Sampling and Analysis Plan

Remedial Investigation/Feasibility Study
Van Der Horst Ground Water Plume Site
Terrell, Kaufman County, Texas

Remedial Action Contract 2 Full Service
Contract: EP-W-06-004
Task Order: 0063-RICO-A6H1

Prepared for

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CONTENTS

Page

APPENDICES

Appendix A:	Standard Operating Procedures
Appendix B:	Field Forms

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS AND ABBREVIATIONS

95UCLM	95% Upper Confidence Limit of the Mean
bgs	Below ground surface
C	Celsius
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
COPC	Contaminant of potential concern
CRDL	Contract-required Detection Limit
CRQL	Contract-required Quantitation Limit
CSM	Conceptual Site Model
DCE	1,2-Dichloroethene
DESR	Data Evaluation Summary Report
DQA	Data quality assessment
DQO	Data quality objective
EA	EA Engineering, Science, and Technology, Inc.
EDD	Electronic data deliverable
EPA	U.S. Environmental Protection Agency
ERA	Ecological risk assessment
FS	Feasibility Study
FSP	Field Sampling Plan
GPS	Global positioning system
H_o	Null hypothesis
H_a	Alternative hypothesis
HHRA	Human health risk assessment
HSP	Health and Safety Plan
IDW	Investigation-derived waste
LCS	Laboratory control spike
MCL	Maximum contaminant level
MIP	Membrane Interface Probe
MD	Matrix duplicate
MDL	Method detection limit
MNA	Monitored natural attenuation
MS	Matrix spike
MSD	Matrix spike duplicate
ORNL	Oak Ridge National Laboratory
OSHA	Occupational Safety and Health Administration
PARCC	Precision, accuracy, representativeness, completeness, and comparability
ppb	Part(s) per billion
PSQ	Principal study question
PWS	Public water supply

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
RAC	Remedial Action Contract
RAGS	Risk Assessment Guidance for Superfund
RI	Remedial Investigation
ROD	Record of Decision
RPD	Relative percent difference
RSL	Regional Screening Level
SAP	Sampling and Analysis Plan
SHSO	Site Health and Safety Officer
Site	Van Der Horst Ground Water Plume Superfund Site
SOP	Standard operating procedure
SOW	Statement of Work
SVOC	Semivolatile organic compound
TAL	Target Analyte List
TCE	Trichloroethene
TCEQ	Texas Commission on Environmental Quality
TCLP	Toxicity Characteristic Leaching Procedure
TOC	Top of casing
TOM	Task Order Monitor
TXDOT	Texas Department of Transportation
ug/L	Micrograms per liter
VC	Vinyl Chloride
VOC	Volatile organic compound

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1. PROJECT DESCRIPTION AND MANAGEMENT

EA Engineering, Science, and Technology, Inc. (EA) has been authorized by the U.S. Environmental Protection Agency (EPA), under Remedial Action Contract (RAC) Number EP-W-06-004, Task Order 0063-RICO-A6H1, to conduct a Remedial Investigation/Feasibility Study (RI/FS) at the Van Der Horst Ground Water Plume Superfund Site (Site). EA has prepared this Sampling and Analysis Plan (SAP) in accordance with: (1) specifications provided in the EPA Statement of Work (SOW), dated 19 August 2010 (EPA 2010a); and (2) the EPA-approved EA Work Plan (Revision 00), dated 2 September 2010 (EA 2010a).

This SAP is a combination Quality Assurance Project Plan (QAPP) and Field Sampling Plan (FSP). It details the field sampling schedule, sample collection procedures, and analytical methods required to collect sufficient data to perform a RI/FS for the Site. Combining the QAPP and FSP into the SAP allows a streamlining of the planning process, while ensuring that data collected is of sufficient quality for its intended use.

This SAP was prepared in conjunction with the Health and Safety Plan (HSP) (EA 2010b), which together, present the overall approach for implementing the RI field program. The Health and Safety Plan (HSP) (EA 2010b) specifies employee training, protective equipment, personal air monitoring procedures, medical surveillance requirements, standard operating procedures, and contingency planning procedures.

This SAP was prepared in accordance with EA’s Quality Management Plan (EA 2005a) and meets requirements set forth in *EPA Requirements for Quality Assurance Project Plans for Environmental Data Operation (QA/R-5)* (EPA 2001a) and *Guidance for Quality Assurance Project Plans (QA/G-5)* (EPA 2002a).

This SAP describes procedures to assure that the project-specific data quality objectives (DQOs) are met, and that the quality of data (represented by precision, accuracy, completeness, comparability, representativeness, and sensitivity) is known and documented. The SAP presents the project description, project organization and responsibilities, and quality assurance (QA) objectives associated with the sampling and analytical services to be provided in support of the RI/FS. Table 1 demonstrates how this SAP complies with elements of a QAPP currently required by EPA guidance (EPA 2001a, 2002a).

TABLE 1 ELEMENTS OF EPA QA/R-5 IN RELATION TO THIS SAP

EPA QA/R-5 QAPP Element	EA SAP (QTRAK # 08-056)
A1 Title and Approval Sheet	Title and Approval Sheet
A2 Table of Contents	Table of Contents
A3 Distribution List	Distribution List
A4 Project/Task Organization	1.0 Project Description and Management
A5 Problem Definition/Background	1.1 Problem Definition and Background
A6 Project/Task Description	1.2 Description of Project Objectives and Tasks
A7 Quality Objectives and Criteria	1.3 Data Quality Objectives

EPA QA/R-5 QAPP Element	EA SAP (QTRAK # 08-056)
	1.4 Quality Assurance Objectives for Measurement Data
A8 Special Training/Certification	1.5 Special Training and Certification
A9 Documents and Records	1.6 Documents and Records
B1 Sampling Process Design	2.1 Sampling Process Design 2.2 Consent for Property Access
B2 Sampling Methods	2.3 Sampling Methodology 2.4 Sample Processing 2.7 Sample Designation
B3 Sample Handling and Custody	2.8 Sample Container, Volume, Preservation, and Holding Time Requirements 2.9 Sample Handling and Custody
B4 Analytical Methods	2.10 Analytical Methods Requirements
B5 Quality Control	2.11 Quality Control Requirements
B6 Instrument/Equipment Testing, Inspection, and Maintenance	2.11.4 Instrument and Equipment Testing, Inspection, and Maintenance Requirements
B7 Instrument/Equipment Calibration and Frequency	2.12 Instrument Calibration and Frequency
B8 Inspection/Acceptance of Supplies and Consumables	2.13 Requirements for Inspection and Acceptance of Supplies and Consumables
B9 Non-direct Measurements	2.14 Data Acquisition Requirements (Non-Direct Measurements)
B10 Data Management	2.15 Data Management
C1 Assessment and Response Actions	3.1 Assessment and Response Actions
C2 Reports to Management	3.2 Reports to Management
D1 Data Review, Verification, and Validation	4.1 Data Review and Reduction Requirements
D2 Validation and Verification Methods	4.2 Validation and Verification Methods
D3 Reconciliation with User Requirements	4.3 Reconciliation with Data Quality Objectives

The overall QA objectives are as follows:

- Attain quality control (QC) requirements for analyses specified in this SAP;
- Obtain data of known quality to support goals set forth for this project; and
- Document aspects of the quality program including performance of the work and required changes to work at the Site.

The EPA Region 6 Task Order Monitor (TOM), Mr. Philip Allen, is responsible for the project oversight. The Project Officer for EPA Region 6 is Ms. Rena McClurg. The Contracting Officer for EPA Region 6 is Mr. Michael Pheeny. EA will perform tasks under this Task Order in accordance with this SAP. The EA Project Manager, Mr. Doug McReynolds, is responsible for implementing activities required by this Task Order; the alternate EA project manager is Ms. Kim Wallace-Wymore. Figure 1 presents the proposed project organization for this Task Order.

1.1 PROBLEM DEFINITION AND BACKGROUND

This section describes the following:

- Purpose of the investigation and sampling events (Section 1.1.1); and
- Site background and description (Section 1.1.2).

1.1.1 Purpose of the Investigation and Sampling Events

The purpose of this investigation is to collect ground water, surface soils, subsurface soils, sediment, and other ancillary data to support a RI/FS. The RI/FS process will allow the EPA to select a remedy that eliminates, reduces, or controls risks to human health and the environment. The goal is to develop the minimum amount of data necessary to support the selection of an approach for the Site's investigation, and then to use the data to support a Record of Decision (ROD). The EPA RI/FS SOW (EPA 2010a) and EPA approved Work Plan (EA 2010a) sets forth the framework and requirements for this effort.

1.1.2 Site Background and Description

The Site is located at 410 and 419 East Grove Street in Terrell, Kaufman County, Texas (Figure 2). The facility is located in a mixed industrial/residential area on the southeast boundary of the City of Terrell, Texas. The Site is located on properties that encompass approximately four acres. The facility is an inactive hard-chrome (tri- and hexavalent chromium) and iron electroplating facility that began operations in the 1950s. Finished products associated with these plating operations included pipeline cylinders for the transportation of natural gas and cylinder bores for large diesel engines such as railroad locomotive engines. As part of the plating operations, the facility generated spent kerosene, wastewater treatment sludge, and chromium-contaminated wastewater. The main building where electroplating activities occurred is 46,368 square feet and is located at 419 East Grove Street. The building has significant structural damage, and portions of the roof sag, allowing rainwater to leak directly into the facility. Rain has contributed to the deterioration of the facility including the erosion of drums and vats within the building. Another building, approximately 29,000 square feet in size, is located south of the main building at 410 East Grove Street. This building housed the wastewater treatment area for the facility. Plating operations ceased at the facility on 26 December 2006, and the facility was abandoned in April 2007.

The nearest residences are located in the Stallings Addition housing complex, less than one mile southeast of the facility. Two churches are located within one mile of the Site. The Site is approximately 300 yards from downtown Terrell, Texas. Residents ranging from small children to the elderly have been seen walking directly next to the facility on adjacent public sidewalks. Before EPA's assessment activities began in 2008, the facility was not fenced and was accessible to the public.

The Site features generally flat topography, and the surface water runoff sheet flows overland to the municipal storm water drainage system approximately 300 feet east to Frazier Creek. Frazier Creek flows for approximately 2,000 feet before joining Kings Creek, which then eventually empties into Cedar Creek Reservoir.

The facility contained four sources of contamination which are described in this summary: the settling lagoons, the underground sumps, the vats, and the drums (Figure 3). These sources contained hazardous substances that have released into the adjacent surface water of Kings Creek via a surface water transportation pathway. However, much of the Site has been remediated during a Removal Action conducted by EPA.

The Van Der Horst USA Corporation facility has a long history of violations and environmental concerns dating back to the 1950s. In 1968, the Texas Water Quality Board (TWQB) file information indicated that the facility was discharging an estimated 43,200 gallons of wastewater per day directly to Kings Creek via a 16-inch pipe. The discharge went into a roadside ditch located on the side of the wastewater treatment plant. Texas Parks and Wildlife documentation indicated chromium levels as high as 353,600 micrograms per liter (ug/L) in the discharging wastewater. A public hearing by the TWQB subsequently set limits on the discharge of hexavalent chromium to 1000 ug/L and trivalent chromium to 5000 ug/L. To meet TWQB discharge limits, the facility requested to place the waste in unlined lagoons on their property. At that time, the facility’s request was denied. In July 1969, file documentation shows the City of Terrell was receiving all Van Der Horst USA Corporation wastewater; however, in September 1969, the TWQB indicated the City of Terrell would not accept any further wastewater from the facility unless additionally treated. The previously noted discharge into the ditch was still ongoing.

In December 1969, the facility constructed two settling lagoons on the east side of the former wastewater treatment plant, and the lagoons operated into the 1980s. In May 1984, closure of two surface lagoons or impoundments at the site was initiated, and a closure plan was approved, but closure was not implemented. The District 4 Office of the Texas Department of Water Resources (TDWR) submitted an enforcement request against Van Der Horst USA Corporation in October 1984 for continuing to operate the settling lagoons without financial assurance or ground water monitoring. As a result, closure certification was completed in September 1986 following removal of soils from both lagoons. On 6 November 1985, soil sample results, collected by TDWR investigators, revealed highly elevated levels of chromium in the soil, with results as high as 2,250 milligrams per kilogram (mg/kg).

On 28 May 2008, a small fire occurred in the main building at the Van Der Horst USA Corporation facility. The fire was started by a torch used to cut material to be sold for scrap. The water used to extinguish the fire was reportedly contained in the basement sump beneath the facility equipment floor, and no firewater runoff reportedly occurred. The Texas Commission on Environmental Quality (TCEQ) responded to the fire incident, and upon further investigation, requested the EPA to assist in assessing the amount of hazardous waste located on the site.

Prior to closure and abandonment, much of the machining and plating equipment had not been removed. A large quantity of liquid waste remained onsite in two underground sumps, 27 various-sized vats, and four-hundred and fifty 55-gallon drums. During EPA and TCEQ assessment and removal activities conducted at the Van Der Horst USA Corporation facility in May and June 2008, these waste sources underwent hazardous categorization, were sampled, and were separated into wastestreams. Results from the hazardous categorization and sampling indicate the presence of strong acids and bases. Also, inorganic constituents such as chromium, hexavalent chromium, copper, and lead were detected as well as volatile organic compounds such as toluene, xylene, butylbenzene, acetone, and trimethylbenzene.

In June 2008, EPA removed 140,000 gallons of chromium rinse water from the facility sump located in the basement of the main onsite building. Analysis of the liquid removed showed total chromium as high as 307,000 ug/L, trivalent chromium as high as 119,000 ug/L, and hexavalent chromium as high as 188,000 ug/L.

On 23 June 2008, EPA completed stabilization at the Van Der Horst USA Corporation facility. Stabilization included construction of a temporary earthen berm around the facility to minimize migration of contamination to the sewer and overland drainage. Fencing was also erected around the facility to prevent access to the facility. The 27 vats were covered with thick plastic sheeting, and the drums were staged into wastestreams prior to removal.

1.2 DESCRIPTION OF PROJECT OBJECTIVES AND TASKS

This section describes the project objectives and tasks for this SAP.

1.2.1 Project Objectives

The primary objectives of the RI/FS are to determine the nature and extent of contamination and to gather sufficient information so that the EPA can select a remedy that eliminates, reduces, or controls risks to human health. Specifically, the RI/FS involves multimedia environmental sampling of the Site. In order to meet these objectives, the following activities will be implemented:

- **Install Monitoring Wells** - EA estimates that monitoring wells will be installed at approximately 15 locations during Phase I activities. EA estimates that monitoring wells will be installed at approximately 5 locations during Phase II activities. EA may install the 20 monitoring wells during one mobilization if directed by EPA. Samples may be utilized for geotechnical testing.

- **Ground Water Data Collection/Aquifer Testing** - EA will collect continuous water monitoring data using data-logger probes with a pressure transducer, conductivity, and temperature sensor during a 24-hour pump or slug test to be conducted during Phase II activities.

- **Ground Water Sampling** - EA will collect samples from 16 existing wells and up to 20 newly installed monitoring wells during Phase I activities. EA will collect samples from up to 20 newly installed monitoring wells and approximately 25% of the existing wells during Phase II activities. Samples will be analyzed for Target Analyte List (TAL) metals, hexavalent chromium, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), monitored natural attenuation (MNA) parameters due to the presence of chlorinated solvents, or other parameters, as directed by EPA.

- **Passive Soil Gas Sampling** - EA will conduct passive soil gas sampling at up to 40 locations during Phase II activities (this effort may also be conducted during a previous or subsequent phase). The samples will be analyzed for VOCs.

- **Vadose Zone Soil Sampling/Analysis** - Soil samples will be collected in up to 20 locations (e.g., 10 to the north and 10 to the south of East Grove Street) to characterize the vadose zone impacts. Although significant removal action has occurred at the Site, it is uncertain whether residual contamination exists in the vadose zone, which extends 6 to 9 feet below ground surface (bgs). Also, soil samples may be collected during monitoring well installation as directed by EPA. EA will collect soil samples using direct-push methodology or conventional borings. Samples will be analyzed for total metals, hexavalent chromium, VOCs, SVOCs, or other parameters, as directed by EPA. Samples may be utilized for geotechnical testing.

- **Sediment Sampling** – EA will collect sediment samples in up to 40 locations. The following are estimated sample groups:
    - 10 samples along each of the two storm water transport pathways (ditch/culverts) that lead from the Site towards Frazier Creek; these surface water transport pathways are west of Garner Street. Samples will be analyzed for TAL metals and hexavalent chromium. Surface water samples will be collected if available;
    - 10 samples within Frazier Creek (west of Garner Street), because it appears that previous samples were not analyzed for TAL metals and hexavalent chromium and surface water samples may have not been collected. Surface water samples will be collected if available; and
    - 10 background samples to evaluate anthropogenic contributions to the waterways. Background samples will also assist in risk management decisions as necessary. The samples will be analyzed for TAL metals and hexavalent chromium.

1.2.2 Project Tasks

To complete the Site RI/FS site activities, EA will perform the following tasks (with subtasks), which are generally outlined in the Task Order SOW (EPA 2010a) and detailed in Sections 2, 3, and 4 of this SAP:

- Project planning and support;
- Field investigation/data acquisition;
- Sample analysis;
- Analytical support and data validation;
- Data evaluation;
- Risk assessment;
- RI Report preparation;
- Remedial alternatives screening and evaluation;
- FS Report preparation; and
- Post-RI/FS support.

EA's field activities will be conducted in accordance with this SAP to ensure proper sample management, including accurate chain-of-custody procedures for sample tracking, protective sample packaging techniques, and proper sample preservation techniques, as well as EA's site-specific HSP (EA 2010b). Sample management will be conducted using the EPA-approved Forms II Lite software.

EA will perform investigation derived waste (IDW) characterization and disposal in accordance with local, State, and Federal regulations; IDW will be subject to disposal, as appropriate.

1.3 DATA QUALITY OBJECTIVES

The following sections present the DQOs for this project. Much of the information used to develop DQOs was obtained from the SOW issued by the EPA (2010a) and the EPA-approved Work Plan (EA 2010a).

This DQO assessment follows EPA's 7-step DQO process (Table 2), which is outlined in *Guidance on Systematic Planning Using the Data Quality Objectives Process (QA/G-4)* (EPA 2006a) and *Systematic Planning: A Case Study for Hazardous Waste Site Investigations (QA/CS-1)* (EPA 2006b).

Additional information is referenced, as appropriate, in the following sections:

- Section 1.3.1 Purpose and Goal;
- Section 1.3.2 Step 1 – State the Problem;
- Section 1.3.3 Step 2 – Identify the Goal of the Study;
- Section 1.3.4 Step 3 – Identify Information Inputs;
- Section 1.3.5 Step 4 – Define the Boundaries of the Study;
- Section 1.3.6 Step 5 – Develop the Analytical Approach;
- Section 1.3.7 Step 6 – Specify the Performance or Acceptance Criteria; and
- Section 1.3.8 Step 7 – Develop the Plan for Obtaining Data.

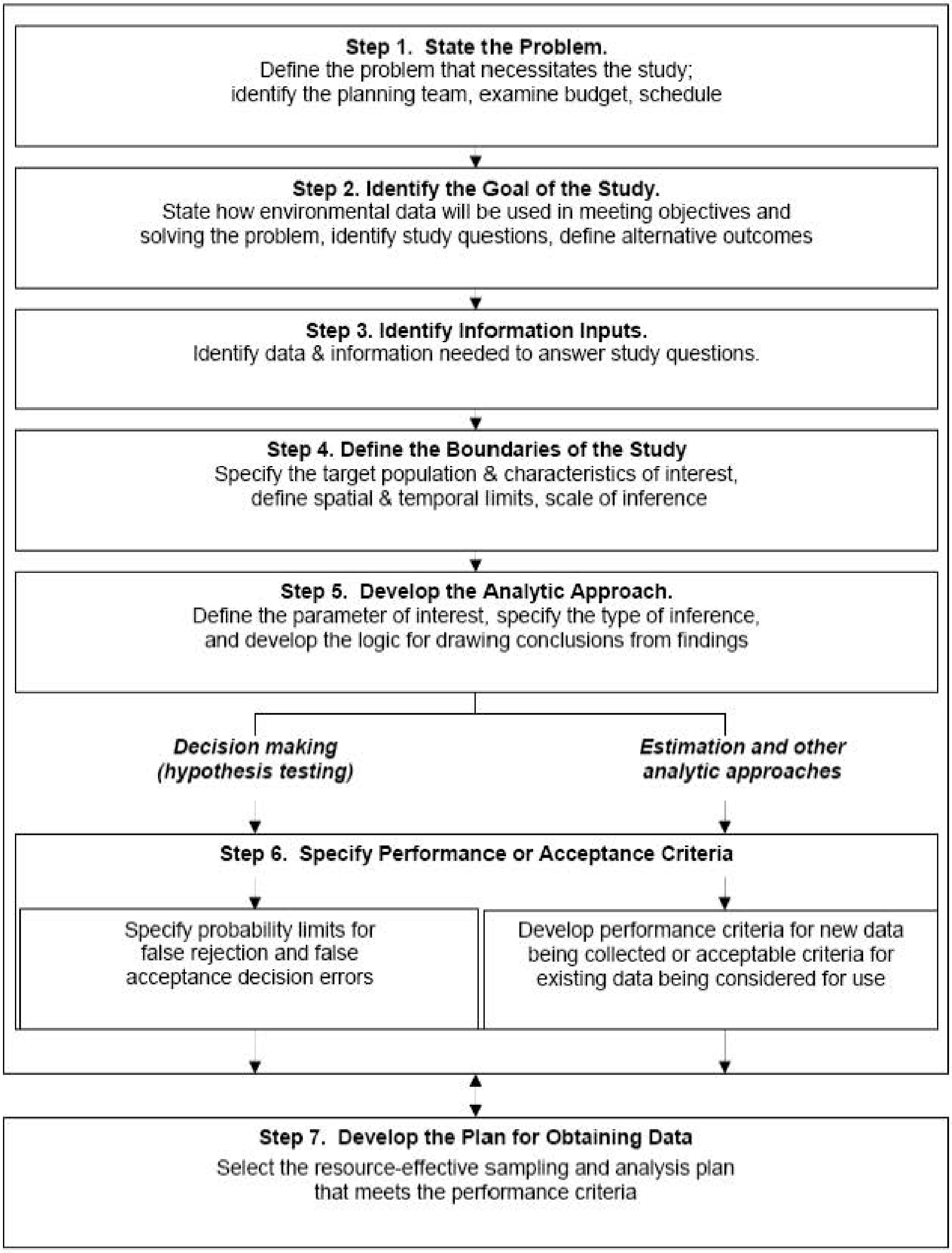
1.3.1 Purpose and Goal

The purpose of defining the DQOs for the Site is to support decision making by applying a systematic planning and statistical hypothesis testing methodology to decide between alternatives. The goal was to develop an analytic approach and data collection strategy that was effective and efficient.

1.3.2 Step 1 – State the Problem

The first step in systematic planning process, and therefore the DQO process, is to define the problem that has initiated the study. As environmental problems are often complex combinations of technical, economic, social, and political issues, it is critical to the success of the process to separate each problem, define it completely, and express it in an uncomplicated format.

TABLE 2 DATA QUALITY OBJECTIVE PROCESS



Step 1. State the Problem.
Define the problem that necessitates the study;
identify the planning team, examine budget, schedule

Step 2. Identify the Goal of the Study.
State how environmental data will be used in meeting objectives and
solving the problem, identify study questions, define alternative outcomes

Step 3. Identify Information Inputs.
Identify data & information needed to answer study questions.

Step 4. Define the Boundaries of the Study
Specify the target population & characteristics of interest,
define spatial & temporal limits, scale of inference

Step 5. Develop the Analytic Approach.
Define the parameter of interest, specify the type of inference,
and develop the logic for drawing conclusions from findings

Decision making
(hypothesis testing)

Estimation and other
analytic approaches

Step 6. Specify Performance or Acceptance Criteria

Specify probability limits for
false rejection and false
acceptance decision errors

Develop performance criteria for new data
being collected or acceptable criteria for
existing data being considered for use

Step 7. Develop the Plan for Obtaining Data
Select the resource-effective sampling and analysis plan
that meets the performance criteria

The most important activities in DQO Step 1 are as follows:

- Give a concise description of the problem;
- Identify leader and members of the planning team;
- Develop a Conceptual Site Model (CSM) of the environmental hazard to be investigated; and
- Determine resources (i.e., budget, personnel, and schedule).

1.3.2.1 Problem Description

Based upon previous site investigations by EPA and TCEQ, shallow ground water, vadose zone soil, and sediment in the vicinity of the Site are impacted with chromium/metals. While preparing for highway construction activities, the Texas Department of Transportation (TXDOT) also identified a chlorinated solvent ground water plume (i.e. TCE, DCE, and vinyl chloride) to the north-northeast of the Site across the railroad tracks. Potential unacceptable risk to human health or ecological receptors as a result of exposure to contaminants of potential concern (COPCs) in site-related media (i.e., air, soil, sediment, surface water, or ground water) has not been estimated.

1.3.2.2 Planning Team Members and Stakeholders

A proven effective approach to formulating a problem and establishing a plan for obtaining information that is necessary to resolve the problem is to involve a team of experts and stakeholders that represent a diverse, multidisciplinary background. Such a team provides the ability to develop a concise description of complex problems, and multifaceted experience and awareness of potential data uses. Planning team members (including the leader) and stakeholders are presented below.

Planning Team Members

- Philip Allen, EPA TOM
- Buddy Henderson, TCEQ Project Manager

Stakeholders

- EPA Region 6 Superfund Division Management
- EPA Headquarters
- TCEQ Remediation Division
- TXDOT
- Other interested parties

If additional planning team members and/or stakeholders are identified as the RI/FS progresses, they will be incorporated into the decision-making process as appropriate.

1.3.2.3 Conceptual Site Model

It is critical to carefully develop an accurate CSM of the environmental problem, as this model will serve as the basis for subsequent inputs and decisions. A summary of the nature and extent of evaluation for chromium and chlorinated solvents is presented below.

Chromium and Other Plating Metals

Shallow ground water, vadose zone soil, and sediment in the vicinity of the Site are impacted with chromium/metals. A release to the ground water pathway has been documented based on the results of ground water samples collected by TCEQ from two onsite monitoring wells and the relatively shallow depth to groundwater. For example, hexavalent chromium was detected in MW-4 at concentration of 200 µg/L; the EPA Tap Water Regional Screening Level (RSL) for hexavalent chromium is 0.043 µg/L. Total chromium was detected at concentrations ranging from 29 µg/L to 399 µg/L; the EPA Tap Water Regional Screening Levels for chromium is 55,000 µg/L.

A release to the surface water transport pathway has been documented based on the results of the EPA sampling efforts and samples collected by TCEQ. EPA sediment samples detected chromium at concentrations of 63.3 mg/kg and 100 mg/kg, which are greater than three times the concentration reported in the background samples. Background chromium was reported at concentrations of 15.2 mg/kg and 16.8 mg/kg, respectively.

Impact to vadose zone soil has been documented based on soil samples collected during the EPA Removal Assessment in March 2009. Soil samples were collected from 0 to 60 inches bgs at the two former lagoon locations. Three samples collected from 24 to 42 inches bgs and four samples collected from 24 to 48 inches bgs contained chromium concentrations above the EPA industrial RSL of 5.6 mg/kg for hexavalent chromium. The highest total chromium concentrations included concentrations of 1,560 mg/kg and 9,180 mg/kg.

Chlorinated Solvents

TXDOT identified a chlorinated solvent ground water plume (i.e. TCE, DCE, and vinyl chloride) to the north-northeast of the Site across the railroad tracks while preparing for highway construction activities in February 2009. Although concentrations in a single well exceeded the EPA Tap Water RSLs, the source and extent of contamination are unknown and will be evaluated during the field investigation.

Potential unacceptable risk to human health or ecological receptors as a result of exposure to COPCs in site-related media (i.e., air, soil, sediment, surface water, or ground water) has not been estimated.

1.3.2.4 Determine Resources

Resources should be identified by the planning team so that constraints (e.g., budget, time, etc.) associated with collecting/evaluating data can be anticipated during the project life cycle. To assist in this evaluation, the DQO process (e.g., developing performance or acceptance criteria) and the SAP (i.e., for collecting and analyzing samples, and interpreting and assessing the collected data) should be completed.

EPA has tasked EA to perform the investigation and prepare the deliverables required for the Site RI/FS. EA will utilize the services of the EPA's Region 6 Laboratory, EPA Contract Laboratory Program (CLP), TCEQ Houston Laboratory, or a private laboratory depending on the needs of the RI/FS and the availability of the laboratory's services.

The EPA will perform a review of each required deliverable and provide comments as necessary. EPA will also solicit comments from other planning team members or stakeholders as appropriate. Additional details pertaining to the schedule of events and deliverables necessary to meet the RI/FS milestones are provided in the RI/FS Work Plan (EA 2010a).

1.3.3 Step 2 – Identify the Goal of the Study

Step 2 of the DQO process involves identifying the key questions that the study attempts to address, along with alternative actions or outcomes that may result based on the answers to these key questions. These two items are combined to develop a decision statement, which is critical for defining decision performance criteria later in Step 6 of the DQO process.

The most important activities in DQO Step 2 are as follows:

- Identify principal study question(s);
- Consider alternative actions that can occur upon answering the question(s); and
- Develop decision statement(s) and organize multiple decisions.

1.3.3.1 Principal Study Question

The principal study question(s) (PSQ) define the question(s) to be answered by the human health risk assessment (HHRA), ecological risk assessment (ERA), and RI. The PSQs are as follows:

> ***What are the nature and extent of air, soil, sediment, surface water, and ground water contamination?***
>
> ***What are the migration pathways for these contaminants to be transported?***
>
> ***What is the potential risk to human health and ecological receptors from exposure to Site related COPCs?***

1.3.3.2 Alternative Actions

The alternative actions provide PSQ alternatives in the FS, as follows. Potential alternative actions, which will be evaluated in the FS, include, but are not limited to, the following:

- Remediate the source areas;

- Mitigate migration pathways;

- Prevent exposure to COPCs in ground water by installing (point-of-use) filtration systems; and

- Address other migration/exposure pathways impacting receptors by employing engineering or institutional controls.

1.3.3.3 Decision Statement

For decision-making problems, the PSQs and alternative actions are combined to develop decision statements, which are critical for defining decision performance criteria later in DQO Step 6.

The decision statements are as follows:

> ***Determine the nature and extent of air, soil, sediment, surface water, and ground water contamination.***
>
> ***Determine the migration pathways for these contaminants to be transported.***
>
> ***Determine if exposure to Site-related COPCs pose a potential unacceptable risk to human health and ecological receptors.***

1.3.4 Step 3 – Identify Information Inputs

Step 3 of the DQO process determines the types and sources of information needed to resolve the following: (1) the decision statement or produce the desired estimates; (2) whether new data collection is necessary; (3) the information basis the planning team will need for establishing appropriate analysis approaches and performance or acceptance criteria; and (4) whether appropriate sampling and analysis methodology exists to properly measure environmental characteristics for addressing the problem.

The most important activities in DQO Step 3 are as follows:

- Identify types and sources of information needed to resolve decisions or produce estimates;

- Identify the basis of information that will guide or support choices to be made in later steps of the DQO process; and

- Select appropriate sampling and analysis methods for generating the information.

The EPA RI/FS SOW (EPA 2010a) and EPA approved Work Plan (EA 2010a) set forth the framework and requirements for this effort.

1.3.4.1 Necessary Information and Sources

A variety of sources and types of information form the basis for resolving the decision statements. The following information and sources are necessary to resolve this step of the DQO process.

The decision statements are supported by the following:

Determine the nature and extent of air, soil, sediment, surface water, and ground water contamination.

- An evaluation of previous investigation data was conducted; these data shaped the field investigation by narrowing or broadening the data needs. These data will also be subject to further evaluation in the RI.

- Additional soil, sediment, and ground water data will be collected to augment the historical dataset.

- Geologic and hydrogeologic information (e.g., soil borings, new monitoring wells, etc.) coupled with physical/chemical property data will be collected to evaluate the impacts to vadose zone soil and the underlying ground water.

Determine the migration pathways for these contaminants to be transported.

- An evaluation of the ground water transports will be conducted to aid in understanding the transport of contamination.

- An evaluation of vadose zone source material leaching to ground water will evaluated by the collection of vadose zone source area data.

- An evaluation of vadose zone source material vapor migration to indoor air will evaluated by the collection of vadose zone passive soil gas and air data as necessary.

Determine if exposure to Site related COPCs pose a potential unacceptable risk to human health and ecological receptors.

- The area in the vicinity of the source areas will be evaluated for potential human health and ecological exposure pathways.

1.3.4.2 Basis of Information

The basis of information will guide or support choices to be made in later steps of the DQO process.

The basis of information is supported by the following:

Determine the nature and extent of soil, sediment, surface water, and ground water contamination.

- Biased or judgmental sample locations will be based on evaluation of historical data, photographs, or visual cues.

- An evaluation of previous investigation data will utilize EPA guidance documents including, but not limited to the following: Guidance for Data Usability in Risk Assessment (EPA 1992); Data Quality Assessment - Statistical Methods for Practitioners (EPA 2006d); Guidance for Data Quality Assessment (EPA 2000); Guidance on Systematic Planning Using the Data Quality Objectives Process (EPA 2006a).

- Geologic and hydrogeologic information (e.g., soil borings, new monitoring wells, etc.) coupled with physical/chemical property data will be collected to evaluate the impacts to Site media.

Determine the migration pathways for these contaminants to be transported.

- The Final Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (EPA 1988) describes the process for evaluating migration pathways.

Determine if exposure to Site related COPCs pose a potential unacceptable risk to human health and ecological receptors.

- A HHRA will be conducted in accordance with the EPA's guidance which includes, but is not limited to, the following:

    - Risk Assessment Guidance for Superfund (RAGS), Volume I: Human Health Evaluation Manual (EPA 1989);

    - RAGS for Superfund Volume I: Human Health Evaluation Manual. Supplemental Guidance: Standard Default Exposure Factors (EPA 1991);

    - RAGS, Volume I, Human Health Evaluation Manual, Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments (EPA 2001b);

    - Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites (EPA 2002b);

    - Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Interim Guidance (EPA 2002c); and

    - RAGS, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) (EPA 2004).

- A Screening Level ERA will be conducted in accordance with the EPA's guidance which includes, but is not limited to, the following:

    - RAGS, Volume II: Environmental Evaluation Manual (EPA 1997a); and

- Ecological RAGS: Process for Designing and Conducting Ecological Risk Assessments (EPA 1997b, 1999).

1.3.4.3 Sampling and Analysis Methods

An extensive field investigation has been proposed to collect air, soil, sediment, surface water, and ground water data. Details pertaining to this effort are contained in Section 2.0 and will not be repeated here for brevity.

1.3.5 Step 4 – Define the Boundaries of the Study

In Step 4 of the DQO process, the target population of interest and spatial/temporal features pertinent for decision making should be identified. The most important activities in DQO Step 4 are as follows:

- Define the target population of interest and
- Specify temporal or spatial boundaries and other practical constraints associated with sample/data collection.

1.3.5.1 Target Population

There are two potential source areas that are subject to investigation for the Site: (1) the former Van Der Horst facility with chromium/metals impacts; and (2) the chlorinated solvent ground water plume to the north-northeast of the former Van Der Horst facility. Vadose zone soil, sediment, surface water, air, and ground water are the focus of the investigation.

The target population consists of soil, ground water, sediment, surface water, and air in proximity to and downgradient of the vadose zone source areas. The following descriptions of the target populations are segregated by media below.

Generally soil is not considered mobile because ground cover or vegetation often precludes migration. However, some portions of the impacted vadose zone source areas may be subject to leaching and storm water migration. Although these factors can lead to a slight temporal aspect to characterization, soil is not considered to be mobile enough to have a significant temporal aspect. The distribution of soil is from the surface to one of the following: the bottom of impacted soil, native soil below source material, the ground water saturated zone, or to 10-feet bgs, which is generally considered the deepest depth interval for risk assessment.

Ground water is generally found at approximately 6 to 9-feet bgs. The mobility and migration of ground water is unknown because it is dependent on preferential pathways, the type of aquifer (e.g., alluvial), and other site-specific parameters. Nevertheless, ground water is likely to have a temporal aspect related to season, when infiltration, water usage, or other factors vary.

Air concentrations in vadose zone soil are affected by humidity, soil concentrations, topography, soil surface conditions, soil moisture content, wind speed, wind direction, and various other factors. Therefore, air concentrations are expected to have a high temporal aspect.

Sediment and surface water concentrations are subject to mobilization through surface water and storm water transport pathways. For example, there may be significant sediment and surface water transport to and within Kings Creek. Transport is affected by rainfall, media concentrations, topography, media characteristics, and various other factors. Therefore, sediment and surface water concentrations are expected to have a temporal aspect.

1.3.5.2 Temporal or Spatial Boundaries

The Van Der Horst USA Corporation Site is located at 410 and 419 East Grove Street in Terrell, Kaufman County, Texas. The facility is located in a mixed industrial/residential area on the southeast boundary of the City of Terrell, Texas. The property on which the facility is located is approximately four acres in size.

The horizontal study boundary for the Site RI/FS includes the two potential source areas that are subject to investigation for the Site: (1) the former Van Der Horst facility with chromium/metals impacts; and (2) the chlorinated solvent ground water plume to the north-northeast of the former Van Der Horst facility. It is possible that additional areas will be discovered pending further investigation and additional information regarding historical use, presence of contaminants, potential reuse, available receptors, etc.

The ground water is shallow (e.g., 6 to 9-feet bgs) within the Nacatoch formation in the vicinity of the Site. This ground water may be utilized for watering lawns, washing vehicles, and is considered a potential drinking source by the TCEQ.

1.3.6 Step 5 – Develop the Analytical Approach

Step 5 of the DQO process involves developing an analytic approach that will guide how to analyze the study results and draw conclusions from the data. It is the intention of this step to integrate the outputs from the previous four steps with the parameters developed in this step.

The most important activities in DQO Step 5 are as follows:

- Specify the appropriate population parameters for making decisions and
- Choose a workable action level and generate an “If … then … else” decision rule which involves it.

1.3.6.1 Population Parameters

The population parameter is defined as the value used in the decision statement to evaluate a decision point. The population parameter will be used as an exposure point concentration in the HHRA and Screening Level ERA. A population parameter will be determined for each chemical (e.g., hexavalent chromium); in each exposure area (e.g., Kings Creek); for each sample group (e.g., sediment from 0 to 0.5-feet bgs). In this example, the population is hexavalent chromium in Kings Creek sediment from 0 to 0.5-feet bgs. The population parameter for site comparisons will be the 95% Upper Confidence Limit of the Mean (95UCLM), which will be calculated using ProUCL version 4.0 (Singh, Singh, and Maichle 2007), or the maximum detected concentration if lower.

1.3.6.2 Action Level Decision Rule

The action levels for the Site will likely be either: (1) risk-based screening criteria developed during the HHRA or Screening Level ERA; or (2) federally mandated ground water criteria such as MCLs.

The following risk-based screening criteria were used to evaluate whether analytical data will be of sufficient quality for risk assessment:

Human Health

- Soil – Residential and Industrial Regional Screening Levels for Chemical Contaminants at Superfund Sites (Oak Ridge National Laboratory [ORNL] 2008); and

- Ground water – Tap Water Screening Levels for Chemical Contaminants at Superfund Sites (ORNL 2008) or Maximum Contaminant Levels (EPA 2010b).

Ecological

- Soil – EPA Ecological Soil Screening Levels (EPA 2010c); ORNL Preliminary Remediation Goals (ORNL 2008).

Mineral or chemical interference may lead to elevated sample quantitation limits, which are greater than their respective risk-based screening values. If these analytes are not detected in an exposure area and sample quantitation limits are greater than risk-based values, then they may be a source of potential risk underestimation or additional sampling may be conducted to mitigate the uncertainty.

The decision rule for the Site is as follows:

- If Site concentrations are less than risk based criteria, then a risk evaluation is generally not recommended; and

- Else, if Site concentrations are greater than risk based criteria, then a risk evaluation is generally recommended.

1.3.7 Step 6 – Specify the Performance or Acceptance Criteria

Step 6 of the DQO process specifies the tolerable limits on decision errors. Data are subject to various types of errors (e.g., how samples were collected, how measurements were made, etc.). As a result, estimates or conclusions that are made from the collected data may deviate from what is actually true within the population. Therefore, there is a chance that an erroneous conclusion could be made or that the uncertainty in the estimates will exceed what is acceptable.

The performance or acceptance criteria for collected data will be derived to minimize the possibility of either making erroneous conclusions or failing to keep uncertainty in estimates to within acceptable levels. Performance criteria and QA practices will guide the design of new data collection efforts. Acceptance criteria will guide the design of procedures to acquire and evaluate existing data.

The most important activities in DQO Step 6 are as follows:

- Recognizing the total study error and devising mitigation techniques to limit error, and
- Specifying the decision rule as a statistical hypothesis test, examining consequences of making incorrect decisions from the test, and placing acceptable limits on the likelihood of making decision errors.

1.3.7.1 Total Study Error

Even though unbiased data collection methods may be used, the resulting data will still be subject to random and systematic errors at different stages of the collection process (e.g., from field sample collection to sample analysis). The combination of these errors is called the “total study error” (or “total variability”) associated with the collected data. There can be many contributors to total study error, but there are typically two main components, sampling error and measurement error.

Sampling Error

Sampling error, sometimes called statistical sampling error, is influenced by the inherent variability of the population over space and time, the sample collection design, and the number of samples collected. It is usually impractical to measure the entire population space, and limited sampling may miss some features of the natural variation of the measurement of interest. Sampling design error occurs when the data collection design does not capture the complete variability within the population space, to the extent appropriate for making conclusions. Sampling error can lead to random error (i.e., random variability or imprecision) and systematic error (bias) in estimates of population parameters. In general, sampling error is much larger than measurement error and consequently needs a larger proportion of resources to control.

Measurement Error

Sometimes called physical sampling error, measurement error is influenced by imperfections in the measurement and analysis protocols. Random and systematic measurement errors are introduced in the measurement process during physical sample collection, sample handling, sample preparation, sample analysis, data reduction, transmission, and storage.

The potential for measurement error will be mitigated by using accurate measurement techniques. As described in Section 2, sampling techniques were selected to limit the measurement error, including the following:

- Sample collection procedures, sample processing, and field sample analysis protocols are fairly standard. This will ensure that the methodology remains consistent and limits the potential for measurement error;

- Field teams will be trained and will perform specific tasks (e.g., sample collection or processing) throughout the field sampling effort to limit the potential for measurement error;

- Potential for measurement error in the sample analysis will be limited by the analysis of QC samples (e.g., duplicates), as described in Section 1.4; and

- Data management procedures will limit the potential for data reduction, transmission, and storage errors.

1.3.7.2 Statistical Hypothesis Testing and Decision Errors

Decision-making problems are often transformed into one or more statistical hypothesis tests that are applied to the collected data. Data analysts make assumptions on the underlying distribution of the parameters addressed by these hypothesis tests, in order to identify appropriate statistical procedures for performing the chosen statistical tests.

Due to the inherent uncertainty associated with the collected data, the results of statistical hypothesis tests cannot establish with certainty whether a given situation is true. There will be some likelihood that the outcome of the test will lead to an erroneous conclusion (i.e., a decision error).

When a decision needs to be made, there are typically two possible outcomes: either a given situation is true, or it is not. Although it is impossible to know whether an outcome is really true, data are collected and statistical hypothesis testing is performed to make an informed decision. In formulating the statistical hypothesis test, one of the two outcomes is labeled the "baseline condition" and is assumed to represent the *de facto*, true condition going into the test, and the other situation is labeled the "alternative condition." The baseline condition is retained until the information (data) from the sample indicates that it is highly unlikely to be true.

The statistical theory behind hypothesis testing allows for defining the probability of making decision errors. However, by specifying the hypothesis testing procedures during the design phase of the project, the performance or acceptance criteria can be specified.

There are four possible outcomes of a statistical hypothesis test. Two of the four outcomes may lead to no decision error; there is no decision error when the results of the test lead to correctly adopting the true condition, whether it is the baseline or the alternative condition. The remaining two outcomes represent the two possible decision errors. The first is a false rejection decision error, which occurs when the data leads to decision that the baseline condition is false when, in reality, it is true. The second is a false acceptance decision error, which occurs when the data are insufficient to change the belief that the baseline condition is true when, in reality, it is false.

In the statistical language of hypothesis testing, the baseline condition is called the "null hypothesis" (H_o) and the alternative condition is called the "alternative hypothesis" (H_a). A false rejection decision error, or a Type I error, occurs when you reject the null hypothesis when it is actually true. The probability of this error occurring is called alpha (α) and is called the hypothesis test's level of significance. A false acceptance decision error, or a Type II error, occurs when you fail to reject the null hypothesis when it is actually false. The probability that this error will occur is called beta (β). Frequently, a false rejection decision error is the more severe decision error, and therefore, criteria placed on an acceptable value of alpha (α) are typically more stringent than for beta (β). Statisticians call the probability of rejecting the null hypothesis when it is actually false the statistical power of the hypothesis test. Statistical power is a measure of how likely the collected data will allow you to make the correct conclusion that the alternative condition is true rather than the default baseline condition and is a key concept in determining DQOs for decision-making problems. Note that statistical power represents the probability of "true rejection" (i.e., the opposite of false acceptance) and, therefore, is equal to 1-β.

Decision errors can never be totally eliminated when performing a statistical hypothesis test. However, the primary aim of this step is to arrive at the upper limits on the probabilities of each of these two types of decision errors that the planning team finds acceptable.

The null hypothesis is the mean concentration of a contaminant does exceed (i.e., is greater than or equal to) the action level and the alternative hypothesis is the mean concentration does not exceed the action level as follows:

H_o = Mean Media Analyte Concentration $\geq$ Action Level

H_a = Mean Media Analyte Concentration < Action Level

For the statistical evaluations conducted for the Site, the probability of a Type I error occurring will be established at 5 percent and a Type II error will be established at 10 percent.

The Type I error rate was set more conservatively because this type of error would result in finding the site uncontaminated when it actually was contaminated. Type I error is considered more serious than Type II error because it would leave contamination in place for continuing exposure to receptors. By comparison, a higher Type II error rate of 10 percent was tolerable because this type of error would result in considering the site contaminated when it is actually not contaminated.

1.3.8 Step 7 – Develop the Plan for Obtaining Data

In the Steps 1 through 6 of the DQO process, performance or acceptance criteria were developed. The goal of Step 7 is to develop a resource-effective sampling design for collecting and measuring environmental samples, or for generating other types of information needed to address the PSQ. In addition, this sampling design will lead to data that will achieve the performance and acceptance criteria.

The most important activity in DQO Step 7 is as follows:

- Use the information from Steps 1 through 6 of the DQO process to identify a sampling and analysis design that will answer the PSQ and achieve the performance or acceptance criteria.

Normally, this step would require compiling a few different sampling and analysis designs, which could be evaluated to determine the best approach to answer the PSQ and achieve the performance or acceptance criteria. However, the sampling and analysis design was largely dictated by the SOW issued by EPA on 19 August 2010 (EPA 2010a); the scoping meeting that was conducted on 25 August 2010; and the EPA-approved EA Work Plan dated 2 September 2010 (EA 2010a).

The soil, sediment, and surface water sampling approach contains biased or judgmental samples. Vadose zone air sampling locations will be biased in the vicinity of suspected impacted vadose zone areas (i.e., near chlorinated solvent ground water impacts). Soil samples will also be biased toward vadose zone impacted areas using historical site evidence (e.g., previous sampling results). Ground water samples will be collected from monitoring wells in the vicinity of the Site where impacted ground water is likely to be present. This approach does introduce bias and potential sampling error; however, the bias is likely to increase the sample concentration, which will likely result in a more protective remedial decision. Sampling error that is considered more protective of human health or the environment is acceptable for this evaluation.

Additional details pertaining to the sampling and analysis design are detailed throughout this document and will not be repeated here for brevity.

1.4 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

A well-defined QA/QC process is integral to the generation of analytical data of known and documented quality. The QC process includes those activities required during data collection to produce data of sufficient quality to support the decisions that will be made based on the data (e.g., decisions to be made prior to, during, and after site remedial actions) (EPA 2006a). After environmental data are collected, QA activities focus on evaluating the quality of the data in order to determine the data usability with respect to support for remedial or enforcement decisions. Table 3 presents the acceptance criteria for definitive onsite and offsite laboratory data for chemical analyses of investigation samples only.

1.4.1 Data Categories

In order to produce data suitable for decision-making, an appropriate analytical technique must be selected. The EPA Superfund program has developed two descriptive categories of analytical techniques: (1) field-based techniques; and (2) fixed-laboratory techniques. The type of data generated depends on the qualitative and quantitative DQOs developed for a project. Regardless of whether the data was analyzed utilizing field or laboratory techniques, it must be of adequate quality for the decision-making process for which it was collected. For this project, data from both types of techniques will be collected. Section 2 discusses the methods that will be used to analyze the samples. Both field-based and definitive analytical data will be used to support decisions made for this project.

Rigorous analytical methods (e.g., EPA CLP methods) are used to generate analyte-specific, definitive data. The definitive quality of the data is assured by: (1) using Standard Operating Procedures (SOP) and QC processes during data collection; (2) documented control and traceability of reference standards, calibrations, and instrument performance; and (3) acceptable performance of field and laboratory QC procedures within the defined limits established for these procedures.

TABLE 3 QUALITY ASSURANCE INDICATOR CRITERIA

Indicator Parameter	Analytical Parameter	QC Sample	Acceptance Criteria for Laboratory Analysis
Accuracy (percent recovery)	VOCs, SVOCs, MNA parameters	MS, MSD Blanks	50 to 150 percent recovery Less than CRQL
	TAL Metals and hexavalent chromium	MS LCS Blanks [a]	75 to 125 percent recovery 80 to 120 percent recovery Less than CRDL
Precision (RPD)	VOCs, SVOCs, MNA parameters	MS, MSD Field duplicates	30 percent RPD 50 percent RPD
	TAL Metals and hexavalent chromium	MS, MD Field duplicates	20 percent RPD (aqueous) 35 percent RPD (solid) 50 percent RPD
Sensitivity (quantitation limits)	Analytical tests	MS, MD, MSD Field duplicates	Not applicable
Completeness	The objective for data completeness is 90 percent.		
Representativeness	The sampling network analytical methods for this site are designed to provide data that are representative of site conditions.		
Comparability	The use of standard published sampling and analytical methods, and the use of QC samples, will ensure data of known quality. These data can be compared to other data of known quality.		

Notes:

[a] May include method blanks, reagent blanks, instrument blanks, calibration blanks, and other blanks collected in the field (such as field blanks)

CRDL = Contract-required detection limit
CRQL = Contract-required quantitation limit
LCS = Laboratory control sample
MD = Matrix duplicate
MS = Matrix spike
MSD = Matrix spike duplicate
MNA = Monitored natural attenuation
QC = Quality control
RPD = Relative percent difference
SVOC = Semivolatile organic compound
TAL = Target analyte list
VOC = Volatile organic compound.

The majority of the fixed-laboratory analysis for samples collected during the RI/FS sampling event will be conducted by the EPA's Region 6 Laboratory, EPA CLP, TCEQ Houston Laboratory, or a private laboratory depending on the needs of the RI/FS and the availability of the laboratory's services. A subcontracted, non-CLP laboratory will provide the following analytical support: hexavalent chromium or other parameters (e.g., MNA) as necessary.

1.4.2 Measurement Quality Objectives

Analytical results will be evaluated in accordance with precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters to document the quality of the data and to ensure that the data are of sufficient quality to meet the project objectives. Of these PARCC parameters, precision and accuracy will be evaluated quantitatively by collecting the QC check samples listed in Table 3.

The sections below describe each of the PARCC parameters and how they will be assessed within this project.

1.4.2.1 Precision

Precision is the degree of mutual agreement between individual measurements of the same property under similar conditions. Usually, combined field and laboratory precision is evaluated by collecting and analyzing field duplicates and then calculating the variance between the samples, typically as a relative percent difference (RPD).

RPD is calculated as follows:

$$\mathrm{RPD} = \frac{|\mathrm{A} - \mathrm{B}|}{(\mathrm{A} + \mathrm{B})/2} \times 100\%$$

where: A = first duplicate concentration
B = second duplicate concentration

Field sampling precision is evaluated by analyzing field duplicate samples. For every 10 samples collected, one soil blind duplicate sample will be collected. Field measurements will be calibrated each day following manufacturer recommendations prior to, and following daily field use (see Section 2.12.1). If calibration readings deviate 20 percent or more from the concentration of the calibration standard, the unit will be recalibrated.

Laboratory analytical precision is evaluated by analyzing laboratory duplicates (also called matrix duplicates [MDs]) or matrix spikes (MSs) and matrix spike duplicates (MSDs). For this project, MS/MSD and MS/MD samples will be generated for analytes. The results of the analysis of each MS/MSD or MS/MD pair will be used to calculate the RPD as a measure of lab precision. The RPD acceptance criteria are listed in Table 3.

1.4.2.2 Accuracy

A program of sample spiking will be conducted to evaluate laboratory accuracy. This program includes analysis of the MS and MSD samples, laboratory control spikes (LCSs) or blank spikes, surrogate standards, and method blanks. MS and MSD samples will be prepared and analyzed at a frequency of 5 percent for soil samples. LCSs or blank spikes are also analyzed at a frequency of 5 percent. Surrogate standards, where available, are added to every sample analyzed for inorganic constituents. The results of the spiked samples are used to calculate the percent recovery for evaluating accuracy.

$$\text{Percent Recovery} = \frac{S - C}{T} \times 100\%$$

where: S = measured spike sample concentration
C = sample concentration
T = true or actual concentration of the spike

The objective for accuracy of field measurements is to achieve and maintain factory specifications for the field equipment. Field-portable analyzers will be calibrated using calibration standards at the start and end of each field day.

1.4.2.3 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent the characteristics of a population, variations in a parameter at a sampling point, or an environmental condition that they are intended to represent. For this project, representative data will be obtained through careful selection of sampling locations and analytical parameters. Representative data will also be obtained through proper collection and handling of samples to avoid interference and minimize contamination.

Representativeness of data will also be ensured through the consistent application of established field and laboratory procedures. Field blanks (if appropriate) and laboratory blank samples will be evaluated for the presence of contaminants to aid in evaluating the representativeness of sample results. Data determined to be non-representative, by comparison with existing data, will be used only if accompanied by appropriate qualifiers and limits of uncertainty.

1.4.2.4 Completeness

Completeness is a measure of the percentage of project-specific data that are valid. Valid data are obtained when samples are collected and analyzed in accordance with QC procedures outlined in this SAP, and when none of the QC criteria that affect data usability are exceeded. When data validation is completed, the percent completeness value will be calculated by dividing the number of useable sample results by the total number of sample results planned for this investigation.

As discussed further in Section 4.2, completeness will also be evaluated as part of the data quality assessment process (EPA 2006c; 2006d). This evaluation will help determine whether limitations are associated with the decisions to be made based on the data collected.

1.4.2.5 Comparability

Comparability expresses the confidence with which one data set can be compared with another. Comparability of data will be achieved by consistently following standard field and laboratory procedures and by using standard measurement units in reporting analytical data. Standard EPA analytical methods and QC will be used to support the comparability of analytical results with those obtained in other testing. Calibrations will be performed in accordance with EPA or manufacturer's specifications and will be checked with the frequency specified in the EPA CLP SOW(s).

1.4.3 Detection and Quantitation Limits

The analytical parameters and their quantitation limits for use on this project are determined under the EPA CLP SOW(s). The Contract-required Detection Limit (CRDL) is the minimum concentration of an analyte that can be reliably distinguished from background noise for a specific analytical method. The quantitation limit represents the lowest concentration of an analyte that can be accurately and reproducibly quantified in a sample matrix. Contract-required Quantitation Limit (CRQLs) are contractually specified maximum quantitation limits for specific analytical methods and sample matrices, such as soil or water, and are typically several times the method detection limit (MDL) to allow for matrix effects.

For this project, analytical methods have been selected so that the CRQL for each target analyte is below the applicable regulatory screening criteria, wherever practical. For this project, samples results will be reported as estimated values if concentrations are less than CRQLs but greater than CRDLs. The CRDL for each analyte will be listed as the detection limit in the laboratory's electronic data deliverable (EDD).

1.5 SPECIAL TRAINING AND CERTIFICATION

This section outlines the training and certification required to complete the activities described in this SAP. The following sections describe the requirements for the EA team and subcontractor personnel working onsite.

1.5.1 Health and Safety Training

EA field team personnel who work at hazardous waste project sites are required to meet the Occupational Safety and Health Administration (OSHA) training requirements defined in 29 Code of Federal Regulations (CFR) 1910.120(e). These requirements include: (1) 40 hours of formal offsite instruction; (2) a minimum of 3 days of actual onsite field experience under the supervision of a trained and experienced field supervisor; and (3) 8 hours of annual refresher training. Field personnel who directly supervise employees engaged in hazardous waste operations also receive at least 8 additional hours of specialized supervisor training.

Copies of the field team's health and safety training records, including course completion certifications for the initial and refresher health and safety training, and specialized supervisor training are maintained in project files.

For more health and safety details, see EA's site-specific HSP (EA 2010b).

1.5.2 Subcontractor Training

Subcontractors who work onsite will certify that their employees have been trained for work on hazardous waste project sites. Training will meet OSHA requirements defined in 29 CFR 1910.120(e). Before work begins at the project site, subcontractors will submit copies of the training certification for each employee to EA.

Employees of associate and professional services firms and technical services subcontractors will attend a safety briefing and complete the Safety Meeting Sign-Off Sheet before they conduct onsite work (EA 2010b). This briefing is conducted by the EA Site Health and Safety Officer (SHSO) or other qualified person.

Subcontractors are responsible for conducting their own safety briefings; EA personnel may audit these briefings. Alternatively, the subcontractors may elect to attend the EA safety briefings.

1.6 DOCUMENTS AND RECORDS

The following sections discuss the requirements for documenting field activities and for preparing laboratory data packages. This section also describes reports that will be generated as a result of this project.

1.6.1 Field Documentation

Field personnel will use permanently bound field logbooks with sequentially numbered pages to record and document field activities and will follow SOP 016 for completing field logbooks (Appendix A). The logbook will list the contract name and number; site name; and names of subcontractors, service client, and Project Manager. At a minimum, the following information will be recorded in the field logbook:

- Name and affiliation of onsite personnel or visitors;
- Weather conditions during the field activity;
- Summary of daily activities and significant events;
- Notes of conversations with coordinating officials;
- References to other field logbooks or forms that contain specific information;
- Discussions of problems encountered and their resolution;
- Discussions of deviations from the SAP or other governing documents; and
- Description of photographs taken.

1.6.2 Laboratory Documentation

This section describes the data reporting requirements for EA field personnel and laboratories (e.g., EPA CLP laboratories, EPA Region 6 laboratory, or subcontracted non-CLP laboratories) that submit field and laboratory measurement data under the EPA Region 6 RAC II program.

EA will require fixed offsite non-CLP laboratories to prepare and submit data packages in accordance with the EPA CLP protocols (EPA 2005; 2007a; 2007b, 2010d; 2010e) for hardcopy and EDD format of lead data. Data packages will include applicable documentation for independent validation of data and verification of the DQOs. The following documentation will be required for full data validation, if applicable:

- Case narratives, which will describe QC non-conformances that are encountered during the analysis of samples in addition to corrective actions that are taken:

  - Statement of samples received,
  - Description of deviations from the specified analytical method,
  - Explanations of data qualifiers that are applied to the data, and
  - Other significant problems that were encountered during analysis;

- Tables that cross-reference field and laboratory sample numbers;

- Chain-of-custody forms, which pertain to each sample delivery group or sample batch that is analyzed;

- Laboratory reports, which must show traceability to the sample analyzed and must contain specified information:
  - Project identification,
  - Field sample number,
  - Laboratory sample number,
  - Sample matrix description,
  - Dates and times of sample collection, receipt at the laboratory, preparation, and analysis,
  - Description of analytical method and reference citation,
  - Results of individual parameters, with concentration units, including second column results, second detector results, and other confirmatory results, where appropriate,
  - Quantitation limits achieved, and
  - Dilution or concentration factors;

- Data summary forms and QC summary forms showing analytical results, if applicable:
  - Samples,
  - Surrogates,
  - Blanks,
  - Field QC samples,
  - LCS,
  - Initial and continuing calibrations, and
  - Other QC samples;

- Laboratory control charts:
  - Raw data,
  - Instrument printouts, and
  - Laboratory bench sheets for preparation of samples; and

- MDL study results.

EA's Project Manager, in cooperation with the QA Officer, will define site-specific requirements for data reporting. Requests for analytical services define these requirements, the turnaround time for receipt of the data deliverables specified, and requirements for retaining samples and laboratory records. Laboratory QA managers are responsible for ensuring that laboratory data reporting requirements in this SAP are met.

1.6.3 Full Data Package

When a full data package is required, the laboratory will prepare data packages in accordance with the instructions provided in the EPA CLP SOWs (EPA 2005; 2007a; 2007b, 2010d; 2010e). Full data packages will contain the information from the summary data package and associated raw data. Full data packages are due to EA within 35 days after the last sample in the sample delivery group is received. Unless otherwise requested, the subcontractor will deliver one copy of the full data package.

1.6.4 Reports Generated

Following the completion of the RI field program and receipt of validated data, EA will prepare the following reports associated with the Site RI/FS:

- Data Validation Report;
- Data Evaluation Summary Report (DESR);
- Baseline HHRA Report;
- Screening-Level ERA Report;
- RI Report;
- Remedial Alternatives Technical Memorandum;
- Remedial Alternatives Evaluation;
- FS Report; and
- FS Addendum (if requested by EPA).

The specific requirements and elements of each of these reports are discussed in detail in the EPA-approved RI/FS Work Plan (EA 2010a).

2. DATA GENERATION AND ACQUISITION

This section describes the requirements for the following:

- Sampling process design (Section 2.1);
- Consent for property access (Section 2.2);
- Stander Operating Procedures/Sampling (Section 2.3);
- Land Surveying (Section 2.4)
- Sample processing (Section 2.5);
- Decontamination (Section 2.6);
- Management of investigation-derived waste (Section 2.7);
- Sample designation (Section 2.8);
- Sample container, volume, preservation, and holding time requirements (Section 2.9);
- Sample handling and custody (Section 2.10);
- Analytical methods requirements (Section 2.11);
- Quality control requirements (Section 2.12);
- Instrument calibration and frequency (Section 2.13);

- Requirements for inspection and acceptance of supplies and consumables (Section 2.14);
- Data acquisition requirements (Section 2.15); and
- Data management (Section 2.16).

2.1 SAMPLING PROCESS DESIGN

For the activities associated with this Task Order and SAP, main elements of the sampling design include the numbers and types of samples to be collected, sampling locations, sampling frequencies, and sample matrices.

As stated in the DQOs (Section 1.3), the following principle study questions were formulated for the RI:

> ***What are the nature and extent of air, soil, sediment, surface water, and ground water contamination?***
>
> ***What are the migration pathways for these contaminants to be transported?***
>
> ***What is the potential risk to human health and ecological receptors from exposure to Site related COPCs?***

The primary objective of the sampling design is to collect data of sufficient quantity and quality to resolve the study question and support risk assessment and remedy evaluation. The purpose of the RI/FS is to determine the nature and extent of contamination and to gather sufficient information so that the EPA can select a remedy that eliminates, reduces, or controls risks to human health or the environment, as follows:

> ***Determine the nature and extent of air, soil, sediment, surface water, and ground water contamination.***
>
> ***Determine the migration pathways for these contaminants to be transported.***
>
> ***Determine if exposure to Site related COPCs pose a potential unacceptable risk to human health and ecological receptors.***

The goal is to develop the minimum amount of data necessary to support the selection of an approach for the Site's investigation, and then to use the data to support a ROD. To achieve this goal, soil, sediment, surface water, ground water, and air will be sampled during the RI/FS at the Site.

