RCRA Facility Investigation Work Plan

Volume V

General Motors Corporation
NAO Flint Operations Site
Flint, Michigan

March 30, 2001

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BLASLAND, BOUCK & LEE, INC.
engineers, scientists, economists

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Field Sampling Plan/Quality Assurance Project Plan (FSP/QAPP)

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1. Introduction

This Field Sampling Plan (FSP)/Quality Assurance Project Plan (QAPP) contains procedures related to the collection and analysis of soil and groundwater samples at the General Motors Corporation's (GM's) North American Operations - Flint Operations Site in Flint, Michigan (the Site). Specifically, this FSP/QAPP defines the various field procedures and sample collection methods and the quality assurance/quality control (QA/QC) procedures, protocols, and methodologies that will be employed by GM and its contractors during investigations conducted under the Resource Conservation and Recovery Act (RCRA) Corrective Action Program.

This FSP/QAPP sets forth the organization, objectives, planned activities, and QA/QC procedures associated with the RCRA Facility Investigation (RFI) for the Site. Specific protocols for sampling, sample custody, documentation, reporting procedures, and analytical methods to be used in performing the investigation activities are described or are specifically referenced to related RFI documents (i.e., RFI Work Plan) and guidance. This FSP/QAPP was prepared in a manner consistent with the following reference and guidance documents:

- U.S. Environmental Protection Agency (USEPA) *Test Methods for Evaluating Solid Waste, SW-846* (USEPA, 1996);

- The USEPA's guidance document entitled *EPA Requirements for Quality Assurance Project Plans for Environmental Operations* EPA-QA/R-5 (USEPA, 1998), which replaces QAMS-005/80 *Interim Guidance and Specifications for Preparing Quality Assurance Project Plans*;

- The National Enforcement Investigations Center (NEIC) *Policies and Procedures Manual* (USEPA, 1991); and

- USEPA Region 5 RCRA QAPP Instructions (USEPA, 1998).

Information contained in the FSP/QAPP has been organized into the following sections:

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2	Project Description
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2. Project Description

2.1 Site Location and Description

The Site is located at 902 East Hamilton Avenue in Flint, Michigan, in Genesee County (Figure 1). The Site encompasses approximately 452 acres of land and is oriented in a north-to-south direction. It is generally bounded to the north by Stewart Avenue and Pierson Road, to the south by Harriet Street, to the east by James P. Cole Boulevard and CSX Railroad, and to the west by Industrial Avenue and North Street.

The topography of the Site is fairly flat, although the regional topography slopes east-southeast toward the Flint River (approximately 100 feet away at the Southend of the Site and approximately 3,000 feet away at the Northend of the Site).

A recycling facility is located on the northeast corner of James P. Cole Boulevard and Garfield Avenue, and a Consumers Power Building is located on the southeast corner of James P. Cole Boulevard, between the Site and the Flint River. A former DuPont facility is located south of Hamilton Avenue, east of the Site. Several other industries are located east of the Site, between the Site and the Flint River, including Bell's Produce, PPG Industries, Kasle Steel/Auto Blankers, Flint Coatings, and Lockhart Chemicals. The remaining areas surrounding the Site are generally occupied by residential neighborhoods and other industries, including Universal Systems, Flint Plating, Associated Truck, and Unit Terminal (GM).

2.2 Site History

Portions of the Site were originally developed in the late 1800s for the purpose of producing the "horseless carriage." In 1898, Billy Durant and J. Dallas Dort purchased the Imperial Wheel Company, making it a subsidiary of the Durant/Dort Carriage Company. After acquisition of the Imperial Wheel Company, manufacturing operations were relocated approximately 3,000 feet south of the Site, at the intersection of Hamilton Avenue and St. John Street (currently James P. Cole Boulevard).

The Buick Motor Company was first established in Flint when Flint Wagon Works purchased the company from David Buick in September 1903. In 1903, the Buick Motor Company was relocated from Detroit to the Site, on Hamilton Avenue between Industrial Avenue and St. John Street (now James P. Cole Boulevard). With David Buick as president, and Billy Durant as general manager, 16 experimental cars were produced by the end of 1903,

and 37 cars were produced in 1904. The Buick Motor Company became a division of General Motors when the corporation was formed in 1908. The Buick Motor Company experienced very rapid growth and produced approximately 30,000 cars in 1910. By that time, the Buick Motor Company had expanded its facility to include the southern portion of the Site. By the end of 1923, the Buick Motor Company had produced 1 million cars, with the Buick complex continuing to grow northward from Hamilton Avenue toward Pierson Road.

In addition to the manufacturing of automobiles, in response to World War I, the Buick Motor Company began producing the Liberty Aircraft engine in 1918. Similarly, in response to World War II, the production of automobiles was stopped in 1942, and the Buick complex was converted for the production of military equipment.

Portions of the Site have recently become inactive, while others remain in full production. Recent and current manufacturing processes include:

- Machining of ferrous and nonferrous metals;
- Plating (discontinued);
- Automobile painting (discontinued);
- V-6 engine manufacturing;
- Coil spring manufacturing (discontinued);
- Torque converter manufacturing;
- Transmission components manufacturing and assembly;
- Plastic injection (discontinued); and
- Vehicle assembly (discontinued).

These manufacturing processes include(d) activities or equipment with potential environmental significance as identified below:

- Storing/conveying/using/recycling numerous liquids, including gasolines, oils, solvents, and paints, etc., via sumps, vaults, underground storage tanks (USTs), aboveground storage tanks (ASTs), collection trenches, collection vessels, and materials recovery for various manufacturing operations;
- Degreasing parts;
- Coal-fired steam generation (discontinued); and
- Industrial wastewater treatment.

For further details regarding the current and historical operations at the Site, refer to the following:

- *Description of Current Conditions for Areas of South of Leith Street* (BBL, May 30, 2000); and
- *Description of Current Conditions for Areas of North of Leith Street* (BBL, November 26, 2000).

2.3 Site Investigation Objectives

The objectives of the RFI Work Plan are to guide data collection and interpretations necessary to:

- Determine the presence and extent of hazardous constituents in media from releases at the Site or from AOIs at the Site;

- Develop the data necessary to assess human health and ecological risks associated with exposure scenarios based on current and reasonable expected future land and groundwater use at and around the Site. The Michigan Part 201 generic screening criteria will be the primary criteria used for evaluating the Site data to determine whether Site characterization is adequate;

- Develop the data necessary to evaluate the hydrogeologic flow regime, including groundwater gradients, flow direction, hydraulic conductivity, and groundwater depth at the Site;

- Develop the data necessary to evaluate the feasibility and design of interim and final remedial alternatives needed to attain risk levels that are within USEPA's acceptable risk range, meet the environmental indicators, and address nonaqueous phase liquid (NAPL);

- Provide the data necessary to characterize material for disposal as needed throughout the Site investigation and Site remedial activities;

- Provide the data necessary to evaluate the need for interim and final remedial actions at the Site; and

- Provide the data necessary to assess overall accuracy, representativeness, comparability, precision, and sensitivity of the various project data sets.

The following sections provide descriptions of activities to be performed during the planned soil and groundwater investigations.

2.4 Soil Investigation

Surface and subsurface soil investigations will be performed at multiple locations related to the Site. Specific numbers of samples and rationale for each sample location are discussed in Volume 1, Section 5 of the RFI Work Plan. The soil investigation will be performed within these designated areas to delineate the horizontal and vertical extent of site-related hazardous constituents. In general, the subsurface investigation activities will include the completion of soil borings using conventional drilling or direct-push methods, with soil samples being collected typically at 2-foot intervals from the surface down to the water table. Soil samples will be collected for field parameters including: soil classification, visual observations, and photoionization detector (PID) readings. Soil samples will be collected for fixed-based laboratory analyses at the surface interval (0 to 2 feet below ground surface [bgs]), at the 8- to 10-feet bgs interval, provided that this soil interval is not saturated, and just above the water table interface (saturated zone). If the water table is found to be 10 feet or less, a single soil sample will be collected just above the water table. Additionally, one more soil sample may be collected for laboratory chemical analysis if the interval is other than these predetermined intervals and has a high PID reading during field headspace analysis.

Each soil sample will be classified in the field for completion of a well boring log and observed for odors or potential sheens. In areas where NAPL is known or suspected to occur, soil samples will be subjected to shake testing (to identify the potential presence of sheens), as appropriate. After the completion of any soil boring, for the purpose of groundwater monitoring, a 1.5- or 2-inch-diameter polyvinyl chloride (PVC) or stainless steel monitoring well may be installed pending the need for monitoring of NAPL thickness, the collection of groundwater samples, or the collection of water table measurements.

2.4.1 Oil-Water Shake Tests

During the performance of soil investigation activities, field oil-water shake tests will be used to investigate the presence, and to delineate soils containing NAPL in the subsurface. The visual presence of a sheen will be used to indicate whether or not NAPL is present in subsurface soil.

In areas of the Site where NAPL is known or suspected to occur, soil samples from selected boring locations will be evaluated using a field oil-water shake test. Samples for oil-water shake tests will be collected from soil samples generated at the proposed boring installations. Soil samples will undergo oil-water shake tests from those portions of the soil core that exhibit potential sheens or odors or have a high PID reading. In the absence of sheens and odors at the selected boring locations, oil-water shake tests may be conducted on the samples collected immediately above the water table.

2.4.2 PID Headspace Testing

Field PID headspace testing will be used to investigate the potential presence of volatile organic compounds (VOCs) and to delineate any soils containing oil constituents in the subsurface. All soil samples will undergo field PID headspace testing. At least one soil sample, in addition to the 0- to 2-foot, 8- to 10-foot, and unsaturated zone sample immediately above the water table, from each boring may also be collected for laboratory analysis based on high PID readings.

2.4.3 Soil Analysis Sampling

Soil will be sampled to characterize the surface and subsurface environment of each new monitoring well/soil boring installed. Specific soil boring interval samples will be collected for laboratory analysis as described previously in Section 2.4. Soil samples will be analyzed for analytes listed in Table 2. These analytes include Target Compound List (TCL) VOCs, TCL semivolatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), toxic inorganic constituents present on the Target Analyte List (TAL), and several additional constituents previously detected at the Site that may affect human health risk assessment. The overall Project Analyte List (PAL) presented in Table 2 is hereinafter referred to as the PAL constituents.

Up to three (depending on the depth of the water table), and as many as four (depending on field PID screening and observations), soil samples will be collected from each monitoring well/soil boring location during the course of the soil investigations. The laboratory analytical methods to be utilized are listed in Table 1.

2.5 Groundwater Investigation

Groundwater monitoring wells will be completed for those soil borings so designated. The number and rationale for location of each monitoring well is detailed in Volume I, Section 5 of the RFI Work Plan. Groundwater samples will be collected and analyzed to characterize the groundwater conditions in the vicinity of each of the investigation areas following well development. Analytical data for groundwater samples will consist of field analysis for dissolved oxygen, temperature, conductivity, turbidity, and pH, and laboratory analysis for PAL VOCs, PAL SVOCs, PCBs (filtered and unfiltered), and PAL metals (filtered).

Groundwater will be collected from selected existing and newly installed monitoring wells using standard hand bailing techniques or low-flow purging techniques (if appropriate). If light nonaqueous phase liquid (LNAPL) is encountered at any of the newly installed monitoring wells, a sample of the LNAPL will be collected and analyzed in place of a groundwater sample to represent the occurrence in that area. The LNAPL samples will be analyzed for density, viscosity, interfacial tension, PAL VOCs, PAL SVOCs, PCBs, and PAL metals. The laboratory analytical methods are listed in Table 1.

In addition to groundwater sampling, select existing wells and newly installed wells will be surveyed and gauged to determine the depth to groundwater to determine a Sitewide understanding of the groundwater flow direction(s). Also, a select number of the newly installed wells will undergo specific-capacity testing to determine an estimated hydraulic conductivity of the water-bearing zone.

Surface water sampling may be performed during the RFI field activities at specific locations. These locations may include interior basements of buildings, and shafts or pits associated with buildings that may contain standing water.

3. Project Organization and Responsibilities

3.1 Project Organization

The soil and groundwater investigations will require integration of personnel from the organizations identified below, collectively referred to as the project team. A detailed description of the responsibilities of each member of the project team is presented below.

3.1.1 Overall Project Management

Blasland, Bouck & Lee, Inc. (BBL), on behalf of GM, has overall responsibility for the Site soil and groundwater investigations. BBL personnel will be responsible for the performance or oversight of all related sampling activities. In addition, BBL will be responsible for evaluating resultant data and preparing the deliverables associated with soil and groundwater investigation activities. Project direction and oversight will be provided by Robert J. Anderson, P.G. and Derek C. Kaiding. A listing of key project management personnel is provided below.

Title	Company/Organization	Name	Phone Number
Project Manager	U.S. Environmental Protection Agency	Gary Cygan	(312) 886-5902
Project Manager	General Motors Corporation	Robert S. Metcalf, P.E.	(810) 236-0300
Project Manager	Blasland, Bouck & Lee, Inc.	Robert J. Anderson, P.G.	(412) 231-6624
Assistant Project Manager	Blasland, Bouck & Lee, Inc.	Derek C. Kaiding	(315) 446-9120
Health and Safety Officer	Blasland, Bouck & Lee, Inc.	Jay D. Keough	(609) 860-0590

3.1.2 Task Managers

The staff performing the investigations and Site activities will be directed by representatives of BBL, unless otherwise noted. The personnel responsible for each of the Site activities are listed below.

Project Title	Company/Organization	Name	Phone Number
Subsurface Investigations Task Managers	Blasland, Bouck & Lee, Inc.	Raymond A. Wagner Lisa A. Coffey	(315) 446-9120
Interim Measures Task Manager	Blasland, Bouck & Lee, Inc.	Donald F. Sauda	(315) 446-9120
Health and Safety Manager	Blasland, Bouck & Lee, Inc.	Gregory N. Ertel	(716) 292-6740

3.1.3 Analytical Laboratory Services

Laboratory analytical services for environmental media samples associated with the Site investigations will be provided by CT&E Environmental Services of Ludington, Michigan. Laboratory management personnel are listed below.

Project Title	Company/Organization	Name	Phone Number
Laboratory Project Manager	CT&E Environmental Services, Inc.	Denise Califato	(231) 843-1877

3.1.4 Quality Assurance/Data Management Staff

The following personnel have been assigned to this project:

Title	Company/Organization	Name	Phone Number
Quality Assurance Manager	Blasland, Bouck & Lee, Inc.	Keith Stang	(412) 231-6624
Data Validation Task Manager	Blasland, Bouck & Lee, Inc.	Laurie Indick	(315) 446-9120
Quality Assurance Manager	CT&E Environmental Services, Inc.	Peter Priniski	(231) 843-1877
Database/GIS Administrator	Blasland, Bouck & Lee, Inc.	Mark Hattersley	(315) 446-9120

3.2 Team Member Responsibilities

Soil and groundwater investigations will require integration of personnel from the organizations identified above, collectively referred to as the project team. This section of the FSP/QAPP discusses the responsibilities and duties of the project team members.

3.2.1 Overall Project Management

The GM Project Manager is responsible for implementing the project and has overall responsibility for all phases of the RFI, including the authority to commit the resources necessary to meet project objectives and requirements. The GM Project Manager's primary function is to ensure that technical, financial and scheduling objectives are achieved successfully. The GM Project Manager will provide the major point of contact and control for matters concerning the project.

3.2.2 BBL Project Management

BBL Project Manager/Assistant Project Manager

Responsibilities and duties include:

1. Overall direction of the soil and groundwater investigations;
2. Direction of oversight contractor; and
3. Review of work product including data, memoranda, letters, and reports, and all documents transmitted to the USEPA Region 5.

BBL Health and Safety Officer/Health and Safety Manager

Responsibilities and duties include:

1. Overall health and safety of field investigation team;
2. Corporate health and safety monitoring and medical surveillance; and
3. Preparation and implementation of the site-specific health and safety plan.

BBL Subsurface Investigations Task Managers

Responsibilities and duties of each Task Manager include:

1. Manage day-to-day relevant investigation activities;
2. Develop, establish, and maintain files on relevant investigation activities;
3. Review data from the relevant investigation activities;
4. Perform final review of reduced field data and reports on relevant investigation activities;
5. Assure corrective actions are taken for deficiencies cited during audits of relevant investigation activities;
6. Overall quality assurance/quality control (QA/QC) of the relevant portions of the investigation;
7. Review all relevant field records and logs;
8. Instruct personnel working on relevant investigation activities;
9. Coordinate field and laboratory schedules pertaining to relevant investigation activities;
10. Request sample bottles from laboratory;
11. Review the field instrumentation, maintenance, and calibration to meet quality objectives, as applicable;
12. Prepare sections of investigation reports pertaining to relevant activities; and
13. Maintain field and laboratory files of notebooks and logs, data reductions and calculations, and transmit originals to the Project Manager.

Field Task Managers and Subcontractor Coordinators

Responsibilities and duties include:

1. Coordinate field investigative activities so that field protocols and methods are followed; impose corrective actions, if necessary;
2. Check that appropriate records are maintained, and are accurate;
3. Check that sample chain of custody forms are properly executed and are properly filed; and
4. Report to the Project Manager any deviance from identified work activities associated with the investigations, or any corrective actions that may be necessary to conform to the FSP/QAPP.

Field Personnel

Responsibilities and duties include:

1. Perform field procedures associated with the investigations;
2. Perform field screening analyses (as appropriate) and collect QA samples;

3. Calibrate, operate, and maintain field equipment;
4. Reduce field data;
5. Maintain sample custody; and
6. Prepare field records and logs.

Quality Assurance Manager

Responsibility for the overall QA/QC of the RFI investigation. Responsibilities and duties include:

1. Review laboratory data packages;
2. Oversee and interface with the analytical laboratory, the data management, and data validation teams;
3. Coordinate field QA/QC activities with task managers, including audits of investigations activities (if desired), concentrating on field analytical measurements and practices to meet data quality objectives;
4. Review field reports;
5. Review audit reports;
6. Prepare interim QA/QC compliance reports; and
7. Prepare QA/QC report which includes an evaluation of field and laboratory data and data review reports.

Database/GIS Administrator

Responsibilities and duties include:

1. Review laboratory electronic disk deliverables (EDD) for completeness in terms of the EQUiS database requirements:
2. Extract the EDD into the project Site database in EQUiS;
3. Coordinate updates to the project chemical data reported based on the findings of the data validation process and entry of geological data; and
4. Complete the EQUiS database in anticipation of the preparation of Site data reporting for the RFI (data summary tables, maps, etc.)

3.2.3 Analytical Laboratory

Laboratory Project Manager

Responsibilities and duties include:

1. Serve as primary communication link between oversight contractor and laboratory technical staff;
2. Monitor work loads and ensure availability of resources;
3. Oversee preparation of analytical reports;
4. Supervise in-house chain of custody; and
5. Be responsible for overall quality of analytical work reported for project and timeliness of data deliverables.

Laboratory Quality Assurance Manager

Responsibilities and duties include:

1. Supervise the group which reviews and inspects all project-related laboratory activities; and
2. Conduct audits of laboratory activities.

Laboratory Analytical Personnel

General responsibilities and duties of the laboratory include:

1. Perform sample analyses and associated laboratory QA/QC procedures;
2. Supply sampling containers and shipping cartons;
3. Maintain laboratory custody of samples; and
4. Strictly adhere to all protocols in the FSP/QAPP.

4. General Field Protocols

4.1 Sampling

Samples will be collected at the locations and frequencies specified in the RFI Work Plan and in accordance with the procedures identified herein.

