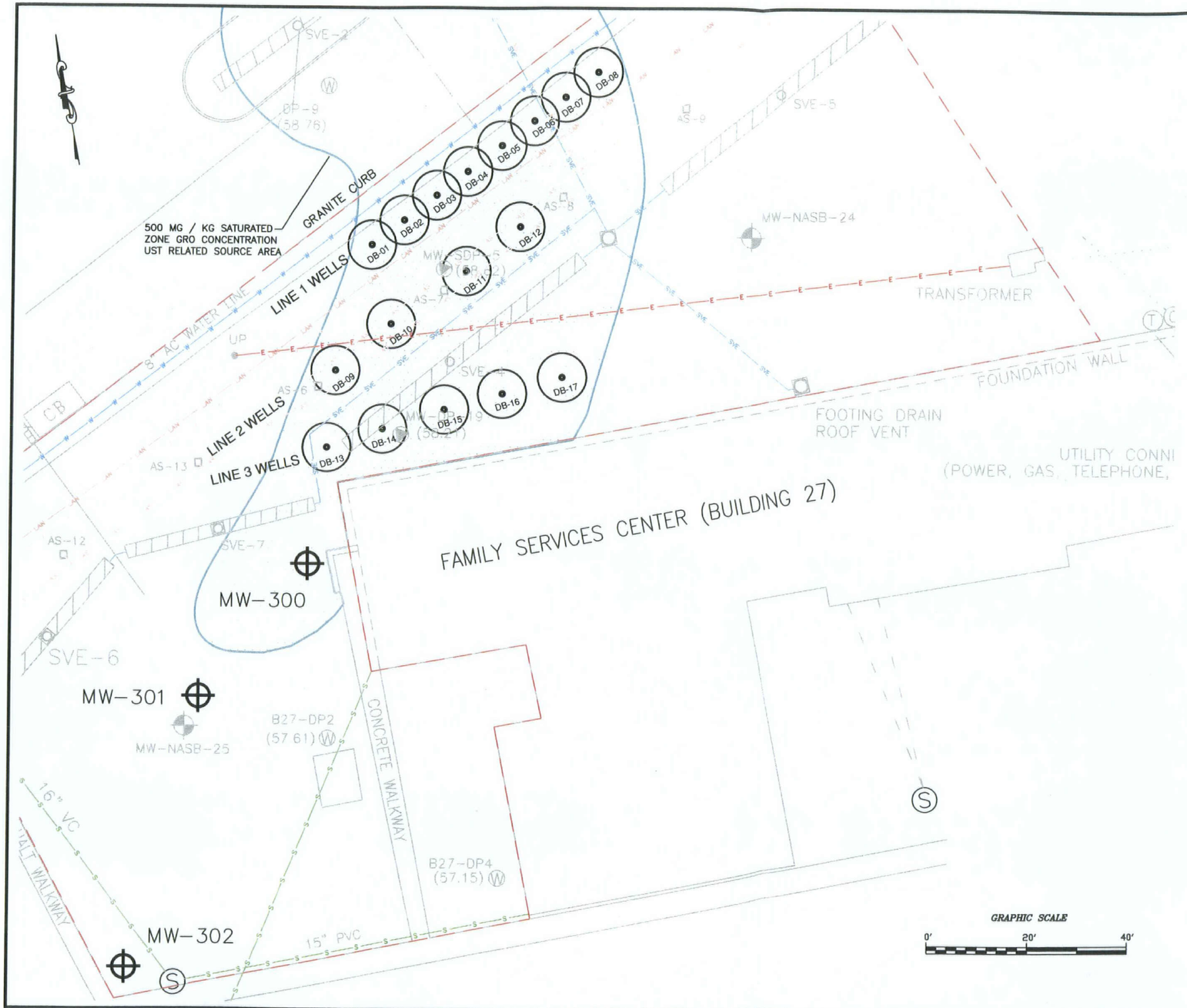
3 (totaling 11 sets of samples) for GRO analysis. It is anticipated that there will be two sample intervals per borehole, and one sample per interval shall be collected (consistent with the *Draft Work Plan*).

As previously discussed with the Maine Department of Environmental Protection (DEP) representatives, additional soil samples will also be collected to address DEP comments and concerns. Soil samples will be collected from two locations (DB-11 and MW-300) adjacent to GRO hot spots delineated previously for volatile petroleum hydrocarbon (VPH) analysis. Top of clay samples will also be acquired from DB-11 and MW-300 to assess potential permeation of GRO into the low-permeability zone.

