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# **Work Plan Background Soil Investigation**

**for**

**NUWC Disposal Area, SA-08  
Naval Station Newport  
Newport, Rhode Island**



**Engineering Field Activity Northeast  
Naval Facilities Engineering Command**

**Contract Number N62472-94-D-0888**

**Contract Task Order 0849**

**March 2003**

**WORK PLAN  
BACKGROUND SOIL INVESTIGATION**

**FOR**

**NUWC DISPOSAL AREA, SA-08  
NAVAL STATION NEWPORT  
NEWPORT, RHODE ISLAND**

**COMPREHENSIVE LONG-TERM  
ENVIRONMENTAL ACTION - NAVY (CLEAN) CONTRACT**

**Submitted to:**

**Engineering Field Activity Northeast  
Environmental Branch, Code 1823/JS  
Naval Facilities Engineering Command  
10 Industrial Highway, Mail Stop No. 82  
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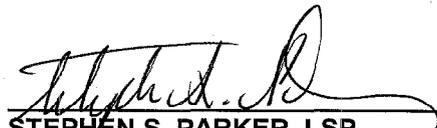
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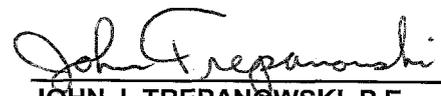
**Contract Number N62472-94-D-0888  
"CLEAN" Contract Task Order 0849**

**March 2003**

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March 28, 2003

Project Number N8856

Mr. James Shafer  
Remedial Project Manager  
EFA Northeast, Naval Facilities Engineering Command  
10 Industrial Highway, Mail Stop 82  
Lester, Pennsylvania 19113

Reference: CLEAN Contract No. N62467-94-D-0888  
Contract Task Order No. 0849

Subject: Draft Work Plan for Background Investigations  
Study Area 08, NUSC Disposal Area  
Naval Underwater Warfare Center, Middletown Rhode Island

Dear Mr. Shafer:

Enclosed you will find four copies of the Draft Work Plan for Background Investigations, prepared for the site referenced above. Recipients should be made aware that an addendum to the Work Plan for Study Area Screening Evaluation at this site (Brown and Root Environmental, January 1998) is under preparation, and will be issued under a separate letter.

Four electronic copies of this delivery (on CD ROM) will be issued shortly to Ms. Kathleen Marley for distribution to interested RAB members. If you have any questions regarding this material, please do not hesitate to contact me.

Very truly yours,

Stephen S. Parker  
Project Manager

SSP/rp

Attachment

- c: P. Denolfo, NUWC (w/encl. - 2)
- K. Finkelstein, NOAA (w/encl. - 1)
- M. Imbriglio, NSN (w/encl. - 3)
- K. Keckler, U.S. EPA (w/encl. - 3)
- P. Kulpa, RIDEM (w/encl. - 4)
- S. McFadden, TAG (w/encl. - 1)
- C. Mueller, NSN (w/encl. - 2)
- J. Stump, Gannett Fleming (w/encl. - 2)
- J. Trepanowski/G. Glenn, TtNUS (w/encl. - 1)
- File N8856-3.2 (w/o encl.), N8856-8.0 (w/encl. - 1)

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- A Field Documentation Forms
- B Tetra Tech NUS, Inc., Standard Operating Procedures

## 1.0 INTRODUCTION

This work plan addresses the implementation of a background soil investigation for the Naval Underwater Warfare Center (NUWC) Disposal Area, Study Area (SA)-08 (the site), at Naval Station Newport (NAVSTA Newport) (formerly the Naval Education and Training Center (NETC)) in Newport, Rhode Island. The site is partially used as a storage facility, with a fenced, paved area, and an unimproved area featuring grassy areas, wetlands, and a small retention pond. This work plan describes the procedures for performing an investigation of background locations to this area. This work plan has been prepared by Tetra Tech NUS, Inc. (TtNUS) under the Comprehensive Long Term Environmental Action Navy (CLEAN) Contract No. N62472-94-D-0888, Contract Task Order (CTO) 849.

The purpose of this plan is to describe the background location selection process, field tasks to be performed, analytical parameters, sampling techniques, methods for data interpretation, and reporting aspects of the investigation.

### 1.1 SPECIFIC INVESTIGATION OBJECTIVES

Previous investigations for nearby sites, and the use of surrounding properties indicate that the background levels of some metals and other persistent chemicals such as arsenic and organochlorine pesticides may be higher in soils at and near this site (from background areas near the site) than in other background areas of Rhode Island. The SA-08 site is located downgradient of a golf course and historically agricultural land. The objective for this study is to establish upgradient and background concentrations of metals and organic chemicals in soils for the SA-08 site by determining the occurrence, geochemical abundance, and variability (scatter) of surface and subsurface soil chemical concentrations at properties upgradient of this site. The background levels for these chemicals will be used to assist in the evaluation of onsite analytical data for the SA-08 site.

Navy policy requires that there is a clear and concise understanding of chemicals released from a site in order to assure proper focus and remediation of the release. To this end, background evaluations are needed during the site investigation in order to differentiate between the site conditions and background sources. These evaluations should include naturally occurring chemicals and anthropogenic chemicals (CNO 2000).

The U.S. Environmental Protection Agency (USEPA) defines "background" as substances or locations that are not influenced by releases from a site, and are usually described as naturally occurring (not influenced by human activity) or anthropogenic (present as a result of human activity) (EPA, 2002).

The Rhode Island Department of Environmental Management (RIDEM) Site Remediation Regulation (DEM-DSR-01-93), defines "background" as the ambient concentrations of hazardous substances present in the environment that have not been influenced by human activities, or the ambient concentrations of hazardous substances consistently present in the environment in the vicinity of the contaminated site, which are the result of human activities unrelated to releases at the contaminated site.

Additionally, RIDEM regulations state that background samples provide baseline measurements to determine what the concentrations of chemicals would be at a site if no releases occurred there. Rhode Island regulations provide an allowance for determining background conditions under the Site Remediation Regulations Section 8.06 A:

"Sampling of hazardous substances in background areas may be conducted to distinguish concentrations related to the contaminated site from concentrations of hazardous substances not related to activities at the contaminated site or to support the development of soil objectives under the provisions of Rule 8.02 (Soil Objectives)."

Because streams flow to the site, bringing washed out soil and sediment particles to the wetlands on site, a separate "upgradient-downgradient" migration conditions exists, which is different from the general background conditions of the other off-site soils. This study will address the upgradient sediments separately from the soils, as described in this work plan.

Since the definitions for background are consistent between the Navy, EPA and RIDEM, the upgradient and background conditions to be sought during the field work described in this work plan include both naturally occurring and anthropogenic chemical contributions to the soils at the site. This data will be compared with the data collected from the NUSC site in order to identify site-contaminants from non-site background (naturally occurring and anthropogenic) contaminants. These comparisons will be provided in the SASE report to be prepared for the site after field investigations are completed.

The background investigation activities will include historical research to evaluate the proposed upgradient and background sampling locations described in this work plan, sampling and analysis of soil samples at up to forty locations, a global positioning system (GPS) survey of the background sample locations, data review, and statistical analysis of the data (to be described in a findings report).

## **1.2 PROJECT DELIVERABLES**

Project deliverables to be submitted during this project will include:

A report of the background investigation including:

- Summary of site background information
- Description of field investigation activities
- Summary and interpretation of the data
- Summary of statistical analysis of the data
- Conclusions and recommendations for use of upgradient and background data

Supporting documentation, including:

- Maps depicting sampling points and other significant features
- Results from laboratory analysis of samples
- Statistical analysis supporting documentation
- Photographs of sample locations

A more detailed description of the report is presented in Section 6.0 of this work plan.

### **1.3 WORK PLAN ORGANIZATION**

Section 1.0 of this work plan consists of this introductory section.

Section 2.0 of this work plan describes the site history, selection of background stations, and basis for the Data Quality Objectives (DQOs) developed for this project.

Section 3.0 presents a description of the field work planned for this investigation. Sample collection procedures and analytical parameters are also included in this section.

Section 4.0 presents the Quality Assurance Plan for this work plan. This plan describes the QA/QC sample collection procedures and frequencies, data quality protocols, and analytic data validation requirements.

Section 5.0 presents a general outline of the data evaluation and statistical analysis that will be conducted following completion of the field work (described in Section 3.0).

Section 6.0 presents a brief description of information to be included in the report.

Guidelines from the applicable portions of the existing site-specific Health and Safety Plan, previously prepared for the SA-08 site fieldwork, will be observed for the fieldwork presented in this work plan. Appendix A to this work plan presents documentation forms to be used for execution of the work described in this work plan, and Appendix B presents applicable TtNUS Standard Operating Procedures for field activities.

#### **1.4 CHANGES TO THE WORK PLAN**

During implementation of the proposed background soil investigation it may become necessary to modify some portion(s) of the work described in this work plan. If the plan for collecting data needs to be altered, the work plan may be amended through the use of a Request for Field Modification (RFM) form. This form will be prepared by the TtNUS Field Operations Leader (FOL) and forwarded to the TtNUS Project Manager (PM). The PM will make a recommendation to the Navy Remedial Project Manager (RPM), who will forward the RFM to the regulatory oversight RPMs, if necessary. Time limits on acceptance of, or comment to, the field modification requests will be stated. An example of the RFM form is presented in Appendix A.

## 2.0 BACKGROUND INFORMATION AND DATA QUALITY OBJECTIVES

The following sections present a brief historical description of the area surrounding the SA-08 site, a basis for selection of the locations for upgradient and background sample collection, and the data quality objectives to be followed for this project.

### 2.1 SITE DESCRIPTION AND HISTORY

This section provides a brief description and history of NAVSTA Newport, Coasters Harbor Island, and the SA-08 site. Figure 2-1 presents a locus map showing the SA-08 site.

#### Naval Station Newport:

NAVSTA Newport is located approximately 60 miles southwest of Boston, Massachusetts and 25 miles south of Providence, Rhode Island. It occupies approximately 1,063 acres, with portions of the facility located in the City of Newport and Towns of Middletown and Portsmouth, Rhode Island. The facility layout is long and narrow, following the western shoreline of Aquidneck Island for nearly 6 miles, facing the east passage of Narragansett Bay.

The NAVSTA Newport facility has been in use by the Navy since the era of the Civil War. During World Wars I and II, military activities at the facility increased significantly and the base provided housing for many servicemen. In subsequent peacetime years, use of on-site facilities was slowly phased out until Newport became the headquarters of the Commander Cruiser-Destroyer Force Atlantic in 1962. In April 1973, the Shore Establishment Realignment (SER) Program resulted in the reorganization of naval forces, and activity again declined.

#### Middletown Area:

Aerial photo analysis shows that much of the Middletown area was agricultural prior to the 1940s. Development of housing and commercial complexes began in the 1950s and continued through the late 1990s. In air photos evaluated from 1942 and 1951, made available by the Rhode Island State Planning office, it is apparent that the NUWC area was constructed from what was previously farmland during the World War II time period.

SA 08 Area:

The area occupied by SA-08 is noted as a portion of farmland in the earliest photo available at the Rhode Island State Planning office, dated 1939 (Figure 2-2). This photo shows a typical farmhouse located approximately 100 yards southwest of the current site, and farmland surrounding the site to the west, east, and south. To the north is a golf course (Plate 106, Lot 1), currently known as the Wanumetonomy Golf Course. Land records show that the golf course was established on this land in January of 1922. The land was purchased from the DeBlois family who accepted it to settle debts from the Brown Family. It is believed this land had earlier been used as farmland by the Brown and Sanford families. The earliest recording of this land available in town records is dated 1887.

Land records show that the land occupied by the site itself was a part of the property owned by the Vanicek family and was acquired by the Navy by court order on May 25, 1942. The pond on the site is present in all air photos available at the state office, back as far as 1939. It is presumed that it was constructed as a farm pond, and its current use is unknown.

The southern portions of the site were reportedly used as a fill area and a storage area for the NUWC. Fill activities are evident in air photos taken between 1951 and 1988. Two streams enter the site, one from the north and one from the east. The stream from the north is likely to transport nutrients, fertilizers, and other lawn treatment chemicals from the upgradient golf course to the north. The stream from the east is likely to transport fertilizers and agricultural chemicals from the upgradient land to the east, which was agricultural until approximately the 1970s. These upgradient inputs are assumed to impact the wetland sediments directly, including the sediments in the on-site portions of the streams and the pond at the northwest portion of the site.

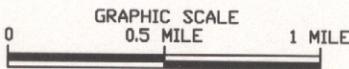
Based on these records and photos, it is also possible that the site soils could have been impacted by chemical contaminants from anthropogenic activities from agriculture and golf course maintenance prior to the 1940s (time of Navy occupation) and well before the 1950s, when the area was filled.

## **2.2 DATA QUALITY OBJECTIVES**

The data quality objectives (DQOs) for this project 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 a field investigation is a determining factor in defining the DQOs for that data. To be certain that the data is consistent with the goals of the investigation, the seven steps of defining DQOs are presented in this section, as described in the following subsections:



BASE MAP IS A PORTION OF THE FOLLOWING 7.5 X 15 MINUTE U.S.G.S. QUADRANGLE:  
PRUDENCE ISLAND, RHODE ISLAND, 1955, PHOTOREVISED 1970 AND 1975



QUADRANGLE LOCATION

SITE LOCUS

FIGURE 2-1

SA-08, NUSC, DISPOSAL AREA  
MIDDLETOWN, RHODE ISLAND



TETRA TECH NUS, INC.

DRAWN BY:	D.W. MACDOUGALL	REV.:	0
CHECKED BY:	S. PARKER	DATE:	FEBRUARY 21, 2003
SCALE:	AS NOTED	ACAD NAME:	DWG\8856\0420\FIG_2-1.DWG

55 Jonspin Road  
Wilmington, MA 01887  
(978)658-7899

0316D014

DRAFT



SOURCE: RIDEM PLANNING OFFICE  
 PHOTO DATED 5/10/39

STUDY AREA IN 1939		FIGURE 2-2	
SA-08, NUSC, DISPOSAL AREA		 <b>TETRA TECH NUS, INC.</b> 55 Jonspin Road      Wilmington, MA 01887 (978)658-7899	
MIDDLETOWN, RHODE ISLAND			
DRAWN BY: D.W. MACDOUGALL CHECKED BY: S. PARKER SCALE: AS NOTED	REV.: 0 DATE: MARCH 28, 2003 ACAD NAME: DWG\8856\0420\FIG_2-2A.DWG		

### 2.2.1 Statement of the Problem

Current Navy policy states that site-specific risk be determined through evaluation of background or upgradient conditions (CNO, 2000). RIDEM regulations require that concentrations of contaminants on site be compared to "RIDEM direct exposure criteria" in part to determine if remedial actions need to be taken at each site. Background conditions must be measured to properly evaluate the site data for exposure and for risk.

Site history and use of abutting properties indicate that upgradient properties are likely to have contributed chemical contaminants associated with agriculture and golf course maintenance prior to the presence of the Navy at the site. Additionally, recent site investigations conducted at the NAVSTA Newport sites, including the Melville North Landfill, Old Firefighting Training Area, and, in general, on the west side of Aquidneck Island, indicate that RIDEM direct exposure criteria may not reflect naturally occurring concentrations of arsenic in soil.

The objective of this investigation is to determine appropriate upgradient and background concentrations for these chemicals through evaluation of similar properties nearby, which represent a background condition for the SA-08 site soils.

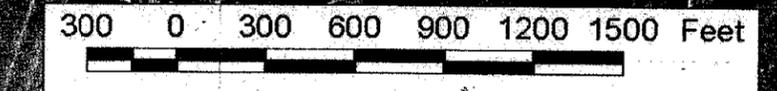
Navy policy and guidance requires that background conditions be assessed at areas with similar geological and physical conditions. RIDEM remediation regulations for background determination require background samples to be collected from areas having the same soil characteristics as the contaminated site. EPA guidance for background evaluations indicates that the background reference areas should have the same physical, chemical, geological, and biological conditions as the site to be investigated (EPA, 2002). Therefore, potential background locations have been evaluated using soil types as well as use history, as described below:

#### Soil Types:

According to the U.S. Department of Agriculture (USDA) Soil Survey of Rhode Island (fieldwork completed from 1970 to 1977), soils on the SA-08 site, and on the surrounding upgradient properties are classified mostly as Stissing silt loam (Se) as shown on Figure 2-3. The Se classification is given to nearly level, poorly drained soils on glacial upland hills and drumlins in the southeastern part of Rhode Island. Subsoils are shallow (to 7 inches) and both surface and subsoils are acidic. Also within the site is a small area of soils identified as Pittstown silt loam with 3-8 percent slopes (PmB). The Pittstown classification notes that soils are moderately well drained, and subsoils are deeper (to 20 inches) than the Stissing classification, making them more suitable for cultivation and for woodland.



NOTES  
 1) PLAN NOT TO BE USED FOR DESIGN  
 2) ALL LOCATIONS TO BE CONSIDERED APPROXIMATE  
 3) SOIL CLASSIFICATIONS MAPPED BY USGS, PROVIDED BY RIGIS, 1990  
 4) CLASSIFICATION ABBREVIATIONS DEFINED IN TEXT



SOIL TYPES		FIGURE 2-3	
SA-US SAC RD AND SOIL INVESTIGATION WORKPLAN			
MIDDLETOWN, RHODE ISLAND			
DRAWN BY: L. SEYDEWITZ	DATE: FEBRUARY 21, 2003	TETRA TECH NUS, INC.	
CHECKED BY: S. PARKER	FILE: \CT0849.APR	55 JONSPIN ROAD	WILLINGTOWN, VA 01887
		(678)558-7859	

0316D02Z

The stream entering the site from the southeast passes through a small area of soil classified as Mansfield mucky silt loam (Ma). This soil classification is similar to the Stissing classification, though characterized by high water table and water content, indicating that these areas are likely to be sumps into which erosion has brought silts from surrounding upgradient areas. This area shows less agricultural activity in the air photos, indicating it was too wet for practical cultivation.

To the southwest and west of the site, at the Naval facility property, soils are classified as Udorthents (UD) which are soils disturbed or modified by filling and construction activities. However, it is reasonable to presume that prior to the construction of the naval facilities in this area, soils were similar to those to the east and north, as described above.

Evaluation of aerial photography performed for development of the SASE Work Plan for the site (B&R Environmental, 1998) showed evidence of fill and storage operation at the site between 1951 and 1988. Fill areas identified in that work plan appear to be within the portions of the site where soils are classified as Se. Therefore, the Se soil type is selected as the focus of this background evaluation.

Although not differentiated by the soil maps, the soil chemistry even within the Se soil designation may differ based on the soils being hydric or non-hydric. Soils that are near or within the stream beds that drain into the site are presumed to be hydric soils, though they are not differentiated from non-hydric soils on the map. Therefore, separation of two subgroups within the representative soil classification is appropriate – that for hydric soils in and adjacent to the stream beds, and for non-hydric soils outside the stream beds. In fact, soils (sediments) within the stream beds are highly mobile, in comparison to those not within the direct water flow regime. The presence of a water current providing a directional flow toward the site dictates that these upgradient sediments constitute upgradient source for sediments at the site. Therefore, two data groups will need to be evaluated: 1) Those non-hydric soils constituting a general background condition for soils at the site, and 2) those hydric soils or sediments that present an upgradient condition for hydric or wetland soils at the Site.

#### Property Use:

Prior to occupation of the site by the Navy, soil treatments common to the agricultural use of the land are likely to have been applied at the site (prior to 1942). Particularly under active cultivation and use as pastures, soil is likely to have been washed into the streams at upgradient properties, transported down stream, and deposited into the sediments of the wet areas and the pond at the site. Soil treatments used at the golf course could have been transported to the soil and sediment at the site through overspray at the abutting property or by overland flow of surface water or by blowing dust. Contaminants brought to the site in this manner could include organic compounds, pesticides, herbicides, nutrients and inorganics

including metals, and such contributions could have occurred both prior to and following site development, up to the present day. Additionally, inorganics including heavy metals associated with the parent bedrock from which the soils were formed are likely to be present in the soils.

The common and consistent uses of some parcels north and east of the site strongly suggest that portions of these upgradient parcels exhibit conditions that could be considered "background", as defined earlier in this section: The contaminants present on these upgradient parcels are likely to reflect both naturally occurring and anthropogenic chemicals present at the site if no releases had occurred there.