A CSM will summarize the current understanding of the Site and will include a detailed list of data gaps that will be addressed by this SAP. EA will conduct environmental sampling that includes the following elements as outlined in the EPA SOW (EPA 2010a):

- **Install Monitoring Wells** - EA estimates that monitoring wells will be installed at approximately 15 locations during Phase I activities. EA estimates that monitoring wells will be installed at approximately 5 locations during Phase II activities. EA may install the 20 monitoring wells during one mobilization if directed by EPA. Samples may be utilized for geotechnical testing.

- **Ground Water Data Collection/Aquifer Testing** - EA will collect continuous water monitoring data using data-logger probes with a pressure transducer, conductivity, and temperature sensor during a 24-hour pump or slug test to be conducted during Phase II activities.

- **Ground Water Sampling** - EA will collect samples from 16 existing wells and up to 20 newly installed monitoring wells during Phase I activities. EA will collect samples from up to 20 newly installed monitoring wells and approximately 25% of the existing wells during Phase II activities. Samples will be analyzed for TAL metals, hexavalent chromium, VOCs, SVOCs, MNA parameters due to the presence of chlorinated solvents, or other parameters, as directed by EPA.

- **Passive Soil Gas and Air Sampling** - EA will conduct passive soil gas sampling at up to 40 locations during Phase II activities (this effort may also be conducted during a previous or subsequent phase). The samples will be analyzed for VOCs.

- **Vadose Zone Soil Sampling/Analysis** - Soil samples will be collected in up to 20 locations (e.g., 10 to the north and 10 to the south of East Grove Street) to characterize the vadose zone impacts. Although significant removal action has occurred at the Site, it is uncertain whether residual contamination exists in the vadose zone, which extends 6 to 9 feet bgs. Also, soil samples may be collected during monitoring well installation as directed by EPA. EA will collect soil samples using direct-push methodology or conventional borings. The samples will be analyzed for TAL metals and hexavalent chromium. Samples may be utilized for geotechnical testing.
- **Sediment Sampling** - EA will conduct sediment sampling in accordance with SOP 021 (Appendix A). Surface water samples will be collected in accordance with SOP 016. The following are estimated sample groups: 1) 10 along each of the two storm water transport pathways (ditches/culverts) that lead from the Site towards Frazier Creek; these surface water transport pathways are west of Garner Street. Surface water samples will be collected if available. 2) 10 within Frazier Creek (west of Garner Street) because it appears that previous samples were not analyzed for hexavalent chromium and surface water samples may have not been collected; surface water samples will be collected if available. 3) 10 background samples to evaluate anthropogenic contributions to the waterways.

2.2 CONSENT FOR PROPERTY ACCESS

Sampling activities will be performed on privately-owned properties located within the City of Terrell, Texas. EPA will obtain consent for property access agreements from the private property owners that have been identified for investigation under the RI/FS. For properties where the property owner cannot be identified and/or the property owner is not responsive, other properties may be identified for characterization as appropriate.

2.3 STANDARD OPERATING PROCEEDURES/SAMPLING

This section describes the procedures for sample collection and major investigatory activities; additional ancillary investigatory activities are detailed in the SOPs provided in Table 4. The SOPs are provided in Appendix A.

During sample collection, preparation, and field analysis, chain of custody will be maintained and documented as required in Section 2.10. Sample locations will be documented photographically and sketched in the field logbook; an accompanying photograph log will be completed in the field logbook (see Section 1.6.1). Sample collection and handling procedures for samples that will be analyzed using the CLP will follow CLP protocols in accordance with EPA's *Contract Laboratory Program Guidance for Field Samplers* (EPA 2007b).

TABLE 4 STANDARD OPERATING PROCEDURES

SOP Number	SOP Title
001	Labels
002	Chain-of-Custody Form
003	Subsurface/Utility Clearance
004	Sample Packing and Shipping
005	Field Decontamination
008	pH Measurement
009	Temperature Measurement
010	Water Level and Well Depth Measurements
012	Specific Conductance Measurements
013	Monitoring Well Sample Collection
016	Surface Water, Ground water, and Soil/Sediment Logbooks
019	Monitoring Well Installation
021	Sediment Sampling
024	Photo-Ionization Detector
025	Soil Sampling
027	Passive Soil Gas Surveys
028	Well Boring and Abandonment
036	Turbidity Measurements
037	Dissolved Oxygen Measurements
038	Redox Potential Measurements
039	Sample Preservation and Container Requirements
042	Disposal of Investigation-Derived Material
046	Aqueous Diffusion Samplers
047	Direct-Push Technology Sampling
048	Low-Flow Sampling
051	Low-Flow Purge and Sampling With Dedicated Pumps
053	Concrete Coring

EA will conduct the following elements as outlined in the EPA SOW (EPA 2010a).

- **Install Monitoring Wells** - EA estimates that monitoring wells will be installed at approximately 15 locations during Phase I activities. EA estimates that monitoring wells will be installed at approximately 5 locations during Phase II activities. EA may install the 20 monitoring wells during one mobilization if directed by EPA. All wells will be installed in accordance with SOPs 003 and 019 (Appendix A);

- **Ground Water Data Collection/Aquifer Testing** - EA will collect continuous water monitoring data using data-logger probes with a pressure transducer, conductivity, and temperature sensor during a 24-hour pump or slug test to be conducted during Phase II activities in accordance with SOP 010 (Appendix A). Data will be used to develop ground water potentiometric maps for the respective water-bearing zones;

- **Ground Water Sampling** - EA will conduct environmental sampling that includes the following elements as outlined in the EPA SOW (EA 2010a) in accordance with SOPs 013, 046, 048, and 051 (Appendix A). EA will collect samples from 16 existing wells and up to 20 newly installed monitoring wells during Phase I activities. EA will collect samples from up to 20 newly installed monitoring wells and approximately 25% of the existing wells during Phase II activities. At EPA's direction, EA will use passive diffusion bag samplers, tap water sample collection techniques, or other sampling techniques as directed by EPA:

    - **Tap and Municipal Water Sampling -** Prior to the EA field team mobilizing, each resident will be notified by EPA and given an approximate date and time for their well to be sampled along with documentation of special requirements by the resident. EA will coordinate with EPA prior to Site mobilization to identify which wells are to be sampled and to ensure that the necessary access agreements are in place. The residential wells will be purged and geochemical parameters monitored and logged using a calibrated water quality meter in accordance with SOP 014 (Appendix A). The parameters collected will include pH, temperature, and conductivity (SOPs 008, 009, and 012). These parameters will be measured for 15 minutes prior to sampling or until the readings have stabilized (conductivity within 10%, pH within plus or minus 0.5 pH units, and temperature within plus or minus 1 ^{o}C). Measurement of field parameters is further described in SOPs 008, 009, 012, 036, 037, 038, and 048 (Appendix A).

    - **Passive Diffusion Bags -** The PDBs are low-density polyethylene bags containing deionized water that are used to collect ground water samples for laboratory analyses of VOCs (SOP 046, Appendix A). The samplers are typically 24 inches in length and 1.25 inches in diameter. The number of PDBs and well depths will be determined following analysis of the historical data. The PDBs will remain in the wells long enough for the well water, contaminant distribution, and flow dynamics to restabilize following sampler deployment.

- **Passive Soil Gas and Air Sampling** - EA will conduct passive soil gas sampling in an effort to delineate the vadose zone source area in accordance with SOPs 003, 027, and 053 (Appendix A).

  - **Passive Soil Gas** - Soil gas samples will be deployed at depths ranging between 12 and 30 inches bgs, depending upon the soil gas vendor selected. The soil gas samplers will be installed on a 25 or 50-foot-square grid system. Sample borings will be advanced with a hammer drill equipped with a ¾-inch diameter bit. The boring will be advanced to the desired depth and the sampler will be lowered into the hole on a retrieval wire. A pin flag will also be placed at each location (if possible), and the boring covered. After a minimum of 7 days, the soil gas samplers will be retrieved by removing the pin flag and placing the sample into the sample container provided by the contracted soil gas vendor. The soil gas sample locations will be surveyed using a hand-held global positioning system (GPS) unit. GPS data attributes for each well position will be logged and include:

    - Latitude and longitude
    - Collector name
    - Collection method
    - Datum
    - Maximum Positional Dilution of Precision
    - Date and time.

    Passive soil gas samples will be submitted to the contracted vendor for VOC analysis using SW-846 Method 8260C Modified (or equivalent method).

- **Vadose Zone Soil Sampling/Analysis** - Soil samples will be collected in accordance with SOPs 025 and 047 (Appendix A). Using the results of the passive soil gas sampling, EA will conduct soil and vadose zone sampling to characterize soil contaminant concentrations and additional parameters that may be required for remedy evaluation/selection. Based on evaluation of the initial data and an investigation of the Site geology, EA will propose, and after approval by EPA, implement the most appropriate and cost-effective method (i.e., direct push, conventional boring, MIP, etc.) to collect this data given the local soil conditions;

- **Sediment Sampling** - EA will conduct sediment sampling in accordance with SOP 021 (Appendix A). Surface water samples will be collected in accordance with SOP 016. The following are estimated sample groups: 1) 10 along each of the two storm water transport pathways (culverts) that lead from the Site towards Frazier Creek; these surface water transport pathways are west of Garner Street. Surface water samples will be collected if available. 2) 10 within Frazier Creek (west of Garner Street) because it appears that previous samples were not analyzed for hexavalent chromium and surface water samples may have not been collected; surface water samples will be collected if available. 3) 10 background samples to evaluate anthropogenic contributions to the waterways.

2.4 LAND SURVEYING

During the RI field program, EA will survey soil sample locations using portable GPS equipment. The determination of locations and top of casing (TOC) elevations for newly installed monitoring wells will be subcontracted to a local Registered Professional Licensed Surveyor in the State of Texas. Elevations for each new monitoring well TOC will be measured and referenced to a relative benchmark. After field activities are complete, the surveyor will draft survey maps illustrating the information collected.

Private and municipal supply wells that have not previously been surveyed may be surveyed using a GPS unit. GPS Data Attributes for each well position will be logged and include the following:

- Latitude and longitude;
- Collector name;
- Collection method;
- Datum;
- Maximum Positional Dilution of Precision;
- GPS date and time; and
- Total Positions collected at each well location.

2.5 SAMPLE PROCESSING

Samples for fixed laboratory analysis will be processed and packaged in accordance with the *Contract Laboratory Program Guidance for Field Samplers* (EPA 2007b) and/or SOP 004 (Appendix A), as applicable.

2.6 DECONTAMINATION

Re-usable field equipment utilized during the RI/FS will be decontaminated prior to and after use in accordance with SOP 005 (Appendix A). Decontamination of field equipment will occur in buckets, plastic containers, or other similar containers with sealing lids, and the resulting fluid will be transferred to 55-gallon IDW drums staged designated staging area (Support Zone). The decontamination water will be properly sampled and disposed of following local, State, and Federal guidelines (see Section 2.7).

2.7 MANAGEMENT OF INVESTIGATION-DERIVED WASTE

EA will incorporate best management practices of green remediation as it relates to the management of IDW. Soil from the offsite areas will drummed, sealed, labeled, and stored at the designated staging area (Support Zone) until profiled for acceptance at an approved disposal facility (SOP 042, Appendix A). IDW soil samples will be submitted to an EA-subcontracted laboratory for disposal characterization. Landfill Disposal Restrictions will dictate sample quantities and analysis.

Decontamination water generated during well installation, ground water sampling, and equipment decontamination will be drummed, sealed, labeled, and stored at the designated staging area (Support Zone) until profiled for acceptance at an approved disposal facility (SOP 042, Appendix A). IDW water samples will be submitted to an EA-subcontracted laboratory for disposal characterization.

2.8 SAMPLE DESIGNATION

Each sampling location will be designated with a unique alphanumeric designation according to the following sample classifications:

- **Passive Soil Gas.** Passive soil gas sample designations will include two fields that are separated by dashes; for example: AA-1000.
    - The first and second fields will be assigned an alphanumeric location number based on an x-y grid system alphabetically increasing from south to north and numerically increasing from west to east.

- **Surface and Subsurface Soil.** Soil sample designation will include four fields that are separated by dashes; for example: C-500-0-2 or C-500-0-2.
    - The first field, "C," identifies the area of investigation
    - The second field, "500," represents the sample identifier.
    - The third field, "0," represents the top of the sample interval measured in feet bgs.
    - The fourth field, "2," represents the bottom of the sample interval measured in feet bgs.

- **Ground Water Sample Designation.** Ground water sample designation for private and municipal wells will utilize the well designations presented below. Two or three fields will be separated by dashes; for example: MW-01 or MW-01-10.
    - The first two fields are well designations established for the project, "MW-01," that identify that the sample came from a permanent private or municipal ground water well.
    - The third field, "10," denotes the passive diffusion bag sample depth if applicable.

- **New Monitoring Well Designation.** Newly constructed monitoring well sample designation will include two fields that are separated by dashes; for example: MW-01.
    - The two alpha characters in the first field, "MW," identifies that the sample came from a permanent monitoring well.
    - The second field, "01," represents the monitoring well number designation or identifier.

    - **Field Duplicate Sample Designation.** Field duplicate samples will be identified by adding a "D" to the end of the sample designations described above; for example, MW-01-D.

    - **Matrix Spike/Matrix Spike Duplicate (MS/MSD) Sample Designation** (for organic analysis). MS and MSD samples may be identified by adding an "MSD" to the end of the sample designations described above; for example, MW-01-MSD.

- **Matrix Spike/Matrix Duplicate (MS/MD) Sample Designation** (for inorganic analysis). MS and MD samples may be identified by adding an “MD” to the end of the sample designations described above; for example, MW-01-MD.

- **Field, Trip, and Equipment Rinsate Blank Sample Designation**. Trip and equipment blank samples will be identified sequentially beginning with TB-1, FB-1, and ER-1, respectively.

2.9 SAMPLE CONTAINER, VOLUME, PRESERVATION, AND HOLDING TIME REQUIREMENTS

Table 5 specifies the required sample volume, container type, preservation technique, and holding time for each analysis that is to be conducted during each phase of sampling. Required containers, preservation techniques, and holding times for field QC samples, such as field duplicates, will be the same as for investigative samples, but may require additional volumes as described in Section 2.11.

2.10 SAMPLE HANDLING AND CUSTODY

Each sample collected by the EA field team will be traceable from the point of collection through analysis and final disposition to ensure sample integrity. Sample integrity helps to ensure the legal defensibility of the analytical data and subsequent conclusions. Sample handling will follow CLP protocols as required in EPA’s *Contract Laboratory Program Guidance for Field Samplers* (EPA 2007b).

The EA field team will use EPA’s data management system known as “Forms II Lite” to generate chain-of-custody records in the field. Applicable copies of generated Forms II Lite files will be delivered to EPA data management personnel as required by CLP protocols.

2.11 ANALYTICAL METHODS REQUIREMENTS

The source of analytical services to be provided will be determined in part by DQOs and the intended use of the resulting data. EA will use EPA-approved methods for laboratory analyses of the samples.

EA will follow the analytical services request procedures that are outlined EA’s Analytical Services Delivery Plan (EA 2005b). If an analytical system fails, the QA officer will be notified, and corrective action will be taken. In general, corrective actions will include stopping the analysis, examining instrument performance and sample preparation information, and determining the need to re-prepare and reanalyze the samples.

TABLE 5 REQUIRED VOLUME, CONTAINERS, PRESERVATIES, AND HOLDING TIMES

Parameter	Method	Volume and Container	Preservatives	Holding Time [a]
Investigative Soil Samples				
VOCs	CLP SOM01.2 [b]	Three 5-gram EnCore samplers One 4-ounce glass jar with Teflon™-lined cap (moisture content)	Store at 4±2°C	48 hours
SVOCs	CLP SOM01.2 [b]	One 8-ounce glass jar with Teflon™-lined cap	Store at 4±2°C	7 days
TAL metals	CLP ISM01.2 [b]	One 8-ounce glass jar with Teflon™-lined cap	Store at 4±2°C	6 months
Hexavalent Chromium	EPA Method 3060A / 7199	One 8-ounce glass jar with Teflon™-lined cap	Store at 4±2°C	30 days
Investigative Ground water Samples				
TAL metals	CLP ISM01.2 [b]	One 250-millilter polyethylene bottle	Nitric Acid to pH < 2; Store at 4±2°C	180 days for analysis 28 days for Hg
Hexavalent Chromium	EPA Method 7199	One 500-millilter HDPE bottle	Store at 4±2°C	24 hours
TCL VOCs	CLP SOM01.2 [b]	Three 40-milliliter glass vials with Teflon™-lined cap	Hydrochloric acid to pH < 2; Store at 4±2°C	14 days
TCL SVOCs	CLP SOM01.2 [b]	Two 1-liter amber glass bottles with Teflon™-lined cap	Store at 4±2°C	7 days
Methane, Ethane, and Ethene	RSK-175	Three 40-mililiter clear glass VOA vials	HCl; store at 4±2°C	14 days
Nitrite	EPA 353.2	One 1-L HDPE bottle	Store at 4±2°C	48 hours
Sulfate and Chloride	EPA 300.1			28 days
Sulfide	EPA 376.1	One 1-L HDPE bottle	ZnOAc; NaOH to pH > 9; store at 4±2°C	7 days
Nitrate	EPA 353.2	One 1-L HDPE bottle	H2SO4; store at 4±2°C	48 hours
Total Organic Carbon	EPA 415.2			28 days
Ammonia	EPA 350.1			28 days
ortho-Phosphate	EPA 365.1			48 hours
Anions/cations	SW-846 300.0, 6020	One 250-500 milliliter polyethylene bottles	Store at 4±2°C	7 days
Total Dissolved Solids	SW-846 160.1	One 250-milliliter polyethylene bottle	Store at 4±2°C	7 days
Soil Gas Samples				
Passive Soil Gas	SW-846 8260C	Passive soil gas sampler/module	Store at 4±2°C	NA
IDW Soil and Water Samples				
Reactivity Corrosivity Ignitibility	SW-846 9045C, 1030, and Chapter 7 [c]	One 8-ounce glass jar with Teflon™-lined cap	Store at 4 °C ± 2 °C	NA/72 hours

Parameter	Method	Volume and Container	Preservatives	Holding Time [a]
TCLP metals	SW-846 1311 [c]	One 8-ounce glass jar with Teflon^{TM}-lined cap	Store at 4±2°C	14 days

Notes:
a Holding time is measured from the time of sample collection to the time of sample extraction and analysis.
b EPA 2005; 2007a
c EPA 1996
CLP = Contract Laboratory Program
HCl = Hydrochloric acid
HDPE = High-density polyethylene
H_2SO_4 = Sulfuric acid
NA = Not applicable
NaOH = Sodium hydroxide
SVOC = Semi-volatile Organic Compound
TAL = Target Analyte List
TCL = Target Compound List
TCLP = Toxicity Characteristic Leaching Procedure
VOC = Volatile Organic Compound
ZnOAc = Zinc acetate

Laboratories that are subcontracted by EA or EPA will conduct definitive laboratory analysis of samples. Table 5 lists the laboratory analytical methods for this project. In cases, appropriate methods of sample preparation, cleanup, and analyses are based on specific analytical parameters of interest, sample matrices, and required quantitation limits. The following sections briefly discuss each analytical method and required modifications for definitive investigative analyses. Analyses for the IDW profiling will be conducted according to the specifications in the selected analytical method listed in Table 5.

The source of analytical services to be provided will be determined in part by DQOs and the intended use of the resulting data. EA will use EPA-approved methods for laboratory analyses of the samples.

2.11.1 Field Analytical Methods

Water quality parameters that include pH, temperature, specific conductivity, oxidation-reduction potential, dissolved oxygen, and turbidity will be monitored using field-based methods during the collection of ground water samples. EA will follow manufacturer-recommended procedures for operating field equipment.

2.11.2 Fixed-Laboratory Analytical Methods

Fixed-laboratory analyses will be conducted by EPA's Region 6 Laboratory, EPA CLP, TCEQ Houston Laboratory, or a private laboratory depending on the needs of the RI/FS and the availability of the laboratory's services. Samples submitted to the analytical laboratory will be analyzed in accordance with CLP SOWs SOM01.2 (EPA 2005; 2007a) and ISM01.2 (EPA 2010d). Modifications to analytical methods that may be required to manage atypical matrices or to achieve low quantitation limits are not anticipated. Decisions regarding the use and type of method modifications will be made during the procurement of laboratories, as different laboratories have equipment and SOPs that generate varying quantitation limits.

2.12 QUALITY CONTROL REQUIREMENTS

Various field and laboratory QC samples and measurements will be used to verify that analytical data meet the QA objectives. Field QC samples and measurements will be collected to assess the influence of sampling activities and measurements on data quality. Similarly, laboratory QC samples will be used to assess how the laboratory's analytical program influences data quality. This section describes the QC samples that are to be analyzed during the site sampling activities for: (1) each field and laboratory environmental measurement method; and (2) each sample matrix type. Table 3 shows the acceptance criteria for each type of QC sample, and Table 6 presents the frequency of QC samples to be collected at the Site.

2.12.1 Field Quality Control Requirements

Field QC samples will be collected and analyzed to assess the quality of data that are generated by sampling activities. These samples will include laboratory QC samples collected in the field, field duplicates, equipment rinsates, MS/MSDs, MDs, and temperature blanks. QC samples collected in the field for fixed-laboratory analysis are presented in Table 6.

Field duplicates are independent samples that are collected as close as possible, in space and time, to the original investigative sample. Field duplicates can measure the influence of sampling and field procedures on the precision of an environmental measurement. They can also provide information on the heterogeneity of a sampling location. Field duplicates will be collected at a frequency of one for every 10 investigative samples, as listed in Table 6.

Immediately following collection of the original sample, the field duplicates are collected using the same collection method.

Field blanks are collected to assess: (1) impact from ambient air conditions during sample collection; (2) cross-contamination during sample collection, preservation, and shipment, as well as in the laboratory; and (3) cleanliness of the sample containers and preservatives. Field blank samples consist of sample containers filled with analytically-certified, organic-free water. Field blank samples are typically collected during ground water sample collection for VOC analysis at a frequency of one field blank for each day of ground water sampling activities (specifically for VOC analysis). Field blanks may be collected for other media and analytes as dictated by site conditions during investigative sampling activities. If contaminant is present in the blank samples above the method detection limit, the result for associated field samples that contain the same contaminant will be qualified as potentially not detected if the concentration of the field sample is less than five times the concentration found in the blank.

Equipment rinsate blanks are collected when nondedicated or nondisposable sampling equipment is used to collect samples and put the samples into containers. These blanks assess the cleanliness of the sampling equipment and the effectiveness of equipment decontamination. Equipment rinsate blanks are collected by pouring analyte-free water over the decontaminated surfaces of sampling equipment that contacts sampling media. Equipment rinsate blanks are collected after sampling equipment has been decontaminated, but before the equipment is reused for sampling. If nondedicated or nondisposable equipment is used, equipment rinsate blanks will be collected in accordance with the frequency listed in Table 6.

TABLE 6 FREQUENCY OF FIELD QUALITY CONTROL SAMPLES

Field QC Sample	Frequency [a]
Trip blank	1 per cooler containing aqueous samples for VOC analysis
Field blank	1 per day, if site conditions render this sample necessary
Filter blank	1 per 20 primary air samples
Field duplicate	1 per 10 samples
Equipment rinsate blank	1 per non-dedicated equipment type per day or 1 per 20 samples
MS/MD [b] (inorganics)	1 per 20 samples (or per Region 6 EPA Laboratory requirements)
MS/MSD[b] (organics)	1 per 20 samples (or per Region 6 EPA Laboratory requirements)
Temperature blank	1 per cooler

Notes:
a The QC sample collection frequency applies to samples collected for fixed-laboratory analysis (EPA 1996; 2005; 2007a, 2007b).
b MS, MSD, and MD analyses are technically not field QC samples; however, they generally require that the field personnel collect additional volumes of samples and are, therefore, included on this table for easy reference.

MS/MSD samples are laboratory QC samples that are collected for organic methods; MS/MD samples are collected for inorganic methods. For aqueous samples, MS/MSDs require double or triple the normal sample volume, depending on analytical laboratory specifications; MS/MDs require double the normal sample volume. In the laboratory, MS/MSD and MS/MD samples are split and spiked with known amounts of analytes. Analytical results for MS/MSD and MS/MD samples are used to measure the precision and accuracy of the laboratory's organic and inorganic analytical programs, respectively. Each of these QC samples will be collected and analyzed at a frequency of one for every 20 investigative samples for CLP laboratories or subcontract non-CLP laboratories, or in accordance with the requirements of the EPA Region 6 Laboratory.

Trip blanks are analyzed for VOCs only. VOC samples are susceptible to contamination by diffusion of organic contaminants through the Teflon-lined septum of the sample vial; therefore, a VOC trip blank will be analyzed to monitor for possible sample contamination. Also, the trip blank will screen for possible contamination of VOC samples during handling and shipment from the field to the laboratory. The trip blanks will be provided by the laboratory and placed in each cooler that contains VOC samples.

Temperature blanks are containers of deionized or distilled water that are placed in each cooler shipped to the laboratory. Their purpose is to provide a container to test the temperature of the samples in the respective cooler.

2.12.2 Laboratory Quality Control Requirements

Laboratories that perform analytical work under this project must adhere to a QA program that is used to monitor and control laboratory QC activities. Each laboratory must have a written QA manual that describes the QA program in detail. The laboratory QA manager is responsible for ensuring that laboratory internal QC checks are conducted in accordance with EPA methods and protocols, the laboratory's QA manual, and the requirements of this SAP.

Many of the laboratory QC procedures and requirements are described in EPA-approved analytical methods, laboratory method SOPs, and method guidance documents.

The EPA methods specify the preparation and analysis of QC samples, and may include, but are not limited to, the following types: (1) LCSs; (2) method blanks; (3) MS, MSD, and MD samples; (4) surrogate spikes; and (5) standard reference materials or independent check standards. The following subsections discuss the QC checks that will be required for this project.

2.12.2.1 Laboratory Control Sample

LCSs are thoroughly characterized, laboratory-generated samples that are used to monitor the laboratory's day-to-day performance of analytical methods. The results of LCS analyses are compared to well-defined laboratory control limits to determine whether the laboratory system is in control for the particular method. If the system is not in control, corrective action will be implemented. Appropriate corrective actions will include: (1) stopping the analysis, (2) examining instrument performance or sample preparation and analysis information, and (3) determining whether samples should be re-prepared or reanalyzed.

2.12.2.2 Method Blanks

Method blanks, which are also known as preparation blanks, are analyzed to assess the level of background interference or contamination in the analytical system and the level that may lead to elevated concentration levels or false-positive data. Method blanks will be required for laboratory analyses and will be prepared and analyzed at a frequency of one method blank per every 20 samples or one method blank per batch, if the batches consist of fewer than 20 samples.

A method blank consists of reagents that are specific to the analytical method and are carried through every aspect of the analytical procedure, including sample preparation, cleanup, and analysis. The results of the method blank analysis will be evaluated in conjunction with other QC information to determine the acceptability of the data generated for that batch of samples. Ideally, the concentration of a target analyte in the method blank will be below the reporting limit for that analyte. For some common laboratory contaminants, a higher concentration may be allowed.

If the method blank for analysis is beyond control limits, the source of contamination must be investigated, and appropriate corrective action must be taken and documented. This investigation includes an evaluation of the data to determine the extent of the contamination and its effect on sampling results. If a method blank is within control limits but analysis indicates a concentration of analytes that is above the reporting limit, an investigation should be conducted to determine whether corrective action could eliminate an ongoing source of target analytes.

For organic and inorganic analyses, the concentration of target analytes in the method blank must be below the reporting limit for that analyte for the blank to be considered acceptable. An exception may be made for common laboratory contaminants (such as methylene chloride, acetone, 2-butanone, and phthalate esters) that may be present in the blank at up to five times the reporting limit. These compounds are frequently detected at low levels in method blanks from materials that are used to collect, prepare, and analyze samples for organic parameters.

2.12.2.3 Matrix Spikes

MSs and MSDs are aliquots of an environmental sample for organic analysis to which known concentrations of target analytes and compounds have been added. The MS is used to evaluate the effect of the sample matrix on the accuracy of the analysis. If there are many target analytes, they will be divided into two to three spike standard solutions. Each spike standard solution will be used alternately. The MS, in addition to an unspiked aliquot, will be taken through the entire analytical procedure, and the recovery of the analytes will be calculated. Results will be expressed in terms of percent recoveries and RPD. The percent recoveries of the target analytes and compounds are calculated and used to determine the effects of the matrix on the precision and accuracy of the method. The RPD between the MS and MSD results is used to evaluate method precision.

The MS/MSD is divided into three separate aliquots, two of which are spiked with known concentrations of target analytes. The two spiked aliquots, in addition to an unspiked sample aliquot, are analyzed separately, and the results are compared to determine the effects of the matrix on the precision and accuracy of the analysis. Results will be expressed as RPD and percent recovery and compared to control limits that have been established for each analyte. If results fall outside control limits, corrective action will be performed.

2.12.2.4 Laboratory (Matrix) Duplicates

MDs, which are also called laboratory duplicates, are prepared and analyzed for inorganic analyses to assess method precision. Two aliquots of sample material are taken from the sample and processed simultaneously without adding spiking compounds. The MD and the original sample aliquot are taken through the entire analytical procedure, and the RPD of the duplicate result is calculated. Results are expressed as RPD and are compared to control limits that have been established for each analyte.

2.12.2.5 Surrogate Spikes

Surrogates are organic compounds that are similar to the analytes of interest in chemical properties but are not normally found in environmental samples. Surrogates are added to field and QC samples, before the samples are extracted, to assess the efficacy of the extraction procedure and to assess the bias that is introduced by the sample matrix. Results are reported in terms of percent recovery. Individual analytical methods may require sample reanalysis based on surrogate criteria.

The laboratory will use surrogate recoveries mainly to assess matrix effects on sample analysis. Obvious problems with sample preparation and analysis (such as evaporation to dryness or a leaking septum) that can lead to poor surrogate spike recoveries must be eliminated before low surrogate recoveries can be attributed to matrix effects.

2.12.3 Common Data Quality Indicators

This section describes how QA objectives for precision, accuracy, completeness, and sensitivity are measured, calculated, and reported.

2.12.3.1 Precision

Precision of many analyses is assessed by comparing analytical results of MS and MSD sample pairs for organic analyses, field duplicate samples, laboratory duplicate samples (MDs), and field replicate measurements. If precision is calculated from two measurements, it is normally measured as RPD. If precision is calculated from three or more replicates, relative standard deviation is calculated.

2.12.3.2 Accuracy

The accuracy of many analytical methods is assessed by using the results of MS and MSD samples for organic analyses, MS samples for inorganic analyses, surrogate spike samples, LCSs, standard reference materials, independent check standards, and measurements of instrument responses against zero and span gases.

For measurements in which spikes are used, percent recovery will be calculated.

2.12.3.3 Completeness

Completeness is a measure of the percentage of project-specific data that are valid. Valid data are obtained when samples are collected and analyzed in accordance with QC procedures outlined in this SAP, and when none of the QC criteria that affect data usability are exceeded.

When data validation is completed, the percent completeness value will be calculated by dividing the number of useable results by the total number of sample results planned for this investigation.

Completeness will also be evaluated as part of the data quality assessment (DQA) process (EPA 2006c; 2006d). This evaluation will help determine whether limitations are associated with the decisions to be made based on the data collected.

2.12.3.4 Sensitivity

The achievement of MDLs depends on instrument sensitivity and matrix effects. Therefore, it is important to monitor the instrument sensitivity to ensure data quality and to ensure that analyses meet the QA objectives that have been established for sensitivity.

2.12.4 Instrument and Equipment Testing, Inspection, and Maintenance Requirements

This section outlines testing, inspection, and maintenance procedures for field equipment and instruments and for laboratory instruments.

2.12.4.1 General Requirements

Testing, inspection, and maintenance methods and frequency will be based on: (1) the type of instrument; (2) the instrument's stability characteristics; (3) the required accuracy, sensitivity, and precision of the instrument; (4) the instrument's intended use, considering project-specific DQOs; (5) manufacturer's recommendations; and (6) other conditions that affect measurement or operational control. For most instruments, preventive maintenance is performed in accordance with procedures and schedules recommended in (1) the instrument manufacturer's literature or operating manual, or (2) SOPs associated with particular applications of the instrument.

In some cases, testing, inspection, and maintenance procedures and schedules will differ from the manufacturer's specifications or SOPs. This can occur when a field instrument is used to make critical measurements or when the analytical methods that are associated with a laboratory instrument require more frequent testing, inspection, and maintenance.

2.12.4.2 Field Equipment and Instruments

Leased field equipment and instruments will be used to conduct sampling. The vendor will be responsible for thoroughly checking and calibrating field equipment and instruments before they are shipped or transported to the field. Copies of testing, inspection, and maintenance procedures will be shipped to the field with the equipment and instruments.

After the field equipment and instruments arrive in the field, they will be inspected for damage. Damaged equipment and instruments will be replaced or repaired immediately. Battery-operated equipment will be checked to ensure full operating capacity; if needed, batteries will be recharged or replaced.

Following use, field equipment will be decontaminated properly before being returned to the source. When the equipment is returned, copies of field notes regarding equipment problems will be included so that problems are not overlooked and necessary equipment repairs are performed.

2.12.4.3 Laboratory Instruments

Laboratories that analyze samples collected under the EPA Region 6 RAC II program must have a preventive maintenance program that addresses: (1) testing, inspection, and maintenance procedures; and (2) the maintenance schedule for each measurement system and required support activity. This program is usually documented by a SOP for each analytical instrument that is to be used. Typically, the program will be laboratory-specific; however, it should follow requirements outlined in EPA-approved guidelines. Some of the basic requirements and components of such a program are as follows:

- As a part of its QA/QC program, each laboratory will conduct a routine preventive maintenance program to minimize instrument failure and other system malfunction.

- An internal group of qualified personnel will maintain and repair instruments, equipment, tools, and gauges. Alternatively, manufacturers' representatives may provide scheduled instrument maintenance and emergency repair under a repair and maintenance contract.

- The laboratory will perform instrument maintenance on a regularly scheduled basis. The scheduled service of critical items should minimize the downtime of the measurement system. The laboratory will prepare a list of critical spare parts for each instrument. The laboratory will request the spare parts from the manufacturer and will store the parts.

- Testing, inspection, and maintenance procedures described in laboratory SOPs will be performed in accordance with manufacturer's specifications and the requirements of the specific analytical methods that are used.

- Maintenance and service must be documented in service logbooks (or the site-specific logbook) to provide a history of maintenance records. A separate service logbook should be kept for each instrument; however, due to the limited scope of this project, the service records will be maintained in the site-specific field logbook. Maintenance records will be traceable to the specific instrument, equipment, tool, or gauge.

- The laboratory will maintain and file records that are produced as a result of tests, inspections, or maintenance of laboratory instruments. These records will be available for review by internal and external laboratory system audits that are conducted under the EPA Region 6 RAC II program.

2.13 INSTRUMENT CALIBRATION AND FREQUENCY

This section describes the procedures for maintaining the accuracy of field equipment and laboratory instruments that are used for field tests and laboratory analyses. The equipment and instruments should be calibrated before each use or, when not in use, on a scheduled periodic basis.

2.13.1 Field Equipment

EA will perform calibration of field equipment during the field activities specified herein. Calibration of the field equipment (e.g., multi-parameter water quality meter) will be conducted on a daily basis following manufacturer recommendations, and will be performed prior to sample analysis activities. Should water quality readings appear to be questionable during sample analysis, EA will recalibrate the equipment as deemed necessary. The equipment calibration procedures described below will be followed.

Equipment will be maintained and calibrated with sufficient frequency and in such a manner that the accuracy and reproducibility of results are consistent with the manufacturer's specifications and with project-specific DQOs. Upon arrival of the field equipment, EA field personnel will examine it to verify that it is in good working condition. The manufacturer's operating manual and instructions that accompany the equipment will be consulted to ensure that calibration procedures are followed. Measuring and testing equipment may be calibrated either internally—by using in-house reference standards—or externally—by agencies, manufacturers, or commercial laboratories. Calibration records will contain a reference identifying the source of the procedure and, where feasible, the actual procedure. Each piece of measuring and testing equipment will also be accompanied by an equipment use log. The equipment use log (which may be contained within the site-specific field logbook) will be kept current and may contain the following information: (1) date of use; (2) times of use; (3) operating and assisting technicians; (4) calibration status; and (5) comments.

2.13.2 Laboratory Instruments

Laboratory equipment that is used to analyze samples collected under the EPA Region 6 RAC II program will be calibrated on the basis of written SOPs that are maintained by the laboratory. Calibration records (including the dates and times of calibration and the names of the personnel performing the calibration) will be filed at the location at which the analytical work was performed and maintained by the laboratory personnel who performed QC activities. Subcontractor laboratories may conduct laboratory work under the EPA Region 6 RAC II program. The laboratory QA manager is responsible for ensuring that laboratory instruments are calibrated in accordance with the requirements of this SAP.

The laboratories will follow the method-specific calibration procedures and requirements for laboratory measurements. Calibration procedures and requirements will also be provided, as appropriate, for laboratory support equipment, such as balances, mercury thermometers, pH meters, and other equipment that is used to take chemical and physical measurements.

2.14 REQUIREMENTS FOR INSPECTION AND ACCEPTANCE OF SUPPLIES AND CONSUMABLES

The EA Project Manager is responsible for identifying the types and quantities of supplies and consumables that are needed for collecting the samples for this Task Order. The Project Manager is also responsible for determining acceptance criteria for these items. When supplies are received, the EA field personnel will check packing slips against purchase orders and inspect the condition of supplies before the supplies are accepted for use on a project. If the supplies do not meet the acceptance criteria, deficiencies will be noted on the packing slip and purchase order. Afterward, the item will be returned to the vendor for replacement or repair.

2.15 DATA ACQUISITION REQUIREMENTS (NON-DIRECT MEASUREMENTS)

For this project, EA anticipates acquiring data from non-direct measurements such as databases, spreadsheets, and literature files.

2.16 DATA MANAGEMENT

A comprehensive data management program has been designed to assure that: (1) multiple information sources will result in similar data sets; and (2) data management practices will be adequate for the types of data processing required by a task order. Site team members will follow these protocols to assure results will have uniform units of measure, analytical methods, and reporting forms.

Data for this project will be obtained from a combination of sources, including: field measurements, EPA's Region 6 Laboratory, EPA CLP, TCEQ Houston Laboratory, or a private laboratory depending on the needs of the RI/FS and the availability of the laboratory's service. The data-gathering process requires a coordinated effort and will be conducted by project staff members in conjunction with potential data producers. The data will be obtained from the analytical service provider, when appropriate, in the form of an EDD, in addition to the required hard copy analytical data package. Formal verification (or validation) of data will be conducted before associated results are presented or are used in subsequent activities.

Data tracking is essential to ensure timely, cost-effective, and high-quality results. Data tracking begins with sample chain of custody. When the analytical service provider receives custody of the samples, the provider will send a sample acknowledgment to EA. The sample acknowledgment will confirm sample receipt, condition, and required analyses. The EPA tracking software (Forms II Lite) will contain pertinent information about each sample and can track the data at each phase of the process. The tracking software carries the data through completion of the data validation.

EA will validate 10% of the investigative analytical data received from subcontract laboratories (other than the EPA Region 6 Laboratory or CLP laboratories) to ensure that the confirmatory data are accurate and defensible. A partial review will be conducted on the remaining 90% of the data received from subcontract laboratories. Data will be evaluated for usability by EA in accordance with EPA CLP guidelines for data review (EPA 2002a; 2007b; 2008; 2010e).

As a part of the data validation process, EDDs will be reviewed against hard copy deliverables to ensure accurate transfer of data. In addition, the hard copy will be evaluated for errors in the calculation of results. After the data validation, qualifiers can be placed on the data to indicate the usability of the data. These qualifiers will be placed into an electronic data file. Upon approval of the data set with the appropriate data qualifiers, the electronic data will be released to the Project Manager for reporting.

3. ASSESSMENT AND OVERSIGHT

This section describes the field and laboratory assessments that may be conducted during this project, the individuals responsible for conducting assessments, corrective actions that may be implemented in response to assessment results, and how quality-related issues will be reported to EA and EPA.

3.1 ASSESSMENT AND RESPONSE ACTIONS

Under the EPA Region 6 RAC II program, performance and system audits of field and laboratory activities may be conducted to verify that sampling and analysis are performed in accordance with the following:

- Performance and system audits
  - Audit personnel,
  - Audit scope of work,
  - Audit frequencies, and
  - Audit reports;

- Corrective action
  - Sample collection and field measurements, and
  - Laboratory analyses.

Nonconforming items and activities are those that do not meet the project requirements, procurement document criteria, and approved work procedures. Nonconformance may be detected and identified by the following personnel:

- Project personnel—During field operations, supervision of subcontractors, and field inspections;

- Testing personnel—During preparation for and performance of tests, equipment calibration, and QC activities; and

- QA personnel—During the performance of audits, surveillance, and other QA activities.

Each nonconformance that affects quality will be documented by the person who identifies or originates the nonconformance. Documentation of nonconformance will include the following components:

- Description of nonconformance;

- Identification of personnel who are responsible for correcting the nonconformance and, if verification is required, for verifying satisfactory resolution;

- Method(s) for correcting the nonconformance (corrective action) or description of the variance granted; and

- Proposed schedule for completing corrective action and the corrective action taken.

Nonconformance documentation will be made available to the Project Manager, QA Manager, and subcontractor (e.g., non-CLP subcontract laboratories) management personnel, as appropriate.

The field personnel and QA personnel, as appropriate, are responsible for notifying the Project Manager and the QA manager of the nonconformance. In addition, the Project Manager and the project staff, as appropriate, will be notified of significant nonconformances that could affect the results of the work. The Project Manager is responsible for determining whether notification of EPA is required.

The completion of corrective actions for significant nonconformances will be documented by QA personnel during future auditing activities. Significant recurring nonconformance will be evaluated by project and QA personnel, as appropriate, to determine its cause. Appropriate changes will be instituted, under corporate or project procedures, to prevent recurrence. When such an evaluation is performed, the results will be documented.

3.2 REPORTS TO MANAGEMENT

Effective management of environmental data collection operations requires timely assessment and review of measurement activities. It is essential that open communication, interaction, and feedback be maintained among project participants, including: (1) the EA QA Manager, Program Manager, Project Manager, technical staff, and laboratory subcontractors; and (2) the EPA Region 6 TOM and QA Officer.

During the RI field program, EA will prepare reports that summarize the following elements:

- Work progress since the last report;
- Site observations, problems, and decisions;
- Problems that may impede planned progress;
- Safety-related observations, incidents, or potential safety problems and the corrective action(s) taken to mitigate the problem(s);
- Corrective measures and procedures to regain the planned schedule, if required; and
- Work scheduled for the next work period.

EA prepares monthly progress reports for each Task Order that is conducted under the EPA Region 6 RAC II program. These reports address QA issues that are specific to the Task Order and facilitate timely communication of such issues.

At the program level, the QA Manager prepares quarterly status reports of QA issues that are related to EA’s work on the EPA Region 6 RAC II program. These reports are distributed to EA’s President, Corporate QA Manager, RAC II Program Manager, and, upon request, the EPA Region 6 Project Officer. QA status reports address the following areas:

- Results of QA audits and other inspections, including quality improvement; opportunities that have been identified for further action;
- Instrument, equipment, or procedural problems that affect QA;
- Subcontractor performance issues;
- Corrective actions;

- Status of previously reported activities and quality improvement initiatives; and
- Work planned for the next reporting period.

4. DATA VALIDATION AND USABILITY

This section describes the procedures that are planned to review, verify, and validate field and laboratory data. Procedures for verifying that the data are sufficient to meet DQOs and measurement quality objectives for the project are also discussed. Section 4.1 focuses on data review and reduction requirements for work conducted under the EPA Region 6 RAC II program. Section 4.2 addresses data validation and verification requirements. Section 4.3 addresses reconciliation with DQOs.

4.1 DATA REVIEW AND REDUCTION REQUIREMENTS

Data reduction and review are essential functions for preparing data that can be used effectively to support project decisions and DQOs. These functions must be performed accurately and in accordance with EPA-approved procedures and techniques. Data reduction includes computations and data manipulations that produce the final results that are used during the investigation. Data review includes procedures that field or laboratory personnel conduct to ensure that measurement results are correct and acceptable in accordance with the QA objectives that are stated in this SAP. Field and laboratory measurement data reduction and review procedures and requirements are specified in previously discussed field and laboratory methods, SOPs, and guidance documents.

Field personnel will record, in a field logbook and/or on the appropriate field form, raw data from chemical and physical field measurements (SOP 016, Appendix A). The EA field staff has the primary responsibility for: (1) verifying that field measurements were made correctly; (2) confirming that sample collection and handling procedures specified in this project-specific SAP were followed; and (3) ensuring that field data reduction and review procedures requirements are followed. The EA field staff is also responsible for assessing preliminary data quality and for advising the data user of potential QA/QC problems with field data. If field data are used in a project report, data reduction methods will be fully documented in the report.

The EPA Region 6 Laboratory, CLP laboratory, and/or subcontracted non-CLP laboratory will complete data reduction for chemical and physical laboratory measurements and will complete an in-house review of laboratory analytical results. The laboratory QA manager will be responsible for ensuring that laboratory data reduction and review procedures follow the requirements that are stated in this SAP. The laboratory QA manager will also be responsible for assessing data quality and for advising the EA QA Manager of possible QA/QC problems with laboratory data.

4.2 VALIDATION AND VERIFICATION METHODS

Data that are used to support activities under the EPA Region 6 RAC II program must be valid for their intended purposes. This section outlines the basic data validation procedures that will be followed for field and laboratory measurements. The following sections identify personnel who are responsible for data validation and the general data validation process and EPA data validation guidance that will be followed.

4.2.1 Data Validation Responsibilities

When analytical services are provided by laboratories subcontracted by EA, EA is responsible for data validation. The QA Manager has primary responsibility for coordinating EA's data validation activities. EA will conduct full validation on 10% of subcontracted laboratory data for investigation samples. Partial validation will be conducted on the remaining 90% of subcontracted laboratory data. Data validation and review will be completed by one or more experienced data reviewers. When data are generated by the EPA Region 6 Laboratory, it will be used as received from the laboratory, with no further validation. Data from CLP laboratories are validated by EPA's Environmental Services Assistance Team.

4.2.2 Data Validation Procedures

The validity of a data set is determined by comparing the data with a predetermined set of QC limits. EA data reviewers will conduct a systematic review of the data for compliance with established QC limits (such as sensitivity, precision, and accuracy), on the basis of spike, duplicate, and blank sampling results that are provided by the laboratory. The data review will identify out-of-control data points or omissions. EA data reviewers will evaluate laboratory data for compliance with the following information:

- Method and project-specific analytical service requests;
- Holding times;
- Initial and continuing calibration acceptance criteria;
- Field, trip, and method blank acceptance criteria;
- Surrogate recovery;
- Field duplicates and MS and MSD acceptance criteria;
- MD precision;
- LCS accuracy;
- Other laboratory QC criteria specified by the method or on the project-specific analytical service request form;
- Compound identification and quantitation; and
- Overall assessment of data, in accordance with project-specific objectives.

EA will follow the most current EPA CLP guidelines (EPA 2002a; 2007b; 2008; 2010e) for completing data validation for applicable test methods. General procedures in the CLP guidelines will be modified, as necessary, to fit the specific analytical method that is used to produce the data. In cases, data validation requirements will depend on: (1) DQO levels that are defined in Section 1.4; (2) reporting requirements that are defined in Section 1.6; and (3) data deliverables that are requested from the laboratory, as discussed in Section 1.6.

4.3 RECONCILIATION WITH DATA QUALITY OBJECTIVES

The main purpose of a QA system is to define a process for collecting data that are of known quality, are scientifically valid, are legally defensible, and fully support decisions that will be based on the data. To achieve this purpose, the SAP requires that DQOs be fully defined (Section 1.3). Other parts of the QA system must then be planned and implemented in a manner that is consistent with the DQOs. QA system components that follow directly from the DQOs include: (1) documentation and reporting requirements (Section 1.6); (2) sample process design and sampling methods requirements (Sections 2.1 through 2.10); (3) analytical methods and analytical service requests (Section 2.11); (4) QC requirements (Section 2.12); and (5) data reduction and validation and reporting methods (Sections 4.1 and 4.2).

After environmental data have been collected, reviewed, and validated, the data will undergo a final evaluation to determine whether the DQOs specified in this SAP have been met. EA will follow EPA's DQA process to verify that the type, quality, and quantity of data that are collected are appropriate for their intended use (EPA 2006c; 2006d).

The DQA process involves: (1) verifying that the data have met the assumptions under which the data collection design and DQOs were developed; (2) taking appropriate corrective action if the assumptions have not been met; and (3) evaluating the extent to which the data support the decision that must be made so that scientifically valid and meaningful conclusions can be drawn from the data. To the extent possible, EA will follow DQA methods and procedures that have been outlined by EPA (EPA 2006c; 2006d).

Following the conclusion of the RI field program and receipt of fixed-laboratory data, the data evaluation will include the following:

- Data usability evaluation and field QA/QC – The usability of the laboratory analytical data in terms of the CLP data validation summaries and field QA/QC will be evaluated;

- Data Reduction and Tabulation – Soil borings, field sampling data, and analytical results will be reduced and tabulated; and

- DESR – A DESR will be submitted that documents and summarizes the analytical data collected during this RI/FS, including the data quality and usability as related to the site-specific DQOs. The DESR may also include previous data collected during previous Site investigations (if made available) for statistical comparisons to the data collected during the RI/FS. Field QA/QC results will be summarized in context with fixed-laboratory sample results.

EA will compile analytical and field data into a format that is compatible with EPA Region 6 or National Electronic Data Management Network. EA will use the data to prepare the: Data Validation Report; DESR; Baseline HHRA Report; Screening-Level ERA Report; RI Report; Remedial Alternatives Technical Memorandum; Remedial Alternatives Evaluation; FS Report; and FS Addendum (if requested by EPA), as well as to support the ROD. The specific requirements and elements of each of these reports are discussed in detail in the EPA-approved RI/FS Work Plan (EA 2010a).

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FIGURES

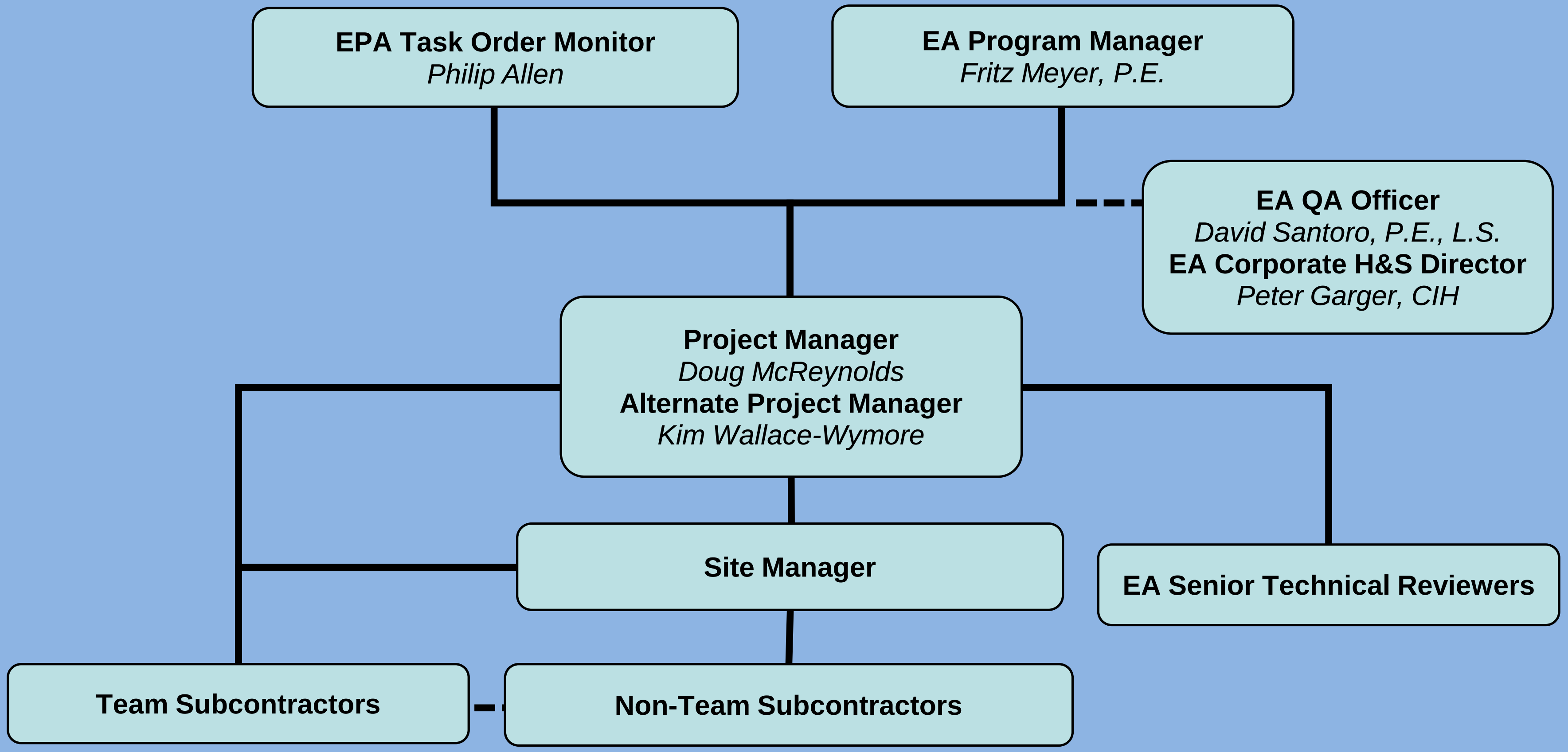
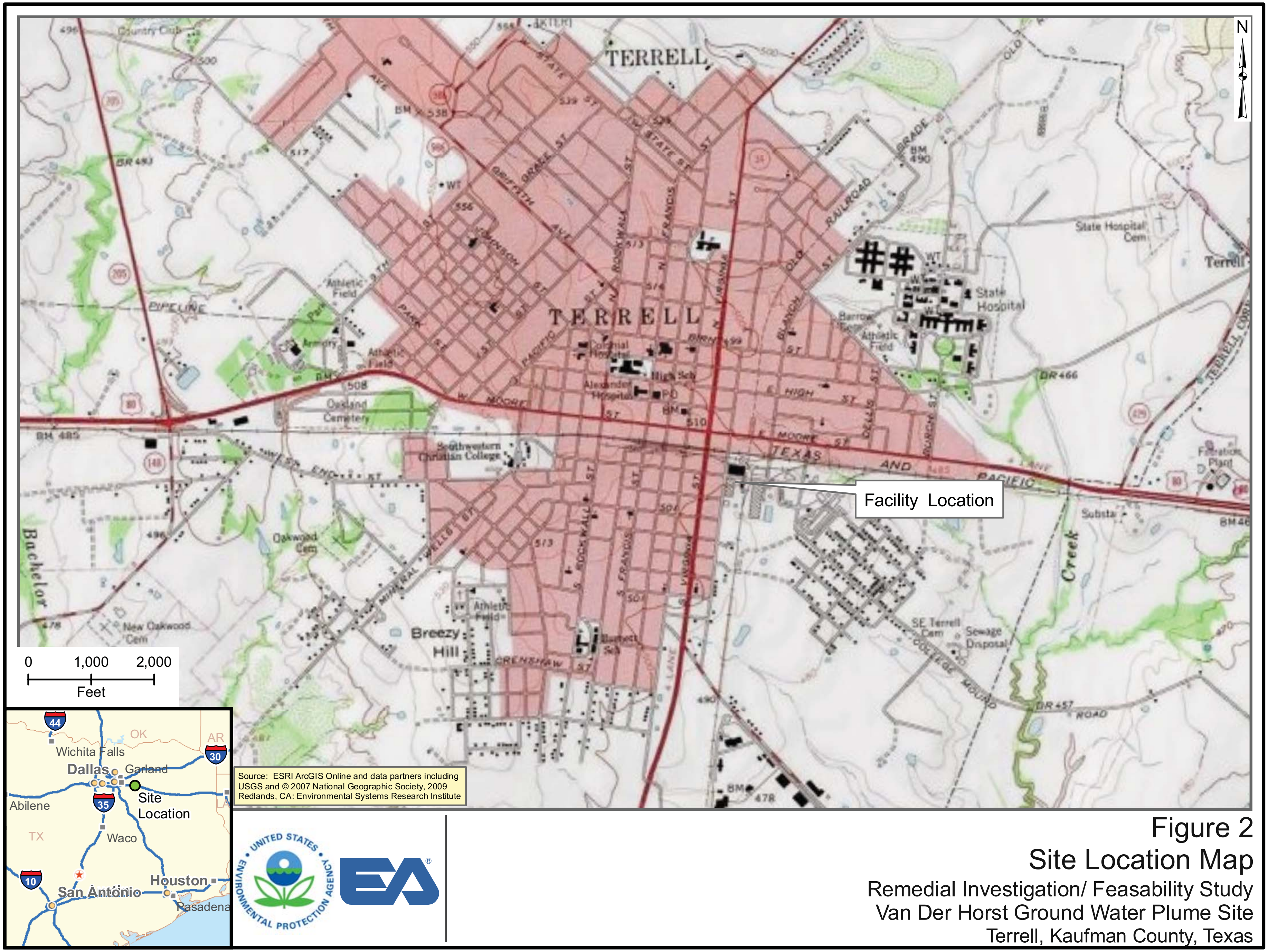


Figure 1 - Project Organization

Remedial Investigation/Feasibility Study
Van Der Horst Ground Water Plume Superfund Site
Terrell, Kaufman County, Texas



Source: ESRI ArcGIS Online and data partners including USGS and © 2007 National Geographic Society, 2009 Redlands, CA: Environmental Systems Research Institute

Figure 2
Site Location Map

Remedial Investigation/ Feasability Study
Van Der Horst Ground Water Plume Site
Terrell, Kaufman County, Texas

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Image Source: Texas Orthoimagery Program (TOP) and the USDA National Agriculture Imagery Program (NAIP), 2009.

Source: ESRI Data & Maps [CD-ROM]. (2009). Redlands, CA: Environmental Systems Research Institute.

Legend:

▭	Facility Boundary
▭	Buildings
▭	Source Areas

Figure 3
Site Layout Map

Remedial Investigation/ Feasability Study
Van Der Horst Ground Water Plume Site
Terrell, Kaufman County, Texas

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Appendix A

Standard Operating Procedures

Standard Operating Procedure No. 001
for
Sample Labels

Prepared by

EA Engineering, Science, and Technology, Inc.
11019 McCormick Road
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CONTENTS

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure is to delineate protocols for the use of sample labels. Every sample will have a sample label uniquely identifying the sampling point and analysis parameters. An example label is provided below. Other formats with similar levels of detail are acceptable.

PROJECT NAME _____________ PROJECT NUM. ___________
SAMPLE LOCATION/SITE ID ___________________________
DATE: ____/____/____ TIME: _____:_____
ANALYTES: METALS VOC EXPLOSIVES ORGANICS OTHER
FILTERED: [NO] [YES]
PRESERVATIVE: [NONE] [HNO_3] [OTHER ______]
SAMPLER: ____________________

2. MATERIALS

The following materials may be required: sample label and indelible laboratory marker.

3. PROCEDURE

The following sections describe how to use the sample labeling system.

3.1 LABEL INFORMATION

As each sample is collected/selected, fill out a sample label. Enter the following information on each label:

- Project name
- Project number
- Location/site identification—Enter the media type (i.e., well number, surface water, soil, etc.) sampling number, and other pertinent information concerning where the sample was taken
- Date of sample collection

- Time of sample collection

- Analyses to be performed (NOTE: Due to number of analytes, details of analysis should be arranged with laboratory *prior to start of work)*

- Whether filtered or unfiltered (water samples only)

- Preservatives (water samples only)

- Number of containers for the sample (e.g., 1 of 2, 2 of 2).

3.2 ROUTINE CHECK

Double-check the label information to make sure it is correct. Detach the label, remove the backing, and apply the label to the sample container. Cover the label with clear tape, ensuring that the tape completely encircles the container.

3.3 RECORD INFORMATION

Record the sample number and designated sampling point in the field logbook, along with the following sample information:

- Time of sample collection (each logbook page should be dated)

- Location of the sample

- Organic vapor meter or photoionization meter readings for the sample (when appropriate)

- Any unusual or pertinent observations (oily sheen on groundwater sample, incidental odors, soil color, grain size, plasticity, etc.)

- Number of containers required for each sample

- Whether the sample is a quality assurance sample (split, duplicate, or blank).

3.3.1 Logbook Entry

A typical logbook entry might look like this:

- 7:35 a.m. Sample No. MW-3. PID = 35 ppm
- Petroleum odor present. Sample designated MW-3-001.

NOTE: Duplicate samples will be given a unique sample designation rather than the actual sample number with an added prefix or suffix. This will prevent any indication to the laboratory that this is a duplicate sample. This fictitious sample number will be listed in the logbook along with the actual location of the sample.

3.4 SHIPMENT

Place the sample upright in the designated sample cooler. Make sure there is plenty of ice in the cooler at all times.

4. MAINTENANCE

Not applicable.

5. PRECAUTIONS

5.1 INCIDENTAL ODORS

Note that although incidental odors should be noted in the logbook, it is unwise from a safety and health standpoint to routinely "sniff test" samples for contaminants.

5.2 DUPLICATE SAMPLE

No indication of which samples are duplicates is to be provided to the laboratory.

6. REFERENCES

U.S. Environmental Protection Agency. 1980. Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans. QAMS-005/80.

Standard Operating Procedure No. 002
for
Chain-of-Custody Form

Prepared by

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Revision 0
August 2007

CONTENTS

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure is to delineate protocols for use of the chain-of-custody form. An example is provided as Figure SOP002-1. Other formats with similar levels of detail are acceptable.

2. MATERIALS

The following materials may be required: chain-of-custody form and indelible ink pen.

3. PROCEDURE

- Give the site name and project name/number.
- Enter the sample identification code.
- Indicate the sampling dates for all samples.
- List the sampling times (military format) for all samples.
- Indicate “grab” or “composite” sample with an “X.”
- Specify the sample location.
- Enter the total number of containers per cooler.
- List the analyses/container volume.
- Obtain the signature of sample team leader.
- State the carrier service and airbill number, analytical laboratory, and custody seal numbers.
- Sign, date, and time the “relinquished by” section.
- Upon completion of the form, retain the shipper copy, and affix the other copies to the inside of the sample cooler, in a zip-seal bag to protect from moisture, to be sent to the designated laboratory.

4. MAINTENANCE

Not applicable.

5. PRECAUTIONS

None.

6. REFERENCES

U.S. Environmental Protection Agency (U.S. EPA). 1980. Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans, QAMS-005/80.

U.S. EPA. 1990. Sampler's Guide to the Contract Laboratory Program. EPA/540/P-90/006, Directive 9240.0-06, Office of Emergency and Remedial Response, Washington, D.C. December.

U.S. EPA. 1991. User's Guide to the Contract Laboratory Program. EPA/540/O-91/002, Directive 9240.0-01D, Office of Emergency and Remedial Response. January.

Company Name:

Project Manager or Contact:

Phone:

Project No.

Dept.: Task:

Project Name:

Sample Storage Location:

ATO Number:

Page of

Report #:

Parameters/Method Numbers for Analysis

Chain of Custody Record

EA Laboratories
19 Loveton Circle
Sparks, MD 21152
Telephone: (410) 771-4950
Fax: (410) 771-4077

Report Deliverables:
1 2 3 4 D E

EDD: Yes/No

DUE TO CLIENT: __________

Date	Time	Water	Soil	Sample Identification 19 Characters	**No. of Containers**														**EA Labs Accession Number**	Remarks
																				LPM:

Samples by: (Signature)	Date/Time |	Relinquished by: (Signature)	Date/Time |	Received by: (Signature)	Date/Time |
Relinquished by: (Signature)	Date/Time |	Received by Laboratory: (Signature)	Date/Time |	Airbill Number:	Sample Shipped by: (Circle) Fed Ex. Puro. UPS Hand Carried Other:

Cooler Temp. _______C pH: ___ Yes ___ No Comments: Custody Seals Intact ___ Yes ___ No

NOTE: Please indicate method number for analyses requested. This will help clarify any questions with laboratory techniques.