The following protocols will be employed during all sampling conducted during the RFI:

1. Prior to the collection of samples for laboratory analysis at each location, all sampling instruments and equipment must be cleaned in accordance with the protocols presented herein and in Attachment H.

2. A new pair of disposable nitrile gloves must be used for the collection of samples at each location. If, during the course of sample collection, the gloves are observed to be torn, or the gloves are suspected of being soiled from a source other than the sample media at hand, the gloves must be replaced.

3. Quality assurance samples will be collected as outlined in Section 10.

4. All personal protective equipment wastes generated during sampling, such as gloves, Tyveks, etc., will be collected and containerized for proper disposal.

5. Samples will be identified using labels affixed to the sample container. Sample labels will identify the site, sample location, sample interval (if appropriate), laboratory analysis required, preservative added, date and time of collection, and sampler's initials. A hardcover bound field book and/or field forms will be used to record the information associated with the sampling events and sample collection.

6. Sample containers and preservation requirements will be determined by the requirements of the laboratory analytical analysis. All sample containers will be provided by the laboratory and will be prepared using a standard laboratory validated washing procedure. The sample bottles will be delivered by the laboratory to the Site in sealed containers.

7. All properly labeled collected samples will be shipped to the laboratory for laboratory analysis in laboratory-supplied coolers. The coolers must be packed with ice to maintain the required preservation temperature as

identified in Section 7, any remaining space will be filled with packing to cushion the containers. Each cooler will be sealed with two seals comprised of BBL's chain of custody tape and/or the sampler's name. The coolers will then be properly sealed with packing tape.

All samples will be delivered to the laboratory by commercial courier or laboratory personnel the day of or the day following sample collection.

8. Samples will be shipped under the chain of custody procedures as outlined in Section 7.

4.2 Equipment Cleaning

Upon mobilization of the equipment on the Site, and prior to commencing work, all equipment must be thoroughly cleaned. The cleaning shall, at a minimum, consist of the use of pressurized water or steam wash to remove oil, grease, mud, and other foreign matter. The equipment will be inspected by the on-site BBL representative to check that all seals and gaskets are intact and that no fluids are leaking. After the visual inspection has been completed, the on-site BBL representative will determine if additional cleaning is required. If additional cleaning is required, the equipment will receive a thorough recleaning using pressurized water or steam wash. If a drill rig is used, the augers and tooling will be decontaminated between soil borings, as required. Soil sampling equipment will be decontaminated between samples by washing thoroughly with non-phosphate detergent and potable water using a brush to remove particulate matter or surface film, if any.

Prior to the collection of any samples for laboratory analyses, all reusable sampling equipment and tools, or dedicated equipment, will be thoroughly cleaned in accordance with the Equipment Decontamination Procedures included in Attachment H.

Upon completion of activities, the equipment will be thoroughly cleaned by pressurized water or steam wash to remove soils and other foreign matter prior to demobilization from the Site.

Fluids used for cleaning will not be recycled.

4.3 Waste Handling

All water, and excess sampling waters developed as a result of cleaning, will be placed in GM-supplied drums and stored in GM's disposal area (as required) and labeled by BBL. The material contained within the drums will be laboratory analyzed for waste characterization prior to disposal. All other waste materials developed as a result of RFI activities, such as personal protective equipment, will be placed in GM-supplied drums and stored in GM's disposal area (as required). An inventory of all drums containing waste materials will be kept by the supervising geologist.

Investigation-derived waste (IDW), including soil cuttings generated as a result of drilling and sampling will be placed in GM-supplied drums and stored in GM's disposal area (as required) and labeled by BBL. The IDW within the drums will be laboratory analyzed for waste characterization prior to disposal. All IDW generated from RFI activities will be properly disposed of by GM in accordance with appropriate protocols. An inventory of all IDW generated during the investigation will be kept by the supervising geologist.

Additional protocols specific to each sampling method are presented in the following sections.

4.4 Soil Boring Protocols

Soil borings will be completed at the locations identified in the RFI Work Plan. Soil borings will be completed using standard procedures and in accordance with the protocols identified in Section 6. Soil borings will generally be completed to the encountered water table. Representative soil samples will be typically collected in 2-foot depth intervals. Field oil-water shake tests will be conducted on soil samples in areas of known or suspected NAPL occurrence and based on visual and PID readings.

If NAPL is observed during installation of a soil boring, a monitoring well will be installed and a new soil boring(s) will be proposed nearby following the Decision Logic Flow Chart (Figure 2) of the RFI Work Plan in an attempt to delineate the extent of NAPL in the area. These new soil borings will be installed following appropriate utility clearance, and in the same manner as other planned soil borings.

Refer to Attachment D for the procedure for soil boring completion.

4.4.1 Surface Soil Sampling Procedure

Subsurface soil samples will be collected at each soil boring location identified in the RFI Work Plan. The surface soil samples will consist of the material from the ground surface (or immediately beneath the pavement) to a depth of 2 feet. Also, surface soil samples will be collected from selected locations for characterization of direct-contact criteria. The samples will consist of the 0- to 2-foot interval (only) at each location.

Refer to Attachment D for the procedure for surface soil sample collection.

4.4.2 Subsurface Soil Sampling Protocols

Subsurface soil samples will be collected at the soil boring locations identified in the RFI Work Plan. Up to three subsurface soil samples may be collected from each soil boring. The following indicates the locations of subsurface soil sample collection for each soil boring location:

- One subsurface soil sample will be collected from the 8- to 10-foot depth increment unless shallow water table conditions exist (10 feet below grade or less) in which case this sample will not be collected;
- One subsurface soil sample will be collected from the 2-foot depth increment immediately above the groundwater table; and
- Up to one other subsurface sample may be collected based on high PID reading at a boring location or visual evidence of contamination as determined by the supervising geologist.

All soil samples will be collected using the standard methods. Alternate sampling techniques may be proposed to USEPA if the identified method proves to be ineffective or is not feasible due to field constraints (e.g., limited access). Soils will be described and classified according to the Unified Soil Classification System (USCS).

The laboratory QA/QC procedures for the subsurface soil sample collection will be in accordance with Section 10.

Refer to Attachment D for the procedures for subsurface soil sample collection.

4.5 Monitoring Well Installation Procedures

Monitoring well installations will be completed at the locations identified in the RFI Work Plan. All monitoring wells will be installed and developed in accordance with Attachments B and C, and in accordance with USEPA technical guidance. Soil samples for stratigraphic definition will be collected continuously using a split-spoon or direct-push methods. In areas where dense nonaqueous phase liquid (DNAPL) is not suspected, monitoring wells will generally be screened to straddle the encountered water table with well screen lengths of either 5 or 10 feet.

In areas where DNAPL is suspected, monitoring wells will be screened below the water table such that the lower portion of the screen intersects the upper contact of the first confining unit. The well screen will be fitted with a 2-foot-long sump at the bottom of the screen and installed into the upper contact of the confining unit to allow the collection of DNAPL, if present.

A typical monitoring well installation detail is presented in Attachment B-1. An alternative detailed flushmount installation detailed is presented on Attachment B-2. A typical DNAPL monitoring well installation is presented in Attachment B-3.

Refer to Attachments B and C for the procedures for monitoring well installation and development.

4.6 Groundwater and NAPL Sampling Protocols

Groundwater samples will be collected at the locations identified in the RFI Work Plan. Following the installation and development of monitoring wells, two rounds of groundwater sampling will be conducted. The first round of groundwater sampling will consist of sampling all wells installed as part of the RFI Work Plan and those existing wells selected for additional sampling. A subsequent round of groundwater samples will be collected only from the wells where the confirmation of the presence or absence of site-specific constituents are required to address RFI objectives. All groundwater samples will be collected using standard hand-bailing or low-flow sampling methods. Refer to Attachments J and L for the procedures for groundwater sampling using hand-bailing or low-flow, respectively. Prior to the collection of groundwater samples, water level measurements will be obtained. Refer to Attachment I for the procedure for water level measurements.

If LNAPL or DNAPL are encountered in monitoring wells at the time of groundwater sampling, a representative sample of NAPL will be collected and laboratory analyzed in accordance with the RFI Work Plan. Refer to Attachment P for the procedures for LNAPL sample collection and Attachment U for DNAPL sample collection.

Hydraulic conductivity testing using the specific capacity tests procedure will be performed at selected monitoring wells. Refer to Attachment O for the procedure for specific capacity testing.

4.7 Surface Water Sampling Protocols

Surface water sampling may be performed during the RFI field activities at specific locations. These locations may include interior basements of buildings, and shafts or pits associated with buildings that may contain standing water. Procedures for the collection of surface water samples are provided in Attachment W.

4.8 Geophysical Survey

Geophysical investigation methods may be implemented during the RFI will be in accordance with the following objectives:

- Provide geophysical data to supplement soil boring and well data to delineate subsurface conditions (i.e., stratigraphy);
- Identify potential subsurface preferential pathways (i.e., Site piping/utilities) at various AOI locations; and
- Provide a supplemental method to soil borings and monitoring wells to assist in the delineation of potential NAPL areas.

These objectives will be addressed by performing a geophysical investigation consisting of ground-penetrating radar (GPR) and magnetic surveys. Performing the GPR and magnetic surveys may aid in identifying these subsurface features at the Site.

The identification and location of such features may be useful in determining the final location of proposed sampling locations and may be used to supplement the data between proposed sampling locations.

The magnetic survey may be used (if deemed necessary) in areas outside of Site buildings. Detailed operating procedures for the magnetometer are provided in Attachment R.

The GPR survey may be used (if deemed appropriate) in areas both inside and outside of Site buildings. The GPR system's data can be reviewed "real time" to assist in the field evaluation of the targeted subsurface features of interest. Detailed operating procedures for the GPR survey are provided in Attachment S.

4.9 Test Pit Excavation Procedures

The completion of test pit excavations during the RFI field activities is not planned; nevertheless, there may be a need to perform test pit excavations for the RFI program. Test pit excavations may be performed based on the need to identify subsurface structures, facilitate the collection of soil samples that cannot be collected by soil borings, and in areas requiring excavations for Interim Measure (IM) design or implementation. Refer to Attachment V for the procedure for test pit excavation.

5. Quality Assurance Objectives for Measurement Data

Data quality objectives (DQOs) are qualitative and quantitative statements that specify the quality of the data required to support decisions made during Site-related activities associated with the soil and groundwater investigations and are based on the end uses of the data to be collected as part of these programs. DQOs were developed with the intention that the data generated during field investigations will produce a representative characterization of Site conditions that will be of adequate quality and sufficient quantity to form a sound basis for decision making purposes. A DQO summary for the sampling investigation effort is presented below. The summary consists of stated DQOs relative to: data uses, data types, data quantity, sampling and analytical methods, and data measurement performance criteria.

Two data categories have been defined to address various analytical data uses and the associated QA/QC effort. A description and the methods required to achieve the desired levels of quality for each of these categories are:

Screening Data: Screening data afford a quick assessment of Site characteristics or conditions. This objective for data quality is applicable to data collection activities that involve rapid, non-rigorous methods of analysis and quality assurance. This objective is generally applied to: physical and/or chemical properties of samples; degree of contamination relative to concentration differences; and a preliminary health and safety assessment.

Definitive Data: Definitive data are generated using analytical methods, such as approved USEPA reference methods. Data are analyte-specific, with confirmation of analyte identity and concentration. Methods produce raw data (e.g., chromatograms, spectra, concentration values) in the form of paper printouts or computer-generated electronic files.

It is anticipated that both the screening and definitive data categories will be used during the investigation. Field parameters (i.e., dissolved oxygen, conductivity, temperature and pH) which will be obtained during groundwater column sampling for use in qualitatively interpreting other Site data will be determined using screening techniques. Oil-water shake testing for identification of occurrence of NAPL and PID field screening will also be used for select samples. All remaining parameters will be determined using definitive techniques.

For this project, two levels of data reporting have been defined. They are as follows:

Level 1 - Minimal Reporting: Minimal or "results only" reporting is used for analyses which, either due to their nature (i.e., field monitoring) or the intended data use (i.e., preliminary screening), do not generate or require extensive supporting documentation.

Level 2 - Full Reporting: Full "CLP-type" reporting is used for those analyses which, based on the intended data use, require full documentation (particularly to support data validation efforts). Definitive data during site characterization and delineation sampling will normally fall under this level of reporting.

A DQO summary and associated reporting levels for the field investigation activities is presented below. The summary consists of stated DQOs relative to the following items:

- Data uses;
- Data types;
- Data quantity;
- Sampling and analytical methods; and
- Measurement performance criteria.

5.1 Objectives

The purpose of this FSP/QAPP is to present specific QA/QC procedures to be implemented during Site investigation activities to provide data quality that is sufficient to meet the investigation objectives. The overall objective of the soil investigation is to provide the data necessary to complete the characterization of the Site soil and to facilitate the preparation of the final RFI reporting.

5.1.1 Soil Sampling

The overall objective of soil sampling as part of Site investigation activities is to provide the data necessary to complete the characterization of the Site areas to facilitate the preparation of the RFI reporting.

Three soil sampling tasks will be performed during the soil investigations to support this objective including:

1. Oil-water shake tests on selected samples;
2. PID headspace testing; and
3. Soil analysis sampling.

Data Uses

Oil-water shake tests will be used as a field method to evaluate for potential NAPL in subsurface soils in areas of known or suspected NAPL occurrence. PID headspace measurements will be conducted to investigate the potential presence of volatile organics in subsurface soils. Both PID and oil-water shake tests will be used for screening level and gross non-chemical specific soil analysis. Soil analysis sampling will be used to delineate, through fixed-based laboratory analysis, the potential presence of PAL VOCs, PAL SVOCs, PCBs, and PAL metals in the surface and subsurface soils. The chemical-specific analytical results will be used to determine Site potential health risks and, if necessary, to determine whether remedial actions are necessary at select areas of the Site.

Data Types

The soil investigations will include the collection and analysis of surface and subsurface soil samples that will be analyzed by a commercial analytical laboratory for PAL VOCs, PAL SVOCs, PCBs, and PAL metals. Visual examination of soil samples from various depth intervals will also be conducted to evaluate subsurface conditions at the Site. The following testing will be conducted for the three soil sampling tasks:

1. Oil-Water Shake Tests - Field shake testing for potential presence of NAPL products. The presence of a sheen will be used to indicate whether organic material is present in subsurface soils.

2. PID Headspace Measurements - Field test used to determine the gross presence of volatile organics.

3. Soil Analysis Sampling - Analytical laboratory analysis for PAL VOCs, SVOCs, PCBs, and PAL metals.

Data Quantity

Table 1 contains a summary of the number of samples to be collected and associated QC analyses for laboratory-based analyses. Oil-water shake tests will be performed at borings in areas of known or suspected NAPL occurrence. Soil samples will be collected from the 0- to 2-foot, 8- to 10-foot, and unsaturated zone immediately above the water table where the water table is at a depth 12 feet or greater. If the water table is found to be 10 feet or less, a single soil sample (in addition to the 0- to 2-foot sample) will be collected just above the water table. All soil samples will undergo PID headspace testing.

Sampling and Analytical Methods

Samples will be collected during the boring operations for each monitoring well/soil boring installation. Procedures for sample collection are presented in Attachment D. The laboratory methods to be utilized are listed in Table 1. Reporting for the oil-water shake tests and PID headspace measurements will be Level 1. Reporting for the laboratory-based PAL VOCs, PAL SVOCs, PCBs, and PAL metals analyses will be Level 2.

Measurement Performance Criteria

Precision and accuracy QC limits for chemical constituents which are used during data review to assess analytical performance are included in the analytical laboratory's (CT&E) Quality Assurance Plan (Attachment T).

Data representativeness is addressed by the sample quantities and locations included in the soil investigation program design. Data comparability is intended to be achieved through the use of standard USEPA approved methods, which are presented in Table 1. Data completeness will be assessed at the end of the soil investigation.

5.1.2 Groundwater Sampling

The overall objective of groundwater sampling as part of Site investigation activities is to provide the data necessary to complete the characterization of the Site areas to facilitate the preparation of the RFI reporting.

Groundwater samples will be collected either manually by use of a bailer or by using low-flow sampling techniques from selected existing wells and each new monitoring well installed during the investigation. During groundwater sampling, each well will be visually inspected for NAPL. Water table elevation measurements will be taken and groundwater will be tested for NAPL with a groundwater/interface probe. After the completion of the monitoring well stabilization period (approximately seven days), groundwater samples will be collected from area specific wells to characterize water quality. Additionally, in-situ grab groundwater samples (e.g., hydropunch) will be collected at locations specified in the RFI Work Plan. In-situ grab groundwater samples will be collected from area-specific locations to characterize water quality.

Data Uses

Groundwater samples will be visually inspected for product in each well sampled. Groundwater samples will be collected from select well locations to provide sufficient groundwater data for use in determining whether groundwater contamination has been delineated for areas investigated.

Data Types

Data types include both hydrogeologic and water quality data. Hydrogeologic data will consist of water level and hydraulic conductivity information which may be used to calculate other hydrogeologic parameters (gradient, flow conditions, etc.). Water quality data will consist of field parameters, including water/NAPL interface measurements, visual inspections for NAPL, conductivity, dissolved oxygen, pH, and temperature, as well as laboratory parameters for PAL VOCs, PAL SVOCs, PCBs (filtered and unfiltered), and PAL metals (filtered).

Data Quantity

The subsurface investigation activities will involve the collection of groundwater samples from select newly installed monitoring wells, select existing wells, and in-situ grab sample locations (as appropriate or determined by a specific investigation activity). Groundwater elevations will be established at all new wells and the selected existing wells used for the groundwater investigation.

Sampling and Analytical Methods

Samples will be collected using standard hand bailers or sampling pumps (e.g., peristaltic pump). Samples will be visually inspected for and be sampled for NAPL with a groundwater interface probe. Procedures for sample collection are provided in Attachment J. Section 5 contains a description of the water quality measurement procedures and groundwater sampling procedures to be followed during the groundwater investigations. Reporting for field-measured parameters will be Level 1. Reporting for laboratory analyses will be Level 2.

Measurement Performance Criteria

Precision and accuracy QC limits for chemical constituents which are used during data review to assess analytical performance are included in the analytical laboratory's (CT&E's) Quality Assurance Plan (Attachment T).

Data representativeness is addressed by the sample quantities and locations associated with groundwater investigation work activities. Data comparability is intended to be achieved through the use of standard USEPA-approved methods, which are presented in Table 1. Data completeness will be assessed at the end of the groundwater investigations.

5.1.3 Surface Water Sampling

Surface water sampling may be performed during the RFI field activities at specific locations as described below.

Data Uses

Surface water samples may be collected from select locations to provide water quality data for use in determining whether standing water contains hazardous constituents.

Data Types

Data types include only water quality data. Water quality data will consist of field parameters, including water/NAPL interface measurements, visual inspection for NAPL, pH, conductivity and temperature. Laboratory parameters will consist of PAL VOCs, PAL SVOCs, PCBs, PAL metals, and possible waste characterization data (TCLP analysis).

Data Quantity

During the RFI field activities, surface water samples may be collected at specific locations (e.g., Building 40 basement). These locations may include interior basements of buildings, and shafts or pits associated with buildings (as appropriate) that may contain standing water. The number of surface water samples to be collected and analyzed as part of the RFI field activities is anticipated to be less than 10 locations.

Sampling and Analytical Methods

Samples will be collected using standard hand bailers or sampling pumps (e.g., peristaltic pump). Procedures for the collection of surface water samples are provided in Attachment W. Surface water samples will be visually inspected for sheens or evidence of NAPL at each sample location. Reporting for field-measured parameters will be Level 1. Reporting for laboratory analyses will be Level 2.