Based on the historical use of the site, the current and historical use of the upgradient properties, and based on the soil types onsite and upgradient of the site, the upgradient properties which have not undergone major change since the site was developed in approximately 1942, that are also classified with the Stissing soil type, will be used for the selection of background soil sample locations. Hydric and non-hydric soils will be collected separately, and separate upgradient sediment and background soil concentrations will need to be established for these two different soil groups, following the applicable methods and tests listed in Section 5.0. The soil and sediment background data sets will be compared using statistical tests to answer the questions: Do the data groups match the same distributional shape (normal or lognormal)? Is the mean or the overall population median of one background data group higher (or lower) than the other (t-test for normal or lognormal data; versus Mann-Whitney Gehan tests for non-normal data sets)? Is there a significantly greater proportion of high concentration data points in the upper ranks of one data set versus the other (quantile test)? Are the quartiles and 95<sup>th</sup> percentile concentrations similar for the two subsets?

The background data subsets will be treated as distinct populations if any tests show significant differences, or will be merged if all tests show no statistically significant differences.

This study will evaluate surface soils and surface sediment only. Because soil in background areas and upgradient sediment have not been significantly altered for many years (with the exception of maintaining existing golf greens and bunkers), anthropogenic and naturally occurring contaminants common to the Site are anticipated to be within the upper 12 inches of soils or sediments.

### **2.2.2 Identification of the Decision**

After the completion of this study, a determination will be made of upgradient sediment and background soil contaminant concentrations in proximity to the SA-08 site. This decision will be supported by calculation of various test statistics.

### 2.2.3 Inputs to the Decision

Inputs to the decision are the elements used in the decision process. Inputs to the decision as stated in Section 2.2.2 are as follows:

- locations of proposed background samples
- actual concentrations of chemicals detected
- results of multiple statistical analyses performed in a manner to ensure a 95% confidence level for decision making

### 2.2.4 Definition of the Study Boundaries

The decision stated in Section 2.2.2 focuses on the upgradient sediment and background soil contaminant concentrations in the vicinity of the SA-08 site. Background soil samples having a composition similar to the soil type that may have been found at the SA-08 site prior to Navy operations are to be collected from areas at relatively undisturbed locations upgradient of the site determined to be free of influence from either the site or other non-uniformly distributed anthropogenic sources. Because the site and the surrounding land was previously used for agriculture prior to the Navy presence, and because the upgradient property to the north was used as a golf course prior to the Navy presence on the site, the golf course maintenance and agricultural impacts are presumed to be free of influence from the site. Additionally, any impacts from such activities are also considered to be uniformly distributed anthropogenic sources, at least locally, and thus constitute a background condition.

Similarly, sediments within streambeds which are upgradient of the site will be collected and evaluated. The consistent flow of water to the site provides for an upgradient source to on-site sediments from these upgradient streams.

Based on the current drainage patterns and soil types, five areas (A, B, C1, C2, and D) were evaluated as potential background sample locations for the SA-08 background study (see Figure 2-4). Available historical information, maps, and aerial photographs were reviewed to determine prior land uses and activities at the five areas. Based on the research, two areas (Areas A and B), have been identified as primary sample areas, and two additional areas, Area C1 and D, have been identified as secondary, or contingency sample areas. The results of the research are summarized in Table 2-1.

**TABLE 2-1  
AERIAL PHOTOGRAPH SUMMARY  
DRAFT WORK PLAN FOR BACKGROUND SOIL INVESTIGATION  
NAVAL UNDERWATER WARFARE CENTER DISPOSAL AREA, SA-08  
NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND**

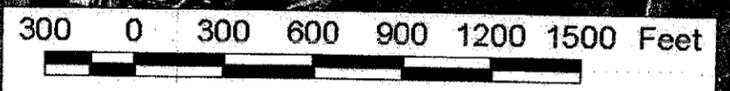
Area*	1939 (Figure 2-2)	1942 (Air Photo, not reproduced)	1951 (Air Photo, not reproduced)	1970 (Air Photo, not reproduced)	1981 (Air Photo, SASE Work Plan)	1988 (Air Photo, SASE Work Plan)	1995/ Current (DOQ EGIS)	Soil Types	Historical use/activities	Comments on Use as Background Location
A	Golf Course	Golf Course	Golf Course	Golf Course	Golf Course	Golf Course	Golf Course	Soil Types Se and PmB.	Golf Course	Selected based on upgradient location and continuous use as a golf course prior to and following development and use of the site
B	Pasture / Cultivated	Open, resolution poor on photo	Open, no structures	Development of structures, west side	Structures present on west side fenced property	Structures present on west side fenced property	West side fully developed, Structure present in center	Soil Types Se and Ma	Limited development and use	Areas with Se soil types selected based on limited use and development
C1	Cultivated	Cultivated	Cultivated	Cultivated	Cultivated/ Undeveloped	Cultivated/ Undeveloped	South sections developed into commercial and residential	Soil Types PmA and Se	Agriculture	Selected based on common past use as agricultural and similar soil types
C2	Cultivated	Cultivated	Cultivated	Cultivated	Cultivated/ Undeveloped	Cultivated/ Undeveloped	Developed into commercial and residential	Soil Types PmA and Se	Agriculture, residential, light commercial	Rejected based on recent development and culverting of intermittent stream
D	Cultivated	Cultivated	Cultivated	Cultivated	Cultivated	Cultivated	Cultivated	Soil Types PmA, PmB, and Se	Agriculture, abutts commercial and residential properties	Selected as backup area based on upgradient location and continuous use as agricultural land prior to and following development and use of the site

\* Areas shown on Figure 2-4  
Source: Aerial photographs made available from Rhode Island State Planning Office, 2/4/03



⊙ Proposed Background Sample Station

Areas Comparable to the Site (see text)



NOTES:

- 1) PLAN NOT TO BE USED FOR DESIGN
- 2) ALL LOCATIONS TO BE CONSIDERED APPROXIMATE
- 3) SOIL CLASSIFICATIONS MAPPED BY USGS, PROVIDED BY RICIS, 1990
- 4) CLASSIFICATION ABBREVIATIONS DEFINED IN TEXT

SOIL TYPES		FIGURE 2-4	
SA-DE BACKGROUND SOIL INVESTIGATION WORKPLAN			
MIDDLETOWN, RHODE ISLAND			
DRAWN BY: L. SEYDEWITZ		DATE: FEBRUARY 21, 2003	
CHECKED BY: S. PARKER		FILE: \CT0849.APR	
55 JONSPIN ROAD		WILMINGTON, VA 01867	
978/558-7809			

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### 2.2.5 Decision Rule

Typically, the decision rule is a clear statement defining the requirements of the investigation based on the possible outcomes of the study. The decision rule related to the primary objective of this study is to determine the background concentrations for metals and organic chemicals in soil that can be used for comparison with the SA-08 site data in the evaluation of nature and extent of contamination and determination of site-related risk. The number and types of samples collected must be sufficient to allow a determination of the background soil concentrations representative of the soil type (Stissing). These background values can then be used to determine whether contaminant levels in soil from the SA-08 site are statistically elevated above background.

Multiple statistical tests will be performed to determine contaminant concentrations representative of upgradient sediment and/or background soil, with an acceptable (95 percent) level of confidence, in accordance with the guidance and recommendations presented in US Navy, EPA, and related publications (US Navy, 1998 and 1999; Battelle, 2002; EPA, 1989, 1992a, 1992b, and 1996; Gilbert, 1987, 1993;) and applicable regulatory guidance (RIDEM, 1996).

### 2.2.6 Limits on Decision Errors

The limits of decision errors are set to limit the potential for false negative and false positive decisions. This study was designed to result in a high probability of sampling sediment and soils in the site vicinity with analyte concentrations that are unaffected by the site. Therefore, a relatively large number of upgradient and background sample stations are required, generally targeted toward areas unlikely to have been affected by activities at the SA-08 site, while not sacrificing randomness of individual sample stations.

By complying with the RIDEM requirement for collecting a minimum of 20 background samples of each soil type (1-hydric soil or sediment and 2-non-hydric soil), the background study should have sufficient statistical power to detect relatively small differences in the site and background population characteristics for contaminants. To be certain, some data properties, such as population distributional shape and standard deviations, are unknown prior to actually collecting background data, so designating a minimum number of samples for the background study provides at best only partial control over the potential ability to differentiate site and background concentrations exceeding a specific minimum threshold difference with a specified probability (power). However, if the data are approximately normally distributed, then reasonably successful statistical performance is expected given the assumption that site and background data sets are comprised of 20 samples each, based on formulas for

estimating statistical performance presented in Navy guidance (NFEC, 1999) and EPA guidance (EPA, 1994),:

- T-test: Using 20 samples for each of the two data groups being compared, a difference will be detectable between site and background populations if the means are different by a magnitude of at least 60 percent of the magnitude of the population standard deviation, under the conditions where the value of alpha (probability of deciding site exceeds background when in fact the populations are the same) is set to 0.05 and beta (power of the test) is assumed to be 0.8 (80 percent probability of detecting a difference if the means differ to this extent).
- Mann-Whitney test: A difference in concentrations having a magnitude of at least one standard deviation will be detectable, under the conditions where alpha is set to 0.05 and beta (power) is assumed to be 0.75, and 16 samples are collected for each data group, or alternatively, under the same circumstances except assuming a power of 0.9 and collecting 26 samples. Twenty samples is an intermediate value that is associated with an expected power in between 0.8 and 0.85.
- Quantile test: Using 20 samples for each data group, a difference in concentrations having a magnitude of at least four standard deviations will be detectable among a "hot spot" subset of the site data group representing only 30 percent of the total site related samples, under the conditions where alpha is set to 0.05 and beta (power) is assumed to be 0.8. However, the larger the percentage of the site-related sample population that exhibits increased concentrations relative to background, favorably implies a smaller threshold or minimum shift in the hot spot concentrations that the quantile test will be able to identify as a hot spot.

### **2.2.7 Design for Obtaining Data**

The DQO process presented in the G4 DQO document describes the use of various statistical approaches for developing a database. These approaches are based on the representativeness of the data that is required. For instance, if the Decision Rule was to "remove soils with concentrations of arsenic above 1.7 mg/kg" the sampling plan would be based on identifying hot spots of a specific size, which is determined by the precision of the removal action to be taken.

However, since this investigation is being performed to measure and establish the naturally occurring and anthropogenic background concentrations for metals and organic compounds, the design of the sampling plan can be more qualitative, or "targeted" toward locations that are anticipated to be impacted by human activities but not site activities. The sampling plan is provided in Section 3 of this work plan.

Specifics on the precision, accuracy, etc. of the data collected are described in the Quality Assurance/Quality Control Procedures, presented in Section 4 of this work plan.

### 3.0 FIELD SAMPLING PLAN

This section presents a description of the field investigation activities that are planned for the SA-08 site background soil investigation.

#### 3.1 INTRODUCTION

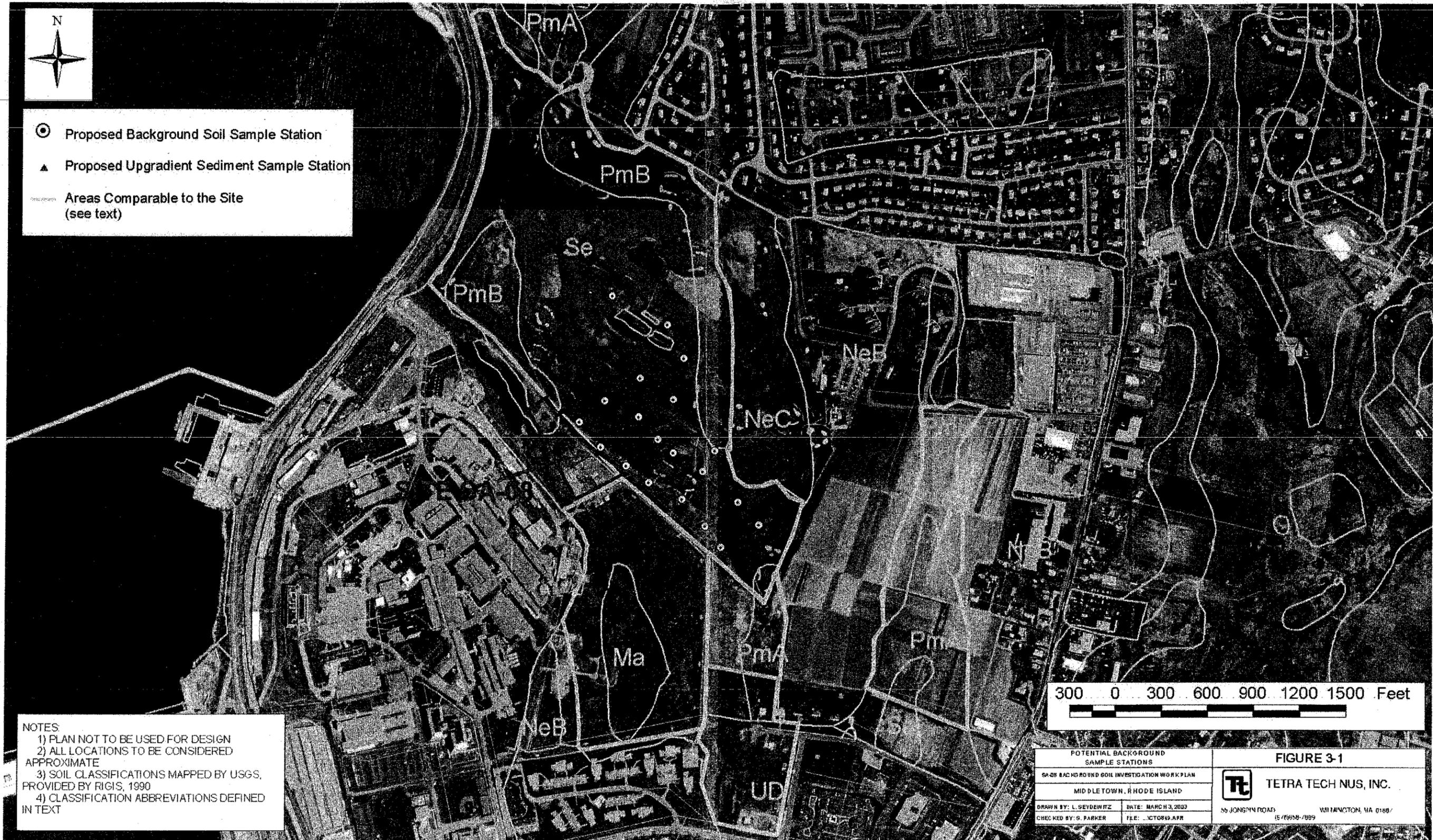
The objective of the Field Sampling Plan (FSP) is to obtain surficial soil data and shallow subsurface soil data to establish background concentrations of metals and organic compounds for the SA-08 site. The following section details the soil sampling field activities to be performed during this investigation. Specific Standard Operating Procedures (SOPs) will be referenced where applicable (SOP Reference Manual, Tetra Tech NUS, Inc., 1990).

#### 3.2 SOIL SAMPLING

Soil samples will be collected from the locations presented on Figure 3-1. According to soil survey maps presented in the USDA Soil Survey of Rhode Island, the soil type mapped at the SA-08 site is largely Stissing (Se) soil. Although a small fragment of the Pittstown soils are found on the north boundary of the site, this is thought to be a portion of SA-08 that is unaffected by site activities. Therefore, the Stissing soil is the only soil type that will be sampled as part of the background soil concentration investigation (refer to Figure 2-3 for a map depicting the area soil types). No sample location will be within 100 feet of a roadway. All proposed sample locations are on Navy property and it is assumed that the Navy will obtain access as required.

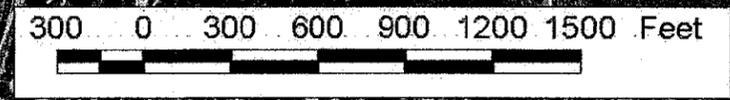
All of the soil sample locations will be within Areas A and B, unless access to these properties is restricted for some reason. A surface soil (0-1 foot depth interval) sample will be collected at each location using direct push technology (DPT) methods. Prior to collection of a background soil sample, approximately the top 2 inches of the soil/biomass layer will be removed from the location to limit the effects of potential pollutant sources such as automobile emissions and road runoff. The materials to be removed may also include partially decomposed organic matter (leaves, grass, vegetative roots, etc.). This process is included in order to remain consistent with the manner that site samples are prepared and handled. Additionally, the following considerations will be adhered to when selecting acceptable background soil locations:

- Areas directly beneath pine trees, hemlocks, and oaks will be avoided, if possible, to avoid leaching effects from acid soils associated with these species.



○ Proposed Background Soil Sample Station  
 ▲ Proposed Upgradient Sediment Sample Station  
 - - - Areas Comparable to the Site  
 (see text)

**NOTES**  
 1) PLAN NOT TO BE USED FOR DESIGN  
 2) ALL LOCATIONS TO BE CONSIDERED APPROXIMATE  
 3) SOIL CLASSIFICATIONS MAPPED BY USGS, PROVIDED BY RIGIS, 1990  
 4) CLASSIFICATION ABBREVIATIONS DEFINED IN TEXT



POTENTIAL BACKGROUND SAMPLE STATIONS		<b>FIGURE 3-1</b>	
SP-05 BACKGROUND SOIL INVESTIGATION WORK PLAN		 <b>TETRA TECH NUS, INC.</b>	
MIDDLE TOWN, RHODE ISLAND		55 JONSON ROAD WASHINGTON, MA 01887	
DRAWN BY: L. SEYDENITZ	DATE: MARCH 3, 2003	15 / 10000-1099	
CHECKED BY: S. PARKER	FILE: \LCT0849.APR		

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- Soil samples will not be collected within the water table. Sediment samples may be taken below the local water table.

If refusal is encountered before any boring is advanced 2 feet, the location will be adjusted for additional advancement attempts.

Soil samples will be transferred from the DPT probe by hand, shovel, or other hand tool, depending on the soil conditions and accessibility, in accordance with TtNUS SOP No. SA-1.3. The soil will be deposited into a stainless steel bowl and homogenized using a stainless steel trowel and then transferred to the appropriate sample containers. Field data will be recorded on the appropriate field data forms and field logbook. Recorded data will include identification of the soil type, a soil description (structure, texture, color, consistency, etc.) and classification of the soil (Unified Soil Classification System). All non-disposable sampling equipment will be decontaminated prior to each use, as described in Section 3.3. If necessary, sample locations will be backfilled with clean sand to the original grade.

Appropriate chain-of-custody procedures will be followed (see Section 4.4.2) and samples will be labeled, packaged and shipped according to TtNUS SOP SA-6.1. Analytical parameters, sample preservation requirements, required sample containers, and a summary of quality control samples are presented in Section 4.

All soil samples will be analyzed for metals, pesticides and semivolatile organic compounds (SVOCs). A total of 40 field samples will be collected, 20 as hydric soils or sediments within the stream beds feeding into the site, and 20 as background non-hydric soils. In addition, four field duplicates, and field (source and rinsate) blanks will be required. Analysis will be performed by an analytical laboratory subcontracted to TtNUS.

The analytical laboratory will provide data within 21 calendar days of sample receipt. Data will be validated using a procedure equivalent to EPA Tier II validation. Validation memoranda will be provided to the project manager for review, and the data will be supplied in database format for statistical analysis and inclusion into the NAVSTA Newport IR Program EGIS.

All soil sample locations will be photo-documented and surveyed with a global positioning system (GPS) survey equipment with sub-meter accuracy. Any stakes or flagging will be removed from public areas and private property after surveying.

**3.3 DECONTAMINATION PROCEDURES**

All non-disposable sampling equipment that comes in contact with the sample medium will be decontaminated to prevent cross-contamination between sampling points. This includes equipment such as soil sampling spatulas and stainless steel bowls, etc. The following decontamination sequence will be employed:

- Remove gross contamination by scrubbing with potable water.
- Scrub with potable water/liquinox.
- Rinse with potable water.
- Rinse with 10 percent nitric acid.
- Rinse with 2-propanol (Laboratory Grade)
- Rinse with deionized water.
- Air dry (to extent possible).
- Wrap with aluminum foil, dull side toward equipment.