Standard Operating Procedure No. 003
for
Subsurface/Utility Clearance

Prepared by

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Revision 0
August 2007

CONTENTS

1. SCOPE AND APPLICATION

1.1 PURPOSE

The purpose of this Standard Operating Procedure is to prevent injury to workers and damage to subsurface structures (including tanks, pipe lines, water lines, gas lines, electrical service, etc.) during ground disturbance activities (including drilling, augering, sampling, use of direct-push technologies, excavation, trenching, concrete coring or removal, fence post installation, grading, or other similar operations).

1.2 LIMITATIONS

The procedures set forth in this document are the suggested procedures but may not be applicable to particular sites based on the site-specific considerations. The Project Manager is responsible for making a site-specific evaluation of each site to determine whether the Subsurface/Clearance Procedures should be utilized or require modification. If safety or other site-specific considerations require a modified or different procedure, the Project Manager should review the modified procedure with the Business Unit Director, Profit Center Manager, or Senior Technical Reviewer.

1.3 SCOPE

This procedure provides minimum guidance for subsurface clearance activities, which must be followed prior to and during ground disturbance activities at EA project sites. Even after completing the subsurface clearance activities required in this procedure, all ground disturbance activities should proceed with due caution.

Deviations from this procedure may be provided on an exception basis for specific situations, such as underground storage tank systems removals, verified aboveground/overhead services/lines, undeveloped land/idle facilities, shallow groundwater conditions, soil stability, or well construction quality assurance/quality control concerns, etc.

EA or its subcontractors are responsible for, and shall ensure that, all ground disturbance activities are completed safely, without incident, and in accordance with applicable federal, state, and local regulations.

This procedure shall not override any site-specific or consultant/contractor procedures that are more stringent or provide a greater degree of safety or protection of health or the environment.

2. PROCEDURES

The EA Project Manager or his designee must complete the Subsurface Clearance Procedure Checklist (Appendix A) in conjunction with the following procedures. The checklist must be completed before initiating any ground disturbance activities. The completed checklist must be submitted to the appropriate team individuals, subcontractors, and/or the client and included in the project files.

2.1 SAFETY

A Health and Safety Plan must be available onsite and followed by all contractors and subcontractors.

All work areas shall be defined and secured with safety cones, safety tape, construction fence, other barriers, or signs as appropriate.

Site work permits must be obtained as required by site procedures. Based on site conditions or classification, the use of intrinsically-safe equipment may be required.

To ensure the safety of all onsite personnel and subsurface structure integrity, consideration should be given to de-energizing and locking out selected site utilities or temporarily shutting down a portion of or the entire facility.

2.2 PREPARATION TASKS

Objective—To gather all relevant information about potential subsurface structures prior to the actual site visit.

2.2.1 Obtain Permits and Site Access

The consultant/contractor is responsible for following all applicable laws, guidance, and approved codes of practice; obtaining all necessary permits and utility clearances; and securing site access permission.

2.2.2 Historic Site Information

Obtain most recent as-built drawings and/or site plans (including underground storage tank, product, and vent lines) as available.

NOTE: As-built drawings may not accurately depict the locations and depths of improvements and subsurface structures and should, therefore, not be **solely** relied upon.

EA should obtain any other site information such as easements, right-of-ways, historical plot plans, fire insurance plans, tank (dip) charts, previous site investigations, soil surveys, boring logs, and aerial photographs, etc. as relevant to the planned ground disturbance activities.

Where applicable, EA should also contact contract personnel who may have historic site knowledge.

2.2.3 Mark-Outs

Objective—To identify location of subsurface structures on surface.

EA must ensure that a thorough mark-out at the site is completed to locate electrical, gas, telephone, water, sewer, low voltage electric lines, product delivery pipelines, fiber optic, and all other subsurface utilities/services.

- Where available, public utility companies must be contacted to identify underground utilities. (This can be accomplished through the One-Call system in most instances.)

- In addition, where available and warranted by site conditions, a private utility/pipeline mark-out company should be contracted to perform an electronic subsurface survey to identify the presence of suspected hazardous or critical underground utilities and subsurface structures. In some cases, this is necessary to confirm public utility mark-outs in the vicinity of planned ground disturbance activities.

EA will review all available site plan subsurface information with the private mark-out company to assist in locating utilities and other subsurface structures.

NOTE: Mark-outs may not accurately depict the exact locations of improvements and subsurface structures and should, therefore, not be **solely** relied upon.

Where possible, EA personnel are encouraged to be onsite at the time of subsurface mark-outs. This is to ensure accuracy and understanding of subsurface structures identified and provides an opportunity to exchange information with mark-out company personnel regarding planned work activities.

Subsurface structures should be marked throughout the entire work area(s) with adequate materials (e.g., site conditions may require paint and tape/flags). Ground disturbance activities must be started within 30 days of mark-out, unless local ordinances specify a shorter time period. If activities are not started within required time period or markings have faded, mark-outs must be redone.

EA personnel will record time and date of mark-out request and list all companies contacted by the service and confirmation number. This should be available for review onsite and checked off after visual confirmation of markings.

2.2.4 Initial Site Visit

Objective—To compare the site plan to actual conditions based on information gathered in Procedures 2 and 3 above, obtain additional site information needed, and prepare a vicinity map.

EA will document all findings and update the site plan with this information. On third party sites, close coordination with the site owner's representatives for mark-outs, review of as-builts, and other information reviews should be conducted prior to work. Project Managers are encouraged to provide updated as-built information to the client.

In some regions, it may be more effective and efficient to conduct the site visit at the same time the contractor and drill rig are mobilized to the site. The inspection should include the following activities and may include others as determined by the consultant/contractor and the Project Manager.

2.2.5 Utilities

EA shall perform a detailed site walk-through for the purpose of identifying all aboveground indicators of subsurface utilities/services that may be leading to or from buildings within the planned work area. The inspection shall include, but not be limited to, the following:

- Utility mark-outs
- Aboveground utilities
- Area lights/signs
- Phones
- Drains
- Junction boxes
- Natural gas meters or connections
- Other utilities including: fire hydrants, on/below grade electrical transformers, splice cages, sewer lines, pipeline markers, cable markers, valve box covers, clean-outs/traps, sprinkler systems, steam lines (including insulated tanks that may indicate steam lines), and cathodic protection on lines/tanks
- Observe paving scars (i.e., fresh asphalt/concrete patches, scored asphalt/concrete).

NOTE: In many cases, the onsite location of low-voltage electrical lines and individual property water and sewer line branches may be approximated by using the following technique:

- Locate the entry/connection location at the facility building

- Attempt to identify utility connections for the mains (water sewer, etc.) by locating clean-outs, valve manways, etc. The location path of the utility is likely with the area between the main connection and facility building connection. Subsurface electrical line locations from the facility building to signs, lamps, etc. can be estimated with the same process.

2.2.6 Other Subsurface Systems

Some other subsurface systems to be cognizant of during subsurface activities include product delivery systems (i.e., at gas stations) and existing remediation systems.

2.2.7 Selection of Ground Disturbance Locations

EA will utilize the information collected to this point in combination with regulatory requirements and project objectives to select ground disturbance locations. Ground disturbance locations should also consider the location of overhead obstructions (e.g., power lines). Work at active gasoline retail locations must consider several special considerations that should be outlined in the site-specific safety and health plan.

2.2.8 Review of Selected Locations with the Client

EA will review the selected ground disturbance locations with the client. EA will not proceed with the subsurface activities until the plan has been discussed with the client. During execution of the project, subsurface activities are required outside of the area previously approved by the client. EA will submit these changes to the client for approval prior to execution.

2.2.9 Ground Disturbance Activity Sequence

EA will plan ground disturbance activities starting at the point farthest from the location of suspected underground improvements. This is done to determine the natural subsurface conditions and to allow EA site personnel to recognize fill conditions.

Experience has shown that the following warning signs may indicate the presence of a subsurface structure:

- Warning tape (typically indicative of underground services).

- Pea gravel/sand/non-indigenous material (typically indicative of tanks or lines).

- Red concrete (typically indicative of electrical duct banks).

- The abrupt absence of soil recovery in a hand auger. This could indicate pea gravel or sand that has spilled out of the auger. This may not be indicative in areas where native soil conditions typically result in poor hand auger recoveries.

- Any unexpected departure from the native soil or backfill conditions as established by prior onsite digging.

If any of these conditions is encountered by EA site personnel, digging should stop and the client should be contacted.

3. SUBSURFACE CLEARANCE METHODS

The method used to delineate the subsurface should be compatible with the inherent associated risk given the type of facility/property, soil stratigraphy, and the location of the ground disturbance activity, such that required delineation is obtained. It should be noted that in areas where there is paving, sufficient paving should be removed to allow clear visibility of the subsurface conditions during clearance activities. The following is a list of potential clearance methods that may be used on a job site:

- Vacuum digging
- Probing
- Hand digging
- Hand augering
- Post-hole digging.

EA personnel will evaluate the potential for electrical shock or fire/explosion for each subsurface disturbance project and will evaluate as necessary the use of non-conductive or non-sparking tools (i.e., fiberglass hand shovels, and thick electrically insulating rubber grips on hand augers or probes). The potential need for the use of non-conductive materials, electrical safety insulated gloves, and footwear will also be evaluated on a case-by-case basis.

3.1 SUBSURFACE CLEARANCE PROCEDURES FOR DRILLING, DIRECT-PUSH TECHNOLGY, AUGERING, FENCE POST INSTALLATION, OR OTHER BOREHOLE INSTALLATION ACTIVITIES

The area to be delineated will exceed the diameter of the largest tool to be advanced and sufficiently allow for visual inspection of any obstructions encountered.

3.2 SUBSURFACE CLEARANCE PROCEDURES FOR TRENCHING/ EXCAVATION ACTIVITIES

Appropriate subsurface clearance methods should be conducted along the length and width of the excavation at a frequency sufficient to ensure adequate precautions have been applied to the entire work area. The frequency and density of investigations will be based on site knowledge, potential hazards, and risks of the work area to surrounding locations (e.g., proximity to a residential area or school).

Whenever subsurface structures are exposed, EA will cease work and mark the area (e.g., flags, stakes, cross bracing) to ensure the integrity of these exposed structures is maintained during subsequent trenching/excavation/backfilling.

Uniform color codes for marking of underground facilities are provided in Appendix B.

Appendix A

Subsurface Clearance Procedure Checklist

Subsurface Clearance Procedure Checklist

Site Identification: ______________________

Project Consultant/Contractor: ______________________

Section 1: Safety, Preparation Tasks, and Mark-Outs

Activity	Yes	No	N/A	Comments including Justification if Response Is No or Not Applicable
Health and Safety Plan is available and all contractors and subcontractors are familiar with it.				
All applicable local, state, and federal permits have been obtained.				
Site access/permission has been secured.				
Most recent as-built drawings and/or site plans (including underground storage tank, product, and vent lines) obtained.				
Reviewed site information to identify subsurface structures relevant to planned site activities (easements, rights-of-way, historical plot plans, fire insurance plans, tank dip charts, previous site investigations, soil surveys, boring logs, aerial photographs, etc.).				
Utility mark-outs have been performed by public utility company(s). Mark-outs clear/visible.				
Subsurface structure mark-outs performed by private mark-out company. Mark-outs clear/visible.				
Additional Activities: Were dig locations reviewed with site representative?				

Section 2: Initial Site Visit and Selecting Ground Disturbance Locations

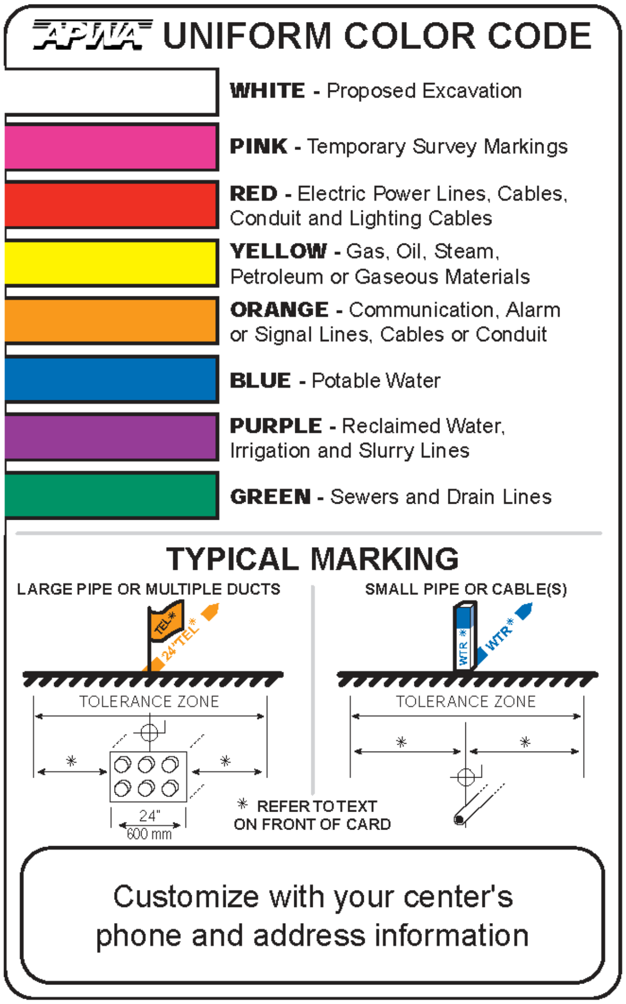
Activity	Yes	No	N/A	Comments including Justification if Response Is No or Not Applicable
Location of all aboveground indicators of subsurface utilities/services that may be leading to or from buildings within the planned work area has been identified.				
Location of utility mark-outs by all utility companies previously contacted has been identified within required time period.				
Location of all subsurface structure mark-outs by private mark-out company has been identified within required time period.				
Location of area lights/signs and associated subsurface lines identified.				
Location of all phones and associated subsurface lines identified.				
Location of all drains and associated interconnecting lines identified.				
Location of all electrical junction boxes and associated interconnecting lines identified				
Location of all natural gas meters or connections and all interconnecting lines identified				

Completed by: ______________________
Name

Signature: ______________________ ____________
Company Date

Appendix B

Uniform Color Codes for Excavation



APWA UNIFORM COLOR CODE

WHITE - Proposed Excavation

PINK - Temporary Survey Markings

RED - Electric Power Lines, Cables, Conduit and Lighting Cables

YELLOW - Gas, Oil, Steam, Petroleum or Gaseous Materials

ORANGE - Communication, Alarm or Signal Lines, Cables or Conduit

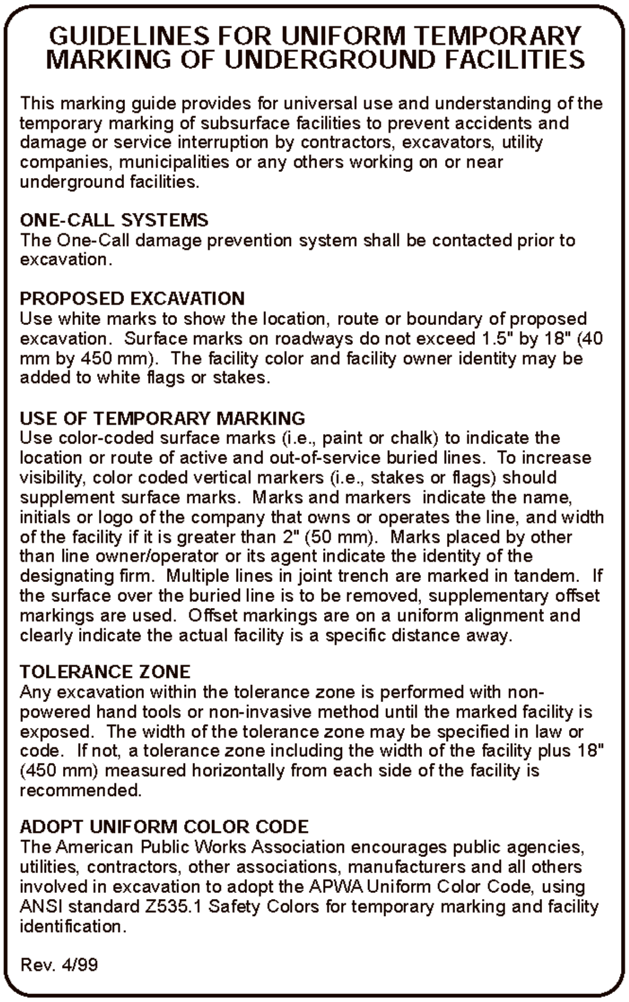
BLUE - Potable Water

PURPLE - Reclaimed Water, Irrigation and Slurry Lines

GREEN - Sewers and Drain Lines

TYPICAL MARKING

Customize with your center's phone and address information



GUIDELINES FOR UNIFORM TEMPORARY MARKING OF UNDERGROUND FACILITIES

This marking guide provides for universal use and understanding of the temporary marking of subsurface facilities to prevent accidents and damage or service interruption by contractors, excavators, utility companies, municipalities or any others working on or near underground facilities.

ONE-CALL SYSTEMS
The One-Call damage prevention system shall be contacted prior to excavation.

PROPOSED EXCAVATION
Use white marks to show the location, route or boundary of proposed excavation. Surface marks on roadways do not exceed 1.5" by 18" (40 mm by 450 mm). The facility color and facility owner identity may be added to white flags or stakes.

USE OF TEMPORARY MARKING
Use color-coded surface marks (i.e., paint or chalk) to indicate the location or route of active and out-of-service buried lines. To increase visibility, color coded vertical markers (i.e., stakes or flags) should supplement surface marks. Marks and markers indicate the name, initials or logo of the company that owns or operates the line, and width of the facility if it is greater than 2" (50 mm). Marks placed by other than line owner/operator or its agent indicate the identity of the designating firm. Multiple lines in joint trench are marked in tandem. If the surface over the buried line is to be removed, supplementary offset markings are used. Offset markings are on a uniform alignment and clearly indicate the actual facility is a specific distance away.

TOLERANCE ZONE
Any excavation within the tolerance zone is performed with non-powered hand tools or non-invasive method until the marked facility is exposed. The width of the tolerance zone may be specified in law or code. If not, a tolerance zone including the width of the facility plus 18" (450 mm) measured horizontally from each side of the facility is recommended.

ADOPT UNIFORM COLOR CODE
The American Public Works Association encourages public agencies, utilities, contractors, other associations, manufacturers and all others involved in excavation to adopt the APWA Uniform Color Code, using ANSI standard Z535.1 Safety Colors for temporary marking and facility identification.

Rev. 4/99

Standard Operating Procedure No. 004
for
Sample Packing and Shipping

Prepared by

EA Engineering, Science, and Technology, Inc.
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CONTENTS

Page

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to delineate protocols for the packing and shipping of samples to the laboratory for analysis.

2. MATERIALS

The following materials may be required:

Clear tape	Plastic garbage bags
Custody seals	Sample documentation
Ice	Waterproof coolers (hard plastic or metal)
Metal cans with friction-seal lids (e.g., paint cans)	Zip-seal plastic bags
Packing material[1]	

3. PROCEDURE

Check cap tightness and verify that clear tape covers label and encircles container. Wrap sample container in bubble wrap or closed cell foam sheets. Enclose each sample in a clear zip-seal plastic bag.

Place several layers of bubble wrap, or at least 1 in. of vermiculite on the bottom of the cooler. Line cooler with open garbage bag, place all the samples upright inside a garbage bag, and tie the bag.

Double bag and seal loose ice to prevent melting ice from soaking the packing material. Place the ice outside the garbage bags containing the samples.

Pack shipping containers with packing material (closed-cell foam, vermiculite, or bubble wrap). Place this packing material around the sample bottles or metal cans to avoid breakage during shipment.

Enclose all sample documentation (i.e., Field Parameter Forms, chain-of-custodies) in a waterproof plastic bag and tape the bag to the underside of the cooler lid. If more than one cooler is being used, each cooler will have its own documentation.

Seal the coolers with signed and dated custody seals so that if the cooler were opened, the custody seal would be broken. Place clear tape over the custody seal to prevent damage to the seal.

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1. Permissible packing materials are: (a) (non-absorbent) bubble wrap or closed cell foam packing sheets, or (b) (absorbent) vermiculite. Organic materials such as paper, wood shavings (excelsior), and cornstarch packing "peanuts" will not be used.

Refer to SOP Nos. 001, 002, 016, and 039.

Tape the cooler shut with packing tape over the hinges and place tape over the cooler drain. Ship all samples via overnight delivery on the same day they are collected if possible.

4. MAINTENANCE

Not applicable.

5. PRECAUTIONS

Any samples suspected to be of medium/high contaminant concentration or containing dioxin must be enclosed in a metal can with a clipped or sealable lid (e.g., similar to a paint can). Label the outer metal container with the sample number of the sample inside.

6. REFERENCES

U.S. Environmental Protection Agency (U.S. EPA). 1980. Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans, QAMS-005/80.

U.S. EPA. 1990. Sampler's Guide to the Contract Laboratory Program. EPA/540/P-90/006, Directive 9240.0-06, Office of Emergency and Remedial Response, Washington, D.C. December.

U.S. EPA. 1991. User's Guide to the Contract Laboratory Program. EPA/540/O-91/002, Directive 9240.0-01D, Office of Emergency and Remedial Response. January.

Standard Operating Procedure No. 005
for
Field Decontamination

Prepared by

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CONTENTS

Page

1. SCOPE AND APPLICATION

All personnel or equipment involved in intrusive sampling, or which enter a hazardous waste site during intrusive sampling, must be thoroughly decontaminated prior to leaving the site to minimize the spread of contamination and prevent adverse health effects. This Standard Operating Procedure describes the normal decontamination of sampling equipment and site personnel.

2. MATERIALS

The following materials may be required:

0.01N HCl	Non-phosphate laboratory detergent (liquinox)
0.10N nitric acid	Plastic garbage bags
Aluminum foil or clean plastic sheeting	Plastic sheeting, buckets, etc. to collect wash water and rinsates
Approved water	Pressure sprayer, rinse bottles, brushes
High performance liquid chromatography (HPLC)-grade water[1]	Reagent grade alcohol[2]

3. PROCEDURE

3.1 SAMPLE BOTTLES

At the completion of each sampling activity, the exterior surfaces of the sample bottles must be decontaminated as follows:

- Ensure the bottle lids are on tight.
- Wipe the outside of the bottle with a paper towel to remove gross contamination.

3.2 PERSONNEL DECONTAMINATION

Review the project Health and Safety Plan for the appropriate decontamination procedures.

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[1] For the purposes of this Standard Operating Procedure, HPLC-grade water is considered equivalent to "deionized ultra filtered water," "reagent-grade distilled water," and "deionized organic-free water." The end product being water which is pure with no spurious ions or organics to contaminate the sample. The method of generation is left to the individual contractor.

[2] For the purposes of this Standard Operating Procedure, the term "reagent grade alcohol" refers to either pesticide grade isopropanol or reagent grade methanol.

3.3 EQUIPMENT DECONTAMINATION

3.3.1 Water Samplers

3.3.1.1 Bailers

After each use, polytetrafluoroethelyne (PTFE) double check valve bailers used for groundwater sampling will be decontaminated as follows:

- Discard all ropes used in sampling in properly marked sealable container, or as directed by the Health and Safety Plan. NOTE: No tubing is to be used in conjunction with a bailer in collecting samples.
- Scrub the bailer to remove gross (visible) contamination, using appropriate brush(es), approved water, and non-phosphate detergent.
- Rinse off detergent three times with approved water.
- Rinse bailer with reagent grade alcohol.
- Rinse bailer three times with HPLC-grade water.
- Rinse bailer with 0.10N nitric acid solution.
- Rinse bailer three times with HPLC-grade water.
- Allow bailer to air dry.[3]
- Wrap bailer in aluminum foil or clean plastic sheeting, or store in a clean, dedicated polyvinyl chloride or PTFE storage container.
- Dispose of used decontamination solutions with drummed purge water.
- Rinse bailer with HPLC-grade water immediately prior to re-use.

3.3.1.2 Pumps

Submersible pumps will be decontaminated as follows:

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[3] If the bailer has just been used for purging and is being decontaminated prior to sampling, do not air dry. Double rinse with HPLC-grade water and proceed to collect samples.

- Scrub the exterior of the pump to remove gross (visible) contamination, using appropriate brush(es), approved water, and non-phosphate detergent. (Steam cleaning may be substituted for detergent scrub.)
- Calculate the volume of pump plus any tubing which is not disposable and not dedicated to a single well. Pump three volumes of non-phosphate laboratory detergent solution to purge and clean the interior of the pump.
- Rinse by pumping no less than nine volumes of approved water to rinse.
- Rinse pump exterior with reagent grade alcohol.
- Rinse pump exterior with HPLC-grade water.
- Allow pump to air dry.
- Wrap pump in aluminum foil or clean plastic sheeting, or store in a clean, dedicated polyvinyl chloride or PTFE storage container.
- Prior to reusing pump rinse exterior again with HPLC-grade water. (Double rinse in Bullet 5 above may be substituted for this step).

3.3.1.3 Dip Samplers

All dip samplers, whether bucket, long-handled, or short-handled, will be decontaminated in the same manner as provided in Section 3.3.1.1.

3.3.1.4 Labware

Labware, such as beakers, which are used to hold samples for field measurements, water chemistry, etc. will be decontaminated according to the procedures in Section 3.3.1.1.

3.3.1.5 Water Level Indicators

Electric water level indicators, weighted measuring tapes, or piezometers used in the determination of water levels, well depths, and/or non-aqueous phase liquid levels will be decontaminated in accordance with Section 3.3.1.1. Clean laboratory wipes may be substituted for brushes. Tapes, probes, and piezometers should be wiped dry with clean laboratory wipes, and coiled on spools or clean plastic sheeting rather than allowed to air dry.

3.3.2 Solid Materials Samplers

Solid materials samplers include soil sampling probes, augers, trowels, shovels, sludge samplers, and sediment samplers, which will be decontaminated as follows:

- Scrub the sampler to remove gross (visible) contamination, using appropriate brush(es), approved water, and non-phosphate laboratory detergent.

- Rinse off detergent with approved water.

- Rinse sampler with reagent grade alcohol.

- Rinse sampler with HPLC-grade water.

- For non-metallic samplers only, rinse sampler with 0.10N nitric acid solution.

- For non-metallic samplers only, rinse sampler with HPLC-grade water.

- Allow sampler to air dry.

- Wrap sampler in aluminum foil clean plastic sheeting, or store in a new zipseal bag (size permitting) or clean, dedicated polyvinyl chloride or PTFE storage container.

- Dispose used decontamination solutions properly according to the site-specific Health and Safety Plan.

- Rinse sampler with HPLC-grade water immediately prior to re-use.

3.3.3 Other Sampling and Measurement Probes

Soil gas sampling probes will be decontaminated as solids sampling devices.

Temperature, pH, conductivity, redox, and dissolved oxygen probes will be decontaminated according to manufacturer's specifications. If no such specifications exist, remove gross contaminant and triple rinse probe with HPLC-grade water. A summary of the decontamination procedures to be used must be included in the instrument-specific standard operating procedure.

Measuring tapes that become contaminated through contact with soil during field use will be decontaminated as follows:

- Wipe tape with a clean cloth or laboratory wipe that has been soaked with non-phosphate laboratory detergent solution to remove gross contamination. Rinse cloth in the solution and continue wiping until tape is clean.

- Wipe tape with a second clean, wet cloth (or laboratory wipe) to remove soap residues.

- Dry tape with a third cloth (or laboratory wipe) and rewind into case, or re-coil tape.

3.3.4 Drilling Rigs and Other Heavy Equipment

All drilling rigs and associated equipment such as augers, drill casing, rods, samplers, tools, recirculation tank, and water tank (inside and out) will be decontaminated prior to site entry after over-the-road mobilization and immediately upon departure from a site after drilling a hole. Supplementary cleaning will be performed prior to site entry when there is a likelihood that contamination has accumulated on tires and as spatter or dust enroute from one site to the next.

- Place contaminated equipment in an enclosure designed to contain all decontamination residues (water, sludge, etc.).
- Steam clean equipment until all dirt, mud, grease, asphaltic, bituminous, or other encrusting coating materials (with the exception of manufacturer-applied paint) have been removed.
- Water used will be taken from an approved source.
- Containerize in 55-gal drums; sample; characterize; and, based on sample results, dispose of all decontamination residues properly.

Other heavy equipment includes use of backhoes, excavators, skid steers, etc. If heavy equipment is utilized during field activities, i.e., a backhoe for test pitting, the bucket should not come in contact with soil to be sampled. If the bucket contacts the soil to be sampled, then it should be decontaminated between sample locations, following the same procedures as listed above for a drill rig.

3.3.5 High Performance Liquid Chromatography-Grade Water Storage

Dedicated glass storage containers will be used solely for dispensing HPLC-grade water. New HPLC-grade water containers will be decontaminated as follows:

- Clean with tap water from approved source and non-phosphate laboratory detergent while scrubbing the exterior and interior of the container with a stiff-bristled brush.
- Rinse thoroughly with approved water.
- Rinse with 0.01N nitric acid.
- Rinse with approved water.
- Rinse thoroughly with HPLC-grade water.
- Fill clean container with HPLC-grade water. Cap with one layer of PTFE-lined paper and one layer of aluminum foil. Secure cap with rubber band and date the container.

Used HPLC-grade water containers will be decontaminated as follows:

- Clean the exterior with tap water from an approved source, non-phosphate laboratory detergent, and a stiff-bristled brush.
- Rinse the exterior thoroughly with HPLC-grade water.
- Rinse the interior twice with pesticide-grade isopropanol.
- Rinse interior thoroughly with HPLC-grade water.
- Fill clean container with HPLC-grade water. Cap with one layer of PTFE-lined paper and one layer of aluminum foil. Secure cap with rubber band and date the container.

3.3.6 Ice Chests and Reusable Shipping Containers

- Scrub exterior/interior with approved brush and liquinox detergent.
- Rinse off detergent three times with approved water.
- Let air dry and properly store until re-use.

NOTE: If container/ice chest is severely contaminated, clean as thoroughly as possible, render unusable, and properly dispose.

4. MAINTENANCE

HPLC-grade water will be stored only in decontaminated glass containers with aluminum foil lids as stipulated above. The water may not be stored for more than nor used more than 3 days after manufacture.

HPLC-grade water will be manufactured onsite. An approved tap water source will be used as the influent to the system. Procedures for system setup, operation, and maintenance will conform to manufacturer’s specifications.

5. PRECAUTIONS

Dispose of all wash water, rinse water, rinsates, and other sampling wastes (tubing, plastic sheeting, etc.) in properly marked, sealable containers, or as directed by the Health and Safety Plan.

Once a piece of equipment has been decontaminated, be careful to keep it in such condition until needed.

Do not eat, smoke, or drink onsite.

6. REFERENCES

Site-specific Health and Safety Plan.

Standard Operating Procedure No. 008
for
pH Measurement

Prepared by

EA Engineering, Science, and Technology, Inc.
11019 McCormick Road
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Revision 0
August 2007

CONTENTS

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to delineate protocols for measuring the pH of all types of aqueous solutions, including drinking water, saline water, and industrial and domestic wastes. As a measure of the hydrogen ion content of a solution, pH gives a general indication of the acidity or alkalinity of a water sample.

Use of brand names in this SOP is not intended as endorsement or mandate that a given brand be used. Alternate equivalent brands of detectors, sensors, meters, etc. are acceptable. If alternate equipment is to be used, the contractor will provide applicable and comparable SOPs for the maintenance and calibration of same.

2. MATERIALS

The following materials may be required:

Φ ® 12 pH Meter
Automatic temperature compensator (ATC) probe
Beakers
Combination (pH) electrode
Commercial buffer solutions (standards) of pH 4.00, 7.00, and 10.00
HPLC-grade water
Laboratory wipes for blotting electrodes
Wash bottle

3. PROCEDURE

3.1 CALIBRATION CHECK

Calibration of the pH meter will be checked on a daily basis. A two-point calibration should be used as follows:

1. Prepare beakers of buffer solutions of pH 4.00, 7.00, and 10.00.

2. Calibration should closely bracket the expected pH range of the samples to be taken.

3. Turn on instrument, clear instrument.

4. Rinse the electrode with distilled water and blot excess.

5. Immerse probes in beaker of pH 4.00 or 7.00 standard, swirl gently.

6. Press pH key, then STD key.

7. Keep the probes in the sample until the reading stabilizes. The reading should be the pH of the standard.

8. Rinse the electrode with distilled water and blot excess.

9. Repeat the procedure with pH 7.00 and 10.00 standards.

10. Record the initial readings.

11. If the measured values vary from the expected value by greater than 0.2 pH units, recalibrate the instrument with fresh aliquots of buffer solution. If the discrepancy persists, alert the Field Operations Leader, who has the option of trying to fix the meter or obtaining a second pH meter.

12. Record all measurements in the field logbook.

13. Verify calibration by reading the pH of the third buffer solution.

14. Refer to SOP No. 016.

3.2 pH MEASUREMENTS

Measurements of pH will be taken using the two-point standardization method as follows:

1. Connect the ATC and pH electrodes to the appropriate inputs.

2. Turn on instrument, clear instrument.

3. Prepare two small beakers of standard buffer solutions. Ideally, the pH values of these standards will “bracket” the expected pH value of the sample and be as close as possible to the pH of the sample.

4. Rinse a small beaker with distilled water, then sample water. Fill the beaker with sample water.

5. Rinse the probes with distilled water. Blot excess.

6. Immerse electrode and ATC in first standard. Swirl gently. Press pH key and STD key. Wait for display to stop flashing.

7. Rinse the probes with distilled water. Blot excess.

8. Immerse electrode and ATC in second standard. Swirl gently. Press STD key. Wait for display to stop flashing.

9. Rinse the probes with distilled water. Blot excess.

10. Immerse the probes in the sample and swirl gently, keeping the probes in the sample until the display stops flashing.

11. Record the sample pH and temperature after stabilization. Note any problems such as meter drift.

12. Rinse the probes with distilled water. Blot excess.

13. Repeat Steps 9 through 12 for additional samples.

Decontaminate probe according to manufacturer's specifications.

Decontaminate beakers according to SOP No. 005, Section 3.3.1.4 (Labware).

4. MAINTENANCE

The following steps will be taken to maintain the pH meter:

1. Check the batteries each time the meter is used.

2. Keep the probe stored in a 0.1 M KCl solution adjusted to pH 4 when the meter is not in use. Alternatively, the electrode may be rinsed with deionized water and the protective cap put on, trapping any residual water inside it (do not blot the electrode dry prior to putting the cap on).

5. PRECAUTIONS

Remove coatings of oil material or particulate matter that can impair electrode response by gentle wiping or detergent washing, followed by distilled water rinsing.

As noted in Section 1, these procedures may not apply to alternate manufacturer's equipment.

Calibration is always performed using the pH 7.00 and one end point (pH4.00 or 11.00) standard. **Never** calibrate the instrument using two end points only.

6. REFERENCES

Beckman Instruments, Inc. Users Manual for Φ® 10 pH Meter, Φ® 11 pH meter, and Φ® 12 pH/ISE Meter.

Franston, M.H. et al. (eds). 1981. Standard Methods for the Examination of Water and Wastewater, 15th Edition. American Public Health Association, American Water Works Association and Water Pollution Control Federation.

U.S. Environmental Protection Agency. 1983. Methods for Chemical Analysis of Water and Wastes. March.

Standard Operating Procedure No. 009
for
Temperature Measurement

Prepared by

EA Engineering, Science, and Technology, Inc.
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CONTENTS

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to delineate protocols for measuring the temperature of a solid or liquid sample, in particular, for measuring water temperature. Groundwater temperature does not vary dramatically over the course of a year. Therefore, groundwater temperature can be used to help identify an aquifer, identify stream reaches where groundwater inflow is occurring, identify thermal gradients in lakes or ponds, and also indicate when sufficient water has been removed from a well during purging.

2. MATERIALS

The following materials may be required: digital reading thermocouple thermometer in combination meter or in a stick. Accuracy = ±0.5°C.

3. PROCEDURE

Rinse the probe with distilled water. Insert the probe into the sample, and leave it in the sample until the temperature stabilizes. Record the temperature reading, being sure to indicate °C or °F. Decontaminate the probe according to Section 3.3 of SOP No. 005 (Field Decontamination).

Refer to SOP Nos. 005 and 016.

NOTE: °C = (°F - 32) (5/9)
°F = ([9/5]°C) + 32.

4. MAINTENANCE

Not applicable.

5. PRECAUTIONS

None.

6. REFERENCES

U.S. Environmental Protection Agency. 1983. Methods for Chemical Analysis of Water and Wastes. March.

Standard Operating Procedure No. 010
for
Water Level and
Well Depth Measurements

Prepared by

EA Engineering, Science, and Technology, Inc.
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CONTENTS

Page

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to delineate protocols for measuring water level and well depth. This procedure is applicable to the sampling of monitoring wells and must be performed prior to any activities which may disturb the water level, such as purging or aquifer testing.

2. MATERIALS

The following materials may be required:

Electric water level indicator (dipmeter) with cable measured at 0.01-ft increments OR weighted steel tape and chalk OR transducer and datalogger
Oil/water interface probe
Plastic sheeting
Photoionization detector or intrinsically safe flame ionization detector

3. PROCEDURE

3.1 PRELIMINARY STEPS

Locate the well and verify its position on the site map. Record whether positive identification was obtained, including the well number and any identifying marks or codes contained on the well casing or protective casing. Gain access to the top of the well casing.

Locate the permanent reference mark at the top of the casing. This reference point will be scribed, notched, or otherwise noted on the top of the casing. If no such marks are present, measure to the top of the highest point of the well casing and so note this fact in the field logbook. Determine from the records and record in the notebook the elevation of this point.

Record any observations and remarks regarding the completion characteristics and well condition, such as evidence of cracked casing or surface seals, security of the well (locked cap), and evidence of tampering.

Keep all equipment and supplies protected from gross contamination; use clean plastic sheeting. Keep the water level indicator probe in its protective case when not in use.

3.2 OPERATION

Sample the air in the well head for gross organic vapors by lifting the well cap only high enough for an organic vapor meter (photoionization detector or flame ionization detector) probe to be entered into the well casing. This will indicate the presence of gross volatile contaminants as well as indicating potential sampler exposure.

Remove cap. Allow well to vent for 60-90 seconds. Resample headspace. Record both readings. If the second reading is lower than the first, use the second reading to determining whether respiratory protection will be required during subsequent water level and well depth determinations, and sampling.

Note that all headspace sampling must be performed at arm's length and from the upwind side of the well if possible.

Refer to SOP Nos. 011, 023, or 024 as appropriate.

If non-aqueous phase liquid (NAPL) contamination is suspected[1], use an interface probe to determine the existence and thickness of NAPLs.

Open the probe housing, turn the probe on, and test the alarm. Slowly lower the probe into the well until the alarm sounds. A continuous alarm indicates a NAPL while an intermittent alarm indicates water. If a NAPL is detected, record the initial level (first alarm). Mark the spot by grasping the cable with the thumb and forefingers at the top of the casing. If a mark is present on the casing, use the mark as the reference point. If no mark is present, use the highest point on the casing as the reference point. Withdraw the cable sufficiently to record the depth.

Continue to slowly lower the probe until it passes into the water phase. Slowly retract the probe until the NAPL alarm sounds and record that level in the manner as described above.

Record the thickness of the light NAPL[2] (Section 3.3).

Continue to slowly lower the interface probe through the water column to check for the presence of dense NAPL.

Measure and record the thickness of the dense NAPL layer (if any) as described above.

Slowly raise the interface probe, recording the depth to each interface as the probe is withdrawn. If there is a discrepancy in depths, clean the probe sensors and re-check the depths.

NOTE: Air/liquid interface depth is more reliable if probe is lowered into liquid. NAPL/water depths are more accurate if probe is moved from water into NAPL.

Always lower and raise interface probe slowly to prevent undue mixing of media.

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[1] Interface probes will be used in all wells for first round sampling, regardless of site history. If no NAPLs are detected during the first round of sampling, this step may be omitted during subsequent sampling events **unless** conditions such as site history or headspace vapors would indicate otherwise.

[2] If NAPL is viscous, such as coal tar or weather bunker oil, several confirmation measurements should be made after decontamination of the probe to verify that the NAPL is not sticking to the probe and causing erroneous readings. One way to accomplish this would be to partially fill a 5-gal bucket with water and dip the probe to ensure that decontamination has effectively removed the NAPL.

Always perform NAPL check in wells installed in areas with suspected NAPL contamination. Always perform NAPL check if headspace test reveals presence of volatiles. Always perform NAPL check the first time a well is sampled. **If** a well has been sampled previously **and** no NAPLs were present **and** none of the preceding conditions are met, the NAPL check may be omitted.

If no NAPL is present, use an electronic water level detector as follows:

- Remove the water level indicator probe from the case, turn on the sounder, and test check the battery and sensitivity scale by pushing the red button. Adjust the sensitivity scale until you can hear the buzzer.

- Slowly lower the probe and cable into the well, allowing the cable reel to unwind. Continue lowering until the meter buzzes. Very slowly, raise and lower the probe until the point is reached where the meter **just** buzzes. Marking the spot by grasping the cable with the thumb and forefingers at the top of the casing. If a mark is present on the casing, use the mark as the reference point. If no mark is present, use the highest point on the casing as the reference point. Withdraw the cable and record the depth.

Alternatively use a steel tape with an attached weight if aquifer gradients are lower than 0.05 ft/ft. Due to the possibility of adding unknown contaminants from chalk colorants, only white chalk is permitted.

Rub chalk onto the first 1 ft of the steel tape and slowly lower the chalked end into the well until the weighted end is below the water surface. (A small splash can be heard when the weighted end hits the water surface.)

Using the method described above read and record the length from the steel tape.

Remove the steel tape. The chalk will be wet or absent where the tape was below the water surface. Locate, read, and record this length. Subtract wetted length from total length and record the difference. This is the depth to water table.

Transducers and dataloggers will be used where water level fluctuations over time are to be measured, such as tidal fluctuation studies (SOP No. 045) and aquifer (hydraulic) tests (SOP No. 033). Note that transducers are inappropriate for measuring well depth.

Slowly lower the transducer into the well until it is below the lowest possible piezometric level (typically 2-3 ft below the water table).

Tape the umbilical to the protective casing to prevent the transducer from falling further.

Attach the umbilical leads to the datalogger.

Turn datalogger on.

To measure the well depth, lower electric water level indicator probe or tape until slack is noted. Very slowly raise and lower the cable until the exact bottom of the well is "felt." Measure (cable) or read the length (tape) and record the depth.

Note that if the electric water level indicator is used to determine depth of well, the offset distance between the tip of the probe and the electrode must be added to the reading to determine actual depth.

Withdraw the probe or tape. Decontaminate the probe(s) and cable(s).

3.3 DATA RECORDING AND MANIPULATION

Record the following computations:

- Date and time
- Weather
- Method of measurement
- Casing elevation
- NAPL surface elevation = casing elevation – depth to NAPL
- NAPL thickness = depth to bottom of NAPL – depth to top of NAPL
- Water level elevation = casing elevation – depth to water
- Well bottom elevation = casing elevation – depth to bottom (or read directly from tape).

Refer to SOP Nos. 005 and 016.

4. CALIBRATION

No calibration is needed.

5. PRECAUTIONS

Depending upon the device used, correction factors may be required for some measurements. Check instrument batteries prior to each use. Exercise care not to break the seals at the top of the electric water level indicator probe.

6. REFERENCES

McAlary, T.A. and J.F. Barker. 1987. Volatilization Losses of Organics during Groundwater Sampling from Low Permeability Materials in Groundwater Monitoring Review. Fall.

Thornhill, J.T. 1989. Accuracy of Depth to Groundwater Measurements in U.S. Environmental Protection Agency Superfund Groundwater Issue EPA/540/4-89/002.

Standard Operating Procedure No. 012
for
Specific Conductance Measurements

Prepared by

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CONTENTS

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to delineate protocols for measuring the specific conductance of any aqueous solution, including drinking water, saline water, and industrial and domestic wastes. Conductivity is the ability of an aqueous solution to pass an electrical current. The current is primarily carried by dissolved inorganic ions such as chlorides, nitrates, sulfates, along with cations such as sodium, calcium, magnesium and others. Organic compounds do not carry current and, therefore, have almost no conductivity.

2. MATERIALS

The following materials may be required:

Conductivity meter with integral temperature compensation; accuracy = ±2 percent at 25°C (77°F)
Conductivity cell
Appropriate conductivity reference solution
High performance liquid chromatography (HPLC)-grade water (see SOP No. 005, Footnote 2)
Thermometer (optional, Section 5)

3. PROCEDURE

3.1 CALIBRATION

The specific conductivity meter should be calibrated at the beginning of each day[1] as follows:

1. Thoroughly rinse the probe with appropriate conductivity reference solution.

2. Zero meter if appropriate.

3. Measure the specific conductance of fresh appropriate conductivity reference solution record it in the field notebook, and adjust the calibration knob until the meter reads properly.

4. Rinse probe with HPLC-grade water.

5. Measure the specific conductance of HPLC-grade water and record in the field logbook. If specific conductivity of HPLC-grade water is not 0 (±2 percent) recalibrate instrument.

---

[1] The meter should be recalibrated any time the readings are suspect (e.g., out of expected range).

3.2 OPERATION

The specific conductivity meter will be operated as follows:

1. Thoroughly rinse the probe and sample beaker with sample water.

2. Measure the temperature of the sample water. Convert Fahrenheit temperature readings to Celsius using C = 5/9(F - 32) if Celsius temperature is not obtained directly.

3. Place the probe in the sample beaker with sufficient sample to completely submerge the probe. Swirl the probe to remove any air bubbles trapped in the probe.

4. Select the highest multiplier scale on the meter and turn the instrument on. Progressively use lower multiplier scales until a mid-scale deflection is obtained.

5. If appropriate, check probe accuracy by pressing cell test button. If value change is >10 percent check probe.

6. Record the temperature and conductivity values.

7. Specific conductivity values are corrected for temperature using:

   K^25^oC = {*K measured*} over {1+ 0.0191 (t-25)}

   where

   K = Conductivity in µmhos
   t = Temperature, °C

8. Decontaminate the probe (see SOP No. 005, Section 3.3.3).

Refer to SOP Nos. 005 and 016.

4. MAINTENANCE

The following steps will be taken to properly maintain the conductivity meter:

1. Check the batteries each time the instrument is used.

2. Inspect the probe on a daily basis for damage or loss of platinum black plating from the electrode. If the platinum is damaged, alert the Field Team Leader and arrange to get a new cell.

3. Follow manufacturer's specifications regarding storage of probe between uses.

5. PRECAUTIONS

Be certain there is no air in the cell before taking a reading. If conductivity meter does not have integral temperature compensation, use a thermometer to determine temperature of the sample.

6. REFERENCES

Manufacturer's Manual.

U.S. Environmental Protection Agency. 1983. Methods for Chemical Analysis of Water and Wastes. March.

Standard Operating Procedure No. 013
for
Collection of Monitoring Well Samples

Prepared by

EA Engineering, Science, and Technology, Inc.
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CONTENTS

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure is to delineate protocols for the collection of groundwater samples from monitoring wells.

2. MATERIALS

The following materials may be required:

0.45 µM filters	Polyvinyl chloride bailer (for purging only)
Bladder pump (dedicated to one well only)	Sample bottles and labels
Conductivity meter	Stainless steel bailer (for purging and sampling)
Dissolved oxygen meter	Submersible pump and hose (for purging only)
Generator	Thermometer (optional)[1]
Logbook or book of field parameter forms	Transparent bailer with a double check valve
Peristaltic pump with tubing for filtering samples	Turbidity meter
pH meter with oxidation-reduction potential probe	Tygon tubing
Photoionization detector organic vapor analyzer.	Variable speed, low flow submersible pump (e.g., Grundfos MP1 groundwater sampling pump) (for purging and sampling)
Plastic sheeting	Water level indicator
Polypropylene rope	
Polytetrafluoroethelyne (PTFE) bailer with PTFE-coated stainless steel cable, double check valve top, and controlled flow bottom discharge attachment[2] for volatile organic compound (VOC) sampling (40-mL vials), and top discharge attachment for collecting larger samples (1-L bottles) (for purging and sampling)	

3. PROCEDURE

3.1 GENERAL

Groundwater sampling will follow these general steps:

- Arrive onsite
- Set up apparatus (generators, pumps, etc.)
- Glove
- Organic vapor check, water level, and well depth measurements

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1. Temperature compensation and measurement capabilities are generally available as integral functions of pH meters and conductivity meters. If this is the case, a separate thermometer is not required.
2. Although use of a controlled flow bottom discharge valve is historically preferred, use of such a device can cause aeration of the sample.

- Sample non-aqueous phase liquids (NAPLs) (as required)

- Begin purge procedure

  - If using bailer to purge and sample, see Section 3.6
  - If using pump to purge and bailer to sample, see Section 3.7
  - If using bladder or low-flow pump to purge and sample, see Section 3.8

- Decontaminate/reglove

- Take samples

  - If with bailer, see Section 3.6
  - If with bladder or low flow pumps, see Section 3.8

- Decontaminate/dispose of wastes, move equipment to next site.

3.2 GENERAL RULES FOR GROUNDWATER FIELD PARAMETER LOGBOOK

Only one site or installation per logbook, and only one sampling location per page or form (if using pre-printed forms). The same book may be used for more than one sampling event. First five pages will be reserved for index, general notes, etc. Sign and date each entry. Last five pages will be reserved for recording calibration data for the pH, temperature, turbidity, oxidation-reduction potential, dissolved oxygen, and conductivity meters. Use the page number or a separately recorded "Cal Reference Number" to refer to each calibration. As appropriate, insert the cardboard flap under the form being filled out, so that writing does not go through to the pages below. As appropriate, fill in the forms from front to back of the logbook, tearing out the white copy for each sample when the sample has been collected. This copy goes in the cooler with the sample, directly to the laboratory. The original copy must be torn out before you write on the back of the duplicate form. As appropriate, duplicate copies, index pages, and calibration sheets remain intact.

3.3 GROUNDWATER SAMPLING GENERAL RULES

Groundwater samples will be collected from the least contaminated wells first, progressing to the most contaminated[3]. Upon arrival at the well site, immediately set up and organize the purging, sampling, and filtration equipment. If needed, due to muddy or contaminated ground, remoteness from sampling vehicle, and\or for placement of hose(s) and\or power cord if a pump is used, place clean plastic sheeting at, or around the well, to serve as a clean staging area for purging and sampling equipment, as conditions warrant. Care must be exercised not to step on plastic sheeting. If the well is remote from the sampling vehicle, set up the filtration equipment

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[3] First round samples are to be collected from upgradient wells first, moving to downgradient wells under the assumption that upgradient wells will be less contaminated than downgradient wells. Results of first round analysis may mandate a change in sampling sequence.

and place rope, wrapped bailer, and pre-labeled sample containers on the plastic sheet, from the well. When a pump is to be used, situate the portable generator on level ground approximately 15 ft away from and downwind from the well. All generator maintenance (oil and fueling) is to be performed offsite. If the hose(s) and/or power cord of the pump are not on a reel, place the pump with its hose and power cord on the plastic sheeting downhill from the well.

Check well headspace for organic vapor which may pose a health and safety hazard and indicate the presence of NAPL. Measure depth(s) to and thickness(es) of NAPL(s) as appropriate. Measure the depth to water and depth of well. From the water depth, well diameter, sand pack length, etc., calculate the equivalent volume (1 EV) of water in the well.

1 EV = volume in casing + volume in saturated sand pack. Therefore, if the water table lies below the top of the sandpack, use the following equation:

$$1\ \text{EV} = (\pi R_w^2 h_w) + (0.30\pi(R_s^2 - R_w^2)h_w) * (0.0043)$$

If the water table lies above the top of the sandpack use this equation:

$$1\ \text{EV} = [(\pi R_w^2 h_w) + (0.30\pi(R_s^2 - R_w^2)h_s)] * (0.0043)$$

where

R_s = Radius of sandpack in inches
R_w = Radius of well casing in inches
h_s = Height of sandpack in inches
h_w = Water depth in inches

0.0043 gal/in.^{3}
Assumed filter pack porosity = 30 percent.

Samples will always be collected in order of decreasing volatility (i.e., the samples to be analyzed for the volatile constituents should be collected first). Deliver the VOC sample to the vial by allowing the water to trickle down the inside wall of the vial at a rate no greater than approximately 100 ml/min. Other samples may be delivered at a faster rate. Sampling rates will at no time exceed 1 L/min. Procedures for each class of samples are contained in the site-specific Quality Assurance Project Plan.

When collecting samples for volatile analysis, care should be taken to prevent analyte loss by volatilization. The following procedures should be adhered to when collecting these samples:

- Avoid excessive aeration and agitation of sample.
- Fill vial so that a reverse meniscus is present by adjusting the flow rate from the sampling device.

- Place septum on vial so that the PTFE side is in contact with the sample. After the cap is on the bottle, check for air bubbles in the sample. If air bubbles are present, properly dispose of that sample and recollect the sample in the same vial.

- Make sure vial is labeled and immediately transfer the vial to the cooler with ice.

Filtered and unfiltered samples will be taken for inorganics (metals) analyses. The samples will be filtered through an in-line 0.45-μM filter (preferred method), or by gravity through a 0.45-μM membrane placed in a filter funnel. Use forceps to place the membrane into the funnel and pour sample through funnel until appropriate volumes have been filtered.

If necessary, due to slow filtering, a peristaltic pump may be used to filter the sample through an in-line filter. Connect the pump to the generator, attach tygon tubing to the bottom discharge valve on the bailer. Start pump and collect sample from the end of the in-line filter directly into the proper container, preserved, and placed in the cooler. Filtered samples will be preserved in the field with acid to a pH of less than 2. Make sure sample bottle is labeled and the cap is on tightly. Then place in cooler with ice immediately.

— OR —

If a low flow pump is used collect the samples, filtered samples will be taken by installing a 0.45-μM filter in-line and pumping the water through the filter. Collect sample from the end of the in-line filter directly into the proper container, preserved, and placed in the cooler. Filtered samples will be preserved in the field with acid to a pH of less than 2. Make sure sample bottle is labeled and the cap is on tightly. Then place in cooler with ice immediately.

Unfiltered samples will be collected by slowly pouring the sample water into the appropriate sample container, being careful not to agitate or cause bubbles to form. Do not overfill bottles. Make sure sample bottle is labeled and the cap is on tightly, then place the sample in cooler with ice immediately.

All samples will be delivered to the laboratory as soon as possible. If possible, samples will be shipped on the same day as they are collected. If samples must be retained due to weekend sampling (Friday through Sunday), the laboratory will be notified as to the time sensitive nature of the samples.

3.4 SAMPLING OF NON-AQUEOUS PHASE LIQUIDS

If NAPLs are detected in the well, a sample from all layers must be collected prior to any purging activities. NAPLs may be indicated by the presence of volatiles in the well headspace, and confirmed by the oil/water interface probe.

Collecting light non-aqueous phase liquid (LNAPL) will be accomplished using a transparent bailer with a double check valve. This bailer will be slowly lowered until the bottom of the bailer is 1-2 in. below the LNAPL-water interface, then slowly withdrawn. Verify that the interface was sampled by visual inspection of the bailer contents through the side of the bailer. Measure the thickness of the LNAPL in the bailer and note in the Field Logbook. Sample for laboratory analysis. An additional field verification may be performed by decanting the remainder of the contents of the bailer into a glass jar, adding a hydrophobic dye such as Sudan IV, or Redoil, shaking the sample and looking for coloration of NAPL. Alternate field tests are: examine the sample under ultraviolet light (many fluoresce), or allow the sample to stand overnight, and examine for interface and/or volatiles in the headspace the following day. Refer to following sections on purging and sample collection for setup and general operation.

Collecting dense non-aqueous phase liquids (DNAPLs) will be accomplished using a transparent bailer with a double check valve. The bailer must be lowered very slowly to the bottom of the well and raised slowly out of the well in a controlled fashion. Sample for analysis as above. The same field check described above may be employed for DNAPL. Refer to following sections on purging and sample collection for set up and general operation.

If NAPLs are present in the well, **and** a low-flow pump is to be used for purging and sampling, the well will be allowed to re-equilibrate prior to purging and sampling. This will be accomplished by allowing the well to stand undisturbed for at least 8 hours prior to purging and sample collection.

3.5 WELL PURGING GENERAL RULES

Water within the casing of a well will stagnate, degas, lose volatiles, possibly precipitate metals due to changes in redox potential, and may react with the screen and/or casing material. It is, therefore, necessary to purge a sufficient volume of this stagnant water from the well and/or casing to ensure that a representative sample of formation water can be obtained. Traditionally, the volume of water to be purged was arbitrarily set at 3-5 equivalent volumes. Recent advances in sampling technologies have caused a re-thinking of such arbitrary purge volumes. It is for this reason that monitoring of select chemical and physical properties of the sample medium will be used instead of strict volumes to determine when a representative sample may be taken from a well.

Acceptable purge/sampling devices include: bailers, high-discharge submersible pumps (purge only), and variable speed, low-flow pumps which include both submersible pumps (purge and sample) and dedicated bladder pumps (purge and sampling). It is recommended to purge and sample at similar rates with one type device per well. An acceptable exception to this general rule is to use a high-discharge submersible pump to purge a deep, fast-recharging well, and a bailer to sample the same well.

Peristaltic, gas-lift, and centrifugal pumps can cause volatilization, produce high pressure differentials, and can result in variability in the analysis of some analytes of interest. These types of pumps will not be used to purge or sample wells.

To prevent groundwater from cascading down the sides of the screen into an open hole, thereby aerating the sample, purge rates will closely match recharge rates. If the static water level is within the casing, the initial purge rates may be set high enough to lower the water level to the top of the screen, then reduced to maintain that level.

Purging will be accomplished with either a submersible pump, a low-flow (submersible or bladder) pump, or bailer. The choice of bailer or pump will be based on depth to water table, volume to be purged, and permeability of the aquifer. If the well recharges rapidly and/or has greater than 20 gal (estimated EV) to be purged, water may be removed with a submersible pump or a low-flow pump. If the well recharges slowly and/or has less than 20 gal to be purged, water will be removed with a bailer or a low-flow pump.

Purging will be accomplished with as minimal disturbance to the surrounding formation as possible.

Purge water will be containerized onsite until analysis of samples is completed. Based on sample results, accumulated purge water will be properly disposed.

If the water level is within the screened interval and the well recharge rate is less than 0.1 L/min, purge the well using a low-flow pump as follows:

1. Draw the water down to within 1 ft of the top of the pump.

2. Allow the well to recover.

3. Check and record field parameters.

4. Repeat Steps 1 through 3 then collect samples for metals analysis only[4].

5. Note the event in the Field Logbook, and report the problem to the Project Manager. If this extremely low recharge problem consistently occurs in a given well, the well may be considered for re-development and/or replacement.

6. If adjacent wells have elevated VOC levels, additional soil gas surveys will be considered in the vicinity of the low recharge well to help determine the need for replacement.

3.6 PURGING AND SAMPLING WITH BAILERS

Bailers may be used for both purging and sampling wells if: (a) the well recharge rate is less than 4 L/min, (b) depth to the water table is less than 50 ft, and (c) less than 20 gal are to be purged (5 EV < 20 gal)[5].

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[4] Analyte losses due to volatilization in a drained well are too high for valid VOC sampling (McAlary and Barker 1987).

When purging with a bailer, either a polyvinyl chloride, PTFE, or stainless steel bailer may be used. The bailer will be attached to either a spool of PTFE-coated stainless steel cable or polypropylene rope. If using cable, attach it to the bailer using stainless steel cable clamps. Thoroughly decontaminate the cable after each use, prior to rewinding cable onto spool. Cable clamps and raw cable ends may serve to trap contamination. Exercise particular caution in decontaminating these areas. If using rope, attach the rope to the bailer using a bowline knot, dispense the needed length (a few feet more than the well depth) and cut the remainder away; then, at the end opposite the bailer, make a slip knot and place it around the well casing or protective posts to prevent losing the bailer and rope down the well. The polypropylene rope will be not reused; it will be properly disposed of. Either type of bailer will be repeatedly lowered gently into the well until it fills with water, removed, and the water will be discharged into an appropriate container until purging is complete. Care must be taken not to unduly agitate the water, as this tends to aerate the sample, increase turbidity, makes stabilization of required parameters difficult to achieve, and generally prolongs purging.

After purging 2 EV, obtain a sample of groundwater and measure the following stabilization parameters: temperature, conductivity, pH, turbidity, redox potential (Eh), and dissolved oxygen level at each successive half-well volume. When three of these stabilization parameters are in agreement within approximately 10 percent in three consecutive half-well volume samples, sufficient water has been purged from the well. The results of these tests should be recorded in the sampling logbook. Should these parameters not reach agreement, no more than five well volumes will be purged.

Immediately upon completion of purging, collect samples for laboratory analysis using a PTFE bailer on a PTFE-coated stainless steel cable. The bailer will be equipped with double check valve top and controlled flow bottom discharge attachments for VOC sampling (40-mL vials), and top discharge attachment for collecting larger samples (1-L bottles).

Slowly, so as not to agitate the water, lower the bailer into the well, using a spool of PTFE-coated cable. Allow bailer to fill, withdraw smoothly. Refill bailer as needed.

If the controlled flow bottom discharge attachment is used for VOC sampling, attach it to the bottom of the bailer. Using the stopcock valve on the bailer to control the flow, fill sample vials as described above in Section 3.3.

Remove check valve top and pour unfiltered sample into inorganics sample bottles.

Collect filtered samples as described in Section 3.3. Decontaminate bailer and cable.

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5. These numbers are based on the following assumptions: (1) In purging, it is preferable to remove water at approximately the recharge rate; (2) 4 L/min is estimated as the approximate maximum rate at which water can be removed with a bailer from depths of 20-50 ft; and (3) 20 gal is estimated to be at the limit of the sampler’s endurance, at which point fatigue and sloppiness of technique begin.

3.7 PURGING WITH PUMP, SAMPLING WITH BAILER

If the recharge rate of the well is greater than 30 L/min, or the water level is deeper than 50 ft, or more than 20 gal of purge water will be generated (5 EV > 20 gal), then purging and sampling may be accomplished using a submersible pump/bailer combination.

When purging with a pump, gradually lower the intake until it is submerged within the screened interval. Lower an electronic water level probe to the top of the screen (as determined from completion records) to the monitor water level, start pump, and slowly lower the pump as the water level continues to fall. Care should be exercised to lower the water column to the top of the screened interval (water level probe will stop beeping) but not below the top of the screen if possible. This will ensure that the stagnant layer has been removed, but should minimize the detrimental effects of over pumping the well. Secure hose(s) and/or power cord to casing and place discharge hose into the proper container, downhill and as far away from the well as possible. Determine and record the discharge rate.

Discharge rate = volume of container/time to fill container

The discharge rate will be established at approximately equal to or just greater than the well's recharge rate (determined from well development). If well development records are incomplete, recharge rate can be determined by monitoring the rise/fall of the water level within the casing as one purges the well. If the water level is static at a given pumping rate, but fluctuates up or down as pumping rate is decreased or increased, the pumping rate at which the water level is static is the recharge rate.

After purging 2 EV, obtain a sample of groundwater and measure the following stabilization parameters: temperature, conductivity, pH, turbidity, redox potential (Eh), and dissolved oxygen level at each successive half-well volume. When three of these stabilization parameters are in agreement within approximately 10 percent in three consecutive half-well volume samples, sufficient water has been purged from the well. The results of these tests should be recorded in the sampling logbook. Should these parameters not reach agreement, no more than five well volumes will be purged.