Measurement Performance Criteria

Precision and accuracy QC limits for constituents used during data review to assess analytical performance are included in the analytical laboratory's (CT&E's) Quality Assurance Plan (Attachment T).

Data representativeness is addressed by the sample quantities and locations associated with groundwater investigation work activities. Data comparability is intended to be achieved through the use of standard USEPA-

approved methods, which are presented in Table 1. Data completeness will be assessed at the end of the groundwater investigations.

5.1.4 Nonaqueous Phase Liquid (NAPL) Sampling

NAPL sampling will be performed during the RFI field activities in areas where LNAPL or DNAPL is identified in existing or newly installed monitoring wells and in areas where analytical data are currently not available.

Data Uses

NAPL samples will be collected from select monitoring well locations to determine both physical and chemical characteristic data of the NAPL for use in determining the presence of hazardous constituents in the product, as well as physical characteristics (e.g., viscosity, specific gravity) as they pertain to NAPL recovery.

Data Types

Data types include both field parameters and laboratory data. Field data will consist of general parameters, including NAPL thickness measurements and visual inspection of the NAPL for color and general viscosity. Laboratory parameters will consist of chemical analyses for PAL VOCs, PAL SVOCs, PCBs, PAL metals, and physical analysis for viscosity, specific gravity, and interfacial tension.

Data Quantity

NAPL, if identified, will be collected at existing or newly installed monitoring wells, as appropriate, to represent areas containing NAPL where analytical data are currently not available. These locations may include select existing or newly installed well locations within interior or exterior building areas. NAPL thickness measurements and elevations will be collected at locations containing NAPL and used for the groundwater investigation.

Sampling and Analytical Methods

NAPL samples will be visually inspected for color, relative viscosity and thickness at each sample location. Samples will be collected using standard hand bailers or sampling pumps (e.g., peristaltic pump). NAPL data will consist of field parameters, including NAPL thickness measurements, and visual inspection of the NAPL for color and general viscosity. Procedures for the collection of LNAPL and DNAPL samples are provided in Attachments

P and U, respectively. Laboratory parameters will consist of chemical analyses for PAL VOCs, PAL SVOCs, PCBs, PAL metals, and physical analysis for viscosity, specific gravity, and interfacial tension. Reporting for field-measured parameters will be Level 1. Reporting for laboratory analyses will be Level 2.

Measurement Performance Criteria

Precision and accuracy QC limits for chemical and physical constituents that are used during data review to assess analytical performance are included in the analytical laboratory's (CT&E) Quality Assurance Plan (Attachment T).

Data representativeness is addressed by the sample quantities and locations associated with NAPL occurrence. Data comparability is intended to be achieved through the use of standard USEPA-approved methods. Data completeness will be assessed on an interim basis at the end of each NAPL sampling program for each AOI or facility area (as appropriate).

6. Sampling Procedures

Groundwater and soil samples will be collected as required for the soil and groundwater investigation programs. Sample tracking and identification of the investigations is part of the sampling procedures. An important aspect of sample tracking and identification is based on the ability to discern the difference between and document the origin of a number of environmental samples collected for future reference in reporting and performing an assessment of the distribution of chemical analytical results in any specific area. Detailed descriptions of the sample designation system, documentation, and reporting requirements are presented below.

6.1 Sample Designation System

A four-tier sample designation code and the sample date will provide each sample with a unique "name" or identifier. This alphanumeric system will apply to all samples collected that are to be transmitted to the laboratory for analysis. The sample designation code system includes the prefix "RFI" followed by another prefix indicating the sample location (i.e., Building 31 area) followed by a sequential number assigned at the time of installation for monitoring wells or at the installation of soil borings. These codes are followed with a depth interval in the case of soil borings, and with a date designation in the case of monitoring wells.

Example sample designation codes for groundwater samples and soil samples under this system would be RFI 70-161 (3/21/99) and 20-277 (8-10), respectively. Additional sample volumes collected for matrix spike ("MS") and matrix spike duplicate ("MSD") analysis will be noted on the chain of custody forms, and the associated additional sample containers will be labeled with the appropriate suffix ("MS" or "MSD").

6.2 Field Documentation

Field personnel will provide comprehensive documentation covering all aspects of field sampling, field analysis, and sample chain of custody. This documentation constitutes a record that allows reconstruction of all field events to aid in the data review and interpretation process. All documents, records, and information relating to the performance of the field work will be retained in the project file.

The various forms of documentation to be maintained throughout the investigation activities include:

- Daily Production Documentation - A field logbook consisting of a waterproof, bound notebook that will contain a record of all activities performed at the Site. All logbook entries will be made in pen. Any additions or corrections to the field logbook information will be single-lined out, dated, and initialed.

- Sampling Information - Detailed notes will be made as to the exact site of sampling, physical observations, personnel present, and weather conditions (as appropriate).

- Sample Chain of Custody – Chain of custody forms will provide the record of responsibility for sample collection, transport, and submittal to the laboratory. Chain of custody forms will be filled out at each sampling site, at a group of sampling sites, or at the end of each day of sampling by BBL's field personnel designated to be responsible for sample custody. In the event that the samples are relinquished by the designated sampling person to other sampling or field personnel, the chain of custody form will be signed and dated by the appropriate personnel to document the sample transfer. The original chain of custody form will accompany the samples to the laboratory and copies will be forwarded to the project files. A sample chain of custody form is included in Attachment A.

- Field Equipment, Calibration, and Maintenance Logs - To document the calibration and maintenance of field instrumentation, calibration and maintenance logs will be maintained for each piece of field equipment that is not only factory-calibrated.

6.3 Field Data Reporting

Information collected in the field through visual observation, manual measurement and/or field instrumentation will be recorded in field notebooks or data sheets, and/or on pre-prepared forms. Such data will be reviewed by the appropriate Task Manager for adherence to the specific requirements associated with the soil and groundwater investigation requirements and for consistency. Concerns identified as a result of this review will be discussed with the field personnel, corrected if possible, and as necessary, incorporated into the data evaluation process.

Where appropriate, field data forms and calculations will be processed and included in appendices to investigation reports. The original field logs, documents, and data reductions will be maintained with the project file at the BBL office in Syracuse, New York.

6.4 Sampling Methods

The project-specific scope of work is presented in detail in the RFI Work Plan. The sampling procedures for the various investigation tasks are summarized in the following subsections. Detailed field procedures are included in the attachments to this FSP/QAPP. The attachments also contain other investigation supportive procedures such as for cleaning equipment, packing, handling, executing chain of custody, shipping samples, and obtaining field measurements.

6.5 Monitoring Well and Boring Installation

New monitoring wells will be installed to augment the existing wells. Additionally, boreholes will be completed for the additional characterization of surface and subsurface soil conditions.

Shallow monitoring wells (water table wells) will be constructed of 1.5- or 2-inch-diameter, Schedule 40, machine-slotted PVC. Monitoring well installation procedures are provided in Attachment B. Prior to groundwater sample collection, all monitoring wells will be developed in accordance with the procedures described in Attachment C.

If boring refusal is encountered, either a new boring will be initiated (with the previous boring being abandoned following procedures described in Attachment D) or a tri-cone or hammer-head drill bit, or equivalent method, will be used to penetrate through the zone of refusal. If physically possible, a sample will be obtained for identification purposes from the zone of refusal. Any sheen observed during the drilling and monitoring well installation will be noted on the boring logs.

Lithologic Characterization

To provide a vertical profile of the subsurface, soil samples will be collected continuously for visual classification using split-spoon sampling methods from the ground surface to the bottom of each boring. Soil boring completion, soil sample collection, and lithologic characterization will be performed in accordance with the procedures described in Attachment D. A PID will be used to obtain PID headspace readings of each sample interval, as well as provide health and safety monitoring for field personnel during the drilling program as described in Attachment E. Oil-water shake tests will be performed on samples taken from boreholes in areas where NAPL may be present following the procedures outlined in Attachment F.

The visual descriptions of the subsurface lithology will be evaluated to assess the extent to which the geologic unit may influence migration of NAPL and dissolved-phase constituents at the Site and will provide a vertical profile of the subsurface. This information will be used to prepare detailed boring/well logs and geologic cross sections of the subsurface area. Specific details in the lithologic descriptions normally include the following:

Color/discoloration
Fill component description
(cinder, clay, metal, tires, etc.)
Odors
Principal components
Contacts when observed
Mottling/staining
Minor Components
Particle angularity/shape
Weathering
Structure and bedding
Particle sizes

PID Measurements
Field moisture conditions
Moisture content
Unified Soil Classification System group symbol
Fill or geologic origin, if known
Organic content
Vertical fractures
Sheen
Relative cohesiveness
Item which may indicate age of deposit
(identification of archeological artifacts, newspapers, etc.)

6.6 Soil Sampling and Analysis

Soil samples will be selected for analytical characterization from samples collected during the installation of the soil boreholes. In general, three or four soil samples will be collected from each borehole in areas where the water table is 12 feet or greater below ground surface (bgs). Samples submitted for analytical laboratory testing will consist of soil collected at the following intervals: at the surface (0 to 2 feet bgs) or the remaining interval present beneath concrete pads or pavement, the 8 to 10 feet bgs interval, and at or immediately above the water table interface. In areas where the water table is found to be 10 feet or less (bgs), a single soil sample will be collected just above the water table. Additionally, one more 2-foot soil interval may be submitted for analysis if unusually high PID readings are encountered.

Soil samples will be obtained following the sampling criteria identified in Section 5 of the RFI Work Plan. Soil samples will be collected in accordance with the procedures outlined in Attachment D with samples to be submitted for VOC analysis being collected following the procedures outlined in Attachment G. These soil samples will be

used to assess potential source materials at each area where a monitoring well or borehole is installed. The soil samples will be analyzed for PAL VOCs, PAL SVOCs, PCBs, and PAL metals.

Soil samples will be identified, packaged, and shipped to the analytical laboratory using the chain of custody procedures set forth in Attachment A. Equipment decontamination will be performed in accordance with the procedures described in Attachment H.

6.7 Groundwater Sampling and Analysis

Water level measurements will be obtained from each monitoring well in accordance with procedures set forth in Attachment I. In general, measurements will be obtained with a water level probe and measured to the nearest 0.01 foot. Water levels will be converted to elevations using the surveyed measurement point (i.e., top of casing) elevations.

The water level measurements will be used to determine groundwater elevations and determine groundwater flow directions.

Groundwater samples will be collected from newly installed monitoring wells upon completion of well development and associated stabilization period. Standard hand bailing techniques or low-flow sampling will be utilized for groundwater sampling at each selected monitoring well location using sampling procedures as described in Attachment J or Attachment L.

A representative groundwater sample from each monitoring well will be collected in the field and measured for dissolved oxygen (DO), temperature, conductivity, turbidity, and pH. Specific field procedures for measurement of these water quality parameters are described in Attachment K. If low-flow purging is used, additional water quality measurements for temperature and turbidity will also be used to determine well stability and when purging is complete.

Groundwater samples will be analyzed using USEPA SW-846 methods at the laboratory for PAL VOCs, PAL SVOCs, PCBs (filtered and unfiltered), and PAL metals (filtered).

Filtered samples will be collected for PCB and metals analyses. A 0.45-micron filter will be used to filter groundwater samples for PCB and metals analyses. Filtered only groundwater samples will be collected for metals

because of the fines encountered in water accumulating in the monitoring well as a result of drilling and even sampling.

To characterize the hydraulic conductivity at selected monitoring well locations, data will be obtained during well purging consistent with specific capacity testing procedures. Specific capacity tests entail pumping a well at an approximately constant rate and measuring the drawdown inside the pumped well. To optimize the efficiency of data acquisition, specific capacity tests will be performed as part of purging prior to groundwater sampling. The relationship between the specific capacity test duration and pumping rate, the measured drawdown, and the geometry of the well intake section (wetted sand filter pack) will be used to estimate the hydraulic conductivity of the water-bearing formation surrounding the well intake section. Specific capacity testing will be performed in accordance with the procedures specified in Attachment O.

6.8 Oil/Sludge Grab Sampling Procedures

Oil/sludge samples from sumps, pits, trenches, etc., may be collected, if encountered, for chemical analysis. Oil/sludge samples may be collected utilizing a grab sampler, hand-held dredge, peristaltic pump, and/or a hand bucket auger. The specific procedures for collection of oil/sludge grab samples are presented in Attachment M.

6.9 NAPL Sampling and Passive Oil Recovery

NAPL samples may be collected to facilitate laboratory characterization of these materials. Standard procedures for the collection of NAPL samples and passive oil recovery are presented in Attachments P and U for LNAPL and DNAPL, respectively. The procedures for determining oil layer thickness in monitoring wells is presented in Attachment Q.

If NAPL is measured in any of the new wells or in any of the existing wells (associated with each subsurface investigation area) where it was not previously found and sampled, a representative sample of the liquid, if present in sufficient quantity, will be collected in place of a groundwater sample. The location and physical characteristics of the NAPL will be noted in the field logs. The NAPL will be analyzed for density, viscosity, interfacial tension, PAL VOCs, PAL SVOCs, PCBs, and PAL metals.

6.10 Magnetometer and Ground-Penetrating Radar Surveys

Magnetometer and ground-penetrating radar (GPR) procedures may be used to identify the location of buried materials, if deemed necessary during subsurface investigation activities. These surveys will be conducted following the procedures presented in Attachments R and S, respectively.

6.11 Surface Water Sampling

Surface water sampling may be performed during the RFI field activities at specific locations. These locations may include interior basements of buildings (e.g., Building 40 basement), and shafts or pits associated with buildings that may contain standing water. In general, surface water sampling will be performed using either bailers or a sampling pump (e.g., peristaltic pump). Procedures for the collection of surface water samples are provided in Attachment W.

7. Custody Procedures

7.1 Sample Containers and Preservation

Appropriate sample containers, preservation methods, and laboratory holding time requirements for planned environmental samples are shown in Table 1.

The analytical laboratory will supply appropriate sample containers and preservatives, as necessary. The bottles will be purchased pre-cleaned to USEPA Office of Solid Waste and Emergency Response (OSWER) Directive 9240.05A requirements. The field personnel will be responsible for properly labeling containers and preserving samples (as appropriate). Sample labeling procedures are described in Attachment A.

7.2 Packing, Handling, and Shipping Requirements

Sample packaging and shipment procedures are designed to ensure that the samples will arrive at the laboratory with the custody intact.

Samples will be packaged for shipment as outlined below:

- Ensure that all sample containers have the sample labels securely affixed to the container with clear packing tape;
- Check the caps on the sample containers to ensure that they are properly sealed;
- Wrap the sample container cap with clear packing tape to prevent it from becoming loose;
- Complete the chain of custody form with the required sampling information and ensure that the recorded information matches the sample labels. NOTE: If the designated sampler relinquishes the samples to other sampling or field personnel for packing or other purposes, the sampler will complete the chain of custody prior to this transfer. The appropriate personnel will sign and date the chain of custody form the document the sample custody transfer.
- Using duct tape, secure the outside drain plug at the bottom of the cooler;
- Wrap sample containers in bubble wrap or other cushioning material (not vermiculite);
- Place 1 to 2 inches of cushioning material at the bottom of the cooler;
- Place the sealed sample containers into the cooler;

- Place ice in plastic bags and seal. Place loosely in the cooler;
- Fill the remaining space in the cooler with cushioning material;
- Place chain of custody forms in a plastic bag and seal. Tape the forms to the inside of the cooler lid;
- Close the lid of the cooler, lock, and secure with duct tape;
- Wrap strapping tape around both ends of the cooler at least twice;
- Mark the cooler on the outside with the following information: shipping address, return address, "Fragile" labels, and arrows indicating "this side up." Cover the cooler label with clear plastic tape. Place a signed custody seal over the cooler lid.

All samples will be packaged by the field personnel and transported as low-concentration environmental samples. The coolers will be hand-delivered or delivered by an express carrier to be received within 48 hours of the time of collection. All shipments will be accompanied by the chain of custody form identifying the contents. The original form will accompany the shipment; copies will be retained by the sampler for the sampling office records. If the samples are sent by common carrier, a bill of lading should be used. Receipts or bills of lading will be retained as part of the permanent project documentation. Commercial carriers are not required to sign off on the chain of custody form as long as the forms are sealed inside the sample cooler and the custody seals remain intact.

Sample custody seals and packing materials for filled sample containers will be provided by the analytical laboratory. The filled, labeled, and sealed containers will be placed in a cooler on ice and carefully packed to eliminate the possibility of container breakage. Trip blank(s) of analyte-free water will be provided by the laboratory and included in each cooler containing aqueous samples to be analyzed for VOCs.

General procedures for packing, handling, and shipping environmental samples are included in Attachment A and in Attachment N.

7.3 Field Custody Procedures

The objective of field sample custody is to assure that samples are not tampered with from the time of sample collection through time of receipt by the analytical laboratory. Persons will have "custody of samples" when the samples are in their physical possession, in their view after being in their possession, or in their physical possession and secured so they cannot be tampered with. In addition, when samples are secured in a restricted area accessible only to authorized personnel, they will be deemed to be in the custody of such authorized personnel.
Field custody documentation consists of both field logbooks and field chain of custody forms.

7.3.1 Field Logbooks

Field logbooks will provide the means of recording data collection activities performed. As such, entries will be described in as much detail as possible so that persons going to the Site could re-construct a particular situation without reliance on memory.

Field logbooks will be bound field survey books or notebooks. Logbooks will be assigned to field personnel, but will be stored in a secure location when not in use. Each logbook will be identified by the project-specific document number. The title page of each logbook will contain the following:

- Person to whom the logbook is assigned;
- Logbook number;
- Project name;
- Project start date; and
- End date.

Entries into the logbook will contain a variety of information. At the beginning of each entry, the date, start time, weather, names of all sampling team members present, level of personal protection being used, and the signature of the person making the entry will be entered. The names of visitors to the Site, field sampling or investigation team personnel, and the purpose of their visit will also be recorded in the field logbook.

Measurements made and samples collected will be recorded. All entries will be made in ink and no erasures will be made. If an incorrect entry is made, the information will be crossed out with a single strike mark. Whenever a sample is collected, or a measurement is made, a detailed description of the location of the station shall be recorded. The number of the photographs taken of the station, if any, will also be noted. All equipment used to make measurements will be identified, along with the date of calibration of any field instruments used.

Samples will be collected following the sampling procedures documented in Section 6. The equipment used to collect samples will be noted, along with the time of sampling, sample description, depth at which the sample was collected, volume and number of containers. A sample identification number will be assigned prior to sample collection for each environmental sample. Field duplicate samples, which will receive an entirely separate sample identification number, will be noted under sample description.

Preprinted sample labels will be affixed to sample bottles prior to delivery to the sampling location. The following information is required on each sample label:

- Project;
- Date collected;
- Time collected;
- Location;
- Sampler;
- Analysis to be performed;
- Preservative; and
- Sample number.

7.3.2 Field Chain of Custody Form

Completed chain of custody forms will be required for all samples to be analyzed. Chain of custody forms will be initiated by the sampling crew in the field. The chain of custody forms will contain the sample's unique identification number, sample date and time, sample description, sample type, preservation (if any), and analyses required. The original chain of custody form will accompany the samples to the laboratory. Copies of the chain of custody will be made prior to shipment (or multiple copy forms used) for field documentation. The chain of custody forms will remain with the samples at all times. The samples and signed chain of custody forms will remain in the possession of the sampling crew until the samples are delivered to the express carrier (e.g., FedEx) or hand delivered to the fixed-based laboratory, or placed in secure storage.

Sample labels are completed for each sample using waterproof ink unless prohibited by weather conditions. The labels include sample information such as sample number and location, type of sample, date and time of sampling, sampler's name or initials, preservation, and analyses to be performed. The completed sample labels are affixed to each sample bottle and covered with clear tape.