## 4.0 QUALITY ASSURANCE/QUALITY CONTROL

This section provides technical guidelines and procedures for maintaining an appropriate level of quality for data to be collected during the proposed field work. The pertinent TtNUS Standard Operating Procedures (SOPs) for activities discussed in Section 3.0 are included in this work plan as Appendix B. These SOPs include, but are not limited to:

<u>SOP</u>	<u>DESCRIPTION</u>
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

Sampling objectives are to provide sufficient data to establish background concentrations for organic and inorganic contaminants relative to the SA-08 site area.

Achieving these objectives 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 and 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 2.2; the PARCC parameters are discussed below.

### 4.1 PARCC PARAMETERS

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

#### 4.1.1 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.

Analytical precision and accuracy will be evaluated upon receipt of the analytical data. Analytical precision will be measured as the relative percent difference from duplicate measurements and relative standard deviation from three or more replicates. Analytical accuracy measures the bias as the percent recovery from matrix spike and matrix spike duplicate 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 soil samples submitted for laboratory analysis.

Analytical results from field duplicates and field quality control blanks will be evaluated to determine the usability of all analytical data, with respect to its intended use. In general, results that are rejected by the data review process will be disqualified from application to the intended use. Qualified data will be used to the greatest extent practicable.

#### **4.1.2            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 is representative of the existing contaminant levels.

Representativeness of data is also affected by sampling techniques. Sampling techniques are described in Section 3.0 and in the TtNUS SOPs included in Appendix B.

#### **4.1.3            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, 100 percent completeness is expected. However, as matrix complexity and heterogeneity increase, 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's objectives. However, critical data points may be identified after 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 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.

#### **4.1.4            Comparability**

One of the objectives of the sampling effort is to provide analytical data that is 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 and others SOPs, the potential for variables to affect the final data quality will be effectively minimized. Analytical methods for this work are presented in Table 4-1; SOPs appear in Appendix B.

### **4.2                QUALITY CONTROL SAMPLES**

Quality Control (QC) samples to be used during the sampling effort are identified below, and include field duplicates or replicates, laboratory duplicates or replicates, rinsate blanks, and field blanks. Each type of field quality control sample defined below will undergo the same preservation, holding times, etc., as the field samples. Table 4-1 presents a summary of the QC samples to be collected during this field sampling event.

#### **4.2.1            Field Duplicates**

Field duplicates will be submitted at the rate of one for every ten samples, or at a rate greater than one per ten samples if fewer than ten are shipped to the laboratory on a given day. 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.

**TABLE 4-1**  
**ANALYTICAL METHODS AND SAMPLE SUMMARY**  
**DRAFT WORK PLAN FOR BACKGROUND SOIL INVESTIGATION**  
**NAVAL UNDERWATER WARFARE CENTER DISPOSAL AREA, SA-08**  
**NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND**

MEDIA	ANALYSIS	METHOD	FIELD SAMPLES	DUPLICATE (1 per 10 field samples)	RINSATE BLANK (1 per day)	FIELD BLANK (1 per source)	TOTAL QUANTITY
Soil	TAL Metals	CLP SOW ILM04.0 <sup>(1)</sup>	40	4	0	0	44
Soil	Pesticides	CLP OLM03.2 <sup>(2)</sup>	40	4	0	0	44
Soil	Semivolatile Organic Compounds	8270C (SIM)	40	4	0	0	44
Aqueous	Semivolatile Organic Compounds	8270 C (SIM)	0	0	4	1	5
Aqueous	Pesticides	CLP OLM03.2 <sup>(2)</sup>	0	0	4	1	5
Aqueous	TAL Metals	CLP SOW ILM04.0 <sup>(1)</sup>	0	0	4	1	5

## Notes:

- (1) U.S.EPA Contract Laboratory Program statement of work for inorganic analysis multi-media, multi-concentration. ILM04.0 and revisions.
- (2) U.S.EPA Contract Laboratory Program statement of work for organic analysis multi-media, multi-concentration. OLM03.2 and revisions.

Field personnel will note in the remarks block on the chain-of-custody form which of the samples is to be used for internal laboratory matrix spike/matrix spike duplicate analysis. Field duplicates and multiple sample aliquots are collected by mixing a double 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.

**4.2.2 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 will be prepared at the rate of one per sampling event.

**4.2.3 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.

**4.2.4 Trip Blanks**

Trip blanks will not be prepared or analyzed for this sampling activity since volatile organic compound (VOC) analysis is not being conducted.

**4.2.5 Matrix Spike/Matrix Spike Duplicates**

A matrix spike sample will be identified by field teams at a frequency of 1 in 20 field samples collected.

**4.3 SAMPLING PROCEDURES**

Field sampling will be conducted in accordance with Section 3.0 of this document and the TtNUS SOPs presented in Appendix B. Allowable sample holding times and preservation requirements are shown in Table 4-2.

**TABLE 4-2**  
**SAMPLE CONTAINER, PRESERVATION, AND HOLDING TIME REQUIREMENTS**  
**DRAFT WORK PLAN FOR BACKGROUND SOIL INVESTIGATION**  
**NAVAL UNDERWATER WARFARE CENTER DISPOSAL AREA, SA-08**  
**NAVAL STATION NEWPORT, NEWPORT, RHODE ISLAND**

<b>MEDIA</b>	<b>ANALYSIS</b>	<b>SAMPLE CONTAINER</b>	<b>PRESERVATIVE</b>	<b>HOLDING TIME</b>
Soils	Semivolatile Organic Compounds	8 oz wide mouth jar	cool to 4°C	7 days (extraction)
Soils	Pesticides	8 oz. wide-mouth jar	cool to 4°C	28 days
Soils	TAL Metals	4 oz. wide-mouth jar	cool to 4°C	7 days
Aqueous	Semivolatile Organic Compounds	1 Liter Amber Bottle	cool to 4°C	7 days (extraction)
Aqueous	Pesticides	1 Liter Amber Bottle	cool to 4°C	7 days (extraction)
Aqueous	TAL Metals	1 Liter Poly	HNO <sub>3</sub> pH of <2	6 Months

Note:

Sample containers shall meet specifications delineated in EPA OSWER Directive No. 9240.0-05A.

**4.4 SAMPLE DESIGNATION AND CUSTODY**

Samples collected will be tracked by a designated sample number and by the date collected. The sample number will be the basis for maintaining chain of custody. The sample numbering system is described below.

**4.4.1 Sample Numbering**

Samples will be labeled as soon as they are collected. Soil sample numbers will reflect the site, sample location, medium, and depth interval. An alpha-numeric numbering system will be used to describe this information. This system is detailed below:

AANN -	AANN-	AA -	NNNN
(Site Identifier) -	(Project/Location Identifier) -	(Medium)	(Sample Depth)
SA08	BK##	SO	0#0#

The site identifier for the SA-08 background investigation will be "SA08". The project/location identifier will be "BK" for "background" followed by the location number to be determined in the field. Medium will be indicated by "SO" for soil sample. Sample depth will be indicated by expressing the actual depth interval. For example, a subsurface soil sample collected from location 01 at a depth interval of zero to two feet will be identified as SA08-BK01-S0-0002.

Blind duplicate samples will be designated such that the location designation will be replaced with a chronological number, as shown below. The location designation for the duplicate sample will be recorded on the field sample data form to ensure the duplicate pair can be identified.

Duplicates:                   SA08-BK-DUP##

Field blanks will be designated such that they can clearly be identified as field blanks. The designation will include the field blank identifier (FB) and its chronological number. The source of water for the field blank (DIUF water or potable water source) will be recorded on the field sample data forms to ensure that the sample can be tracked to its source.

Field Blanks:                   SA08-BK-FB##

Rinsate blanks will be identified using a chronological number. The rinsate blank identifier (RB) and its chronological number and the sample tool used will be recorded on the field sample data form.

Rinsate Blanks: SA08-BK-RB##

Matrix spike samples are labeled with their appropriate sample designation (SA08-BK## -SO-####) and then marked as "matrix spike" on the sample containers and on the chain-of-custody record.

#### **4.4.2 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". 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. All samples will be accompanied by a chain-of-custody form that will describe the analytical parameters, and the persons who are responsible for their integrity.

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 presented in Appendix B.

#### **4.5 CALIBRATION PROCEDURES**

Field equipment normally requiring calibration will be calibrated and operated in accordance with the manufacturer's instructions and manuals. A log will be kept onsite, documenting 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 NFESC requirements and contract requirements under the Master Agreements (MA).

#### **4.6 LABORATORY ANALYSIS**

Samples collected will be analyzed for various parameters described in previous sections and listed in Table 4-1.

The environmental samples collected for laboratory analysis during the field investigation will be analyzed by a laboratory previously approved by the Navy. Standard EPA analytical procedures will be employed, as listed in Table 4-1.

#### **4.7 DATA REDUCTION, REVIEW, AND REPORTING**

Laboratory analytical data will be reviewed by qualified TtNUS technical staff. A data review memoranda will be prepared and submitted to the project manager as a part of that activity. Data review procedures are described in Section 4.11.

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

#### **4.8 INTERNAL QUALITY CONTROL**

Section 4.2 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 4-1. Laboratory analysis will follow the QC criteria described in the analytical procedures.

#### **4.9 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 FOL will supervise and on a daily basis check to ensure that the sampling equipment is thoroughly decontaminated, samples are collected and handled properly, and the field work is accurately and neatly documented.
- The data reviewer(s) will review the data to ensure it was 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.

#### **4.10 PREVENTATIVE MAINTENANCE**

TtNUS has established a field equipment maintenance program 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 or supplier 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 or supplier conducts routine checks on the status of equipment and is responsible for stocking spare parts and for equipment readiness.
- The equipment manager or supplier maintains the equipment manual library and trains field personnel in the proper use and care of equipment.
- The FOL is responsible for ensuring 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 takes responsibility for the equipment, maintains calibration records, and performs or delegates maintenance operations and checks.

#### **4.11 DATA ASSESSMENT PROCEDURES**

The following paragraphs describe the procedures used to evaluate data prior to inclusion and description in the deliverable report, described in Section 6.0 of this work plan.

##### **4.11.1 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 met.

The PARCC parameter assessment will be conducted by qualified TtNUS personnel. The representativeness of the data will be assessed by determining if the data are consistent with known or anticipated chemical conditions and accepted principles.

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

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

#### **4.11.2            Analytical Data Validation**

Samples will be analyzed for the parameters listed on Table 4-1. Results will be validated using a Tier II validation protocol as specified in the "National Functional Guidelines for Organic/Inorganic Data Review" (U.S. EPA December 1990, revised February 1994 [organic] and February 1993 [inorganic]). Use of these validation protocols is allowed under the NFESC (formerly NEESA) guidelines and is described in the Navy Installation Restoration Laboratory Quality Assurance Guide, Interim Document (revised February 1996), and the NEESA 20.2047B; June 1988 guidelines.

This level of validation is appropriate for data used to perform quantitative risk evaluations under CERCLA.

#### **4.12                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 is dependent on a nonconforming activity will not be performed until the source of the problem has been addressed.

**4.13 DOCUMENTATION**

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, description of photographs, etc. The site logbook maintained by the FOL will contain a summary of the day's activities and will reference the other field logbooks when applicable.

Some field documentation will be recorded on sample chains of custody, sample collection log sheets, site entry logs, and other field forms. Examples of these forms are provided in Appendix A. At completion of the field work, this information will be bound and incorporated into the project files.

## 5.0 DATA ANALYSIS AND STATISTICAL TESTING

Following the completion of the field sampling and analytical work described in Section 3, data analysis and statistical testing will be performed. The background data set will undergo an exploratory evaluation that will include several statistical comparisons, after which the final background data set(s) will be established and upper tolerance limits (UTLs) on background will be calculated for each contaminant.

Exploratory data tests will be used to determine whether or not the two data subsets for background soil types (upgradient hydric soil or sediment versus non-hydric background soil) are statistically similar. If allowable, statistically similar background data sets will be merged because use of the composite data set will result in a much lower chance of overlooking any significant difference that might exist between site and background populations (i.e., better statistical power). Following the applicable methods and tests as listed below, preliminary tests will answer the questions: Is the mean of one group higher (or lower) than the other? Is there a significantly greater proportion of high concentration data points in the upper ranks of one data set versus the other? Are subgroups both normal or lognormal in shape? Are the quartiles and 95<sup>th</sup> percentile concentrations similar for the two subsets? Because the two separate soil chemistries, it is anticipated that the datasets for the upgradient sediments and background soils will remain separated through the evaluation process.

The different background data sets will be compared using the following tests (as applicable):

- Shapiro-Wilk test for determining normality/lognormality of background data sets
- Student's t-test (difference in means for normal/lognormal data with equal variances)
- Satterthwaite t-test (difference in mean for normal/lognormal data with unequal variances)
- Bartlett's test (determines if background data subsets have equal variances)
- Mann-Whitney test (if rank distribution is similar given detection limits that are uniform)
- Gehan's test (if rank distribution is similar given that multiple detection limits exist)
- Quantile test (if ranks similar for the upper concentrations subset of site and background)
- The test of proportions (if frequency of detection is similar given sufficient data points)
- Fisher's exact test (if frequency of detection is similar in the case of few data points)

Upon completion of the tests, preliminary background concentration corresponding to the 95 percent UTL of background will be calculated for use as a reference value evaluating site data. This limit will be established for each soil interval. In the event background data do not match a normal or lognormal shape, an alternative limit concentration corresponding to the 95<sup>th</sup> quantile will be tabulated (Gilbert, 1987).

The above tests will be performed in accordance with the guidance and recommendations presented in US Navy, EPA, and related publications (US Navy, 1998 and 1999; EPA, 1989, 1992a, 1992b, and 1996; Gilbert, 1987 and 1993). Statistical guidance issued by the Navy (US Navy, 1998) recommends a decision-tree approach wherein only parametric tests of central tendency (overall population differences) are to be performed if the data fit normal or lognormal distributions, and in this instance would allow the omission of certain nonparametric tests that compare overall population ranks (Gehan's test or Mann-Whitney test). Similarly, a quantile test that looks for subsets of the data (possible hot spots) is recommended only if the various tests comparing the overall populations do not indicate elevated results. These omissions help to reduce labor-intensive manual calculations for the purpose of efficiency; however, these are not statistical preconditions that would preclude using the omitted tests on a more general basis. For example, including the quantile test on a general basis will yield important information on whether a small subset of elevated values occur in one data set but not the other, even if the means are similar.

For this project, computer algorithms will be employed to automatically perform applicable statistical tests wherever the necessary underlying assumptions are valid. This approach allows the use of any valid test result that identifies that concentrations from one data set are elevated, regardless of the outcome of unrelated statistical tests.

Because of limitations in statistical confidence, the upper tolerance limit (UTL) test will not be used as a stand-alone test, consistent with Navy guidance that indicates this test can produce an unacceptably high false positive rate (above 5 percent as the number of site-related sampling points increases).

## 6.0 REPORTING

Following the completion of the field sampling, laboratory analysis, and data analysis and statistical testing, the results will be described in a brief report. The report will contain the following information:

- A statement describing the purpose of the reports, summary of background information.
- A description of the background investigation based on Section 3.0 of the work plan and on modifications to the field work, if any.
- Preliminary exploratory statistical test results will be presented that demonstrate whether the background soil data subgroups are statistically similar. Documentation will be provided for comparison of each subgroup's best fit distributional shape, mean, overall population ranks, upper ranks, frequency of detection, and qualitative tests (such as similarities of quantile frequencies and probability plots).
- Tables will also present and compare descriptive statistics (frequency of detection, range, mean, and location of maximum); results of quantitative distributional fit tests (Shapiro-Wilk W-test critical values and test scores for lognormal and normal fits), and the results of a detection limit distributional evaluation that includes supporting data for 25, 50, 75, and 95 percent quantile frequencies for nondetect and positive results.
- Conclusions and recommendations for use of the upgradient sediment and background soil data.
- Pertinent information such as contaminant concentrations, soil types, and sample locations will be included in figures.
- An appendix will present individual sample results for all chemical contaminants consistently detected in the background soil samples collected for this investigation.

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**APPENDIX A**

**FIELD DOCUMENTATION FORMS**



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:	_____	_____



TETRA TECH NUS, INC.

### SAMPLE LOG SHEET - LIQUID PHASE

Site Name: \_\_\_\_\_  
Sample ID: \_\_\_\_\_

Tetra Tech NUS Charge No. \_\_\_\_\_  
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:

Micro Tip/OVA Monitor Reading: \_\_\_\_\_ ppm

Well Depth	feet	Purge Start	hrs
Inside Diameter	Inches	Purge Stop Time	hrs
Water Level	feet	Total Gallons Purged	
Well Volume	gal.	Purge Method	

Sampling/Purge Data:				
Vol. #	Temp °C	pH	Spec. Cond.	DO
0	_____	_____	_____	_____
1	_____	_____	_____	_____
3	_____	_____	_____	_____
4	_____	_____	_____	_____

Color: \_\_\_\_\_ Turbidity: CLR/SL CLDY/CLDY/OPAQ

ANALYSIS	BOTTLE LOT NO.	TRAFFIC REPORT NO.		COMMENTS
		ORGANIC	INORGANIC	







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): \_\_\_\_\_

TYPE OF SAMPLE: (Check all that apply)

<input type="checkbox"/> Soil	<input type="checkbox"/> Trip Blank*
<input type="checkbox"/> Sediment	<input type="checkbox"/> Rinsate Blank*
<input type="checkbox"/> Lagoon/Pond	<input type="checkbox"/> Field Duplicate collected
<input type="checkbox"/> Grab	<input type="checkbox"/> Other (Specify): _____

Data Recorded By: \_\_\_\_\_  
 Signature

PID/OVA Monitor Reading: \_\_\_\_\_ ppm

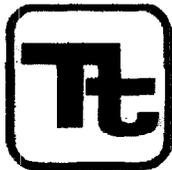
Description: (Sand, Clay, Muck, Peat, Dry, Moist, Wet, Etc.) \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

SAMPLE DATA/REMARKS: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

ANALYSIS	BOTTLE LOT NO.	NOTES/SKETCH:

**APPENDIX B**

**TETRA TECHNUS, INC., STANDARD OPERATING PROCEDURES**



TETRA TECH NUS, INC.

# STANDARD OPERATING PROCEDURES

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Effective Date	06/99	Revision	6
Applicability	Tetra Tech NUS, Inc.		
Prepared	Earth Sciences Department		
Approved	D. Senovich <i>ds</i>		

Subject  
SOIL SAMPLING

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## 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, and pits, and excavations are spaces that may have limited means of entry.); and 3) is not designed for continuous employee occupancy. TtNUS considers all confined space as permit-required confined spaces.

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#### 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

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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.

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.

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#### 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 +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 nearest 0.01 gram as described above and recorded in 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.

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### 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 and other required forms (see SOP SA-6.3). Do not allow tubes to freeze, and store the samples vertically with the same orientation they had in the

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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.
- Required decontamination equipment.
- Required sample container(s).
- Wooden stakes or pin flags.
- Sealable polyethylene bags (i.e., Ziploc® baggies).
- Heavy duty cooler.
- Ice (if required) double-bagged in sealable polyethylene bags.
- 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.

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#### 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"). 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 or on standardized data sheets) any changes in the color, texture or odor of the soil.

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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 A). 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:

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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 were 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 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.

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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 as described in SOP SA-6.3.

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.

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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 described in SOP SA-6.3. 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 and hand augers, stainless steel 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.

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- Remote sampler consisting of 10-foot sections of steel conduit (1-inch-diameter), hose clamps and right angle adapter for conduit (see Attachment B).

#### 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 5.7.3.4.

- 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 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 B, 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-

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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.

#### 5.8.3.4 In-Pit Sampling

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, usually Level B. 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 5.7.3.2, 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.

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- 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 5.7.3.4 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 5.7.3.4 of this procedure must be followed. Prepare, label, pack and transport the sample in the required manner, as described in SOP SA-6.3.