During the Rounds 1, 2, and 3 events, soil samples will be obtained from the three lines (11 locations) and from MW-300 and will be analyzed for GRO. VPH analysis will also be performed for samples obtained from DB-11 and MW-300. The need to collect the top of clay samples for periodic GRO analysis will be assessed after the evaluation of the baseline soil sampling results.

6.0 TENTATIVE SCHEDULE

TtNUS and the DPT drilling subcontractor, Yarmouth Environmental Service of Yarmouth, Maine, are scheduled to perform the baseline DP soil sampling and mini-well installations during the week of September 27, 2004. Geovation will apply the first dose of N-Blend during the week of October 4, 2004.



LEGEND

- MONITORING WELL
- FH — FIRE HYDRANT WITH BOLLARDS
- UP — UTILITY POLE
- CB — STORM WATER CATCH BASIN
- MANHOLE
- EXISTING CHAIN LINK FENCE
- UNDERGROUND STRUCTURE
- APPROXIMATE AREA OF INTEREST
- ELECTRIC LINE
- WATER LINE
- SEWER LINE
- SVE — SVE SYSTEM
- LAN LINE
- AIR SPARGE LINE
- UNKNOWN LINE
- PROPOSED NBLEND APPLICATION WELL DB SERIES
- PROPOSED MONITORING WELL
- DBB PILOT TEST AREA

NOTES:

1. BASE MAP DEVELOPED FROM ERM-NEW ENGLAND, INC. SITE PLAN DATED 24 JUNE 1992 AND SURVEYS PERFORMED BY CORNERSTONE PROFESSIONAL LAND SURVEYING, INC., 20 MAY 1994, 19 JULY 1995, MAY 1997, AND 7 NOVEMBER 2001.
2. BASE MAP UPDATED AND VERIFIED BASED ON SURVEY COMPLETED 11 JUNE 2003 BY BRIAN SMITH SURVEYORS, INC.
3. SOIL VAPOR EXTRACTION/AIR SPARGING SYSTEM COMPONENTS NOT SHOWN.
4. UTILITIES SHOWN FOR REFERENCE PURPOSE ONLY. ACTUAL LOCATIONS MUST BE FIELD VERIFIED.
5. PROPOSED WELL LOCATIONS TO BE IN SUBSTANTIAL COMPLIANCE WITH PLAN BUT LOCATIONS MAY CHANGE DUE TO ACTUAL UTILITY AND/OR OTHER OBSTRUCTIONS FOUND IN THE FIELD.

SOURCE:

FOCUSED FEASIBILITY STUDY, NAVY EXCHANGE SERVIE STATION, NAVAL AIR STATION, BRUNSWICK, MAINE; EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC. APRIL 2004.