7.4 Laboratory Custody Procedures

Upon sample receipt, laboratory personnel will be responsible for sample custody. The original field chain of custody form will accompany all samples requiring laboratory analysis. The laboratory will use chain of custody guidelines described in the USEPA guidance documents. Samples will be kept secured in the laboratory until all

stages of analysis are complete. All laboratory personnel having samples in their custody will be responsible for documenting and maintaining sample integrity. The selected commercial analytical laboratory's custody procedures are described in the CT&E Quality Assurance Plan (QAP) (Attachment T).

7.4.1 Sample Receipt and Storage

Immediately upon sample receipt, the laboratory sample custodian will verify the package seal, open the package, and compare the contents against the field chain of custody. If a sample container is received broken, the sample is in an inappropriate container, or has not been preserved by appropriate means, BBL will be notified. The laboratory sample custodian will be responsible for logging the samples in, assigning a unique laboratory identification number to each sample, labeling the sample bottle with the laboratory identification number, and moving the sample to an appropriate storage location to await analysis. The project name, field sample code, date sampled, date received, analysis required, storage location and date, and action for final disposition will be recorded in the laboratory logbook. All relevant custody documentation will be placed in the project file.

7.4.2 Sample Analysis

Analysis of an acceptable sample will be initiated by laboratory documentation that contain all pertinent information for analysis. The analyst will sign and date the laboratory chain of custody form when removing the samples from storage.

Samples will be organized into sample delivery groups (SDGs) by the laboratory. A SDG may contain up to 20 field samples (field duplicates, trip blanks, and rinse blanks are considered field samples for the purposes of SDG assignment). All field samples assigned to a single SDG shall be received by the laboratory over a maximum of fourteen calendar days and must be processed through the laboratory (preparation, analysis, and reporting) as a group. Every SDG must include a minimum of one site-specific matrix spike/matrix spike duplicate or MS/Dup pair, which shall be received by the laboratory at the start of the SDG assignment.

Each SDG will be self-contained for all of the required QC samples. All parameters within an SDG will be extracted or prepared and analyzed together in the laboratory. At no time will the laboratory be allowed to run any sample (including QC samples) at an earlier or later time than the rest of the SDG. These rules for analysis will ensure that the QC samples for an SDG are applicable to the field samples of the same SDG and that the best possible comparisons may be made.

7.4.3 Sample Storage Following Analysis

All samples will be maintained by the laboratory for one month after the final report is delivered to BBL. After this period, the samples will be disposed of in accordance with applicable rules and regulations.

8. Instrument Calibration and Frequency

This section describes procedures for maintaining the accuracy of the instruments and measuring equipment used for conducting field tests and laboratory analyses. These instruments and equipment should be calibrated prior to use or on a scheduled periodic basis. The laboratory's specific schedule and procedures for instrument calibrations are dictated by the analytical methods and are presented in general detail in the laboratory's (CT&E's) Quality Assurance Plan (QAP) (Attachment T).

8.1 Field Instruments and Equipment

Field personnel are responsible for ensuring that a master calibration/maintenance log is maintained following the procedures specified for each measuring device. Each log will include, at a minimum where applicable:

- Name of device and/or instrument calibrated;
- Device/instrument serial/identification number;
- Frequency of calibration;
- Date(s) of calibration(s);
- Results of calibration(s); and
- Name of person(s) performing calibration(s).

Instruments and equipment used to gather, generate, or measure environmental data will be calibrated with sufficient frequency and in such a manner that accuracy and reproducibility of results are consistent with the manufacturer's specifications.

Equipment to be used during the field sampling will be examined to certify that it is in operating condition. This includes checking the manufacturer's operating manual to ensure that all maintenance requirements are being observed. Field notes from previous sampling events will be reviewed to ensure that any prior equipment problems are not overlooked and that any necessary repairs to equipment have been carried out.

Calibration of field instruments will be performed at the intervals specified by the manufacturer or more frequently as conditions dictate. Field instruments will include at a minimum a pH meter, thermometer, dissolved oxygen meter, and specific conductivity meter. A flow-through multi-meter may be elected for use, particularly if low-flow purging techniques are utilized during groundwater sampling. The calibration of this instrument is normally

dictated by the manufacturer's instructions. In the event that an internally calibrated field instrument fails to meet calibration/checkout procedures, it will be returned to the manufacturer for service.

Calibration of field instruments is governed by the specific SOPs for the applicable field analysis method, and such procedures take precedence over the following general discussion. The water quality calibration procedures are detailed in Attachment K.

8.2 Laboratory Instruments and Equipment

When analyses are conducted according to the USEPA SW-846 methods, the calibration procedures and frequencies specified in the applicable method will be followed. The laboratory QAP has a general description of internal calibration procedures and frequencies. Records of calibrations will be filed and maintained by the laboratory. These records will be subject to QA audit. For all instruments, the laboratory will maintain trained repair staff with in-house spare parts or will maintain service contracts with vendors.

All standards used in the calibration of equipment are traceable, directly or indirectly, to the National Institute of Science and Technology (NIST) standards. All standards received are logged into standard receipt logs maintained by the individual analytical groups. Each group maintains a standards log that tracks the preparation of standards used for calibration and QC purposes. Specific instrument tuning and calibration requirements as specified in the analytical methods for the analytical categories (VOC, SVOC, PCB, and metals) are presented below.

Volatile Organics (Method 8260)

Prior to calibration of the GC/MS, it is necessary to ensure that the hardware tune meets specifications. This is done through the analysis of a performance evaluation tuning standard, p-Bromofluorobenzene (BFB). 50 nanograms (ng) of BFB is analyzed and the resulting mass spectrum checked against the following criteria.

Mass	Ion Abundance Criteria
50	15.0-40.0% of the base peak
75	30.0-60.0% of the base peak
95	base peak, 100% relative abundance
96	5.0-9.0% of the base peak
173	less than 2.0% of mass 174
174	greater than 50% of mass 95

175	5.0-9.0% of mass 174
176	95.0-101.0% of mass 174
177	5.0-9.0% of mass 176

Once the standard has passed criteria, calibration of the system can begin. A minimum of a five-point calibration is run and the response factors relative to an internal standard are calculated for all compounds. If the percent relative standard deviation (%RSD) of the RRFs and the minimum RRFs meet the method-specified criteria for the following compounds:

Calibration Check Compounds (CCCs)

Vinyl Chloride	%RSD <30
1,1-Dichloroethene	%RSD <30
Chloroform	%RSD <30
1,2-Dichloropropane	%RSD <30
Toluene	%RSD <30
Ethylbenzene	%RSD <30

System Performance Check Compounds (SPCCs)

Chloromethane	RRF >0.10
1,1-Dichloroethane	RRF >0.10
Bromoform	RRF >0.10
1,1,2,2-Tetrachloroethane	RRF >0.30
Chlorobenzene	RRF >0.30

Then the calibration is considered valid and sample analysis may begin. If the %RSD for all target compounds are less than 15%, the relative response factors are assumed to be constant over the calibration range and the average relative response factor may be used for quantitation. A calibration curve must, however, be generated for any compounds that exceed a 15% RSD.

A performance evaluation standard must be run at the beginning of each additional 12-hour analytical sequence. The performance evaluation standard is followed by a continuing calibration check standard. The response factors for the standard are calculated and checked against the calibration curve. If the percent difference of the CCCs are

less than 20% and the RRF for the SPCCs meet the method-specified minimum limits, the continuing calibration is considered valid and sample analysis may continue.

Semivolatile Organics (Method 8270)

Prior to calibration of the GC/MS, it is necessary to ensure that the hardware tune meets specifications. This is done through the analysis of a performance evaluation tuning standard, decafluoro-triphenylphosphine (DFTPP). 50 ng of DFTPP is analyzed and the resulting mass spectrum checked against the following criteria.

Mass	Ion Abundance Criteria
51	30.0-60.0% of mass 198
68	less than 2.0% of mass 69
70	less than 2.0% of mass 69
127	40.0-60.0% of mass 198
197	less than 1.0% of mass 198
198	base peak, 100% relative abundance
199	5.0-9.0% of mass 198
275	10.0-30.0% of mass 198
365	greater than 1.0% of mass 198
441	present but less than mass 443
442	greater than 40.0% of mass 198
443	17.0-23.0% of mass 442

Once the standard has passed criteria, calibration of the system can begin. A five-point calibration is run and the response factors relative to an internal standard are calculated for all compounds. If the percent relative standard deviation (%RSD) of the RRFs and the minimum RRFs meet the method-specified criteria for the following compounds:

Calibration Check Compounds (CCCs)	
Acenaphthene	%RSD <30
1,4-Dichlorobenzene	%RSD <30
Hexachlorobutadiene	%RSD <30
N-Nitrosodiphenylamine	%RSD <30
Di-n-octyl phthalate	%RSD <30

Fluoranthene	%RSD <30
Benzo(a)pyrene	%RSD <30
4-Chloro-3-methylphenol	%RSD <30
2,4-Dinitrophenol	%RSD <30
Phenol	%RSD <30
Pentachlorophenol	%RSD <30
2,4,6-Trichlorophenol	%RSD <30

System Performance Check Compounds (SPCCs)

N-Nitroso-di-n-propylamine	RRF >0.05
Hexachlorocyclopentadiene	RRF >0.05
2,4-Dinitrophenol	RRF >0.05
4-Nitrophenol	RRF >0.05

Then calibration is considered valid and sample analysis may begin. If the %RSD for all compounds are less than 15%, the relative response factors are assumed to be constant over the calibration range and the average relative response factor may be used for quantitation. A calibration curve must, however, be generated for any compounds that exceed a 15% RSD.

A performance evaluation standard must be run at the beginning of each additional 12-hour analytical sequence. The performance evaluation standard is followed by a continuing calibration check standard. The response factors for the standard are calculated and checked against the calibration curve. If the percent difference of the CCCs are less than 20% and the RRF for the SPCCs meet the method-specified minimum limits, the continuing calibration is considered valid and sample analysis may continue.

PCBs-Aroclor (Method 8082)

The gas chromatographs are calibrated by analysis of standard solutions containing target compounds that do not coelute. A minimum 5-point calibration is required for Aroclors 1016 and 1260, with single-point standards for the remaining Aroclors. A minimum of 3 to 5 peaks are to be calibrated for each Aroclor. The calibration factors (CFs) are determined using a peak area or peak height versus concentration calculation. If the %RSD for the calibration factor is less than 20% for all compounds, the curve is considered valid and analysis may begin. Alternatively, calibration curves may be generated. The correlation coefficients of these curves must be greater than 0.995 to be considered valid.

Continuing calibration check standards are run every 12 hours, or every 20 samples, whichever is more frequent. If the percent difference of the continuing calibration CF from the initial calibration CF is less than 15%, the continuing calibration is considered valid and analysis may continue. A final calibration check standard must be analyzed at the end of the analytical sequence. The percent difference of this standard must also be less than 15%. If any of the continuing calibration standards (including the final continuing calibration standard) fail to meet method specifications, all samples analyzed since the last compliant standard must be reanalyzed.

Metals (Method 6010 series)

The Inductively Coupled Plasma (ICP) instruments are calibrated using a minimum of three standards and a blank. The initial calibration is verified prior to the analysis of samples by an initial calibration verification standard (ICV). The recovery of this standard must be between 95 and 105% for the initial calibration to be considered valid.

Continuing calibration verification (CCV) standards are analyzed every 10 samples. The recovery of this standard must be between 90 and 110%. In addition, a final CCV must be analyzed at the end of the analytical sequence. Recovery of this standard must also be between 90 and 110%. If any of the CCVs (including the final CCV) fail to meet method specifications, all samples analyzed since the last compliant standard must be reanalyzed for the failed analyte(s).

Atomic absorption instruments (including direct-aspiration, furnace and cold-vapor) instruments are calibrated using a minimum of three standards and a blank. The initial calibration is verified prior to the analysis of samples by an initial ICV. The recovery of this standard must be between 90 and 110% for the initial calibration to be considered valid.

CCV standards are analyzed every 10 samples. The recovery of this standard must be between 80 and 120%. In addition, a final CCV must be analyzed at the end of the analytical sequence. Recovery of this standard must also be between 80 and 120%. If any of the CCVs (including the final CCV) fail to meet method specifications, all samples analyzed since the last compliant standard must be reanalyzed for the failed analyte(s).

9. Analytical Procedures

9.1 Field Parameter and Methods

Field analytical procedures associated with the soil and groundwater investigations will include the measurement of conductivity, dissolved oxygen, pH, temperature, turbidity, groundwater/product interfaces, groundwater elevation levels, and PID headspace screening. Specific field measurement protocols are provided in Attachments E, I, K, and Q.

9.2 Laboratory Parameters and Methods

The following tables summarize general analytical requirements:

Table 1 – Analytical Methods, Sample Container, Preservation, and Holding Time Requirements
Table 2 – Listing of PAL Constituents
Table 3 – Typical Reporting Limits, Method Detection Limits, and Practical Quantitation Limits

9.2.1 Soil Investigation

Soil samples will be analyzed for the following parameters:

PAL VOCs	EPA SW-846 Method 5035/8260;
PAL SVOCs	EPA SW-846 Method 8270;
PCBs	EPA SW-846 Method 8082; and
PAL Metals	EPA SW-846 Methods 6010 and 7470

9.2.2 Groundwater Sampling for Characterization Investigations

Groundwater samples associated with the characterization investigations will be analyzed for the following parameters:

PAL VOCs	EPA SW-846 Method 5030/8260;
PAL SVOCs	EPA SW-846 Method 8270;
PCBs (filtered and unfiltered)	EPA SW-846 Method 8082; and
PAL Metals (filtered)	EPA SW-846 Methods 6010 and 7470.

10. Internal Quality Control Checks

The overall quality assurance objective for this FSP/QAPP is to develop and implement procedures for sampling, chain of custody, laboratory analysis, instrument calibration, data reduction and reporting, internal QC, audits, preventive maintenance, and corrective action, such that valid data will be generated. These procedures are presented or referenced in the sections of the FSP/QAPP. General field QC checks and laboratory QC checks related to the sampling and analysis planned for these investigations are discussed below. QA/QC limits for laboratory and field QC checks are presented in Table 4.

10.1 Field Quality Control Checks

10.1.1 Field Measurements

To verify the quality of data using field instrumentation, duplicate measurements will be obtained and reported for all field measurements. A duplicate measurement will involve obtaining measurements a second time at the same sampling location. Both results will be recorded in field logs.

10.1.2 Sample Containers

New, certified-clean sample containers (I-Chem 300 series or equivalent) will be supplied by the analytical laboratory. Certificates of analysis demonstrating these containers to be analyte-free will be filed in the project file.

10.1.3 Field Duplicates

Field duplicates will be collected for groundwater and soil samples to check reproducibility of the sampling methods. In general, soil and groundwater sample field duplicates will be analyzed at a 5% frequency (every 20 samples) for the chemical constituents. Specific sampling procedures for collecting field duplicates are included in the appropriate attachments.

10.1.4 Rinse Blanks

Rinse blanks are used to monitor the cleanliness of the sampling equipment and the effectiveness of the cleaning procedures used. Rinse blanks will be prepared and submitted for analysis at a frequency of one per day (when sample equipment cleaning occurs) or once for every 20 samples collected, whichever is more. Rinse blanks will be prepared by filling sample containers with analyte-free water (supplied by the laboratory) which has been routed through a cleaned sampling device. When dedicated sampling devices are used or sample containers are used to collect the samples, rinse blanks will not be necessary.

10.1.5 Trip Blanks

Trip blanks will be used to assess whether samples have been exposed to volatile constituents during sample storage and transport. Trip blanks will be analyzed at a frequency of one per cooler containing groundwater samples to be analyzed for volatile organic constituents. A trip blank will consist of a container filled with analyte-free water (supplied and prepared by the laboratory) which remains unopened with field samples throughout the sampling event. Trip blanks will only be analyzed for volatile organic constituents.

10.2 Laboratory Quality Control Checks

Internal laboratory QC checks will be used to monitor data integrity. These checks will include method blanks, matrix spikes (and matrix spike duplicates), spike blanks, internal standards, surrogate spikes, calibration standards, and reference standards. Project QC limits for duplicates and matrix spikes are identified in Table 4. Laboratory control charts will be used to determine long-term instrument trends.

10.2.1 Method Blanks

Sources of contamination in the analytical process, whether specific analytes or interferences, need to be identified, isolated, and corrected. The method blank is useful in identifying possible sources of contamination within the analytical process. The laboratory will analyze blank samples as a check on possible sample collection, preparation, and analytical background interferences or contamination. At a minimum, one method blank will be prepared and analyzed with each analytical series associated with no more than 20 samples.

10.2.2 Matrix Spikes/Matrix Spike Duplicates

Matrix spikes and matrix spike duplicates will be used to measure the accuracy of organic analyte recovery from the sample matrices. All matrix spikes and matrix spike duplicates will be site-specific. For organic constituents, matrix spike/matrix spike duplicate pairs will be analyzed at a 5% frequency (every 20 samples correlating to one per typical SDG). For inorganics, a matrix spike will also be analyzed at a 5% frequency.

Analytes suggested by the analytical method or by other specific requirements must be spiked into the sample. Selection of the sample to be spiked and/or split depends on the information required and the variety of conditions within a typical matrix. The laboratory's selection will be guided by the objective of spiking which is to determine the extent of matrix bias or interference on analyte recovery. This procedure will be followed for both organic and inorganic chemical analysis, where applicable. Specific spiking procedures for each parameter can be referenced in the analytical method.

When matrix spike recoveries are outside QC limits, associated laboratory control sample and surrogate spikes will be evaluated, as applicable, to attempt to verify the reason for the deviation and determine the effect on the reported sample results.

10.2.3 Surrogate Spikes

Surrogates are compounds unlikely to be found in nature that have properties similar to the analytes of interest. This type of control is primarily used for organic samples analyzed by GC/MS and GC methods and is added to the samples prior to purging or extraction. The surrogate spike is utilized to provide broader insight into the proficiency and efficiency of an analytical method on a sample specific basis. This control reflects analytical conditions which may not be attributable to sample matrix.

Every blank, standard, and environmental sample (including matrix spike/matrix spike duplicate samples) will be spiked with surrogate compounds prior to purging or extraction. Surrogates will be spiked into samples according to the appropriate analytical methods. Dilution of samples to bring analyte concentrations into the linear range of calibration may dilute the surrogates below the quantification limit. Evaluation of analytical quality will then rely on the QC embodied in the standard, spiked, and duplicate spiked samples.

Surrogate spike compounds will be selected utilizing the guidance provided in the analytical methods.

10.2.4 Laboratory Duplicates

For inorganics, laboratory duplicates will be analyzed to assess analytical precision for that parameter. Laboratory duplicates are defined as a second aliquot of an individual sample that is analyzed as a separate sample.

10.2.5 Reference Standards/Control Samples

Reference standards/control samples are standards/samples of known concentration and independent origin from the calibration standards. The intent of reference/control sample analysis is to provide insight into the analytical proficiency within an analytical series. This includes the preparation of calibration standards, the validity of the calibration, sample preparation, instrument performance, and in quantitation. Reference standards will be analyzed at the frequencies specified in the analytical methods.

10.2.6 Calibration Standards

Calibration standards analyzed within a particular analytical series provide insight regarding the instruments' stability. The initial calibration established the linearity and working range of the instrument. The calibration verification standard verifies the instrument's daily or continuing performance is within acceptable tolerances. In general, calibration verification standards will be analyzed at the start of the analytical series and again for every 12 hours of continuing analysis, or more frequently as specified in the applicable analytical method. In analyses where internal standards are used (i.e., GC/MS and some GC methods), calibration verification standard analysis is required only at the beginning of the 12-hour series. For analyses that employ external standards, calibration verification standard analysis is required at both the beginning and end of the analytical series. If the results of the final calibration verification standard exceed the specified tolerances, then all samples analyzed since the last acceptable standard must be reanalyzed.