#### **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.

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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 SOP SA-6.3; Field Documentation) must be completed by the site geologist/sampler. All soil sampling locations must be documented by tying in the location of two or more nearby permanent landmarks (building, telephone pole, fence, etc.) 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 SOP SA-6.3; Field Documentation) 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

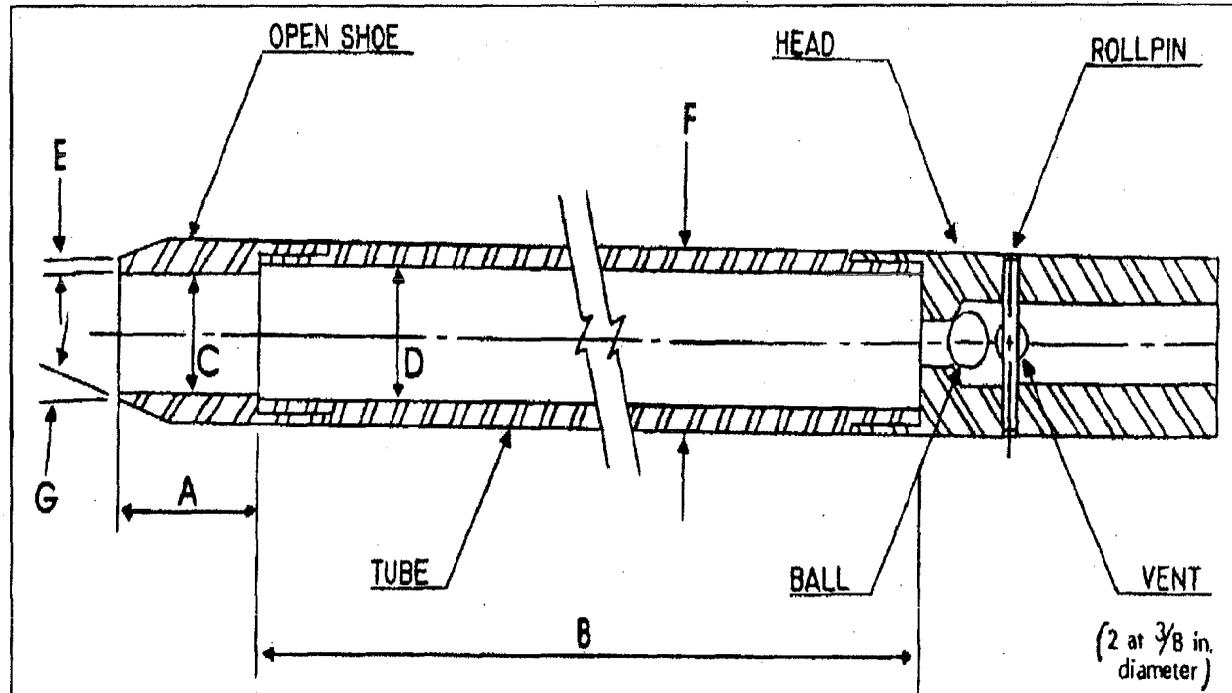
American Society for Testing and Materials, 1987. ASTM Standards D1587-83 and D1586-84. ASTM Annual Book of Standards. ASTM. Philadelphia, Pennsylvania. Volume 4.08.

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.



- A = 1.0 to 2.0 in. (25 to 50 mm)  
 B = 18.0 to 30.0 in. (0.457 to 0.762 m)  
 C =  $1.375 \pm 0.005$  in. ( $34.93 \pm 0.13$  mm)  
 D =  $1.50 \pm 0.05 - 0.00$  in. ( $38.1 \pm 1.3 - 0.0$  mm)  
 E =  $0.10 \pm 0.02$  in. ( $2.54 \pm 0.25$  mm)  
 F =  $2.00 \pm 0.05 - 0.00$  in. ( $50.8 \pm 1.3 - 0.0$  mm)  
 G =  $16.0^\circ$  to  $23.0^\circ$

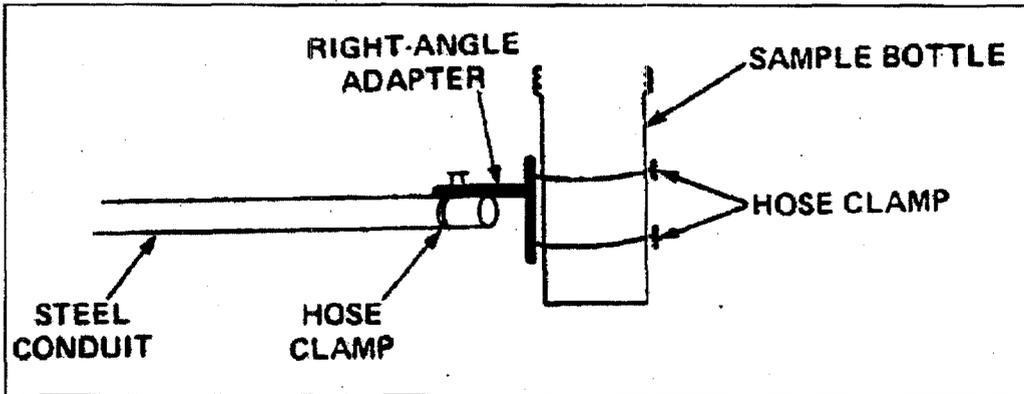
The 1½ in. (38 mm) inside diameter split barrel may be used with a 16-gage wall thickness split liner. The penetrating end of the drive shoe may be slightly rounded. Metal or plastic retainers may be used to retain soil samples.

ATTACHMENT A  
SPLIT-SPOON SAMPLER

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**ATTACHMENT B  
REMOTE SAMPLE HOLDER FOR TEST PIT/TRENCH SAMPLING**





TETRA TECH NUS, INC.

# STANDARD OPERATING PROCEDURES

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Effective Date	03/00	Revision	1
Applicability	Tetra Tech NUS, Inc.		
Prepared	Earth Sciences Department		
Approved	D. Senovich <i>ds</i>		

Subject  
NON-RADIOLOGICAL SAMPLE HANDLING

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## 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.
- Provides instruction for sample packaging and shipping in accordance with current U.S. Department of Transportation (DOT) and International Air Transportation Association (IATA) regulations. IATA regulates transportation of hazardous materials by air (which is the mode of transportation used for shipping nearly all samples derived during TNUS projects).

## 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 (y261.30 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 (y261.20 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.

ORM - Other regulated material (see DOT 49 CFR 173.144).

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.

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Common Preservatives:

- Hydrochloric Acid - HCl
- Sulfuric Acid - H<sub>2</sub>SO<sub>4</sub>
- Nitric Acid - HNO<sub>3</sub>
- Sodium Hydroxide - NaOH

Other Preservatives

- Zinc Acetate
- Sodium Thiosulfate - Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub>

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

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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<sub>3</sub>, 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.

### 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 Required for Preservation
Hydrochloric Acid (HCl)	1 part concentrated HCl: 1 part double-distilled, deionized water	6N	5-10 mL
Sulfuric Acid (H <sub>2</sub> SO <sub>4</sub> )	1 part concentrated H <sub>2</sub> SO <sub>4</sub> : 1 part double-distilled, deionized water	18N	2 - 5 mL
Nitric Acid (HNO <sub>3</sub> )	Undiluted concentrated HNO <sub>3</sub>	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:

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- 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).

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- 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 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**

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 and hazardous material 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 (e.g. "garbage" bag). Drain plugs on coolers must be taped shut.
- Pack with enough noncombustible, absorbent, cushioning materials such as vermiculite (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), double-bag ice in Ziploc baggies and place around sample container shoulders, and on top of absorbent 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) and extra carbonless copies 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 first cooler. 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.

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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.

#### 5.4.2 Hazardous Material Samples

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

NOTE: Packaging and shipping of hazardous materials can only be performed by personnel who have participated in the TtNUS training course "Shipping Hazardous Materials" (or equivalent training approved by Health Sciences).

##### 5.4.2.1 Known Substances

If the substance in the sample is known or can be identified, package, mark, label, and ship according to the specific instructions for that material (if it is listed) in the DOT Hazardous Materials Table (49 CFR 172.101) or the IATA List of Dangerous Goods Table (IATA Dangerous Goods Regulations). DOT Guide for shippers can be found in Attachment D of this document.

To determine the proper shipping name, use the following steps to help locate the shipping name on the Hazardous Materials Table, DOT 49 CFR 172.101.

1. Look first for the chemical or technical name of the material, for example, ethyl alcohol. Note that many chemicals have more than one technical name, for example, perchloroethylene (not listed in 172.101) is listed as tetrachloroethylene (listed 172.101). It may be useful to consult Health Sciences or a chemist for all possible technical names a material can have. If your material is not listed by its technical name, then . . .
2. Look for the chemical family name. For example, pentyl alcohol is not listed but the chemical family name is: alcohol, n.o.s. (not otherwise specified). If the chemical family name is not listed, then . . .
3. Look for a generic name based on end use. For example, Paint, n.o.s. If a generic name based on end use is not listed, then . . .
4. Look for a generic family name based on end use, for example, drugs, n.o.s. or cosmetics, n.o.s. Finally, if your material is not listed by a generic family name but you suspect or know the material is hazardous because it meets the definition of one or more hazardous classes, then . . .
5. You will have to use the general hazard class for a proper shipping name. For example, Flammable Liquid, n.o.s. or Oxidizer, n.o.s.

If you have any doubt regarding the proper shipping name, contact Health Sciences in Pittsburgh, Pennsylvania for assistance.

##### 5.4.2.2 Unknown Substances

For samples of hazardous substances that are not listed on the Hazardous Materials Table, or are of unknown content, the shipper is required to:

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1. Determine that the substance is not forbidden for shipment. Items forbidden include explosives (solid and liquid), substances liable to produce a dangerous evolution of heat or gas, and listed "unusual" compounds (which TtNUS fortunately does not typically handle). If the substance is in any way atypical of routine shipments, contact Health Sciences for further information on determining if the substance is forbidden.
2. Classify the substance by assessing whether it is anticipated to exhibit any unusual physical properties as defined by DOT (flammability, explosivity, etc.). If the substance has more than one hazard, follow the hazardous materials classification scheme identified in Attachment C of this SOP.
3. Use the generic or "n.o.s." proper shipping name that most accurately describes the article or substance. There are two types of general proper shipping names:
  - Generic, e.g., Alcohols, n.o.s. \*
  - Hazard description, e.g., Flammable liquid, n.o.s.\*

Generic or n.o.s. proper shipping names marked with an "\*" require the addition of the technical name in parenthesis ( ) immediately following the proper shipping name. For example, most of our instrument calibration gases are not listed by name and must be declared under the most accurately descriptive name, which is "Compressed Gas, n.o.s. (Mixture Nitrogen and Oxygen)".

The correct shipping classification for an unknown sample is therefore selected through a process of elimination as described above (and detailed in 49 CFR 172.101(c)(11)). By using the provisions in this paragraph, the proper shipping name and description will be determined. A step-by-step guide is provided by the DOT and can be found in Attachment D of this SOP. Again, if you have any doubt regarding the proper shipping name, contact Health Sciences for assistance.

#### **5.4.3 Packaging and Shipping of Samples Classified as Flammable Liquid (or Solid)**

##### **5.4.3.1 Packaging**

Applying the word "flammable" to a sample does not necessarily mean that it is in fact flammable. The word prescribes the class of packaging according to DOT regulations and classification schemes. The DOT defines flammable liquids as substances with a flash point less than 140°F (60°C). For shipping purposes, liquids with a flash point exceeding 95°F (35°C) need not be considered as flammable liquids if they are miscible solutions and have a water content of more than 90% by weight. For solutions classified as flammable liquids:

1. Containerize sample as required (see Attachments A and B). To prevent leakage, fill container no more than 90 percent full. Seal lid with teflon tape or wire.
2. Complete sample label and attach securely to sample container.
3. Seal container and place in 2-mil-thick (or thicker) polyethylene bag (e.g., Ziploc baggie), one sample per bag. Position sample identification label so that it can be read through bag. Seal bag.
4. For soil jars, place sealed bag inside metal can (available from laboratory or laboratory supplier) and cushion it with enough noncombustible, absorbent material (for example, vermiculite or diatomaceous earth) between the bottom and sides of the can and bag to prevent breakage and absorb leakage. Pack one bag per can. Use clips, tape, or other positive means to hold can lid securely, tightly and permanently. Mark can as indicated in Paragraph 1 of Section 5.3.4.2, below. Single 1-gallon bottles do not need to be placed in metal cans.

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5. Place one or more metal cans (or a single 1-gallon bottle) into a strong outside container, such as a metal picnic cooler or a DOT-approved fiberboard box. Surround cans (or bottle) with noncombustible, absorbent cushioning materials for stability during transport. The absorbent material should be able to absorb the entire contents of the container. Mark container as indicated in Paragraph 2 below.

#### 5.4.3.2 Marking/Labeling

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

- Laboratory name and address.
- Proper shipping name from the hazardous materials table (DOT Regulation CFR 49 172.101). Example: "Flammable Liquid, n.o.s. (with the technical name in parentheses).

2. Determine packing group. The packing group must be included on the shipping papers in the description section. Packaging groups are classified as follows:

Group I.	Most Hazardous
Group II.	Medium Hazard
Group III.	Least Hazardous

The packing group will be listed in the hazardous materials table, column 5.

3. Place the following information on outside shipping container per the instructions provided in the "Shipping Hazardous Materials" course:

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

For flammable liquids, the following are the proper labels to be placed on the outside shipping container:

- DOT "Flammable liquid" label
- Package orientation label (arrows pointing upward) on at least two opposite sides of the package
- "Cargo Aircraft Only" label if shipping more than 30L of flammable liquids in the package.

#### 5.4.3.3 Shipping Papers

Principally because of limitations in sample holding times, TtNUS almost exclusively uses air transportation to ship hazardous materials and other environmental samples. The "Dangerous Goods Airbill" is the shipping paper used to document the information associated with the shipment. As identified previously, only personnel who have participated in "Shipping Hazardous Materials" training (or equivalent course) are authorized to prepare hazardous materials for shipment - including preparation of associated shipping papers. Included in this training are instructions on what specific information is to be provided on the Airbill for hazardous materials typically shipped by TtNUS. Refer to the training course Student Manual or contact Health Sciences for this information.

The properly executed Chain-of-Custody Report must be included in the container. Use custody seals.

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Using the Airbill of our common carrier (i.e., Federal Express) as an example, the following instructions apply to the information to be provided under "Transport Details", "Nature and Quantity of Dangerous Goods", and other associated fields.

a) Transport Details

- Select "Passenger and Cargo" or "Cargo Aircraft Only" (This is based on the type and quantity of dangerous goods you are shipping). X-out the non-applicable selection.
- Airport of Departure - Enter the full name of the airport or city of departure.
- Airport of Destination - Enter the full name of the airport or city of destination.

b) Shipment Type – Delete the option that does not apply (Non-Radioactive/Radioactive)

c) Nature and Quantity of Dangerous Goods

1. Dangerous Goods Identification

- Proper Shipping Name - List the proper shipping name (this is the name as it appears on the List of Dangerous Goods Table and NOT the product or trade name), and if applicable, the technical name in parenthesis.
- Class or Division - List the class or division number and, if applicable, compatibility group.
- UN or ID No - List the UN or I.D. number, preceded with "UN" or "I.D." This selection may change when shipping in accordance with 49 CFR regulations that permit the shipment under NA (North American Continental Shipments) designations for certain substances.
- Packing Group – List the appropriate packing group, if applicable. This is the level of anticipated hazard of the shipment. It does not apply for all shipments. When no information is available, leave the space blank.
- Subsidiary Risk – List the class or division number of the subsidiary risk, if applicable. The subsidiary risk is any additional hazard beyond the most significant (or primary) hazard. This information is obtained from the List of Dangerous Goods Table.

2. Quantity and Type of Packaging – List the number of packages, the type of package, and the net quantity in each package. The type of packaging you are shipping the hazardous material in is presented first, followed by the amount (Kg, L, etc.). For example, "1 fiberboard box X 2 Kg". When no outer packaging is identified, the packaging selected must provide limited protection of the inner packaging by securing and cushioning during shipment. NOTE: Always use the package that the hazardous material was shipped to the site in. If it is not available, contact the Health Sciences Department in Pittsburgh for further instruction.

3. Packing Instructions – Enter the Packing Instruction number. These instructions are provided in Section 5 of the IATA Dangerous Goods Regulations. They provide the exact type of packaging required by the industry for various hazard classes. When no addition packaging considerations are given, the shipper may use their best judgment for the shipment of an identified substance and/or article.

4. Authorization – List the words " Limited Quantity," if applicable; list any special provision(s) or approval(s) if applicable. This section provides for exceptions to this transportation regulation and the conditions for those exceptions.

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- d) Additional handling Information - Enter any required special handling information.
- e) Prepared for Air Transport according to: Check the ICAO/IATA box.
- f) Emergency Telephone Number - Enter the 24-hour emergency contact number. This number is required of all US Origin or Destination Shipments. List the number for InfoTRAC (1-800-535-5053). InfoTRAC is a company retained by TtNUS to provide 24-Hour Emergency Hotline service for dangerous goods shipment. This company has MSDSs for the substances routinely shipped by TtNUS. They provide information to FedEx or any other emergency responders, should situations arise with one of our shipments. In addition, they have telephone numbers of certain Tetra Tech NUS Health Science Department personnel in the Pittsburgh Office in the event of an emergency.
- g) Name/Title of the Signatory - Enter name and job title (Field Operations Leader, Geologist, Health & Safety Specialist, etc.)
- h) Place and date - Enter the city and date of shipment
- i) Signature - Sign the form (must be a complete signature). All alterations must be signed with the same signature used to sign the declaration.

#### 5.4.3.4 Transportation

1. The majority of unknown hazardous substance samples will be classified as flammable liquids. The samples will be transported by rented or common carrier truck, railroad, or express overnight package services. Do not transport samples on any passenger-carrying air transport system, even if the system has cargo-only aircraft. DOT regulations permit regular airline cargo-only aircraft, but difficulties with most suggest avoiding them. Instead, ship by airline carriers that carry only cargo. If unsure of what mode of transportation to use, consult Health Sciences.<sup>1</sup>
2. For transport by government-owned vehicle, including aircraft, DOT regulations do not apply. However, procedures described above, with the exception of execution of the bill of lading with certification, shall still be followed.
3. Use the hazardous materials shipping check list (Attachment E) as a guidance to ensure that all sample-handling requirements are satisfied.
4. In some cases, various materials may react if they break during shipment. To determine if you are shipping such materials, refer to the DOT compatibility chart in Attachment F.

#### 5.5 Shipment of Lithium Batteries

Monitoring well data are analyzed using either the Hermit SE 1000 or the Hermit SE 2000 environmental data logger. These instruments are typically powered by lithium batteries in sufficient quantity to make the unit subject to hazardous material shipping requirements. The DOT determined that lithium batteries are to be shipped using the following information:

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<sup>1</sup> Note: If you are unsure as how to ship the sample (hazardous or environmental sample), contact Health Sciences so that a decision can be made as to the proper shipping practices. The DOT and IATA penalties for improper shipment of a hazardous material are stringent and may include a prison term for intentional violations.

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- Product Designation
  - Hermit SE 1000
  - Hermit SE 2000
- Proper Shipping Name
  - Lithium batteries, contained in equipment, UN3091
- UN No - UN-3091
- Classification or Division
  - Class 9

Shipment of equipment containing lithium batteries must be accompanied by shipping papers completed as indicated in Attachment G. The instrument will be shipped by Federal Express as a Hazardous Material. Place the instrument in the same container in which it was received. This container or case is a DOT-approved shipping container. For Federal Express procedures to ship hazardous materials, call 1-800-238-5355, extension 922-1666. In most cases, the return shipping papers and DOT labels will be shipped to you from the company warehouse or the vendor. An example of the types of labels used for shipment and the wording are shown in Attachment G. These labels will be attached to the outside container and include all the information noted under Section 5.4.3.2. Instead of the Flammable Liquid information, however, the following will be presented with the following wording:

- Lithium Batteries Contained in Equipment
  - UN-3091
- DOT Miscellaneous Hazardous Materials (Class 9) label
- "Cargo Aircraft Only" label

## 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.

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### ATTACHMENT A

#### GENERAL SAMPLE CONTAINER AND PRESERVATION REQUIREMENTS

Sample Type and Concentration	Container <sup>(1)</sup>	Sample Size	Preservation <sup>(2)</sup>	Holding Time <sup>(2)</sup>
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#### WATER

Organics (GC&GC/MS)	VOC	Low	Borosilicate glass	2 x 40 mL	Cool to 4°C HCl to ≤ 2	14 days <sup>(9)</sup>
	Extractables SVOCs and pesticide/PCBs)	(Low	Amber glass	2x2 L or 4x1 L	Cool to 4°C	7 days to extraction; 40 days after extraction
	Extractables SVOCs and pesticide/PCBs)	(Medium	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 <sub>3</sub> 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		Wide-mouth glass with teflon liner	2 x 4 oz.	Cool to 4°C	14 days
	Extractables SVOCs and pesticides/PCBs)	(Low	Wide-mouth glass	8 oz.	Cool to 4°C	14 days to extraction; 40 days after extraction
	Extractables SVOCs and pesticides/PCBs)	(Medium	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/Inorga nic	High Hazard		Wide-mouth glass	8 oz.	None	NA
Dioxin/Furan	All		Wide-mouth glass	4 oz.	None	7 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
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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.