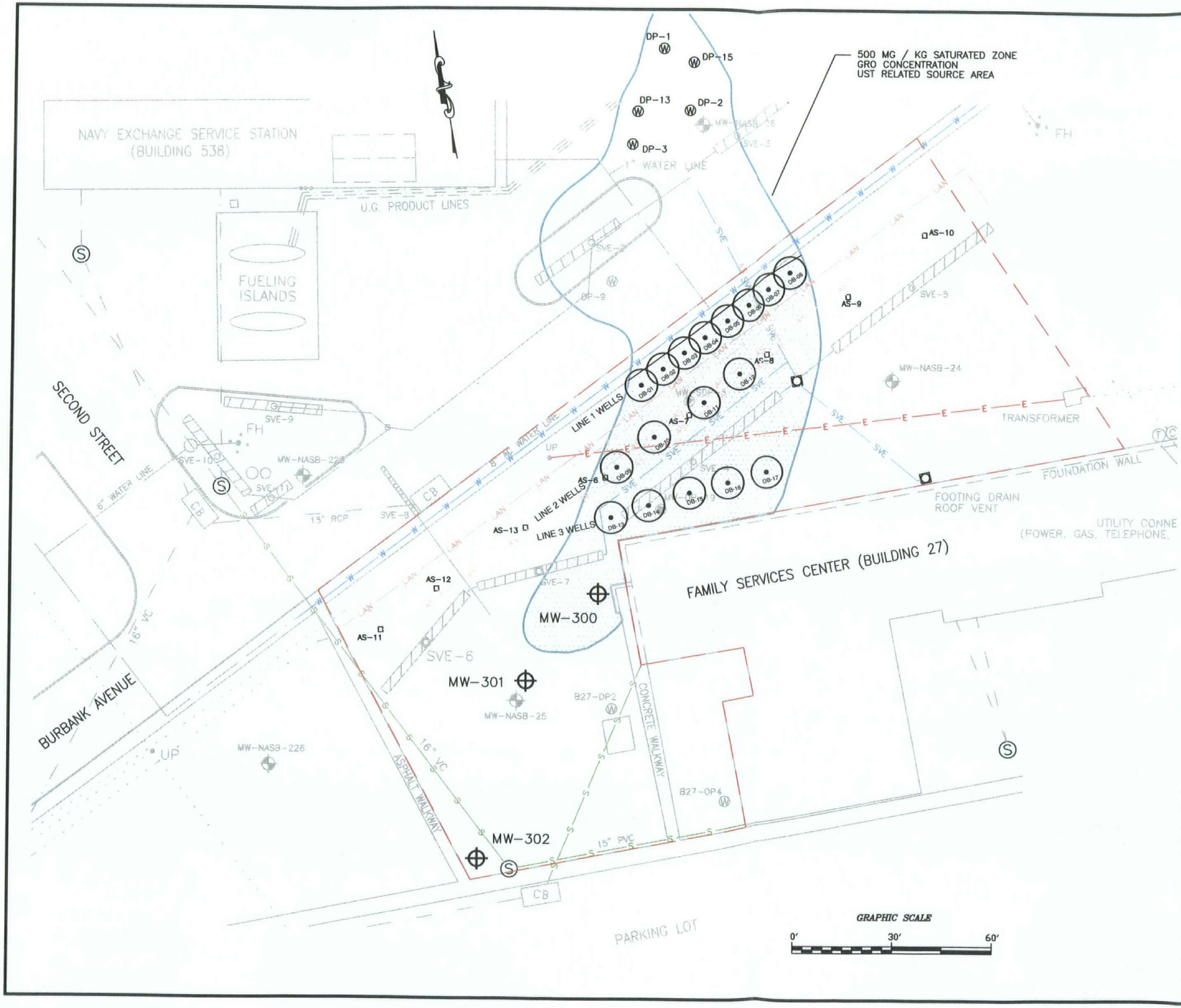
GEOPHYSICAL SURVEY, HAGER-RICHTER GEOSCIENCE, INC., SALEM, NEW HAMPSHIRE, AUGUST 2004.

TETRA TECH NUS, INC.

PROPOSED WELL LOCATIONS
NAVAL EXCHANGE SERVICE STATION
US NAVY NAVFAC EFANE
NAVAL AIR STATION, BRUNSWICK, MAINE

FILE	SCALE
DWG\4590\3511\WELL_LOC_PROP.DWG	AS NOTED

FIGURE NUMBER	REV	DATE
1	0	09/14/04



LEGEND

- MONITORING WELL
- FH — FIRE HYDRANT WITH BOLLARDS
- UP — UTILITY POLE
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- E — ELECTRIC LINE
- W — WATER LINE
- S — SEWER LINE
- SVE SYSTEM
- LAN — LAN LINE
- AIR SPARGE LINE
- UNKNOWN LINE
- PROPOSED NBLEND APPLICATION WELL DB SERIES
- PROPOSED MONITORING WELL
- DBB PILOT TEST AREA

NOTES:

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SOURCE:

FOCUSED FEASIBILITY STUDY, NAVY EXCHANGE SERVIE STATION, NAVAL AIR STATION, BRUNSWICK, MAINE; EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC. APRIL 2004.

GEOPHYSICAL SURVEY, HAGER-RICHTER GEOSCIENCE, INC., SALEM, NEW HAMPSHIRE, AUGUST 2004.

TETRA TECH NUS, INC.

SITE PLAN OF KNOWN UTILITY LOCATIONS
NAVAL EXCHANGE SERVICE STATION
US NAVY NAVFAC EFANE
NAVAL AIR STATION, BRUNSWICK, MAINE

FILE DWG\4590\3511\SITE_PLAN.DWG	SCALE AS NOTED
FIGURE NUMBER 2	REV 0 — DATE 09/14/04