Immediately upon completion of purging, collect samples for laboratory analysis using a PTFE bailer on a PTFE-coated stainless steel cable. The bailer will be equipped with double check valve top and controlled flow bottom discharge attachments for VOC sampling (40-mL vials), and top discharge attachment for collecting larger samples (1-L bottles). Filtration of metals samples will be accomplished using either an in-line filter attached to the bottom of the bailer, or a funnel and appropriate filter (Section 3.3).

Slowly, so as not to agitate the water, lower the bailer into the well, using a spool of PTFE-coated cable. Allow bailer to fill, withdraw smoothly, fill sample containers as described in Section 3.6. Decontaminate bailer and cable in and decontaminate pump.

3.8 PURGING AND SAMPLING WITH LOW-FLOW PUMP

To obtain representative samples, subsurface disturbances should be kept to a minimum, thereby preventing sample alteration due to sampling actions. The reasoning behind the use of low-flow pumps to purge and sample monitoring wells is that these pumps minimize physical disturbance (turbulence) at the sampling point and chemical changes (aeration) in the medium. For these reasons, the low-flow pump is the preferred method for both purging and sampling in most cases. For the purposes of this SOP, "low-flow pumps" are defined as either dedicated bladder pumps or variable speed submersible pumps. Practical operational flow rates for these sampling devices range from 0.1 L/min to 30 L/min.

Low-flow pumps may be used for purging and sampling any well having recharge greater than 0.1 L/min, which is the practical lower limit of pump performance. Below that pumping rate, pump inefficiencies and/or overheating may alter the physical and chemical properties of the sample. If the pump is continuously operated at sampling rates higher than the well recharge rate, the water level will be lowered in the well, possibly allowing aeration of the sample which is unacceptable sampling procedure. Low-flow pumps are suitable for sampling wells with recharge rates lower than 0.1 L/min if precautions are taken to avoid aeration of the sample.

Low flow submersible pumps will be used as follows:

- Lower the pump into the well, slowly so as not to agitate the water, until the pump is at the mid-point of the screened interval or the mid-point of the water column if the static water table lies below the top of the screen[6]

- Attach the pump's umbilical cord (which will consist of power cord and sampling tubing) to the protective casing, or lock the cord spool so that the pump cannot move vertically in the well during sampling.

- Lower the water level probe into the well behind the pump until it just touches water. This will allow the sampler to monitor the water level while purging and sampling, and prevent the inadvertent drying of the well.

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[6] This assumes a 10-ft screened interval. If the screened interval is greater than 10 ft, multiple samples should be taken as follows:
- If the screen is 10-12 ft, sample the canter of the water column, as outlined above.
- If the screen is longer than 12 ft, and the water column is 10 ft or less, sample the center of the water column.
- If the screen is longer than 12 ft, and the water column fills the screen, or extends above the screen, sample at 1/3 and 2/3 the height of the water column, or about every 6 ft.

- Begin purging at the pump's lowest setting, then gradually increase rate[7] until the pumping rate matches the aquifer recharge rate. **If the water level is above the top of the screen**, the pumping rate may be allowed to slightly exceed recharge rate, lowering the water level to no less than 1 ft above the screen, then reduced until it matches recharge rate and purging continued. **If the water level is below the top of the screen**, always keep the purge rate lower than well's recharge rate.

- Monitor stabilization parameters listed in Section 3.6 beginning immediately, using an in-line monitoring system. Record parameters regularly, at a rate of one set of parameters per each 1-3 liters of water removed from the well. When these parameters stabilize to within 10 percent over three consecutive readings, reduce[8] flow rate to 0.1 L/min (if needed) and begin collecting VOC samples directly from the discharge line.

- If the well recharges at a rate less than 0.1 L/min, purge until the water level is even with the top of the screen, allow the well to recover, and sample immediately.

- Remove and decontaminate water level probe and pump.

4. MAINTENANCE

Refer to manufacturer's requirements for maintenance of pumps and generators.

5. PRECAUTIONS

Refer to the site-specific Health and Safety Plan for appropriate personal protective equipment.

6. REFERENCES

Garske, E.E. and M.R. Schock. 1986. An Inexpensive Flow-Through Cell and Measurement System for Monitoring Selected Chemical Parameters in Groundwater.

Gass, T.E., J.F. Barker, R. Dickhout, and J.S. Fyfe. 1991. Test Results of the Grundfos Groundwater Sampling Pump, in Proceedings of the Fifth National Symposium on Aquifer Restoration and Groundwater Monitoring.

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[7] Some sources indicate that the pumping rate should not exceed 1 L/min, with 0.5 L/min being preferable. The optimal purge rate is highly aquifer dependent, and may range from less than 0.5 L/min to greater than 10 L/min. The purge rate for a given well will, therefore, be a field decision, based on well development, purge, and sampling records rather than SOP mandate.

[8] Sampling should occur at the same rate as purging as long as aeration of sample does not occur.

McAlary, T. A. and J.F. Barker. 1987. Volatilization Losses of Organics During Groundwater Sampling From Low Permeability Materials, in Groundwater Monitoring Review. Fall.

Puls, R.W. and R.M. Powell. 1992. Acquisition of Representative Groundwater Quality Samples for Metals, in Groundwater Monitoring Review. Summer.

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Puls, R.W., R.M. Powell, D.A. Clark, and C.J. Paul. 1991. Facilitated Transport of Inorganic Contaminants in Groundwater: Part II Colloidal Transport, in EPA Environmental Research Brief. EPA/600/M-91/040. July.

Puls, R.W., R.M. Powell, B. Bledsoe, D.A. Clark, and C.J. Paul. 1992. Metals in Groundwater: Sampling Artifacts and Reproducibility, in Hazardous Waste & Hazardous Materials. Volume 9, No. 2.

Standard Operating Procedure No. 016
for
Surface Water, Groundwater, and Soil/Sediment Field Logbooks

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CONTENTS

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to delineate protocols for recording surface water, groundwater, soil/sediment sampling information, instrument calibration data, and data from hydrologic testing in the field logbooks. Acceptable field logbooks are: bound, unprinted books such as a surveyor's field book, or a federal supply service No. 7530-00-222-3525 record book (or equivalent); or they may be company-proprietary, pre-printed forms bound into a field logbook. Example forms are provided herein. Alternate, equivalent forms are acceptable.

2. MATERIALS

The following material may be required: applicable field logbook and indelible ink pen.

3. PROCEDURE

Information pertinent to soil/sediment, groundwater, or surface water sampling will be recorded in the appropriate logbook. Each page/form of the logbook will be consecutively numbered. Entries will be made in indelible ink. Corrections will consist of line-out deletions that are initialed and dated. If using carbon paper or self-duplicating forms, before entering data in logbook, insert a sheet protector between form sets to isolate first blank form from remaining forms.

3.1 SOIL/SEDIMENT LOGBOOK (Requires Figures SOP016-1 and SOP016-3)

3.1.1 Field Parameter Form (Items on Figures SOP016-1 and SOP016-2)

1. HIGH CONCENTRATION EXPECTED?: Answer "Yes" or "No."

2. HIGH HAZARD?: Answer "Yes" or "No."

3. SITE: Record the complete name of the site.

4. AREA: Record the area designation of the sample site.

5. INST CODE: Record the 2-letter installation code appropriate for the installation or site. Correct abbreviations can be found on Pages 3-6 of the IRDMS User's Guide for chemical data entry.

6. FILE NAME: Record "CSO" for a soil sample or "CSE" for a sediment sample.

7. SITE TYPE: Record the abbreviation appropriate for where the sample was taken. Correct abbreviations can be found on Pages 18-21 of the IRDMS User's Guide for chemical data entry. This entry must match the Site Type on the map file form.

8. SITE ID: Record a code up to 10 characters or numbers which is unique to the site.

9. FIELD SAMPLE NUMBER: Record a code specific for the sample.

10. DATE: Enter the date the sample was taken.

11. TIME: Enter the time (12-hour or 24-hour clock acceptable as long as internally consistent) the sample was taken.

12. AM PM: Circle "AM" or "PM" to designate morning or afternoon (12-hour clock).

13. SAMPLE PROG: Record "GQA" (Groundwater Quality Assessment) or other appropriate sample program.

14. DEPTH (TOP): Record the total depth sampled.

15. DEPTH INTERVAL: Record the intervals at which the plug will be sampled.

16. UNITS: Record the units of depth (feet, meters)

17. SAMPLE MEASUREMENTS: Check the appropriate sampling method.

18. CHK: Check off each container released to a laboratory.

19. ANALYSIS: Record the type of analysis to be performed on each sample container.

20. SAMPLE CONTAINER: Record the sample container type and size.

21. NO.: Record the number of containers.

22. REMARKS: Record any remarks about the sample

23. TOTAL NUMBER OF CONTAINERS FOR SAMPLE: Record the total number of containers.

24. SITE DESCRIPTION: Describe the location where the sample was collected.

25. SAMPLE FORM: Record the form of the sample (i.e., clay, loam, etc.) using The Unified Soil Classification System.

26. COLOR: Record the color of the sample as determined from standard Munsell Color Charts.

27. ODOR: Record the odor of the sample or "none." See SOP No. 001 Section 5.

28. PID (HNu): Record the measured PID (HNu) values.

29. UNUSUAL FEATURES: Record anything unusual about the site or sample.

30. WEATHER/TEMPERATURE: Record the weather and temperature.

31. SAMPLER: Record your name.

3.1.2 Map File Form (Figure SOP016-3)

1. The map file logbook form will be located on the reverse of the field parameter logbook form, or on an adjoining page of the field logbook (if level book is used).

2. SITE ID: Record the Site ID from the field parameter form.

3. POINTER: Record the field sample number for the sample being pointed to.

4. DESCRIPTION/MEASUREMENTS: Describe the location where the sample was taken, along with distances to landmarks.

5. SKETCH/DIMENSIONS: Diagram the surroundings and record the distances to landmarks.

6. MAP REFERENCE: Record which U.S. Geological Survey Quad Map references the site.

7. COORDINATE DEFINITION: Write the compass directions the X- and Y-Coordinates of the map run.

8. COORDINATE SYSTEM: Write “UTM” (Universal Transverse Mercator).

9. SOURCE: Record the 1-digit code representing the Map Reference.

10. ACCURACY: Give units (e.g., write “1-M” for 1 meter).

11. X-COORDINATE: Record the X-Coordinate of the sample site location.

12. Y-COORDINATE: Record the Y-Coordinate of the sample site location.

13. UNITS: Record the units map sections are measured in.

14. ELEVATION REFERENCE: Record whether topography was determined from a map or a topographical survey.

15. ELEVATION SOURCE: Record the 1-digit code representing the elevation reference.

16. ACCURACY: Record the accuracy of the map or survey providing the topographical information.

17. ELEVATION: Record the elevation of the sampling site.

18. UNITS: Write the units in which the elevation is recorded.

19. SAMPLER: Write your name.

3.2 SURFACE WATER LOGBOOK (Requires Figures SOP016-2 and SOP016-3)

3.2.1 Field Parameter Form (Items Unique to Figure SOP016-3)

1. CAL REF: Record the calibration reference for the pH meter.

2. pH: Record the pH of the sample.

3. TEMP: Record the temperature of the sample in degrees Celsius.

4. COND: Record the conductivity of the water.

5. For all other sections, see Section 3.2.1.

3.3 GROUNDWATER SAMPLING LOGBOOK (Requires Figures SOP016-2, SOP016-3, and SOP016-4)

3.3.1 Field Parameter Form (Items on Figure SOP016-4)

1. WELL NO. OR ID: Record the abbreviation appropriate for where the sample was taken. Correct abbreviations can be found on Pages 18-21 of the IRDMS User's Guide for chemical data entry.

2. SAMPLE NO.: Record the reference number of the sample.

3. WELL/SITE DESCRIPTION: Describe the location where the sample was taken, along with distances to landmarks.

4. X-COORD and Y-COORD: Record the survey coordinates for the sampling site.

5. ELEV: Record the elevation where the sample was taken.

6. UNITS: Record the units the elevation was recorded in.

7. DATE: Record the date in the form MM/DD/YY.

8. TIME: Record the time, including a designation of AM or PM.

9. AIR TEMP.: Record the air temperature, including a designation of C or F (Celsius or Fahrenheit).

10. WELL DEPTH: Record the depth of the well in feet and inches.

11. CASING HT.: Record the height of the casing in feet and inches.

12. WATER DEPTH: Record the depth (underground) of the water in feet and inches.

13. WELL DIAMETER: Record the diameter of the well in inches.

14. WATER COLUMN HEIGHT: Record the height of the water column in feet and inches.

15. SANDPACK DIAM.: Record the diameter of the sandpack. Generally, this will be the same as the bore diameter.

16. EQUIVALENT VOLUME OF STANDING WATER: Use one of the following equations, to determine one equivalent volume (EV):

1 EV = Volume in casing + volume in saturated sand pack. Or to restate:

$$1\ \mathrm{EV} = (BR_w^2 h_w + 0.30B(R_s^2 - R_w^2)h_s) * (0.0043)$$

where

R_s = Radius of sandpack in inches
R_w = Radius of well casing in inches
h_s = Height of sandpack in inches
h_w = Water depth in inches

0.0043 = gal/in.^{3}
and filter pack porosity is assumed as 30 percent

— OR —

Volume in casing = (0.0043 gal/in.^{3})(B)(12 in./ft)(R_c^2)(W_h)

where

R_c = Radius of casing in inches
W_h = Water column height in feet

Vol. in sandpack = (0.0043 gal/in.^{3})(B)(12 in./ft)($R_b^2 - R_c^2$)(W_h)(0.30)

(if W_h is less than the length of the sandpack),

— PLUS —

Vol. in sandpack = $(0.0043 \text{ gal/in.}^3)(B)(12 \text{ in./ft})(R_b^2 - R_c^2)(S_h)(0.30)$

(if W_h is greater than the length of the sandpack).

where
R_b = Radius of the borehole
S_h = Length of the sandpack.

Show this calculation in the comments section.

17. VOLUME OF BAILER OR PUMP RATE: Record bailer volume or pump rate.

18. TOTAL NUMBER OF BAILERS OR PUMP TIME: Record the number of bailers required to remove 3 equivalent volumes (EV) of water from the well or the total purge time and volume as applicable.

19. WELL WENT DRY? Write “YES” OR “NO.”

20. NUMBER OF BAILERS OR PUMP TIME: Record the number of bailers or pump time which made the well go dry.

21. VOLUME REMOVED: Record the volume of water (gal) removed before the well went dry.

22. RECOVERY TIME: Record the time required for the well to refill.

23. PURGE AGAIN?: Answer “YES” or “NO.”

24. TOTAL VOL. REMOVED: Record the total volume of water (in gal) removed from the well.

25. CAL REF.: Record the calibration reference for the pH meter.

26. TIME: Record time started (INITIAL T[0]), 2 times DURING the sampling and the time sampling ended (FINAL).

27. pH: Record the pH at start of sampling (INITIAL), twice DURING the sampling and at the end of sampling (FINAL).

28. TEMP: Record the water temperature (Celsius) at the start of sampling, twice DURING the sampling and at the end of sampling (FINAL).

29. COND: Record the conductivity of the water at the start of sampling, twice DURING the sampling and at the end of sampling (FINAL).

30. D.O.: Record the dissolved oxygen level in the water at the start of sampling, twice DURING the sampling and at the end of sampling (FINAL).

31. TURBIDITY: Record the readings from the turbidity meter (nephelometer) and units at the start of sampling, twice DURING the sampling and at the end of sampling (FINAL).

32. ORD: Record the oxidation/reduction (RedOx) potential of the water sample at the start of sampling, twice DURING the sampling and at the end of sampling (FINAL).

33. HEAD SPACE: Record any positive readings from organic vapor meter reading taken in well headspace prior to sampling.

34. NAPL: Record the presence and thickness of any non-aqueous phase liquids (light or dense)

35. COMMENTS: Record any pertinent information not already covered in the form.

36. SIGNATURE: Sign the form.

3.4 FIELD CALIBRATION FORMS (Maintained as a separate logbook, or incorporated into sampling logbooks)

3.4.1 Items on Figure SOP016-5

1. Record time and date of calibration. Note whether 12- or 24-hour clock was used.

2. Record calibration standard reference number.

3. Record meter I.D. number

4. Record initial instrument reading, recalibration reading (if necessary), and final calibration reading on appropriate line.

5. Record value of reference standard (as required).

6. COMMENTS: Record any pertinent information not already covered on form.

7. SIGNATURE: Sign form.

3.5 GROUNDWATER HYDROLOGY TESTS LOGBOOK (Must include Figures SOP016-6 and SOP016-7 and/or SOP016-8, OR SOP016-9 or SOP016-10)

3.5.1 Field Permeability Test Data Sheet (Items on Figures SOP016-6)

1. CONTRACTOR: Organization performing the test.

2. SEQ. #: Enter page number of this set of forms (page # of #).

3. PROJECT NAME: Record the name assigned by the contractor's organization to the project.

4. PROJECT NO.: Record the contractor assigned project number or the contract number.

5. LOCATION: Specific location

6. CLIENT: Agency or company with the contract under which the work is being performed.

7. FIELD PARTY CHIEF: Printed name of the person responsible for this particular field test.

8. WELL #: Record the well number as it appears on the well completion tag, affixed to the protector casing or well completion records.

9. TEST TYPE: Short description of the type of test to be performed.

10. RISING/FALLING HEAD WITH SLUG: Check if the test involved the insertion/removal of and inert object.

11. RISING/FALLING HEAD WITHOUT SLUG: Check if the test involved the addition/removal of a quantity of water.

12. START DATE: Date on which the test was begun.

13. CLOCK TIME: Time each datum (depth to groundwater level) is collected. Note whether 12- or 24-hour clock was used.

14. ELAPSED TIME: Time since the last datum was collected.

15. DEPTH TO GWL (ft): Depth to the top of the groundwater table (Groundwater Level) as measured by manual methods.

16. REC. (ft): Water level as reported by transducer/datalogger (this is the depth of water above the transducer.

17. TIME: Time the discharge rate check was begun (addition or removal of water method). Note whether 12- or 24-hour clock was used.

18. FLOW METER (Addition or removal of water method): The amount of water added or removed as registered by the flowmeter, in gal of liters.

19. DISCHARGE RATE: Flowmeter reading divided by time interval (gal/min or liters/min).

20. SIGNATURE: The person completing this form must sign the form at the end of the test.

21. DATE: Date the form was signed.

3.5.2 Groundwater Levels – Single Well (Items on Figure SOP016-7)

1. CONTRACTOR: Organization performing the test.

2. SEQ. #: Enter page number of this set of forms (page # of #).

3. PROJECT NO.: Record the contractor assigned project number or the contract number.

4. WELL #: Record the well number as it appears on the well completion tag, affixed to the protector casing or well completion records.

5. PROJECT NAME: Record the name assigned by the contractor's organization to the project.

6. LOCATION: Specific location.

7. FIELD PARTY CHIEF: Printed name of the person responsible for this particular field test.

8. CLIENT: Agency with the contract under which the work is being performed.

Well Data

9. STICKUP: Enter the length of well casing extending above the average ground surface at the base of the protective casing.

10. MEASURED UP(+)/DOWN(-) FROM: Describe the starting point for the previous measurement.

11. MP ELEVATION: Enter the elevation of the measuring point here. NOTE: This datum may require reference to tables and/or maps and may be added after completing the day's field work.

12. DATUM = MSL OR: Is the datum for the previous elevation Mean Sea Level? If not, what? Also tell whether it was derived from a map elevation (write "MAP") or survey data (write "SURVEY").

13. MEASURING POINT DESCRIPTION: Describe the point used as the origin for all down-hole (water table) measurements. NOTE: Remedial investigation wells are required to have a permanently marked reference (measuring) point (refer to SOP No. 019).

14. REMARKS: Record any pertinent observations about the site/well conditions not specifically required in the preceding.

15. DATE: Date of each water level reading

16. TIME: Time of each water level reading. Note whether 12- or 24-hour clock was used.

17. ELAPSED TIME: Time since test was begun.

18. DEPTH TO WATER: Measured depth to the groundwater table.

19. WATER ELEVATION: Elevation of the top of the groundwater table (use datum listed above).

20. MEAS. METH.: Method used to measure the water level in the well (see abbreviation key at the bottom of the data sheet).

21. TAPE NO.: The unique identification number of the traceable standard tape used to calibrate the measuring device.

22. WELL STATUS: Condition of the well at the time of measuring (see abbreviation key at the bottom of the data sheet).

23. REMARKS: Any additional pertinent comments not specifically required above.

24. INITIALS: Initials of person completing this data entry.

25. ABBREVIATION KEYS: Self explanatory.

26. SIGNATURE: The person completing this form must sign the form at the end of the test.

27. DATE: Date the form was signed.

3.5.3 Groundwater Levels – Single Well (Items on Figure SOP016-8)

1. CONTRACTOR: Organization performing the test.

2. SEQ. #: Enter page number of this set of forms (page # of #).

3. PROJECT NO.: Record the contractor assigned project number or the contract number.

4. WELL #: Record the well number as it appears on the well completion tag, affixed to the protector casing or well completion records.

5. PROJECT NAME: Record the name assigned by the contractor’s organization to the project.

6. LOCATION: Specific location.

7. FIELD PARTY CHIEF: Printed name of the person responsible for this particular field test.

8. CLIENT: Agency with the contract under which the work is being performed.

WELL DATA

9. STICKUP: Enter the length of well casing extending above the average ground surface at the base of the protective casing.

10. MEASURED UP(+)/DOWN(-) FROM: Describe the starting point for the previous measurement.

11. MP ELEVATION: Enter the elevation of the measuring point here. NOTE: This datum may require reference to tables and/or maps and may be added after completing the day’s field work.

12. DATUM = MSL OR: Is the datum for the previous elevation Mean Sea Level? If not, what? Also tell whether it was derived from a map elevation (write “MAP”) or survey data (write “SURVEY”).

13. MEASURING POINT DESCRIPTION: Describe the point used as the origin for all down-hole (water table) measurements. NOTE: All Rhode Island wells are required to have a permanently marked reference (measuring) point (refer to SOP No. 019).

14. REMARKS: Record any pertinent observations about the site/well conditions not specifically required in the preceding.

15. DATALOGGER: This section is record of pertinent datalogger information.

16. MANUFACTURER: Record the manufacturer/brand name as stated on the datalogger.

17. MODEL: Enter the model number of the datalogger.

18. S/N: Enter the serial number of this datalogger.

19. TAG PROGRAMMED IN LOGGER: What is the identifier used in the datalogger’s program to indicate that this unit was used to record a given data set?

20. TRANSDUCER: This section is a listing of pertinent information about the transducer used.

21. MANUFACTURER: Record the manufacturer/brand name as stated on the transducer.

22. MODEL: Enter the model number of the transducer.

23. S/N: Enter the serial number of this transducer.

24. INPUT/UNITS: What are the units this transducer uses?

25. RANGE: Record the pressure or depth range over which this transducer is certified.

CALIBRATION

26. PRESSURE RATING: This is taken from the manufacturer's specifications for a given transducer. (Usually in psi, or kpa).

27. "SUBMERGENCE = ___ (V) / (MV)": Record the voltage returned by the transducer at a given depth of submergence. Indicate whether the reading is in volts (v), or millivolts (mv).

28. VOLUME WATER ADDED/REMOVED: (Applicable if inert object insertion/removal method was not employed.) Record the volume of water added to or removed from the well.

29. DISCHARGE RATE: If z (above) is filled, enter the rate at which this water was added or removed.

30. INITIAL WATER LEVEL (ft): Enter the water level in the well at the beginning of the test.

31. PRESSURE TRANSDUCER SUBMERGENCE: Record the depth to which the transducer is submerged at the beginning of the test and the depth to the transducer at the end if the test. All depths will be recorded to the nearest 0.01 ft.

32. TIME: Record the time the test is begun and ended. Note whether 12- or 24-hour clock was used.

33. OBSERVED CHANGES IN ADJACENT WELLS: Note any changes in water levels in nearby wells.

34. RESULTS RECORDED ON DISKETTE #: Tracking number of the diskette on which these data are archived.

35. DISKETTE FILE NAME: Name of the file(s).

36. SIGNATURE: The person completing this form must sign the form at the end of the test

37. DATE: Date the form was signed.

3.6 GROUNDWATER LEVELS – MULTIPLE WELLS (Items on Figure SOP016-9)

1. CONTRACTOR: Organization performing the test.

2. SEQ. #: Enter page number of this set of forms (page # of #).

3. PROJECT NO.: Record the contractor assigned project number or the contract number.

4. PROJECT NAME: Record the name assigned by the contractor’s organization to the project.

5. LOCATION: Specific location.

6. FIELD PARTY CHIEF: Printed name of the person responsible for this particular field test.

7. CLIENT: Agency with the contract under which the work is being performed.

8. REMARKS: Any pertinent observations not specifically required above.

9. WELL: Record the well number as it appears on the well completion tag, affixed to the protector casing or well completion records.

10. DATE: Date this measurement was made.

11. TIME: Time this measurement was made. Note whether 12- or 24-hour clock was used.

12. DEPTH TO WATER: Depth from MP to top of groundwater table.

13. STICKUP: Enter the length of well casing extending above the average ground surface at the base of the protective casing.

14. MP ELEV.: Enter the elevation of the measuring point here. NOTE: This datum may require reference to tables and/or maps and may be added after completing the day’s field work.

15. MEAS. METH.: Method used to measure the water level in the well (see abbreviation key at the bottom of the data sheet).

16. REMARKS/MP: Describe the location and nature of the measuring point.

17. INITIALS: Initials of the person completing this form.

18. ABBREVIATION KEYS: Self explanatory.

19. SIGNATURE: The person completing this form must sign the form at the end of the test.

20. DATE: Date the form was signed.

3.7 GROUNDWATER LEVELS – DATALOGGERS (Items on Figure SOP016-10)

1. CONTRACTOR: Organization performing the test.

2. SEQ. #: Enter page number of this set of forms (page # of #).

3. PROJECT NO.: Record the contractor assigned project number or the contract number.

4. WELL #: Record the well number as it appears on the well completion tag, affixed to the protector casing or well completion records.

5. PROJECT NAME: Record the name assigned by the contractor's organization to the project.

6. LOCATION: Specific location.

7. FIELD PARTY CHIEF: Printed name of the person responsible for this particular field test.

8. CLIENT: Agency with the contract under which the work is being performed.

WELL DATA

9. STICKUP: Enter the length of well casing extending above the average ground surface at the base of the protective casing.

10. MEASURED UP(+)/DOWN(-) FROM: Describe the starting point for the previous measurement.

11. MP ELEVATION: Enter the elevation of the measuring point here. NOTE: This datum may require reference to tables and/or maps and may be added after completing the day's field work.

12. DATUM = MSL OR: Is the datum for the previous elevation Mean Sea Level? If not, what? Also tell whether it was derived from a map elevation (write "MAP") or survey data (write "SURVEY").

13. MEASURING POINT DESCRIPTION: Describe the point used as the origin for all down-hole (water table) measurements. NOTE: All Rhode Island wells are required to have a permanently marked reference (measuring) point (refer to SOP No. 019, Section 3.4).

14. REMARKS: Record any pertinent observations about the site/well conditions not specifically required in the preceding.

DATALOGGER (This section is a record of pertinent datalogger information)

15. MANUFACTURER: Record the manufacturer/brand name as stated on the datalogger.

16. MODEL: Enter the model number of the datalogger.

17. S/N: Enter the serial number of this datalogger.

18. TAG PROGRAMMED IN LOGGER: What is the identifier used in the datalogger's program to indicate that this unit was used to record a given data set?

TRANSDUCER (This section is a listing of pertinent information about the transducer used)

19. MANUFACTURER: Record the manufacturer/brand name as stated on the transducer.

20. MODEL: Enter the model number of the transducer.

21. S/N: Enter the serial number of this transducer.

22. INPUT/UNITS: What are the units this transducer uses?

23. RANGE: Record the pressure or depth range over which this transducer is certified.

CALIBRATION

24. PRESSURE RATING: This is taken from the manufacturer's specifications for a given transducer (usually in psi, or kpa).

25. "SUBMERGENCE = ___ (V) / (MV)": Record the voltage returned by the transducer at a given depth of submergence. Indicate whether the reading is in volts (v), or millivolts (mv).

26. DATE: Date of each water level reading

27. TIME: Time of each water level reading. Note whether 12- or 24-hour clock was used.

28. LOGGING TIME INTERVAL: Time since test was begun.

29. WL FEET BELOW MP: Measured depth to the groundwater table from measuring point.

30. SUBMERGENCE: Depth of water above the transducer.

31. MEAS.METHOD: What device/method was used to measure the water level.

32. TAPE NO.: Record the tape identification number.

33. TRANSDUCER MOVED?: Was the transducer moved since the last water level reading?

34. REMARKS: Any pertinent remarks not otherwise specified.

35. INITIALS:

DATA TRANSFER TO DISKETTE:

36. DATE: Date data were archived onto diskette.

37. TIME: Time stamp the computer assigns the data file.

38. FILE NAME: Name assigned the data file.

39. SOFTWARE USED FOR TRANSFER: Any special software, or computer operating system used to write the files to diskette. NOTE: If a "shareware" archiver which compresses files was used, and the archived file is not self-extracting, a copy of the unarchive program should be copied onto the diskette also.

40. OUTPUT FORMAT: What is the format of the output file? (DOS, UNIX, Binary, Compressed?)

41. INITIALS: Initials of the person who copied the data to diskette.

42. ABBREVIATION KEY: Self-explanatory.

4. MAINTENANCE

Not applicable.

5. PRECAUTIONS

None.

6. REFERENCES

U.S. Environmental Protection Agency. 1984. User's Guide to the Contract Laboratory Program. July.

FIGURE SOP016-1
FIELD PARAMETER LOGBOOK
SOIL AND SEDIMENT SAMPLES

HIGH CONCENTRATION EXPECTED? HIGH HAZARD?

INSTALLATION/SITE ________________________________ AREA ___________________

INST CODE FILE NAME ____

SITE TYPE SITE ID
FIELD SAMPLE NUMBER

DATE (MM/DD/YY) / / TIME AM PM SAMPLE PROG.

DEPTH (TOP) DEPTH INTERVAL UNIT _____________

SAMPLING METHOD:

SPLIT SPOON AUGER SHELBY TUBE SCOOP OTHER

CHK	ANALYSIS	SAMPLE CONTAINER	NO.	REMARKS

TOTAL NUMBER OF CONTAINERS FOR SAMPLE

DESCRIPTION OF SITE AND SAMPLE CONDITIONS
SITE DESCRIPTION:____
SAMPLE FORM ______________________ COLOR _____________ ODOR _____________
PID (HNu) _______________________ UNUSUAL FEATURES _______________________

WEATHER/TEMPERATURE
SAMPLER

HIGH CONCENTRATION EXPECTED? HIGH HAZARD?

FIGURE SOP016-2
FIELD PARAMETER LOGBOOK
GROUNDWATER AND SURFACE WATER SAMPLES

INSTALLATION/SITE AREA
INST CODE FILE NAME SITE TYPE
SITE ID FIELD SAMPLE NUMBER
DATE (MM/DD/YY) / / TIME AM PM SAMPLE PROG.
DEPTH (TOP) DEPTH INTERVAL UNITS

SAMPLING MEASUREMENTS

CAL REF.	pH	TEMPERATURE C	CONDUCTIVITY	OTHER

CHK	ANALYSIS	SAMPLE CONTAINER	NO.	REMARKS

TOTAL NUMBER OF CONTAINERS FOR SAMPLE

DESCRIPTION OF SITE AND SAMPLE CONDITIONS

SITE DESCRIPTION
SAMPLING METHOD
SAMPLE FORM COLOR ODOR
PID (HNu)
UNUSUAL FEATURES
WEATHER/TEMPERATURE ___________________________ SAMPLER __________________

FIGURE SOP016-3
MAP FILE LOGBOOK

SITE ID POINTER ____________________
DESCRIPTION/MEASUREMENTS
SKETCH/DIMENSIONS:

MAP REFERENCE
COORDINATE DEFINITION (X is Y is)
COORDINATE SYSTEM SOURCE ACCURACY
X-COORDINATE Y-COORDINATE UNITS
ELEVATION REFERENCE
ELEVATION SOURCE ACCURACY ELEVATION
UNITS

SAMPLER

FIGURE SOP016-4
MAP FILE AND PURGING LOGBOOK
GROUNDWATER SAMPLES

WELL COORD. OR ID SAMPLE NO.______________
WELL/SITE
DESCRIPTION____

____

X-COORD. Y-COORD. _______________ ELEV. UNITS
DATE ____/____/____ TIME AIR TEMP.

WELL DEPTH _________ ft _________ in. CASING HT. __________ ft _______ in.
WATER DEPTH __________ ft _________ in. WELL DIAMETER __________ in.
WATER COLUMN HEIGHT _________ ft _________ in. SANDPACK DIAM. ________ in.
EQUIVALENT VOLUME OF STANDING WATER ____________ (gal) (L)
VOLUME OF BAILER ___________ (gal) (L) <u>or</u> PUMP RATE ___________ (gpm) (lpm)
TOTAL NO. OF BAILERS (5 EV)___________ or PUMP TIME ___________ MIN.
WELL WENT DRY? [Yes] [No] NUM. OF BAILERS ________ or PUMP TIME_______MIN
VOL. REMOVED __________ (gal) (L) RECOVERY TIME __________ MIN
PURGE AGAIN? [Yes] [No] TOTAL VOL. REMOVED __________ (gal) (L)

Date and Time	Quantity Removed	Time Required	pH	Cond	Temp	ORD	Turb	DO	Character of water (color/ clarity/odor/partic.)
(before)									
(during)									
(during)									
(during									
(after)									

COMMENTS:____

____

____

____

SIGNATURE

FIGURE SOP016-5
FIELD CALIBRATION: pH, CONDUCTIVITY, TEMPERATURE, TURBIDITY, OXIDATION-REDUCTION POTENTIAL, AND DISSOLVED OXYGEN METERS

INITIAL CALIBRATION	FINAL CALIBRATION
DATE:	DATE:
TIME:	TIME:

pH METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO: _______________

METER ID ______________________________

pH STANDARD	INITIAL READING	RECALIB. READING	FINAL READING
7.0			
10.0			
4.0			

CONDUCTIVITY METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO: _______________

METER ID _________________

COND. STANDARD	INITIAL READING	RECALIB. READING	FINAL READING

TEMPERATURE METER CALIBRATION

METER ID ________________

TEMP. STANDARD	INITIAL READING	RECALIB. READING	FINAL READING
ICE WATER			
BOILING WATER			
OTHER			

FIGURE SOP016-5 *(continued)*

TURBIDITY METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO: _______________

METER ID ________________

STANDARD	INITIAL READING	RECALIB. READING	FINAL READING

ORD METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO: _______________

METER ID ________________

STANDARD	INITIAL READING	RECALIB. READING	FINAL READING

DISSOLVED OXYGEN METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO: _______________

METER ID ____________________________

STANDARD	INITIAL READING	RECALIB. READING	FINAL READING

COMMENTS:____

____

____

____

____

SIGNATURE

FIGURE SOP016-6
FIELD PERMEABILITY TEST DATA SHEET

Contractor: **Seq. #** /

Project Name:	Project #:
Location:	Client:
Party Chief:	Contractor:
Observation Well:	
Test Type: Rising/Falling Head w/Slug	Rising/Falling Head w/out Slug
Start Date:	

								Discharge Rate		
Clock Time	Elapsed Time (min)	Depth to GWL (ft)	Rec (ft)	Clock Time	Elapsed Time	Depth to GWL (ft)	Rec (ft)	Time	Flow Meter	Discharge Rate

Signature: ____ **Date:** ______________________

FIGURE SOP016-7
GROUNDWATER LEVELS – SINGLE WELL

Contractor: **Seq. #** /

Project No.:
Project Name:
Field Party Chief:

WELL DATA:

Stickup: (ft)
MP Elevation:
Area:

Datum = MSL or:

Measuring Point Description:

Datalogger:
Manufacturer: Model: S/N:
Tag No. Programmed in Logger:

Transducer: Manufacturer: Model: S/N:
Input/Units: Range:

Calibration:
Pressure Rating:
0 ft submergence = (v) / (mv) ft submergence = (v) / (mv)

Volume Water Added/Removed:
Discharge Rate:
Initial Water Level (ft):

Pressure Transducer Submergence
Initial (ft): Final(ft): Time:Start: End:
Observed Changes in Adjacent Wells:

Results Recorded on Diskette #:
Diskette File Name:

Signature: ______________________________ **Date:** ____________________

FIGURE SOP016-8
GROUNDWATER LEVELS – MULTIPLE WELLS

Contractor: **Seq. #** /

Project No.:
Project Name:
Field Party Chief:

WELL DATA:

Stickup: (ft)
MP Elevation:

Measuring Point Description:
Remarks:
Well No.:
up (+)/down (-) from:
Datum = MSL or:

Date	Time	Elapsed Time	Depth to Water	Water Elevation	Meas. Meth.	Tape No.	Well Status	Remarks	Initials

Measurement Method:
A = Airline
C = Chalk and tape
E = Electric tape
T = Tape with popper
X = Other (describe in remarks)

Well Status:
D = Dry
F = Flowing
P = Pumping
RP = Recently pumped
NP = Nearby well pumping
NRP = Nearby well recently
X = Obstructed

Signature: ______________________________ Date: ____________________

FIGURE SOP016-8 *(continued)*

Contractor:
Seq. # /

Project No.:
Project Name:
Field Party Chief:

Location:
Client:

Well	Date	Time	Depth to Water	Stickup	MP Elev.	Meas. Meth.	Tape No.	Remarks/MP	Initials

Measurement Method:
A = Airline
C = Chalk and tape
E = Electric tape
T = Tape with popper
X = Other (describe in remarks)

Well Status:
D = Dry
F = Flowing
P = Pumping
RP = Recently pumped
NP = Nearby well pumping
NRP = Nearby well recently
X = Obstructed

FIGURE SOP016-9
GROUNDWATER LEVELS DATALOGGERS

Contractor
Project No.: **Well No.:**
Project Name: **Site:**
Field Party Chief: **Area:**

WELL DATA: Stickup: **(ft)** **up (+)/down (-) from:**

Measuring Point Description:
Remarks:

Datalogger:
Manufacturer: Model: S/N:
Tag No. Programmed in Logger:
Transducer: Manufacturer: Model: S/N:
Input/Units: Range:
Calibration: Pressure Rating:
0 ft submergence = (v) / (mv) ft submergence = (v)

Logging	Date	Time	Logging Time Interval	WL, ft Below MP	Submergence (logger reading)	Meas. Method	Tape No.	Well Status	Transducer Moved	Remarks	Initials
Start											
Stop											
Start											
Stop											

Data Transfer to Disk

Date	Time	File Name	Software Used for Transfer	Output Format	Initials

Measurement Method:
A = Airline
C = Chalk and tape
E = Electric tape
T = Tape with popper
X = Other (describe in remarks)

Well Status:
D = Dry
F = Flowing
P = Pumping
RP = Recently
NP = Nearby well pumping
NRP = Nearby well recently pumped
X = Obstructed

Signature **Date**

Standard Operating Procedure No. 019
for
Monitoring Well Installation

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CONTENTS

Page

1. SCOPE AND APPLICATION

The installation of monitoring wells is contingent upon the existing conditions at the project site. The purpose of this Standard Operating Procedure is to delineate the quality control measures required to ensure the accurate installation of monitoring wells. The applicable Work Plan should be consulted for specific installation instructions. The term “monitoring wells,” as used herein, is defined to denote any environmental sampling well. An example well log form is provided in Appendix A. Alternate, equivalent forms are acceptable.

2. MATERIALS

2.1 DRILLING EQUIPMENT

The following drilling equipment may be required:

- Appropriately sized drill adequately equipped with augers, bits, drill stem, etc.
- Steam cleaner and water obtained from approved source for decontaminating drilling equipment.
- Photoionization Detector: Microtip HL-200 (or equivalent)
- Water level indicator
- Weighted steel tape measure
- Lower explosive limit – oxygen monitor
- Steel drums for intrusion derived wastes (drill cuttings, contaminated personal protective equipment, decontamination solutions, etc.)
- Source of approved water
- Heavy plastic sheeting
- Sorbent pads and/or log.

2.2 WELL INSTALLATION MATERIALS[1]

The following well installation materials may be required:

- Well screen:[2]
  - Polyvinyl chloride (PVC): JOHNSON (or equivalent); PVC 0.010 slot; Schedule 40; flush-threaded (leak-proof) joints; PVC complies with American Society for Testing and Materials (ASTM) D2665, ASTM D1784, and ASTM F480; free of ink markings; cleaned and prepackaged by manufacturer.
  - Stainless steel: JOHNSON (or equivalent); stainless steel 0.010 slot; 304 stainless steel[3]; ASTM F480 flush threads; cleaned, wrapped, and heat sealed by manufacturer.
- Riser pipe:
  - PVC: JOHNSON (or equivalent); STD; PVC; Schedule 40; flush-threaded (leak-proof) joints; PVC complies with ASTM D2665, ASTM D1784, and ASTM F480; free of ink markings; cleaned and prepackaged by manufacturer.
  - Stainless steel: JOHNSON (or equivalent); Schedule 5; 304 stainless steel; ASTM Type A312 material; 4-in. diameter; cleaned, wrapped, and heat sealed by manufacturer.
- Plugs/caps: JOHNSON (or equivalent); standard PVC or stainless steel.
- Filter pack: MORIE, 100 well gravel (or equivalent). NOTE: Final gradation may vary as a function of the gradation of the formation.[2]
- Fine Ottawa sand.
- Bentonite seal: BAROID, bentonite pellets (3/8-in. diameter)
- Cement: Type II Portland Cement (table below).

---

[1] Technical information on all installed materials (screens, riser pipe, filter pack, bentonite, cement, etc.) and representative samples of the proposed filter pack, bentonite powder, and bentonite pellets will be supplied to the Project Manager.

[2] Well screen slot size and filter pack gradation will be determined from sieve analysis of aquifer materials. Screen and casing material type will be determined based on field tests of groundwater chemistry and contaminants.

[3] Unless the sum of Cl-, F-, and Br- is >1,000 ppm, in which case Type 316 should be used.

Cement Type	Special Characteristics	Recommended Usage
I	No special properties	General use as grout mix or cement plug (if sulfates <250 ppm), surface pad.
IA	Air-entraining Type I (Note that air entrainment properties can be achieved by chemical admixtures)	Air entrainment gives cement greater freeze-thaw resistance. Recommended for surface pads.
II	Moderate sulfate resistance, low heat of hydration	General use as grout mix or cement plug where groundwater sulfate >250 ppm and <1,500 ppm, surface pad.
IIA	Air-entraining Type II	See Type IA.
III	High early strength, high heat of hydration	Elevated temperature can damage well casing and fracture grout/cement plugs. NOT RECOMMENDED.
IIIA	Air-entraining Type III	NOT RECOMMENDED.
IV	Low heat of hydration	General use as grout mix or cement plug preferred type for well abandonment to ensure intact grout/cement plug.
V	High Sulfate resistance	Use when groundwater sulfate levels >1,500 ppm.

- Bentonite powder: BAROID, Aquagel Gold Seal.
- Steel protective casing: BRAINARD-KILMAN (or equivalent) zinc-plated steel, lockable, painted.[4]
- Geotextile: MIRAFI (or equivalent); GTF 130; non-woven; 4 oz.
- Coarse (blanket) gravel: Crushed stone aggregate.
- Containers for purged water, as required.
- Submersible pump or bailer of appropriate capacity, and surge block sized to fit well.
- Hach DREL 2000 portable laboratory (or equivalent).
- Conductivity, pH, oxidation-reduction potential (ORP), turbidity, dissolved oxygen, and temperature meters.
- Electric well sounder and measuring tape.
- Portland Type II cement (see previous table).
- Steel Posts (pickets), painted (see footnote).

---

4. All painted components (protector casing, steel pickets) will be painted high-visibility orange and allowed to dry completely prior to being brought onsite.

2.3 DOCUMENTATION

The following document may be provided:

- Copy of appropriate Work Plan
- Copy of approved Health and Safety Plan
- Copies of well and excavation permits
- Boring log forms
- Well completion diagram form
- Well development form.

2.4 GEOLOGIST'S PERSONAL EQUIPMENT

The following equipment may be required for the geologist:

- 10X handlens
- Unified Soil classification System chart
- Munsell color chart
- Sieve set (Keck model SS-81 or equivalent)
- Personal protective equipment as required by the Health and Safety Plan.

3. PROCEDURE

3.1 MATERIALS APPROVAL

Water sources for drilling, grouting, sealing, filter placement, well installation, and equipment decontamination must be approved by the Project Manager prior to arrival of the drilling equipment. Information required for the water source includes: water source, manufacturer/ owner, address and telephone number, type of treatment and filtration prior to tap, time of access, cost per gallon (if applicable), dates and results associated with all available chemical analyses over the past 2 years, and the name and address of the analytical laboratory (if applicable).

Pure sodium bentonite with no additives (bentonite) will be the only drilling fluid additive allowed, and its use must be approved by the Project Manager prior to the arrival of the drilling equipment. The information required for evaluation includes: brand name, manufacturer, manufacturer's address and telephone number, product description, and intended use for the product.

Granular Filter Pack material must be approved by the Project Manager prior to drilling. A 1-pint representative sample must be supplied to the Project Manager. Information required includes: lithology, grain size distribution, brand name, source, processing method, and slot size of intended screen.

Portland Type II cement will be used for grout (see previous table).

3.2 DRILLING

The objective of the selected drilling technique is to ensure that the drilling method provides representative data while minimizing subsurface contamination, cross-contamination of aquifers, and drilling costs. The preferred drilling method is with a hollow-stem auger. Other drilling methods[5] are approved as conditions warrant, and will not require variances be issued by the U.S. Environmental Protection Agency. The method used at a specific site will be proposed in the work plan and evaluated by the Project Manager. Any drilling method not listed herein will require approval on a case by case basis by the U.S. Environmental Protection Agency.

A Site Geologist will be present during all well drilling and installation activities and will fully characterize all tasks performed in support of these activities into the monitoring well logbook. The Site Geologist will be responsible at only one operating rig for the logging of samples, monitoring of drilling operations, recording of water losses/gains and groundwater data, preparing the boring logs and well diagrams, and recording the well installation procedures of the rig. The Site Geologist will have onsite sufficient equipment in operable condition to perform efficiently his/her duties as outlined in the contractual documents. Items in the possession of each Site Geologist will include the approved Health and Safety Plan, this Standard Operating Procedure, a hand lens (10X), a standard color chart, grain-size chart, and a weighted (with steel or iron) steel tape long enough to measure the deepest well, heavy enough to reach that depth, and small enough to fit readily within the annulus between the well and drill casing. The Site Geologist will also have onsite, a water level measuring device, preferably electrical.

Only solid vegetable shortening (e.g., Crisco®) without flavoring or additives may be used on downhole drilling equipment. Additives containing either lead or copper will not be allowed. In addition, polychlorinated biphenyls will not be permitted in hydraulic fluids or other fluids used in the drilling rig, pumps, and field equipment/vehicles.

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5. If the design depth of the well is <100 ft, open, hollow-stem augers will be used to drill the well unless "running sands" preclude the use of open augers. In that case, an inert "knockout" plug may be used in the bottom of the auger string. This plug will be driven out of the augers and left at the bottom of the hole when the well is installed.

   If the design depth of the well is >100 ft, rotary drilling methods may be used to install wells. The following drill fluids and methods are approved in the order listed: (1) rotary drilling with water from an approved source as drilling fluid (clays from the formations will tend thicken the fluid and coat the walls of the borehole and this is acceptable); (2) rotary drilling with water as a fluid, advancing a temporary casing with the bit to maintain an open hole; and (3) mud rotary using water with additives as drill fluid. Due to the potential for aquifer contamination and plugging, mud rotary drilling is not recommended for monitoring wells. If, however, "running sands" are encountered and the aquifer is expected to have a relatively high flow rate, then mud rotary is considered an approved method. Pure sodium bentonite is the only approved additive. Mud rotary drilling must be halted at the last aquitard above the target aquifer. Casing must be set, all bentonite-bearing fluids flushed from the hole and drill rig, and drilling may be resumed using water only as the drill fluid until the target depth is reached.

Surface runoff or other fluids will not be allowed to enter any boring or well during or after drilling/construction.

Antifreeze used to keep equipment from freezing will not contain rust inhibitors and sealants. Antifreeze is prohibited in areas in contact with drilling fluid. The ground surface at the well site will be protected from possible coolant, fuel, and hydraulic fluid spills and/or leakage by placement of plastic sheeting with raised edges, draining into a lined catch basin large enough to contain spills and/or leakage from motors, radiators, or vehicle tanks. Sorbent pillows will be placed to catch obvious leaks from the drill rig. Sorbent logs may be used instead of, or in conjunction with, a lined catch basin to contain spills.

An accurate measurement of the water level will be made upon encountering water in the borehole and later upon stabilization. Levels will be periodically checked throughout the course of drilling. Any unusual change in the water level in the hole, such as a sudden rise of a few inches may indicate artesian pressure in a confined aquifer, will be the basis for cessation of drilling. The geologist will immediately contact the Project Manager[6]. Particular attention for such water level changes will be given after penetrating any clay or silt bed, regardless of thickness, which has the potential to act as a confining layer.

Anticipated depths of wells are given in well specific work plans. In case the previously defined criteria have not been met before the depth range for a given hole is reached, the geologist will stop the drilling and confer with the Project Manager. The current boring conditions (depth, nature of the stratigraphic unit, and water table depth) will be compared to those of other wells nearby to decide to continue drilling or to terminate and complete the well.

If the well is to be installed in the surficial aquifer, drilling will be terminated before penetrating the basal aquitard. The basal aquitard is defined as the first 2 ft-thick clay below the water table, or below 5 ft in the case of a shallow aquifer.

If the well is to be installed in a lower, confined aquifer:

- Penetrations of aquifers located lower than the water table aquifer will be limited to avoid cross-contamination.
- Placement of new upper confined aquifer wells will be initially limited to those areas where contamination has been confirmed.
- The location of upper confined aquifer wells will be based upon the findings of the water table aquifer investigation. Areas of known contamination will be targeted for installing upper confined aquifer wells for the purposes of delineating vertical contamination.

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[6] The contract technical oversight will also be contacted for guidance.

- Where possible, upper-confined aquifer wells will be located such that they afford triangulation with other wells within the same aquifer to allow for a determination of groundwater flow direction.

- Some upper-confined aquifer wells will be installed approximately 10-15 ft from water table wells to enable the accurate assessment of vertical hydraulic gradients. If the direction of groundwater flow is known, wells within a group will be located sidegradient of each other.

- The boring will be advanced until the base of the surficial aquifer is reached (Section 3.2).

- An outer, surface casing will be set 2-5 ft into the confining layer to minimize the potential for cross-contamination from the unconfined aquifer during drilling activities.

- The surface casing will be driven into the confining bed and grouted into place. Grout will be tremied into the annulus around the outside of the casing to within 5 ft of the ground surface. A grout plug at least 2 ft thick will be tremied into the bottom of the surface casing. The grout will be permitted to cure for 24 hours. All drilling fluids within the surface calling will then be removed, and the casing will be flushed with clean potable water.

- The drilling equipment will be decontaminated, a smaller bit or auger selected, and the hole will be continued through the grout plug into the confined aquifer.

- If deeper aquifers are to be screened, repeat preceding steps until total depth is reached.

If dense non-aqueous phase liquid (DNAPL) contamination is detected during drilling, the well will be terminated and completed at the base of the aquifer. Drilling will not continue through the confining unit.

Stainless steel screens will be used in DNAPL wells. Screen size selection will be according to criteria set forth in Section 3.4. The formation grain size will be multiplied by the higher factor (6) to determine filter pack grain size. This will ensure that the filter pack is sufficiently coarse to permit DNAPL to pass freely from the formation into the coarser filter pack, then into the open well (Cohen and Mercer 1993).

DNAPL sampling cups are prohibited. The well screen will be capped, and set 0.3 ft (0.5 ft max.) into the top of the confining bed and rest on the bottom of the hole or bentonite backfill (if used). No sand will be placed below the screen. The remainder of the well installation and completion will be accomplished according to Section 3.4.

3.3 LOGGING

All borings for monitoring wells will be logged by a geologist. Logs will be recorded in a field logbook and/or a boring log. If the information is recorded in a logbook, it will be transferred to Boring Log Forms on a daily basis. Field notes are to include, as a minimum:

- Boring number
- Material description (as discussed below)
- Weather conditions
- Evidence of contamination
- Water conditions (including measured water levels)
- Daily drilling footage and quantities (for billing purposes)
- Notations on man-placed materials
- Drilling method and borehole diameter
- Any deviations from established field plans
- Blow counts for standard penetration tests
- Core and split-spoon recoveries.

Material description for soil samples must include:

- Classification
- Unified Soil Classification symbol
- Secondary components and estimated percentages
- Color
- Plasticity
- Consistency
- Density
- Moisture content
- Texture/fabric/bedding and orientation
- Grain angularity
- Depositional environment and formation
- Incidental odors
- Photoionization detector reading(s)
- Staining.

Material description for rock samples must include:

- Classification
- Lithologic characteristics
- Bedding/banding characteristics
- Color
- Hardness
- Degree of cementation
- Texture
- Structure and orientation

- Degree of weathering
- Solution or void conditions
- Primary and secondary permeability
- Sample recovery
- Incidental odors
- Photoionization detector reading(s)
- Staining.

3.4 WELL CONSTRUCTION AND INSTALLATION

After the hole is drilled and logged, backfill hole as required for proper screen placement. The integrity of the aquitard will be restored by placing a bentonite plug of an appropriate thickness, either to the top of the aquitard (normal well installation) or to within 0.3 ft of the top of the aquitard (DNAPL well). Aquifer fill will be clean filter pack.

Normal screen placement for the water table (surficial) aquifer will be within 2 ft of the screen extending above the static water level. The bottom of the screen will rest no more than 6 in. from the bottom of the hole or backfill material, whichever is applicable.

NOTE: The end cap in DNAPL wells will rest on the bottom of the bottom of the hole, or bentonite backfill if applicable (Section 3.2).

Screen placement for a confined aquifer well will normally be at the top of the confined aquifer.

Screen lengths will not normally exceed 10 ft. If it appears advantageous in a given situation (e.g., to screen an entire aquifer which is thicker than 10 ft), approval must be sought on a case-by-case basis from the appropriate regulatory agency. Otherwise, wells will be screened as follows:

Thickness of Aquifer	Action
<10 ft	Screen entire aquifer
>10 ft <30 ft	Screen top 10 ft consider vertically nested well cluster
>30 ft	Install vertically nested well cluster

The installation of monitoring wells in uncased or partially cased holes will begin within 12 hours of completion of drilling, or if the hole is to be logged, within 12 hours of well logging, and within 48 hours for holes fully cased with temporary drill casings. Once installation has begun, work will continue until the well has been grouted and the drill casing has been removed.

Well screens, casings, and fittings will conform to National Sanitation Foundation Standard 14 or ASTM equivalent for potable water usage. These materials will bear the appropriate rating logo. If the logos are not present, a written statement from the manufacturer/supplier stating that the materials contain the appropriate rating must be obtained. Material used will be new and essentially chemically inert to the site environment.

Well screen and casing should be inert with respect to the groundwater; therefore, the selection of screen and casing material will be based on select field tests of aquifer chemistry and potential contaminants. The screen will be capped without sediment trap or DNAPL sampling cup, and lowered into the hole. The well casing will be pre-cut to extend 2-2.5 ft above ground surface. Prior to placement of the last piece of well casing, a notch or other permanent reference point will be cut, filed, or scribed into the top edge of the casing.

Screen slot size will be appropriately sized to retain 90-100 percent of the filter pack material, the size of which will be determined by sieve analysis of formational material (Section 3.4).

The tops of all well casing will be capped with covers composed of materials compatible with the products used in the well installation. Caps may either be vented, or a telescopic fit, constructed to preclude binding to the well casing caused by tightness of fit, unclean surfaces, or weather conditions. In either case, it should be secure enough to preclude the introduction of foreign material into the well, yet allow pressure equalization between the well and the atmosphere.

Filter pack material will be placed, lightly tamped, and leveled. Filter pack will extend from the bottom of the hole to a height of 1-2 ft above the top of the screen. The filter pack will be capped with a minimum of 1 ft of fine (Ottawa) sand to prevent the bentonite seal from infiltrating the filter pack. If the bentonite seal is placed as a slurry, a minimum of 2 ft of fine sand will be required.

If the hole is less than 20-ft deep, the filter pack may be poured into the annulus directly. If the hole is deeper than 20 ft, the filter pack must be tremied into place.

Granular filter packs will be chemically and texturally clean, inert, and siliceous.

Filter pack grain size will be based on formation grain-size analysis. The D30 (70 percent retained) sieve size multiplied by a factor of not less than 3 nor greater than 6 will be used to determine the appropriate grain size.

Calculations regarding filter pack volumes will be entered into the Field Logbook along with any discrepancies between calculated and actual volumes used. If a discrepancy of greater than 10 percent exists between calculated and actual volumes exists, an explanation for the discrepancy will also be entered in the Field Logbook.

Bentonite seals will be no less than 2-ft thick nor more than 5-ft thick as measured immediately after placement. The normal installation will include a 5-ft seal. Thinner seals may be used in special cases. The final depth to the top of the bentonite seal will be measured and recorded.

3.4.1 Grout

Grout used in construction will be composed by weight of:

- 20 parts cement (Portland cement, type II) (see previous table)
- 0.4-1 part (maximum) (2-5 percent) bentonite
- 8-gal (maximum) approved water per 94-lb bag of cement.

Neither additives nor borehole cuttings will be mixed with the grout. Bentonite will be added after the required amount of cement is mixed with the water.

All grout material will be combined in an aboveground container and mechanically blended to produce a thick, lump-free mixture. The mixed grout will be recirculated through the grout pump prior to placement. Grout placement will be performed using a commercially available grout pump and a rigid, side discharge tremie pipe.

The following will be noted in the Field Logbook: (1) calculations of predicted grout volumes; (2) exact amounts of cement, bentonite, and water used in mixing grout; (3) actual volume of grout placed in the hole; and (4) any discrepancies between calculated and actual volumes used. If a discrepancy of greater than 10 percent exists between calculated and actual volumes exists, an explanation for the discrepancy will also be entered in the Field Logbook.

Well protective casings will be installed around all monitoring wells on the following day as the initial grout placement around the well. Any annulus formed between the outside of the protective casing and the borehole will be filled to ground surface with cement.

The construction of each well will be depicted as built in a well construction diagram. The diagram will be attached to the boring log and will graphically denote:

- Screen location, length
- Joint location
- Granular filter pack
- Seal
- Grout
- Cave-in
- Centralizers
- Height of riser
- Protective casing detail.

3.5 MONITORING WELL COMPLETION

Assemble appropriate decontaminated lengths of pipe and screen. Make sure these are clean and free of grease, soil, and residue. Lower each section of pipe and screen into the borehole, one at a time, screwing each section securely into the section below it. No grease, lubricant, polytetrafluoroethelyne tape, or glue may be used in joining the pipe and screen sections.

If a well extends below 50 ft, centralizers will be installed at 50 ft and every 50 ft thereafter except within screened interval and bentonite seal. Centralizer material will be PVC, polytetrafluoroethelyne, or stainless steel. Determination of centralizer material will be based on the same criteria as screen and calling selection.

Cut the riser with a pipe cutter approximately 2-2.5 ft above grade. All pipe cuts MUST be square to ensure that the elevation between the highest and lowest point of the well casing is less than or equal to 0.02 ft Notch, file, or otherwise permanently scribe a permanent reference point on the top of the casing.

Torches and saws may not be used to cut the riser. Care must be taken that all filings or trimmings cut from the reference point fall outside the riser rather than into the well. **Under no circumstances will a permanent marker or paint pencil be used to mark the reference point**.

In some locations, safety requirements may mandate that a well be flush-mounted with no stick-up. If a flush-mounted well is required at a given location, an internal pressure cap must be used instead of a vented cap to ensure that rainwater cannot pool around the wellhead and enter the well through the cap.

When the well is set to the bottom of the hole, temporarily place a cap on top of the pipe to keep the well interior clean.

Place the appropriate filter pack (Section 3.4). Monitor the rise annulus with a weighted tape to assure that bridging is not occurring.

After the pack is in place, wait 3-5 minutes for the material to settle, tamp and level a capped PVC pipe, and check its depth weighted steel tape.

Add a 1-2 ft cap of fine-grained (Ottawa) sand to prevent infiltration of the filter pack by overlying bentonite seal. See Section 3.4 for guidance on appropriate thickness of fine sand layer.

Install the bentonite seal (2- to 5-ft thick) by dropping bentonite pellets into the hole gradually. If the well is deeper than 30 ft, a tremie pipe will be used to place either bentonite pellets or slurry. Tamp and level pellets. If the well is 30 ft, tamp with a capped PVC pipe, if >30 ft, tamping bay be accomplished with the weighted end of the tape. In either case, check the depth to the top of the seal with a weighted tape as above.

If the bentonite pellets are of poor quality, they may have a tendency to hydrate and swell inside the tremie pipe and bridge. This situation may be solved by the following procedure:

1. Use a different brand of pellets. Different brands may have longer hydration times.

2. Freeze the pellets[7]. Note that this will require a longer wait time to allow proper hydration after the pellets thaw.

3. Place the bentonite seal as a slurry using a side-discharge tremie pipe as though installing grout. Note (Section 3.4) this will require that a minimum of 2 ft of fine sand be placed as a cap on top of the filter pack material.

Wait for the pellets to hydrate and swell. Hydration times will be determined by field test or by manufacturer's instructions. Normally this will be 30-60 minutes. Document the hydration time in the field notebook. If the pellets are above the water level in the hole, add several buckets of clean water to the boring. Document the amount of water added to the hole.

Mix an appropriate cement-bentonite slurry (Section 3.4). Be sure the mixture is thoroughly mixed and as thick as is practicable.

Lower a side discharge tremie pipe into the annulus to the level of the pellet seal.

Pump the grout slurry into the annulus while withdrawing the tremie pipe and temporary casing.

Stop the grout fill at 5 ft below the ground surface. Allow to cure for not less than 12 hours.
If grout settles more than 6 in., add grout to bring level back up to within 5 ft of ground surface. Place approximately 2 ft of bentonite pellets (minimum 0.5 ft) in annulus. Seat the protective casing in the bentonite seal, allowing no more than 0.2 ft between the top of the well casing and the bottom of the protective casing cap. Fill inner annulus (between well casing and protective casing) with bentonite pellets to the level of the ground surface. Cover bentonite pellets with 1 ft of clean granular material (coarse sand or pea gravel filter pack). Fill the outer annulus (between the protective casing and the borehole) with neat cement. Allow the cement to mound above ground level and finish to slope away from the casing. Lock the cap.

— OR —

Continue the grout fill to the ground surface. Seat the protective casing in the grout, allowing no more than 0.2 ft between the top of the well casing and the bottom of the protective casing cap. Lock the cap.

— AND —

Allow the grout slurry to set overnight.

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[7] Bentonite pellets may be "flash-frozen" by brief immersion in liquid nitrogen (LN2). This can be accomplished by pouring LN2 over a small quantity (0.25-0.5 bucket) of pellets, allowing the LN2 to boil off, then pouring the pellets into the tremie pipe. **NOTE:** Use of LN2 is an additional jobsite hazard and must be addressed in the contractor's Health and Safety Plan. This contingency must be covered before drilling starts in order to avoid delays in well installation.

Fill the outer annulus (between the casing and the borehole) with neat cement. Allow the cement to mound above ground level and finish to slope away from the casing.

Slope the ground surface away from the casing for a distance of 2 ft, at a rate of no less than 1 in. in 2 ft. Surface this sloping pad with a geotextile mat covered by 3 in. of coarse gravel.