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**ATTACHMENT B**

**ADDITIONAL REQUIRED CONTAINERS, PRESERVATION TECHNIQUES,  
AND HOLDING TIMES**

Parameter Number/Name	Container <sup>(1)</sup>	Preservation <sup>(2)(3)</sup>	Maximum Holding Time <sup>(4)</sup>
<b>INORGANIC TESTS:</b>			
Acidity	P, G	Cool, 4°C	14 days
Alkalinity	P, G	Cool, 4°C	14 days
Ammonia - Nitrogen	P, G	Cool, 4°C; H <sub>2</sub> SO <sub>4</sub> 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 <sub>2</sub> SO <sub>4</sub> 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 <sup>(5)</sup>	14 days <sup>(6)</sup>
Fluoride	P	None required	28 days
Hardness	P, G	HNO <sub>3</sub> to pH 2; H <sub>2</sub> SO <sub>4</sub> to pH 2	6 months
Total Kjeldahl and Organic Nitrogen	P, G	Cool, 4°C; H <sub>2</sub> SO <sub>4</sub> to pH 2	28 days
Nitrate - Nitrogen	P, G	None required	48 hours
Nitrate-Nitrite - Nitrogen	P, G	Cool, 4°C; H <sub>2</sub> SO <sub>4</sub> to pH 2	28 days
Nitrite - Nitrogen	P, G	Cool, 4°C	48 hours
Oil & Grease	G	Cool, 4°C; H <sub>2</sub> SO <sub>4</sub> to pH 2	28 days
Total Organic Carbon (TOC)	P, G	Cool, 4°C; HCl or H <sub>2</sub> SO <sub>4</sub> 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 <sub>2</sub> SO <sub>4</sub> to pH 2	28 days
Phosphorus, Total	P, G	Cool, 4°C; H <sub>2</sub> SO <sub>4</sub> 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

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**ATTACHMENT B  
ADDITIONAL REQUIRED CONTAINERS, PRESERVATION TECHNIQUES,  
AND HOLDING TIMES  
PAGE TWO**

Parameter Number/Name	Container <sup>(1)</sup>	Preservation <sup>(2)(3)</sup>	Maximum Holding Time <sup>(4)</sup>
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**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:<sup>(7)</sup>**

Chromium VI (Hexachrome)	P, G	Cool, 4°C	24 hours
Mercury (Hg)	P, G	HNO <sub>3</sub> to pH 2	28 days
Metals, except Chromium VI and Mercury	P, G	HNO <sub>3</sub> to pH 2	6 months

**ORGANIC TESTS:<sup>(8)</sup>**

Purgeable Halocarbons	G, Teflon-lined septum	Cool, 4°C; 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>(9)</sup>	14 days
Purgeable Aromatic Hydrocarbons	G, Teflon-lined septum	Cool, 4°C; 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>(9)</sup> HCl to pH 2 <sup>(9)</sup>	14 days
Acrolein and Acrylonitrile	G, Teflon-lined septum	Cool, 4°C; 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>(9)</sup> adjust pH to 4-5 <sup>(10)</sup>	14 days
Phenols <sup>(11)</sup>	G, Teflon-lined cap	Cool, 4°C; 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>(9)</sup>	7 days until extraction; 40 days after extraction
Benzidines <sup>(11), (12)</sup>	G, Teflon-lined cap	Cool, 4°C; 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>(9)</sup>	7 days until extraction <sup>(13)</sup>
Phthalate esters <sup>(11)</sup>	G, Teflon-lined cap	Cool, 4°C	7 days until extraction; 40 days after extraction
Nitrosamines <sup>(11), (14)</sup>	G, Teflon-lined cap	Cool, 4°C; store in dark; 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>(9)</sup>	7 days until extraction; 40 days after extraction
PCBs <sup>(11)</sup>	G, Teflon-lined cap	Cool, 4°C	7 days until extraction; 40 days after extraction
Nitroaromatics & Isophorone <sup>(11)</sup>	G, Teflon-lined cap	Cool, 4°C; 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>(9)</sup> ; store in dark	7 days until extraction; 40 days after extraction
Polynuclear Aromatic Hydrocarbons (PAHs) <sup>(11), (14)</sup>	G, Teflon-lined cap	Cool, 4°C; 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>(9)</sup> ; store in dark	7 days until extraction; 40 days after extraction
Haloethers <sup>(11)</sup>	G, Teflon-lined cap	Cool, 4°C; 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>(9)</sup>	7 days until extraction; 40 days after extraction
Dioxin/Furan (TCDD/TCDF) <sup>(11)</sup>	G, Teflon-lined cap	Cool, 4°C; 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>(9)</sup>	7 days until extraction; 40 days after extraction

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**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-diphenylhydrazine 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<sub>2</sub>S<sub>2</sub>O<sub>3</sub> 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<sub>2</sub>S<sub>2</sub>O<sub>3</sub>.

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**ATTACHMENT C**

**DOT HAZARDOUS MATERIAL CLASSIFICATION  
(49 CFR 173.2a)**

1. Radioactive material (except a limited quantity)
2. Division 2.3, Poisonous Gases
3. Division 2.1, Flammable Gas
4. Division 2.2, Nonflammable gas
5. Division 6.1, Poisonous Liquids, Packing Group 1 (poison by inhalation only)
6. Division 4.2, Pyrophoric Material
7. Division 4.1, Self-Reactive Material
8. Class 3, Flammable Liquids\*
9. Class 8, Corrosive Material
10. Division 4.1, Flammable Solid\*
11. Division 4.2, Spontaneously Combustible Materials\*
12. Division 4.3, Dangerous When Wet Materials\*
13. Division 5.1, Oxidizers\*
14. Division 6.1, Poisonous Liquids or Solids (other than Packing Group 1)\*
15. Combustible liquid
16. Class 9, Miscellaneous Hazardous Materials

\* If a material has or meets the criteria for more than one hazard class, use the precedence of hazardous table on the following page for Classes 3 and 8 and Divisions 4.1, 4.2, 4.3, 5.1, and 6.1. The following table ranks those materials that meet the definition of Classes 3 and 8 and Divisions 4.1, 4.2, 4.3, 5.1, and 6.1.

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**ATTACHMENT C (Continued)**

**DOT HAZARDOUS MATERIAL CLASSIFICATION  
(49 CFR 173.2a)**

Class	Packing Group	4.2	4.3	5.1 I <sup>(a)</sup>	5.1 II <sup>(a)</sup>	5.1 III <sup>(a)</sup>	6.1 I (Dermal)	6.1 I (Oral)	6.1 II	6.1 III	8 I (Liquid)	8 I (Solid)	8 II (Liquid)	8 II (Solid)	8 III (Liquid)	8 III (Solid)
3	I						3	3	3	3	3	(c)	3	(c)	3	(c)
3	II						3	3	3	3	8	(c)	3	(c)	3	(c)
3	III						6.1	6.1	6.1	3 <sup>(d)</sup>	8	(c)	8	(c)	3	(c)
4.1	II <sup>b</sup>	4.2	4.3	5.1	4.1	4.1	6.1	6.1	4.1	4.1	(c)	8	(c)	4.1	(c)	4.1
4.1	III <sup>b</sup>	4.2	4.3	5.1	4.1	4.1	6.1	6.1	6.1	4.1	(c)	8	(c)	8	(c)	4.1
4.2	II		4.3	5.1	4.2	4.2	6.1	6.1	4.2	4.2	(c)	8	(c)	4.2	(c)	4.2
4.2	III		4.3	5.1	4.2	4.2	6.1	6.1	6.1	4.2	(c)	8	(c)	8	(c)	4.2
4.3	I			5.1	4.3	4.3	6.1	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
4.3	II			5.1	4.3	4.3	6.1	4.3	4.3	4.3	8	8	8	4.3	4.3	4.3
4.3	III			5.1	4.3	4.3	6.1	6.1	6.1	4.3	8	8	8	8	4.3	4.3
5.1	I <sup>a</sup>						5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1
5.1	II <sup>a</sup>						6.1	5.1	5.1	5.1	8	8	8	5.1	5.1	5.1
5.1	III <sup>a</sup>						6.1	6.1	6.1	5.1	8	8	8	8	5.1	5.1
6.1	I, Dermal										8	6.1	6.1	6.1	6.1	6.1
6.1	I, Oral										8	6.1	6.1	6.1	6.1	6.1
6.1	II, Inhalation										8	6.1	6.1	6.1	6.1	6.1
6.1	II, Dermal										8	6.1	8	6.1	6.1	6.1
6.1	II, Oral										8	8	8	6.1	6.1	6.1
6.1	III										8	8	8	8	8	8

- (a) There are at present no established criteria for determining Packing Groups for liquids in Division 5.1. At present, the degree of hazard is to be assessed by analogy with listed substances, allocating the substances to Packing Group I, Great; Group II, Medium; or Group III, Minor Danger.
- (b) Substances of Division 4.1 other than self-reactive substances.
- (c) Denotes an impossible combination.
- (d) For pesticides only, where a material has the hazards of Class 3, Packing Group III, and Division 6.1, Packing Group III, the primary hazard is Division 6.1, Packing Group III.

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## ATTACHMENT D

### GUIDE FOR HAZARDOUS MATERIALS SHIPPERS

USE OF GUIDE - This guide is presented as an aid to shippers of hazardous materials. It does not contain or refer to all of the DOT requirements for shipping hazardous materials. For specific details, refer to all of the DOT requirements for shipping hazardous materials, as provided in the Code of Federal Regulations (CFR), Title 49, Transportation, Parts 100-199.

The following is offered as a step-by-step procedure to aid in compliance with the applicable DOT regulations.

**STEP 1 - DETERMINE THE PROPER SHIPPING NAME.** The shipper must determine the proper shipping name of the materials as listed in the Hazardous Materials Table, 49 CFR 172.101, Column (2).

**STEP 2 - DETERMINE THE HAZARD CLASS OR CLASSES.**

- a. Refer to the Table, 49 CFR 172.101, Column (3), and locate the hazard class of the material.
- b. If more than one class is shown for the proper shipping name, determine the proper class by definition.
- c. If the materials have more than one hazard, classify the material based on the order of hazards in 49 CFR 173.2.

**STEP 3 - SELECT THE PROPER IDENTIFICATION NUMBERS.**

- a. Refer to the Table, 49 CFR 172.101, Column (3a), and select the Identification Number (ID) that corresponds to the proper shipping name and hazard class.
- b. Enter the ID number(s) on the shipping papers and display them, as required, on packagings, placards and/or orange panels.

**STEP 4 - DETERMINE THE MODE(S) OF TRANSPORT TO ULTIMATE DESTINATION.**

- a. As a shipper, you must assure yourself that the shipment complies with various modal requirements.
- b. The modal requirements may affect the following: (1) Packaging; (2) Quantity per Package; (3) Marking; (4) Labeling; (5) Shipping Papers; and (6) Certification.

**STEP 5 - SELECT THE PROPER LABEL(S) AND APPLY AS REQUIRED.**

- a. Refer to the Table, 49 CFR 172.101, Column (4) for required labels.
- b. For details on labeling refer to (1) Additional Labels, 49 CFR 172.402; (2) Placement of Labels, 49 CFR 172.406; (3) Packagings (Mixed or Consolidated), 49 CFR 172.404(a) and (h); (4) Packages Containing Samples, 49 CFR 172.402(h); (5) Radioactive Materials, 49 CFR 172.403; and (6) Authorized Label Modifications, 49 CFR 172.405.

**STEP 6 - DETERMINE AND SELECT THE PROPER PACKAGES.**

- a. Refer to the Table, 49 CFR 172.101, Column (5a) for exceptions and Column (5b) for specification packagings. Consider the following when selecting an authorized package: Quantity per Package; Cushioning Material, if required; Proper Closure and Reinforcement; Proper Pressure; Outage; etc., as required.
- b. If packaged by a prior shipper, make sure the packaging is correct and in proper condition for transportation.

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**ATTACHMENT D (Continued)  
GUIDE FOR HAZARDOUS MATERIALS SHIPPERS**

**STEP 7 - MARK THE PACKAGING (INCLUDING OVERPACKS).**

- a. Apply the required markings (49 CFR 172.300); Proper shipping name and ID number, when required (49 CFR 172.301); Name and address of Consignee or Consignor (49 CFR 172.306).
- b. For details and other required markings, see 49 CFR 172.300 through 172.338.

**STEP 8 - PREPARE THE SHIPPING PAPERS.**

- a. The basic requirements for preparing shipping papers include Proper Shipping Name; Hazard Class; ID Number; Total Quantity; Shipper's Certification; and Emergency Response Telephone Number.
- b. Make all entries on the shipping papers using the information required and in proper sequence (49 CFR 172.202).

**STEP 9 - CERTIFICATION.**

- a. Each shipper must certify by printing (manually or mechanically) on the shipping papers that the materials being offered for shipment are properly classified, described, packaged, marked and labeled, and in proper condition for transportation according to the applicable DOT Regulations (49 CFR 172.202).

**STEP 10 - LOADING, BLOCKING, AND BRACING.** When hazardous materials are loaded into the transport vehicle or freight container, each package must be loaded, blocked, and braced in accordance with the requirements for mode of transport.

- a. If the shipper loads the freight container or transport vehicle, the shipper is responsible for the proper loading, blocking, and bracing of the materials.
- b. If the carrier does the loading, the carrier is responsible.

**STEP 11 - DETERMINE THE PROPER PLACARD(S).** Each person who offers hazardous materials for transportation must determine that the placarding requirements have been met.

- a. For Highway, unless the vehicle is already correctly placarded, the shipper must provide the required placard(s) and required ID number(s) (49 CFR 172.506).
- b. For Rail, if loaded by the shipper, the shipper must placard the rail car if placards are required (49 CFR 172.508).
- c. For Air and Water shipments, the shipper has the responsibility to apply the proper placards.

**STEP 12 - HAZARDOUS WASTE/HAZARDOUS SUBSTANCE.**

- a. If the material is classed as a hazardous waste or hazardous substance, most of the above steps will be applicable.
- b. Pertinent Environmental Protection Agency regulations are found in the Code of Federal Regulations, Title 40, Part 262.

**As a final check and before offering the shipment for transportation, visually inspect the shipment. The shipper should ensure that emergency response information is on the vehicle for transportation of hazardous materials.**

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## ATTACHMENT E

### HAZARDOUS MATERIALS SHIPPING CHECK LIST

#### **PACKAGING**

1. Check DOT 173.24 for appropriate type of package for hazardous substance.
2. Check for container integrity, especially the closure.
3. Check for sufficient absorbent material in package.
4. Check for sample tags and log sheets for each sample and for chain-of-custody record.

#### **SHIPPING PAPERS**

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

#### **RCRA MANIFEST**

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

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**ATTACHMENT F  
DOT SEGREGATION AND SEPARATON CHART**

Class or Division	Notes	1.1-1.2	1.3	1.4	1.5	1.6	2.1	2.2	2.3 gas Zone A*	2.3 gas Zone B*	3	4.1	4.2	4.3	5.1	5.2	6.1 liquids PG-I Zone A*	7	8 liquids only
Explosives... 1.1 and 1.2	A	*	*	*	*	*	X	X	X	X	X	X	X	X	X	X	X	X	X
Explosives..... 1.3		*	*	*	*	*	X		X	X	X	X	X	X	X	X	X	X	X
Explosives..... 1.4		*	*	*	*	*	O		O	O	O		O				O		O
Very insensitive explosives ..... 1.5	A	*	*	*	*	*	X	X	X	X	X	X	X	X	X	X	X	X	X
Extremely insensitive explosives ..... 1.6		*	*	*	*	*													
Flammable gases .... 2.1		X	X	O	X				X	O							O	O	
Non-toxic, non-flammable gases .... 2.2		X			X														
Poisonous gas - Zone A** ..... 2.3		X	X	O	X		X				X	X	X	X	X	X			X
Poisonous gas - Zone B** ..... 2.3		X	X	O	X		O				O	O	O	O	O	O			O
Flammable liquids..... 3		X	X	O	X				X	O					O		X		
Flammable solids..... 4.1		X			X				X	O							X		O
Spontaneously combustible materials ..... 4.2		X	X	O	X				X	O							X		X
Dangerous-when-wet materials ..... 4.3		X	X		X				X	O							X		O
Oxidizers ..... 5.1	A	X	X		X				X	O	O						X		O
Organic peroxides..... 5.2		X	X		X				X	O							X		O
Poisonous liquids PG I - Zone A** ..... 6.1		X	X	O	X		O				X	X	X	X	X	X			X
Radioactive materials . 7		X			X		O												
Corrosive liquids ..... 8		X	X	O	X				X	O		O	X	O	O	O	X		

No entry means that the materials are compatible (have no restrictions).

X These materials may not be loaded, transported, or stored together in the same vehicle or facility.

O The materials may not be loaded, transported, or stored together in the same vehicle or facility unless they are separated for 4 feet on all sides.

\* Check the explosives compatibility chart in 49 CFR 179.848(f).

A Ammonium nitrate fertilizers may be stored with Division 1.1 materials.

\*\* Denotes inhalation hazardous for poisons; consult field team leader or project manager if you encounter a material in this class 1 before shipment.

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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)	Airport of Departure
<del>HAZARDOUS MATERIALS</del> <del>PERISHABLE</del> <del>FRIGID</del> <del>FLAMMABLE</del> <del>EXPLOSIVE</del>	CARGO AIRCRAFT ONLY
Airport of Destination: 19CYS	

Shipment type: (delete non-applicable)

NON-RADIOACTIVE  ~~RADIOACTIVE~~

**NATURE AND QUANTITY OF DANGEROUS GOODS**

Dangerous Goods Identification				Quantity and type of packing	Packing Inst.	Authorization
Proper Shipping Name	Class or Division	UN or ID No.	Subsidiary Risk			
LITHIUM BATTERIES CONTAINED IN EQUIPMENT	9	UN3091		1 PLASTIC BOX X 55 GRAMS	912 II	PER CA-9206009

FOR SHIPMENTS TO  
USA, AK, AND HI ONLY

Additional Handling Information

1 HERMIT SERIES DATALOGGER X 55 GRAMS (11 GRAMS/CELL)

I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in the proper condition for transport by air according to the applicable International and National Government Regulations.	Name/Title of Signatory
	Place and Date
	Signature (see warning above)
Emergency Telephone Number (Required for US Origin or Destination Shipments) 800-535-5053	
IF ACCEPTABLE FOR PASSENGER AIRCRAFT, THIS SHIPMENT CONTAINS RADIOACTIVE MATERIAL INTENDED FOR USE IN, OR INCIDENT TO, RESEARCH, MEDICAL DIAGNOSIS, OR TREATMENT.	