Laboratory instrument calibration standards will be selected utilizing the guidance provided in the analytical methods, as discussed in Section 7.

11. Data Reduction, Validation, and Reporting

11.1 Data Management

An integral overall part of the data reduction, validation, and reporting process is data management. The following subsection discusses data management guidance to be used for the Site investigations.

The purpose of the data management is to assure that all of the necessary data are accurate and readily accessible to meet the analytical and reporting objectives of the project. The field investigations will encompass a large number of samples and variety of sample matrices and analytes from a large geographic area. From the large amount of resulting data, the need arises for a structured, comprehensive, and efficient program for management of Site data.

Sampling activities will include analyses for PAL VOCs, PAL SVOCs, PCBs, and PAL metals. The data management program established for the project includes field documentation and sample QA/QC procedures, methods for tracking and managing the data, and a system for filing all site-related information. More specifically, data management procedures will be employed to efficiently process the information collected such that the data are readily accessible and accurate. These procedures are described in detail in the following section.

The data management plan specifies methods for data collection, storage and retrieval, presentation, and security, as well as document control.

11.1.1 Sample Designation System

A concise and easily understandable sample designation system is an important part of the project sampling activities. It provides a unique sample number that will facilitate both sample tracking and easy re-sampling of select locations to evaluate data gaps, if necessary. The sample designation system to be employed during the sampling activities will be consistent, yet flexible enough to accommodate unforeseen sampling events or conditions. A combination of letters and numbers will be used to yield a unique sample number for each field sample collected, as outlined in Section 6.

11.1.2 Field Activities

Field activities designed to gather the information necessary to make decisions regarding the Site require consistent documentation and accurate record keeping. During Site activities, standardized procedures will be used for documentation of field activities, data security, and QA. These procedures are described in further detail in the following subsections.

11.1.3 Field Documentation

Complete and accurate record keeping is a critical component of the field investigation activities. When interpreting analytical results and identifying data trends, investigators realize that field notes are an important part of the review and validation process. To assure that all aspects of the field investigation are thoroughly documented, several different information records, each with its own specific reporting requirements, will be maintained, including:

- Field logs;
- Instrument calibration records; and
- Chain of custody forms.

A description of each of these types of field documentation is provided below.

Field Logs

The personnel performing the field activities will keep field logs which detail all observations and measurements made during the remedial investigation. Data will be recorded directly into Site-dedicated, bound notebooks, with each entry dated and signed. To assure at any future date that notebook pages are not missing, each page will be sequentially numbered. Erroneous entries will be corrected by crossing out the original entry, initialing it, and then documenting the proper information. In addition, certain media sampling locations will be surveyed to accurately record their locations. The survey crew will use their own field logs and will supply the sampling location coordinates to the File Custodian. Additional logs such as boring logs, test pit logs, and monitoring well logs may also be used to supplement the information found in the field logs.

The field logbook will be a bound document with consecutively numbered pages. The entries for each day commence on a new page which will be dated. All entries will be made only in indelible ink. Corrections will be made by marking through the error with a single line, so as to remain legible, and initialing this action followed

by writing the correction. The field logbooks generated will be numbered consecutively and maintained by the on-site BBL representative. The field logbook will be supplemented, as appropriate, by field forms.

The following information will be recorded in the field logbook or field forms for each sample collected:

- Site location identification;
- Unique sample identification number;
- Date and time (in 2400-hour time format) of sample collection;
- Weather conditions;
- Designation as to the type of sample;
- Designation as to the means of collection;
- Name of sampler;
- Analyses to be performed on sample; and
- Any other relevant comments such as odor, staining, texture, filtering, preservation, etc.

Instrument Calibration Records

As part of data quality assurance procedures, field monitoring and detection equipment will be routinely calibrated. Instrument calibration ensures that equipment used is of the proper type, range, accuracy, and precision to provide data compatible with the specified requirements and desired results. Calibration procedures for the various types of field instrumentation are described in Section 8 and in the associated attachments. In order to demonstrate that established calibration procedures have been followed, calibration records will be prepared and maintained to include, as appropriate:

- Calibration date and time;
- Type and identification number of equipment;
- Calibration frequency and acceptable tolerances;
- Identification of individual(s) performing calibration;
- Reference standards used;
- Calibration data; and
- Information on calibration success or failure.

The calibration record serves as a written account of monitoring or detection equipment quality assurance. All erratic behavior or failures of field equipment will be subsequently recorded in the calibration log.

Chain of Custody Forms

Chain of custody forms are used as a means of documenting and tracking sample possession from time of collection to the time of disposal. A chain of custody form will accompany each field sample collected, and one copy of the form will be filed in the field office. All field personnel will be briefed on the proper use of the chain of custody procedure. A copy of a chain of custody form can be found in Attachment A.

Chain of custody records will be used to track all samples from time of sampling to the arrival of samples at the laboratory.

Each shipping container being sent to the laboratory will contain a chain of custody form. The chain of custody form consists of four copies which are distributed to the sampler, to the shipper, to the contract laboratory and to the office file of BBL. The sampler and shipper will maintain their copies while the other two copies are enclosed in a waterproof enclosure within the sample container. The laboratory, upon receiving the samples, will complete the remaining copies. The laboratory will maintain one copy for its records. The executed original will be returned to BBL with the data deliverables package.

Sample Containers and Handling

Required sample containers, sample preservation methods, maximum holding times and filling instructions are provided in Section 7.

All samples will be placed in appropriate sample containers, labeled, tagged, and properly sealed. In addition, sample labels and sample tags (which will be affixed to the neck with a wire) will include sample number, place of collection, date and time of collection and analyses to be performed. Samples will be cushioned within the shipping coolers by the use of vermiculite and/or bubble pack. Samples will be kept cool by the use of plastic bags of ice or cooler packs, as required, and each sample will have an individual sample tag.

Samples will be shipped by commercial courier on a daily basis to the project laboratory.

Two seals comprised of BBL's chain of custody tape and/or the sampler's name will be placed around each shipping cooler prior to shipment to secure the lid and provide evidence that the samples have not been tampered with en route to the laboratory. Clear tape will be placed over the seals to ensure that they are not accidentally broken during shipment.

Upon receipt of the cooler at the laboratory, the cooler will be inspected by the designated sample custodian. The condition of the cooler and seal will be noted on the chain of custody form by the sample custodian. The sample custodian will document the date and time of receipt of the cooler and sign the chain of custody forms.

The sample custodian then will check the contents of the cooler with those samples listed on the chain of custody form. If damage or discrepancies are noticed, they will be recorded in the remarks column of the chain of custody form, dated and signed. They will be reported to the laboratory supervisor who will inform the laboratory manager and QA Officer.

Sample disposal will be the responsibility of the laboratory. Upon disposal, the laboratory shall sign the next open "Relinquished by" box, and the word "Disposed" shall be written in the "Received by" box.

11.1.4 Data Security

Measures will be taken during the field investigation to assure that samples and records are not lost, damaged, or altered. When not in use, all field notebooks will be stored at the field office in a locked, fireproof cabinet. Access to these files will be limited to the field personnel who utilize them.

11.1.5 Sample Management and Tracking

A record of all field documentation, as well as analytical and QA/QC results, will be maintained to ensure the validity of data used in the Site analysis. To effectively execute such documentation, carefully constructed sample tracking and data management procedures will be used throughout the sampling program.

Sample tracking begins with the completion of chain of custody forms as summarized in Section 7. On a daily basis, the completed chain of custody forms associated with samples collected that day will be faxed from the project office to the Quality Assurance Manager (QAM). Copies of all completed chain of custody forms will be maintained in the field office.

When analytical data are received from the laboratory, the QAM will review the incoming analytical data packages against the information on the chain of custody forms to confirm that the correct analyses were performed for each sample and that results for all samples submitted for analysis are received. Any discrepancies noted will be promptly followed up by the QAM.

11.1.6 Data Management System

In addition to the sample tracking system, a data management system will be implemented. The central focus of the data management system will be the development of a personal computer-based, project database using EarthSoft, Inc.'s EQUiS software. The project database, to be maintained by the Database Administrator, will combine pertinent geographical, field and analytical data. Information that will be used to populate the database will be derived from three primary sources: surveying of sampling locations, field observations, and analytical results. Each of these sources are discussed in the following sections.

11.1.7 Computer Hardware

The database will be constructed on Pentium (or equivalent) based personal computer workstations connected through a Novell network server. The Novell network will provide access to various hardware peripherals, such as laser printers, backup storage devices, image scanners, modems, etc. Computer hardware will be upgraded to industrial and corporate standards as necessary in the future.

11.1.8 Computer Software

The database will be developed and maintained using EQUiS software. Custom applets, such as diskette importing and data tabulation programs, will be written in either Microsoft VBA or Microsoft Visual Basic 5.0. Tables and other database reports will be generated through Microsoft Access in conjunction with EQUiS, Microsoft Excel, Microsoft Word and/or Seagate Crystal Reports. These software products will be upgraded to current industrial standards, as they become necessary.

11.1.9 Surveying Information

In general, each location sampled as part of the Site investigation will be surveyed to ensure accurate documentation of sample locations for mapping purposes, to facilitate the resampling of select sample locations during future monitoring programs, if needed, and for any potential remediation activities. Exceptions to this

general rule includes biota sampling locations (which will be identified by geographical designation). The surveying activities that will occur in the field will consist of the collection of information that will be used to compute northing and easting in-state plane coordinates for each sample location and the collection of information to compute elevations relative to the National Geodetic Vertical Datum of 1988 for select sample locations, as appropriate. All field books associated with the surveying activities will be stored as a record of the project activities.

Conventional surveying techniques will be used to gather information such as the angle and distance between the sample location and the control monument, as well as point attributes. This information will be digitally stored in a data logger attached to the total station. Periodically, each data logger in use will be transferred to the BBL Syracuse office where the information will be downloaded into a personal computer for processing with surveying software. Control monuments will be established using global positioning system (GPS) techniques. The surveying software permits the rapid computation of a location's state plane coordinates.

Differential leveling techniques will be used to gather information to be used to compute a sample location's (or top of casing for groundwater monitoring wells) elevation. During the differential leveling process, which includes at least one benchmark of known elevation, detailed field notes will be kept in a field book. On a regular basis, copies of the relevant pages will be forwarded to Syracuse where the relevant information will be manually keyed into BBL surveying software package for further processing. The surveying software reduces the field notes and calculates a location's elevation relative to the project datum.

Following computation of a location's state plane coordinates and, at select locations, elevations the computer information will undergo a QA/QC review by a licensed land surveyor. Following the approval of the computed information, the coordinates and elevations will be transferred to the File Custodian both in a digital and a hard copy format. This data will then be loaded into a database table and linked to the field and analytical data using primary key fields.

11.1.10 Field Observations

An important part of the information that will ultimately reside in the data management system for use during the project will originate in the observations that are recorded in the field. All pertinent field data will be manually entered, via a custom database input form, into the appropriate database tables from the chain of custody forms and field notebooks.

11.1.11 Analytical Results

Analytical results provided by the laboratory will generally be available in both a digital and a hard copy format. Upon receipt of each analytical package the original chain of custody form will be placed in the project files. The data packages will be examined to assure that the correct analyses were performed for each sample submitted and that all of the analyses requested on the chain of custody form were performed. If discrepancies are noted, the QAM will be notified and will promptly follow up with the laboratory to resolve any issues.

Each data package will be reviewed in accordance with the procedures presented below. Any data that does not meet the specified standards will be flagged pending resolution of the issue. The flag will not be removed from the data until the issue associated with the sample results is resolved. Although flags may remain for certain data, the use of that data may not necessarily be restricted. Following completion of the data review, the digital files of analytical data will be processed to populate the appropriate EQUiS database tables.

The individual electronic data deliverables (EDDs) supplied by the laboratory will be prepared based on the USEPA Region V EDD format specifications (USEPA Region V Electronic Data Deliverable Version 1.0 [V-12a], dated August 2000) and will be loaded into the appropriate project database. Any analytical data that cannot be provided by the laboratory in electronic format will be entered manually. After entry into the EQUiS database, the EDD data will be compared to the field information previously entered into the database to confirm that all requested analytical data have been received.

11.1.12 Data Analysis and Reporting

A valuable function of the data management system will be the generation of tables of analytical results from the EQUiS databases. The capability of the data management system to directly produce tables reduces the redundant manual entry of analytical results during report preparation and precludes transcription errors that may occur otherwise. The data management system function creates a file of analytical results and qualifiers for a given media. The file is then processed through a spreadsheet that transforms the file into a table of rows and columns. The digital spreadsheet file is then formatted for presentation and titles and notes are added. Tables of analytical data will be produced as part of data interpretation tasks, the reporting of data, and the generation of the Site Investigation Report.

Another function of the data management system will be to create digital files of analytical results and qualifiers suitable for transfer to mapping/presentation software. A function has been created by BBL that creates a digital file consisting of sample location number, state plane coordinates, sampling date, and detected constituents and associated concentrations and analytical qualifiers. The file is then transferred to an AutoCAD work station where another program has been developed to plot a location's analytical data in a "box" format at the sample location (represented by the state plane coordinates). This routine greatly reduces the redundant keypunching of analytical results and facilitates the efficient production of interpretative and presentation graphics.

The data management system also has the capability of producing a digital file of select parameters that exist in one or more of the databases. This type of custom function is accomplished on an interactive basis and is best used for transferring select information into a number of analysis tools such as statistical or graphing programs.

11.1.13 Document Control and Inventory

BBL maintains project files in its Syracuse, New York, office. Each client project is assigned a file/job number (e.g., for Site investigation activities, 644.10). Each file is then broken down into the following subfiles:

#1- Agreements and Contracts - all agreements and contracts involving the Site;
#2- Correspondence - all external correspondence, including reports;
#3- Memoranda - all internal and external memoranda;
#4- Notes and Data - notes and data from field, laboratory, and internal calculations; and
#5- News Clippings - local newspapers, USEPA publications, and technical publications are sources of articles.

Originals, when possible, are placed in the files. These are the central files and will serve as the site-specific files for the Site.

11.2 Data Reduction and Review

After field and laboratory data are obtained, the data will be subject to the following:

- Reduction or manipulation mathematically or otherwise into meaningful and useful forms;
- Review;
- Organization, interpretation, and reporting; and
- Data validation.

11.3 Field Data Reduction and Review

11.3.1 Field Data Reduction

Information collected in the field through visual observation, manual measurement and/or field instrumentation will be recorded in field notebooks or data sheets, and/or on forms. Such data will be reviewed by the appropriate Task Manager for adherence to the soil and groundwater investigations scopes of work and for consistency. Concerns identified as a result of this review will be discussed with the field personnel, corrected if possible, and as necessary, incorporated into the data evaluation process.

Specific data reduction activities which will be performed for the soil investigation include identification of subsurface layers and calculation of depths/thickness based on soil boring activities. Reduction of the field data collected during the groundwater investigation will include the calculation of potentiometric elevations in monitoring wells by subtracting the depth-to-water data from the surveyed elevation of the measuring point (i.e., top of casing).

11.3.2 Field Data Review

Field data calculations, transfers, and interpretations will be conducted by the field personnel and reviewed for accuracy by the appropriate Task Manager and the QAM. All logs and documents will be checked for:

- General completeness;
- Readability;
- Usage of appropriate procedures;
- Appropriate instrument calibration and maintenance;
- Reasonableness in comparison to present and past data collected;
- Correct sample locations; and
- Correct calculations and interpretations.

Where appropriate, field data forms and calculations will be processed and included in attachments to the soil and groundwater investigations reports.

11.4 Laboratory Data Reduction and Review

11.4.1 Laboratory Data Reduction

The calculations used for data reduction are specified in each of the analytical methods referenced previously. Whenever possible, analytical data is transferred directly from the instrument to a computerized data system. Raw data is entered into permanently bound laboratory notebooks. The data entered are sufficient to document all factors used to arrive at the reported value.

Concentration calculations for chromatographic analyses (i.e., VOCs, SVOCs, and PCBs) are based on response factors. Quantitation is performed using either internal or external standards.

Inorganic analyses are based on regression analysis. Regression analysis is used to fit a curve through the calibration standard data. The sample concentrations are calculated using the resulting regression equations.

Nonaqueous values are reported on a dry-weight basis. Unless otherwise specified, all values are reported uncorrected for blank contamination.

11.4.2 Laboratory Data Review

All data are subject to multi-level review by the laboratory. The group leader reviews all data reports prior to release for final data report generation. The QAM reviews the final data reports before releasing them to the laboratory Project Manager who reviews all final reports prior to shipment to BBL.

If discrepancies or deficiencies exist in the analytical results, then corrective action will be taken. Deficiencies discovered as a result of internal data review, as well as the corrective actions to be used to rectify the situation, will be documented on a Corrective Action Form. This form will be submitted to the BBL Project Manager.

11.5 Data Validation

Validation for data associated with the soil and groundwater investigations will be performed following a tiered approach. The tiers are defined as follows:

Tier 1: A completeness review is performed and, in addition, the results of all QC checks and procedures are evaluated and used to assess and qualify sample results. Tier 1 validation is performed primarily from information contained on the EDD and will be performed using the EarthSoft, Inc. EQUiS Data Verification Module (DVM).

Tier 2: Validation based on Region 3's *Innovative Approaches to Data Validation* for data review.

It is currently proposed that all data will undergo Tier 1 validation using the EQUiS DVM and 100 percent of the data will undergo Tier 2 validation utilizing the M-2 (organic) and IM-1 (inorganic) methods.

Under Tier 1 validation, the following procedures will be executed by the data validator using the EQUiS DVM:

- Evaluate completeness of data package;
- Verify that field chain of custody forms were completed and that samples were handled properly;
- Verify that holding times were met for each parameter. Holding time exceedances, should they occur, will be documented. Data for all samples exceeding holding time requirements will be flagged as either estimated or rejected. The decision as to which qualifier is more appropriate will be made on a case-by-case basis;
- Verify that parameters were analyzed according to the methods specified;
- Review QA/QC data (e.g., make sure duplicates, blanks, and spikes were analyzed on the required number of samples, as specified in the method, verify that duplicate and matrix spike recoveries are acceptable); and
- Investigate anomalies identified during review. When anomalies are identified, they will be discussed with the Project Manager and/or Laboratory Manager, as appropriate.

Deficiencies discovered as a result of the data review, will be documented and submitted in the form of a checklist with supplemental text descriptions of anomalies.

Data validation reports will be included as an appendix to the Subsurface Investigation Report, if appropriate, and kept in the project file at the BBL office in Syracuse, New York.

BBL will validate the analytical data using the most recent versions of the USEPA Region 3's *Innovative Approaches to Data Validation* for data validation available at the time of project initiation as guidance, where appropriate. These procedures and criteria may be modified as necessary to address project-specific and method-specific criteria, control limits, and procedures. Tier 2 data validation will consist of data screening, checking, reviewing, editing, and interpretation to document analytical data quality and to determine if the quality is sufficient to meet the data quality objectives.

11.6 Reconciliation and User Requirements

The data results will be examined to determine the performance that was achieved for each data usability criteria. The performance will then be compared with the project objectives. Of particular note will be samples at or near action levels. All deviations from objectives will be noted. Additional action may be warranted when performance does not meet performance objectives for critical data. Action options may include any or all of the following:

- Retrieval of missing information;
- Request for additional explanation or clarification;
- Reanalysis of sample from extract (when appropriate); and
- Recalculation or reinterpretation of results by lab.