— OR —

Frame and pour a 4-ft square × 6-in. thick (4 ft × 4 ft × 6 in.) concrete pad centered around the protective casing.

— AND —

Set pre-painted protective steel pickets (3 or 4) evenly around and 4 ft out from well. These pickets will be set into 2 ft deep holes, the holes will then be filled with concrete; and if the pickets are not capped, they will also be filled with concrete.

3.6 WELL DEVELOPMENT

Well development is the process by which drilling fluids, solids, and other mobile particulates within the vicinity of the newly installed monitoring well have been removed while restoring the aquifer hydraulic conductivity. Development corrects any damage to or clogging of the aquifer caused by drilling, increases the porosity of the aquifer in the vicinity of the well, and stabilizes the formation and filter pack sands around the well screen.

Well development will be initiated after 48 consecutive hours but no longer than 7 calendar days following grouting and/or placement of surface protection.

Two well development techniques, over pumping and surging, will be employed in tandem. Over pumping is simply pumping the well at a rate higher than recharge. Surging is the operation of a plunger up and down within the well casing similar to a piston in a cylinder.

3.6.1 Materials Required

The following materials will be required for well development:

- Well Development Form
- Boring Log and Well Completion Diagram for the well
- Submersible pump or bailer of appropriate capacity, and surge block
- Conductivity, pH, ORP, turbidity, dissolved oxygen, and temperature meters
- Electric well sounder and measuring tape
- Containers for purged water, if required.

3.6.2 Summary of Procedures and Data Requirements

Pump or bail the well to ensure that water flows into it, and to remove some of the fine materials from the well. Removal of a minimum of one equivalent volume is recommended at this point. The rate of removal should be high enough to stress the well by lowering the water level to approximately half its original level. If well recharge exceeds 15 gpm, the requirement to lower the head will be waived.

Slowly lower a close-fitting surge block into the well until it rests below the static water level, but above the screened interval. (NOTE: This latter is not required in the case of a light non-aqueous phase liquid well.)

Begin a gentle surging motion which will allow any material blocking the screen to break up, go into suspension, and move into the well. Continue surging for 5-10 minutes, remove surge block, and pump or bail the well, rapidly removing at least one equivalent volume.

Repeat previous step at successively lower levels within the well screen until the bottom of the well is reached. Note that development should always begin above, or at the top of, the screen and move progressively downward to prevent the surge block from becoming sand locked in the well casing. As development progresses, successive surging can be more vigorous and of longer duration as long as the amount of sediment in the screen is kept to a minimum.

Development is expected to take at least 2 hours in a small well installed in a clean sand, and may last several days in large wells, or in wells set in silts with low permeabilities.

Development will continue until little or no sediment can be pulled into the well, and target values for parameters listed below are met.

At a minimum, development will remove 3-5 well volumes of water. One development volume (DV) is defined as (1) equivalent volume, plus (1) the amount of fluid lost during drilling, plus (1) the volume of water used in filter pack placement.

1. Monitor water quality parameters before beginning development procedures, and after removing 2, 2.5, and 3 well volumes of water.

2. If these parameters have stabilized over the three readings, the well will be considered developed.

3. If the parameters have not stabilized after these three readings, continue pumping the well to develop, but stop surging. Monitor the stabilization parameters every half DV.

4. When the parameters have stabilized over three consecutive readings at half DV intervals, the well will be considered developed.

All water removed must be disposed of as directed by the Work Plan.

Record all data as required on a Well Development Record Form (Appendix A), which is made a part of the complete Well Record. These data include:

- Depths and dimensions of the well, casing, and screen obtained from the well diagram.
- Water losses and uses during drilling, obtained from the boring log for the well.
- Measurements of the following indicator parameters: turbidity, pH, conductivity, ORP potential, dissolved oxygen, and temperature.
- Target values for the indicator parameters listed above are as follows: pH – stabilize, conductivity – stabilize, ORP – stabilize, dissolved oxygen –– stabilize, temperature – stabilize, turbidity – 5 nephelometric turbidity units or stabilize. A value is considered to have stabilized when three consecutive readings taken at half DV intervals are within 10 percent of each other.
- Notes on characteristics of the development water.
- Data on the equipment and technique used for development.
- Estimated recharge rate and rate/quantity of water removal during development.

4. MAINTENANCE

Not applicable.

5. PRECAUTIONS

Refer to the site-specific Health and Safety Plan for discussion of hazards and preventive measures during well development activities.

6. REFERENCES

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Appendix A

Field Record of Well Development Form

EA Engineering, P.C.
EA Science and Technology

FIELD RECORD OF WELL DEVELOPMENT

Project Name:	Project No:	Date:
EA Personnel:	Development Method:	
Weather/Temperature/Barometric Pressure:		Time:

Well No.:	Well Condition:
Well Diameter:	Measurement Reference:
Well Volume Calculations	
A. Depth To Water (ft):	D. Well Volume/ft:
B. Total Well Depth (ft):	E. Total Well Volume (gal)[C*D]:
C. Water Column Height (ft):	F. Five Well Volumes (gal):

Parameter	Beginning	1 Volume	2 Volumes	3 Volumes	4 Volumes	5 Volumes
Time (min)						
Depth to Water (ft)						
Purge Rate (gpm)						
Volume Purged (gal)						
pH						
Temperature (°F)						
Conductivity (µmhos/cm)						
Dissolved Oxygen						
Turbidity (NTU)						
ORP (mV)						

Parameter	6 Volumes	7 Volumes	8 Volumes	9 Volumes	10 Volumes	End
Time (min)						
Depth to Water (ft)						
Purge Rate (gpm)						
Volume Purged (gal)						
pH						
Temperature (°F)						
Conductivity (µmhos/cm)						
Dissolved Oxygen						
Turbidity (NTU)						
ORP (mV)						

NOTE: NTU = Nephelometric turbidity unit.
ORP = Oxidation-reduction potential.

COMMENTS AND OBSERVATIONS:

FIELD RECORD OF WELL DEVELOPMENT

Project Name:	Project No:	Date:
EA Personnel:	Development Method:	
Weather/Temperature/Barometric Pressure:		Time:

Well No.:	Well Condition:
Well Diameter:	Measurement Reference:

Parameter	Beginning	1 Volume	2 Volumes	3 Volumes	4 Volumes	5 Volumes
Time (min)						
Depth to Water (ft)						
Purge Rate (gpm)						
Volume Purged (gal)						
pH						
Temperature (°F)						
Conductivity (μmhos/cm)						
Dissolved Oxygen						
Turbidity (NTU)						
ORP (mV)						

Parameter	6 Volumes	7 Volumes	8 Volumes	9 Volumes	10 Volumes	End
Time (min)						
Depth to Water (ft)						
Purge Rate (gpm)						
Volume Purged (gal)						
pH						
Temperature (°F)						
Conductivity (μmhos/cm)						
Dissolved Oxygen						
Turbidity (NTU)						
ORP (mV)						

Standard Operating Procedure No. 021
for
Sediment Sampling

Prepared by

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Revision: 1
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CONTENTS

1. SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) delineates protocols for sampling sediments from streams, rivers, ditches, lakes, ponds, lagoons, and marine and estuarine systems.

EA recognizes that other protocols have been developed that meet the criteria of quality and reproducibility. Clients may have their own sediment sampling protocols which may contain methodologies and procedures that address unique or unusual site-specific conditions or may be in response to local regulatory agency requirements. In such cases, EA will compare its and the client's protocols. The goal is to provide the client with the most quality; therefore, if the client's protocols provide as much or more quality assurance than EA's protocols for the particular site or project, EA will adopt those particular protocols and this SOP will be superseded in those respects. If EA is required to implement the client's protocols in lieu of EA's protocols, EA will make the client formally aware of any concerns regarding differences in protocols that might affect data quality and will document such concerns in the project file.

2. PROCEDURES

The water content of sediment varies. Sediments range from soft to dense and fine to rocky. A variety of equipment may be necessary to obtain representative samples, even at a single site. Factors to consider in selecting the appropriate sampling equipment include sample location (edge or middle of the waterbody), depth of water and sediment, grain size, water velocity, and analytes of interest.

3. GENERAL PROCEDURES

1. Surface water and sediment samples are to be collected at the same location (if both are required in the project-specific Sampling and Analysis Plan).

2. Collect the surface water sample first. Sediment sampling usually results in disturbance of the sediments, which may influence the analytical results of the surface water samples.

3. Wear gloves when collecting samples. Comply with the Health and Safety Plan specifications for proper personal protective equipment.

4. If sampling from a boat or near waterbodies with depths of 4 ft or more, the sampling team will wear life jackets.

5. Wading into a waterbody disturbs the sediment. Move slowly and cautiously, approach the sample location from downstream. If flow is not strong enough to move entrained particles away from the sample location, wait for the sediment to resettle before sampling.

6. Collect samples first from areas suspected of being the least contaminated, thus minimizing the risk of cross-contamination.

7. Collecting samples directly into sample containers is not recommended. Sediment samples should be placed in Teflon®, stainless steel, or glass trays, pans, or bowls for sample preparation.

8. Use the proper equipment and material construction for the analytes of interest. For example, for volatile organic compound analysis, the sampling material in direct contact with the sediment or surface water must consist of Teflon, polyethylene, or stainless steel.

9. Refer to EA SOP No. 005 (Field Decontamination) for proper decontamination methods before and after sampling and between samples.

10. Collect samples for volatile organic compound analysis first. Do not mix such samples before placing them in the sample containers. For composite volatile organic compound samples, place equal aliquots of each subsample in the sample container.

11. Sediment that will be analyzed for other than volatile organic compounds should be prepared as follows:

    - Place the sediment in a mixing container.

    - Divide the sediment into quarters.

    - Mix each quarter separately and thoroughly.

    - Combine the quarters and mix thoroughly.

    - For composite samples, mix each subsample as described above. Place equal aliquots of each subsample in a mixing container and follow the procedure described above.

12. Mark the sampling location on a site map. Record sampling location coordinates with a Global Positioning System unit, photograph (optional, recommended) and describe each location, and place a numbered stake above the visible high water mark on the bank closest to the sampling location. The photographs and description must be adequate to allow the sampling station to be relocated at a future date.

13. Dispose of investigation-derived wastes according to applicable rules and regulations.

4. CORERS

A corer provides a vertical profile of the sediment, which may be useful in tracing historical contaminant trends. Because displacement is minimal, a corer is particularly useful when sampling for trace metals and organics. Corers can be constructed out of a variety of materials.

For example, a 2-in. diameter polyvinyl chloride pipe with a Teflon or polyethylene liner can be lowered into the sediment; a 2-in. diameter well cap can be used to form an airtight seal and negative pressure as the pipe is withdrawn.

- Ensure that the corer and (optional) liner are properly cleaned.
- Stand downstream of the sample location.
- Force the corer into the sediment with a smooth continuous motion. Rotate (not rock) the corer if necessary to penetrate the sediment.
- Twist the corer to detach the sample; then withdraw the corer in a single smooth motion. If the corer does not have a nosepiece, place a cap on the bottom to keep the sediment in place.
- Remove the top of the corer and decant the water (into appropriate sample containers for surface water analysis, if required).
- Remove the nosepiece or cap and deposit the sample into a stainless steel, Teflon, or glass tray.
- Transfer the sample into sample containers using a stainless steel spoon (or equivalent device).

5. SCOOPS AND SPOONS

When sampling at the margins of a waterbody or in shallow water, scoops and spoons may be the most appropriate sampling equipment. For collecting samples several feet from shore or in deeper water, the scoop or spoon may be attached to a pole or conduit.

- Stand downstream of the sample location.
- Collect the sample slowly and gradually to minimize disturbing the fine particles.
- Decant the water slowly to minimize loss of fine particles.
- Transfer the sediment to sample containers or mixing trays, as appropriate.

6. DREDGES

Three types of dredges are most frequently used: Peterson, Ponar, and Eckman. Many other dredge types are available; their applicability will depend upon site-specific factors.

6.1 PETERSON AND PONAR DREDGES

These dredges are suitable for hard, rocky substrates, deep waterbodies, and streams with fast currents. Ponars have top screens and side plates to prevent sample loss during retrieval.

- Open the jaws and place the cross bar into the proper notch.
- Lower the dredge to the bottom, making sure it settles flat.
- When tension is removed from the line, the cross bar will drop, enabling the dredge to close as the line is pulled upward during retrieval.
- Pull the dredge to the surface. Make sure the jaws are closed and that no sample was lost during retrieval.
- Open the jaws and transfer the sediment to sample containers or to a mixing tray.

6.2 ECKMAN DREDGE

The Eckman dredge works best in soft substrates in waterbodies with slow or no flow.

- Open the spring-loaded jaws and attach the chains to the pegs at the top of the sampler.
- Lower the dredge to the bottom, making sure it settles flat.
- Holding the line taut, send down the message to close the jaws.
- Pull the dredge to the surface. Make sure the jaws are closed and that no sample was lost during retrieval.
- Open the jaws and transfer the sediment to sample containers or a mixing tray.

7. REFERENCES

None.

Standard Operating Procedure No. 024
for
Photoionization Detector (Microtip HL-200)

Prepared by

EA Engineering, Science, and Technology, Inc.
11019 McCormick Road
Hunt Valley, Maryland 21031

Revision 0
August 2007

CONTENTS

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure is to delineate protocols for field operations with a photoionization detector (PID). PIDs use an ultraviolet emitting lamp designed to detect, measure, and display the total concentration of airborne ionizable gases and vapors. This information is used to determine control measures such as protection and action levels.

Use of brand names in this Standard Operating Procedure is not intended as endorsement or mandate that a given brand be used. Alternate equivalent brands of detectors, sensors, meters, etc. are acceptable. If alternate equipment is to be used, the contractor will provide applicable and comparable standard operating procedure for the maintenance and calibration of same.

2. MATERIALS

The following materials may be required:

Battery back	Regulator
Calibration gas (100ppm Isobutylene)	Tedlar bag
PID (i.e., Microtip HL-200)	Tygon tubing

3. STARTUP/CALIBRATION PROCEDURE

The following describes startup and calibration procedures:

- Turn the instrument on by pressing the back of the power switch located on the handle of the Microtip.

- The message “Warming up now, please wait” will be displayed for up to 3 minutes. After normal display appears, the Microtip is ready for calibration.

- Fill a Tedlar bag with the desired calibration gas (usually 100 ppm isobutylene).

- Press SETUP button and select the desired Cal Memory using the arrow keys (normally set to 200 ppm). Press EXIT button to leave setup function.

- Press CAL button and expose Microtip to Zero Gas. (Usually clean outdoor air will be suitable. If any doubt exists as to the cleanliness of the background air, a commercial source of zero gas should be used.).

- The Microtip then asks for the Span Gas concentration. Enter the known span gas concentration and then connect the Tedlar bag containing the Span Gas.

NOTE: THE SPAN GAS CONCENTRATION IS DEPENDENT UPON BOTH THE CONCENTRATION OF THE SPAN GAS USED AND THE RATING OF THE ULTRAVIOLET LAMP IN THE MICROTIP AT TIME OF CALIBRATION. IF USING 100 ppm ISOBUTYLENE AND THE STANDARD 10.6 eV LAMP, THE SPAN GAS CONCENTRATION WILL BE 56 ppm.

- Press enter and the Microtip sets its sensitivity. Once the display reverts to normal, the Microtip is calibrated and ready for use. Remove the Span Gas from the inlet probe. The instrument should be calibrated at least once a day.

4. BATTERY CHARGING

The following is a summary of battery charging procedures:

- Ensure Microtip is off.
- Set the voltage selector switch on the bottom of the battery charger to the appropriate AC line voltage.
- Press the release button on the bottom of the Microtip and remove the battery pack by sliding it backwards.
- Plug charger into the battery pack and then into an AC outlet and allow the battery to charge for at least 8 hours.
- After charging, remove the charger, first from the outlet then from the battery pack, and slide the battery pack back onto the Microtip.

5. PRECAUTIONS

The following is a summary of precautions while using the Microtip:

- Microtip does not carry an Intrinsic Safety Rating and must not be used in a hazardous location where flammable concentrations of gases or vapors are constantly present.
- All calibration, maintenance, and servicing of this device, including battery charging, must be performed in a safe area away from hazardous locations.
- Do not open or mutilate battery cells.
- Do not defeat proper polarity orientation between the battery pack and battery charger.
- Substitution of components may affect safety rating.

6. REFERENCES

Microtip HL-200 User's Manual. February 1990.

Standard Operating Procedure No. 025
for
Soil Sampling

Prepared by

EA Engineering, Science, and Technology, Inc.
11019 McCormick Road
Hunt Valley, Maryland 21031

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August 2007

CONTENTS

Page

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure is to delineate protocols for sampling surface and subsurface soils. Soil samples give an indication of the area and depth of site contamination, so a representative sample is very important.

2. MATERIALS

The following materials may be required:

Bucket auger or push tube sampler	Split-spoon, Shelby tube, or core barrel sampler
Drill rig and associated equipment	Stainless steel bowl
Personal protective equipment as required by the Health and Safety Plan	Stainless steel spoon, trowel, knife, spatula (as needed)

3. PROCEDURE

3.1 SUBSURFACE SAMPLES

Don personal protective equipment. Collect split-spoon, core barrel, or Shelby Tube samples during drilling. Upon opening sampler, or extruding sample, immediately screen soil for volatile organic compounds using either a photoionization detector or flame ionization detector. If sampling for volatile organic compounds, determining the area of highest concentration, use a stainless steel knife, trowel, or laboratory spatula to peel and sample this area. Log the sample in the Field Logbook while it is still in the sampler. Peel and transfer the remaining sample in a decontaminated stainless steel bowl. Mix thoroughly with a decontaminated stainless steel spoon or trowel. Place the sample into the required number of sample jars. Preserve samples as required. Discard any remaining sample into the drums being used for collection of cuttings. Decon sampling implements. All borings will be abandoned.

NOTE: If sample recoveries are poor, it may be necessary to composite samples before placing them in jars. In this case, the procedure will be the same, except that two split-spoon samples will be mixed together. The Field Logbook should clearly state that the samples have been composited, which samples were composited, and why the compositing was done.

Samples taken for geotechnical analysis will be undisturbed samples, collected using a thin-walled (Shelby tube) sampler.

3.2 SURFICIAL SOIL SAMPLES

Don personal protective equipment. Remove vegetative mat. Collect a sample from under the vegetative mat with a stainless steel trowel, push tube sampler, or bucket auger. If a representative sample is desired over the depth of a shallow hole or if several shallow samples are to be taken to represent an area, composite as follows:

- As each sample is collected, place a standard volume in a stainless steel bowl.
- After all samples from each hole or area are in the bucket, homogenize the sample thoroughly with a decontaminated stainless steel spoon or spatula.

If no compositing is to occur, place sample directly into the sample jars. Place the leftover soil in the auger borings and holes left by sampling. If necessary, add clean sand to bring the subsampling areas back to original grade. Replace the vegetative mat over the disturbed areas. Samples for volatile organic compounds will not be composited. A separate sample will be taken from a central location of the area being composited and transferred directly from the sampler to the sample container. Preserve samples as required. Decon sampling implements.

4. MAINTENANCE

Not applicable.

5. PRECAUTIONS

Refer to the Health and Safety Plan.

Soil samples will not include vegetative matter, rocks, or pebbles, unless the latter are part of the overall soil matrix.

6. REFERENCES

American Society for Testing and Materials (ASTM). Method D1586-84, Penetration Test and Split-Barrel Sampling of Soils.

ASTM. Method D1587-83, Thin Walled Sampling of Soils.

Department of the Army, Office of the Chief of Engineers. 1972. Engineer Manual 1110-2-1907 Soil Sampling. 31 March.

Standard Operating Procedure No. 027A
for
Passive Soil Gas Surveys
– Gore Sorbers

Prepared by

EA Engineering, Science, and Technology, Inc.
11019 McCormick Road
Hunt Valley, Maryland 21031

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CONTENTS

Page

1. SCOPE AND APPLICATION

The steps and information herein are the Standard Operating Procedures (SOPs) for conducting a GORE-SORBER Screening Survey. GORE-SORBER® Screening Modules and organic analyses will be supplied/conducted by:

W.L. Gore & Associates, Inc.
101 Lewisville Road
P.O. Box 1100
Elkton, Maryland 21922-1100
(410) 392-3300

Use of brand names in this SOP is not intended as endorsement or mandate that a given brand be used. Alternate equivalent brands of detectors, sensors, meters, etc. are acceptable. If alternate equipment is to be used, the contractor will provide applicable and comparable SOPs for the maintenance and calibration of same.

2. COLLECTOR DESCRIPTION

The sorbent containers and insertion/retrieval cords are constructed solely of inert, hydrophobic, microporous GORE-TEX® expanded polytetrafluoroethylene (ePFTE, similar to Teflon) with no fillers or plasticizer introduced during manufacturing. The unique feature of this construction is that the entire sorbent container surface area, as well as the surrounding insertion/retrieval "cord," facilitates vapor transfer. Sorbent containers (sorbers) are typically filled with TENAX®.

3. FIELD OPERATIONS

3.1 MATERIALS

The following materials may be required for field operations:

Cooler(s) with chilled ice packs or ice	Knife, scissors, and needle nose pliers
Corks with screw eyes	Latex surgical gloves or equivalent
Correctly scaled site map	Measuring tape, transit, or other distance measuring device
Electric power source (AC power outlet or generator)	Paper towels and American Society for Testing and Materials Type II water or equivalent
Electric rotary, hammer-action, or combination hammer with 1-in. carbide-tipped bit (31-36 in. long)	Patching compound for concrete and/or asphalt holes (if required)
Extension cord	Pen, clipboard, field notebook, chain-of-custody (COC) form, and SOP
Fiberglass staff flags or some other means of location marking	Slide hammer/tile probe
GORE-SORBER® Screening Modules and Vials	Small shovel
Insertion rod	Trash bags

3.2 LOCATING SAMPLE SITES

Lay out sampling grid using point spacing specified in Work Plan. From a known survey point, locate and mark all screening module location sites to the nearest inch using fiberglass staff flags.

Note on field maps and/or field log any deviations to the sample grid as presented in the Work Plan.

Drill Hole—A 9/16- to 1-in. hole is cored to a depth of 2-3 ft below ground surface (installation depth is held constant for a given survey). This depth has been selected to keep the modules below the daily effects of atmospheric temperature changes. Coring is accomplished using a variety of tools depending on the nature of the material being cored. The holes should be vertical and as free from debris as possible.

Prepare Sorber Unit and Note the Unique Serial Number—Immediately after the hole is cored, a GORE-SORBER® Screening Module is removed from its sealed container. Note that each module has a unique serial number recorded on top of the module vial and a metal tag attached to the module. Each vial is also individually numbered. **Record this number on the site map and/or field notebook immediately**.

Insert Sorber Unit—Insert the stainless steel insertion rod into the pocket in the bottom of the module, and lower it into the hole. Ensure that the module goes the entire way down the hole. If a large resistance is felt during insertion, remove the module and re-drill the hole. Re-insert the module. When the module is completely inserted in the hole, press the insertion rod against the side of the hole. Twist the rod and pull the rod out.

Seal Hole—Attach the end of the module to the screw eye in the cord. **Do not remove the metal ID tag**. Coil the excess retrieval cord and push it with the metal tag into the hole. Cork the hole to prevent the intrusion of rain and atmospheric gasses during exposure. If the cork does not fit snugly into the hole, and wrap a short length of the module retrieval cord around the cork and re-insert the cork into the hole.

Decontaminate the auger and insertion rod. After each use, decontaminate all intrusive equipment using decontamination procedures specified in Section 3.3.2 of SOP No. 005.

3.3 EXPOSURE TIME

Exposure times, typically 14 days, are defined in the site Work Plan. Exposure times should be sufficient to allow equilibration of the modules with subsurface conditions. Actual subsurface exposure time and conditions will be measured and recorded.

3.4 FIELD QUALITY CONTROL BLANKS

3.4.1 Temperature Control Blank

Water temperature control blanks are normally supplied by Gore with one blank supplied with each cooler of shipped modules. Temperature control blanks consist of a small vial of American Society for Testing and Materials Type I water that is used to determine the temperature of the modules upon arrival at the laboratory. One temperature control blank must be included with each cooler shipped to Gore for analysis.

3.4.2 Trip Blanks

The trip blank is a set of sorbent modules used to detect volatile organic compound (VOC) contamination during sample shipping and handling. Trip blanks travel to the site with the sampling modules and are returned to the laboratory with the sampling modules. The trip blank will not be exposed to field conditions. The trip blank will be used to assess whether or not any chemical detected by the sorbers are the result of sources other than the study sites. One trip blank is to accompany each cooler containing VOCs. Trip blanks will be kept in sample refrigerators during the course of field work.

3.4.3 Field Duplicates

The collection of field duplicate samples provides for evaluation of overall sampling and laboratory precision by comparing analytical results of two samples of the same matrix from the same location. Two sorber units will be installed into one hole for a duplicate sample. The additional modules will allow for duplicate analysis of several modules from the same hole. If there is a wide difference in analytical results between duplicate samples, it can indicate poor precision of analytical technique and suggest increased evaluation of the data may be warranted. Field duplicates will be collected at a frequency of 10 percent of the samples collected per event.

3.5 SORBER RETRIEVAL

Evaluate the Sample Site**—**Note any site disturbance that may have occurred since the sorber module was installed. Note any stains on the ground, cork removal, or other such features that might indicate tampering. Remove cork.

Remove Sorber Unit from Hole**—**Wearing surgical gloves, and wrap retrieval cord once or twice around your hand. Using slow, steady tension, pull the cord straight out of the ground. **Double check the Module ID number on the sample module, sample vial, and COC/Field Logbook to ensure that the correct module is retrieved from the correct grid position**. Cut off the cork and discard.

Place Sorber Unit in Vial**—**Put the entire retrieval cord, including the metal tag, back into the correctly labeled vial. Tightly reseal the vial. Immediately place the vial in a cooler with blue ice. Sorbers will be stored onsite in a freezer until shipped to the laboratory.

3.6 SORBER SHIPMENT

Sample packing procedures will follow the steps outlined in SOP No. 004. The sorbers should be packed in the blue ice certified by W.L. Gore to be volatile free. Do not use Styrofoam “peanuts” or any other packing material which may contain volatiles or out-gas and contaminate sorbers during shipment. Bubble packing is acceptable. Receive clearance from SciTech to ship samples.

Carefully cut three modules from each sorber unit, one sorber at a time. Care must be taken at this point to ensure that the serial number for each sorber unit is transposed to the sample vial and COC. Do not start a new sorber unit until the transfer of modules from the previous sorber unit is completed in full. Place these three modules in a clean bottle supplied by the contract laboratory.

Note the serial number of the sorber unit tag on the bottle label. Place this number on the contract laboratory COC. Seal the bottle. Place bottle in cooler and pack the samples following the steps in SOP No. 004.

Using the vial racks, coolers, and ice substitutes supplied by the contract laboratory, return the exposed vials and COC document to the contract laboratory via overnight carrier service. Return the remaining sorber module to the GORE vial and seal. Place vials in cooler and pack the samples following steps in SOP No. 004.

Using the vial racks, coolers, and ice substitutes supplied by Gore, return the exposed vials and COC document to Gore’s analytical laboratory via overnight carrier service.

4. ANALYTICAL AND DATA PRESENTATION

4.1 SAMPLE RECEIVING

Upon receipt at the W.L. Gore and contract laboratories, all soil gas samplers are inspected and sample labels are cross-referenced against the COC form. Any anomalies observed during the inspection are noted on the COC. When all anomalies, if any, are resolved, the samplers are ready for analysis.

4.2 VOLATILE ORGANIC COMPOUND ANALYSIS

W.L. Gore will analyze for VOCs and report the results of this work directly to the organization conducting the soil gas survey.

4.3 SAMPLE HOLDING

There are no holding time limitations.

4.4 INSTRUMENTATION

Instrumentation at W.L. Gore consists of a Hewlett-Packard 5890-II gas chromatograph, 5971A mass selective detector, and 7673 liquid autosampler. A 25-m, 0.2-mm bore, 0.5 μm "HP-5" 95 percent dimethyl, 5 percent diphenyl polysiloxane capillary column is normally used. A typical temperature program developed for analyzing the sorbers is: initial temperature 40°C for 4 minutes, ramp 20 C/minute to 320°C, final temperature 2 minutes. Injection port temperature (for method extraction) is 250°C, detector transfer line is 380°C. A Perkin-Elmer ATD-400 Automated Thermal Desorption unit is the extraction device used by Gore for sites with low concentrations of gasoline and solvent contamination. By cryofocusing the sample extract prior to sample injection into the gas chromatograph column, Gore has achieved greatly increased sensitivity to all compounds, and superior separation of VOCs compared to solvent or headspace extraction methods.

4.5 ANALYTICAL PARAMETERS

Table SOP027A-1 includes proposed analytical parameters. The soil gas contractor will also conduct a library search to identify and report up to 100 organic chemical constituents present in each module if requested.

4.6 LABORATORY QUALITY ASSURANCE PROCEDURES

W.L. Gore will conform to its Quality Assurance Plan (1994) to be appended to the project-specific Quality Assurance Project Plan with regard to quality control sample type, frequency, handling, preparation, and analytical procedure.

4.7 MAPPING/REPORTING

Graphic presentation of the data extracted from the GORE-SORBER® Screening Modules is presented by overlaying the contamination patterns detected during the analysis onto computer-aided design maps supplied by the field investigator.

5. REFERENCES

W.L. Gore. 1994. Quality Assurance Plan.

TABLE SOP027A-1 PROPOSED ANALYTICAL PARAMETERS PASSIVE SOIL GAS SURVEY

Analytes	Limit (µg/sorber)
Acetone	(a)
Benzene	0.04
2-Butanone	(a)
Carbon Tetrachloride	0.06
Chlorobenzene	0.03
Chloroform	0.03
Chloromethane	(a)
1,4-Dichlorobenzene	0.04
1,1-Dichloroethane	(a)
1,2-Dichloroethane	(a)
1,1-Dichloroethylene	(a)
trans-1,3-Dichloroethylene	(a)
1,2-Dichloropropane	(a)
cis-1,3-Dichloropropene	(a)
trans-1,3-Dichloropropene	(a)
Ethylbenzene	0.03
Methyl tert-Butyl Ether	0.07
Methylene Chloride	0.23
2-Methylnapthalene	0.03
2-Methylphenol	0.04
Naphthalene	0.03
Octane	0.02
Pentadecane	0.06
Phenanthrene	0.015
Phenol	0.05
Styrene	(a)
1,1,2,2-Tetrachloroethane	(a)
Tetrachloroethylene	0.07
1,2,4,5-Tetramethylbenzene	0.02
Toluene	0.03
1,1,1-Trichloroethane	0.06
1,1,2-Trichloroethane	(a)
Trichloroethylene	0.04
Tridecane	0.04
1,2,4-Trimethylbenzene	0.03
1,3,5-Trimethylbenzene	0.03
Undecane	0.04
Vinyl Chloride	(a)
m-Xylene	0.02
o-Xylene	0.03
Total Xylenes	(a)
(a) Method detection limit studies currently being conducted.	

Standard Operating Procedure No. 027B
for
Passive Soil Gas Surveys
– Petrex Technique

Prepared by

EA Engineering, Science, and Technology, Inc.
11019 McCormick Road
Hunt Valley, Maryland 21031

Revision 0
August 2007

CONTENTS

Page

1. SCOPE AND APPLICATION

The steps and information herein are the Standard Operating Procedures (SOPs) for carrying out a Petrex environmental survey. Possible deviations from SOPs may occasionally be implemented onsite by EA field staff to adjust for unique survey conditions. The Petrex technique is also frequently used for oil and gas, geothermal, and mineral exploration which force slight variations on this SOP. Surveys performed in winter in frozen ground offer a unique situation and slightly different field practices.

The fact that the SOPs may occasionally be altered is done to maintain quality service while using the Petrex technique. It must also be understood that the ion flux data from one survey at a given site and a given time interval should not be compared to the flux numbers from another survey. Since the data are semi-quantitative, only the flux patterns of a survey or the relative difference between flux values of two samples from the same survey should be considered during interpretation.

If any questions arise upon review of this document, please address questions to Northeast Research Institute, Inc. (NERI) technical staff at:

Northeast Research Institute, Inc.
309 Farmington Avenue, Suite A-100
Farmington, Connecticut 06032
(203) 677-9666

– OR –

Northeast Research Institute, Inc.
605 Parfet Street, Suite 100
Lakewood, Colorado 80215
(303) 238-0090

Use of brand names in this SOP is not intended as endorsement or mandate that a given brand be used. Alternate equivalent brands of detectors, sensors, meters, etc. are acceptable. If alternate equipment is to be used, the contractor will provide applicable and comparable SOPs for the maintenance and calibration of same.

2. SAMPLE PRODUCTION AND PREPARATION

2.1 CHARCOAL SIEVING

The static volatile organic compound (VOC) collector is prepared by applying pre-sieved activated charcoal to the end of a ferromagnetic wire.

2.2 CHARCOAL BONDING

The details of the procedure for preparing the activated charcoal are proprietary information. The procedure results in the production of a collector consisting of size-sorted activated charcoal bonded to the area within 1 cm of the end of a ferromagnetic wire with a Curie point of 358°C.

2.3 COLLECTOR CONTAINERS

Culture tubes, measuring 25 mm × 125 mm and having a screw cap closure, are washed in a biodegradable detergent, rinsed in methanol, and baked at 180°C for 1 hour.

2.4 WIRE CLEANING

The previously constructed wires are cleaned by heating in a special apparatus at 358°C a total of 35 times under high vacuum. The wires are cleaned in lots of 32 wires. From each lot, two wires are removed for immediate analysis to verify the cleanliness of the lot. The remaining 30 wires are then sealed in one clean culture tube under an inert atmosphere and placed in inventory.

2.5 PACKAGING FOR CLIENT

Immediately prior to shipping the wires to the field, the tubes containing 30 wires are removed from inventory and the wires are repackaged under an inert atmosphere in individual tubes. All of the repackaged tubes contain two wires. Ten percent of these have three wires. The collectors are packaged by bagging in zipseal plastic bags in an inert atmosphere. These bags are then placed in inventory in a temperature-controlled room. The basis for having two wires in each tube is that it allows NERI to analyze one wire by standard Thermal Desorption-Mass Spectrometry while the second sample is available for Thermal Desorption-Gas Chromatography/Mass Spectrometry or as a backup to the Thermal Desorption-Mass Spectrometry. The third wire in selected samples from each survey is used to establish optimum instrument parameters.

2.6 QUALITY CONTROL AND QUALITY ASSURANCE

Prior to releasing stocked wires for a field survey, two single wires from each lot are checked for cleanliness and collecting potential. This quality assurance/quality control phase measures and documents collector preparedness when leaving the laboratory. One of these wires is analyzed without exposure in order to demonstrate that the lot is clean, and the other wire is exposed to hexane vapor for two seconds and then analyzed in order to verify that the charcoal is highly adsorptive. The triplicate wires are used when the wires return from the field. These wires help determine the required machine sensitivity and act as a measure of reproducibility.

2.7 CUSTODY DOCUMENT

A "custody document" accompanies each group of collectors leaving the laboratory and remains with the group until the collectors have been exposed, analyzed, and disposed of.

3. FIELD OPERATIONS

3.1 LOCATING SAMPLE SITES

Sample placement sites, usually predetermined on an accepted survey proposal, are located from a nearby, surveyable landmark using a compass and pacing or some other measuring device (e.g., pacing wheel, hip chain, or tape measure). A transit may be used for more accurate placement, but such accuracy is seldom required.

3.2 SOIL CORING

Once a sample site has been established, a hole is cored to a predetermined depth (sample placement depth is held constant for a given survey). This is accomplished using a variety of tools depending on the nature of the material to be cored. The holes should be vertical and as free from debris as possible. When the sampling is performed in areas covered by asphalt or concrete, a generator-powered rotary hammer drill with a carbide-tipped bit is used to drill a 1.5-in. diameter hole in the cover. A hand auger is used to remove the cuttings and road base from the hole.

3.3 COLLECTOR PLACEMENT

Immediately after the hole is cored, a collector tube is removed from the zipseal plastic bag and the bag is resealed. The cap is then removed from the tube, and the tube is placed vertically, open end down, into the hole. The hole is then backfilled with the soil core which was removed. The cap is placed in a clean zipseal plastic bag and stored until collector retrieval. Collectors placed under asphalt or concrete are treated the same as those in uncovered soil, except for modifications to permit easy retrieval and to avoid potential down-hole contamination from surface cuttings. To allow retrieval of these collectors, a piece of galvanized wire is twisted around the neck of the tube and run to the surface so that the sample may be recovered by pulling the retrieval wire. An aluminum plug is then placed near the top of the hole, and the remainder of the hole is plugged with quick setting hydraulic cement.

3.4 SITE IDENTIFICATION

Each site is flagged using pin flags, spray paint, or ribbon flagging, and the site location is marked and numbered on a base map. A field logbook is used to record the date, collector number, site location description, soil type, and general observations.

3.5 EXPOSURE TIME

Time calibration collectors are included as part of every survey. These are quality assurance collectors used to monitor sample loading during the survey. These collectors are placed in an area of known or suspected contamination, and sets are retrieved and analyzed at intervals to indicate the appropriate residence time for survey samples. Separate “travel blank” collectors are also included as a quality control measure in every survey. These collectors are transported along with the survey collectors but the tubes are never opened. These control collectors monitor for potential contamination during transport or placement.

3.6 COLLECTOR RETRIEVAL

The collectors are retrieved when the time calibration collectors reveal that there has been sufficient loading of gases on the charcoal absorbent. In the field, the soil is removed until the tube is exposed. A cap is taken from the sealed zipseal plastic bag. The Viton seal is checked to make sure it is seated inside the cap. The culture tube is removed from the hole and any dirt that is on the threads of the tube is wiped off with a clean cloth. In the event the tube is broken or cracked, the collector wire is transferred to a new tube using forceps. The tube is capped and sealed. All flagging material is retrieved.

3.7 COLLECTOR NUMBERING

Each tube is immediately numbered according to the scheme established in the field notes and on the base map. The collector number is written on adhesive labels which are applied to the tube cap. No two sites may have the same number.

3.8 COLLECTOR SHIPMENT

Once the collectors have been retrieved, they are sealed in zipseal plastic bags and then wrapped with bubble packing. Materials such as styrofoam peanuts or newsprint can introduce possible contaminants to the collectors and should not be used for packaging. The collectors, field notes, base map, and chain-of-custody document are either hand carried back to NERI’s analytical laboratories or shipped by overnight carrier service.

3.9 DECONTAMINATION

All down-hole equipment and tool parts which contact excavated soil are constructed of heavy gauge steel and have no natural or synthetic components that could absorb and retain most soil-borne organic contaminants. These tools are decontaminated between use at each sampling location by rotation through a four-step cleaning process:

1. Immersion and vigorous scrubbing in a mild solution of laboratory grade detergent until all visual accumulations of soil are removed

2. Thorough rinsing with potable water
3. Spray rinsing with methyl alcohol
4. Air dry.

All derived liquids (and sediment) are contained in dedicated disposable vessels.

4. COLLECTOR ANALYSIS

4.1 NUMBERING CHECK

Upon receipt of the collectors, the number on each tube is recorded and any missing or duplicated numbers are noted. A missing number generally indicates that the collector could not be retrieved. Samples with identical numbers generally cannot be used unless their true site location can be established.

4.2 SAMPLE HOLDING

A Petrex soil gas sample consists of a minute quantity of various volatile organic compounds sorbed onto a charcoal element and enclosed in a protective container with a near impervious Viton seal.

Maximum sample holding time is a function of both the chemical stability of the sorbed compounds and the integrity of the seal of the container.

It has been the experience of NERI that Petrex soil gas samples that are properly repackaged after retrieval from the field and stored under environmentally controlled conditions typically remain compositionally and quantitatively unchanged through periods of greater than 4 months.

All samples scheduled for analysis via Curie-point pyrolysis/mass spectrometry are analyzed within 3 weeks of retrieval from the field.

4.3 INSTRUMENTATION

Thermal desorption is accomplished using a Fisher radio frequency power supply and a Curie point pyrolizer designed by NERI and Extrel. The mass spectrometer used is an Extrel Spectrel quadrapole mass spectrometer. The analysis is controlled and recorded by a DEC PDP 11/23 microcomputer. Following the analysis, all data are collected and archived on a PDP 11/73 microcomputer. Data for all active jobs are stored on both of the PDP 11 computers, as well as on magnetic tape. Data for all completed jobs are stored on magnetic tape in perpetuity.

4.4 CALIBRATION

An Extranuclear Quadrupole Spectrometer equipped with a Curie-point pyrolysis/thermal desorption inlet is used for collector analysis. Mass assignment and resolution are manually adjusted using a perfluorotributylamine (PFTBA) standard. A linear correction, based on the known spectrum of PFTBA, is calculated. This correction is applied to a second PFTBA spectrum. If correct mass (M/Z) values are obtained, the operator proceeds to the next turning step. If not, Step 1 is repeated until correct masses are obtained.

Peak intensity ratios are set from the major peaks in the PFTBA spectrum using the following values:

Mass (M/Z)	Spectrum Intensities
69	100%
131	25%±5%
219	35%±5%
502	5%±2%

At the standard mass (M/Z = 69), PFTBA is measured at a preset sample pressure and detector voltage and compared to previous values at the same setting.

Electron energy is set to 70 electron volts and emission is set at 12 milliseconds. All other operating parameters, such as scans, scan range, and mass offset, are established in the computer program. These values may only be changed by the laboratory manager.

Tuning is performed at the beginning of a run so that an individual survey is analyzed at the same set of instrument conditions. The samples are analyzed in random order.

4.5 INSTRUMENT PARAMETERS

The instrument is operated with the following parameters:

Vacuum	<3 × 10-6 torr
Ionization Energy	70.0 eV
Ionization Current	12.0 mA
Desorption Time	5.0 sec
Desorption Temperature	358°C
Number of Scans/Sample	30
Scan Rate	1,250 amu/sec

4.6 MASS SPECTROMETER ANALYSIS AND QUALITY ASSURANCE/QUALITY CONTROL

Each collector wire is analyzed in random order. The entire group of survey collectors is analyzed as one run without interruption from other surveys.

The organic gases adsorbed on the carbon are thermally desorbed from the carbon, separated according to ion mass, counted, and a mass spectrum of masses from 29 to 240 is obtained.

Periodic (approximately every 20 samples) machine background analyses are performed as a quality control measure to assure minimal influence from internal communication. If there are peaks that are not related to atmospheric gases, the supervisor is notified and the mass spectrometer is shut down and cleaned as necessary.

A written sample number record is kept during the analysis to prevent accidental cross numbering.

The mass spectrometer control program prompts the operator with a warning if a sample number is entered that has already been used. The operator then checks the current number, along with the disk storage location of the previously entered number, to resolve the true numbering situation.

4.7 DATA FILING

The raw data file generated by the sample analysis is labeled and stored under a unique file name.

4.8 SCHEDULE OF MAINTENANCE

1,000 Samples:	Cleaning of sample introduction area, ion source, and expansion chamber by in-house technicians.
4,000 Samples:	Above noted procedures plus cleaning of lenses and quadrapoles
Annually:	Preventative maintenance program conducted by manufacturer’s service representative.

5. DATA INTERPRETATION AND PRESENTATION

5.1 MAP GENERATION

The sample location maps are created by placing the field base map on a digitizing board and entering each site as an X-Y coordinate relative to an origin. The relative ion counts for each compound can then be plotted at the sample locations. Cultural and topographic features can also be digitized onto the map as reference points.

5.2 COMPOUND IDENTIFICATION

The mass spectrum that is drawn for each sample is compared to a library of mass spectra derived from known volatile organic compounds. Several thousand pure compound spectra have been developed by the Bureau of Standards and are available for spectra comparison. NERI has also developed its own library of spectra through headspace analysis of pure compounds using the Petrex wires. Once a compound has been identified in this manner, the ion current or “flux” for this compound is defined as the total ion current for the “parent peak” or least interfered peak of that compound.

5.3 RELATIVE FLUX DETERMINATION

The process of determining ion currents (relative intensities) of indicator peaks is computerized. All ion current data are extracted from the original data file and processed for identification.

The relative ion current intensity (relative intensities) of the gases that are desorbed from the collectors is matched with sample locations on a map of the survey area. These relative intensities are useful for inferring the areal extent of contamination and relative differences in the concentrations of compounds in the soil or groundwater. This can aid in determining the location of source areas or direction of movement of contamination.

These surface collections and analyses **cannot** be used to determine the depth to the source contaminants or the precise concentration at depth.

Because compounds can be differentiated by their spectra, analyses from the carbon collectors can be used to help differentiate multiple compounds and multiple source areas within a single survey.

5.4 DATA INTERPRETATION

Once the relative intensities for a compound are mapped, the data can be contoured to reveal those areas with “hot spots” and the orientation of plume migration. All other available data, such as geologic setting, soil types, groundwater conditions, type of contaminant, site history, and other factors, are taken into account as the interpreter draws his/her conclusions.

5.5 ADDITIONAL USES OF PETREX COLLECTORS

Some of the other uses of the Petrex Technique that are utilized in surveys are headspacing of soil and water samples and depth profiling.

5.5.1 Headspace

A headspace soil sample is analyzed by collecting approximately 25 g of soil, which are transferred to a thermochemically cleaned headspace container. Several adsorption wires are added and the headspace container is sealed and allowed to equilibrate for up to 24 hours, depending on the level of contamination. The wires are then removed and prepared for desorption mass spectrometric analysis as described earlier. An identical process is performed for screening water samples.

5.5.2 Depth Profiling

In order to determine if the source of the soil gas signal is near surface or in a deeper vadose/saturated zone, depth profiling can be used.

At each selected location, shallow boreholes are drilled a few feet apart to depths such as 1, 2, 4, and 6 ft deep. After the loose cuttings and carvings have been removed from the bottom of the hole, a core of soil may be taken for headspace analysis. Next, a Petrex collector is lowered into the hole and backfilled. The collectors remain in place for the same length of time as the survey wires.

Each of the sampling methods addresses a different aspect that will help indicate the nature of the VOC source. In the case of composite soil sampling, detection of VOCs during analysis implies that the VOCs are actually contained within the soil matrix. When the VOC is anthropogenic in nature, the VOC presence is indicative of soil contamination of that depth interval.

When performing an *in situ* time-integrated sampling program with Petrex collectors, the collector serves as both an extended headspace sampler relative to the soil matrix in its immediate vicinity, as well as measuring the soil gas flux through that zone during the exposure period.

Soil gas movement through the vadose zone is theorized to be a diffusion process. If the headspace data indicate that the VOC is not present in the soil matrix, then the *in situ* depth profiling collectors should show a relative increase of ion counts as the depth increases. By combining both pieces of data, the nature of the VOC source (near surface or deep vadose/saturated) can be inferred.

5.6 DATA PRESENTATION

Once the data have been compiled, interpreted, and mapped, a report is produced for the client’s use. The maps are printed which display the relative intensity of the compounds of the client’s specifications. These reports and maps are for the client’s use only, and no report or map is released to anyone else without prior written consent of the client. This confidentiality policy is never breached.

6. INTERPRETATION OF PETREX MAPS

The policies outlined in this SOP are strictly followed on each survey. It should be noted that the relative intensities for any compound at one sample location can only be compared to another location within the same survey for the same compound. Relative intensities of different compounds cannot be compared to each other. The relative intensities of one survey cannot be compared to the relative intensities of any other survey, even between two surveys at different times of the year over the same site. However, the same “hot spots” and plumes should contour in the same place over multiple surveys at a given site, allowing for migration.

Standard Operating Procedure No. 028
for
Well and Boring Abandonment

Prepared by

EA Engineering, Science, and Technology, Inc.
11019 McCormick Road
Hunt Valley, Maryland 21031

Revision 0
August 2007

CONTENTS

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure is to establish the protocols by which all wells and borings will be safely abandoned. The primary objective of well abandonment is to ensure that the abandoned well or boring does not provide a conduit for the vertical migration of contamination between aquifers.

2. MATERIALS

The following materials may be required:

Drill rig	Bentonite pellets (seal)
Filter pack material	Cement (Portland Type II)
Pure sodium bentonite with no additives (bentonite) powder (grout)	Approved water

3. PROCEDURE

The procedures used in boring abandonment will ideally accomplish two objectives: (1) protect aquifers from cross-contamination by sealing the borehole, and (2) restore the strata in the borehole to nearly original conditions by selective placement of fill material.

Any casing will be pulled, drilled out, or thoroughly pierced. Using tremie pipe, grout will be placed from the bottom of the hole to within 3 ft of the ground surface, and allowed to settle for 24 hours. The remainder of the hole will be filled with concrete. The surface of the concrete will be mounded, smoothed, and inscribed with “ABD,” for abandoned, any assigned well or boring designation, and the date the hole was abandoned. All boring logs, samples, completion records, and abandonment procedures will be included in the records of work on the site or cluster.

If the hole is within 10 ft of a monitoring well in the same aquifer, or a replacement well is to be installed within 10 ft of the well, any temporary casing will be pulled, drilled out, or thoroughly pierced. Using tremie pipe, the hole will then be backfilled with filter pack material opposite sand strata and bentonite or grout opposite substantial (2 ft or thicker) clay and silt strata. Where sand as backfill approaches the ground surface, 2 ft of bentonite will be placed above the sand and a 3-ft concrete plug will be placed at the surface. Otherwise, backfill materials will be placed from the bottom of the hole to within 3 ft of the ground surface. These materials will be allowed to settle for 24 hours. The remainder of the hole will be filled with concrete. The surface of the concrete will be mounded, smoothed, and inscribed with “ABD,” for abandoned, any assigned well or boring designation, and the date the hole was abandoned. All boring logs, samples, completion records, and abandonment procedures will be included in the records of work on the site cluster.

If the well is not within 10 ft of another monitoring well, or if there are no substantial, continuous sand bodies, and no replacement well is planned within 10 ft of the original well location, then the hole may be grouted from the bottom to the top.

3.1 GROUT

Grout used in construction will be composed by weight of:

- 20 parts cement (Portland cement, Type II or V)
- 0.4-1 part (maximum) (2-5 percent) bentonite
- 8 gal (maximum) approved water per 94-lb bag of cement.

Neither additives nor borehole cuttings will be mixed with the grout. Bentonite will be added after the required amount of cement is mixed with the water.

All grout material will be combined in an aboveground container and mechanically blended to produce a thick, lump-free mixture. The mixed grout will be recirculated through the grout pump prior to placement.

Grout placement will be performed using a commercially available grout pump and a rigid tremie pipe removal and grouting will be accomplished in stages, aquifer by aquifer, sealing the boring from the bottom to ground surface. This will be accomplished by placing a grout pipe to the bottom and pumping grout through the pipe until undiluted grout reaches the bottom of the next higher section of casing or, for the top-most section, until grout flows from the boring at ground surface. Efforts will be made to grout incrementally as the temporary casing is removed.

After 24 hours, the abandoned drilling site will be checked for grout settlement. On that day, any settlement depression will be filled with grout and rechecked 24 hours later. This process will be repeated until firm grout remains at the ground surface.

3.2 BORINGS

The term “Borings” as used in this Standard Operating Procedure applies to any drilled hole made during the course of a remedial investigation which is not completed as a well. This includes soil test borings, soil sampling borings, and deep stratigraphic borings. Whether completed to the planned depth or aborted for any reason prior to reaching that depth, borings will be grouted and normally closed within 4 hours, or within 4 hours or completion of logging of completion of logging.

3.2.1 Shallow Borings not Penetrating Water Table

Shallow borings made for the collection of subsurface soil samples will be abandoned by backfilling the hole with cuttings from the hole, **if and only if the boring does not penetrate the water table.** Clean sand will be used to make up any volume not filled by the cuttings.

3.2.2 Borings Penetrating the Water Table

Shallow borings made for the collection of subsurface soil samples **which penetrate the water table** will be abandoned by grouting the hole from the bottom to the top.

3.2.3 Deep Stratigraphic Borings

Deep stratigraphic borings will normally be located in areas which, by virtue of the historical record, are presumed relatively uncontaminated. Therefore, these borings are usually over 100 ft from any sampling well locations. Any boring located within 10 ft of a proposed well location, or located directly upgradient or downgradient (on anticipated flow line) of a proposed well location, will be abandoned by placing clean sand in the aquifer intervals and bentonite or grout in aquitard intervals as described above. If the boring is over 10 ft from and/or not upgradient of a proposed well location, the boring will be completely filled with grout.

3.3 WELLS

The following procedure applies to wells aborted prior to completion and existing wells determined to be ineffective or otherwise in need of closure.

Prior to abandoning any developed well, the proper well licensing body will be provided written notification along with an abandonment plan for that well.

If the well is within 10 ft of another monitoring well in the same aquifer, or a replacement well is to be installed within 10 ft of the well, casing will be pulled, drilled out, or thoroughly pierced. Using tremie pipe, the hole will then be backfilled with filter pack material opposite sand strata and bentonite or grout opposite substantial (2 ft or thicker) clay and silt strata. Where sand as backfill approaches the ground surface, 2 ft of bentonite will be placed above the sand and below the concrete plug near the surface. Backfill materials will be placed from the bottom of the hole to within 3 ft of the ground surface. These materials will be allowed to settle for 24 hours. The remainder of the hole will be filled with concrete. The surface of the concrete will be mounded, smoothed, and inscribed with “ABD,” for abandoned, any assigned well or boring designation, and the date the hole was abandoned. All boring logs, samples, completion records, and abandonment procedures will be included in the records of work on the site cluster.

If the well is not within 10 ft of another monitoring well, and is not to be replaced by another well within 10 ft of the original location, casing will be pulled, drilled out, or thoroughly pierced. Using tremie pipe, grout will be placed from the bottom of the hole to within 3 ft of the ground surface, and allowed to settle for 24 hours. The remainder of the hole will be filled with concrete. The surface of the concrete will be mounded, smoothed, and inscribed with “ABD,” for abandoned, any assigned well or boring designation, and the date the hole was abandoned. All boring logs, samples, completion records, and abandonment procedures will be included in the records of work on the site cluster.

4. REPLACEMENT WELLS

Replacement wells (if any) will normally be offset at least 10 ft from any abandoned well in a presumed upgradient or crossgradient groundwater direction. Site-specific conditions may necessitate variation to this placement.

5. PRECAUTIONS

None.

Standard Operating Procedure No. 036
for
Turbidity Measurements (DRT 100)

Prepared by

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Revision 0
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CONTENTS

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to delineate protocols for measuring the turbidity of all types of aqueous solutions, including drinking water, saline water, and industrial and domestic wastes. Turbidity is an indication of the optical properties that cause light to be scattered or absorbed through an aqueous sample. Turbidity is largely a function of the refractive index and the size and shape of the particles suspended or dissolved in the solution. Turbidity meters do not produce an "absolute" measurement, but one that is "relative" to the optical nature of the solids in solution.

Use of brand names in this SOP is not intended as endorsement or mandate that a given brand be used. Alternate equivalent brands of detectors, sensors, meters, etc. are acceptable. If alternate equipment is to be used, the contractor will provide applicable and comparable SOPs for the maintenance and calibration of same.

2. MATERIALS

The following materials may be required:

Turbidity meter (DRT 100 or equivalent)
Lint free laboratory wipes (Kimwipes or equivalent)
Formazin standards (from manufacturer)
Sample bottle
Cuvettes

3. PROCEDURE

Calibration of the turbidity meter will be checked on a daily basis as follows:

- Set the range switch to 1000 range before turning the turbidity meter on and whenever the light shield is not in place over the sample well.
- Allow the turbidity meter 15-60 minutes to warmup.
- Clean the reference standard with kimwipes.
- Place the formazin suspension or reference standard in the turbidity meter sample well.
- Place the light shield over the reference standard.
- Rotate the front panel range switch counterclockwise to the appropriate nephelometric turbidity unit range.

- Adjust the reference adjust knob counterclockwise to read the same value as the reference standard value. This value is stamped on top of the reference standard.
- The turbidity meter is now standardized on all ranges to the factory formazin calibration and unknown samples may be read directly in nephelometric turbidity unit, feeder terminal unit, or Jackson turbidity unit.
- Rotate the range switch clockwise to the 1000 range before removing the reference standard.
- Record reading in field logbook (Refer to SOP Nos. 003 and 016).
- Do not leave the reference standard in the sample well for long periods.

Turbidity will be measured as follows:

- Pour aqueous sample into a new cuvette assuring no air bubbles.
- Place the cuvette into the sample well.
- Place the light shield over the sample.
- Rotate the range switch counterclockwise to the range which provides best readability and sensitivity for the sample being measured.
- Allow the turbidity meter to stabilize before recording the nephelometric turbidity unit value.
- Turn the range switch clockwise to the 1000 range and then remove the sample.
- Do not leave the filled cuvette in the sample well for long periods.
- Repeat above steps for additional samples.

Cuvette cleaning procedure is as follows:

- Cuvette must be clean and free of rubs or scratches.
- Wash the cuvette in a detergent solution.
- Rinse thoroughly 8-10 times, preferably with distilled water to remove all streaks.
- Polish with kimwipes.
- Cuvettes must be stored in a clean dust-free environment.

4. MAINTENANCE

Source lamp may be replaced as follows:

- Remove the instrument case per manufacturer instruction.
- Remove the bulb by loosening a screw and removing the electrical leads.
- Insert the new bulb and reconnect the electrical leads.
- Before tightening the screw, be sure to position the filament so that it will be parallel to the axis of the sample well.
- Insert the lamp alignment tool in the sample well to focus the new bulb.
- Move the lamp bracket assembly in or out until a focused image of the filament is within the rectangular box on the lamp alignment tool.
- Once the filament image has been aligned and focused within the rectangular box on the lamp adjustment tool, tighten all screws snugly.
- Replace the instrument case.

5. PRECAUTIONS

Handle the reference standard or sample cuvettes by the top to prevent surface scratches or finger smudges which will cause analysis errors.

Check the mechanical meter zero when the instrument is in a vertical position and the power switch is off. Adjust to zero only if necessary by means of the black screw on the meter face.

The turbidity meter should be left on for the entire work shift to minimize warm-up and recalibration delays.

Do not leave the reference standard or filled curvette in the sample well for long periods.

Leave the light shield in place on the instrument when it is not in use in order to protect the sample well for long periods.

Always set the range switch to 1000 range before turning the instrument on and whenever the light shield is not in place over the well.

6. REFERENCES

Manufacturer's Manual.

Standard Operating Procedure No. 037
for
Dissolved Oxygen Measurements
(YSI Model 57)

Prepared by

EA Engineering, Science, and Technology, Inc.
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Revision 0
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CONTENTS

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to delineate protocols for measuring the dissolved oxygen (DO) of all types of aqueous solutions, including drinking water, saline water, and industrial and domestic wastes. DO is a measurement of the amount of soluble oxygen in an aqueous solution. It is a general indication of an aerobic/anaerobic condition of a water sample.

Use of brand names in this SOP is not intended as endorsement or mandate that a given brand be used. Alternate equivalent brands of detectors, sensors, meters, etc. are acceptable. If alternate equipment is to be used, the contractor will provide applicable and comparable SOPs for the maintenance and calibration of same.

2. MATERIALS

The following materials may be required:

DO meter (YSI Model 57 or equivalent)
Self-stirring biological oxygen demand bottle probe
Membrane standards
Biological oxygen demand bottle

3. PROCEDURE

3.1 SETUP

It is important that before the meter is prepared for use and calibrated, it should be placed in the intended operating position, i.e., vertical, tilted, or horizontal. The instrument may need readjustment if the operating position is altered. The setup procedures should be as follows:

- With the switch set to **OFF**, adjust the meter pointer to zero with the screw in the center of the meter panel.

- Switch to **RED LINE** and adjust the **RED LINE** knob until the meter needle aligns with the red mark if necessary.

- Switch to **ZERO** and adjust to 0 mg/L scale with the **ZERO** control knob.

- Attach the prepared probe to the **PROBE** connector of the instrument and adjust the retaining ring finger tight.

- Before calibrating, allow 15 minutes for optimum probe stabilization. Repolarize whenever the instrument has been **OFF** or the probe has been disconnected.

3.2 CALIBRATION

Calibration is accomplished by exposing the probe to a known oxygen concentration, such as water-saturated air (%), or water of a known oxygen content (mg/L), and then adjusting the calibration controls so the display shows a reading matching the oxygen concentration of the known sample. Calibration can be disturbed by physical shock, touching the membrane, and fouling of the membrane or drying out of the electrolyte. Calibration will be checked after each series of measurements. Calibration of the DO meter will be performed on a daily basis as follows:

1. Place the probe in moist air. Biological oxygen demand probes can be placed in partially filled (50 ml) biological oxygen demand bottles. Wait 10 minutes for temperature to stabilize ± 2°C.

2. Switch to **TEMPERATURE** and read. Refer to Table SOP037-1 for solubility of oxygen in fresh water (calibration value).

3. Determine altitude or atmospheric correction factor from Table SOP037-2.

4. Multiply the calibration value from Table SOP037-1 by the correction factor from Table SOP037-2 to obtain the correct calibration value.

   EXAMPLE: Assume a temperature of 20°C and an altitude of 1,100 ft. From Table SOP037-1, the calibration value of 20°C is 9.09 mg/L. From Table SOP037-2, the correction factor for 1,100 ft is 0.96. Therefore, the corrected calibration value is 9.09 mg/L × 0.96 = 8.73 mg/L.

5. Switch to the appropriate mg/L range, set the **SALINITY** knob to zero and adjust the **CALIBRATE** knob until the meter reads the calibration value from Step 4. Wait 2 minutes to verify calibration stability. Readjust if necessary.

3.3 DISSOLVED OXYGEN MEASUREMENT

- With the instrument prepared for use and the probe calibrated, place the probe in the sample.

- Turn the **STIRRER** knob **ON**.

- Adjust the **SALINITY** knob to the salinity of the sample if appropriate.

- Allow sufficient time for the probe to equilibrate to the sample temperature and DO.

- Read DO on appropriate scale.

- Before measuring the DO of the next sample, rinse probe and sample bottle with distilled water and then with next water sample.

Follow steps above for the next sample(s).

The DO meter should normally be left on during the working day to avoid the delay of waiting for probe repolarization.

4. MAINTENANCE

The following steps will be taken to maintain the DO meter:

- Replace the batteries when the **RED LINE** knob is at its extreme adjustment or at least annually.

- In the **BATT CHECK** position on the **STIRRER** knob, the voltage of the stirrer batteries is displayed on the red **0-10** scale. Do not permit them to discharge below 6 volts.

- Replace membrane every 2 weeks depending on application. Probes will be stored in a humid environment to prevent drying out.

5. PRECAUTIONS

The DO meter case is water resistant when properly closed. As a precaution against damaged gaskets or loose fittings, the instrument case will be opened and inspected for moisture whenever the instrument has been subjected to immersion or heavy spray. The case is opened by removing the screws on the rear cover an lifting the cover off.

6. REFERENCES

Manufacturer’s handbook.

TABLE SOP037-1 SOLUBILITY OF OXYGEN IN WATER EXPOSED TO WATER SATURATED AIR AT 760 mm Hg PRESSURE

Temperature (°C)	Solubility (mg/L)	Temperature (°C)	Solubility (mg/L)	Temperature (°C)	Solubility (mg/L)
0	14.62	17	9.67	34	7.07
1	14.22	18	9.47	35	7.95
2	13.83	19	9.28	36	7.84
3	13.46	20	9.09	37	6.73
4	13.11	21	8.92	38	6.62
5	12.77	22	8.74	39	6.52
6	12.45	23	8.58	40	6.41
7	12.14	24	8.42	41	6.31
8	11.84	25	8.26	42	6.21
9	11.56	26	8.11	43	6.12
10	11.29	27	7.97	44	6.02
11	11.03	28	7.83	45	5.95
12	10.78	29	7.69	46	5.84
13	10.54	30	7.56	47	5.74
14	10.31	31	7.43	48	5.65
15	10.08	32	7.31	49	5.56
16	9.87	33	7.18	50	5.47

NOTE: Derived from 17th Edition, Standard Methods for the Examination of Water and Wastewater.