ATTACHMENT G  
LITHIUM BATTERY SHIPPING PAPERS

Subject  
NON-RADIOLOGICAL SAMPLE  
HANDLING

Number  
SA-6.1

Revision  
1

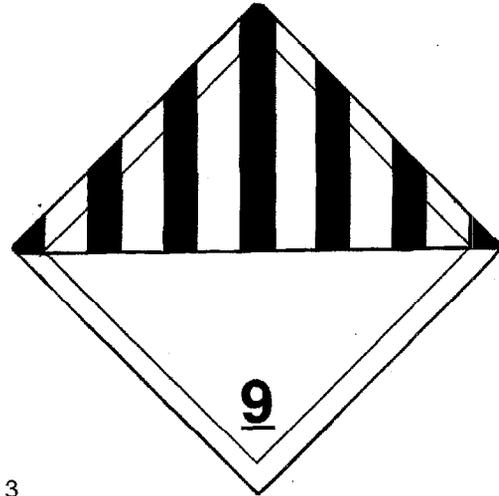
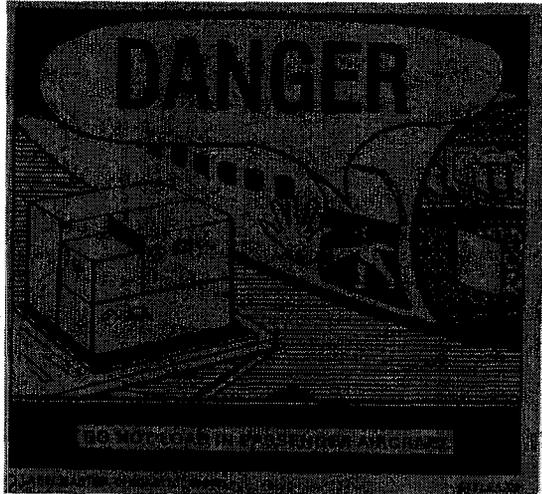
Page  
23 of 24

Effective Date  
03/00

Tetra Tech NUS, Inc.

Subject NON-RADIOLOGICAL SAMPLE HANDLING	Number SA-6.1	Page 24 of 24
	Revision 1	Effective Date 03/00

**ATTACHMENT G (CONTINUED)  
LITHIUM BATTERY SHIPPING PAPERS**



**LITHIUM BATTERIES CONTAINED  
IN EQUIPMENT.  
UN-3091.  
SHIPPED UNDER CA-9206009**



TETRA TECH NUS, INC.

# STANDARD OPERATING PROCEDURES

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Effective Date	01/00	Revision	1
Applicability	Tetra Tech NUS, Inc.		
Prepared	Earth Sciences Department		
Approved	D. Senovich <i>DS</i>		

Subject  
FIELD DOCUMENTATION

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## 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
- Arrival/departure of equipment
- 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.

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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 data 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 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 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 Sample Forms

A summary of the forms illustrated in this procedure is shown as the listing of Attachments in the Table of Contents for this SOP. Forms may be altered or revised for project-specific needs contingent upon client

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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. Attachments B-1 to B-4 are examples of Sample Log Sheets. The data recorded on these sheets are useful in describing the waste source and 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-5. 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, 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 first cooler. The COC form should then state how many coolers are included with that shipment. An example of a Chain-of-Custody Record form is provided as Attachment B-6. 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 B-7 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 samplers and affixed across the opening edges of each cooler containing environmental samples. COC seals may be available from the laboratory; these seals may also be purchased from a supplier.

#### 5.3.1.5 Field Analytical Log Sheets for Geochemical Parameters

Field Analytical Log Sheets (Attachment B-8) are used to record geochemical and/or natural attenuation field test results. Attachments B-8 (3-page form) should be used when applicable.

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**5.3.2 Hydrogeological and Geotechnical Forms**

**5.3.2.1 Groundwater Level Measurement Sheet**

A groundwater level measurement sheet, shown in Attachment C-1 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 (Attachment C-2) facilitates this task by standardizing the data collection format, 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 shown in Attachment C-3 must be completed for each well upon which a packer test is conducted.

**5.3.2.4 Summary Log of Boring**

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, (Attachment C-4) 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 results 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), different forms are used (see Attachments C-5 through C-9). Similar forms are used for flush-mount well completions.

**5.3.2.6 Test Pit Log**

When a test pit or trench is constructed for investigative or sampling purposes, a Test Pit Log (Attachment C-10) 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 (Attachment C-11) should be used as the project directs to document all materials utilized during each monitoring well installation.

The Monitoring Well Development Record (Attachment C-12) should be used as the project directs to document all well development activities.

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### 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 (Attachment D) 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.

### 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 (Attachment E is an example of a Daily Activities Report).

##### 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.

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It should be noted that in addition to the summaries described herein, other summary reports may also be contractually required. Attachment F is an example of a Field Trip Summary Report form.

**6.0 ATTACHMENTS**

- Attachment A TYPICAL SITE LOGBOOK ENTRY
- Attachment B-1 EXAMPLE GROUNDWATER SAMPLE LOG SHEET
- Attachment B-2 EXAMPLE SURFACE WATER SAMPLE LOG SHEET
- Attachment B-3 EXAMPLE SOIL/SEDIMENT SAMPLE LOG SHEET
- Attachment B-4 CONTAINER SAMPLE LOG SHEET FORM
- Attachment B-5 SAMPLE LABEL
- Attachment B-6 CHAIN-OF-CUSTODY RECORD FORM
- Attachment B-7 CHAIN-OF-CUSTODY SEAL
- Attachment B-8 FIELD ANALYTICAL LOG SHEET
- Attachment C-1 EXAMPLE GROUNDWATER LEVEL MEASUREMENT SHEET
- Attachment C-2 EXAMPLE PUMPING TEST DATA SHEET
- Attachment C-3 PACKER TEST REPORT FORM
- Attachment C-4 EXAMPLE BORING LOG
- Attachment C-5 EXAMPLE OVERBURDEN MONITORING WELL SHEET
- Attachment C-5A EXAMPLE OVERBURDEN MONITORING WELL SHEET (FLUSHMOUNT)
- Attachment C-6 EXAMPLE CONFINING LAYER MONITORING WELL SHEET
- Attachment C-7 EXAMPLE BEDROCK MONITORING WELL SHEET - OPEN HOLE WELL
- Attachment C-8 EXAMPLE BEDROCK MONITORING WELL SHEET - WELL INSTALLED IN BEDROCK
- Attachment C-9 EXAMPLE BEDROCK MONITORING WELL SHEET - WELL INSTALLED IN BEDROCK (FLUSHMOUNT)
- Attachment C-10 EXAMPLE TEST PIT LOG
- Attachment C-11 MONITORING WELL MATERIALS CERTIFICATE OF CONFORMANCE
- Attachment C-12 MONITORING WELL DEVELOPMENT RECORD
- Attachment D EXAMPLE EQUIPMENT CALIBRATION LOG
- Attachment E EXAMPLE DAILY ACTIVITIES RECORD
- Attachment F FIELD TRIP SUMMARY REPORT

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**ATTACHMENT A  
TYPICAL SITE LOGBOOK ENTRY**

START TIME: \_\_\_\_\_ DATE: \_\_\_\_\_

SITE LEADER: \_\_\_\_\_  
PERSONNEL: \_\_\_\_\_

TINUS	DRILLER	SITE VISITORS
_____	_____	_____
_____	_____	_____
_____	_____	_____

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

ACTIVITIES:

1. Steam jenny 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





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**ATTACHMENT B-3**



Tetra Tech NUS, Inc.

**SOIL & SEDIMENT SAMPLE LOG SHEET**

Page \_\_\_ of \_\_\_

Project Site Name: _____	Sample ID No.: _____
Project No.: _____	Sample Location: _____
<input type="checkbox"/> Surface Soil	Sampled By: _____
<input type="checkbox"/> Subsurface Soil	C.O.C. No.: _____
<input type="checkbox"/> Sediment	Type of Sample:
<input type="checkbox"/> Other: _____	<input type="checkbox"/> Low Concentration
<input type="checkbox"/> QA Sample Type: _____	<input type="checkbox"/> High Concentration

GRAB SAMPLE DATA:			
Date:	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Time:			
Method:			
Monitor Reading (ppm):			

COMPOSITE SAMPLE DATA:				
Date:	Time	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings (Range in ppm):				

SAMPLE COLLECTION INFORMATION:			
Analysis	Container Requirements	Collected	Other

<b>OBSERVATIONS/NOTES:</b>	<b>MAP:</b>

<b>Circle if Applicable:</b>		<b>Signature(s):</b>
<input type="checkbox"/> MS/MSD	<input type="checkbox"/> Duplicate ID No.:	

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**ATTACHMENT B-4**



Tetra Tech NUS, Inc.

**CONTAINER SAMPLE & INSPECTION SHEET**

Page \_\_\_\_\_ of \_\_\_\_\_

Project Site Name: _____	Sample ID No. _____
Project Number: _____	Sampled By: _____
Site Identification: _____	C.O.C. No. _____
Container Number(s): _____	Concentration: <input type="checkbox"/> High
Sample Type: <input type="checkbox"/> Grab	<input type="checkbox"/> Medium
<input type="checkbox"/> Composite	<input type="checkbox"/> Low

CONTAINER SOURCE	CONTAINER DESCRIPTION
<b>DRUM:</b> <input type="checkbox"/> Bung Top <input type="checkbox"/> Lever Lock <input type="checkbox"/> Bolted Ring <input type="checkbox"/> Other _____	<b>COLOR:</b> _____  <b>CONDITION:</b> _____
<b>TANK:</b> <input type="checkbox"/> Plastic <input type="checkbox"/> Metal <input type="checkbox"/> Other _____	<b>MARKINGS:</b> _____  <b>VOL. OF CONTENTS:</b> _____
<b>OTHER:</b> _____	<b>OTHER:</b> _____

CONTAINER DISPOSITION	CONTENTS DESCRIPTION																				
<b>SAMPLED:</b> _____  <b>OPENED BUT NOT SAMPLED:</b> Reason _____ _____  <b>NOT OPENED:</b> Reason _____ _____	<b>SINGLE PHASED:</b> _____  <b>MULTIPHASE :</b> <table border="0"> <tr> <td></td> <td align="center"><b>Layer 1</b></td> <td align="center"><b>Layer 2</b></td> <td align="center"><b>Layer 3</b></td> </tr> <tr> <td>Phase (Sol. or Liq.)</td> <td align="center">_____</td> <td align="center">_____</td> <td align="center">_____</td> </tr> <tr> <td>Color</td> <td align="center">_____</td> <td align="center">_____</td> <td align="center">_____</td> </tr> <tr> <td>Viscosity</td> <td align="center">L, M or H</td> <td align="center">L, M or H</td> <td align="center">L, M or H</td> </tr> <tr> <td>% of Total Volume</td> <td align="center">_____</td> <td align="center">_____</td> <td align="center">_____</td> </tr> </table>		<b>Layer 1</b>	<b>Layer 2</b>	<b>Layer 3</b>	Phase (Sol. or Liq.)	_____	_____	_____	Color	_____	_____	_____	Viscosity	L, M or H	L, M or H	L, M or H	% of Total Volume	_____	_____	_____
	<b>Layer 1</b>	<b>Layer 2</b>	<b>Layer 3</b>																		
Phase (Sol. or Liq.)	_____	_____	_____																		
Color	_____	_____	_____																		
Viscosity	L, M or H	L, M or H	L, M or H																		
% of Total Volume	_____	_____	_____																		

<b>MONITOR READING:</b>	<b>SAMPLE and /or INSPECTION DATE &amp; TIME:</b>
	_____ HRS.
	<b>METHOD:</b> _____
<b>SAMPLER(S) and / or INSPECTOR(S) SIGNATURE:</b>	<b>ANALYSIS:</b>

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**ATTACHMENT B-5**

	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:	



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ATTACHMENT B-7

CHAIN-OF-CUSTODY SEAL

<b>Signature</b> <hr/>		<b>CUSTODY SEAL</b> <hr/>
<b>Date</b> <hr/>		<b>Date</b> <hr/>
<b>CUSTODY SEAL</b>		<b>Signature</b> <hr/>

**ATTACHMENT B-8**



**FIELD ANALYTICAL LOG SHEET  
GEOCHEMICAL PARAMETERS**

Tetra Tech NUS, Inc.

Page    of   

Project Site Name: _____	Sample ID No.: _____
Project No.: _____	Sample Location: _____
Sampled By: _____	Duplicate: <input type="checkbox"/>
Field Analyst: _____	Blank: <input type="checkbox"/>
Field Form Checked as per QA/QC Checklist (initials): _____	

Date:	Color	pH	S.C.	Temp.	Turbidity	DO	Salinity	Other
Time: _____	(Visual)	(S.U.)	(mS/cm)	(°C)	(NTU)	(mg/l)	(%)	
Method: _____								

**SAMPLE COLLECTION/ANALYSIS INFORMATION:**

ORP (Eh) (+/- mv): \_\_\_\_\_ Electrode Make & Model: \_\_\_\_\_  
Reference Electrode (circle one): Silver-Silver Chloride / Calomel / Hydrogen

**Dissolved Oxygen:**

Equipment: HACH Digital Titrator OX-DT    CHEMetrics (Range: \_\_\_\_\_ mg/L)    Analysis Time: \_\_\_\_\_

Range Used:	Range	Sample Vol.	Cartridge	Multiplier	Titration Count	Multiplier	Concentration
<input type="checkbox"/>	1-5 mg/L	200 ml	0.200 N	0.01	_____	x 0.01	= _____ mg/L
<input type="checkbox"/>	2-10 mg/L	100 ml	0.200 N	0.02	_____	x 0.02	= _____ mg/L

CHEMetrics: \_\_\_\_\_ mg/L

**Alkalinity:**

Equipment: HACH Digital Titrator AL-DT    CHEMetrics (Range: \_\_\_\_\_ mg/L)    Analysis Time: \_\_\_\_\_  
Filtered:

Range Used:	Range	Sample Vol.	Cartridge	Multiplier	Titration Count	Multiplier	Concentration
<input type="checkbox"/>	10-40 mg/L	100 ml	0.1600 N	0.1	_____ & _____	x 0.1	= _____ mg/L
<input type="checkbox"/>	40-160 mg/L	25 ml	0.1600 N	0.4	_____ & _____	x 0.4	= _____ mg/L
<input type="checkbox"/>	100-400 mg/L	100 ml	1.600 N	1.0	_____ & _____	x 1.0	= _____ mg/L
<input type="checkbox"/>	200-800 mg/L	50 ml	1.600 N	2.0	_____ & _____	x 2.0	= _____ mg/L
<input type="checkbox"/>	500-2000 mg/L	20 ml	1.600 N	5.0	_____ & _____	x 5.0	= _____ mg/L
<input type="checkbox"/>	1000-4000 mg/L	10 ml	1.600 N	10.0	_____ & _____	x 10.0	= _____ mg/L

Parameter:	Hydroxide	Carbonate	Bicarbonate
Relationship:			

CHEMetrics: \_\_\_\_\_ mg/L

Notes: \_\_\_\_\_

Standard Additions:     Titrant Molarity: \_\_\_\_\_    Digits Required: 1st.: \_\_\_\_\_ 2nd.: \_\_\_\_\_ 3rd.: \_\_\_\_\_

**Carbon Dioxide:**

Equipment: HACH Digital Titrator CA-DT    CHEMetrics (Range: \_\_\_\_\_ mg/L)    Analysis Time: \_\_\_\_\_

Range Used:	Range	Sample Vol.	Cartridge	Multiplier	Titration Count	Multiplier	Concentration
<input type="checkbox"/>	10-50 mg/L	200 ml	0.3636 N	0.1	_____	x 0.1	= _____ mg/L
<input type="checkbox"/>	20-100 mg/L	100 ml	0.3636 N	0.2	_____	x 0.2	= _____ mg/L
<input type="checkbox"/>	100-400 mg/L	200 ml	3.636 N	1.0	_____	x 1.0	= _____ mg/L
<input type="checkbox"/>	200-1000 mg/L	100 ml	3.636 N	2.0	_____	x 2.0	= _____ mg/L

CHEMetrics: \_\_\_\_\_ mg/L

Notes: \_\_\_\_\_

Standard Additions:     Titrant Molarity: \_\_\_\_\_    Digits Required: 1st.: \_\_\_\_\_ 2nd.: \_\_\_\_\_ 3rd.: \_\_\_\_\_

**ATTACHMENT B-8 (Continued)**



**FIELD ANALYTICAL LOG SHEET  
GEOCHEMICAL PARAMETERS**

Tetra Tech NUS, Inc.

Page \_\_\_ of \_\_\_

Project Site Name: _____	Sample ID No.: _____
Project No.: _____	Sample Location: _____
Sampled By: _____	Duplicate: <input type="checkbox"/>
Field Analyst: _____	Blank: <input type="checkbox"/>
Field Form Checked as per QA/QC Checklist (initials): _____	
<b>SAMPLE COLLECTION/ANALYSIS INFORMATION:</b>	
<b>Sulfide (S<sup>2-</sup>):</b>	
Equipment: DR-700      DR-8 __      HS-WR Color Wheel      Other: _____	Analysis Time: _____
Program/Module: 610nm      93	
Concentration: _____ mg/L	Filtered: <input type="checkbox"/>
Notes: _____	
<b>Sulfate (SO<sub>4</sub><sup>2-</sup>):</b>	
Equipment: DR-700      DR-8 __      Other: _____	Analysis Time: _____
Program/Module: 91	
Concentration: _____ mg/L	Filtered: <input type="checkbox"/>
Standard Solution: <input type="checkbox"/>	Results: _____
Standard Additions: <input type="checkbox"/>	Digits Required: 0.1ml: _____ 0.2ml: _____ 0.3ml: _____
Notes: _____	
<b>Nitrite (NO<sub>2</sub><sup>-</sup>-N):</b>	
Equipment: DR-700      DR-8 __      Other: _____	Analysis Time: _____
Program/Module: 60	Filtered: <input type="checkbox"/>
Concentration: _____ mg/L	Reagent Blank Correction: <input type="checkbox"/>
	Standard Solution: <input type="checkbox"/> Results: <input type="checkbox"/>
Notes: _____	
<b>Nitrate (NO<sub>3</sub><sup>-</sup>-N):</b>	
Equipment: DR-700      DR-8 __      Other: _____	Analysis Time: _____
Program/Module: 55	Filtered: <input type="checkbox"/>
Concentration: _____ mg/L	Nitrite Interference Treatment: <input type="checkbox"/>
Standard Solution: <input type="checkbox"/>	Reagent Blank Correction: <input type="checkbox"/>
Standard Additions: <input type="checkbox"/>	Digits Required: 0.1ml: _____ 0.2ml: _____ 0.3ml: _____
Notes: _____	

**ATTACHMENT B-8 (Continued)**



**FIELD ANALYTICAL LOG SHEET  
GEOCHEMICAL PARAMETERS**

Tetra Tech NUS, Inc.