These actions may improve the data quality and reduce uncertainty and may eliminate the need to qualify or reject data. If these actions do not improve the data quality to an acceptable level, the following actions may be taken:

- Extrapolation of missing data from existing data points;
- Use of historical data; and
- Evaluation of the critical/noncritical nature of the sample.

If the data gap can not be resolved by these actions, an evaluation of the data bias and potential for false negatives and positives can be performed. If the resultant uncertainty level is unacceptable, then additional sample collection and analysis must be performed.

11.7 Laboratory Documentation

11.7.1 Laboratory Project Files

The laboratory will establish a file for all pertinent data. The file will include all correspondence, faxed information, phone logs and chain of custody forms. The laboratory will retain all project files and data packages for a period of five years.

11.7.2 Laboratory Logbooks

Workbooks, bench sheets, instrument logbooks, and instrument printouts, are used to trace the history of samples through the analytical process, and to document and relate important aspects of the work, including the associated QCs. As such, all logbooks, bench sheets, instrument logs, and instrument printouts are part of the permanent record of the laboratory.

Each page or entry is dated and initialed by the analyst at the time of entry. Errors in entry are crossed out in indelible ink with a single stroke, corrected without the use of correction fluid or by obliterating or writing directly over the erroneous entry, and initialed and dated by the individual making the correction. Pages of logbooks that are not used are completed by lining out unused portions.

Information regarding the sample, analytical procedures performed, and the results of the testing will be recorded on laboratory forms or personal notebook pages by the analyst. These notes will be dated, and will also identify the analyst, the instrument used, and the instrument conditions.

Laboratory notebooks are periodically reviewed by the laboratory group leaders for accuracy, completeness, and compliance to this FSP/QAPP. All entries and calculations are verified by the laboratory group leader. If all entries on the pages are correct, then the laboratory group leader initials and dates the pages. Corrective action is taken for incorrect entries before the laboratory group leader signs.

11.7.3 Computer Tape and Hard Copy Storage

All electronic files are maintained on magnetic tape or diskette for five years, hard copy data packages are maintained in files for five years.

11.8 Data Reporting Requirements

11.8.1 Laboratory Data Reporting

The laboratory is responsible for preparing full "CLP-type" data packages for all VOC, SVOC, PCB, and PAL metals data, and reduced data packages and case narratives for all other analyses.

All data reports for all parameters will include, at a minimum, the following items:

Narrative: Summary of activities that took place during the course of sample analysis, including the following information:

- Laboratory name and address;
- Date of sample receipt;
- Cross reference of laboratory identification number to contractor sample identification;
- Analytical methods used;
- Deviations from specified protocol; and
- Corrective actions taken.

Included with the narrative are any sample handling documents including field and internal chain of custody forms, air bills, and shipping tags.

Analytical Results: Reported according to analysis type, and including the following information, as acceptable:

- Sample ID;
- Laboratory ID;
- Date of collection;
- Date of receipt;
- Date of extraction;
- Date of analysis; and
- Detection limits.

Sample results on the report forms will be corrected for dilutions. Soil samples will be reported on a dry weight basis normally in units of micrograms per kilogram (µg/kg) for organic parameters and milligrams per kilogram (mg/kg) for inorganic parameters. Aqueous samples will be reported normally in units of micrograms per liter (µg/L). Unless otherwise specified, results will be reported uncorrected for blank contamination.

The data for PAL VOC, PAL SVOC, PCB, and PAL metals analyses will be expanded to include all supporting documentation necessary to provide a "CLP-equivalent" package. This additional documentation includes, but is not limited to, all raw data required to recalculate any result including printouts, chromatograms, and quantitation reports. The report will also include: standards used in calibration and calculation of analytical results; sample extraction, digestion, and other preparation logs; standard preparation logs; instrument run logs; and moisture content calculations.

11.9 Project File

Project documentation will be placed in a single project file at the BBL office in Syracuse, New York. This file will consist of the following components:

1. Agreements (filed chronologically);
2. Correspondence (filed chronologically);
3. Memos (filed chronologically); and
4. Notes and data (filed by topic).

Reports (including QA reports) will be filed with correspondence. Analytical laboratory documentation (when received) and field data will be filed with notes and data. Filed materials may be removed and signed out by authorized personnel on a temporary basis only.

12. Performance and System Audits

12.1 General

Performance and systems audits will be completed in the field and the laboratory during the performance of soil and groundwater investigations activities as described below.

12.2 Field Audits

The following field performance and systems audits will be completed during soil and groundwater investigations.

The appropriate Task Manager will monitor field performance. Field performance audit summaries will contain an evaluation of field measurements and field meter calibrations to verify that measurements are taken according to established protocols. The QAM will review all field reports and communicate concerns to the Project Manager and/or Task Managers, as appropriate. In addition, the QAM will review the rinse and trip blank data to identify potential deficiencies in field sampling and cleaning procedures. In addition, systems audits comparing scheduled QA/QC activities from this document with actual QA/QC activities completed will be performed. The appropriate Task Manager and QAM will periodically confirm that work is being performed consistent with this FSP/QAPP, the scope of work associated with the soil and groundwater investigations programs, and Health and Safety Plan (HASP).

12.3 Laboratory Audits

Internal laboratory audits are conducted by the laboratory's QA manager. As part of the audit, the overall performance of the laboratory staff is evaluated and compared to the performance criteria outlined in the laboratory's QA manual and SOPs. The results of the audits are summarized and issued to each department supervisor, the laboratory manager and the laboratory director. A systems audit of each laboratory is also performed by the QA manager to determine if the procedures implemented by each laboratory are in compliance with the QA plan.

In addition to the laboratory's internal audits, a participant in state and federal certification programs, the laboratory is audited by representatives of the regulatory agency issuing certification. Audits are usually conducted on an annual basis and focus on laboratory conformance to the specific program protocols for which the laboratory is

seeking certification. The auditor reviews sample handling and tracking documentation, analytical methodologies, analytical supportive documentation, and final reports. The audit findings are formally documented and submitted to the laboratory for corrective action, if necessary.

BBL reserves the right to conduct an on-site audit of the laboratory prior to the start of analyses for the project. Additional audits may be performed during the course of the project, as deemed necessary.

13. Preventive Maintenance

13.1 General

Testing and maintenance schedules have been developed for both field and laboratory instruments. A summary of the testing and maintenance activities to be performed is presented below.

13.2 Field Instruments and Equipment

Prior to any field sampling, each piece of field equipment will be inspected to assure it is operational. If the equipment is not operational, it must be serviced prior to use. All meters which require charging or batteries will be fully charged or have fresh batteries. If instrument servicing is required, it is the responsibility of the appropriate Task Manager or field personnel to follow the maintenance schedule and arrange for prompt service.

Field instrumentation to be used in this study includes a PID, pH/conductivity/temperature/turbidity/dissolved oxygen meter to measure VOCs, pH, conductivity, turbidity, and temperature and a dissolved oxygen meter to measure dissolved oxygen. A logbook will be kept for each field instrument. Each logbook contains records of operation, maintenance, calibration, and any problems and repairs. The Subsurface Investigation Task Managers will review calibration and maintenance logs.

Field equipment returned from a Site will be inspected to confirm it is in working order. This inspection will be recorded in the logbook or field notebooks as appropriate. It will also be the obligation of the last user to record any equipment problems in the logbook.

Non-operational field equipment will be either repaired or replaced. Appropriate spare parts will be made available for field meters. Details regarding field equipment maintenance, operation, and calibration are provided in Attachments E and K.

13.3 Laboratory Instruments and Equipment

Laboratory instrument and equipment maintenance procedures are provided in the laboratory's QA manual and associated standard operating procedures (SOPs). Documentation includes details of any observed problems,

corrective measures, routine maintenance, and instrument repair, including information regarding the repair and the individual who performed the repair.

Preventive maintenance of laboratory equipment generally will follow the guidelines recommended by the manufacturer. A malfunctioning instrument will be repaired immediately by in-house staff or through a service call from the manufacturer. Specific procedures used by the laboratory are discussed below.

Maintenance schedules for laboratory equipment adhere to the manufacturer's recommendations. Records reflect the complete history of each instrument and specify the time frame for future maintenance. Major repairs or maintenance procedures are performed through service contracts with manufacturer or qualified contractors. All paperwork associated with service calls and preventive maintenance calls are kept on file by the laboratory.

The laboratory analysts are responsible for the routine maintenance of instruments used in the particular laboratory. Any routine preventative maintenance carried out is logged into the appropriate logbooks. The frequency of routine maintenance is dictated by the nature of samples being analyzed, the requirements of the method used, and the judgment of the analysts and department managers.

All major instruments are backed up by comparable (if not equivalent) instrument systems in the event of unscheduled downtime. An inventory of spare parts is also available to minimize equipment/instrument downtime.

13.4 Inspection/Acceptance Requirements for Supplies and Consumables

All standards, solvents and reagents will be logged and dated upon receipt. Standards will be discarded after the maximum recommended holding time has expired or when analysis indicates that the standard has degraded beyond acceptable tolerances. All solvents and reagents will be used on a revolving "first in, first out" basis to minimize storage time and the potential for degradation and/or contamination.

Each lot of solvents and reagents will be tested, through the use of method blanks, to assess the presence or absence of contaminants and interferents. If contamination is noted, confirmatory analyses will be performed. If the contamination is confirmed, the lot will be discarded.

14. Specific Routine Procedures Used to Assess Data Precision, Accuracy, and Completeness

Quality assurance indicators are generally defined in terms of five parameters:

1. Representativeness;
2. Comparability;
3. Completeness;
4. Precision; and
5. Accuracy.

Each parameter is defined below. Specific objectives for the Site actions are set forth in other sections of this FSP/QAPP as referenced below.

14.1 Representativeness

Representativeness is the degree to which sampling data accurately and precisely represent Site conditions, and is dependent on sampling and analytical variability and the variability of environmental media at the Site. The actions have been designed to assess the presence of the chemical constituents at the time of sampling. This FSP/QAPP presents field sampling methodologies and laboratory analytical methodologies. The use of the prescribed field and laboratory analytical methods with associated holding times and preservation requirements are intended to provide representative data.

14.2 Comparability

Comparability is the degree of confidence with which one data set can be compared to another. Comparability between phases of the actions (if additional phases are required) will be maintained through consistent use of the sampling and analytical methodologies set forth in this FSP/QAPP and through the use of established QA/QC procedures, and the utilization of appropriately trained personnel.

14.3 Completeness

Completeness is defined as a measure of the amount of valid data obtained from an event and/or investigation compared to the total amount that was obtained. This will be determined upon final assessment of the analytical results.

14.4 Precision

Precision is a measure of the reproductability of sample results. The goal is to maintain a level of analytical precision consistent with the objectives of the action. To maximize precision, sampling and analytical procedures will be followed. All work for the soil and groundwater investigations will adhere to established protocols presented in the FSP/QAPP. Checks for analytical precision will include the analysis of matrix spike, matrix spike duplicates, laboratory duplicates, and field duplicates. Checks for field measurement precision will include obtaining duplicate field measurements.

14.5 Accuracy

Accuracy is a measure of how close a measured result is to the true value. Both field and analytical accuracy will be monitored through initial and continuing calibration of instruments. In addition, reference standards, matrix spikes, blank spikes, and surrogate standards will be used to assess the accuracy of the analytical data.

14.6 Data Precision Assessment Procedures

Field precision is difficult to measure because of temporal variations in field parameters. However, precision will be controlled through the use of experienced field personnel, properly calibrated meters, and duplicate field measurements. Field duplicates will be used to assess precision for the entire measurement system, including sampling, handling, shipping, storage, preparation, and analysis.

Laboratory data precision for organic analyses will be monitored through the use of matrix spike/matrix spike duplicate sample analyses. For other parameters, laboratory data precision will be monitored through the use of field duplicates and/or laboratory duplicates.

The precision of data will be measured by calculation of the relative percent difference (RPD) by the following equation:

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

Where:

A = Analytical result from one of two duplicate measurements

B = Analytical result from the second measurement.

Precision objectives for duplicate analyses are identified in Table 4.

14.7 Data Accuracy Assessment Procedures

The accuracy of field measurements will be controlled by experienced field personnel, properly calibrated field meters, and adherence to established protocols. The accuracy of field meters will be assessed by review of calibration and maintenance logs.

Laboratory accuracy will be assessed via the use of matrix spikes, surrogate spikes and reference standards. Where available and appropriate, QA performance standards will be analyzed periodically to assess laboratory accuracy. Accuracy will be calculated in terms of percent recovery as follows:

$$\% \text{ Recovery} = \frac{A-X}{B} \times 100$$

Where:

A = Value measured in spiked sample or standard

X = Value measured in original sample

B = True value of amount added to sample or true value of standard

This formula is derived under the assumption of constant accuracy between the original and spiked measurements. Accuracy objectives for matrix spike recoveries are identified in Table 4.

14.8 Data Completeness Assessment Procedures

Completeness of a field or laboratory data set will be calculated by comparing the number of valid sample results generated to the total number of results generated.

$$\text{Completeness} = \frac{\text{Number Valid Results}}{\text{Total number of results generated}} \times 100$$

As a general guideline, overall project completeness is expected to be at least 90%. The assessment of completeness will require professional judgment to determine data usability for intended purposes.

15. Corrective Action

Corrective actions are required when field or analytical data are not within the objectives specified in this FSP/QAPP, or the identified work activities associated with the Soil and groundwater investigations. Corrective actions include procedures to promptly investigate, document, evaluate, and correct data collection and/or analytical procedures. Field and laboratory corrective action procedures for the actions are described below.

15.1 Field Procedures

When conducting the soil and groundwater investigations field work, if a condition is noted that would have an adverse effect on data quality, corrective action will be taken so as not to repeat this condition. Condition identification, cause, and corrective action implemented will be documented on a Corrective Action Form and reported to the appropriate Task Manager, QAM, and Project Manager.

Examples of situations which would require corrective actions are provided below:

- Protocols as defined by the FSP/QAPP and specific soil and groundwater investigations work activities have not been followed;
- Equipment is not in proper working order or properly calibrated;
- QC requirements have not been met; and
- Issues resulting from performance or systems audits.

Project personnel will continuously monitor ongoing work performance in the normal course of daily responsibilities.

15.2 Laboratory Procedures

In the laboratory, when a condition is noted to have an adverse effect on data quality, corrective action will be taken so as not to repeat this condition. Condition identification, cause, and corrective action to be taken will be documented, and reported to the appropriate Project Manager and QAM. The laboratory's Quality Assurance Plan (Attachment T) provides internal guidance for laboratory corrective actions.

Corrective action may be initiated, at a minimum, under the following conditions:

- Protocols as defined by this FSP/QAPP have not been followed;
- Predetermined data acceptance standards are not obtained;
- Equipment is not in proper working order or calibrated;
- Sample and test results are not completely traceable;
- QC requirements have not been met; and
- Issues resulting from performance or systems audits.

Laboratory personnel will continuously monitor ongoing work performance in the normal course of daily responsibilities. Additional details of corrective action procedures to be used by CT&E are provided below.

For all instrument systems, corrective action is initiated at a point were the problem has been identified. At whatever level this occurs (analyst, supervisor, data review, or QC), it is brought to the attention of the QA manager and, ultimately, the laboratory director. Final approval of any action deemed necessary is subject to the approval of the laboratory director.

Any corrective action deemed necessary based on system or performance audits, the analytical results of split samples or the results of data review will be implemented. The corrective action may include sample re-extraction, re-preparation, re-analysis, cleanup, dilutions, matrix modifications, or other activities.

The process of corrective action will follow the guidelines listed below, as deemed appropriate:

1. Identification and definition of the problem;
2. Assignment of responsibility for investigating the problem;
3. Investigation and determination of the cause of the problem;
4. Determination of a corrective action to eliminate the problem;
5. Assigning and accepting responsibility for implementing the corrective action;
6. Implementing the corrective action and evaluating its effectiveness; and
7. Verifying that the corrective action has eliminated the problem.

16. Quality Assurance Reports to Management

The BBL and GM Project Managers will receive reports on the performance of the measurement system and data quality following each sampling round and at the conclusion of the project.

Minimally, these reports will include:

- assessment of measurement quality indicators (i.e, data accuracy, precision, and completeness);
- results of system and performance audits; and
- QA problems, corrective action taken, and resolutions.

The BBL QA Officer will be responsible for preparing these reports for submission. The final report for the project will also include a separate QA section that will summarize data quality information contained in the periodic QA reports to management and details on overall data assessment and validation in accordance with the DQOs outlined in Section 5.

Glossary

AOI	Area of Interest
BBL	Blasland, Bouck & Lee, Inc.
BFB	p-Bromofluorobenzene
CCV	continuing calibration verification
CF	calibration factor
CLP	Contract Laboratory Program
CCC	calibration check compound
CCV	continuing calibration verification
CT&E	CT&E Environmental Laboratory
DFTPP	decafluoro-triphenyl phosphine
DNAPL	dense nonaqueous phase liquid
DO	dissolved oxygen
DQO	data quality objective
DVM	data verification module
EDD	electronic data deliverable
GC	gas chromatography
GC/MS	gas chromatography/mass spectrometry
GIS	geographic information system
GM	General Motors Corporation
GPR	ground-penetrating radar
GPS	global positioning system
HASP	Health and Safety Plan
ICB	initial calibration blank
ICP	inductively coupled plasma
ICV	initial calibration verification
LNAPL	light nonaqueous phase liquid
MDL	Method Detection Limit
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MS	matrix spike
MSD	matrix spike duplicate
NAPL	nonaqueous phase liquid
NEIC	National Enforcement Investigations Center
ng	nanogram
NIST	National Institute of Science and Technology
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Management
PAL	Project Analyte List
PCBs	polychlorinated biphenyls
PID	photoionization detector
PNA	polynuclear aromatics
PVC	polyvinyl chloride
QAM	Quality Assurance Manager
QAP	Quality Assurance Plan
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control

RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RPD	relative percent difference
RRF	relative response factor
RSD	relative standard deviation
SDG	sample delivery group
SOP	standard operating procedure
SPCC	system performance check compound
SU	standard units
SVOC	semivolatile organic compound
USGS	U.S. Geological Survey
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compound