TABLE SOP037-2 CALIBRATION VALUES FOR VARIOUS ATMOSPHERIC PRESSURES AND ALTITUDES

Pressure			Altitude in		Calibration Value(%)
in. Hg	mm Hg	kPa	feet	meter	
30.23	768	102.3	-276	-84	101
29.92	760	101.3	0	0	100
29.61	752	100.3	278	85	99
29.33	745	99.3	558	170	98
29.02	737	98.3	841	256	97
28.74	730	97.3	1126	343	96
28.43	722	96.3	1413	431	95
28.11	714	95.3	1703	519	94
27.83	707	94.2	1995	608	93
27.52	699	93.2	2290	698	92
27.24	692	92.2	2587	789	91
26.93	684	91.2	2887	880	90
26.61	676	90.2	3190	972	89
26.34	669	89.2	3496	1066	88
26.02	661	88.2	3804	1160	87
25.75	654	87.1	4115	1254	86
25.43	646	86.1	4430	1350	85
25.12	638	85.1	4747	1447	84
24.84	631	84.1	5067	1544	83
24.53	623	83.1	5391	1643	82
24.25	616	82.1	5717	1743	81
23.94	608	81.1	6047	1843	80
23.62	600	80.0	6381	1945	79
23.35	593	79.0	6717	2047	78
23.03	585	78.0	7058	2151	77
22.76	578	77.0	7401	2256	76
22.44	570	76.0	7749	2362	75
22.13	562	75.0	8100	2469	74
21.85	555	74.0	8455	2577	73
21.54	547	73.0	8815	2687	72
21.26	540	71.9	9178	2797	71
20.94	532	70.9	9545	2909	70
20.63	524	69.9	9917	3023	69
20.35	517	68.9	10293	3137	68
20.04	509	67.9	10673	3253	67
19.76	502	66.9	11058	3371	66

NOTE: Derived from 17th Edition, Standard Methods for the Examination of Water and Wastewater.

Standard Operating Procedure No. 038
for
Redox Potential Measurements

Prepared by

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CONTENTS

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure is to delineate protocols for measuring the redox of flooded sediment and soil. Redox is an indication of the reduction of oxidation intensity of an anaerobic system. Redox will be expressed in mV. A complete anaerobic system redox potential is -150 Mv. A positive value indicates an aerobic system.

Redox measurement in a natural system is difficult to obtain due to the absence of true equilibria, heterogeneity of media, and pH effects deprived redox measurements in natural media of precise thermodynamic significance (Ponnamperuma 1972). Despite the difficulties involved in the redox measurements in natural media, it is widely accepted that redox readings in natural anaerobic systems can provide valuable environmental information. Whitfield found redox useful as a semi-quantitative indicator of the degree of stagnation of a particular aquatic environment as did Ponnamperuma for flooded soils and sediments. The redox measurements of natural waters are not representative of that median, since natural waters are in a highly dynamic state rather than in or near equilibrium, according to Stumm and Morgan 1970. It is generally recognized that redox measurements in oxygenated natural waters are invalid.

2. MATERIALS

The following materials may be required:

pH meter	Sample bottle
Combination pH electrode	Standard solution (pH 4 and 7 buffers saturated with quinhydrone)
Lint-free laboratory wipes (Kimwipes, or equivalent)	Wash bottle
Distilled water	

3. PROCEDURE

Calibration of the pH meter will be calibrated on a daily basis as follows.

- Prepare beaker of standard solution with known voltage(s)
- Connect electrodes to instrument
- Turn on and clear
- Rinse electrode with distilled water blot excess with laboratory wipes
- Immerse probe in beaker of standard solution
- Press mV key
- After the reading stabilizes, the absolute mV of solution is displayed.
- Rinse electrode and blot excess.

Redox will be measured after calibration as follows:

- Prepare sample in a beaker
- Rinse electrode and blot excess water
- Immerse electrode in sample and stir briefly
- Press mV switch
- Record the reading after it stabilizes
- For next sample(s), follow above steps.

4. MAINTENANCE

Check the batteries each time the meter is used.

Keep the probe stored in a 0.1 M KCL solution when not in use. Alternatively, the electrode may be rinsed with deionized water and trapping any residual water inside the protective cap.

5. PRECAUTION

Remove coatings of oil material or particulate matter that can impair electrode response by gentle wiping or detergent washing, followed by distilled water rinsing.

6. REFERENCES

Beckman Instruments, Inc. User Manual for 10, 11, and 12 pH/ISE meter.

Ponnamperuma, F.N. 1972. The Chemistry of Submerged Soils, Advances in Agronomy. Vol. 24.

Stumm, W. and J.J. Morgan. 1970. Aquatic Chemistry, Wiley, New York.

Whitfield, M. 1969. Eh as an Operational Parameter in Estuarine Studies. *Limnol. Oceanogr.*, Vol. 14.

Standard Operating Procedure No. 039
for
Sample Preservation and Container Requirements

Prepared by

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CONTENTS

1. PURPOSE AND SCOPE

The purpose of this Standard Operating Procedure (SOP) is to define the preservatives and techniques to be employed in preserving environmental samples between collection and analysis.

2. MATERIALS

The following materials may be required:

Containers (see Section 3 for description)	NaOH
HNO_3	Ice chests
H_2SO_4	Ice

3. DEFINITION OF CONTAINER TYPES

Type A **Container**: 80 oz amber glass, ring handle bottle/jug, 38-mm neck finish.
Closure: White polypropylene or black phenolic, baked polyethylene cap, 38-430 size, 0.015-mm polytetrafluoroethelyne (PTFE) liner.

Type B **Container**: 40-mL glass vial, 24-mm neck finish
Closure: White polypropylene or black phenolic, open top, screw cap, 15-mm opening, 24-400 size.
Septum: 24-mm disc of 0.005-in PTFE bonded to 0.120-in. silicon for total thickness of 0.125-in.

Type C **Container**: 1-L high density polyethylene, cylinder-round bottle, 28-mm neck finish.
Closure: White polyethylene cap, white ribbed, 28-410 size; F217 polyethylene liner.

Type D **Container**: 120-mL wide mouth glass vial, 48-mm neck finish.
Closure: White polyethylene cap, 40-480 size; 0.015-mm PTFE liner.

Type E **Container**: 250-mL boston round glass bottle
Closure: White polypropylene or black phenolic, open top, screw cap.
Septum: Disc of 0.005-in PTFE bonded to 0.120-in silicon for total thickness of 0.125-in.

Type F	**Container**: 8-oz short, wide mouth, straight-sided, flint glass jar, 70-mm neck finish. **Closure**: White polypropylene or black phenolic, baked polyethylene cap, 48-400 size; 0.030-mm PTFE liner.
Type G	**Container**: 4-oz tall, wide mouth, straight -sided, flint glass jar, 48-mm neck finish. **Closure**: White polypropylene or black phenolic, baked polyethylene cap, 48-400 size; 0.015-mm PTFE liner.
Type H	**Container**: 1-L amber, Boston round, glass bottle, 33-mm pour-out neck finish. **Closure**: White polypropylene or black phenolic, baked polyethylene cap, 33-430 size; 0.015-mm PTFE liner.
Type K	**Container**: 4-L amber glass ring handle bottle/jug, 38-mm neck finish. **Closure**: White polypropylene or black phenolic, baked polyethylene cap, 38-430 size; 0.015-mm PTFE liner.
Type L	**Container**: 500-mL high-density polyethylene, cylinder bottle, 28-mm neck finish. **Closure**: White polypropylene, white ribbed, 28-410 size; F217 polyethylene liner.

4. PROCEDURE

All containers must be certified clean, with copies of laboratory certification furnished upon request.

Water samples will be collected into pre-preserved containers appropriate to the intended analyte as given in Quality Assurance Project Plan. Samples taken for volatile organic compounds will be collected in accordance with SOP No. 003, Section 3.3.8. Samples taken for metals analysis will be verified in the field to a pH <2. The container should be tightly capped, then swirled to thoroughly mix the sample. The cap will then be loosened to release any excess pressure this operation may have generated. Samples taken for total phosphorous content will be verified in the field to a pH <2. The container should be tightly capped and swirled to thoroughly mix the sample. The cap will then be loosened to release any excess pressure this operation may have generated. Samples taken for cyanide will be verified for a pH >12. No preservatives will be added to any other water samples. These samples will be immediately placed on ice and cooled to 4°C.

Soil and sediment samples will be collected into containers appropriate to the intended analyte as given in the Quality Assurance Project Plan. Samples taken for volatile organic compound analysis will collected in accordance with the site-specific SOP. Samples taken for metals analysis will be tightly capped, placed on ice, and maintained at a temperature of 4°C. Samples taken for total phosphorous content will be tightly capped, placed on ice, and maintained at a temperature of 4°C. Samples taken for cyanide will be alkalized to a pH > 12 by the addition of NaOH. No preservatives will be added to any other soil samples. These samples will be immediately placed on ice and cooled to 4°C.

5. MAINTENANCE

Not applicable.

6. PRECAUTIONS

Note that acidifying a sample containing cyanide may liberate HCN gas.

- Avoid breathing any fumes emanating from acidified samples.
- Acidify samples only in the open, rather than in closed spaces such as a vehicle.
- Hold suspected HCN-generating sample away from body and downwind while manipulating it.
- See the Health and Safety Plan for other safety measures

7. REFERENCES

U.S. Environmental Protection Agency (U.S. EPA). 1986. Test Methods for Evaluating Solid Waste, SW-845.

U.S. EPA. 1987. A Compendium of Superfund Field Operations Methods, EPA 540-P87-001.

U.S. EPA. 1991. A Compendium of ERT Soil Sampling and Surface Geophysics Procedures.

Standard Operating Procedure No. 042
for
Disposal of
Investigation-Derived Material

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CONTENTS

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure is to define the required steps for disposing of investigation-derived material (IDM) generated during field activities.

IDM, as used herein, includes soil cuttings, drilling muds, purged groundwater, decontamination fluids, and disposable personal protective equipment. For the sake of clarity and ease in use, this Standard Operating Procedure is subdivided into procedures for disposal of liquid IDM and solid IDM as follows:

- Liquid IDM (Section 3.2) includes the following materials:
    - Water from initial development of new wells and the redevelopment of existing wells.
    - Purge water from groundwater sampling.
    - Decontamination fluids (Section 3.4)
- Solid IDM (Section 3.3) consists of the following materials:
    - Drill cuttings from monitoring well installation
    - Grout, a mixture of cement and bentonite, generated during installation of monitoring wells
    - Disposable personal protective equipment (Section 3.4).

2. MATERIALS

The following materials may be required:

Any additional equipment that may be dictated by project or site-specific plans	Hazardous waste labels
Bar codes	Permanent marker
Chain-of-custody forms	Field Logbook (bound)
Department of Transportation 17C spec. metal containers	Waste identification labels

3. PROCEDURE

3.1 GENERAL

No container will be labeled as a “Hazardous Waste” unless the contents are in fact known to be hazardous as defined by 40 CFR 261.

IDM may be disposed onsite if it is: (1) initially screened, or evaluated to determine whether it is contaminated; (2) not abandoned in an environmentally unsound manner; and (3) not inherently waste-like.

IDM are to be considered contaminated if they: (1) are visually or grossly contaminated, (2) have activated any field monitoring device which indicates that the level exceeds standard Level 1, (3) have previously been found to exhibit levels of contamination above environmental quality standards, and (4) the responsible party and/or appropriate regulator deem(s) that records of historical uses indicate that additional testing of the IDM is needed, or additional caution is warranted handling IDM from a given site.

3.2 PROCEDURES FOR LIQUID INVESTIGATION-DERIVED MATERIAL DISPOSAL

1. All water from initial development of new wells, and purge water generated during the first round of groundwater sampling will be containerized in Department of Transportation approved 55-gal drums. Decontamination fluids may be bulk-containerized until completion of field task.

2. Label all containers as to type of media, the date the container was sealed, the point-of-generation, and the points-of-contact. The well number and container number will be identified on the container.

3. The contractor/support personnel will log all media generated onsite into a bound Field Logbook. Media information should include the following: the date of generation, contents of containers, the number of containers with the same contents (if applicable), location of containers, the well number the media is associated with, personnel sampling the media, sampling dates, and sampling results.

4. Containers of well development water and purge water may be stored at the well site pending first round analytical results.

5. Laboratory turnaround time must be no greater than 30 days. Upon receipt of the analytical results, a copy will be furnished to the client within 3 working days. Both the client and contractor will evaluate the data to determine disposal requirements, per state and local regulations. A disposal decision is required within 10 days of receipt of sampling results. Appropriate disposal must be performed no later than 50 days from the decision date unless prevented by inclement weather (e.g., rain and muddy conditions may preclude site access, freezing weather may freeze media).

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1. This value is defined as two times background, where “background” values are to be determined as follows: (1) regional background values will be used where they are available; and (2) if regional values are not available, background may be empirically determined at uncontaminated sampling sites using onsite sensors such as organic vapor analyzers (photoionization detector or flame ionization detector), scintillometers, etc.

Dispose of non-hazardous media in accordance with Step 6 et seq. through 8 et seq. of this procedure.

Dispose of hazardous waste in accordance with Step 9 et seq. of this procedure.

6. If the first round analytical data of the liquid media is below the Maximum Contaminant Levels established by the Federal Safe Drinking Water Act, the water may be gradually infiltrated into the ground at least 50 ft downgradient of the well.

   If the well location has no downgradient area, the water will be infiltrated into the ground in an area deemed appropriate by the client and the contractor/support personnel.

   Disposal locations must allow percolation of the water and prohibit "ponding."

   Upon completion of water discharge to ground, enter type of media, amount of media, date of disposal, and discharge point(s) in a bound Field Logbook and provide this information to the client.

   Empty containers are to be properly decontaminated, stored, and reused by the appropriate personnel.

   If the liquid media sampling results do not meet the required Maximum Contaminant Levels and cannot be discharged to the ground, then determine if the waste meets the sanitary sewer discharge criteria (National Pollutant Discharge Elimination System standards).

7. If at any time visual contamination of purge/development water is observed, or if organic vapor monitor readings (HNu, photoionization detector) register more than 5 ppm above background and/or rad meters register more than twice the background mrems, then the liquid will be drummed and a composite sample will be taken that day. A disposal decision will be based on the analytical results of this sample rather than the first round of analytical results.

3.3 PROCEDURE FOR SOLID INVESTIGATION-DERIVED MATERIAL DISPOSAL

1. If the conditions outlined in Section 3.1 are met, proceed to Section 3.3, Step 2; otherwise, go to Section 3.3, Step 7.

2. During drilling operations, the resulting cuttings and mud will be discharged onto the ground near the well if the following conditions are met: (1) no visual contamination is observed, (2) organic vapors are less than 5 ppm above background, (3) rad meter readings (if applicable) are under two times background, and (4) if the potential for metals contamination exists, the medium has been screened and found to be less than two times background.

Proper sediment and erosion control measures will be implemented as follows:

- Drill cuttings will be uniformly spread and contoured to blend with the surroundings of the site.
- If amount of solid IDM exceeds 5,000 ft^2 or 100 yd^3 of material, a Sediment and Erosion Control Plan is required.
- If the amount of solid IDM is under 5,000 ft^2 or 100 yd^3, the site will be stabilized as soon as possible. Stabilization includes mulch, seed, and tack.
- Critical areas require stabilization within 7 days from the date of well completion. Critical areas include swales, water sources, drainage ditches, etc.
- All other disturbed areas require stabilization within 14 days from the date of well completion.

3. If the well location is in or near a wetland, the drill cuttings will be drummed and transported away from the site for spreading.

4. Label all IDM containers that will not be spread on the day of generation. Each container should be labeled with the type of media, the date the container was sealed, the point-of-generation, and the name of the contact person. The well number and container number should be identified on the container.

5. The contractor/support personnel will log all media generated onsite into a bound Field Logbook. Media information should include: the date of generation, contents in containers, the number of containers with the same contents, location of containers, and the well number the media is associated with.

6. Containers will be staged at the well site until contractor/support personnel spread the cuttings in the appropriate locations, using proper sediment and erosion control measures per Section 3.3 et seq.

7. If drilling mud and cuttings show visible contamination, or organic vapor readings are more than 5 ppm above background levels, or rad meter readings (if applicable) show greater than two times background levels, media will immediately be containerized, labeled appropriately (Section 3.2), and sampled on the same day.

8. The solid IDM should be sampled and appropriate Toxicity Characteristic Leaching Procedure analyses conducted prior to determining disposition. Laboratory turn-around time must be no greater than 30 days. Upon receipt of analytical results, a copy will be furnished to the client within 3 working days. The contractor will evaluate the data to determine disposal requirements within 10 days. Appropriate disposal must be performed no later than 50 days after the decision date if weather permits (Section 3.2).

- If the solid IDM are determined to be non-hazardous and uncontaminated, go to Section 3.3.

- If the solid IDM are determined to be non-hazardous but contaminated , go to Section 3.3.

- If the solid IDM are found to be hazardous wastes, go to Section 3.3.

9. If the solid IDM are not a hazardous waste **and** analytical data shows contaminant concentrations below the U.S. Environmental Protection Agency Region 3 (or applicable Region where work is being performed) Risk-Based Concentrations, contact the appropriate federal, state, or local agency for approval to discharge onto the ground near the site of generation.

   - Follow steps detailed in Section 3.3, Step 2 et seq. (above) pertaining to sediment and erosion control.

   - Upon completion of the solid IDM discharge to the ground, enter type of media, amount of media, date of disposal, and discharge point(s) in a bound Field Logbook. This information must be provided to the client.

   - Empty containers are to be properly decontaminated, stored and reused by appropriate personnel.

10. If the intrusive media is not a hazardous waste but analytical data shows concentrations above the screening criteria, dispose of the IDM according to state and local regulations.

    - Ensure that the waste containers are properly labeled as applicable in accordance with Section 3.3, Step 4.

    - Inform the client of the type and amount of waste, and the location of the waste.

    - When the waste is removed, enter the type of waste, amount of waste, date of pickup, and the destination of the waste in a bound Field Logbook. This information must be provided to the client.

3.4 PROCEDURES FOR DECONTAMINATION SOLUTION AND PERSONAL PROTECTIVE EQUIPMENT DISPOSAL

Decontamination solutions include catch water from steam-cleaning operations performed on large sampling equipment, drill rigs, and drums, as well as smaller quantities of soapy water and rinse solutions used in decontaminating field sampling equipment. At the completion of the field event, a composite sample of the decontamination solution will be taken. The decontamination solution will be treated as liquid IDM pending results (Section 3.2 et seq.).

Personal protective equipment will be containerized onsite, appropriately labeled, and disposed of in a designated trash receptacle.

4. MAINTENANCE

Not applicable.

5. REFERENCES

Environment Article Section 7-201(t).

U.S. Environmental Protection Agency. 1991. Management of Investigation-Derived Wastes during Site Inspections PB91-921331, OERR Directive 9345.3-02. Office of Emergency and Remedial Response U.S. Environmental Protection Agency, Washington, D.C. May.

Standard Operating Procedure No. 046
for
Aqueous Diffusion Samplers

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CONTENTS

1. SCOPE OF APPLICATION

The purpose of this Standard Operating Procedure is to establish the protocol for collecting groundwater samples using aqueous diffusion samplers. The procedure is designed to permit the collection of representative groundwater samples for analysis of volatile organic compounds (VOCs).

2. CONSTRUCTION OF AQUEOUS DIFFUSION SAMPLERS

The aqueous diffusion samplers are constructed by sealing de-ionized water in a 2-in. diameter × 1-mil thick polyethylene tubing. The de-ionized water is sealed in the poly tubing by using a heat seal device. One end of the poly tube is rolled over onto itself several times, then heat is applied to seal this end. The poly tube is then filled with de-ionized water. The top end (unsealed end) of the tube is then rolled over onto itself until there is no headspace in the poly tube; heat is then applied to seal this end. Care is taken to ensure that no headspace or air bubbles are present in the tube prior to sealing the top end. Each diffusion sampler is approximately 2 ft in length. The samplers are weighted with stainless steel bolts enclosed in 4-mil polyethylene tubing attached to the bottom of the sampler, and a string is attached to the top of the sampler for placement and retrieval.

3. EQUIPMENT/MATERIALS

3.1 AQUEOUS DIFFUSION SAMPLER PLACEMENT

- Well construction data, location map, and field data from the previous sampling event.
- Field logbook and Field Record of Well Gauging, Purging, and Sampling form (Figure SOP046-1).
- Electronic water level measuring device, 0.01-ft accuracy for monitoring water level prior to installation of the diffusion sampler.
- Diffusion sampler constructed of 2 ft length × 2 in. width 1-mil polyethylene lay-flat tubing filled with de-ionized water and weight attached to bottom.
- Twine, string, or rope. The depth of each sampler should be established prior to field placement so enough twine, string, or rope is available for installation.

3.2 AQUEOUS DIFFUSION SAMPLER RETRIEVAL

- Volatile organic analyte sample bottles and sample preservation supplies (as required by the analytical methods) needed for diffusion sampler retrieval.

- Sample tags or labels.

- Cooler with bagged ice for storage of sample bottles during shipment to a laboratory.

3.3 PRELIMINARY SITE ACTIVITIES

The following site activities are required prior to performing aqueous diffusion sampler installation and retrieval. Field logbooks and sampling forms should be filled out as the procedure is being performed, as noted:

- Enter the following information in the field logbook and installation and retrieval form, as appropriate: site name, project number, field personnel, well identification, weather conditions, date and time, equipment used, and quality assurance/quality control data for field instrumentation.

- Check well for damage or evidence of tampering, and record pertinent observations in field logbook and field sampling form.

- Unlock well and remove well cap (if applicable).

- Measure VOCs with a photoionization detector instrument at the rim of the well and in the breathing zone, and record the readings in the field logbook and the field sampling form.

- Measure and record the height of protective casing above the concrete pad or ground surface, as appropriate. This reading is compared to that recorded during well installation as an indication of possible well damage or settling that may have occurred.

- Measure and record the depth to water (to 0.01 ft) in the well to be sampled before installation of the aqueous diffusion sampler begins. If the well casing does not have a reference point (usually a v-cut or indelible mark in the well casing), make one. Care should be taken to minimize disturbance of any particulate attached to the sides or at the bottom of the well. The depth to well bottom will be measured prior to installation of the sampler.

3.4 SAMPLING PROCEDURE

The following general procedures should be followed to obtain representative groundwater samples. Field logbooks and sampling forms should be filled out as the procedure is being performed, as noted:

- Enter the following information in the field logbook and field sampling form, as appropriate, prior to installation of the diffusion sampler: date and time of sampler installation, depth of sampler, and total depth of well.

- Prepare the diffusion sampler by attaching weight at the base of the sampler and a string to the top of the sampler.

- Install the sampler at the predetermined depth. Depth of sampler will be determined on a well-by-well basis based on previous low-flow sampling data, or previously collected aqueous diffusion samplers.

- Allow the diffusion to equilibrate for approximately 21 days. Return after approximately 21 days to retrieve the sampler.

- Enter the following information in the field logbook and field sampling form, as appropriate, during retrieval of diffusion sampler: date and time of sampler retrieval, analytical method, and quality assurance/quality control as necessary.

- Retrieve the diffusion sampler from the well.

- After retrieval is complete, remove string and weight, and make a diagonal cut towards the top of the sampler. The diagonal cut allows easier filling of the sample containers.

- Begin filling the sample containers from the diagonal cut, allowing the water to fill the volatile organic analyte sample containers by allowing the water to flow gently down the inside of the container with as little agitation or minimal aeration as possible.

- Label each sample as it is collected. Samples will be placed into a cooler with ice for delivery to a laboratory.

- After collection of the samples, the wells will be capped and locked.

- Complete remaining portions of field sampling form after each well is sampled, including sample date and time (time of retrieval from the well), well sampling sequence, types of sample bottles used, sample identification numbers, preservatives used, parameters requested for analysis, and field observations of the sampling event.

3.5 SAMPLE PRESERVATION

- **VOCs—**Fill the sample bottle pre-preserved with hydrochloric acid, seal with a teflon-lined cap, and place in a cooler with ice for shipment to a laboratory. Cooler will maintain a temperature of 4°C for shipment to the laboratory.

Note that aqueous diffusion samplers are not submitted for other laboratory analytical parameters.

3.6 FIELD QUALITY CONTROL

Quality control samples are required to verify that the sample collection and handling process has not affected the quality of the groundwater samples. Field quality control samples must be prepared exactly as regular investigation samples with regard to sample volume, containers, and preservation. The following quality control samples will be collected for each sample delivery group (a sample delivery group may not exceed 20 samples) at the frequency noted:

- **Equipment Blank—**One aqueous diffusion sampler will be constructed and submersed in a sealed container with de-ionized water for the 21-day equilibration period. This equipment duplicate should be analyzed the same as the other samplers to determine if materials used for aqueous diffusion samplers may have outgased VOCs, or otherwise affected laboratory analytical results.

- **Field Duplicate—**Required at a frequency of 10 percent per sample delivery group, as per the site Long-Term Monitoring Plan.

- **Matrix Spike/Matrix Spike Duplicate—**Required at a frequency of 5 percent, as per the site Long-Term Monitoring Plan.

- **Trip Blank—**Required for VOC samples at a frequency of one per sample shipment, as per the site Long-Term Monitoring Plan.

FIELD RECORD OF WELL GAUGING, PURGING, AND SAMPLING

Site Name: ____________________ Project Number: ____________
Well ID: ____________________ Well Lock Status: ____________
Well Condition: ____________________ Weather: ____________

Gauge Date: ____________________ Gauge Time: ____________
Sounding Method: ____________________ Measurement Ref: ____________
Stick Up/Down (ft): Well Diameter (in.):

Purge Date: ____________________ Purge Time: ____________
Purge Method: ____________________ Field Personnel: ____________
Ambient Air VOCs (ppm): ____________________ Well Mouth VOCs (ppm): ____________

WELL VOLUME

A. Well Depth (ft): ____________________ D. Well Volume/ft (L): ____________

B. Depth to Water (ft): ____________________ E. Well Volume (L) (C*D): ____________

C. Liquid Depth (ft) (A-B) ____________________ F. Three Well Volumes (L) (E*3): ____________

G. Measurable LNAPL? Yes ________ /ft No ________

Parameter	Beginning	1	2	3	4	5
Time (min.)						
Depth to Water (ft)						
Purge Rate (L/min)						
Volume Purged (L)						
pH						
Temperature (°C)						
Conductivity (μmhos/cm)						
Dissolved Oxygen (mg/L)						
Turbidity (NTU)						
eH (mV)						

Total Quantity of Water Removed (L): ____________________
Samplers: ____________ Sampling Time (Start/End): ____________
Sampling Date: ____________ Decontamination Fluids Used: ____________
Sample Type: ____________ Sample Preservatives: ____________
Sample Bottle IDs: ____________________
Sample Parameters: ____________________

Standard Operating Procedure No. 047
Direct-Push Technology Sampling

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CONTENTS

Page

1. SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) establishes the protocol for using direct-push technology (DPT) in media sampling and performing subsurface characterization. This SOP includes the following DPT methods: Geoprobe®, Hydropunch®, Cone Penetrometer Testing (CPT), and Site Characterization and Analysis Penetrometer System (SCAPS).

2. MATERIALS

The following materials may be required:

Appropriately sized, all-terrain vehicle-skid-or track-mounted; DPT equipment; and supplies (i.e., hydraulic derrick and hammer assembly)	Personal protective equipment
Bentonite grout and clean sand for DPT hole abandonment	Phosphate-free, laboratory-grade detergent (e.g., Liquinox, Alconox, etc.)
DPT stainless steel rods	Source of approved water
Heavy plastic sheeting	Steam cleaner/sprayer and water obtained from approved source for decontaminating DPT equipment
Logbook	Steel drums for intrusion derived wastes (e.g., contaminated personal protective equipment, decon solutions, etc.)
Long-handled bristle brushes	Wash and rinse tubs
Mini-bailer or tubing and peristaltic pump (groundwater sampling only)	

3. GEOPROBE® AND HYDROPUNCH®

3.1 MATERIALS

Water sources for Geoprobe® and Hydropunch® activities, grouting, sealing, filter placement, well installation, and equipment decontamination must be approved by the Project Manager prior to arrival of the Geoprobe® and Hydropunch® equipment. Information required for the water source includes: water source, manufacturer/owner, address and telephone number, type of treatment and filtration prior to tap, time of access, cost per gallon (if applicable), dates and results associated with all available chemical analysis over the past 2 years, and the name and address of the analytical laboratory (if applicable).

Pure sodium bentonite with no additives will be the only additive allowed, and its use must be approved by the Project Manager prior to the arrival of the Geoprobe® and Hydropunch® equipment. The information required for evaluation includes: brand name, manufacturer, manufacturer's address and telephone number, product number, product description, and intended use for the product.

Portland Type II cement will be used for grout (refer to SOP No. 019).

3.2 GROUNDWATER – HYDRAULIC PUSHING AND SAMPLING

The objective of the selected DPT sampling technique is to allow grab samples to be taken at a selected site to facilitate aquifer characterization and analysis of potential contaminants. The analytical results from sampling can also be used to determine the placement of monitoring wells.

A site geologist will be present during all sampling and installation procedures, and will fully document all procedures and soil characteristics in the Field Logbook. Refer to SOP No. 003 (Field Logbook).

The site geologist will have on hand, at a minimum, a copy of the approved Health and Safety Plan, this SOP, the Field Investigation Work Plan, a hand lens (10X), a standard color chart, and a grain size chart.

Only solid vegetable shortening (e.g., Crisco®) without flavoring or additives may be used on downhole Geoprobe® and Hydropunch® equipment.

Surface runoff or other fluids will not be allowed to enter any DPT location or well during or after DPT activities.

The subcontractor will use the equipment specific guidelines for installation of the Geoprobe® DPT equipment. Probe rods will be forced into the ground by hydraulic means.

- Drive the sampler to the desired groundwater sampling interval. At the desired depth, insert extension rods down the inside diameter of the probe rods until the extension reaches the bottom of the screen. Remove the probe rods and sampler sheath while holding the screen in place.

- Collect the groundwater sample in the screen interval with a mini-bailer, peristaltic or vacuum pump, or other acceptable small diameter sampling device.

- The head of the rod may be equipped with a sensing device for characterization of soil properties or the contaminant content.

The subcontractor will use the equipment-specific guidelines for installation of the Hydropunch® equipment. Rods will be forced into the ground by hydraulic means.

- The Hydropunch® tool is a double cylinder, designed to be sealed until the desired sampling depth is reached. Upon reaching the desired sampling depth, the outer cylinder is pulled back, exposing a perforated, stainless steel sampling barrel covered with filter material.

- The water sample enters the barrel and the sample is retrieved by pulling the probe rods from the hole with the hydraulic derrick and hammer assembly. Groundwater is the only media that is sampled by Hydropunch® equipment.

- The head of the rod may be equipped with a sensing device for characterization of the soil properties or the contaminant content.

- The sample volume collected with this technique is approximately 500-1,000 ml. Larger sample volumes can be collected by inserting tubing attached to a peristaltic pump into the rods to obtain water samples.

If desired, a small diameter monitoring well may be installed at this point. Refer to SOP No. 019 (Monitoring Well Installation).

If a well will not be installed, the rods will be removed as the borehole is simultaneously filled with a bentonite/grout mixture. A polyvinyl chloride (PVC) tube fed into the rod casing will allow the addition of grout.

3.3 SUBSURFACE SOIL – HYDRAULIC PUSHING AND SAMPLING

The objective of the selected DPT sampling technique is to allow grab samples to be taken at a selected site for characterization of the stratigraphy and for analysis of potential contaminants. The analytical results from sampling can also be used to determine the placement of monitoring wells.

A site geologist will be present during all DPT sampling and soil characterization. All procedures and soil characteristics will be fully documented in the Field Logbook (refer to SOP No. 003 [Field Logbook]).

The site geologist will have on hand, at a minimum, a copy of the approved Health and Safety Plan, this SOP, the Field Investigation Plan, a hand lens (10X), a standard color chart, and a grain-size chart.

Only solid vegetable shortening (e.g., Crisco®) without flavoring or additives may be used on downhole Geoprobe® equipment.

Surface runoff or other fluids will not be allowed to enter any DPT location or well during or after DPT activities.

The subcontractor will use the equipment specific guidelines for installation of the Geoprobe® DPT equipment. Probe rods will be forced into the ground by hydraulic means. Additional rods will be added in 3- to 4-ft increments until the leading edge of the sampler reaches the top of the desired sampling interval.

Once the desired sampling depth has been reached, insert extension rods down the inside diameter of the probe rods until it reaches the top of the sampler assembly. Attach the extension rod handle to the top extension rod. Turn the handle clockwise until the stop-pin detaches from the drive head. Remove the extension rods and the stop-pin. Attach a drive cap to the probe and drive the sampler approximately 2 ft using hydraulic derrick.

The DPT sampler can be retrieved by pulling the probe rods from the hole with the hydraulic derrick and hammer assembly.

The liner will be capped with Teflon® tape and vinyl end caps. The liners can be split open to remove samples for composition analysis or for transfer to other containers for shipment to the laboratory for analysis.

The head of the rod may be equipped with a sensing device for characterization of the soil properties or the contaminant content.

3.4 DECONTAMINATION

All Geoprobe® and Hydropunch® DPT equipment must be thoroughly cleaned before and after each use to allow retrieval of representative groundwater samples. Geoprobe® soil sample liners are disposed of after each use. Scrub all metal parts with a stiff, long bristle brush and a non-phosphate soap solution. Steam cleaning may be substituted where available. Rinse with distilled water and allow to air-dry before assembly.

After decontamination, a new clean liner will be installed and all parts will be inspected for wear or damage.

Refer to SOP No. 005 (Decontamination).

3.5 ABANDONMENT

Pure bentonite or a bentonite/grout mixture (20:1) will be used to fill the resulting borehole if the water table is penetrated. Boreholes that do not penetrate the water table will be backfilled with cuttings from the hole and topped with a bentonite seal. Clean sand will be used to fill any remaining volume in the borehole.

Abandonment of Geoprobe® and Hydropunch® generated DPT boreholes will meet the standards established under SOP No. 028 (Well and Boring Abandonment).

4. CONE PENETROMETER TESTING

4.1 MATERIALS

A CPT rig typically consists of an enclosed 20- to 40-ton truck equipped with vertical hydraulic rams that are used to force a sensor probe into the ground. The weight of the CPT rig is dependent upon the thrust required at the site. The majority of CPT rigs are mounted in heavy-duty trucks that are ballasted to a total dead weight of approximately 15 tons. Screw anchors are utilized to develop the extra reaction to reach the maximum thrust of 20 tons. The rig is separated into two separate workspaces: data acquisition and hydraulic push areas.

Water sources for CPT activities and decontamination must be approved by the Project Manager prior to arrival of the CPT equipment. Information required for the water source includes: water source, manufacturer/owner, address and telephone number, type of treatment and filtration prior to tap, time of access, cost per gallon (if applicable), dates and results associated with all available chemical analysis over the past 2 years, and the name and address of the analytical laboratory (if applicable).

Pure sodium bentonite with no additives will be the only additive allowed, and its use must be approved by the Project Manager prior to the arrival of the DPT equipment. The information required for evaluation includes: brand name, manufacturer, manufacturer’s address and telephone number, product number, product description, and intended use for the product.

Portland Type II cement will be used for grout (refer to SOP No. 019).

4.2 SUBSURFACE CHARACTERIZATION

The objective of this technology is to collect stratigraphic information using CPT equipment to determine subsurface stratigraphy and geotechnical properties at a particular site. CPT activities will be in accordance with American Society for Testing and Materials D 3441-86 and American Society for Testing and Materials D 5778-95. The stratigraphic information gathered can be used to facilitate the selection of DPT sampling screen intervals. At the same time, it is possible to install a 0.25-in. diameter pre-packed PVC monitoring well.

CPT rods are used to hydraulically push the CPT probe into the subsurface. Probes cannot be pushed into hard rock, and significant gravel or cobble content in the formation may impede or preclude penetration of the probe. The depth of penetration achievable depends on the type of formation, type of sampling probe, and size of the hydraulic equipment used.

The CPT probe includes the following components:

- A conical tip to measure vertical resistance beneath the tip.
- A friction sleeve to measure frictional resistance on the side of the probe, as a function of depth.

- Two internal strain gauge-type load cells, which independently measure the vertical resistance and side friction.
- A cone pressure gauge to measure the water pressure as the probe is pushed into the ground.
- Inclinometer to determine potential drifting of the probe (optional).
- Seismic transducers to perform downhole seismic surveys (optional). Therefore, stratigraphic data collected with the CPT include: tip resistance, local friction, friction ratio, pore pressure, and resistivity.

Data will be transferred from the probe to the data acquisition system or logger through an electrical cable. The hole will be advanced continuously at a rate of 0.6-1.0 in. per second. The data will be logged at every 0.4-0.8 in. of penetration. Monitor the probe's stratigraphic position will be monitored as it advances downward. Perform pore water pressure dissipation tests in representative hydrostratigraphic intervals. Record dissipated pore water pressures to represent hydraulic head values.

Once the confining unit underlying the surficial aquifer or the required depth has been reached, the CPT is pulled from the ground. Target interval samples can be collected during CPT hole advancement using direct push sampling techniques, i.e., Geoprobe® or Hydropunch® (Section 3).

4.3 DECONTAMINATION

All CPT equipment must be thoroughly cleaned before arrival at the work site, between test holes, and prior to being moved out of a work area. Scrub all metal parts with a stiff, long bristle brush and a non-phosphate soap solution. Steam cleaning may be substituted where available. Rinse with distilled water and allow to air-dry before assembly.

Refer to SOP No. 005 (Decontamination).

4 .4 ABANDONMENT

If the push hole was developed for the stratigraphic test only, once the testing is completed, grout the hole from bottom to top. If the hole has not collapsed after removing the CPT, PVC piping will be used to grout the hole. If the hole has collapsed after removing the CPT, then hollow CPT rods and a sacrificial tip will be used to grout the hole. The PVC pipe or CPT rods will be pushed to the bottom of the hole. Grout will then be pumped to the bottom of the hole as the PVC pipe or CPT rods are withdrawn.

Refer to SOP No. 028 (Well and Boring Abandonment).

5. SITE CHARACTERIZATION AND ANALYSIS PENETROMETER SYSTEM

5.1 MATERIALS

SCAPS cone penetrometer and laser induced fluorescence (LIF) technology requires the use of a specialized 20-ton truck. The truck has two separate enclosed compartments. Each compartment is temperature controlled and monitored for air quality. The two rooms are the data acquisition and processing room, and the hydraulic ram/rod handling room. Approximately 20 ft of overhead clearance is required to fully extend the hydraulic ram and allow for leveling jack movement.

All materials required to complete SCAPS analysis are provided by the subcontractor to include cone penetrometer equipment. All hydraulic equipment, SCAPS rods, nitrogen lasers, etc. are included within the vehicle. A decontamination water source and a source of water for mixing the grout are required.

Water sources for equipment decontamination must be approved by the Project Manager prior to arrival of the SCAPS equipment. Information required for the water source includes: water source, manufacturer/owner, address and telephone number, type of treatment and filtration prior to tap, time of access, cost per gallon (if applicable), dates and results associated with all available chemical analysis over the past 2 years, and the name and address of the analytical laboratory (if applicable).

Pure sodium bentonite with no additives will be the only additive allowed, and its use must be approved by the Project Manager prior to the arrival of the SCAPS equipment. The information required for evaluation includes: brand name, manufacturer, manufacturer’s address and telephone number, product number, product description, and intended use for the product.

Portland Type II cement will be used for grout (refer to SOP No. 019).

5.2 HYDRAULIC PUSHING AND SAMPLING

The objective of the SCAPS technique is to allow grab samples and stratigraphic information to be collected at a selected site to facilitate subsurface characterization and for analysis of potential contaminants. The analytical results obtained can also be used to determine the placement of monitoring wells. At the same time, it is possible to install a small diameter well for sampling purposes. Refer to SOP No. 019 (Monitoring Well Installation). If a well will not be installed, the borehole can be grouted as the equipment is removed.

A site geologist will be present during all installation and sampling procedures and will fully document all procedures and soil characteristics in the Field Logbook (refer to SOP No. 003 [Field Logbook]).

The site geologist will have on hand, at a minimum, a copy of the approved Health and Safety Plan, this SOP, the Field Investigation Work Plan, a hand lens (10X), a standard color chart, and a grain-size chart.

Only solid vegetable shortening (e.g., Crisco®) without flavoring or additives may be used on downhole SCAPS equipment.

Surface runoff or other fluids will not be allowed to enter any DPT location or well during or after direct-push activities.

The subcontractor will use the equipment specific guidelines for installation of the SCAPS DPT equipment. Prior to SCAPS field activities, calibration soil samples will be collected and analyzed in order to determine the LIF sensor fluorescence threshold and detection limits for the site.

SCAPS LIF technology uses a pulsed nitrogen laser coupled with an optical detector to make fluorescence measurements via optical fibers. The LIF sensor is mounted on a cone penetrometer probe so that soil classification data and fluorescence data are collected simultaneously. The laser consumes nitrogen gas, which is supplied from cylinders stored on the accompanying trailer.

The SCAPS CPT sensors are used to gather stratigraphic information. See Section 4 for CPT operating procedures.

Target interval samples can be collected during SCAPS hole advancement using direct push sampling techniques such as Geoprobe® or Hydropunch® (Section 3).

5.3 DECONTAMINATION

Decontamination of SCAPS equipment is automated after initialization by a field team member. A pressurized hot water system is used to decontaminate the push rods as they are retracted from the ground. The SCAPS vehicle is equipped with a decontamination collar mounted to the bottom that cleans the rods. The decontamination water is removed by vacuum and transferred to a storage drum prior to disposal or treatment. A trailer attached to the back of the vehicle contains the water pump, heater for decontamination, and decontamination water containment drum.

Worker exposure is reduced by minimizing contact with contaminated media.

Refer to SOP No. 005 (Decontamination).

5.4 ABANDONMENT

SCAPS automatically grouts the penetrometer cavity as the rods are removed. The grout is pumped at high pressure through a 0.25-in. diameter tube in the center of the penetrometer rods. The tip is sacrificed at the bottom of the cavity to allow release of the grout.

A trailer attached to the back of the vehicle contains the 300-gal grout mixing bin and pump.

If the automatic grout feed does not work, the cavity will be manually filled with grout.

Abandonment of SCAPS generated borehole will meet the standards established under SOP No. 028 (Well and Boring Abandonment).

6. MAINTENANCE

Not applicable.

7. PRECAUTIONS

Refer to the site-specific Health and Safety Plan for discussion of hazards and preventive measures during intrusive activities.

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Standard Operating Procedure No. 048
for
Low-Flow Sampling

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CONTENTS

1. GROUNDWATER SAMPLING BY LOW-FLOW PURGE AND SAMPLING METHOD USING DEDICATED PUMPS

1.1 SCOPE OF APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to establish the protocol for collecting groundwater samples using dedicated pump systems. The procedure is designed to permit the collection of groundwater samples with minimum turbidity.

1.2 EQUIPMENT/MATERIALS

- Work Plan.
- Well construction data, location map, and field data from last sampling event.
- Field logbook and Field Record of Well Gauging, Purging, and Sampling forms (Figure SOP048-1).
- Electric water level measuring device, 0.01 ft accuracy for monitoring water level during pumping operations.
- Pumps: adjustable rate, submersible pumps constructed of stainless steel and Teflon®.
- Tubing: Teflon or Teflon-lined polyethylene must be used to collect samples for organic analysis. For samples collected for inorganics analysis, Teflon or Teflon-lined polyethylene tubing will be used.
- Flow measurement supplies (e.g., graduated cylinder and stop watch).
- Power source (generator, etc.).
- Water quality indicator parameter monitoring instruments—pH, turbidity, specific conductance, and temperature. Optional indicators—Eh and dissolved oxygen.
- Flow-through cell (preferred) or clean container for water quality probes.
- Decontamination supplies (for monitoring instrumentation).
- Sample bottles and sample preservation supplies (as required by the analytical methods).
- Sample tags or labels.
- Cooler with bagged ice for sample bottles.
- Drum for purge water containment.

1.3 PRELIMINARY SITE ACTIVITIES

The following site activities are required prior to performing well purging and groundwater sampling. Field logbooks and sampling forms should be filled out as the procedure is being performed, as noted:

- Enter the following information in the field logbook and sampling form, as appropriate: site name, project number, field personnel, well identification, weather conditions, date and time, equipment used, and quality assurance/quality control data for field instrumentation.

- Check well for damage or evidence of tampering, record pertinent observations in field logbook and sampling form.

- Lay out sheet of polyethylene for monitoring and sampling equipment.

- Unlock well and remove well cap (if applicable).

- Measure VOCs with an ionization detector (flame or photo) instrument at the rim of the well and in the breathing zone, and record the readings in the field logbook and the sampling form.

- Measure and record the height of protective casing above the concrete pad or ground surface, as appropriate. This reading is compared to that recorded during well installation as an indication of possible well damage or settling that may have occurred.

- Dedicated sampling pumps should be positioned with the pump intake mid-point in the screened interval. If non-dedicated equipment is used, care will be taken to position pump or sampling hose intake at the screen mid-point.

- Measure and record the depth to water (to 0.01 ft) in the well to be sampled before purging begins. If the well casing does not have a reference point (usually a v-cut or indelible mark in the well casing), make one. If a reference point is made, it will be noted in the field logbook. Care should be taken to minimize disturbance of any particulate attached to the sides or at the bottom of the well. The depth to well bottom will be measured following the completion of sampling because of the potential to stir up sediment at the bottom of the well.

- Prepare the pump by checking electrical connections, discharge tubing, and motor (Grundfos Redi-Flo2). Locate the generator (if applicable) downwind of the well; connect the power converter to the generator and to the pump.

1.4 WELL PURGING AND SAMPLING PROCEDURE

The following general procedure should be followed to obtain representative groundwater samples. Field logbooks and sampling forms should be filled out as the procedure is being performed, as noted:

- Enter the following information in the field logbook and sampling form, as appropriate, prior to purging: purge date and time, purge method, and total well depth.

- Connect the flow-through cell or clean container containing the instrumentation header to the pump discharge and begin purging the well at 0.2-0.5 L/min, unless a different purge rate has been previously established for that well. Fill the flow cell completely. Care should be taken not to cause entrapment of air in the system. Record the purge start time and purge rate.

- Establish that the water level has not dropped significantly such that the pump is dry (bubbles in discharge) or water is heard cascading down the inside of the well. Ideally, the pump rate should cause little or no water level drawdown in the well (>0.5 ft and the water level should stabilize). The water level should be monitored every 3-5 minutes (or as appropriate) during pumping. Record pumping rate adjustments and depths to water. Pumping rates should, if needed, be reduced to the minimum capabilities of the pump (e.g., 0.1-0.2 L/min) to avoid pumping the well dry and/or to ensure stabilization of indicator parameters. If water levels continue to drop with the pump on the lowest flow rate, the pump will be shut off and the well will be allowed to recharge to prevent the well from going dry. **The well will not be purged to dryness prior to sampling to prevent erroneous field parameters and groundwater samples.** Sampling will commence as soon as the well has recharged to a sufficient level to collected the appropriate volume of samples with the pump.

- During purging of the well, monitor the water quality indicator parameters (turbidity, temperature, specific conductance, pH, etc.) every 3-5 minutes (or as appropriate). Record purge rate, volume purged, depth to water, water quality indicator parameters values, and clock time at 3- to 5-minute intervals in field logbook and sampling record. Purging of the standing well water is considered complete when three consecutive readings of the water quality indicator parameters agree within approximately 10 percent. Turbidity readings consistently below 10 nephelometric turbidity units (NTU) are considered to represent stabilization of discharge water for this parameter. If the parameters have stabilized, but the turbidity is not in the range of the 10 NTU goal, the pump flow rate should be decreased and measurement of the parameters should continue every 3-5 minutes.

- Purge water at a well will be containerized if a well has exceeded the MEG or MCL in previous sampling events. Any purge water that is collected will be treated at the groundwater treatment plant.

- Prior to sampling, disconnect the discharge tubing from the flow-through cell. If the water discharged by the pump is silty, wait for the water to clear before sampling. Ensure that bubbles are not observed in the discharge tubing. Record pertinent observations in field logbook and sampling records.

- Begin filling sample containers by allowing the pump discharge to flow gently down the inside of the container with as little agitation or aeration as possible. Collect the samples in the order below, as applicable:

  — VOCs
  — Inorganics.

- VOC samples requiring pH adjustment will have their pH checked to assure that the proper pH has been obtained. This will require that a test sample be collected to determine the amount of preservative that needs to be added to the sample containers prior to sampling. Details on sample preservation are discussed in Section 1.5.

- Label each sample as collected. Those samples (VOCs, etc.) requiring cooling will be placed into an ice cooler for delivery to the laboratory. Inorganic samples, after preservation, do not need to be cooled.

- After collection of the samples, restore the dedicated pumping assembly to the well by hanging the tube, electric line, and support cable inside the well by the specially-designed PVC well cap assembly. Lock well.

- Complete remaining portions of Field Record of Well Gauging, Purging, and Sampling form (Figure SOP048-1) after each well is sampled, including sample date and time, total quantity of water removed, well sampling sequence, types of sample bottles used, sample identification numbers, preservatives used, parameters requested for analysis, and field observations of sampling event.

1.5 SAMPLE PRESERVATION

The following preservation procedures are examples of typical preservation protocols specific to the indicated analyses. Pre-preserved bottles will be used if possible. Minimum sample preservation requirements for each parameter group are summarized below:

- **VOCs—**Aqueous VOC samples must be collected as specified below. Each VOC sample is taken in duplicate:

  — Uncap the sample bottle, taking care not to touch the Teflon-faced septum. If the septum is contaminated in any way, it should be replaced.

  — Fill a sample bottle, preserve with HC1, and check the pH. Adjust the volume of HC1 to assure pH<2.

- Add the amount of HC1 determined in the above step, and fill the sample vial slowly from the tubing, minimizing air entrainment, until the vial slightly overflows.
- Place the Teflon-faced silicon rubber septum on the convex meniscus, Teflon side (shiny side) down and screw cap on.
- Invert the bottle, tap lightly, and check for air bubbles.
- If air bubbles are present, open the bottle, add sample to eliminate air bubbles, and reseal. Repeat this procedure until the bottle is filled and no air bubbles are detected.
- Place samples on ice until shipment.

- **Inorganics—**Fill the sample bottle, preserve the sample to pH<2 with nitric acid (HNO_3), seal container, and place sample on ice for shipment.

Disposable pipettes should be used to introduce chemicals into the samples if necessary. Chemicals used for preserving should be poured into a 150-ml beaker. They should not be drawn directly from the preservative bottles because the bottle may become contaminated. Measurements for pH and temperature should not be taken from the sample containers. When preserving samples to a required pH, pH paper should be used to check the resultant pH. The sample should be poured across the pH paper. Never place pH paper directly into sample.

NOTE: Shipping regulations limit the amount of preservative which can be added. For a 1-L sample, this is generally 1.5 ml of acid preservative.

1.6 FIELD QUALITY CONTROL

Quality control samples are required to verify that the sample collection and handling process has not affected the quality of the groundwater samples. All field quality control samples must be prepared exactly as regular investigation samples with regard to sample volume, containers, and preservation. The following quality control samples will be collected for each sample delivery group (SDG) (an SDG may not exceed 20 samples) at the frequency noted:

- Field Duplicate—Required at a frequency of 10 percent per SDG.
- Matrix Spike/Matrix Spike Duplicate—Required at a frequency of 5 percent.
- Equipment Rinsate Blank—Required once prior to installation of dedicated pump systems.
- Source Water Blank—Required at a frequency of once per source per sampling event when equipment (rinsate) blank is required.
- Trip Blank—Required for VOC samples at a frequency of one per sample shipment.

1.7 DECONTAMINATION

Non-dedicated sampling equipment and field monitoring equipment will be decontaminated prior to use and following sampling of each well. This equipment will be decontaminated by the procedure listed below. Alternative procedures must be approved by the Project Manager prior to sampling event. Decontamination fluids will be collected in a 5-gal bucket and treated at the groundwater treatment plant.

The following decontamination procedure will be used:

- Flush the equipment with potable water
- Flush with non-phosphate detergent solution
- Flush with tap water to remove all of the detergent solution
- Flush with distilled/deionized water
- Flush with isopropyl alcohol
- Flush with distilled/deionized water.

It is recommended that the detergent and isopropyl alcohol used in the above sequence be used sparingly.

2. GROUNDWATER SAMPLING BY LOW-FLOW PURGE AND SAMPLING METHOD USING PERISTALTIC PUMPS

2.1 SCOPE OF APPLICATION

The purpose of this SOP is to establish the protocol for collecting groundwater samples using peristaltic pump systems. The procedure is designed to permit the collection of groundwater samples with minimum turbidity, and is intended to be used in conjunction with the analyses for the most common types of groundwater contaminants (VOCs and inorganic compounds).

2.2 EQUIPMENT/MATERIALS

- Work Plan.

- Well construction data, location map, field data from last sampling event.

- Field logbook and Field Record of Well Gauging, Purging, and Sampling forms (Figure SOP048-1).

- Water level measuring device, 0.01 ft accuracy (electronic preferred) for monitoring water level drawdown during pumping operations.

- Peristaltic pump.

- In-well tubing: Teflon or Teflon-lined polyethylene must be used to collect samples for organic analysis. For samples collected for inorganics analysis, Teflon or Teflon-lined polyethylene, PVC, Tygon, or polyethylene tubing may be used.

- Pump head tubing: Silicon tubing must be used to in the pump head assembly.

- Flow measurement supplies (e.g., graduated cylinder and stop watch).

- Power source (battery, etc.).

- Water quality indicator parameter monitoring instruments – pH, turbidity, specific conductance, and temperature. Optional indicators – Eh and dissolved oxygen.

- Flow-through cell (preferred) or clean container for water quality probe.

- Decontamination supplies (for monitoring instrumentation).

- Sample bottles and sample preservation supplies (as required by the analytical methods).

- Sample tags or labels.

- Cooler with bagged ice for sample bottles.

- Drum for purge water containment.

2.3 PRELIMINARY SITE ACTIVITIES

The following site activities are required prior to performing well purging and groundwater sampling. Field logbooks and sampling forms should be filled out as the procedure is being performed, as noted:

- Enter the following information in the field logbook and sampling form, as appropriate: site name, project number, field personnel, well identification, weather conditions, date and time, equipment used, and quality assurance/quality control data for field instrumentation.

- Check well for damage or evidence of tampering, record pertinent observations in field logbook and sampling form.

- Unlock well and remove well cap (if applicable).

- Measure VOCs with an ionization detector (photo or flame) instrument at the rim of the well and in the breathing zone and record the readings in the field logbook and the sampling form.

- Measure and record the height of protective casing above the concrete pad, or ground surface, as appropriate. This reading is compared to that recorded during well installation as an indication of possible well damage or settling that may have occurred.

- Measure and record the depth to water (to 0.01 ft) in the well to be sampled before purging begins. If the well casing does not have a reference point (usually a v-cut or indelible mark in the well casing), make one. If a reference point is made, it will be noted in the field logbook. Care should be taken to minimize disturbance of any particulate attached to the sides or at the bottom of the well. The depth to well bottom will not be measured following the completion of sampling because of the potential to stir up sediment at the bottom of the well.

- Position the intake of the sampling hose at the mid-point of the screened interval.

- Prepare the pump by checking electrical connections and discharge tubing. Locate the battery downwind of the well; connect the peristaltic pump to the battery.

2.4 WELL PURGING AND SAMPLING PROCEDURES

The following general procedure should be followed to obtain representative groundwater samples. Field logbooks and sampling forms should be filled out as the procedure is being performed, as noted:

- Enter the following information in the field logbook and sampling form, as appropriate, prior to purging: purge date and time, purge method, and total well depth.

- Measure the water level with the pump in well before starting the pump. Begin purging the well at 0.3-0.5 L/min, unless a different purge rate has been previously established for that well.

- If well diameter permits, establish that the water level has not dropped significantly such that the pump is dry (air in discharge) or tubing suction is broken. Ideally, the pump rate should cause little or no water level drawdown in the well (>0.5 ft and the water level should stabilize). The water level should be monitored every 3-5 minutes (or as appropriate) during pumping. Care should be taken not to cause pump suction to be broken, or entrainment of air in the pump system. Record pumping rate adjustments and depths to water. Pumping rates should, if needed, be reduced to the minimum capabilities of the pump (e.g., 0.3 L/min) to avoid pumping the well dry and/or to ensure stabilization of indicator parameters. If water levels continue to drop with the pump on the lowest flow rate, the pump will be shut off and the well will be allowed to recharge to prevent the well from going dry. **The well will not be purged to dryness prior to sampling to prevent erroneous field parameters and groundwater samples.** Sampling will commence as soon as the well has recharged to a sufficient level to collected the appropriate volume of samples with the pump.

- During purging of the well, monitor the field indicator parameters (turbidity, temperature, specific conductance, pH, etc.) every 3-5 minutes (or as appropriate). Purging of the standing well water is considered complete when three consecutive readings of the water quality indicator parameters agree within approximately 10 percent. Turbidity readings consistently below 10 NTU are considered to represent stabilization of discharge water for this parameter. If the parameters have stabilized, but the turbidity is not in the range of the 10 NTU goal, the pump flow rate should be decreased and measurement of the parameters should continue every 3-5 minutes.

- Purge water at a well will be containerized if a well has exceeded the MEG or MCL in previous sampling events. Any purge water that is collected will be treated at the groundwater treatment plant.

- Prior to sampling, disconnect the sample discharge tubing from the flow-through cell. If the water discharged by the pump is silty, wait for the water to clear before sampling. Ensure that bubbles are not observed in the discharge tubing.

- Collect groundwater samples directly from the silicon tubing into preserved (when appropriate) sample containers. Begin filling sample containers from the pump discharge, allowing the water to fill the containers by allowing the pump discharge to flow gently down the inside of the container with as little agitation or aeration as possible. Collect the samples in the order below, as applicable:

  — VOCs
  — Inorganics.

- VOC samples requiring pH adjustment will have their pH checked to assure that the proper pH has been obtained. This will require that a test sample be collected to determine the amount of preservative that needs to be added to the sample containers prior to sampling. Detail on sample preservation are discussed in Section 2.5.

- Label each sample as collected. Those samples (VOCs, etc.) requiring cooling will be placed into an ice cooler for delivery to the laboratory. Inorganic samples, after preservation, do not need to be cooled.

- After collection of the samples, restore the dedicated tubing assembly to the well by hanging the tube inside the well by the specially-designed PVC well cap assembly. Lock well.

- Complete remaining portions of Field Record of Well Gauging, Purging, and Sampling form (Figure SOP048-1) after each well is sampled, including: sample date and time, total quantity of water removed, well sampling sequence, types of sample bottles used, sample identification numbers, preservatives used, parameters requested for analysis, and field observations of sampling event.

- The silicon tubing used in the peristaltic pump will be changed after use at each well.

2.5 SAMPLE PRESERVATION

The following preservation procedures are examples of typical preservation protocols specific to the indicated analyses. Pre-preserved bottles will be used if possible. Minimum sample preservation requirements for each parameter group are summarized below:

- **VOCs—**Aqueous VOC samples must be collected as specified below. Each VOC sample is taken in duplicate:

  — Uncap the sample bottle, taking care not to touch the Teflon-faced septum. If the septum is contaminated in any way, it should be replaced.

  — Fill a sample bottle, preserve with HCL, and check the pH. Adjust the volume of HCL to assure pH<2.

  — Add the amount of HCL determined in the above step, and fill the sample vial slowly from the tubing, minimizing air entrainment, until the vial slightly overflows.

  — Place the Teflon-faced silicon rubber septum on the convex meniscus, Teflon side (shiny side) down, and screw cap on.

  — Invert the bottle, tap lightly, and check for air bubbles.

  — If air bubbles are present, open the bottle, add sample to eliminate air bubbles, and reseal. Repeat this procedure until the bottle is filled and no air bubbles are detected.

  — Place samples on ice until shipment.

- **Inorganics—**Fill the sample bottle, preserve the sample to pH<2 with nitric acid (HNO_3), seal container, and place sample on ice for shipment.

Disposable pipettes should be used to introduce chemicals into the samples if necessary. Chemicals used for preserving should be poured into a 150-ml beaker. They should not be drawn directly from the preservative bottles because the bottle may become contaminated. Measurements for pH and temperature should not be taken from the sample containers. When preserving samples to a required pH, pH paper should be used to check the resultant pH. The sample should be poured across the pH paper. Never place pH paper directly into sample.

NOTE: Shipping regulations limit the amount of preservative which can be added. For a 1-L sample, this is generally 1.5 ml of acid preservative.

2.6 FIELD QUALITY CONTROL

Quality control samples are required to verify that the sample collection and handling process has not affected the quality of the groundwater samples. All field quality control samples must be prepared exactly as regular investigation samples with regard to sample volume, containers, and preservation. The following quality control samples will be collected for each SDG (an SDG may not exceed 20 samples) at the frequency noted:

- Field Duplicate—Required at a frequency of 10 percent per SDG

- Matrix Spike/Matrix Spike Duplicate—Required at a frequency of 5 percent

- Equipment (Rinsate) Blank—Required once prior to installation of dedicated sample tubing

- Source Water Blank—Required at a frequency of one per source per sampling event

- Trip Blank—Required for VOC samples at a frequency of one per sample shipment.

- Temperature Blank—Required at a frequency of once per sample shipment container.

2.7 DECONTAMINATION

Non-dedicated sampling and field monitoring equipment will be decontaminated prior to use and following sampling of each well. This equipment will be decontaminated by the procedure listed below. Alternate procedures must be approved by the Project Manager prior to the sampling event. Decontamination fluids will be collected in a 5-gal bucket and treated at the groundwater treatment plant.

The following decontamination procedure will be used:

- Flush the equipment with potable water
- Flush with non-phosphate detergent solution
- Flush with tap water to remove all of the detergent solution
- Flush with distilled/deionized water
- Flush with isopropyl alcohol
- Flush with distilled/deionized water.

It is recommended that the detergent and isopropyl alcohol used in the above sequence be used sparingly.

3. SURFACE WATER AND LEACHATE SEEP SAMPLING PROCEDURE

3.1 SCOPE OF APPLICATION

The purpose of this SOP is to establish the protocol for collecting surface water and leachate seep samples. The procedure is designed to permit the collection of representative surface water and leachate seep samples, and has been adapted from the procedure outlined in the Work Plan. This SOP is suitable for collecting surface water and seep samples requiring analyses for the most common types of surface water contaminants (VOCs and inorganic compounds).

3.2 EQUIPMENT/MATERIALS

- Work Plan.
- Location map, field data from last sampling event.
- Field logbook and Field Record of Surface Water and Sediment Sampling forms (Figure SOP048-2).
- Water quality indicator parameter monitoring instruments – pH, turbidity, specific conductance, and temperature. Optional indicators – Eh and dissolved oxygen.
- Decontamination supplies (for monitoring instrumentation).
- Dedicated, pre-cleaned 1-L wide-mouth or volatile organic analyte sample container (for sample collection).
- Sample bottles and sample preservation supplies (as required by the analytical methods).
- Sample tags or labels.
- Cooler with bagged ice for sample bottles.

3.3 PRELIMINARY SITE ACTIVITIES

The following site activities are required prior to performing surface water or leachate seep sampling. Field logbooks and sampling forms should be filled out as the procedure is being performed, as noted:

- Enter the following information in the field logbook and sampling form, as appropriate: site name, project number, field personnel, sample station identification, weather conditions, date and time, equipment used, and quality assurance/quality control data for field instrumentation.

- Visually inspect sample station for evidence of changes in physical condition; record pertinent observations in field logbook and sampling form.

- Measure VOCs with a flame ionization detector instrument in the breathing zone and record the reading in the field logbook and sampling form.