Page    of   

Project Site Name: _____	Sample ID No.: _____
Project No.: _____	Sample Location: _____
Sampled By: _____	Duplicate: <input type="checkbox"/>
Field Analyst: _____	Blank: <input type="checkbox"/>
Field Form Checked as per QA/QC Checklist (initials): <span style="border: 1px solid black; display: inline-block; width: 40px; height: 15px; vertical-align: middle;"></span>	

**SAMPLE COLLECTION/ANALYSIS INFORMATION:**

**Manganese (Mn<sup>2+</sup>):**

Equipment: DR-700      DR-8 \_\_      HACH MN-5      Other: \_\_\_\_\_      Analysis Time: \_\_\_\_\_

Program/Module: 525nm      41

Concentration: \_\_\_\_\_ mg/L      Filtered:

Standard Solution:       Results: \_\_\_\_\_      Reagent Blank Correction:

Standard Additions:       Digits Required: 0.1ml: \_\_\_\_\_ 0.2ml: \_\_\_\_\_ 0.3ml: \_\_\_\_\_

Notes: \_\_\_\_\_

**Ferrous Iron (Fe<sup>2+</sup>):**

Equipment: DR-700      DR-8 \_\_      IR-18C Color Wheel      Other: \_\_\_\_\_      Analysis Time: \_\_\_\_\_

Program/Module: 500nm      33

Concentration: \_\_\_\_\_ mg/L      Filtered:

Notes: \_\_\_\_\_

**Hydrogen Sulfide (H<sub>2</sub>S):**

Equipment: HS-C      Other: \_\_\_\_\_      Analysis Time: \_\_\_\_\_

Concentration: \_\_\_\_\_ mg/L      Exceeded 5.0 mg/L range on color chart:

Notes: \_\_\_\_\_

**QA/QC Checklist:**

All data fields have been completed as necessary:

Correct measurement units are cited in the SAMPLING DATA block:

Values cited in the SAMPLING DATA block are consistent with the Groundwater Sample Log Sheet:

Multiplication is correct for each *Multiplier* table:

Final calculated concentration is within the appropriate *Range Used* block:

Alkalinity *Relationship* is determined appropriately as per manufacturer (HACH) instructions:

QA/QC sample (e.g., Std. Additions, etc.) frequency is appropriate as per the project planning documents:

Nitrite interference treatment was used for Nitrate test if Nitrite was detected:

Title block on each page of form is initialized by person who performed this QA/QC Checklist:









ATTACHMENT C4 (Continued)

LEGEND  
SOIL TERMS

COARSE-GRAINED SOILS More Than Half of Material is LARGER Than No. 200 Sieve Size				FINE-GRAINED SOILS More Than Half of Material is SMALLER Than No. 200 Sieve Size						
FIELD IDENTIFICATION PROCEDURES (Excluding Particles Larger Than 3 Inches and Basing Fractions on Estimated Weights)		GROUP SYMBOL	TYPICAL NAMES	FIELD IDENTIFICATION PROCEDURES (Excluding Particles Larger Than 3 Inches and Basing Fractions on Estimated Weights)			GROUP SYMBOL	TYPICAL NAMES		
				Identification Procedures on Fraction Smaller than No. 40 Sieve Size						
				DAY STRENGTH (Crushing Characteristics)	DILATANCY (Reaction to Shaking)	TOUGHNESS (Consistency Near Plastic Limit)				
GRAVELS (50%+) <math>1/4''\phi</math>	CLEAN GRAVELS (Low % Fines)	GW	Well graded gravels, gravel-sand mixtures, little or no fines.	SILTS AND CLAYS Liquid Limit <math><50</math>	None to Slight	Quick to Slow	None	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity.	
		GP	Poorly graded gravels, gravel-sand mixtures, little or no fines.		Medium to High	None to Very Slow	Medium	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	
	GRAVELS W/FINES (High % Fines)	GM	Silty gravels, poorly graded gravel-sand-silt mixtures.		Slight to Medium	Slow	Slight	OL	Organic silts and organic silt-clays of low plasticity.	
	Plastic fines (for identification procedures, see CL)	GC	Clayey gravels, poorly graded gravel-sand-clay mixtures.	SILTS AND CLAYS Liquid Limit >math>50</math>	Slight to Medium	Slow to None	Slight to Medium	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	
SANDS 50%+) <math>1/4''\phi</math>	CLEAN SANDS (Low % Fines)	SW	Well graded sand, gravelly sands, little or no fines.		HIGHLY ORGANIC SOILS	High to Very High	None	High	CH	Inorganic clays of high plasticity, fat clays.
		SP	Poorly graded sands, gravelly sands, little or no fines.			Medium to High	None to Very Slow	Slight to Medium	OH	Organic clays of medium to high plasticity.
	SANDS W/FINES (High % Fines)	SM	Silty sands, poorly graded sand-silt mixtures.					PT	Peat and other organic soils	
	Plastic fines (for identification procedures, see CL)	SC	Clayey sands, poorly graded sand-clay mixtures.							

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

DENSITY OF GRANULAR SOILS	
DESIGNATION	STANDARD PENETRATION RESISTANCE-BLOWS/FOOT
Very Loose	0-4
Loose	5-10
Medium Loose	11-30
Dense	31-50
Very Dense	Over 50

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

ROCK TERMS

ROCK HARDNESS (FROM CORE SAMPLES)			ROCK BROKENNESS		
Descriptive Terms	Screwdriver or Knife Effects		Hammer Effects		
			Descriptive Terms	Abbreviation	Spacing
Soft	Easily gouged		Very Broken	(V. Br.)	0-2"
Medium Soft	Can be gouged		Broken	(Br.)	2'-1'
Medium Hard	Can be scratched		Blocky	(Bl.)	1'-3'
Hard	Cannot be scratched		Massive	(M.)	3'-10'

LEGEND:

SOIL SAMPLES - TYPES  
 5-2" Split-Barrel Sample  
 ST-3" O.D. Undisturbed Sample  
 O - Other Samples, Specify in Remarks

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

WATER LEVELS

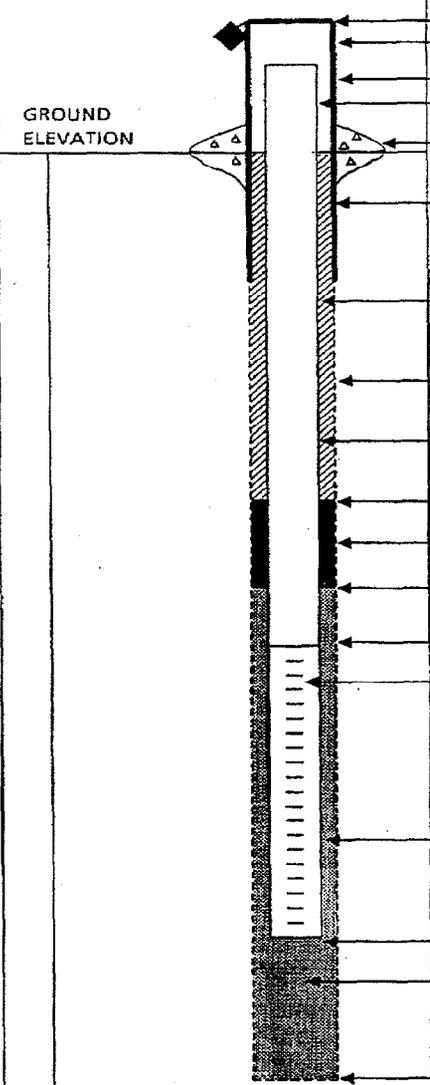
12/18  
 ∇ 12.6 Initial Level w/Date & Depth

12/18

**ATTACHMENT C-5  
EXAMPLE OVERBURDEN MONITORING WELL SHEET**

		BORING NO.: _____	
		<b>OVERBURDEN MONITORING WELL SHEET</b>	
PROJECT _____	LOCATION _____	DRILLER _____	
PROJECT NO. _____	BORING _____	DRILLING _____	
ELEVATION _____	DATE _____	METHOD _____	
FIELD GEOLOGIST _____		DEVELOPMENT _____	
		METHOD _____	

	ELEVATION OF TOP OF SURFACE CASING :	_____
	ELEVATION OF TOP OF RISER PIPE :	_____
	STICK - UP TOP OF SURFACE CASING :	_____
	STICK - UP RISER PIPE :	_____
	GROUND ELEVATION	_____
	TYPE OF SURFACE SEAL :	_____
	I.D. OF SURFACE CASING :	_____
	TYPE OF SURFACE CASING :	_____
	RISER PIPE I.D. _____	
	TYPE OF RISER PIPE :	_____
	BOREHOLE DIAMETER :	_____
	TYPE OF BACKFILL :	_____
	ELEVATION / DEPTH TOP OF SEAL :	_____ / _____
	TYPE OF SEAL :	_____
	DEPTH TOP OF SAND PACK :	_____
ELEVATION / DEPTH TOP OF SCREEN :	_____ / _____	
TYPE OF SCREEN :	_____	
SLOT SIZE x LENGTH :	_____	
I.D. OF SCREEN :	_____	
TYPE OF SAND PACK :	_____	
ELEVATION / DEPTH BOTTOM OF SCREEN :	_____ / _____	
ELEVATION / DEPTH BOTTOM OF SAND PACK :	_____ / _____	
TYPE OF BACKFILL BELOW OBSERVATION WELL :	_____	
ELEVATION / DEPTH OF HOLE :	_____ / _____	

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ATTACHMENT C-5A  
EXAMPLE OVERBURDEN MONITORING WELL SHEET (FLUSHMOUNT)

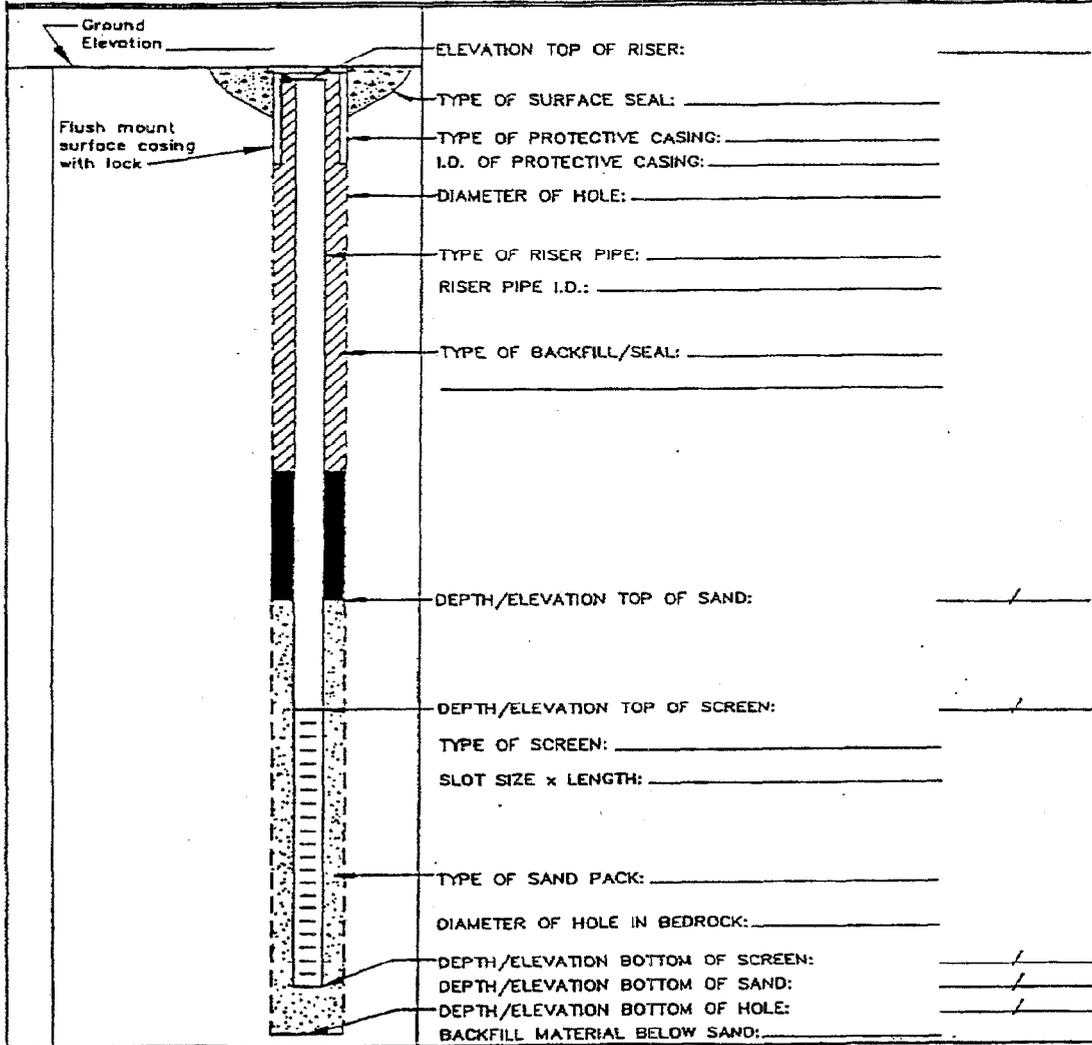
BORING NO.: \_\_\_\_\_



MONITORING WELL SHEET

PROJECT _____	LOCATION _____
PROJECT NO. _____	BORING _____
ELEVATION _____	DATE _____
FIELD GEOLOGIST _____	

DRILLER _____
DRILLING _____
METHOD _____
DEVELOPMENT _____
METHOD _____



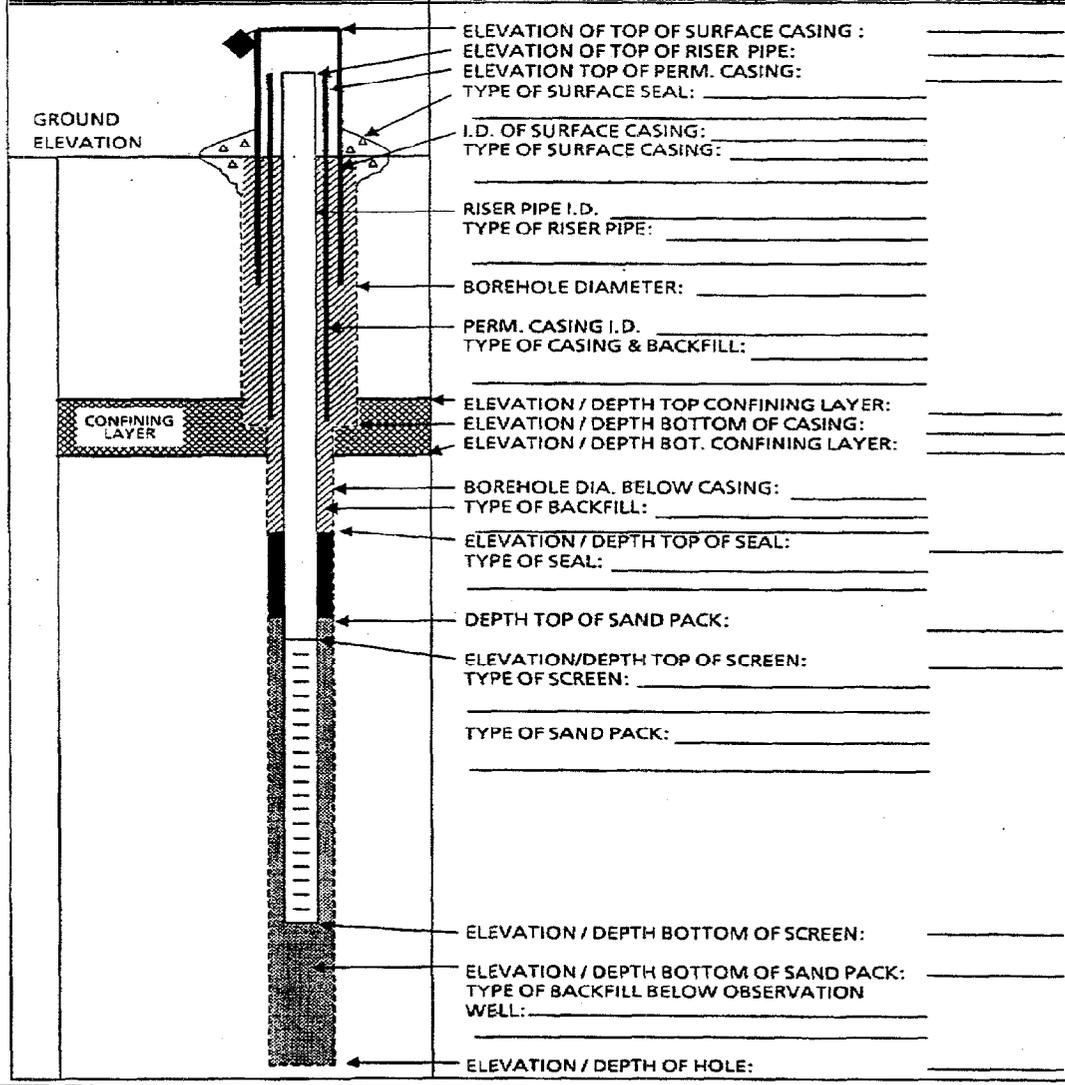
**ATTACHMENT C-6  
EXAMPLE CONFINING LAYER MONITORING WELL SHEET**



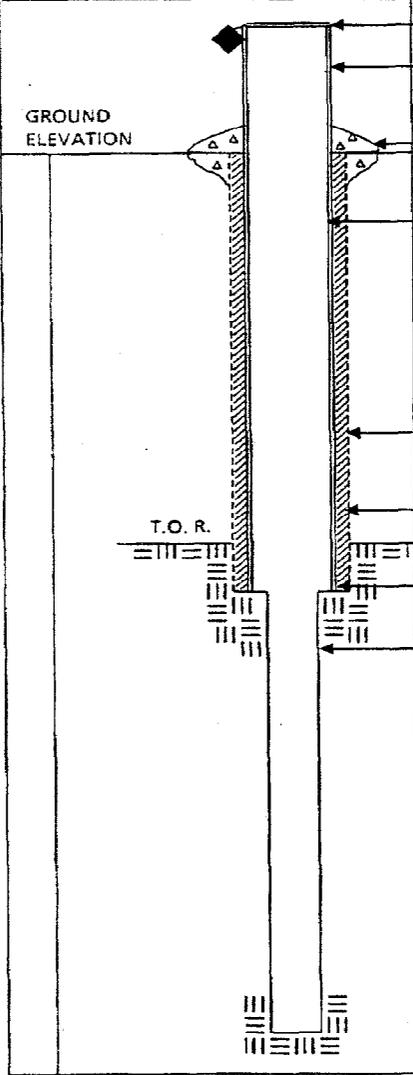
**CONFINING LAYER  
MONITORING WELL SHEET**

BORING NO.: \_\_\_\_\_

PROJECT _____	LOCATION _____	DRILLER _____
PROJECT NO. _____	BORING _____	DRILLING _____
ELEVATION _____	DATE _____	METHOD _____
FIELD GEOLOGIST _____		DEVELOPMENT _____
		METHOD _____

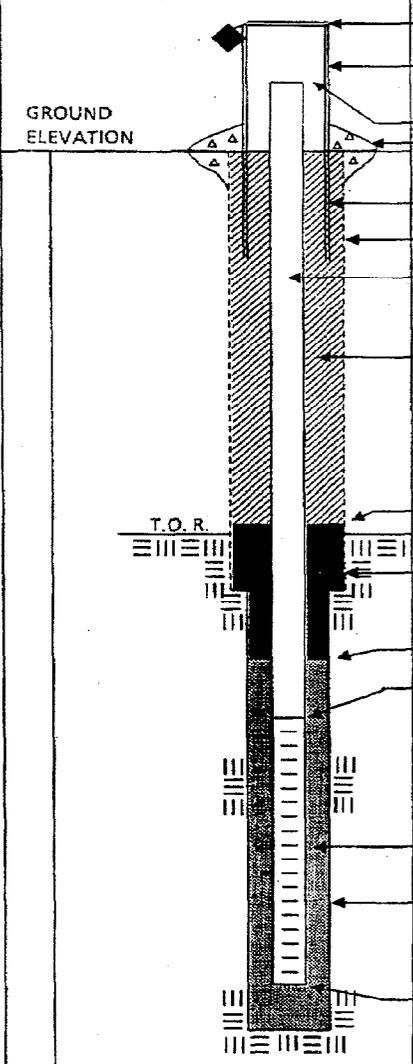


**ATTACHMENT C-7  
EXAMPLE BEDROCK MONITORING WELL SHEET - OPEN HOLE WELL**

	<b>BORING NO.:</b> _____	
	<b>BEDROCK MONITORING WELL SHEET OPEN HOLE WELL</b>	
PROJECT _____ PROJECT NO. _____ ELEVATION _____ FIELD GEOLOGIST _____	LOCATION _____ BORING _____ DATE _____	DRILLER _____ DRILLING METHOD _____ DEVELOPMENT METHOD _____
	ELEVATION OF TOP OF CASING: _____ STICK UP OF CASING ABOVE GROUND SURFACE: _____ TYPE OF SURFACE SEAL: _____ I.D. OF CASING: _____ TYPE OF CASING: _____ TEMP. / PERM.: _____	
	DIAMETER OF HOLE: _____ TYPE OF CASING SEAL: _____ DEPTH TO TOP OF ROCK: _____ DEPTH TO BOTTOM CASING: _____ DIAMETER OF HOLE IN BEDROCK: _____	
	DESCRIBE IF CORE / REAMED WITH BIT: _____ _____	
	DESCRIBE JOINTS IN BEDROCK AND DEPTH: _____ _____ _____	
	ELEVATION / DEPTH OF HOLE: _____	

**ATTACHMENT C-8  
EXAMPLE BEDROCK MONITORING WELL SHEET - WELL INSTALLED IN BEDROCK**

	<b>BEDROCK MONITORING WELL SHEET</b> <b>WELL INSTALLED IN BEDROCK</b>		BORING NO.: _____
	PROJECT _____ PROJECT NO. _____ ELEVATION _____ FIELD GEOLOGIST _____	LOCATION _____ BORING _____ DATE _____	DRILLER _____ DRILLING METHOD _____ DEVELOPMENT METHOD _____