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Tables

TABLE 1

ANALYTICAL METHODS, SAMPLE CONTAINER, PRESERVATION, AND HOLDING TIME REQUIREMENTS

Parameter	Analytical Method	Extraction Method	Cleanup Method	Sample Container[1]	Sample Volume	Preservation[2]	Maximum Holding Time[3]
WATER SAMPLES							
Volatile Organic Compounds	SW-846 Method 8260B	5030B Purge & Trap	-	Glass, Teflon lined, septum sealed screw cap	(2) 40-mL	adjust to pH < 2 with Hydrochloric Acid, Cool to 4°C	14 days
Semivolatile Organic Compounds	SW-846 Method 8270C	3510C-Sep Funnel or 3520C-Continuous	3640-GPC 3660-Sulfur	Amber glass with Teflon lined cap	(2) 1 liter	Cool to 4°C	Extract within 7 days, analyze within 40 days following extraction
PCBs (Aroclor-specific)	SW-846 Method 8082	3510C-Sep Funnel or 3520C-Continuous	3620-Florisil 3665-Sulfuric Acid 3660-Sulfur	Amber glass with Teflon lined cap	(2) 1 liter	Cool to 4°C	Extract within 7 days, analyze within 40 days following extraction
Metals - except mercury	SW-846 Method 6010B/7000A	3005A or 3015 Acid Digestion	-	plastic	1 liter	adjust to pH <2 with Nitric Acid	6 months
Mercury	SW-846 Method 7470A	7470A Acid Digestion	-	plastic or glass	Analyze from metals bottle	adjust to pH <2 with Nitric Acid	28 days
Total Solids/VSS	Standard Method 2540C	-	-	plastic or glass	500 mL	Cool to 4°C	7 days
Turbidity	Standard Method 2130	-	-	Plastic or glass, amber color preferred	100 mL	Light sensitive, store in dark, cool to 4°C	Begin analysis as soon as possible
BOD	EPA Method 405.1	-	-	plastic or glass	1 liter	Cool to 4°C	48 hours
COD	EPA Method 410.2	-	-	plastic or glass	250 mL	Adjust to pH<2 with H_2SO_4, cool to 4°C	28 days
TSS	EPA Method 160.2	-	-	plastic or glass	1 liter	Cool to 4°C	7 days
TDS	EPA Method 160.1	-	-	plastic or glass	100 mL	Cool to 4°C	7 days
Hardness	EPA Method 130.2	-	-	plastic or glass	250 mL	Adjust to pH<2 with HNO_3, cool to 4°C	180 days
TOC	EPA Method 415.1	-	-	plastic or glass	100 mL	Adjust to pH<2 with HCL, Cool to 4°C	28 days
SOIL/SEDIMENT SAMPLES							
Volatile Organic Compounds - low level	SW-846 Method 8260B	5035	-	Glass, Teflon lined, septum sealed screw cap	40 mL	In-field preservation with 0.2g sodium bisulfate per gram of sample, 5 mL organic free reagent water, cool to 4°C	14 days
				Wide mouth glass jar with Teflon-lined screw cap	125 mL (4 oz.)	Field preservation - Cool to 4°C. Upon receipt, laboratory to preserve with 0.2g sodium bisulfate per gram of sample, 5mL organic free reagent water, cool to 4°C	Ship to laboratory within 48-hours, analyze within 14 days
				EnCore™ Sampler, SoilCore™ Sampler, or equivalent	3 (5 gram)		
Volatile Organic Compounds - medium level	SW-846 Method 8260B	5035	-	Glass, Teflon lined, septum sealed screw cap	40 mL	1 mL methanol per gram of sample, cool to 4°C	14 days

TABLE 1

ANALYTICAL METHODS, SAMPLE CONTAINER, PRESERVATION, AND HOLDING TIME REQUIREMENTS

Parameter	Analytical Method	Extraction Method	Cleanup Method	Sample Container[1]	Sample Volume	Preservation[2]	Maximum Holding Time[3]
				Wide mouth glass jar with Teflon-lined screw cap	125 mL (4 oz.)	Field preservation - Cool to 4°C. Upon receipt, laboratory to preserve with 1.0mL methanol per gram of sample	Ship to laboratory within 48-hours, analyze within 14 days
				EnCore™ Sampler, SoilCore™ Sampler, or equivalent	5 gram		
Semivolatile Organic Compounds	SW-846 Method 8270C	3550-Sonication or 3540-Soxhlet	3640-GPC 3660-Sulfur	Wide mouth glass jar with Teflon-lined screw cap	125 mL (4 oz.)	Cool to 4°C	Extract within 14 days, analyze within 40 days following extraction
PCBs (Aroclor-specific)	SW-846 Method 8082	3550-Sonication or 3540-Soxhlet	3620-Florisil 3665-Sulfuric Acid 3660-Sulfur	Wide mouth glass jar with Teflon-lined screw cap	125 mL (4 oz.)	Cool to 4°C	Extract within 14 days, analyze within 40 days following extraction
Metals - except mercury	SW-846 Method 6010B/7000A	3050B or 3051	-	plastic	500 mL (16 oz.)	Cool to 4°C	6 months
Mercury	SW-846 Method 7471A	SW-846 Method 7471A	-	glass or plastic	Analyze from metals jar	Cool to 4°C	28 days
LNAPL/DNAPL SAMPLES							
Volatile Organic Compounds	SW-846 Method 8260B	5030B Purge & Trap	-	Widemouth glass jar with Teflon liner	40 mL	Cool to 4°C	14 days
Semivolatile Organic Compounds	SW-846 Method 8270C	3580A Waste Dilution	-	Widemouth glass jar with Teflon liner	125 mL (4 oz.)	Cool to 4°C	Extract within 14 days, analyze within 40 days following extraction
PCBs (Aroclor-specific)	SW-846 Method 8082	3580A Waste Dilution	3620-Florisil 3665-Sulfuric Acid 3660-Sulfur	Widemouth glass jar with Teflon liner	125 mL (4 oz.)	Cool to 4°C	Extract within 14 days, analyze within 40 days following extraction
Metals - except mercury	SW-846 Method 6010B/7000A	3050B Acid Digestion	-	plastic	125 mL (4 oz.)	Cool to 4°C	6 months
Mercury	SW-846 Method 7471A	7471A Acid Digestion	-	plastic or glass	Analyze from metals jar	Cool to 4°C	28 days
TCLP FOR SOIL AND DEBRIS							
Volatile Organic Compounds	SW-846 Method 8260B	TCLP Method 1311 followed by 5030B Purge & Trap	-	Wide mouth glass jar with Teflon-lined screw cap	125 mL (4 oz.)	Cool to 4°C	TCLP Method 1311 within 14 days, analyze within 14 days following 1311
Semivolatile Organic Compounds	SW-846 Method 8270C	TCLP Method 1311 followed by 3510C-Sep Funnel or 3520C-Continuous	3640-GPC 3660-Sulfur	Wide mouth glass jar with Teflon-lined screw cap	125 mL (4 oz.)	Cool to 4°C	TCLP Method 1311 within 14 days, preparative extraction within 7 days following 1311, analyze within 40 days following preparative extraction
PCBs (Aroclor-specific)	SW-846 Method 8082	TCLP Method 1311 followed by 3510C-Sep Funnel or 3520C-Continuous	3620-Florisil 3665-Sulfuric Acid 3660-Sulfur	Wide mouth glass jar with Teflon-lined screw cap	125 mL (4 oz.)	Cool to 4°C	TCLP Method 1311 within 14 days, preparative extraction within 7 days following 1311, analyze within 40 days following preparative extraction

TABLE 1

ANALYTICAL METHODS, SAMPLE CONTAINER, PRESERVATION, AND HOLDING TIME REQUIREMENTS

Parameter	Analytical Method	Extraction Method	Cleanup Method	Sample Container[1]	Sample Volume	Preservation[2]	Maximum Holding Time[3]
Metals - except mercury	SW-846 Method 6010B/7000A	TCLP Method 1311 followed by 3005A or 3015 Acid Digestion	-	plastic	500 mL (16 oz.)	Cool to 4°C	TCLP Method 1311 within 6 months, analyze within 6 months following 1311
Mercury	SW-846 Method 7470A	TCLP Method 1311 followed by 7470A Acid Digestion	-	glass or plastic	Analyze from metals jar	Cool to 4°C	TCLP Method 1311 within 28 days, analyze within 28 days following 1311

References:

USEPA (January, 1996) Test Methods for Evaluating Solid Waste, SW-846, Third Edition, Rev. 3.
APHA, AWWA, WPCF (1985). Standard Methods for the Examination of Water and Wastewater, 18th ed.
USEPA (1983). Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020.

Notes:

1 Sample container will be new, precleaned, and certified by manufacturer.

2 Whenever possible, pre-preserved bottles will be used.

3 Holding time measured from date of collection, unless noted.

TABLE 2

PROJECT ANALYTE LIST (PAL) AND TCLP CONSTITUENTS

MODIFIED TCL ANALYTES

SEMIVOLATILE COMPOUNDS BY 8270C

Analyte	CAS No.	Analyte	CAS No.
Acenaphthene	83-32-9	3,3'-Dichlorobenzidine	91-94-1
Acenaphthylene	208-96-8	2,4-Dichlorophenol	120-83-2
Acetophenone	98-86-2	Diethyl phthalate	84-66-2
Anthracene	120-12-7	Dimethyl phthalate	131-11-3
Atrazine	1912-24-9	2,4-Dimethylphenol	105-67-9
Benzaldehyde	100-52-7	4,6-Dinitro-2-methylphenol	534-52-1
Benzo(a)anthracene	56-55-3	2,4-Dinitrophenol	51-28-5
Benzo(a)pyrene	50-32-8	2,4-Dinitrotoluene	121-14-2
Benzo(b)fluoranthene	205-99-2	2,6-Dinitrotoluene	606-20-2
Benzo(g,h,i)perylene	191-24-2	Fluoranthene	206-44-0
Benzo(k)fluoranthene	207-08-9	Fluorene	86-73-7
1,1'-Biphenyl	92-52-4	Hexachlorobenzene	118-74-1
bis(2-chloroethoxy)methane	111-91-1	Hexachlorobutadiene	87-68-3
bis(2-chloroethyl)ether	111-44-4	Hexachlorocyclopentadiene	77-47-4
bis(2-chloroisopropyl)ether	108-60-1	Hexachloroethane	67-72-1
bis(2-ethylhexyl)phthalate	117-81-7	Indeno(1,2,3-cd)pyrene	193-39-5
4-Bromophenyl phenylether	101-55-3	Isophorone	78-59-1
Butyl benzyl phthalate	85-68-7	2-Methylnaphthalene	91-57-6
Caprolactam	105-60-2	Naphthalene	91-20-3
Carbazole	86-74-8	2-Nitroaniline	88-74-4
4-Chloro-3-methylphenol	59-50-7	3-Nitroaniline	99-09-2
4-Chloroaniline	106-47-8	4-Nitroaniline	100-01-6
2-Chloronaphthalene	91-58-7	Nitrobenzene	98-95-3
2-Chlorophenol	95-57-8	2-Nitrophenol	88-75-5
4-Chlorophenyl-phenylether	7005-72-3	4-Nitrophenol	100-02-7
2,2'-oxybis(1-Chloropropane)	108-60-1	N-Nitrosodi-n-propylamine	621-64-7
Chrysene	218-01-9	N-Nitrosodiphenylamine	86-30-6
2-Methylphenol (o-Cresol)	95-48-7	Pentachlorophenol	87-86-5
4-Methylphenol (p-Cresol)	106-44-5	Phenanthrene	85-01-8
Di-n-butylphthalate	84-74-2	Phenol	108-95-2
Di-n-octylphthalate	117-84-0	Pyrene	129-00-0
Dibenz(a,h)anthracene	53-70-3	2,4,5-Trichlorophenol	95-95-4
Dibenzofuran	132-64-9	2,4,6-Trichlorophenol	88-06-2

Analyte	CAS No.	Analyte	CAS No.
Acetone	67-64-1	trans-1,2-Dichloroethene	156-60-5
Benzene	71-43-2	1,2-Dichloropropane	78-87-5
Bromodichloromethane	75-27-4	cis-1,3-Dichloropropene	10061-01-5
Bromoform	75-25-2	trans-1,3-Dichloropropene	10061-02-6
Bromomethane	74-83-9	Ethylbenzene	100-41-4
2-Butanone	78-93-3	2-Hexanone	591-78-6
Carbon Disulfide	75-15-0	Isopropylbenzene	98-82-8
Carbon Tetrachloride	56-23-5	Methyl Acetate	79-20-9
Chlorobenzene	108-90-7	Methyl Cyclohexane	108-87-2
Chloroethane	75-00-3	4-Methyl-2-pentanone	108-10-1
Chloroform	67-66-3	Methylene Chloride	75-09-2
Chloromethane	74-87-3	Methyl tert-Butyl Ether	1634-04-4
Cyclohexane	110-82-7	Styrene	100-42-5
Dibromochloromethane	124-48-1	1,1,2,2-Tetrachloroethane	79-34-5
1,2-Dibromo-3-chloropropane	96-12-8	Tetrachloroethene	127-18-4
1,2-Dibromoethane	106-93-4	Toluene	108-88-3
1,2-Dichlorobenzene	95-50-1	1,2,4-Trichlorobenzene	120-82-1
1,3-Dichlorobenzene	541-73-1	1,1,1-Trichloroethane	71-55-6
1,4-Dichlorobenzene	106-46-7	1,1,2-Trichloroethane	79-00-5
Dichlorodifluoromethane	75-71-8	Trichloroethene	79-01-6
1,1-Dichloroethane	75-34-3	Trichlorofluoromethane	75-69-4
1,2-Dichloroethane	107-06-2	1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1
1,1-Dichloroethene	75-35-4	Vinyl Chloride	75-01-4
cis-1,2-Dichloroethene	156-59-2	Xylenes (total)	1330-20-7

TABLE 2

PROJECT ANALYTE LIST (PAL) AND TCLP CONSTITUENTS

MODIFIED TCL ANALYTES

AROCLORS BY 8082

Analyte	CAS No.	Analyte	CAS No.
Aroclor-1016	12674-11-2	Aroclor-1248	12672-29-6
Aroclor-1221	11104-28-2	Aroclor-1254	11097-69-1
Aroclor-1232	11141-16-5	Aroclor-1260	11096-82-5
Aroclor-1242	53469-21-9		

MODIFIED TAL LIST (TOXIC TAL ANALYTES PLUS ADDITIONAL CONSTITUENTS)

INORGANICS BY 6010B/7000A

Analyte	CAS No.	Analyte	CAS No.
Antimony	7440-36-0	Lead	7439-92-1
Arsenic	7440-38-2	Manganese	7439-96-5
Barium	7440-39-3	Mercury	7439-97-6
Beryllium	7440-41-7	Nickel	7440-02-0
Cadmium	7440-43-9	Selenium	7782-49-2
Chromium	7440-47-3	Silver	7440-22-4
Cobalt	7440-48-4	Thallium	7440-28-0
Copper	7440-50-8	Vanadium	7440-62-2
Cyanide	7440-50-7	Zinc	7440-66-6

TCLP ANALYTES

SEMIVOLATILE COMPOUNDS BY 8270C - 1311 (TCLP)

Analyte	CAS No.	Analyte	CAS No.
Antimony	7440-36-0	4-Methylphenol (p-Cresol)	106-44-5
2,4-Dinitrotoluene	121-14-2	Nitrobenzene	98-95-3
Hexachlorobenzene	118-74-1	Pentachlorophenol	87-86-5
Hexachlorobutadiene	87-68-3	Pyridine	110-86-1
Hexachloroethane	67-72-1	2,4,5-Trichlorophenol	95-95-4
2-Methylphenol (o-Cresol)	95-48-7	2,4,6-Trichlorophenol	88-06-2
3-Methylphenol (m-Cresol)	108-39-4		

VOLATILE COMPOUNDS BY 8260B - 1311 (TCLP)

Analyte	CAS No.	Analyte	CAS No.
Benzene	71-43-2	1,1-Dichloroethene	75-35-4
Carbon Tetrachloride	56-23-5	2-Butanone	78-93-3
Chlorobenzene	108-90-7	Tetrachloroethene	127-18-4
Chloroform	67-66-3	Trichloroethene	79-01-6
1,4-Dichlorobenzene	106-46-7	Vinyl Chloride	75-01-4
1,2-Dichloroethane	107-06-2		

AROCLORS BY 8082 - 1311 (TCLP)

Analyte	CAS No.	Analyte	CAS No.
Aroclor-1016	12674-11-2	Aroclor-1248	12672-29-6
Aroclor-1221	11104-28-2	Aroclor-1254	11097-69-1
Aroclor-1232	11141-16-5	Aroclor-1260	11096-82-5
Aroclor-1242	53469-21-9		

INORGANICS BY 6010B/7000A, 9010B, 9030B - TCLP

Analyte	CAS No.	Analyte	CAS No.
Arsenic	7440-38-2	Lead	7439-92-1
Barium	7440-39-3	Mercury	7439-97-6
Cadmium	7440-43-9	Selenium	7782-49-2
Chromium	7440-47-3	Silver	7440-22-4

Notes:

1) This list summarizes the compounds by fraction which are analyzed in accordance with the Superfund Target Compound List (TCL) for volatile and semivolatile organics, and Superfund toxic Target Analyte List (toxic TAL) for inorganics. Additional compounds have been added to this list based on prior Site analytical data.

TABLE 3

TYPICAL REPORTING LIMITS, METHOD DETECTION LIMITS (MDLs), AND PRACTICAL QUANTITATION LIMITS (PQLs)

Compound	Water (ug/L)				Soil/Sediment (ug/Kg)[1]			
	Lowest Criteria	Target Detection Limit[3]	Laboratory MDL[2]	Laboratory PQL[2]	Lowest Criteria	Target Detection Limit[3]	Laboratory MDL[2]	Laboratory PQL[2]
Volatiles								
Acetone	730	25	0.30	25	15,000	750	48.00	250
Benzene	5.0	1.0	0.03	1.0	100	50	2.50	35
Bromodichloromethane	100	1.0	0.07	1.0	2,000	100	2.90	70
Bromoform	100	1.0	0.20	1.0	2,000	100	5.80	70
Bromomethane	10	1.0	0.16	1.0	200	250	91.00	150
2-Butanone	2,200	25	0.07	25	44,000	750	17.00	250
Carbon Disulfide	800	5.0	0.45	5	16,000	250	4.40	150
Carbon Tetrachloride	5.0	1.0	0.06	1.0	100	50	4.40	35
Chlorobenzene	47	1.0	0.03	1.0	940	50	4.10	35
Chloroethane	430	1.0	0.11	1.0	8,600	250	12.00	150
Chloroform	100	1.0	0.07	1.0	2,000	50	3.90	35
Chloromethane	260	1.0	0.08	1.0	5,200	250	25.00	150
Cyclohexane	NA	NA			NA	NA		
Dibromochloromethane	100	1.0	0.07	1.0	2,000	100	2.80	70
1,2-Dibromo-3-chloropropane	0.2	1.0			4	250		
1,2-Dibromomethane	1	1.0			10	250		
Dichlordifluoromethane	1,700	1.0			95,000	100		
1,2-Dichlorobenzene	16	1.0	0.07	1.0	360	100	8.00	70
1,3-Dichlorobenzene	6.6	1.0	0.07	1.0	170	100	6.10	70
1,4-Dichlorobenzene	13	1.0	0.08	1.0	290	100	6.30	70
1,1-Dichloroethane	880	1.0	0.02	1.0	18,000	50	4.80	35
1,2-Dichloroethane	5.0	1.0	0.06	1.0	100	50	3.30	35
1,1-Dichloroethene	7.0	1.0	0.11	1.0	140	50	7.90	35
cis-1,2-Dichloroethene	70	1.0	***0.06***	***1.0***	1,400	***50***	***3.60***	***70***
trans-1,2-Dichloroethene	100	1.0			2,000	50		
1,2-Dichloropropane	5.0	1.0	0.06	1.0	100	50	4.90	35
cis-1,3-Dichloropropene	21	1.0	0.05	1.0	420	50	4.00	35
trans-1,3-Dichloropropene	21	1.0	0.05	1.0	420	50	3.40	35
Ethylbenzene	18	1.0	0.12	1.0	360	50	3.70	35
2-Hexanone	1,000	50	0.12	50	20,000	2500	8.20	250
Isopropylbenzene	800	5			91,000	250		
Methyl Acetate	NA	NA			NA	NA		
Methyl Cyclohexane	NA	NA			NA	NA		
4-Methyl-2-pentanone	1,800	50	0.07	50	36,000	2500	6.50	250
Methyl tert-butyl ether	40	5.0	0.06	1.0	800	250	4.80	250
Methylene Chloride	5.0	5.0	0.06	5.0	100	250	46.00	100
Styrene	80	1.0	0.17	1.0	2,200	50	2.80	35
1,1,2,2-Tetrachloroethane	77	1.0	0.07	1.0	170	100	3.00	70
Tetrachloroethene	5.0	1.0	0.25	1.0	100	50	4.90	35
Toluene	140	1.0	0.07	1.0	2,800	50	0.77	35
1,1,1-Trichloroethane	200	1.0	0.08	1.0	4,000	50	5.80	35
1,1,2-Trichloroethane	5.0	1.0	0.29	1.0	100	50	4.80	35
Trichloroethene	5.0	1.0	0.06	1.0	100	50	2.50	35
1,2,4-Trichlorobenzene	30	5.0	***0.69***	***5***	1,800	***250***	***18.00***	***170***