3.4 SAMPLING PROCEDURE

The technique for surface water and leachate seep sampling must be selected after addressing such items as:

- Depth of waterbody
- Depth of sample
- Stratification
- Seasonal variations
- Analytical parameters of interest.

The following general procedure should be used to obtain representative surface water and leachate seep samples. Field logbooks and sampling forms should be filled out as the procedure is being performed, as noted:

- Enter the following information in the field logbook and sampling form, as appropriate, prior to sampling: date and time, sample method, and sample depth.

- Collect the sample from the surface water, within several tenths of a foot of the streambed, by immersing a new, dedicated 1-L glass or volatile organic analyte sample container into the waterbody. If a stream is being sampled, collect the sample upstream of the sampler with the opening of the sampling device oriented upstream but avoiding floating debris.

- Directly fill the appropriate sample containers from the 1-L or volatile organic analyte sampling device.

- Collect the samples in the order below, as applicable:

  — VOCs
  — Inorganics.

- Water sample containers are generally filled directly from the source or sampler without special considerations. The exception is the collection of aqueous VOC samples requiring pH adjustment. VOC samples will have their pH checked to assure that the proper pH has been obtained. This will require that a test sample be collected to determine the amount of preservative that needs to be added to the sample containers prior to sampling. Details on sample preservation methods are discussed in Section 3.6.

- Label each sample as collected. Those samples (VOCs, etc.) requiring cooling will be placed into an ice cooler for delivery to the laboratory. Inorganic samples, after preservation, do not need to be cooled.

- Measure water quality indicator parameters, if possible, by direct immersion of instrument probes into the waterbody immediately following sample collection. If direct measurement is not possible, measure these parameters from water remaining in the sampling device or another sample bottle. Record this information in the field logbook and sample data record.

- Complete remaining portions of the Field Record of Surface Water and Sediment Sampling form (Figure SOP048-2) after each station is sampled, including: time of sample collection, types of sample bottles used, sample identification numbers, preservatives used, parameters requested for analysis, and field observations of sampling event.

3.5 SAMPLE PRESERVATION

The following preservation procedures are examples of typical preservation protocols specific to the indicated analyses. Minimum sample preservation requirements for each parameter group are summarized below:

- **VOCs—**Aqueous VOC samples must be collected as specified below. Each sample is taken in duplicate:

  — Uncap the sample bottle, taking care not to touch the Teflon-faced septum. If the septum is contaminated in any way, it should be replaced.

  — Fill a sample bottle, preserve with HC1, and check the pH. Adjust the volume of HC1 to assure pH<2.

  — Add the amount of HC1 determined in the above step, and fill the sample vial slowly from the 1-L container, minimizing air entrainment, until the vial slightly overflows.

  — Place the Teflon-faced silicon rubber septum on the convex meniscus, Teflon side (shiny side) down and screw cap on.

  — Invert the bottle, tap lightly, and check for air bubbles.

  — If air bubbles are present, open the bottle, add sample to eliminate air bubbles, and reseal. Repeat this procedure until the bottle is filled and no air bubbles are detected.

  — Place samples on ice until shipment.

- **Inorganics—**Fill the sample bottle, preserve the sample to pH<2 with nitric acid (HNO_3), seal container, and place sample on ice for shipment.

Disposable pipettes should be used to introduce chemicals into the samples. Chemicals used for preserving should be poured into a 150-ml beaker. They should not be drawn directly from the preservative bottles because the bottle may become contaminated. Measurements for pH and temperature should not be taken from the sample containers. When preserving samples to a required pH, pH paper should be used to check the resultant pH. The sample should be poured across the pH paper. Never place pH paper directly into sample.

NOTE: Shipping regulations limit the amount of preservative which can be added. For a 1-L sample, this is generally 1.5 ml of acid preservative.

3.6 FIELD QUALITY CONTROL

Quality control samples are required to verify that the sample collection and handling process has not affected the quality of the surface water and leachate seep samples. All field quality control samples must be prepared exactly as regular investigation samples with regard to sample volume, containers, and preservation. The following quality control samples will be collected for each SDG (an SDG may not exceed 20 samples) at the frequency noted:

- Field Duplicate—Required at a frequency of 10 percent per SDG.

- Matrix Spike/Matrix Spike Duplicate—Required at a frequency of 5 percent.

- Equipment (Rinsate) Blank—Required at a frequency of once per day per media sampled.

- Source Water Blank—Required at a frequency of once per source per sampling event when equipment (rinsate) blank is required.

- Trip Blank—Required for VOC samples at a frequency of one per sample shipment.

3.7 DECONTAMINATION

Field monitoring equipment will be decontaminated prior to use and following sampling of each station by the procedure listed below. Laboratory pre-cleaned, dedicated 1-L glass sample collection containers are used once and discarded and, therefore, do not undergo any decontamination. Decontamination fluids will be collected in a 5-gal bucket and treated at the groundwater treatment plant.

The following decontamination procedure will be used:

- Flush the equipment with potable water
- Flush with non-phosphate detergent solution
- Flush with tap water to remove all of the detergent solution
- Flush with distilled/deionized water
- Flush with isopropyl alcohol
- Flush with distilled/deionized water.

It is recommended that the detergent and isopropyl alcohol used in the above sequence be used sparingly.

4. REFERENCES

U.S. Environmental Protection Agency. 1996. Groundwater Issue-Low Flow Sampling (Minimal Drawdown) Groundwater Sampling Procedures. April.

FIELD RECORD OF WELL GAUGING, PURGING, AND SAMPLING

Site Name: Project Number:
Well ID: Well Lock Status:
Well Condition: Weather:

Gauge Date: Gauge Time:
Sounding Method: Measurement Ref:
Stick Up/Down (ft): Well Diameter (in.):

Purge Date: Purge Time:
Purge Method: Field Personnel:
Ambient Air VOCs (ppm): Well Mouth VOCs (ppm):

WELL VOLUME

A. Well Depth (ft): D. Well Volume/ft (L):
B. Depth to Water (ft): E. Well Volume (L) (C*D):
C. Liquid Depth (ft) (A-B) F. Three Well Volumes (L)
G. Measurable LNAPL? Yes ________ /ft No ________

Parameter	Beginning	1	2	3	4	5
Time (min.)						
Depth to Water (ft)						
Purge Rate (L/min)						
Volume Purged (L)						
pH						
Temperature (°C)						
Conductivity (µmhos/cm)						
Dissolved Oxygen (mg/L)						
Turbidity (NTU)						
eH (mV)						

Total Quantity of Water Removed (L):
Samplers: Sampling Time (Start/End):
Sampling Date: Decontamination Fluids Used:
Sample Type: Sample Preservatives:
Sample Bottle IDs:
Sample Parameters:

Figure SOP048-1.

FIELD RECORD OF WELL GAUGING, PURGING, AND SAMPLING

Site Name: ______________________ Project Number: ______________________ Date: ______________________

Well ID: Field Personnel:

Parameter	6	7	8	9	10	11
Time (min.)						
Depth to Water (ft)						
Purge Rate (L/min)						
Volume Purged (L)						
pH						
Temperature (°C)						
Conductivity (μmhos/cm)						
Dissolved Oxygen (mg/L)						
Turbidity (NTU)						
eH (mV)						

Parameter	12	13	14	15	16	17
Time (min.)						
Depth to Water (ft)						
Purge Rate (L/min)						
Volume Purged (L)						
pH						
Temperature (°C)						
Conductivity (μmhos/cm)						
Dissolved Oxygen (mg/L)						
Turbidity (NTU)						
eH (mV)						

Comments and Observations:

Figure SOP048-1.

FIELD RECORD OF SURFACE WATER AND SEDIMENT SAMPLING

Site Name:			Project Number:
Sample Location ID:			Date:
Time:	Start:	End:	Sample Team Members:

SURFACE WATER INFORMATION

Type of Surface Water:
( ) Stream ( ) River
( ) Pond/Lake ( ) Seep

Water Depth and Sample Location _________ (ft)

Depth of Sample from Top of Water ________ (ft)

Equipment Used for Collection:
( ) None, Grab into Bottle
( ) Bomb Sampler
( ) Pump _____________

Decontamination Fluids Used:
( ) Isopropyl Alcohol
( ) ASTM Type II Water
( ) Deionized Water
( ) Liquinox Solution
( ) Hexane
( ) HNO_3 Solution
( ) Potable Water
( ) None

Water Quality Parameters
( ) Temperature ____
( ) Conductivity ___ µmhs/cm
( ) pH ____ units
( ) Dissolved oxygen ____ mg/L
( ) Turbidity ____ NTU
( ) Eh ____ mv

Velocity Measurements Obtained? ( ) No ( ) Yes, See Flow Measurement Data Record
____

Field QC Data: ( ) Field Duplicate Collected Sample Location Sketch: Method Used:

Duplicate ID ____________
( ) MS/MSD

( ) Yes
( ) No

( ) Winkler
( ) Probe

SEDIMENT INFORMATION

Type of Sample Collected:
( ) Discrete
( ) Composite

Sediment Type:
( ) Clay
( ) Sand
( ) Organic
( ) Gravel

Equipment Used for Collection:
( ) Gravity Corer
( ) Stainless Steel Split Spoon
( ) Dredge
( ) Hand Spoon/Trowel
( ) Aluminum Pans
( ) Stainless Steel Bucket
( ) _____________________________

Decontamination Fluids Used:
( ) Isopropyl Alcohol
( ) ASTM Type II Water
( ) Deionized Water
( ) Liquinox Solution
( ) Hexane
( ) HNO_3 Solution
( ) Potable Water
( ) None

Sample Observations:
( ) Odor ____
( ) Color

Field QC Data: ( ) Field Duplicate Collected ( ) MS/MSD
Duplicate ID __________________________

SAMPLES COLLECTED

Check if Required at this Location	Matrix		Check if Preserved with Acid/Base	Volume Required	Check if Sample Collected	Sample Bottle IDs			
	Surface Water	Sediment							

NOTES/SKETCH

Figure SOP048-2.

Standard Operating Procedure No. 051
for
Low Flow Purge and
Sampling with Dedicated Pumps

Prepared by

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Revision: 0
August 2007

CONTENTS

1. SCOPE OF APPLICATION

The purpose of this Standard Operating Procedure is to establish the protocol for collecting groundwater samples using dedicated pump systems. The procedure is designed to permit the collection of groundwater samples with minimum turbidity, and is intended to be used in conjunction with the analyses for the most common types of groundwater contaminants (volatile organic compounds and semivolatile organic compounds, pesticides, polychlorinated biphenyls, metals, and inorganic compounds). This Standard Operating Procedure was prepared based on draft guidance prepared by U.S. Environmental Protection Agency Region 1 and conforms with the procedures described in the Long-Term Monitoring Plan.

2. EQUIPMENT/MATERIALS

- Long-Term Monitoring Plan.
- Well construction data, location map, and field data from last sampling event.
- Field logbook, Field Record of Well Gauging Form (Figure SOP051-1), and Field Record of Well Gauging, Purging, and Sampling Form (Figure SOP051-2).
- Electronic water level measuring device, 0.01 ft accuracy for monitoring water level during pumping operations.
- Pumps: adjustable rate, submersible pumps constructed of stainless steel and Teflon.
- Tubing: Teflon or Teflon-lined polyethylene must be used to collect samples for organic and inorganic analyses.
- Flow measurement supplies (e.g., graduated cylinder and stop watch).
- Power source (generator, etc.).
- Water quality indicator parameter monitoring instruments—pH, turbidity, specific conductances, and temperature. Optional indicators—Eh and dissolved oxygen. Water quality indicator parameters will be measured in the field in accordance with EPA-600/4-79-020 (1983) using the following methods: temperature (Method 170.1), pH (Method 150.1), turbidity (Method 180.1), specific conductance (Method 120.1), and dissolved oxygen (Method 360.1).

- Flow-through cell for water quality parameters.
- Decontamination supplies (for monitoring instrumentation).
- Sample bottles and sample preservation supplies (as required by the analytical methods).
- Sample tags or labels.
- Cooler with bagged ice for sample bottles.

3. PRELIMINARY SITE ACTIVITIES

The following site activities are required prior to performing well purging and groundwater sampling. Field logbooks and sampling forms should be filled out as the procedure is being performed, as noted:

- Enter the following information in the field logbook and sampling form, as appropriate: site name, project number, field personnel, well identification, weather conditions, date and time, equipment used, and quality assurance/quality control data for field instrumentation.
- Check well for damage or evidence of tampering, record pertinent observations in field logbook and sampling form.
- Lay out sheet of polyethylene for monitoring and sampling equipment.
- Unlock well and remove well cap (if applicable).
- Measure volatile organic compounds with a photoionization detector instrument at the rim of the well and in the breathing zone, and record the readings in the field logbook and the sampling form.
- Measure and record the height of protective casing above the concrete pad or ground surface, as appropriate. This reading is compared to that recorded during well installation as an indication of possible well damage or settling that may have occurred.
- Measure and record the depth to water (to 0.01 ft) in the well to be sampled before purging begins. If the well casing does not have a reference point (usually a v-cut or indelible mark in the well casing), make one. Care should be taken to minimize disturbance of any particulate attached to the sides or at the bottom of the well. The depth to well bottom will be measured following completion of the sampling because of the potential to stir up sediment at the bottom of the well.

- Prepare the pump by checking electrical connections, discharge tubing, and motor (Grundfos Redi-Flo2). Locate the generator (if applicable) downwind of the well; connect the power converter to the generator and the pump.

4. SAMPLING PROCEDURE

The following general procedure should be followed to obtain representative groundwater samples. Field logbooks and sampling forms should be filled out as the procedure is being performed, as noted:

- Enter the following information in the field logbook and sampling form, as appropriate, prior to purging: purge date and time, purge method, and total well depth.

- Connect the flow-through cell containing the instrumentation header to the pump discharge and begin purging the well at 0.2-0.5 L/min, unless a different purge rate has been previously established for that well. Fill the flow-through cell completely. Care should be taken not to cause entrapment of air in the system. Record the purge start time and purge rate.

- Establish that the water level has not dropped significantly such that the pump is dry (bubbles in discharge) or water is heard cascading down the inside of the well. Ideally, the pump rate should cause little or no water level drawdown in the well (<0.5 ft and the water level should stabilize). The water level should be monitored every 3-5 minutes (or as appropriate) during pumping. Record pumping rate adjustments and depths to water. Pumping rates should, if needed, be reduced to the minimum capabilities of the pump (e.g., 0.1-0.2 L/min) to avoid pumping the well dry and/or to ensure stabilization of indicator parameters. If the water level continues to drop with the pump on the lowest flow rate, the pump will be shut off and the well allowed to recharge to prevent it from going dry. **The well will not be purged to dryness prior to sampling to prevent erroneous field parameters and groundwater samples.** Sampling will commence as soon as the well has recharged to a sufficient level to collect the appropriate volume of samples with the pump.

- During purging of the well, monitor the water quality indicator parameters (turbidity, temperature, specific conductance, pH, etc.) every 3-5 minutes (or as appropriate). Record purge rate, volume purged, depth to water, water quality indicator parameters values, and clock time at 3- to 5-minute intervals in field logbook and sampling record. Purging of the standing well water is considered complete when three consecutive readings of the water quality indicator parameters agree within approximately 10 percent. Turbidity readings consistently below 10 nephelometric turbidity units (NTUs) are considered to represent stabilization of discharge water for this parameter. If the parameters have stabilized, but the turbidity is not in the range of the 10 NTU goal, the pump flow rate should be decreased and measurement of the parameters should continue every 3-5 minutes.

- Prior to sampling, disconnect the discharge tubing from the flow-through cell. If the water discharged by the pump is silty, wait for the water to clear before sampling. Ensure that bubbles are not observed in the discharge tubing. Record pertinent observations in field logbook and sampling records.
- The purging rate will be controlled so that the well is not purged dry before sampling. If necessary, purging will be temporarily halted to permit recharge rather than allowing the well to be purged dry.
- Begin filling sample containers from the pump discharge, allowing the water to fill the containers by allowing the pump discharge to flow gently down the inside of the container with as little agitation or aeration as possible.
- Label each sample as collected. Those samples requiring cooling will be placed into an ice cooler for delivery to the laboratory.
- After collection of the samples, restore the dedicated pumping assembly to the well by hanging the tube, electric line, and support cable inside the well by the specially-designed PVC well cap assembly. Lock well.
- Complete remaining portions of Field Record of Well Gauging, Purging, and Sampling form (Figure SOP051-2) after each well is sampled, including sample date and time, total quantity of water removed, well sampling sequence, types of sample bottles used, sample identification numbers, preservatives used, parameters requested for analysis, and field observations of sampling event.

5. SAMPLE PRESERVATION

The following preservation procedures are examples of typical preservation protocols specific to the indicated analyses. Minimum sample preservation requirements for each parameter group are summarized below and in Table 3-1 of the Quality Assurance Project Plan:

- **Pesticides and Herbicides—**Fill the sample bottle, seal with a Teflon-lined cap, and place on ice for shipment.

6. FIELD QUALITY CONTROL

Quality control samples are required to verify that the sample collection and handling process has not affected the quality of the groundwater samples. All field quality control samples must be prepared exactly as regular investigation samples with regard to sample volume, containers, and preservation. The following quality control samples will be collected for each sample delivery group (a sample delivery group may not exceed 20 samples) at the frequency noted:

- **Field Duplicate—**Required at a frequency of 10 percent per sample delivery group

- **Matrix Spike/Matrix Spike Duplicate—**Required at a frequency of 5 percent

- **Equipment Rinsate Blank—**Required once prior to installation of dedicated pump systems

- **Source Water Blank—**Required at a frequency of once per sampling event when equipment rinsate blank is required.

- **Trip Blank—**Required for volatile organic compound samples at a frequency of one per sample shipment.

NOTE: The dedicated pumps remain in the wells between sampling events.

7. DECONTAMINATION

Non-dedicated sampling equipment and field monitoring equipment will be decontaminated prior to use and following sampling of each well. This equipment will be decontaminated by the procedure listed below. Alternative procedures must be approved by the Project Manager prior to sampling event. Decontamination fluids will be collected in a 5-gal bucket and treated at the groundwater treatment plant.

The following decontamination procedure will be used:

- Flush the equipment with potable water
- Flush with non-phosphate detergent solution
- Flush with tap water to remove all of the detergent solution
- Flush with distilled/deionized water
- Flush with isopropyl alcohol
- Flush with distilled/deionized water.

It is recommended that the detergent and isopropyl alcohol used in the above sequence be used sparingly.

FIELD RECORD OF WELL GAUGING

Project Name:
Project No:
Date:
Weather/Temperature:
EA Personnel:
Equipment:

Well Number	Well Elevation	Depth to Water	Depth to LNAPL	LNAPL Thickness	Corrected Water Table Elevation[(a)]

(a) Based on an assumed specific gravity of 0.80 for LNAPL.

NOTE: All measurements in feet.
LNAPL = Light, non-aqueous phase liquid.

FIELD RECORD OF WELL GAUGING, PURGING, AND SAMPLING

Site Name:
Project Number:
Well ID:
Well Lock Status:
Well Condition:
Weather:

Gauge Date:
Gauge Time:
Sounding Method:
Measurement Ref:
Stick Up/Down (ft):
Well Diameter (in.):

Purge Date:
Purge Time:
Purge Method:
Field Personnel:
Ambient Air VOCs (ppm):
Well Mouth VOCs (ppm):

WELL VOLUME

A. Well Depth (ft):
D. Well Volume/ft (L):
B. Depth to Water (ft):
E. Well Volume (L) (C*D):
C. Liquid Depth (ft) (A-B)
F. Three Well Volumes (L) (E*3):
G. Measurable LNAPL? Yes ________ /ft No ________

Parameter	Beginning	1	2	3	4	5
Time (min.)						
Depth to Water (ft)						
Purge Rate (L/min)						
Volume Purged (L)						
pH						
Temperature (°C)						
Conductivity (μmhos/cm)						
Dissolved Oxygen (mg/L)						
Turbidity (NTU)						
eH (mV)						

Total Quantity of Water Removed (L):
Samplers:
Sampling Time (Start/End):
Sampling Date:
Decontamination Fluids Used:
Sample Type:
Sample Preservatives:
Sample Bottle IDs:
Sample Parameters:

Standard Operating Procedure No. 053
for
Concrete Coring

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CONTENTS

1. SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) details all procedures for the concrete coring machine, an electrically operated coring drill. The procedures described within the SOP include, from beginning to end, setup, coring, and teardown of equipment. This SOP also includes equipment lists of the coring machine and accessories needed when coring.

Use of the concrete coring machine is a quick and clean method for penetrating concrete with up to 12 in. of thickness. Concrete coring is a good method when collecting samples from under a concrete surface is required with minimal physical damage to property.

When contaminated materials are anticipated, other precautions of a safety and health nature must be addressed. It is very important that the water be used throughout the coring process as described below in order to limit the production of airborne dust during the process.

1.1 PURPOSE

The purpose of this SOP is to provide a detailed outline of procedures for setup through teardown of concrete coring. This SOP includes an equipment and parts list as well as step by step coring procedures.

1.2 SCOPE

The procedures outlined in this SOP are applicable to all EA personnel using a concrete coring machine as well as any subcontractors EA is responsible for.

2. DEFINITIONS

The concrete coring machine has many specific and specialized parts. For this reason, familiarity with the coring drill, coring stand, and accessories is necessary. These terms are discussed below.

2.1 CORING MACHINE TERMS

The following terms are principally used to discuss the basic operation of the concrete coring machine and its major components.

Vacuum Base—The base of the coring machine stand. This is what is anchored to the ground through the middle slot. This base also has four 0.5-in. bolts, one in each corner for leveling.

Column with Gear Rack—Mounted vertically to the vacuum base with two 0.5-in. bolts. It also has a gear rack on the back side to enable the motor to move up and down smoothly for a good core.

Carriage—The piece that the motor is mounted on. This piece slides over the top of the column with gear rack and has a pinion shaft to enable the carriage with mounted motor to move smoothly on the column.

Ceiling Jack—A threaded piece that screws into the top of the column to enable the user to secure the coring machine to the ceiling or overhead support.

Square Head Set Screw—There are four of these 5/8-in. × 4-in. bolts, one located at each corner of the vacuum base. These bolts are used to level the coring machine (keep oiled).

Drill—The motor/drill, which is the main piece of equipment. It is usually 15-20 amps and has a drill shaft of 5/8 in. or 7/8 in.

Drill Shaft—The threaded piece that comes out of the motor which is the attachment point for the drill bit.

Extension—A metal rod used for core drilling deeper holes. The extension is threaded between the core bit and motor shaft

2.2 DRILL BIT TERMS

Barrel—Common term used for the tube or body of a core bit. The barrels are normally made of steel and are also called a core.

Continuous Rim—Type of bit that has no gullets or spaces between segments. This type of bit is good for smooth cutting.

Gullet—The slots in a core bit that provide faster cooling by allowing water or air to flow between the segments. These also allow the blade to flex under cutting pressure.

Fine Diamond—Smaller sized diamond crystals used for fast cutting.

Hub—The cap of a core bit that is usually welded or screwed into a core barrel. This has threads which screw onto a drill motor.

Stress Cracks—Small cracks that form in the blade core due to too much pressure put on the blade. These also occur because of overheating and if the bond is too hard for the material being cut.

2.3 CORE DRILLING TERMS

Aggregate—Rocks and minerals that are put into cement to make concrete. The type of aggregate determines how hard or soft concrete and asphalt are.

Anchor—Secures the coring machine to the work surface to prevent movement during drilling. Movement during drilling will cause chatter of bit against the work surface, fracturing diamonds and damage to core bit.

Inverted Drilling—Drilling upside down.

Slurry—Mud-like material that is the result of concrete cutting with water as a coolant.

3. MATERIALS

The following materials may be required:

- Coring machine
- Coring bit
- Generator that provides 20 amps
- At 50 ft, you need 14-gauge extension cords
- At 75-100 ft, you need 12-gauge extension cords
- GFI plug
- Hammer drill with 5/8-in. bit
- 0.5-in. drop in concrete anchors
- 0.5-in. threaded rod 1-ft long with 2 hex nuts
- Wrench to tighten hex nuts
- Water hose
- Water supply
- Shop vacuum
- Bullet level.

4. PROCEDURES

4.1 SET UP CORING MACHINE

- Once at location, set coring machine with bit directly over location of core.

- Get hammer drill with 5/8-in. bit and drill a hole through the slot in the middle of the vacuum base, deep enough to set your 0.5-in. drop in concrete anchor.

- Set concrete anchor.

- Take 0.5-in. threaded rod with hex nuts, and screw into drop in anchor.

- Get your bullet level and level your coring machine, using the 5/8-in. square head set screws located at each corner of the vacuum base. **Getting the machine level is the most important step.**

- Once your machine is level, tighten down the hex nuts on the threaded rod in the center of the vacuum base. The coring machine is now secured to the concrete.

- Connect the machine to a power supply using an extension cord of the appropriate length and a Ground Fault Circuit Interrupter.

- Connect water hose to coring machine.

4.2 CORING

Before coring, double check all connections and be sure the coring machine is still level.

- When first starting the machine, turn on the water and set the flow rate at a sufficient volume to cool the bit while coring.

- Using the lever located on the carriage, slowly lower the drill until the bit contacts the concrete. It is important that this is lowered slowly because a rotating bit is not stable and can bounce or even break the bit if advanced too quickly.

- Once the bit is advanced approximately halfway into the concrete, it will be safe to start applying more pressure to the lever to speed up the coring process. Some concrete has heaver aggregate and steel reinforcement that could stress the electric motor; therefore, frequently check the motor for overheating.

- It will be apparent when the coring machine has reached the bottom of the concrete; the underlying soil will feel soft. **Immediately turn off the water**.

- Using the lever on the carriage, raise the bit above the top of the concrete then turn off the machine.

- Remove the concrete core.

The coring is complete.

5. REFERENCES

The following references were used to prepare this SOP.

Dewalt website. www.dewalt.com.

Diamant Boart Inc. 1999. Core Drilling Machine Manual.

Glossary of terms. http://www.diamondproducts.com/glossary_of_terms.htm.

ULTRAMETER II™

Operation
Manual

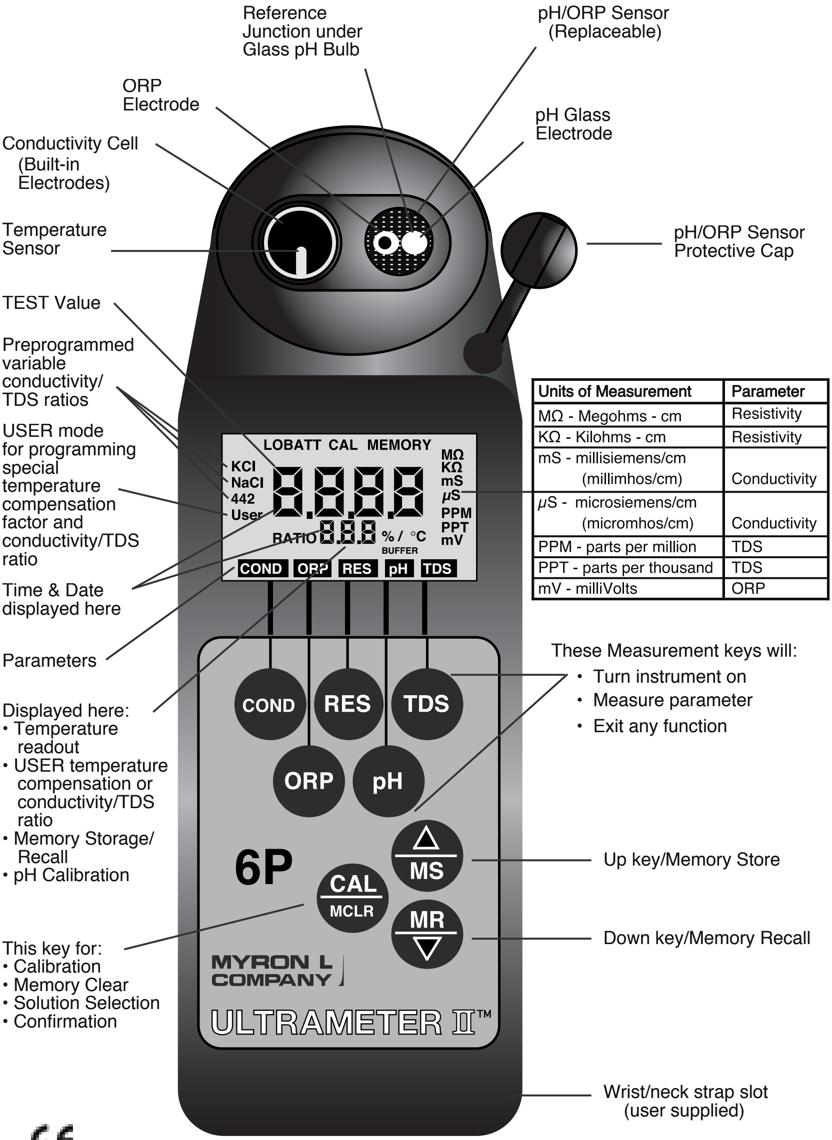
MODELS 6P & 4P

MYRON L
COMPANY
Water Quality Instrumentation
Accuracy • Reliability • Simplicity

12 may 05

029734

Instrument Illustration



Units of Measurement	Parameter
MΩ - Megohms - cm	Resistivity
KΩ - Kilohms - cm	Resistivity
mS - millisiemens/cm (millimhos/cm)	Conductivity
µS - microsiemens/cm (micromhos/cm)	Conductivity
PPM - parts per million	TDS
PPT - parts per thousand	TDS
mV - milliVolts	ORP

MODEL 6P Shown

For detailed explanations see Table of Contents

27apr05

I. INTRODUCTION

Thank you for selecting the feature-packed Ultrameter II™, one of the Myron L Company's latest in an increasing line of instruments utilizing advanced microprocessor-based circuitry and SMT manufacturing processes. This circuitry makes the instrument extremely accurate, reliable and very easy to use.

The Ultrameter II incorporates several new features including a clock with time and date, an increased memory of up to 100 locations with time and date stamp, the ability of the user to adjust the timeout "Auto OFF", and enhanced performance (see pages 2 & 3 for the list of Features and Specifications).

The most exciting new feature is data logging with the ability to download the memory or stored test data with its corresponding time and date. This feature allows the user to create spreadsheets and graphs with ease, and quickly and accurately manipulate data more effectively. The optional uDock™ and software is compatible with most computers using either Microsoft Windows XP or 2000™, or Macintosh OS9.2 or OSX™. The data may be imported into a variety of spreadsheet formats like Microsoft Excel CSV™.

Please Note: Although the Myron L Company has performed extensive testing, we can not guarantee compatibility of all applications and formats. We suggest testing your application and format for compatibility before relying on it.

For your convenience, on the bottom side of your Ultrameter II is a brief set of instructions. A waterproof pocket sized card with abbreviated instructions is also included with the instrument.

Special note ...... Conductivity, resistivity, and TDS require mathematical correction to 25°C values (ref. Temperature Compensation, pg. 38). On the left of the Ultrameter II's liquid crystal display is shown an indicator of the salt solution characteristic used to model temperature compensation of conductivity and its TDS conversion. The indicator may be KCl, NaCl, 442™ or USER. Selection affects the temperature correction of conductivity, and the calculation of TDS from compensated conductivity (ref. Conductivity Conversion to Total Dissolved Solids (TDS), pg. 41). The selection can affect the reported conductivity of hot or cold solutions, and will change the reported TDS of a solution. Generally, using KCl for conductivity, NaCl for resistivity, and 442™ (Natural Water characteristic) for TDS will reflect present industry practice for standardization. This is how your instrument, as shipped from the factory, is set to operate. For use in sea water desalination for example, both the conductivity and TDS may easily be changed to NaCl.

II. FEATURES and SPECIFICATIONS

A. Features

- Superior resolution 4 digit LCD displays full 9999 μS/ppm.
- Accuracy of BETTER than ±1% of reading in a handheld instrument.
- All electrodes are internal for maximum protection.
- Improved 4 electrode sensor technology.
- Waterproof to 1 meter/3 feet.
- Autoranging conductivity/TDS/resistivity.
- Prompts for easy pH calibration (6P).
- Factory calibrations stored in microprocessor.
- 3 conductivity/TDS solution conversions preprogrammed into microprocessor.
- USER mode feature allows:
  - Programming your own cond/TDS conversion factor.
  - Programming your own temperature compensation factor.
  - Disabling temperature compensation.
- Real Time Clock with Time and Date.
- Data Logging with TIME and DATE in memory.
- Memory stores 100 readings.
- Download capability with optional uDock™.
- User adjustable timeout "Auto OFF".

B. General Specifications

Display	4 Digit LCD
Dimensions (LxWxH)	196 x 68 x 64 mm 7.7 x 2.7 x 2.5 in.
Weight	352 g/12.4 oz.
Case Material	VALOX*
Cond/Res/TDS Cell Material	VALOX*
Cond/TDS Electrodes (4)	316 Stainless Steel
Cond/Res/TDS Cell Capacity	5 ml/0.2 oz.
pH/ORP Sensor Well Capacity	1.2 ml (6P)/0.04 oz.
Power	9V Alkaline Battery
Battery Life	>100 Hours/5000 Readings
Operating/Storage Temperature	0-55°C/32-132°F
Protection Ratings	IP67/NEMA 6 (waterproof to 1 meter/3 feet)

* ™ GE Corp.

Additional information available on our website at:
www.myronl.com

CE

C. Specification Chart

	pH (6P)	ORP (6P)	Conductivity	TDS	Resistivity	Temperature
Ranges	0-14 pH	±999 mV	0-9999 µS/cm 10-200 mS/cm in 5 autoranges	0-9999 ppm 10-200 ppt in 5 autoranges	10KΩ - 30MΩ	0-71 °C 32 - 160 °F
Resolution	±.01 pH	±1 mV	0.01 (<100 µS) 0.1 (<1000 µS) 1.0 (<10 mS) 0.01 (<100 mS) 0.1 (<200 mS)	0.01 (<100 ppm) 0.1 (<1000 ppm) 1.0 (<10 ppt) 0.01 (<100 ppt) 0.1 (<200 ppt)	0.01 (<100 KΩ) 0.1 (<1000 KΩ) 0.1 (>1 MΩ)	0.1 °C/F
Accuracy	±.01 pH	±1 mV	±1% of reading	±1% of reading	±1% of reading	±0.1 °C
Auto Temperature Compensation	0-71 °C 32 - 160 °F		0-71 °C 32 - 160 °F	0-71 °C 32 - 160 °F	0-71 °C 32 - 160 °F	
Adjustable Temperature Compensation			0 - 9.99%/ °C	0 - 9.99%/ °C	0 - 9.99%/ °C	
Cond/TDS Ratios Preprogrammed			KCl, NaCl, 442™			
Adjustable Cond/TDS Ratio Factor			0.20 - 7.99			

D. Warranty/Service

The Myron L Ultrameter II, excluding the pH/ORP sensor (6P), has a TWO (2) year limited warranty. The pH/ORP sensor (6P) has a six (6) month limited warranty for materials and workmanship. If an instrument fails to operate properly, see Troubleshooting Chart, pg. 35. The battery and pH/ORP sensor are user-replaceable. For other service, return the instrument prepaid to the Myron L Company.

MYRON L COMPANY
2450 Impala Drive
Carlsbad, CA 92010-7226 USA
760-438-2021
www.myronl.com

If, in the opinion of the factory, failure was due to materials or workmanship, repair or replacement will be made without charge. A reasonable service charge will be made for diagnosis or repairs due to normal wear, abuse or tampering. This warranty is limited to the repair or replacement of the Ultrameter II only. The Myron L Company assumes no other responsibility or liability.

E. Ultrameter II Models

ULTRAMETER II MODELS	4P	6P
PARAMETERS	Conductivity/TDS Resistivity/Temp.	Conductivity/TDS/pH Resistivity/ORP/Temp.

TABLE OF CONTENTS

III. RULES of OPERATION

A. Operation

Using the instrument is simple:

- Individual or multiple parameter readings may be obtained by filling individual sensors or entire cell cup area.
- Rinse the conductivity cell or pH/ORP sensor (6P) well with test solution 3 times and refill. Temperature and/or measurement extremes will require additional rinses for maximum accuracy.
- Press the desired measurement key to start measurement. Pressing the key again does no harm and restarts the 15 second “off” timer.
- Note the value displayed or press the MS key to store the reading (ref. Memory Storage, pg. 21). It’s that simple!

B. Characteristics of the Keys

- Though your Ultrameter II has a variety of sophisticated options, it is designed to provide quick, easy, accurate measurements by simply pressing one key.
- All functions are performed one key at a time.
- There is no “off” key. After 15 seconds of inactivity the instrument turns itself off (60 seconds in CAL mode). User adjustable up to 75 seconds.
- Rarely will a key be required to be held down (as in Procedure to Select a Solution, pg. 11; or Cond. or TDS Calibration, pg. 15).

C. Operation of the Keys (See Instrument Illustration on pg. i)

1. Measurement Keys in General

Any of the 5 measurement keys in the upper part of the keypad turns on the instrument in the mode selected. The mode is shown at the bottom of the display, and the measurement units appear at the right. Pressing a measurement key does this even if you are in a calibration sequence and also serves to abandon a change (ref. Leaving Calibration, pg. 14).

2. COND, RES and TDS keys

These 3 keys are used with solution in the Conductivity Cell.

Precautions:

- While filling cell cup ensure no air bubbles cling on the cell wall.
- If the proper solution is not selected (KCl, NaCl, 442 or USER), refer to Why Solution Selection is Available, pg. 11 and Procedure to Select a Solution, pg. 11.

a. COND Key

Solution to be tested is introduced into the conductivity cell and a press of (COND) displays conductivity with units on the right. On the left is shown the solution type selected for conductivity.

b. RES Key

A press of RES displays resistivity with units on the right. On the left is shown solution type selected for resistivity (ref. Solution Selection, pg. 11). The range of display of resistivity is limited to between 10 kilohms (KΩ) and 30 megohms (MΩ). A solution outside that range will only show [- - - -] in the display.

c. TDS key

A press of TDS displays Total Dissolved Solids with units on the right. This is a display of the concentration of material calculated from compensated conductivity using the characteristics of a known material. On the left is shown solution type selected for TDS (ref. Solution Selection, pg. 11).

3. pH and ORP keys

Measurements are made on solution held in the pH/ORP sensor well (ref. pH and ORP, pg. 44). The protective cap is removed and the sensor well is filled and rinsed with sample enough times to completely replace the storage solution.

After use, the pH/ORP sensor well must be refilled with Myron L Storage Solution, and the protective cap reinstalled securely (ref. Maintenance of the pH/ORP Sensor, pg. 9 and Cleaning pH/ORP Sensors, pg. 33).

a. pH key (6P)

A press of pH displays pH readings. No units are displayed on the right.

b. ORP key (6P)

A press of ORP displays Oxidation-Reduction Potential/REDOX reading in millivolts, “mV” is displayed.

4. CAL/MCLR key

A press of CAL/MCLR allows you to enter the calibration mode while measuring conductivity, TDS or pH. Once in CAL mode, a press of this key accepts the new value. If no more calibration options follow, the instrument returns to measuring (ref. Leaving Calibration, pg. 14).

If CAL/MCLR is held down for about 3 seconds, CAL mode is not entered, but “**SEL**” appears to allow Solution Selection (ref. pg. 11) with the Up or Down keys. As in calibration, the CAL key is now an “accept” key.

While reviewing stored records, the MCLR side of the key is active to allow clearing records (ref. Clearing a Record/Memory Clear, pg. 21).

5. UP or DOWN keys

While measuring in any parameter, the ▲ MS or MR ▼ keys activate the Memory Store and Memory Recall functions.

While in CAL mode, the keys step or scroll the displayed value up or down. A single press steps the display and holding either key scrolls the value rapidly.

While in Memory Recall, the keys move the display up and down the stack of records (ref. Memory Recall, pg. 21).

IV. AFTER USING the ULTRAMETER II

A. Maintenance of the Conductivity Cell

Rinse out the cell cup with clean water. Do not scrub the cell. For oily films, squirt in a foaming non-abrasive cleaner and rinse. Even if a very active chemical discolors the electrodes, this does not affect the accuracy; leave it alone (ref. Cleaning Sensors, pg. 32).

B. Maintenance of the pH/ORP Sensor (6P)

The sensor well must be kept wet with a solution. Before replacing the rubber cap, rinse and fill the sensor well with Myron L pH Storage Solution. If unavailable, use an almost saturated KCl solution, pH 4 buffer or at least a strong table salt solution. NEVER USE DISTILLED WATER. (ref. pH and ORP Practices, pg. 20)

V. SPECIFIC RECOMMENDED MEASURING PROCEDURES

If the proper solution is not selected (KCl, NaCl, 442 or USER), see Solution Selection, pg. 11.

NOTE: *After sampling high concentration solutions or temperature extremes, more rinsing may be required. When sampling low conductivity solutions, be sure the pH cap is well seated so no solution washes into the conductivity cell from around the pH cap.*

A. Measuring Conductivity & Total Dissolved Solids (TDS)

1. Rinse cell cup 3 times with sample to be measured. (This conditions the temperature compensation network and prepares the cell.)

2. Refill cell cup with sample.

3. Press COND or TDS.

4. Take reading. A display of [- - - -] indicates an overrange condition.

B. Measuring Resistivity

Resistivity is for low conductivity solutions. In a cell cup the value may drift from trace contaminants or absorption from atmospheric gasses, so measuring a flowing sample is recommended.

1. Ensure pH protective cap is secure to avoid contamination.

2. Hold instrument at 30° angle (cup sloping downward).

3. Let sample flow continuously into conductivity cell with no aeration.

4. Press RES key; use best reading.

NOTE: *If reading is lower than 10 kilohms display will be dashes: [- - - -]. Use Conductivity.*

C. Measuring pH (6P)

1. Remove protective cap by squeezing its sides and pulling up.

2. Rinse sensor well 3 times with sample to be measured. Shake out each sample to remove any residual liquid.

3. Refill both sensor wells with sample.

4. Press pH.

5. Take reading.

6. **IMPORTANT:** After use, fill pH/ORP sensor well with Myron L pH Sensor Storage Solution and replace protective cap. If Myron L pH Sensor Storage Solution is unavailable, use a strong KCl solution, pH 4 buffer, or a saturated solution of table salt and tap water (ref. Cleaning pH/ORP Sensors, pg. 33). Do not allow pH/ORP sensor to dry out.

D. Measuring ORP (6P)

1. Remove protective cap by squeezing its sides and pulling up.

2. Rinse sensor well 3 times with sample to be measured. Shake out each sample to remove any residual liquid.

3. Refill both sensor wells with sample.

4. Press ORP.

5. Take reading.

6. **IMPORTANT:** After use, fill pH/ORP sensor well with Myron L pH Sensor Storage Solution and replace protective cap. If Myron L pH Sensor Storage Solution is unavailable, use a strong KCl solution, pH 4 buffer, or a saturated solution of table salt and tap water (ref. Cleaning pH/ORP Sensors, pg. 33). Do not allow pH/ORP sensor to dry out.

VI. SOLUTION SELECTION

A. Why Solution Selection is Available

Conductivity, resistivity, and TDS require temperature correction to 25°C values (ref. Standardized to 25°C, pg. 38). Selection determines the temperature correction of conductivity and calculation of TDS from compensated conductivity (ref. Cond. Conversion to TDS, pg. 41).

B. The 4 Solution Types

On the left side of the display is the salt solution characteristic used to model temperature compensation of conductivity and its TDS conversion. Generally, using KCl for conductivity, NaCl for resistivity, and 442 (Natural Water characteristic) for TDS will reflect present industry practice for standardization. This is the setup as shipped from the factory (ref. Solution Characteristics, pg. 41).

The USER selection allows a custom value to be entered for the temperature compensation of conductivity and also the conversion ratio if measuring TDS.

C. Calibration of Each Solution Type

There is a separate calibration for each of the 4 solution types. Note that calibration of a 442 solution does not affect the calibration of a NaCl solution. For example: Calibration (ref. Conductivity or TDS Calibration, pg. 15) is performed separately for each type of solution one wishes to measure (ref. Conductivity/TDS Standard Solutions, pg. 37).

D. Procedure to Select a Solution

NOTE: Check display to see if solution displayed (KCl, NaCl, 442 or USER) is already the type desired. If not:

1. Press COND, RES or TDS to select the parameter on which

you wish to change the solution type.

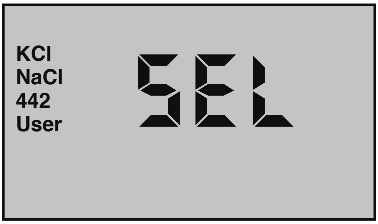


Figure 1

2. Press and hold CAL/MCLR key about 3 seconds to make "**SEL**" appear (see Figure 1). For demonstration purposes, all 4 solution types are shown simultaneously.

3. Use ▲/MS or MR/▼ key to obtain type of solution desired (ref. Solution Characteristics, pg. 41). The selected solution type will be displayed: KCl, NaCl, 442 or User.

4. Press CAL/MCLR to accept new solution type.

E. <u>Application of USER Solution Type</u>

1. <u>User Programmable Temperature Compensation (Tempco)</u>

This feature allows you to change your Ultrameter II's temperature compensating factor to another factor between 0-9.99%/°C (ref. Temperature Compensation, pg. 38). This feature does not apply to pH or ORP.

a. As in Procedure to Select a Solution, pg. 11, select "USER" mode.

b. With "USER" mode now selected, press CAL/MCLR. You may now adjust a temperature compensation from .00%/°C to 9.99%/°C, by pressing ▲/MS or MR/▼. See example in Figure 2.

c. Press CAL/MCLR twice to skip calibration adjustment and accept the new tempco (3 times if in TDS mode). You are now ready to measure samples with your new temperature compensation factor.

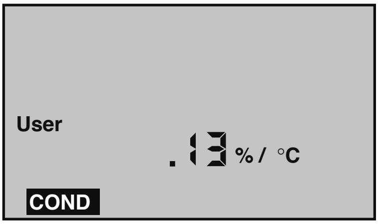


Figure 2

2. Disabling Temperature Compensation

a. Select USER mode, see Procedure to Select a Solution, pg. 11.

b. With “USER” selected, press CAL/MCLR. If the display does not show .00%/°C, hold MR/▼ long enough to bring the tempco to .00%/°C (see Figure 3).

c. Press CAL/MCLR twice (3 times if in TDS mode). Temperature compensation is now disabled (=0) for measurements in USER mode.

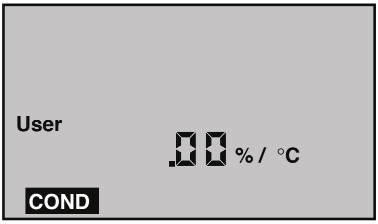


Figure 3

3. User Programmable Conductivity to TDS Ratio

This feature allows you to select a custom conductivity to TDS conversion ratio for USER mode measurements.
For example: The conversion ratio range is 0.20-7.99 (i.e., if conductivity is 100 μS and TDS is 75 ppm, you would adjust to 0.75) (ref. Conductivity Conversion to TDS, pg. 41).

a. While in “USER” mode, press TDS.

b. Press CAL/MCLR twice (to skip over tempco adjustment) and “**RATIO**” will appear (see Figure 4).

c. Adjust with ▲/MS or MR/▼ key until new conversion ratio is displayed.

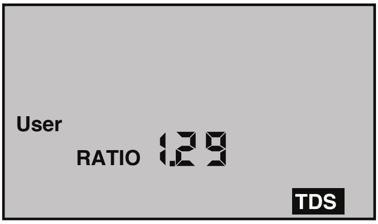


Figure 4

d. Press CAL/MCLR twice (to skip over calibration adjustment) to accept new conversion ratio. You are now ready to measure samples with the new conductivity/TDS ratio.

In these first six sections, you have learned all you need to make accurate measurements. The following sections contain calibration, advanced operations and technical information.

VII. CALIBRATION

A. Calibration Intervals

Generally, calibration is recommended about once per month with Conductivity or TDS solutions. Calibration with pH solutions should be checked twice a month. Calibration of ORP is not necessary (ref. CALIBRATION INTERVALS, pg. 19).

B. Rules for Calibration of the Ultrameter II

1. Calibration Steps

a. Starting Calibration

Calibration is begun by pressing CAL MCLR while measuring Conductivity, TDS or pH. Measuring continues, but the CAL icon is on, indicating calibration is now changeable.

The reading is changed with the ▲ MS and MR ▼ to match the known value. The calibration for each of the 4 solution types may be performed from either conductivity or TDS mode.

Depending on what is being calibrated, there may be 1, 2 or 3 steps to the calibration procedures.

	KCl, NaCl or 442	User
Cond	Gain only	Tempco, then Gain
Res	Done in conductivity	Done in conductivity or TDS
TDS	Gain only	Tempco, Ratio, then Gain
pH	7, acid and/or base (6P)	
ORP	Zero set with pH 7 automatically (6P)	

The CAL MCLR becomes an "ACCEPT" key. At each point, pressing CAL MCLR accepts the new calibration value and steps you to the next adjustment (or out of CAL mode if there are no more steps).

To bypass a calibration step, just press CAL MCLR to accept the present value as is.

b. Leaving Calibration

You know you are finished when the "**CAL**" icon goes out. Pressing any

measurement key abandons changes not yet accepted and exits calibration mode.
Leaving pH after the 2nd buffer results in the same gain being entered in place of the 3rd buffer.

2. Calibration Limits

There are calibration limits. A nominal “FAC” value is an ideal value stored by the factory. Attempts to calibrate too far, up or down, from there will cause the displayed value to be replaced with “FAC”. If you accept it (press the “Cal” key), you will have the original default factory calibration for this measurement. The need to calibrate so far out that “FAC” appears indicates a procedural problem, wrong standard solution, a very dirty cell cup or an aging pH/ORP sensor (ref. Troubleshooting Chart, pg. 35).

C. Calibration Procedures

1. Conductivity or TDS Calibration

a. Rinse conductivity cell three times with proper standard (KCl, NaCl, or 442) (ref. Cond/TDS Standard Solutions, pg. 37). For user calibration see User Calibration Conductivity/TDS below.

b. Refill conductivity cell with same standard. KCl-7000 shown.

c. Press COND or TDS, then press CAL/MCLR, “**CAL**” icon will appear on the display (see Figure 5).

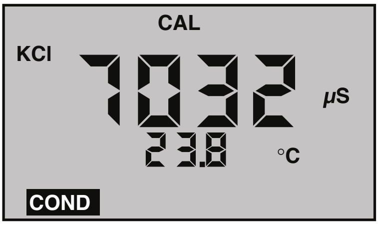


Figure 5

d. Press ▲ MS or MR ▼ to step the displayed value toward the standard’s value (7032 > 7000) or hold a key down to cause rapid scrolling of the reading.

e. Press CAL/MCLR once to confirm new value and end the calibration sequence for this particular solution type. If another solution type is also to be measured, change solution type now and repeat this procedure.

2. User Calibration Conductivity/TDS

Instrument must be in **USER** mode, see Solution Selection, pg. 11.

a. Rinse conductivity cell three times with your standard.

b. Refill conductivity cell with same standard.

c. Press COND or TDS, then press CAL/MCLR twice in COND/three times in TDS. The "**CAL**" icon will appear on the display.

d. Press ▲/MS or MR/▼ to step the displayed value toward the standard's value or hold a key down to cause rapid scrolling of the reading.

e. Press CAL/MCLR once to confirm new value and end the calibration sequence for this particular solution type.

3. Resistivity Calibration

Resistivity is the reciprocal of Conductivity. Resistivity is calibrated only if conductivity is calibrated for the same solution type.

4. Reloading Factory Calibration (Cond or TDS)

If calibration is suspect or known to be wrong, and no standard solution is available, the calibration value can be replaced with the original factory value for that solution. This "FAC" value is the same for all Ultrameter IIs, and returns you to a known state without solution in the cell. The "FAC" internal electronics calibration (which bypasses the electrodes and cell) is not intended to replace calibration with conductivity standard solutions. If another solution type requires resetting, change solution type and repeat this procedure.

a. Press COND or TDS.

b. Press CAL/MCLR. (If in USER solution mode, press CAL key twice if in Conductivity, and three times if in TDS to skip over tempco and ratio adjustments.)

c. Press ▲/MS key until "**FAC**" appears and release.

d. Press CAL/MCLR to accept the factory calibration setting.

5. pH Calibration (6P)

Important: Always “zero” your Ultrameter II with a pH 7 buffer solution before adjusting the gain with acid or base buffers, i.e., 4 and/or 10, etc.

a. pH Zero Calibration (6P)

1. Rinse sensor well 3 times with 7 buffer solution.
2. Refill both sensor wells with 7 buffer solution.
3. Press pH to verify the pH calibration. If the display shows 7.00, skip the pH Zero Calibration and proceed to section b. pH Gain Calibration.

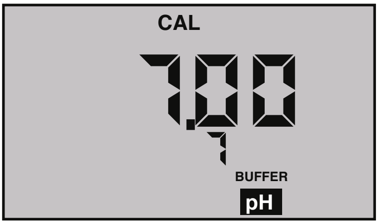


Figure 6

4. Press CAL/MCLR to enter calibration mode. The “**CAL**”, “**BUFFER**” and “**7**” annunciators will appear (see Figure 6). Displayed value will be the uncalibrated sensor.

NOTES: *If a wrong buffer is added (outside of 6-8 pH), “**7**” and **BUFFER**” will flash, and the Ultrameter II will not adjust.*
The uncalibrated pH value displayed in step 4 will assist in determining the accuracy of the pH sensor. If the pH reading is above 8 with pH 7 buffer solution, the sensor well needs additional rinsing or the pH sensor is defective and needs to be replaced.

5. Press ▲/MS or MR/▼ until the display reads 7.00.

NOTE: *Attempted calibration of >1 pH point from factory calibration will cause “**FAC**” to appear. This indicates the need for sensor replacement (ref. Troubleshooting pg. 35) or fresh buffer solution. The “FAC” internal electronic calibration is not intended to replace calibration with pH buffers. It assumes an ideal pH sensor. Each “FAC” indicates a factory setting for that calibration step (i.e., 7, acid, base).*

You may press CAL/MCLR *to accept the preset factory value, or you may* *reduce your variation from factory setting by pressing* ▲ MS *or* MR ▼.

6. Press CAL MCLR to accept the new value. The pH Zero Calibration is now complete. You may continue with pH Gain Calibration or exit by pressing any measurement key.

b. pH Gain Calibration (6P)

Important: Always calibrate or verify your Ultrameter II with a pH 7 buffer solution before adjusting the gain with acid or base buffers, i.e., 4 and/or 10, etc. Either acid or base solution can be used for the 2nd point "Gain" calibration and then the opposite for the 3rd point. The display will verify that a buffer is in the sensor well by displaying either "Acd" or "bAS".

1. The pH calibration mode is initiated by either completion of the pH Zero Calibration, or verifying 7 buffer and pressing the CAL MCLR key twice while in pH measurement mode.
2. At this point the "**CAL**", "**BUFFER**" and "**Acd**" or "**bAS**" annunciators will be displayed (see Figures 7 and 8).

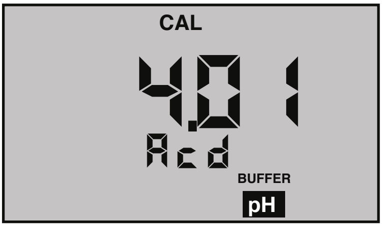


Figure 7

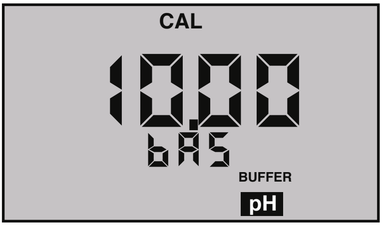


Figure 8

***NOTE:** If the "**Acd**" and "**bAS**" indicators are blinking, the unit is indicating an error and needs either an acid or base solution present in the sensor well.*

3. Rinse sensor well 3 times with acid or base buffer solution.
4. Refill sensor well again with same buffer solution.
5. Press ▲ MS or MR ▼ until display agrees with buffer value.

6. Press CAL/MCLR to accept 2nd point of calibration. Now the display shows the next type of buffer to be used.

Single point Gain Calibration is complete. You may continue for the 3rd point of Calibration (2nd Gain) or exit by pressing any measurement key. Exiting causes the value accepted for the buffer to be used for both acid and base measurements.
To continue with 3rd point calibration, use basic buffer if acidic buffer was used in the 2nd point, or vice-versa. Again, match the display to the known buffer value as in step 2 and continue with the following steps.

7. Repeat steps 3 through 6 using opposite buffer solution.
8. Press CAL/MCLR to accept 3rd point of calibration which ends Calibration procedure. Fill sensor well with Myron L Storage Solution and replace protective cap.

6. ORP Calibration (6P)

ORP electrodes rarely give false readings without problems in the reference electrode. For this reason, and because calibration solutions for ORP are highly reactive and potentially hazardous, your Ultrameter II has an electronic ORP calibration. This causes the zero point on the reference electrode to be set whenever pH 7 calibration is done.

7. Temperature Calibration

Temperature calibration is not necessary in the Ultrameter II.

VIII. CALIBRATION INTERVALS

There is no simple answer as to how often one should calibrate an instrument. The Ultrameter II is designed to not require frequent recalibration. The most common sources of error were eliminated in the design, and there are no mechanical adjustments. Still, to ensure specified accuracy, any instrument has to be checked against chemical standards occasionally.

A. Suggested Intervals

On the average, we expect calibration need only be checked monthly for the Conductivity, RES or TDS functions. The pH (6P) function should be checked every 2 weeks to ensure accuracy. Measuring some solutions will require more frequent intervals.

B. Calibration Tracking Records

To minimize your calibration effort, keep records. If adjustments you are making are minimal for your application, you can check less often. Changes in conductivity calibration should be recorded in percent. Changes in pH calibration (6P) are best recorded in pH units.

Calibration is purposely limited in the Ultrameter II to ±10% for the conductivity cell because more than that indicates damage, not drift. Likewise, calibration changes are limited to ±1 pH unit (6P) because more than that indicates the end of the sensor lifetime, and it should be replaced.

C. Conductivity, RES, TDS Practices to Maintain Calibration

1. Clean oily films or organic material from the cell electrodes with foaming cleaner or mild acid. Do not scrub inside the cell.

2. Calibrate with solutions close to the measurements you make. Readings are compensated for temperature based on the type of solution. If you choose to measure tap water with a KCl compensation, which is often done (ref. An Example, pg. 39), and you calibrate with 442 solution because it is handy, the further away from 25°C you are, the more error you have. Your records of calibration changes will reflect temperature changes more than the instrument's accuracy.

3. Rinse out the cell with pure water after making measurements. Allowing slow dissolving crystals to form in the cell contaminates future samples.

4. For maximum accuracy, keep the pH sensor cap on tight so no fluid washes into the conductivity cell.

D. pH and ORP Practices to Maintain Calibration (6P)

1. Keep the sensor wet with Myron L Storage Solution.

2. Rinse away caustic solutions immediately after use.

ORP calibration solutions are caustic, and ±5% is considered very accurate. By using the pH zero setting (0 mV = 7 pH) for ORP and precision electronics for detection, the Ultrameter II delivers better accuracy without calibration than a simpler instrument could using calibration solutions.

IX. MEMORY

This feature allows up to 100 readings with their temperatures to be stored simultaneously for later recall. At the same time, the TIME and DATE are also recorded. To download the memory to a computer, (ref. uDock™ IR Data Port, pg. 30).

A. Memory Storage

1. While displaying a measurement, press (▲ MS) to record the displayed value.

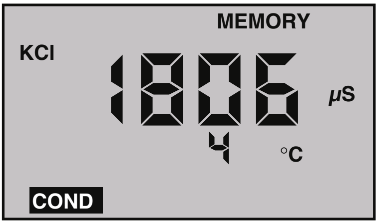


Figure 9

2. "**MEMORY**" will appear and the temperature display will be momentarily replaced by a number (1-100) showing the position of the record. Figure 9 shows a reading of 1806 *µ*S stored in memory record #4.

B. Memory Recall

1. Press any measurement key.
2. Press (MR ▼), "**MEMORY**" will appear, and the display will show the last record stored.
3. Press (▲ MS) or (MR ▼) to scroll to the record location desired (the temperature display alternates between temperature recorded and location number).
4. Press (CAL MCLR) to display time and date stamp.
5. Press any measurement key to leave memory recall or allow to automatically turn off.

C. Clearing a Record/Memory Clear

After recalling a certain record location, press and HOLD (CAL MCLR) to clear that memory. This space will be the place for the next memory record, unless you scroll to another empty position before ending the recall sequence. The next memory stored will go into the next highest available memory location.
Example: You have locations 1-7 filled. You want to clear the conductivity reading stored in record location #**3** and replace it with a pH reading.

1. Press MR ▼ and scroll to location #**3**.
2. Press and HOLD CAL MCLR to clear old record #**3**.
3. Fill pH/ORP sensor well with sample.
4. Press pH to measure sample and press ▲ MS to store reading in location #**3**.
5. The next memory stored will go into location #**8**.
6. To clear **<u>all</u>** records: After pressing MR ▼, scroll down. "**CLr ALL**" will be displayed (see Figure 10).
7. Press CAL MCLR. All records will be cleared.

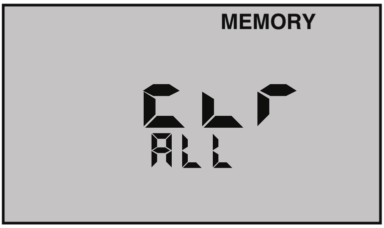


Figure 10

X. <u>TIME and DATE</u>

The Time and Date may easily be changed as you travel.

A. <u>Setting TIME</u>

Time is always displayed in 24 hour time.
Example shown in Figure 11, 16:05 equals 4:05 PM.

1. Press COND.
2. Press MR ▼ until the time is displayed (stored readings, PC OFF, CLr ALL, time i.e. "**16:05**").
3. Press CAL MCLR to initiate. **CAL** will be displayed along with the time, (see Figure 11).

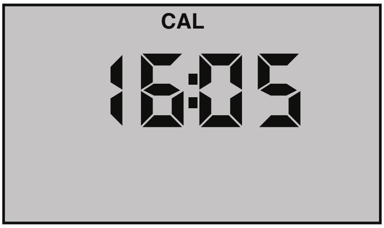


Figure 11

4. Press the ▲ MS or MR ▼ to change the time.

5. Press CAL MCLR to accept the change (new time).

B. Setting DATE

Example shown in Figure 12, is in US format i.e. mo/dy/yr. NOTE: The default format is US. Date format may be changed (ref. Date Format “US and International (Int)”, pg. 24).

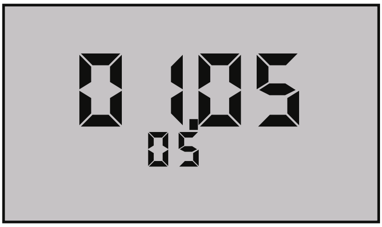


Figure 12

1. Press COND.

2. Press MR ▼ repeatedly until the date is displayed (stored readings, PC OFF, CLr ALL, time, date, i.e. **01.05/05** (January 5, 2005)).