ELEVATION OF TOP OF SURFACE CASING:	_____
STICK UP OF CASING ABOVE GROUND SURFACE:	_____
ELEVATION TOP OF RISER:	_____
TYPE OF SURFACE SEAL:	_____
I.D. OF SURFACE CASING:	_____
DIAMETER OF HOLE:	_____
RISER PIPE I.D.:	_____
TYPE OF RISER PIPE:	_____
TYPE OF BACKFILL:	_____
ELEVATION / DEPTH TOP OF SEAL:	_____ / _____
ELEVATION / DEPTH TOP OF BEDROCK:	_____ / _____
TYPE OF SEAL:	_____
ELEVATION / DEPTH TOP OF SAND:	_____ / _____
ELEVATION / DEPTH TOP OF SCREEN:	_____ / _____
TYPE OF SCREEN:	_____
SLOT SIZE x LENGTH:	_____
I.D. SCREEN:	_____
TYPE OF SAND PACK:	_____
DIAMETER OF HOLE IN BEDROCK:	_____
CORE / REAM:	_____
ELEVATION / DEPTH BOTTOM SCREEN:	_____ / _____
ELEVATION / DEPTH BOTTOM OF HOLE:	_____ / _____

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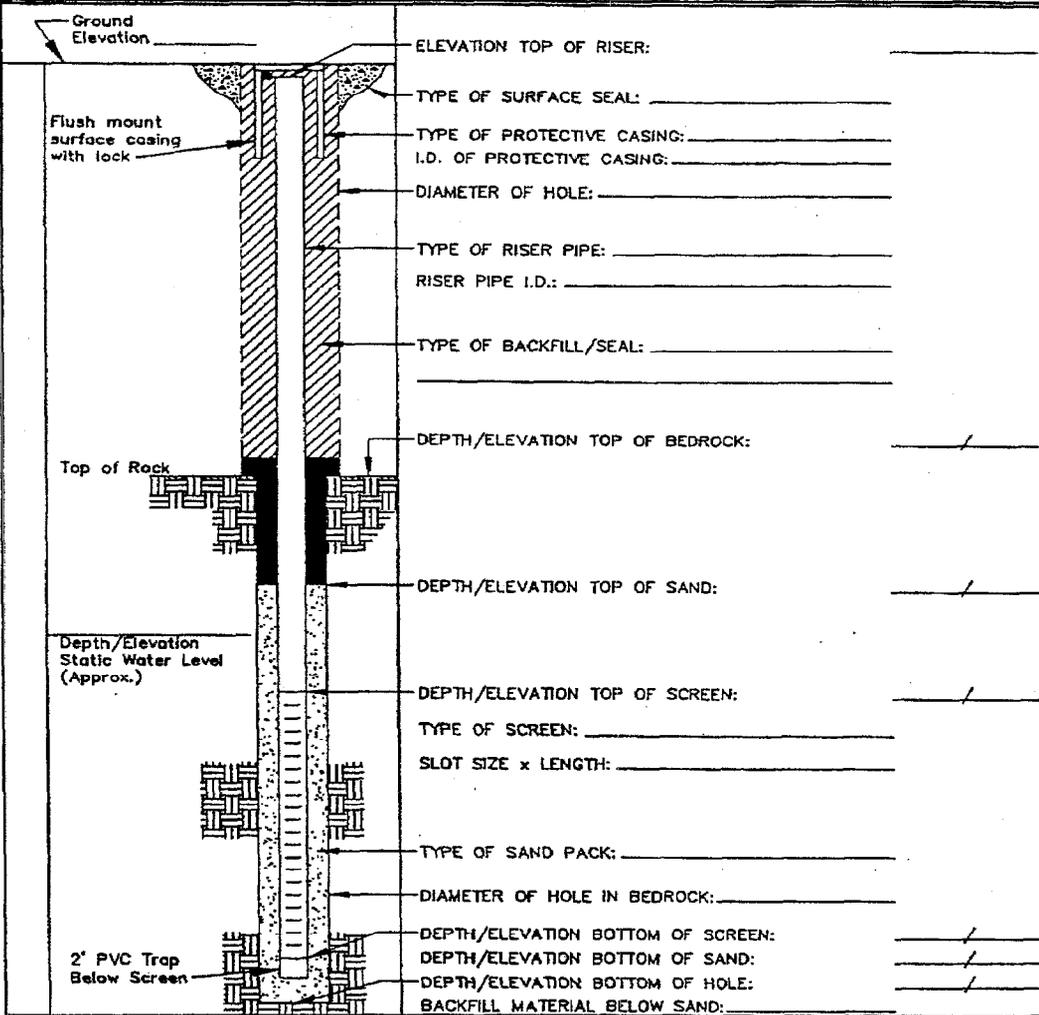
01/00

ATTACHMENT C-9  
EXAMPLE BEDROCK MONITORING WELL SHEET  
WELL INSTALLED IN BEDROCK (FLUSHMOUNT)



BORING NO.: \_\_\_\_\_  
BEDROCK  
MONITORING WELL SHEET  
WELL INSTALLED IN BEDROCK

PROJECT: _____	LOCATION: _____	DRILLER: _____
PROJECT NO.: _____	BORING: _____	DRILLING METHOD: _____
ELEVATION: _____	DATE: _____	DEVELOPMENT METHOD: _____
FIELD GEOLOGIST: _____		



ACFILE: L670\GEOLOGY\BEDROCK.DWG



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ATTACHMENT C-11  
EXAMPLE CERTIFICATE OF CONFORMANCE



MONITORING WELL MATERIALS  
CERTIFICATE OF CONFORMANCE

Well Designation: \_\_\_\_\_

Site Geologist: \_\_\_\_\_

Site Name: \_\_\_\_\_

Drilling Company: \_\_\_\_\_

Date Installed: \_\_\_\_\_

Driller: \_\_\_\_\_

Project Name: \_\_\_\_\_

Project Number: \_\_\_\_\_

Material	Brand/Description	Source/Supplier	Sample Collected ?
Well Casing			
Well Screen			
End Cap			
Drilling Fluid			
Drilling Fluid Additives			
Backfill Material			
Annular Filter Pack			
Bentonite Seal			
Annular Grout			
Surface Cement			
Protective Casing			
Paint			
Rod Lubricant			
Compressor Oil			

To the best of my knowledge, I certify that the above described materials were used during installation of this monitoring well.

Signature of Site Geologist: \_\_\_\_\_







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**ATTACHMENT F  
FIELD TRIP SUMMARY REPORT  
PAGE 1 OF 2**

**SUNDAY**

Date: \_\_\_\_\_ Personnel: \_\_\_\_\_  
Weather: \_\_\_\_\_ Onsite: \_\_\_\_\_

Site Activities: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**MONDAY**

Date: \_\_\_\_\_ Personnel: \_\_\_\_\_  
Weather: \_\_\_\_\_ Onsite: \_\_\_\_\_

Site Activities: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**TUESDAY**

Date: \_\_\_\_\_ Personnel: \_\_\_\_\_  
Weather: \_\_\_\_\_ Onsite: \_\_\_\_\_

Site Activities: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**WEDNESDAY**

Date: \_\_\_\_\_ Personnel: \_\_\_\_\_  
Weather: \_\_\_\_\_ Onsite: \_\_\_\_\_

Site Activities: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Subject  FIELD DOCUMENTATION	Number SA-6.3	Page 37 of 37
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**ATTACHMENT F  
PAGE 2 OF 2  
FIELD TRIP SUMMARY REPORT**

**THURSDAY**

Date: \_\_\_\_\_ Personnel: \_\_\_\_\_

Weather: \_\_\_\_\_ Onsite: \_\_\_\_\_

Site Activities: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**FRIDAY**

Date: \_\_\_\_\_ Personnel: \_\_\_\_\_

Weather: \_\_\_\_\_ Onsite: \_\_\_\_\_

Site Activities: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**SATURDAY**

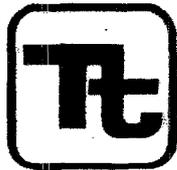
Date: \_\_\_\_\_ Personnel: \_\_\_\_\_

Weather: \_\_\_\_\_ Onsite: \_\_\_\_\_

Site Activities: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_



TETRA TECH NUS, INC.

# STANDARD OPERATING PROCEDURES

Number	SA-7.1	Page	1 of 9
Effective Date	03/16/98	Revision	2
Applicability	Tetra Tech NUS, Inc.		
Prepared	Earth Sciences Department		
Approved	D. Senovich <i>ds</i>		

Subject DECONTAMINATION OF FIELD EQUIPMENT AND WASTE HANDLING

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## 1.0 PURPOSE

The purpose of this procedure is 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 addresses drilling equipment and monitoring well materials decontamination, as well as chemical sampling and field analytical equipment decontamination. 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.

Deionized Water - Deionized (analyte free) water is tap water that has been treated by passing through a standard deionizing resin column. Deionized water should contain no detectable heavy metals or other inorganic compounds at or above the analytical detection limits for the project.

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.

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.

## 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).

## 5.0 PROCEDURES

To ensure that analytical chemical results reflect actual contaminant concentrations present at sampling locations, the various drilling equipment and chemical sampling and analytical equipment used to acquire the environment sample must be properly decontaminated. Decontamination minimizes the potential for cross-contamination between sampling locations, and the transfer of contamination off site.

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## 5.1 Drilling Equipment

Prior to the initiation of a drilling program, all drilling equipment involved in field sampling activities shall be decontaminated by steam cleaning at a predetermined area. The steam cleaning procedure shall be performed using a high-pressure spray of heated potable water producing a pressurized stream of steam. This steam shall be sprayed directly onto all surfaces of the various equipment which might contact environmental samples. The decontamination procedure shall be performed until all equipment is free of all visible potential contamination (dirt, grease, oil, noticeable odors, etc.) In addition, this decontamination procedure shall be performed at the completion of each sampling and/or drilling location, including soil borings, installation of monitoring wells, test pits, etc. Such equipment shall include drilling rigs, backhoes, downhole tools, augers, well casings, and screens. Where the drilling rig is set to perform multiple borings at a single area of concern, the steam-cleaning of the drilling rig itself may be waived with proper approval. Downhole equipment, however, must always be steam-cleaned between borings. Where PVC well casings are to be installed, decontamination is not required if the manufacturer provides these casings in factory-sealed, protective, plastic sleeves (so long as the protective packaging is not compromised until immediately before use).

The steam cleaning area shall be designed to contain decontamination wastes and waste waters and can be a lined excavated pit or a bermed concrete or asphalt pad. For the latter, a floor drain must be provided which is connected to a holding facility. A shallow above-ground tank may be used or a pumping system with discharge to a waste tank may be installed.

In certain cases such an elaborate decontamination pad is not possible. In such cases, a plastic lined gravel bed pad with a collection system may serve as an adequate decontamination area. Alternately, a lined sloped pad with a collection pump installed at the lower end may be permissible. The location of the steam cleaning area shall be onsite in order to minimize potential impacts at certain sites.

Guidance to be used when decontaminating drilling equipment shall include:

- As a general rule, any part of the drilling rig which extends over the borehole, shall be steam cleaned.
- All drilling rods, augers, and any other equipment which will be introduced to the hole shall be steam cleaned.
- The drilling rig, all rods and augers, and any other potentially contaminated equipment shall be decontaminated between each well location to prevent cross contamination of potential hazardous substances.

Prior to leaving at the end of each work day and/or at the completion of the drilling program, drilling rigs and transport vehicles used onsite for personnel or equipment transfer shall be steam cleaned, as practicable. A drilling rig left at the drilling location does not need to be steam cleaned until it is finished drilling at that location.

Error! Bookmark not defined. **5.2 Sampling Equipment**

### 5.2.1 Bailers and Bailing Line

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

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Before the initial sampling and after each successive sampling point, the bailer must be decontaminated. The following steps are to be performed when sampling for organic contaminants. Note: contract-specific requirements may permit alternative procedures.

- Potable water rinse
- Alconox or Liquinox detergent wash
- Scrubbing of the line and bailer with a scrub brush (may be required if the sample point is heavily contaminated with heavy or extremely viscous compounds)
- Potable water rinse
- Rinse with 10 percent nitric acid solution\*
- Deionized water rinse
- Pesticide-grade isopropanol (unless otherwise required)
- Pesticide-grade hexane rinse\*\*
- Copious distilled/Deionized water rinse
- Air dry

If sampling for volatile organic compounds (VOCs) only, the nitric acid, isopropanol, and hexane rinses may be omitted. Only reagent grade or purer solvents are to be used for decontamination. When solvents are used, the bailer must be thoroughly dry before using to acquire the next sample.

In general, specially purchased pre-cleaned disposable sampling equipment is not decontaminated (nor is an equipment rinsate blank collected) so long as the supplier has provided certification of cleanliness. If decontamination is performed on several bailers at once (i.e., in batches), bailers not immediately used may be completely wrapped in aluminum foil (shiny-side toward equipment) and stored for future use. When batch decontamination is performed, one equipment rinsate is generally collected from one of the bailers belonging to the batch before it is used for sampling.

It is recommended that clean, dedicated braided nylon or polypropylene line be employed with each bailer use.

### 5.2.2 Sampling Pumps

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

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

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

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

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

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Whenever possible, dedicated hoses should be used. It is preferable that these types of pumps not be used for sampling, only for purging.

### 5.2.3 Filtering Equipment

On occasion, the sampling plan may require acquisition of filtered groundwater samples. Field-filtering is addressed in SOP SA-6.1 and should be conducted as soon after sample acquisition as possible. To this end, three basic filtration systems are most commonly used: the in-line disposable Teflon filter, the inert gas over-pressure filtration system, and the vacuum filtration system.

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

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

### 5.2.4 Other Sampling Equipment

Field tools such as trowels and mixing bowls are to be decontaminated in the same manner as described above.

## 5.3 Field Analytical Equipment

### 5.3.1 Water Level Indicators

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

- Rinse with potable water
- Rinse with deionized water

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

### 5.3.2 Probes

Probes (e.g., pH or specific-ion electrodes, geophysical probes, or thermometers) which would come in direct contact with the sample, will be decontaminated using the procedures specified above unless manufacturer's instructions indicate otherwise (e.g., dissolved oxygen probes). Probes that contact a volume of groundwater not used for laboratory analyses can be rinsed with deionized water. For probes which make no direct contact, (e.g., OVA equipment) the probe is self-cleaning when exposure to uncontaminated air is allowed and the housing can be wiped clean with paper-towels or cloth wetted with alcohol.

## 5.4 Waste Handling

For the purposes of these procedures, contaminated materials are defined as any byproducts of field activities that are suspected or known to be contaminated with hazardous substances. These byproducts

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include such materials as decontamination solutions, disposable equipment, drilling muds, well-development fluids, and spill-contaminated materials and Personal Protection Equipment (PPE).

The procedures for obtaining permits for investigations of sites containing hazardous substances are not clearly defined at present. In the absence of a clear directive to the contrary by the EPA and the states, it must be assumed that hazardous wastes generated during field activities will require compliance with Federal agency requirements for generation, storage, transportation, or disposal. In addition, there may be state regulations that govern the disposal action. This procedure exclusively describes the technical methods used to control contaminated materials.

The plan documents for site activities must include a description of control procedures for contaminated materials. This planning strategy must assess the type of contamination, estimate the amounts that would be produced, describe containment equipment and procedures, and delineate storage or disposal methods. As a general policy, it is wise to select investigation methods that minimize the generation of contaminated spoils. Handling and disposing of potentially hazardous materials can be dangerous and expensive. Until sample analysis is complete, it is assumed that all produced materials are suspected of contamination from hazardous chemicals and require containment.

## **5.5 Sources of Contaminated Materials and Containment Methods**

### **5.5.1 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. Larger equipment such as backhoes and tractors must be decontaminated in an area provided with an impermeable liner and a liquid collection system. A decontamination area for large equipment could consist of a bermed concrete pad with a floor drain leading to a buried holding tank.

### **5.5.2 Disposable Equipment**

Disposable equipment that could become contaminated during use typically includes PPE, rubber gloves, boots, broken sample containers, and cleaning-wipes. These items are small and can easily be contained in 55-gallon drums with lids. These containers should be closed at the end of each work day and upon project completion to provide secure containment until disposed.

### **5.5.3 Drilling Mud and Well-Development Fluids**

Drilling muds and well-development fluids are materials that may be used in groundwater monitoring well installations. Their proper use could result in the surface accumulation of contaminated liquids and muds that require containment. The volumes of drilling muds and well-development fluids used depend on well diameter and depth, groundwater characteristics, and geologic formations. There are no simple mathematical formulas available for accurately predicting these volumes. It is best to rely on the experience of reputable well drillers familiar with local conditions and the well installation techniques selected. These individuals should be able to estimate the sizes (or number) of containment structures required. Since guesswork is involved, it is recommended that an slight excess of the estimated amount of containers required will be available.

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Drilling muds are mixed and stored in what is commonly referred to as a mud pit. This mud pit consists of a suction section from which drilling mud is withdrawn and pumped through hoses, down the drill pipe to the bit, and back up the hole to the settling section of the mud pit. In the settling section, the mud's velocity is reduced by a screen and several flow-restriction devices, thereby allowing the well cuttings to settle out of the mud/fluid.

The mud pit may be either portable above-ground tanks commonly made of steel (which is preferred) or stationary in-ground pits as depicted in Attachment A. The above-ground tanks have a major advantage over the in-ground pits because the above-ground tanks isolate the natural soils from the contaminated fluids within the drilling system. These tanks are also portable and can usually be cleaned easily.

As the well is drilled, the cuttings that accumulate in the settling section must be removed. This is best done by shoveling them into drums or other similar containers. When the drilling is complete, the contents of the above-ground tank are likewise shoveled or pumped into drums, and the tank is cleaned and made available for its next use.

If in-ground pits are used, they should not extend into the natural water table. They should also be lined with a bentonite-cement mixture followed by a layer of flexible impermeable material such as plastic sheeting. Of course, to maintain its impermeable seal, the lining material used would have to be nonreactive with the wastes. An advantage of the in-ground pits is that well cuttings do not necessarily have to be removed periodically during drilling because the pit can be made deep enough to contain them. Depending on site conditions, the in-ground pit may have to be totally excavated and refilled with uncontaminated natural soils when the drilling operation is complete.

When the above-ground tank or the in-ground pit is used, a reserve tank or pit should be located at the site as a backup system for leaks, spills, and overflows. In either case, surface drainage should be such that any excess fluid could be controlled within the immediate area of the drill site.

The containment procedure for well-development fluids is similar to that for drilling muds. The volume and weight of contaminated fluid will be determined by the method used for development. When a new well is pumped or bailed to produce clear water, substantially less volume and weight of fluid result than when backwashing or high-velocity jetting is used.

#### **5.5.4 Spill-Contaminated Materials**

A spill is always possible when containers of liquids are opened or moved. Contaminated sorbents and soils resulting from spills must be contained. Small quantities of spill-contaminated materials are usually best contained in drums, while larger quantities can be placed in lined pits or in other impermeable structures. In some cases, onsite containment may not be feasible and immediate transport to an approved disposal site will be required.

#### **5.6 Disposal of Contaminated Materials**

Actual disposal techniques for contaminated materials are the same as those for any hazardous substance, that is, incineration, landfilling, treatment, and so on. The problem centers around the assignment of responsibility for disposal. The responsibility must be determined and agreed upon by all involved parties before the field work starts. If the site owner or manager was involved in activities that precipitated the investigation, it seems reasonable to encourage his acceptance of the disposal obligation. In instances where a responsible party cannot be identified, this responsibility may fall on the public agency or private organization investigating the site.

Another consideration in selecting disposal methods for contaminated materials is whether the disposal can be incorporated into subsequent site cleanup activities. For example, if construction of a suitable

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onsite disposal structure is expected, contaminated materials generated during the investigation should be stored at the site for disposal with other site materials. In this case, the initial containment structures should be evaluated for use as long-term storage structures. Also, other site conditions such as drainage control, security, and soil type must be considered so that proper storage is provided. If onsite storage is expected, then the containment structures should be specifically designed for that purpose.

#### 6.0 REFERENCES

Brown & Root Environmental: Standard Operating Procedure No. 4.33, Control of Contaminated Material.

ATTACHMENT A

TWO TYPES OF MUD PITS USED IN WELL DRILLING