3. Press CAL MCLR to initiate. **CAL** will be displayed along with the YEAR, (see Figure 13).

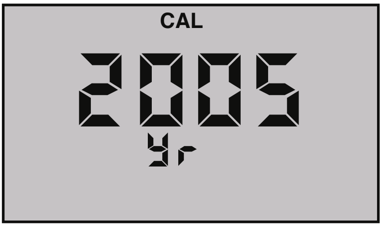


Figure 13

4. Press ▲ MS or MR ▼ to change the YEAR.

5. Press CAL MCLR to accept the change (new year).

6. Press ▲ MS or MR ▼ to change the month.

7. Press CAL MCLR to accept the change (new month), (see Figure 14).

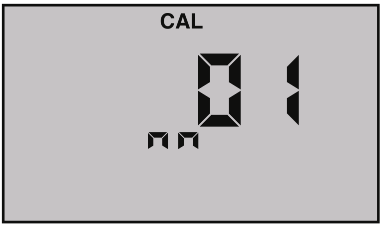


Figure 14

8. Press the ▲ MS or MR ▼ to change the day.

9. Press CAL MCLR to accept the change (new day) (see Figure 15).

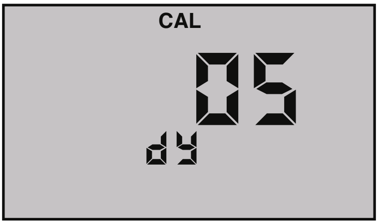


Figure 15

C. DATE FORMAT "US & International (Int)"

1. Press COND.

2. Press MR ▼ repeatedly until the format is displayed (stored readings, PC OFF, CLr ALL, time, date, date **format**).

3. Press CAL MCLR to change. Display will now indicate other format (see Figures 16 & 17).

4. Press any measurement key or allow to automatically turn off.

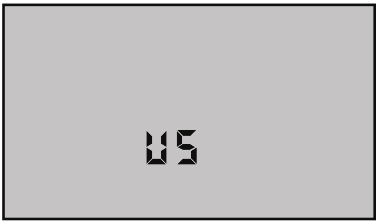


Figure 16

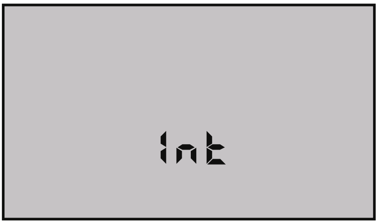


Figure 17

XI. TEMPERATURE FORMAT "Centigrade & Fahrenheit"

1. Press COND.

2. Press MR ▼ to display the stored memory records.

3. Press MR ▼ repeatedly until you pass the "**US**" or "**Int**" date

format location. The display will show a "**C**" or "**F**" (see Figures 18 & 19).

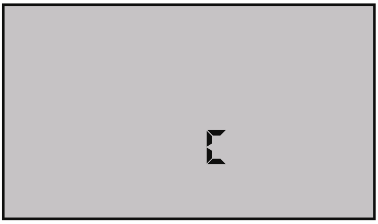


Figure 18

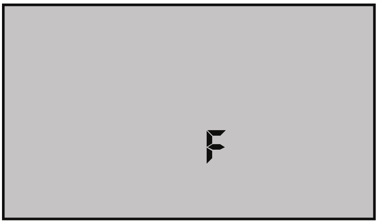


Figure 19

4. Press CAL/MCLR; the display will change to the other unit.

5. Press COND; all temperature readings are now in degrees last shown.

NOTE: *Tempco will still be shown in %/°C.*

XII. TOTAL RETURN to FACTORY SETTINGS "FAC SEL"

There may come a time when it would be desirable to quickly reset all the recorded calibration values in the instrument back to the factory settings. This might be to ensure all calibrations are set to a known value, or to give the instrument to someone else free of adjustments or recorded data for a particular application.
NOTE: All stored data will be lost.

1. Press COND.

2. Press MR ▼ to display the stored memory records.

3. Press MR ▼ repeatedly until you pass the CLr ALL and the C-F locations. The display will show a "**FAC SEL**" (see Figure 20).

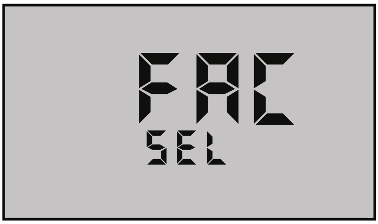


Figure 20

4. Press CAL/MCLR to accept the resetting. Display will return to Cond.

XIII. CELL CHECK

The cell check verifies the cleanliness of the conductivity/TDS/resistivity sensor. In normal use the cell may become dirty or coated and require cleaning. If the display is showing "**.00**" when the cell cup is dry, the sensor is probably clean. However, when testing high purity water in resistivity (RES) mode improved accuracy may be desired. No matter what a manufacturer claims, a sensor can and will become contaminated or coated; therefore require cleaning. A true 4-wire sensor, as in the Ultrameter II, helps to mitigate contamination, but NO SENSOR IS 100% IMMUNE.

1. Press (COND).
2. Press (MR ▼) to display the stored memory records.
3. Press (MR ▼) repeatedly until you pass the **FAC SEL** location. The display will show a "**CELL ch**" (see Figure 21).
4. Press (CAL/MCLR) to test.

   If cell is clean, **Good** will momentarily be displayed (see Figure 22). If cell is dirty, **CELL cLn** will be displayed (see Figure 23), (ref. Cleaning Sensors, pg. 32).

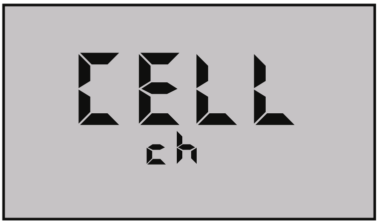


Figure 21

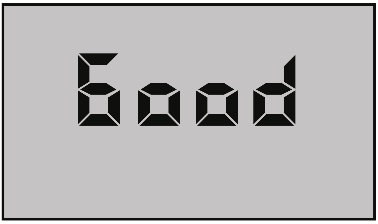


Figure 22

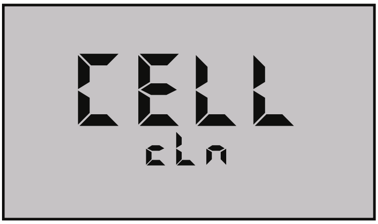


Figure 23

XIV. AUTO OFF

Auto off allows the user to adjust the time the instrument is ON (up to 75 seconds) after each press of a key. Default time is 15 seconds with 60 seconds in CAL (calibration) mode.

1. Press (COND).

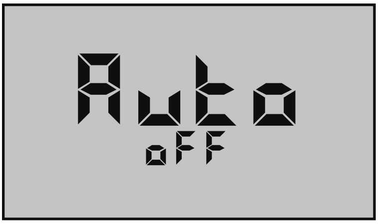


Figure 24

2. Press MR ▼ to display the stored memory records.

3. Press MR ▼ repeatedly until you pass the CELL ch location.

   The display will show “**Auto oFF**” (see Figure 24).

4. Press CAL MCLR to initiate. **CAL** will be displayed along with the “**15 SEC**” (see Figure 25).

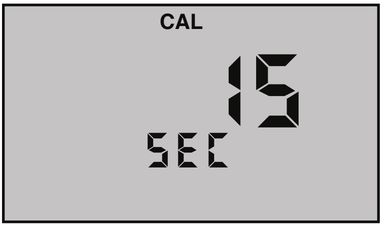


Figure 25

5. Press ▲ MS or MR ▼ to change the time (see Figure 26). Maximum time is shown.

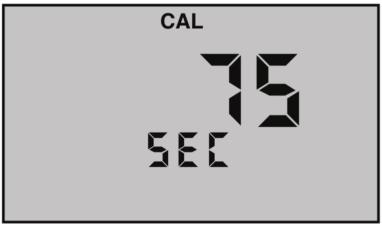


Figure 26

6. Press CAL MCLR to accept the change (new time).

XV. USER MODE CALIBRATION LINC™ FUNCTION

Linc™ function allows easy calibration when in User mode and the user does not have a user standard solution to calibrate the instrument. This function will ensure more repeatable and accurate measurements than many other calibration methods. It is recommended that this function be used to provide the highest degree of confidence when the Ultrameter II is used in “User” mode. When Linc is used, the User mode is linked to another standard, i.e. if User and KCl are linked, a KCl standard solution is used to calibrate the instrument. It is that simple.

A. Calibration of Ultrameter II for use in User Mode

1. Press COND or TDS key.

2. Calibrate the unit using a Standard Solution, (ref. CALIBRATION, pg. 14).

3. Place the Ultrameter II in User mode, (ref. SOLUTION SELECTION, pg. 11).

4. Verify/Set the calibration linc. (See below – Setting User Mode Calibration Linc).

B. Setting User Mode Calibration "Linc"

The linc function sets or "links" the calibration gain factor of a Standard Solution to the User solution mode. Once set, the "linc" will stay intact with future calibrations unless the linc has been canceled. For more information on canceling the User Mode Calibration Linc refer to the section "Canceling User Mode Calibration Linc", pg. 29.
Follow the steps below to set either the KCl, NaCl or 442 calibration factor to the User solution mode.

1. Press measurement key desired to be "Linked", i.e. (COND), (RES) or (TDS).

2. Place the Ultrameter II in User mode, (ref. SOLUTION SELECTION, pg. 11, for selecting the User Mode).

3. Press (MR ▼) arrow key until the menu "**Linc**" appears (see Figure 27).

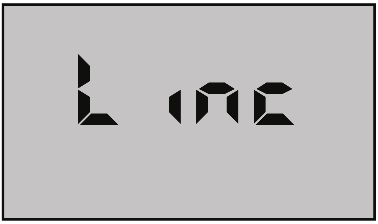


Figure 27

4. Press (CAL/MCLR) key. The instrument will display "**SEL**" and the "**User**" Icon (see Figure 28).

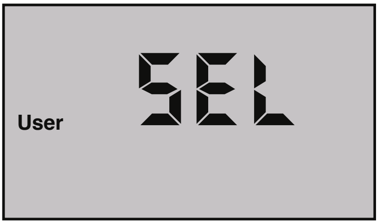


Figure 28

Any additional display of KCl, NaCl or 442 icons indicates a linc between the User solution and the other solution displayed.

5. Press (▲ MS) or (MR ▼) keys to select a Standard Solution to be linked to the User mode calibration constant, (see Figure 29). **User** linked to **KCl**.

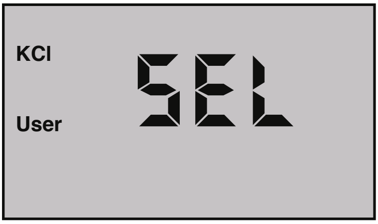


Figure 29

If none of the Solution Selection icons are displayed, (i.e. KCl, NaCl or 442) nothing has been linked to User mode.

6. Press CAL/MCLR key to accept the setting. Pressing any of the measurement keys will exit without changing the setting. User mode "linc" is now complete. The User mode will now use the calibration gain constant used for the calibration of the Standard Solution as outlined above.

C. <u>Canceling User Mode Calibration "Linc"</u>

The Ultrameter II must be in **User** linked mode in order to cancel the "linc", (ref. SOLUTION SELECTION, pg. 11).

1. Press "Linked" measurement key COND, RES or TDS.

   Two solution icons will be shown in the left side of display - "**User**" and another, i.e., "**KCl**".
2. Press MR ▼ key until the menu "**Linc**" appears, (see Figure 27).
3. Press CAL/MCLR key, the instrument will display both "**SEL**" and the "**User**" Icon.
4. Press MR ▼ key until "**User**" is the only solution icon being displayed.
5. Press CAL/MCLR key.
6. The User mode calibration "Linc" has now been canceled.

NOTES:

1. To maintain repeatability, use the same standard solutions for future calibrations.

2. Calibration of the Ultrameter II Gain Factor for User mode is not available when the calibration linc has been established. The other calibration functions (i.e. Temperature Compensation %/C settings and TDS Ratio settings) are still intact. To perform a calibration of the User mode as described in User Calibration Conductivity/TDS, pg. 15, the User Mode Linc should be canceled. See above Canceling User Mode calibration "Linc".

3. Once a "linc" has been established for User mode, the "linc" will apply

to all measurement modes using User solution selection (i.e. TDS/User, Cond/User or Res/User).

XVI. uDock™ IR DATA PORT INSTRUCTIONS

Requires Myron L uDock™ accessory package, Model # U2CIP.
The Myron L uDock is powered via the USB port, requiring no external power source. The uDock application will operate on Windows 2000 & XP*, and Macintosh OS9.2 & OSX** based computer systems.

A. Software Installation

1. Place Myron L Ultrameter II uDock Installation CD into your computer.

2. Upon opening, select the folder for your operating system.

3. Install uDock application. See detailed installation instructions on CD.

4. Additional drivers may be required. See our website for the latest information.

B. Hardware Setup

1. Connect USB cable (provided with uDock) to your computer. Assuming your computer is on, the uDock GREEN LED will illuminate indicating there is power to the uDock and that a proper connection has been made.

C. Memory Stack Download

1. Click** or double-click* the uDock icon to open uDock application.

2. Select the proper comm port setting (first time only).

3. Place CLEAN, DRY Ultrameter II on uDock.

4. Press (COND) key.

5. Press and HOLD (MR ▼) key until the menu “**PC OFF**” appears, (see Figure 30).

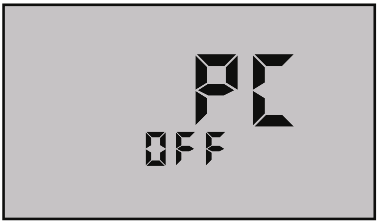


Figure 30

6. Press CAL/MCLR key. “**PC On**” will be displayed, (see Figure 31). The GREEN LED on the uDock will now be blinking periodically, indicating communication has been established between the Ultrameter II and the uDock.

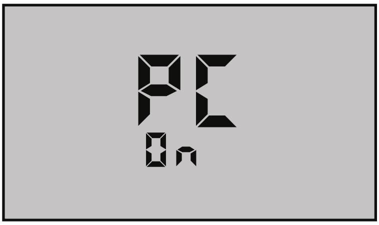


Figure 31

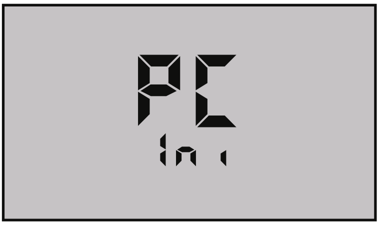


Figure 32

NOTE. “**PC Ini**” may momentarily be displayed while initializing, (see Figure 32).

7. On your computer, click on the data download button. A data transfer bar will appear while the data is being downloaded.

Once downloaded, the data may be manipulated, printed or stored within the Myron L uDock application, or the data may be exported to another more powerful spreadsheet † such as Excel*.

† Please Note: Although the Myron L Company has performed extensive testing, we can not guarantee compatibility of all applications and formats. We suggest testing your application and format for compatibility before relying on it.

Additional features such as setting time and date and erasing data are available. See uDock software installation CD or visit www.myronl.com for the latest instructions.

8. Upon completion, click on the “disconnect” icon.

9. Turn off Ultrameter II PC download mode by selecting any measurement function. Failure to do so will reduce battery life.

* ™ Microsoft
** ™ Macintosh

XVII. CARE and MAINTENANCE

Ultrameter IIs should be rinsed with clean water after use. Solvents should be avoided. Shock damage from a fall may cause instrument failure.

A. Temperature Extremes

Solutions in excess of 71°C/160°F should not be placed in the cell cup area; this may cause damage. The pH sensor may fracture if the Ultrameter II temperature is allowed to go below 0°C (32°F). Care should be exercised not to exceed rated operating temperature.

Leaving the Ultrameter II in a vehicle or storage shed on a hot day can easily subject the instrument to over 66°C/150°F. This will void the warranty.

B. Battery Replacement

Dry Instrument THOROUGHLY. Remove the four (4) bottom screws. Open instrument carefully. Carefully detach battery from circuit board. Replace with 9 volt alkaline battery. Replace bottom, ensuring the sealing gasket is installed in the groove of the top half of case. Re-install screws, tighten evenly and securely.

NOTE: *Because of nonvolatile EEPROM circuitry, all data stored in memory and all calibration settings are protected even during power loss or battery replacement. However, loss of time and date may occur if battery is removed for longer than 3 minutes (180 seconds).*

C. pH/ORP Sensor Replacement (6P)

Order model RPR. When ordering, be sure to include the model and serial number of your instrument to ensure receiving the proper type. Complete installation instructions are provided with each replacement sensor.

D. Cleaning Sensors

1. Conductivity/TDS/Resistivity

The conductivity cell cup should be kept as clean as possible. Flushing with clean water following use will prevent buildup on electrodes. However, if very dirty samples — particularly scaling types — are allowed to dry in the cell cup, a film will form. This film reduces accuracy. When there are visible films of oil, dirt, or scale in the cell cup or on the electrodes, use isopropyl alcohol or a foaming non-abrasive household cleaner. Rinse out the cleaner and your Ultrameter II is ready for accurate measurements.

2. pH/ORP (6P)

The unique pH/ORP sensor in your Ultrameter II is a nonrefillable combination type which features a porous liquid junction. It should not be allowed to dry out. If it does, the sensor can sometimes be rejuvenated by first cleaning the sensor well with isopropyl alcohol or a liquid spray cleaner such as Windex™ or Fantastic™ and rinsing well. Do not scrub or wipe the pH/ORP sensor.

Then use one of the following methods:

1. Pour a HOT salt solution ~60°C/140°F, preferably potassium chloride (KCl) solution (Myron L pH/ORP Sensor Storage Solution) — HOT tap water with table salt (NaCl) will work fine — in the sensor well and allow to cool. Retest.

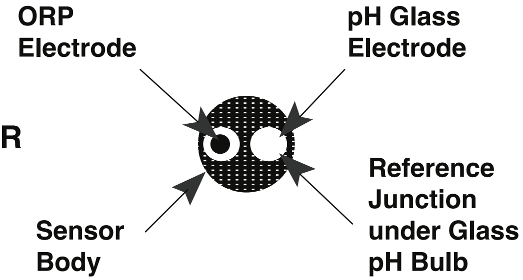
or

2. Pour DI water in the sensor well and allow to stand for no more than 4 hours (longer can deplete the reference solution and damage the glass bulb). Retest.

If neither method is successful, sensor must be replaced.

"Drifting" can be caused by a film on the pH sensor bulb and/or reference. Use isopropyl alcohol (IPA) or spray a liquid cleaner such as Windex™ or Fantastic™ into the sensor well to clean it. The sensor bulb is very thin and delicate. Do not scrub or wipe the pH/ORP sensor.

pH/ORP SENSOR
Top View



Leaving high pH (alkaline) solutions in contact with the pH sensor for long periods of time can damage it. Rinsing such liquids from the pH/ORP sensor well and refilling well with Myron L Storage Solution, a saturated KCl solution, pH 4 buffer, or a salty tap water, will extend the sensor's useful life.

Samples containing chlorine, sulfur, or ammonia can “poison” any pH electrode. If it is necessary to measure the pH of any such sample, thoroughly rinse the sensor well with clean water immediately after taking the measurement. Any sample element which will reduce (add an electron to) silver, such as cyanide, will attack the reference electrode.

Replacement sensors are available only from the Myron L Company or its authorized distributors.

XVIII. TROUBLESHOOTING CHART

Symptom	**Possible Cause**
No **display**, even though measurement key pressed	Battery weak or not connected.
Inaccurate **pH** readings (6P)	1. pH calibration needed (ref. pH Cal., pg. 17). 2. Cross-contamination from residual pH buffers or samples in sensor well. 3. Calibration with expired pH buffers.
No response to **pH** changes (6P)	Sensor bulb is cracked or an electromechanical short caused by an internal crack.
Will not adjust down to **pH** 7 (6P)	pH/ORP sensor has lost KCl.
pH readings drift or respond slowly to changes in buffers/samples *or* “FAC” is displayed repeatedly (6P)	1. Temporary condition due to “memory” of solution in pH sensor well for long periods. 2. Bulb dirty or dried out. 3. Reference junction clogged or coated.
Unstable **Conductivity/TDS/ Resistivity** readings	1. Dirty electrodes. 2. Test samples greater than 1 megohm.
Unable to calibrate **Conductivity/TDS**	Film or deposits on electrodes.
Resistivity readings much lower than expected	1. Contamination from previous sample or from pH sensor well. 2. Carbon dioxide in test sample.

Corrective Action
Check connections or replace battery (ref. Battery Replacement, pg. 32).
1. Recalibrate instrument. 2. Thoroughly rinse sensor well. 3. Recalibrate using fresh buffers (ref. pH Buffer Solutions, pg. 37).
Replace pH/ORP sensor (ref. Replacement pH/ORP Sensor, pg. 38).
Clean and rejuvenate sensor (ref. Cleaning Sensors, pg. 32) and recalibrate. If no improvement, replace pH/ORP sensor (ref. Replacement pH/ORP Sensor, pg. 38).
Clean and rejuvenate sensor (ref. Cleaning Sensors, pg. 32) and recalibrate. If no improvement, replace pH/ORP sensor (ref. Replacement pH/ORP Sensor, pg. 38).
1. Clean cell cup and electrodes (ref. Cleaning Sensors, pg. 32). 2. Minimize test sample exposure to air (ref. Measuring Resistivity, pg. 10).
Clean cell cup and electrodes (ref. Cleaning Sensors, pg. 32).
1. Rinse cell cup more thoroughly before measurement. Ensure pH cap is snugly in place. 2. See Measuring Resistivity, pg. 10.

XIX. ACCESSORIES

A. Conductivity/TDS Standard Solutions

Your Ultrameter II has been factory calibrated with the appropriate Myron L Company NIST traceable KCl, NaCl, and our own 442™ standard solutions. Most Myron L conductivity standard solution bottles show three values referenced at 25°C: Conductivity in microsiemens/micromhos and the ppm/TDS equivalents based on our 442 Natural Water™ and NaCl standards. All standards are within ±1.0% of reference solutions. Available in 2 oz., quarts/liters, and gallon/~3.8 liter bottles.

1. Potassium Chloride (KCl)

The concentrations of these reference solutions are calculated from data in the International Critical Tables, Vol. 6. The 7000 μS is the recommended standard. Order KCl-7000.

2. 442 Natural Water™

442 Natural Water Standard Solutions are based on the following salt proportions: 40% sodium sulfate, 40% sodium bicarbonate, and 20% sodium chloride, which represent the three predominant components (anions) in freshwater. This salt ratio has conductivity characteristics approximating fresh natural waters and was developed by the Myron L Company over four decades ago. It is used around the world for measuring both conductivity and TDS in drinking water, ground water, lakes, streams, etc. The 3000 ppm is the recommended standard.
Order 442-3000.

3. Sodium Chloride (NaCl)

This is especially useful in sea water mix applications, as sodium chloride is its major salt component. Most Myron L standard solution labels show the ppm NaCl equivalent to the conductivity and to ppm 442 values. The 14.0 mS is the recommended standard. Order NaCl-14.0.

B. pH Buffer Solutions (6P)

pH buffers are available in pH values of 4, 7 and 10. Myron L Company buffer solutions are traceable to NIST certified pH references and are color-coded for instant identification. They are also mold inhibited and accurate to within ±0.01 pH units @ 25°C. Order 4, 7 or 10 Buffer.
Available in 2 oz., quarts/liters, and gallon/~3.8 liter bottles.

C. pH Sensor Storage Solution (6P)

Myron L pH Sensor Storage Solution prolongs the life of the pH sensor.
Available in 2 oz., quarts/liters, and gallon/~3.8 liter bottles.

D. Soft Protective Carrying Cases

Padded Cordura® Nylon carrying case features a belt clip for hands-free mobility. Two colors to choose from;
Blue - Model #: UCC
Desert Tan - Model #: UCCDT

® Registered trademark of DuPont

E. Hard Protective Carrying Cases

Large case with 2 oz. bottles of calibration standard solutions (KCl-7000, 442-3000, 4, 7, & 10 pH buffers and pH storage solution).
Model #: PKU
Small case (no calibration standard solutions) - Model #: UPP

F. Replacement pH/ORP Sensor (6P)

pH/ORP sensor is gel filled and features a unique porous liquid junction. It is user-replaceable and comes with easy to follow instructions.
Model #: RPR

G. uDock™ IR Data Port Accessory Package

This accessory allows the operator to download the Ultrameter II memory stack to a spreadsheet on a computer. The package includes a uDock, software CD, and installation and operating instructions.
Model #: U2CIP

XX. TEMPERATURE COMPENSATION (Tempco) of Aqueous Solutions

Electrical conductivity indicates solution concentration and ionization of the dissolved material. Since temperature greatly affects ionization, conductivity measurements are temperature dependent and are normally corrected to read what they would be at 25°C.

A. Standardized to 25°C

Conductivity is very accurately measured in the Ultrameter II by a method that ignores fill level, electrolysis, electrode characteristics, etc., and uses a microprocessor to perform temperature compensation. In simpler instruments, conductivity values are usually assigned an average correction similar to KCl solutions for correction to 25°C. The correction to an equivalent KCl solution is a standard set by chemists. It standardizes the measurements and allows calibration with precise KCl solutions. In the Ultrameter II, this correction can be set to other solutions or tailored for special measurements or applications.

B. Tempco Variation

Most conductivity instruments use an approximation of the temperature characteristics of solutions, perhaps even assuming a constant value. The value for KCl is often quoted simply as 2%/°C. In fact, KCl tempco varies with concentration and temperature in a non-linear fashion. Other solutions have more variation still. The Ultrameter II uses corrections that change with concentration and temperature instead of single average values. See Chart 1.

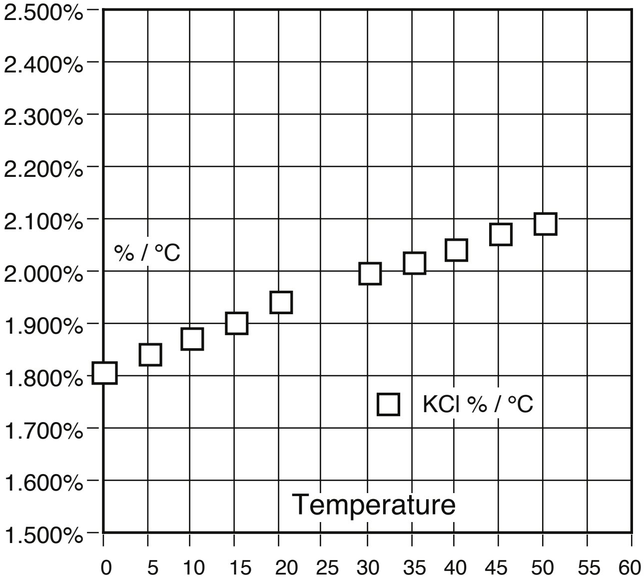


Chart 1

C. <u>An Example of 2 different solution selections and the resulting compensation</u>

How much error results from treating natural water as if it were KCl at 15°C?

A tap water solution should be compensated as 442 with a tempco of 1.68 %/°C, where the KCl value used would be 1.90 %/°C.

Suppose a measurement at 15°C/59°F is 900 microsiemens of true uncompensated conductivity.

Using a 442 correction of 10 (degrees below 25) x 1.68% indicates the solution is reading 16.8% low. For correction, dividing by (.832) yields 1082 microsiemens as a compensated reading.

A KCl correction of 10 (degrees below 25) x 1.9% indicates the solution is reading 19% low. Dividing by (.81) yields 1111 microsiemens for a compensated reading. The difference is 29 out of 1082 = 2.7%.

D. A Chart of Comparative Error

In the range of 1000 μS, the error using KCl on a solution that should be compensated as NaCl or as 442, is shown in the graph below.

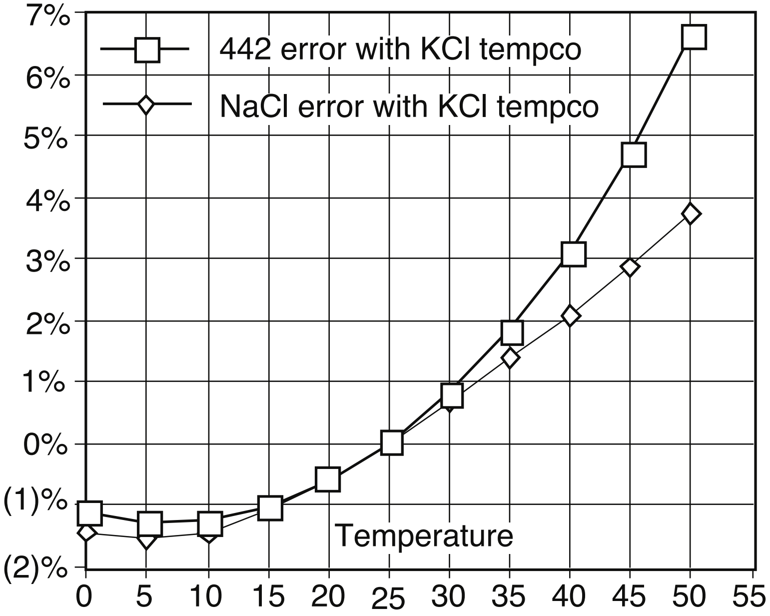


Chart 2

Users wanting to measure natural water based solutions to 1% would have to alter the internal compensation to the more suitable preloaded "442" values or stay close to 25°C. Some who have standardized to KCl based compensation may want to stick with it, regardless of increasing error as you get further from 25°C. The Ultrameter II will provide the repeatability and convertibility of data needed for relative values for process control.

E. Other Solutions

A salt solution like sea water or liquid fertilizer acts like NaCl. An internal correction for NaCl can be selected for greatest accuracy with such solutions. Many solutions are not at all similar to KCl, NaCl or 442. A sugar solution, or a silicate, or a calcium salt at a high or low temperature may require a "User" value peculiar to the application to provide readings close to the true compensated conductivity.

Clearly, the solution characteristics should be chosen to truly represent the actual water under test for rated accuracy of ±1%. Many industrial applications have always been relative measurements seeking a number to indicate a certain setpoint or minimum concentration or trend. The Ultrameter II gives the user the capability to take data in "KCl conductivity units" to compare to older published data, in terms of NaCl or 442, or as may be appropriate. The Ultrameter II can be used to reconcile data taken with other compensation assumptions, especially with its ability to allow custom characteristics through the USER mode.

XXI. CONDUCTIVITY CONVERSION to TOTAL DISSOLVED SOLIDS (TDS)

Electrical conductivity indicates solution concentration and ionization of the dissolved material. Since temperature greatly affects ionization, conductivity measurements are temperature dependent and are normally corrected to read what they would be at 25°C (ref. Temperature Compensation, pg. 38).

A. How it's Done

Once the effect of temperature is removed, the compensated conductivity is a function of the concentration (TDS). Temperature compensation of the conductivity of a solution is performed automatically by the internal processor, using data derived from chemical tables. Any dissolved salt at a known temperature has a known ratio of conductivity to concentration. Tables of conversion ratios referenced to 25°C have been published by chemists for decades.

B. Solution Characteristics

Real world applications have to measure a wide range of materials and mixtures of electrolyte solutions. To solve this problem, industrial users commonly use the characteristics of a standard material as a model for their solution, like the KCl favored by chemists for its stability.

Users dealing with sea water, etc., use NaCl as the model for their concentration calculations. Users dealing with freshwater work with mixtures including sulfates, carbonates and chlorides, the three predominant components (anions) in freshwater that the Myron L Company calls "natural water". These are modeled in a mixture called "442" which the Myron L Company markets for use as a calibration standard, as it does standard KCl and NaCl solutions.

The Ultrameter II contains internal algorithms for these 3 most commonly referenced compounds. In the LCD display, the solution type being used is displayed on the left. Besides KCl, NaCl, and 442, there is the "USER" choice. The benefit of USER is that one may enter the temperature compensation and TDS ratio by hand, greatly increasing accuracy of readings for a specific solution. That value remains a constant for all measurements, and should be reset for different dilutions or temperatures.

C. When does it make a lot of difference?

First, the accuracy of temperature compensation to 25°C determines the accuracy of any TDS conversion. Assume we have industrial process water to be pretreated by RO. Assume it is 45°C and reads 1500 μS uncompensated.

1. If NaCl compensation is used, an instrument would report 1035 μS compensated, which corresponds to 510 ppm NaCl.

2. If 442 compensation is used, an instrument would report 1024 μS compensated, which corresponds to 713 ppm 442.

The difference in values is 40%.

In spite of such large error, some users will continue to take data in the NaCl mode because their previous data gathering and process monitoring was done with an older NaCl referenced device.

Those who want true TDS readings that will correspond to evaporated weight will select the correct Solution Type. If none of the 3 standard solutions apply, the User mode must be used. Temperature Compensation (Tempco) and TDS Derivation below, details the USER mode.

XXII. TEMPERATURE COMPENSATION (Tempco) and TDS DERIVATION

The Ultrameter II contains internal algorithms for characteristics of the 3 most commonly referenced compounds. In the display, the solution type being used is displayed on the left. Besides KCl, NaCl, and 442, there is the “USER” choice. The benefit of USER mode is that one may enter the tempco and TDS conversion values of a unique solution via the keypad.

A. Conductivity Characteristics

When making conductivity measurements, the Solution Selection determines the characteristic assumed as the instrument reports what a measured conductivity would be if it were at 25°C. The characteristic is represented by the tempco, expressed in %/°C. If a solution of 100 μS at 25°C increases to 122 μS at 35°C, then a 22% increase has happened over this change of 10°C. The solution is said to have a tempco of 2.2 %/°C.

Another solution would have a different tempco because of its ionization activity, and that tempco may be a little different at a different concentration or temperature. This is why the Ultrameter II uses mathematically generated models for known salt characteristics that vary with concentration and temperature.

B. Finding the Tempco of an Unknown Solution

One may need to measure compensated conductivity of some solution unlike any of the 3 standard salts. In order to enter a custom fixed tempco for a limited measurement range, enter a specific value through the "USER" function. The tempco can be determined by 2 different methods:

1. Heat or cool a sample of the solution to 25°C, and measure its conductivity. Heat or cool the solution to a typical temperature where it is normally measured. After selecting USER function, set the tempco to 0 %/°C as in Disabling Temperature Compensation, pg. 13 (No compensation). Measure the new conductivity and the new temperature. Divide the % decrease or increase by the 25°C value. Divide that difference by the temperature difference.

2. Heat or cool a sample of the solution to 25°C, and measure its conductivity. Change the temperature to a typical measuring temperature. Set the tempco to an expected value as in User Programmable Temperature Compensation, pg. 12. See if the compensated value is the same as the 25°C value. If not, raise or lower the tempco and measure again until the 25°C value is read.

C. Finding the TDS Ratio of an Unknown Solution

Once the effect of temperature is removed, the compensated conductivity is a function of the concentration (TDS). There is a ratio of TDS to compensated conductivity for any solution, which varies with concentration. The ratio is set during calibration in USER mode as in section User Programmable Conductivity to TDS Ratio, pg. 13. A truly unknown solution has to have its TDS determined by evaporation and weighing. Then the solution whose TDS is now known can be measured for conductivity and the ratio calculated. Next time the same solution is to be measured, the ratio is known.

XXIII. pH and ORP (6P)

A. pH (6P)

1. pH as an Indicator (6P)

pH is the measurement of Acidity or Alkalinity of an aqueous solution. It is also stated as the Hydrogen Ion activity of a solution. pH measures the effective, not the total, acidity of a solution.

A 4% solution of acetic acid (pH 4, vinegar) can be quite palatable, but a 4% solution of sulfuric acid (pH 0) is a violent poison. pH provides the needed quantitative information by expressing the degree of activity of an acid or base.

In a solution of one known component, pH will indicate concentration indirectly. However, very dilute solutions may be very slow reading, just because the very few ions take time to accumulate.

2. pH Units (6P)

The acidity or alkalinity of a solution is a measurement of the relative availabilities of hydrogen (H^+) and hydroxide (OH^-) ions. An increase in (H^+) ions will increase acidity, while an increase in (OH^-) ions will increase alkalinity. The total concentration of ions is fixed as a characteristic of water, and balance would be 10^{-7} mol/liter (H^+) and (OH^-) ions in a neutral solution (where pH sensors give 0 voltage).

pH is defined as the negative logarithm of hydrogen ion concentration. Where (H^+) concentration falls below 10^{-7}, solutions are less acidic than neutral, and therefore are alkaline. A concentration of 10^{-9} mol/liter of (H^+) would have 100 times less (H^+) ions than (OH^-) ions and be called an alkaline solution of pH 9.

3. The pH Sensor (6P)

The active part of the pH sensor is a thin glass surface which is selectively receptive to hydrogen ions. Available hydrogen ions in a solution will accumulate on this surface and a charge will build up across the glass interface. The voltage can be measured with a very high impedance voltmeter circuit; the trick is to connect the voltmeter to solution on each side.

The glass surface encloses a captured solution of potassium chloride holding an electrode of silver wire coated with silver chloride. This is as inert a connection as can be made from metal to an electrolyte. It still can produce an offset voltage, but using the same materials to connect to the solution on the other side of the membrane allows the 2 equal offsets to cancel.

The problem is, on the other side of the membrane is an unknown test solution, not potassium chloride. The outside electrode, also called the Reference Junction, is of the same construction with a porous plug in place of a glass barrier to allow the junction fluid to contact the test solution without significant migration of liquids through the plug material. Figure 33 shows a typical 2 component pair. Migration does occur, and this limits the lifetime of a pH junction, from depletion of solution inside the reference junction or from contamination. The junction is damaged by drying out because insoluble crystals may form in a layer, obstructing contact with test solutions. See pH/ORP, pg. 44.

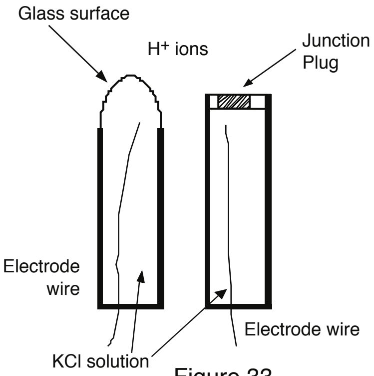


Figure 33

4. The Myron L Integral pH Sensor (6P)

The sensor in the Ultrameter II (see Figure 34) is a single construction in an easily replaceable package. The sensor body holds an oversize solution supply for long life. The reference junction “wick” is porous to provide a very stable, low permeability interface. It is located under the glass pH sensing electrode. The construction combines all the best features of any pH sensor known.

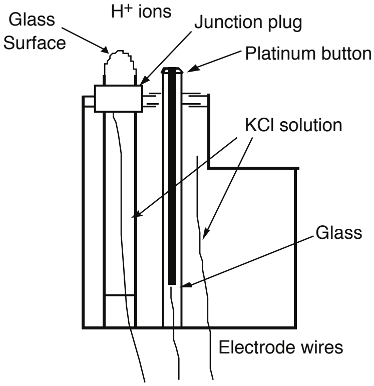


Figure 34

5. Sources of Error (6P)

The basics are presented in pH/ORP, pg. 44.

a. Reference Junction

The most common sensor problem will be a clogged junction because a sensor was allowed to dry out. The symptom is a drift in the “zero” setting at 7 pH. This is why the Ultrameter II does not allow more than 1 pH unit of offset during calibration. At that point the junction is unreliable.

b. Sensitivity Problems

Sensitivity is the receptiveness of the glass surface, which can be diminished by a film on the surface. This problem also causes long response time.

c. Temperature Compensation

pH sensor glass changes its sensitivity slightly with temperature, so the further from pH 7 one is, the more effect will be seen. A pH of 11 at 40°C would be off by 0.2 units. The Ultrameter II senses the sensor well temperature and compensates the reading.

B. ORP/Oxidation-Reduction Potential/REDOX (6P)

1. ORP as an Indicator (6P)

ORP is the measurement of the ratio of oxidizing activity to reducing activity in a solution. It is the potential of a solution to give up electrons (oxidize other things) or gain electrons (reduce).

Like acidity and alkalinity, the increase of one is at the expense of the other, so a single voltage is called the Oxidation-Reduction Potential, with a positive voltage showing, a solution wants to steal electrons (oxidizing agent). For instance, chlorinated water will show a positive ORP value.

2. ORP Units (6P)

ORP is measured in millivolts, with no correction for solution temperature. Like pH, it is not a measurement of concentration directly, but of activity level. In a solution of only one active component, ORP indicates concentration. Also, as with pH, a very dilute solution will take time to accumulate a readable charge.

3. The ORP Sensor (6P)

An ORP sensor uses a small platinum surface to accumulate charge without reacting chemically. That charge is measured relative to the solution, so the solution “ground” voltage comes from a reference junction - same as the pH sensor uses.

4. The Myron L ORP Sensor (6P)

Figure 34, pg. 45, shows the platinum button in a glass sleeve. The same reference is used for both the pH and the ORP sensors. Both pH and ORP will indicate 0 for a neutral solution. Calibration at zero compensates for error in the reference junction.

A zero calibration solution for ORP is not practical, so the Ultrameter II uses the offset value determined during calibration to 7 in pH calibration (pH 7 = 0 mV). Sensitivity of the ORP surface is fixed, so there is no gain adjustment either.

5. Sources of Error (6P)

The basics are presented in pH/ORP, pg. 44, because sources of error are much the same as for pH. The junction side is the same, and though the platinum surface will not break like the glass pH surface, its protective glass sleeve can be broken. A surface film will slow the response time and diminish sensitivity. It can be cleaned off with detergent or acid, as with the pH glass.

XXIV. SOFTWARE VERSION

Contact the Myron L Company to see if a software upgrade is available.

1. Press (COND) key.
2. Press (MR ▼) key until three numbers are displayed as shown in Figure 35.
3. Press (COND) key, instrument will time out in ~15 seconds.

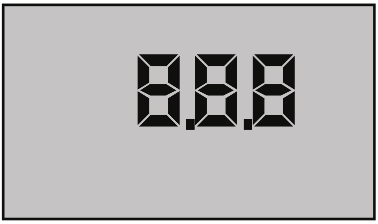


Figure 35

XXV. GLOSSARY

Anions -	Negatively charged ions. See Solution Characteristics, pg. 41.
Algorithm -	A procedure for solving a mathematical problem. See Temperature Compensation and TDS Derivation, pg. 42.
Logarithm -	An arithmetic function. See pH Units, pg. 44.
ORP -	Oxidation-Reduction Potential or REDOX, See ORP/ Oxidation-Reduction Potential/REDOX, pg. 46.
TDS -	Total Dissolved Solids or the Total Conductive Ions in a solution. See Conductivity Conversion to TDS, pg. 41.
Tempco -	Temperature Compensation See Temperature Compensation, pg. 38.
USER -	A mode of operation that allows the instrument user (operator) to set a tempco and/or a TDS factor for their specific solution type. See Temperature Compensation, pg. 38 and Temperature Compensation (Tempco) and TDS Derivation, pg. 42.

For details on specific areas of interest refer to Table of Contents.

XXVI. ADDENDUM

XXVII. NOTES

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YSI Environmental

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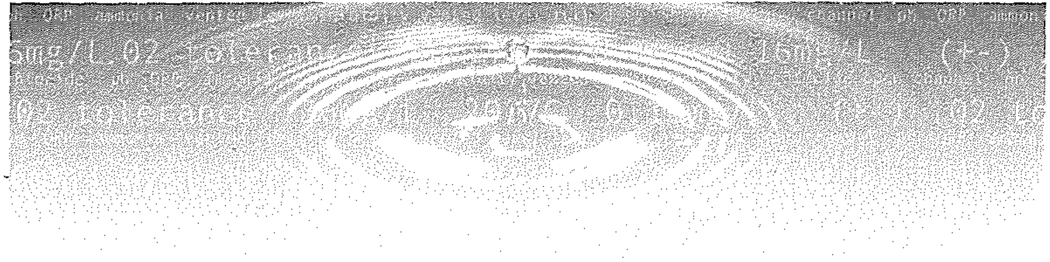


YSI 556 MPS
Multi Probe System

Operations Manual

6. Calibrate

All of the sensors, except temperature, require periodic calibration to assure high performance. You will find specific calibration procedures for all sensors that require calibration in the following sections. If a sensor listed is not installed in your probe module, skip that section and proceed to the next sensor until the calibration is complete.

⚠ **CAUTION:** Reagents that are used to calibrate and check this instrument may be hazardous to your health. Take a moment to review *Appendix D Health and Safety*. Some calibration standard solutions may require special handling.

6.1 Getting Ready to Calibrate

6.1.1 Containers Needed to Calibrate the Probe Module

The transport/calibration cup that comes with your probe module serves as a calibration chamber for all calibrations and minimizes the volume of calibration reagents required.

Instead of the transport/calibration cup, you may use laboratory glassware to perform calibrations. If you do not use the transport/calibration cup that is designed for the probe module, you are cautioned to do the following:

- Perform all calibrations with the Probe Sensor Guard installed. This protects the sensors from possible physical damage.
- Use a ring stand and clamp to secure the probe module body to prevent the module from falling over. Most laboratory glassware has convex bottoms.
- Ensure that all sensors are immersed in calibration solutions. Many of the calibrations factor in readings from other sensors (e.g., temperature sensor). The top vent hole of the conductivity sensor must also be immersed during some calibrations.

6.1.3 Recommended Volumes

Follow these instructions to use the transport/calibration cup for calibration procedures.

- Ensure that an o-ring is installed in the o-ring groove of the transport/calibration cup bottom cap, and that the bottom cap is securely tightened.

  NOTE: Do not over-tighten as this could cause damage to the threaded portions.
- Remove the probe sensor guard, if it is installed.
- Remove the o-ring, if installed, from the probe module and inspect the installed o-ring on the probe module for obvious defects and, if necessary, replace it with the extra o-ring supplied.
- Some calibrations can be accomplished with the probe module upright or upside down. A separate clamp and stand, such as a ring stand, is required to support the probe module in the inverted position.
- To calibrate, follow the procedures in the next section, Calibration Procedures. The approximate volumes of the reagents are specified below for both the upright and upside down orientations.
- When using the Transport/Calibration Cup for dissolved oxygen % saturation calibration, make certain that the vessel is vented to the atmosphere by loosening the bottom cap or cup assembly and that approximately 1/8" of water is present in the cup.

Sensor to Calibrate	Upright	Upside Down
Conductivity	55ml	55ml
pH/ORP	30ml	60ml

Table 6.1 Calibration Volumes

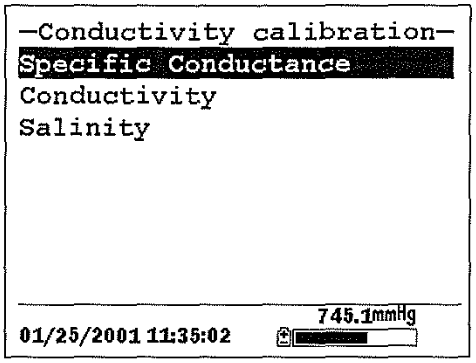
6.2.2 Conductivity Calibration

This procedure calibrates specific conductance (recommended), conductivity and salinity. Calibrating any one option automatically calibrates the other two.

1. Go to the calibrate screen as described in Section 6.2.1 Accessing the Calibrate Screen.

2. Use the arrow keys to highlight the **Conductivity** selection. See Figure 6.2 Calibrate Screen.

3. Press **Enter.** The Conductivity Calibration Selection Screen is displayed.



—Conductivity calibration—
Specific Conductance
Conductivity
Salinity
745.1mmHg
01/25/2001 11:35:02

Figure 6.3 Conductivity Calibration Selection Screen

4. Use the arrow keys to highlight the Specific Conductance selection.

5. Press **Enter.** The Conductivity Calibration Entry Screen is displayed.

7. Carefully immerse the sensor end of the probe module into the solution.

8. Gently rotate and/or move the probe module up and down to remove any bubbles from the conductivity cell.

   NOTE: The sensor must be completely immersed past its vent hole. Using the recommended volumes from Table 6.1 Calibration Volumes, should ensure that the vent hole is covered.

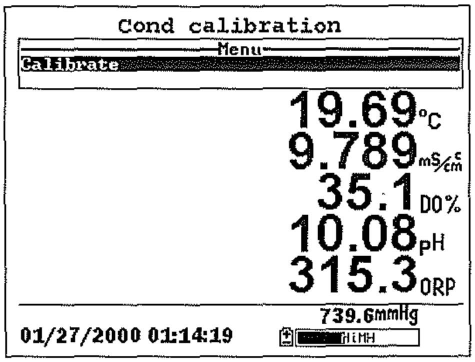
9. Screw the transport/calibration cup on the threaded end of the probe module and securely tighten.

   NOTE: Do not overtighten as this could cause damage to the threaded portions.

10. Use the keypad to enter the calibration value of the standard you are using.

    NOTE: Be sure to enter the value in **mS/cm at 25°C**.

11. Press **Enter**. The Conductivity Calibration Screen is displayed.



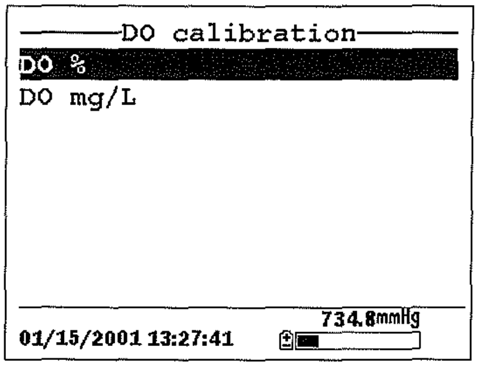
```
Cond calibration
Menu
Calibrate
19.69°C
9.789mS/cm
35.1DO%
10.08pH
315.3ORP
739.6mmHg
01/27/2000 01:14:19
```

Figure 6.5 Conductivity Calibration Screen

12. Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors

NOTE: The instrument must be on for at least 20 minutes to polarize the DO sensor before calibrating.

2. Use the arrow keys to highlight the **Dissolved Oxygen** selection. See Figure 6.2 Calibrate Screen.
3. Press **Enter**. The dissolved oxygen calibration screen is displayed.



DO calibration

DO %

DO mg/L

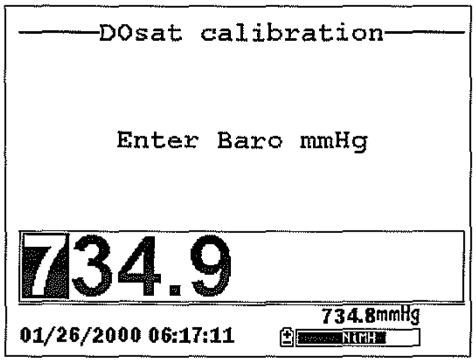
734.8mmHg

01/15/2001 13:27:41

Figure 6.7 DO Calibration Screen

DO Calibration in % Saturation

1. Use the arrow keys to highlight the DO% selection.
2. Press **Enter**. The DO Barometric Pressure Entry Screen is displayed.



DOsat calibration

Enter Baro mmHg

734.9

734.8mmHg

01/26/2000 06:17:11

Figure 6.8 DO Barometric Pressure Entry Screen

the temperature to equilibrate before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.

9. Observe the reading under DO %. When the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue. See Figure 6.6 Calibrated.

10. Press **Enter**. This returns you to the DO calibration screen, See Figure 6.7 DO Calibration Screen.

11. Press **Escape** to return to the calibrate menu. See Figure 6.2 Calibrate Screen.

12. Rinse the probe module and sensors in tap or purified water and dry.

DO Calibration in mg/L

DO calibration in mg/L is carried out in a water sample which has a known concentration of dissolved oxygen (usually determined by a Winkler titration).

1. Go to the DO calibrate screen as described in Section *6.2.3 Dissolved Oxygen Calibration*, steps 1 through 3.

2. Use the arrow keys to highlight the **DO mg/L** selection.

3. Press **Enter**. The DO mg/L Entry Screen is displayed.

7. Stir the water with a stir bar, or by rapidly moving the probe module, to provide fresh sample to the DO sensor.

8. Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.

9. Observe the DO mg/L reading, when the reading is stable (shows no significant change for approximately 30 seconds), press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.

10. Press **Enter**. This returns you to the DO calibration screen. See Figure 6.7 DO Calibration Screen.

11. Press **Escape** to return to the calibrate menu. See Figure 6.2 Calibrate Screen.

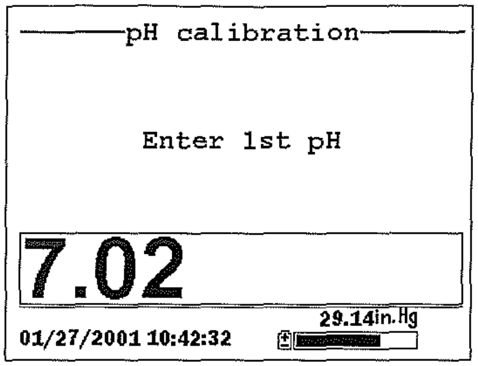
12. Rinse the probe module and sensors in tap or purified water and dry.

6.2.4 pH Calibration

1. Go to the calibrate screen as described in *Section 6.2.1 Accessing the Calibrate Screen.*

2. Use the arrow keys to highlight the **pH** selection. See Figure 6.2 Calibrate Screen.

3. Press **Enter**. The pH calibration screen is displayed.



pH calibration

Enter 1st pH

7.02

29.14in.Hg

01/27/2001 10:42:32

Figure 6.13 pH Entry Screen

6. Place the correct amount (see Table 6.1 Calibration Volumes) of pH buffer into a clean, dry or pre-rinsed transport/calibration cup.

⚠ **WARNING**: Calibration reagents may be hazardous to your health. See *Appendix D Health and Safety* for more information.

NOTE: For maximum accuracy, the pH buffers you choose should be within the same pH range as the water you are preparing to sample.

NOTE: Before proceeding, ensure that the sensor is as dry as possible. Ideally, rinse the pH sensor with a small amount of buffer that can be discarded. Be certain that you avoid cross-contamination of buffers with other solutions.

7. Carefully immerse the sensor end of the probe module into the solution.

8. Gently rotate and/or move the probe module up and down to remove any bubbles from the pH sensor.

NOTE: The sensor must be completely immersed. Using the recommended volumes from Table 6.1 Calibration Volumes, should ensure that the sensor is covered.

15. Rinse the probe module, transport/calibration cup and sensors in tap or purified water and dry.

16. Repeat steps 6 through 13 above using a second pH buffer.

17. Press **Enter**. This returns you to the pH Calibration Screen, See Figure 6.12 pH Calibration Screen.

18. Press **Escape** to return to the calibrate menu. See Figure 6.2 Calibrate Screen.

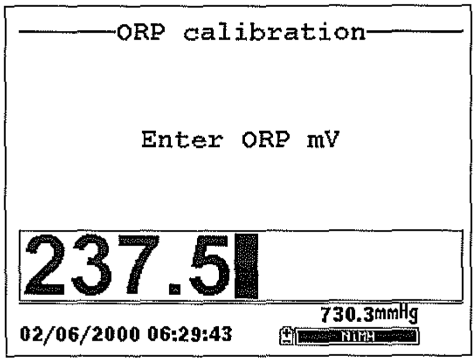
19. Rinse the probe module and sensors in tap or purified water and dry.

6.2.5 ORP Calibration

1. Go to the calibrate screen as described in Section *6.2.1 Accessing the Calibrate Screen.*

2. Use the arrow keys to highlight the **ORP** selection. See Figure 6.2 Calibrate Screen.

3. Press **Enter**. The ORP calibration screen is displayed.



ORP calibration

Enter ORP mV

237.5

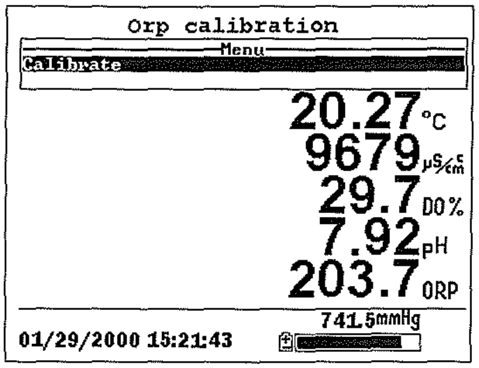
730.3mmHg

02/06/2000 06:29:43

Figure 6.15 Specified ORP Calibration Screen

4. Place the correct amount (see Table 6.1 Calibration Volumes) of a known ORP solution (we recommend Zobell solution) into a clean, dry or pre-rinsed transport/calibration cup.

9. Press **Enter**. The ORP calibration screen is displayed.



```
20.27°C
9679µS/cm
29.7DO%
7.92pH
203.7ORP
741.5mmHg
01/29/2000 15:21:43
```

Figure 6.16 ORP Calibration Screen

10. Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.

    NOTE: Verify that the temperature reading matches the value you used in Table 6.2 Zobel Solution Values.

11. Observe the reading under ORP, when the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.

12. Press **Enter**. This returns you to the Calibrate Screen. See Figure 6.2 Calibrate Screen.

13. Rinse the probe module and sensors in tap or purified water and dry.

CAUTION: This returns a sensor to the factory settings. For example, in selecting to return specific conductance to the factory setting, salinity and conductivity will automatically return to their factory settings.

8. Press **Enter**. This returns you to the Conductivity Calibrate Selection Screen, See Figure 6.3 Conductivity Calibration Selection Screen.
9. Press **Escape** to return to the calibrate menu. See Figure 6.2 Calibrate Screen.

Appendix B

Field Forms

Van Der Horst Ground Water Plume Site
Terrell, Kaufman County, Texas

Sheet _____ of _____
Date: _____________

Ground Water Sampling Data Sheet

Well ID: ☐ **Sample ID:** ☐ **Sample Time:** ☐ ☐ ☐

Casing diameter/type:
Well location:
Weather:
Screened interval(s):
Sampling personnel:
Total depth:
Sampling method:
Initial depth to water (w/o pump):
Water level indicator:
Final depth to water (w/o pump):
Water quality meter: YSI
Measuring point: **North side of casing**
Pump depth setting:
Pump type/model:

	Δ < 1º C	Δ < 3%	Δ <10%	Δ <10%	Δ < 0.1 pH	Δ < 10 mV	Δ < 0.3 ft	< 1L/min	Δ < 10 NTU		Parameter Stabilization Limits (3 consecutive readings)
Time	**Temp (°C)**	**Conductivity (mS/cm)** or **(µS/cm)**	**DO (%)**	**DO (mg/L)**	**pH**	**ORP (mV)**	**Water Level (feet btoc)**	**Flow Rate (L/min)** or **(mL/min)**	**Turbidity (NTU)**	**Purge Volume (L)** or **(mL)**	**Additional Comments**

Parameter Stabilization Limits (3 consecutive readings) for percent difference type parameters.
Percent difference formula =
ABS[((first reading - second reading)/first reading) x 100]
Ex: Readings 12, 16, 15, 13
((12-16)/12)*100 = 33% ((16-15)/16)*100 = 6%
((15-13)/15)*100 = 13% In ex. stabilization has not occurred.

Recorded By:____

Van Der Horst Ground Water Plume Site, Terrell, Kaufman County, Texas

Sheet _____ of _____

Hydrasleeve Ground Water Sampling Data Sheet

Date: ____________

Well ID: ____________ **Sample ID:** ____________ **Sample Time:** ____________

Well owner/location/residence:

Street address:

Filtration system? (circle one) Y N

Sampling personnel:

Start purge time:

Weather:

End purge time:

Sample collected at (circle as appropriate): Wellhead tap In-line House tap

Well ID GPS Coordinates:

HYDRASLEEVE DEPTH (feet)	SAMPLE TIME	NOTES/COMMENTS

Field Parameters:

PDB Depth (ft):							
Time:							
Specific Conductance:							us/cm or ms/cm
pH:							
Temperature:							Fº or Cº
ORP:							mV

Notes/Comments:

Recorded By:____________

Van Der Horst Ground Water Plume Site
Monitoring Well Development Log

Site: Van Der Horst Ground Water Plume Site
Client: EPA Region 6
Project No.: 14342.63
Sample ID:
Well No.:
Development Start Date/Time:
Development End Date/Time:
Developed By:

Depth Measurement Ref. Point* ______________
Well Casing ID: 2" 4" 6" Other ______

Depth to top and bottom of screened interval ______________________

Original DTW ______________ Final DTW ________________

DEVELOPMENT METHOD:

☐ Submersible Pump
☐ Centrifugal Pump
☐ Gas Lift/Displacement Pump
☐ Dedicated Bladder Pump
☐ Peristaltic Pump
☐ Inertial Lift Pump
☐ Bladder Pump
☐ Hand Pump
☐ Other ____________
☐ Bailer
☐ SS
☐ Tef
☐ PVC

Development Equip. (Make, Model, etc.) ____

Development Water Containerized? (Yes / No)

Development Equip. Decontaminated? ☐ Yes ☐ No

Average Development Rate: __________________ gpm

Weather ______________________________

Actual Time (min.)	Vols. Purged (gals.)	Depth to Pump Intake (ft.)	Depth to Water (ft.)	Temp (^{o}C)	pH	Cond. (mS/cm)	Turbidity (NTA)	D.O. (mg/L)	Salinity (%)	Comments

* All depths in feet below reference point on wellhead, generally Top of Casing; DTW = Depth to Water

Van Der Horst Ground Water Plume Site, Terrell, Kaufman County, Texas

Sheet _____ of _____
Date: ______________

Tap Water Sampling Data Sheet

Well ID: ____________ **Sample ID:** ____________ **Sample Time:** ____________

Well owner/location/residence:

Street address:

Filtration system? (circle one) Y N	Sampling personnel:
Start purge time:	Weather:
End purge time:	

Sample collected at (circle as appropriate): Wellhead tap In-line House tap

Well ID GPS Coordinates:

If multiple samples collected (i.e, filtration system in place), please complete the following:

		Collection Point
Sample ID: ____________	**Sample Time:** ____________	**Pre-filter (A)**
Sample ID: ____________	**Sample Time:** ____________	**In-line filter (B)**
Sample ID: ____________	**Sample Time:** ____________	**Post-filter (C)**

Field Parameters:

Time:					Circle One:	
Specific Conductance:					us/cm	ms/cm
pH:						
Temperature:					F°	C°
ORP:					mV	

Notes/Comments:

Recorded By:______________________

Van Der Horst Ground Water Plume Site, Terrell, Kaufman County, Texas

Sheet _____ of _____

Passive Diffusion Bag Ground Water Sampling Data Sheet

Date: ____________

Well ID: ____________ **Sample ID:** ____________ **Sample Time:** ____________

Well owner/location/residence:

Street address: Sampling personnel:

Weather:

PDB DEPTH (feet)	**SAMPLE TIME**	**NOTES/COMMENTS**

Field Parameters:

Time:							
Specific Conductance:							us/cm or ms/cm
pH:							
Temperature:							Fº or Cº
ORP:							mV

Notes/Comments:

Recorded By: ____________

029804

Van Der Horst Ground Water Plume Site
Soil Boring Log

Boring:
Sheet **of**

PROJECT: Van Der Horst Ground Water Plume	**CONTRACTOR:**	**MONUMENT:**
PROJECT NO.: 14342.63	**DRILLER:**	**RISER:**
LOCATION:	**RIG TYPE:**	**SCREEN:**
TOTAL DEPTH:	**METHOD:**	**FILTER PACK:**
DATE:	**CASING ID:**	**SEAL:**
START TIME: **FINISH TIME:**	**BORING ID:**	**GROUT:**
LOGGED BY:		**GROUND ELEV.:**

Sample Lab Analysis	**Depth Range**	**Blows/6 inches**	**Recovery (%)**	**USCS**	**Depth (ft.)**	**LITHOLOGIC DESCRIPTION**	**Graphic Log**
					0		
					0.5		
					1		
					1.5		
					2		
					2.5		
					3		
					3.5		
					4		
					4.5		
					5		
					5.5		
					6		
					6.5		
					7		
					7.5		
					8		
					8.5		
					9		
					9.5		

Groundwater Depth (ft.) **Date/Time**

Comments:

Van Der Horst Ground Water Plume Site
Utilities and Structures Checklist

Area of Interest: ____________________

Location: ____________________

Prepared By: ____________________

Date: ____________________

One Call Checklist	**Number**	**Date Called**	**Date Scheduled**	**Date Field Verified**
One Call Number (State)				
Client				
City/County/Other				

Utilities & Structures Type	**Present**	**Not Present**	**How Marked?**[1]	**Company**	**Name**	**Signature**
Natural Gas Line						
Steam Line						
Water Line (public/private)						
Sewer Line (public/private)						
Storm Drain						
Telephone/Fiber Optic Lines (overhead/buried)						
Electric Power Lines (overhead/buried)						
AST/UST Product Tank/Lines						
Septic Tank/Drain Field						
Petroleum Products Lines						
Cable (TV)						
Switch/Signal (Railroad)						
Sprinkler System						

(1)Flags, paint on pavement, wooden stakes, etc.

Drilling or Excavation Sites. Attach a map of the property showing the proposed drilling or excavation site (or if sites are widely separated, several maps) clearly indicating the area(s) checked for underground utilities or underground structures and the location of above-ground power lines.