TABLE 3

TYPICAL REPORTING LIMITS, METHOD DETECTION LIMITS (MDLs), AND PRACTICAL QUANTITATION LIMITS (PQLs)

Compound	Water (ug/L)				Soil/Sediment (ug/Kg)[1]			
	Lowest Criteria	Target Detection Limit[3]	Laboratory MDL[2]	Laboratory PQL[2]	Lowest Criteria	Target Detection Limit[3]	Laboratory MDL[2]	Laboratory PQL[2]
Trichlorofluoromethane	2,600	1.0			52,000	100		
1,1,2-Trichloro-1,2,2trifluoroethane	170,000	1.0			550,000	250		
Vinyl Chloride	2.0	1.0	0.07	1.0	40	100	11.00	35
Xylenes (total)	35	3.0	0.25	3.0	700	150	7.60	110
Semivolatiles								
Acenaphthene	19	5.0	0.68	5	4,400	330	18.00	170
Acenaphthylene	52	5.0	0.58	5	5,900	330	18.00	170
Acetophenone	1,500	5.0			30,000	330		
Anthracene	43	5.0	0.77	5	41,000	330	18.00	170
Atrazine	NA	NA			NA	NA		
1,1'-Biphenyl	NA	NA			NA	NA		
Benzaldehyde	NA	NA			NA	NA		
Benzo(a)anthracene	2.1	1.0	0.79	1	20,000	330	17.00	170
Benzo(a)pyrene	5.0	2.0	1.0	2	2,000	330	17.00	170
Benzo(b)fluoranthene	2.0	2.0	1.0	2	20,000	330	15.00	170
Benzo(g,h,i)perylene	5.0	5.0	0.96	5	2,500,000	330	21.00	170
Benzo(k)fluoranthene	5.0	5.0	1.0	5	200,000	330	21.00	170
bis(2-Chloroethoxy)methane	NA	5.0	0.51	5	NA	330	17.00	170
bis(2-Chloroethyl)ether	2.0	1.0	0.64	1	330	100	14.00	33
bis(2-Chloroisopropyl)ether	NA	NA			NA	NA		
bis(2-Ethylhexyl)phthalate	6.0	5.0	2.2	5	2,800,000	330	21.00	170
4-Bromophenyl-phenylether	NA	5.0	0.92	5	NA	330	16.00	170
Butylbenzylphthalate	14	5.0	1.0	5	26,000	330	15.00	170
Caprolactam	5,800	10			120,000	330		
Carbazole	10	10	0.74	10	1,100	330	14.00	170
4-Chloro-3-Methylphenol	150	5.0	1.1	5	5,800	330	41.00	170
4-Chloroaniline	NA	20	1.8	20	NA	1700	60.00	670
2-Chloronaphthalene	NA	5.0	0.59	5	NA	330	19.00	170
2-Chlorophenol	22	5.0	1.1	5	440	330	32.00	170
4-Chlorophenyl-phenylether	NA	5.0	0.81	5	NA	330	19.00	170
2,2'-oxybis(1-Chloropropane)	NA	5.0	0.55	5	NA	330	18.00	170
Chrysene	5	5.0	0.91	5	2,000,000	330	16.00	170
2-Methylphenol	71	5.0	1.1	5	1,400	330	34.00	170
3-Methylphenol	71	5.0	1.0	5	1,400	330	39.00	170
4-Methylphenol	71	5.0	1.0	5	1,400	330	39.00	170
Di-n-Butylphthalate	10	5.0	1.2	5	11,000	330	22.00	170
Di-n-Octylphthalate	130	5.0	1.4	5	6,900,000	330	18.00	170
Dibenzo(a,h)anthracene	5	2.0	0.85	2	2,000	330	20.00	170
Dibenzofuran	4	5.0	0.75	4	1,700	330	18.00	170
3,3'-Dichlorobenzidine	0.30	0.3	10	20	2,000	2000	350.00	670
2,4-Dichlorophenol	19	10	1.1	10	380	330	40.00	170
Diethylphthalate	5,500	5.0	0.78	5	110,000	330	23.00	170
Dimethylphthalate	NA	5.0	0.71	5	NA	330	17.00	170
2,4-Dimethylphenol	370	5.0	0.87	5	7,400	330	48.00	170
4,6-Dinitro-2-methylphenol	20	20	0.86	20	1,700	1700	23.00	670
2,4-Dinitrophenol	NA	20	3.7	20	NA	1700	520.00	670

TABLE 3

TYPICAL REPORTING LIMITS, METHOD DETECTION LIMITS (MDLs), AND PRACTICAL QUANTITATION LIMITS (PQLs)

Compound	Water (ug/L)				Soil/Sediment (ug/Kg)[1]			
	Lowest Criteria	Target Detection Limit[3]	Laboratory MDL[2]	Laboratory PQL[2]	Lowest Criteria	Target Detection Limit[3]	Laboratory MDL[2]	Laboratory PQL[2]
Semivolatiles Cont.								
2,4-Dinitrotoluene	8	5.0	0.33	5	430	330	21.00	170
2,6-Dinitrotoluene	NA	5.0	0.35	5	NA	330	18.00	170
Fluoranthene	2	5.0	1.4	2	5,500	330	17.00	170
Fluorene	12	5.0	0.77	5	5,300	330	15.00	170
Hexachlorobenzene	1	5.0	0.77	1	1,800	330	16.00	170
Hexachlorobutadiene	0.053	5.0	0.80	5	330	330	14.00	170
Hexachlorocyclopentadiene	50	5.0	0.49	5	320,000	330	8.10	170
Hexachloroethane	7	5.0	0.33	5	430	330	15.00	170
Indeno(1,2,3-cd)pyrene	5	2.0	0.56	2	20,000	330	26.00	170
Isophorone	570	5.0	0.56	5	11,000	330	18.00	170
2-Methylnaphthalene	260	5.0	0.42	5	57,000	330	17.00	170
Naphthalene	13	5.0	0.74	5	870	330	19.00	170
2-Nitroaniline	NA	20	0.59	20	NA	1700	21.00	670
3-Nitroaniline	NA	20	0.90	20	NA	1700	30.00	670
4-Nitroaniline	NA	20	1.8	20	NA	1700	24.00	670
Nitrobenzene	3.4	2.0	0.50	2	330	200	19.00	67
2-Nitrophenol	20	5.0	0.81	5	400	330	38.00	170
4-Nitrophenol	NA	20	1.37	20	NA	1700	54.00	670
N-Nitroso-di-n-propylamine	5.0	5.0	0.54	5	330	330	16.00	170
N-Nitrosodiphenylamine	270	5.0	0.70	5	5,400	330	17.00	170
Pentachlorophenol	1.0	20	2.5	20	22	800	22.00	670
Phenanthrene	5.0	5.0	0.97	5	2,300	330	16.00	170
Phenol	210	5.0	0.30	5	4,200	330	28.00	170
Pyrene	140	5.0	0.84	5	480,000	330	17.00	170
2,4,5-Trichlorophenol	73	5.0	1.3	5	39,000	330	50.00	170
2,4,6-Trichlorophenol	4.4	4.0	1.3	4	330	330	42.00	170
PCBs (Aroclor-Specific)								
Aroclor-1016	0.20	0.20	0.029	0.1	20,000	330	22.00	35
Aroclor-1221	0.20	0.20	NA	0.1	20,000	330		35
Aroclor-1232	0.20	0.40	0.027	0.1	20,000	330	9.00	35
Aroclor-1242	0.20	0.20	0.066	0.1	20,000	330	14.00	35
Aroclor-1248	0.20	0.20	0.028	0.1	20,000	330	13.00	35
Aroclor-1254	0.20	0.20	0.097	0.1	20,000	330	15.00	35
Aroclor-1260	0.20	0.20	0.037	0.1	20,000	330	11.00	35

TABLE 3

TYPICAL REPORTING LIMITS, METHOD DETECTION LIMITS (MDLs), AND PRACTICAL QUANTITATION LIMITS (PQLs)

Compound	Water (ug/L)				Soil/Sediment (ug/Kg)[1]			
	Lowest Criteria	Target Detection Limit[3]	Laboratory MDL[2]	Laboratory PQL[2]	Lowest Criteria	Target Detection Limit[3]	Laboratory MDL[2]	Laboratory PQL[2]
Metals								
Antimony	6.0				500			
Arsenic	50	20	0.41	20	7,600	100	25	70
Barium	2,000	100	0.040	100	1,300,000	1000	26	500
Beryllium	4.0				51,000			
Cadmium	5.0	0.5	0.017	0.5	6,000	50	4.1	35
Chromium	100	5	0.097	5	3,300	500	35	200
Cobalt	40				800			
Copper	1,000				32,000			
Cyanide	20				390			
Lead	4.0	3.0	0.062	3.0	400,000	1000	19	500
Manganese	50				1,000			
Mercury	0.001	0.20	0.073	0.2	100	100	14	70
Nickel	100				20,000			
Selenium	5.0	5.0	0.16	1.0	400	200	50	100
Silver	0.20	0.5	0.070	0.2	500	500	19	200
Thallium	2.0				2,300			
Vanadium	4.5				72,000			
Zinc	2,400				47,000			
Other								
BOD	NA	2.0	NA	2.0	NA	NS	NA	NA
COD	NA	10	4.6	10	NA	NS	NA	NA
TOC	NA	1.0	0.073	1.0	NA	0.1%	0.04%	0.1%
TPH	NA	5.0	11	5.0	NA	NS	NA	NA

Notes:

NS Not specified in the analytical method. Laboratory derived MDLs (adjusted for dilution and percent solids) will be used.

NA Not applicable or Not available

1. The target detection limits for soil / sediment are based on high level for volatile organics.

2. The selected commercial analytical laboratory (CT&E) is in the process of updating their MDLs and PQLs for 2001. Those listed are current as of February 2001 and may be differ slightly during data reporting.

3. Target detection limits as defined in MDEQ Environmental Response Division Operational Memorandum #6, Revision 6 (January, 2001). In some cases, due to sample matrix interferences, the laboratory may use other reporting limits.

TABLE 4

LABORATORY AND FIELD QA/QC LIMITS

Compounds	Name	Method	Type	UCL	LCL	Matrix
VOC WATER LCS						
108-88-3	Toluene	SW-846 8260B	LCS	110.9	88.9	Aqueous
108-90-7	Chlorobenzene	SW-846 8260B	LCS	113.2	89.1	Aqueous
71-43-2	Benzene	SW-846 8260B	LCS	107.7	86.5	Aqueous
75-35-4	1,1-Dichloroethene	SW-846 8260B	LCS	125.1	76	Aqueous
79-01-6	Trichloroethene	SW-846 8260B	LCS	115.1	84.6	Aqueous
VOC SOIL LCS						
71-43-2	Benzene	SW-846 8260B	LCS	120.5	71.5	Soil
75-35-4	1,1-Dichloroethene	SW-846 8260B	LCS	124.2	62.7	Soil
79-01-6	Trichloroethene	SW-846 8260B	LCS	120	74	Soil
108-90-7	Chlorobenzene	SW-846 8260B	LCS	126.9	70.3	Soil
108-88-3	Toluene	SW-846 8260B	LCS	126.8	67.9	Soil
VOC OIL LCS						
75-35-4	1,1-Dichloroethene	SW-846 8260B	LCS	137	68	Nonaqueous Liquid
71-43-2	Benzene	SW-846 8260B	LCS	135	65	Nonaqueous Liquid
79-01-6	Trichloroethene	SW-846 8260B	LCS	135	61	Nonaqueous Liquid
108-88-3	Toluene	SW-846 8260B	LCS	135	64	Nonaqueous Liquid
108-90-7	Chlorobenzene	SW-846 8260B	LCS	136	68	Nonaqueous Liquid
VOC SOIL MS						
75-35-4	1,1-Dichloroethene	SW-846 8260B	MS	137	68	Soil
71-43-2	Benzene	SW-846 8260B	MS	135	65	Soil
79-01-6	Trichloroethene	SW-846 8260B	MS	135	61	Soil
108-88-3	Toluene	SW-846 8260B	MS	135	64	Soil
108-90-7	Chlorobenzene	SW-846 8260B	MS	136	68	Soil
VOC WATER MS						
108-88-3	Toluene	SW-846 8260B	MS	117	79	Aqueous
108-90-7	Chlorobenzene	SW-846 8260B	MS	112	81	Aqueous
71-43-2	Benzene	SW-846 8260B	MS	118	79	Aqueous
75-35-4	1,1-Dichloroethene	SW-846 8260B	MS	134	65	Aqueous
79-01-6	Trichloroethene	SW-846 8260B	MS	119	84	Aqueous
VOC OIL MS						
75-35-4	1,1-Dichloroethene	SW-846 8260B	MS	137	68	Nonaqueous Liquid
71-43-2	Benzene	SW-846 8260B	MS	135	65	Nonaqueous Liquid
79-01-6	Trichloroethene	SW-846 8260B	MS	135	61	Nonaqueous Liquid
108-88-3	Toluene	SW-846 8260B	MS	135	64	Nonaqueous Liquid
108-90-7	Chlorobenzene	SW-846 8260B	MS	136	68	Nonaqueous Liquid
SVOC WATER LCS						
83-32-9	Acenaphthene	SW-846 8270C	LCS	104.8	29.7	Aqueous
87-86-5	Pentachlorophenol	SW-846 8270C	LCS	154.3	30.2	Aqueous
95-57-8	2-Chlorophenol	SW-846 8270C	LCS	111.9	18.4	Aqueous
59-50-7	4-Chloro-3-methylphenol	SW-846 8270C	LCS	127.7	30.6	Aqueous
621-64-7	N-Nitroso-di-n-propylamine	SW-846 8270C	LCS	104.6	29.6	Aqueous
121-14-2	2,4-Dinitrotoluene	SW-846 8270C	LCS	136.4	16.4	Aqueous
129-00-0	Pyrene	SW-846 8270C	LCS	151.1	32.6	Aqueous
100-02-7	4-Nitrophenol	SW-846 8270C	LCS	78.1	10	Aqueous
108-95-2	Phenol	SW-846 8270C	LCS	60.5	13.1	Aqueous
SVOC WATER MS						
121-14-2	2,4-Dinitrotoluene	SW-846 8270C	MS	144.3	10	Aqueous
95-57-8	2-Chlorophenol	SW-846 8270C	MS	105.7	16.8	Aqueous
59-50-7	4-Chloro-3-methylphenol	SW-846 8270C	MS	119.8	34.6	Aqueous
100-02-7	4-Nitrophenol	SW-846 8270C	MS	121.3	10	Aqueous
83-32-9	Acenaphthene	SW-846 8270C	MS	109.7	28.8	Aqueous
621-64-7	N-Nitroso-di-n-propylamine	SW-846 8270C	MS	114.9	17.7	Aqueous
87-86-5	Pentachlorophenol	SW-846 8270C	MS	141.4	10	Aqueous
108-95-2	Phenol	SW-846 8270C	MS	84	10	Aqueous
129-00-0	Pyrene	SW-846 8270C	MS	140.6	39.5	Aqueous

TABLE 4

LABORATORY AND FIELD QA/QC LIMITS

Compounds	Name	Method	Type	UCL	LCL	Matrix
SVOC SOIL LCS						
121-14-2	2,4-Dinitrotoluene	SW-846 8270C	LCS	128.9	50.4	Soil
95-57-8	2-Chlorophenol	SW-846 8270C	LCS	115.2	38.8	Soil
59-50-7	4-Chloro-3-methylphenol	SW-846 8270C	LCS	125.2	47.8	Soil
100-02-7	4-Nitrophenol	SW-846 8270C	LCS	146.4	53.6	Soil
83-32-9	Acenaphthene	SW-846 8270C	LCS	102.7	40.9	Soil
621-64-7	N-Nitroso-di-n-propylamine	SW-846 8270C	LCS	108.5	36.6	Soil
87-86-5	Pentachlorophenol	SW-846 8270C	LCS	154.4	46.4	Soil
108-95-2	Phenol	SW-846 8270C	LCS	113.7	43.9	Soil
129-00-0	Pyrene	SW-846 8270C	LCS	138.2	52	Soil
SVOC SOIL MS						
100-02-7	4-Nitrophenol	SW-846 8270C	MS	173.5	10	Soil
108-95-2	Phenol	SW-846 8270C	MS	109.5	16.9	Soil
121-14-2	2,4-Dinitrotoluene	SW-846 8270C	MS	126.7	10	Soil
129-00-0	Pyrene	SW-846 8270C	MS	142.8	36.6	Soil
59-50-7	4-Chloro-3-methylphenol	SW-846 8270C	MS	113.9	33.4	Soil
621-64-7	N-Nitroso-di-n-propylamine	SW-846 8270C	MS	110	21.7	Soil
83-32-9	Acenaphthene	SW-846 8270C	MS	110.9	28.9	Soil
87-86-5	Pentachlorophenol	SW-846 8270C	MS	145	10	Soil
95-57-8	2-Chlorophenol	SW-846 8270C	MS	94.3	30.2	Soil
SVOC OIL LCS						
83-32-9	Acenaphthene	SW-846 8270C	LCS	135	39	Nonaqueous Liquid
59-50-7	4-Chloro-3-methylphenol	SW-846 8270C	LCS	135	34	Nonaqueous Liquid
95-57-8	2-Chlorophenol	SW-846 8270C	LCS	135	31	Nonaqueous Liquid
121-14-2	2,4-Dinitrotoluene	SW-846 8270C	LCS	112	44	Nonaqueous Liquid
100-02-7	4-Nitrophenol	SW-846 8270C	LCS	125	39	Nonaqueous Liquid
621-64-7	N-Nitroso-di-n-propylamine	SW-846 8270C	LCS	135	27	Nonaqueous Liquid
87-86-5	Pentachlorophenol	SW-846 8270C	LCS	112	33	Nonaqueous Liquid
108-95-2	Phenol	SW-846 8270C	LCS	135	25	Nonaqueous Liquid
129-00-0	Pyrene	SW-846 8270C	LCS	109	46	Nonaqueous Liquid
SVOC OIL MS						
83-32-9	Acenaphthene	SW-846 8270C	MS	135	39	Nonaqueous Liquid
59-50-7	4-Chloro-3-methylphenol	SW-846 8270C	MS	135	34	Nonaqueous Liquid
95-57-8	2-Chlorophenol	SW-846 8270C	MS	135	31	Nonaqueous Liquid
121-14-2	2,4-Dinitrotoluene	SW-846 8270C	MS	112	44	Nonaqueous Liquid
100-02-7	4-Nitrophenol	SW-846 8270C	MS	125	39	Nonaqueous Liquid
621-64-7	N-Nitroso-di-n-propylamine	SW-846 8270C	MS	135	27	Nonaqueous Liquid
87-86-5	Pentachlorophenol	SW-846 8270C	MS	112	33	Nonaqueous Liquid
108-95-2	Phenol	SW-846 8270C	MS	135	25	Nonaqueous Liquid
129-00-0	Pyrene	SW-846 8270C	MS	109	46	Nonaqueous Liquid
PCB OIL LCS						
11096-82-5	Aroclor-1260	SW-846 8082	LCS	170.2	29.1	Nonaqueous Liquid
12672-29-6	Aroclor-1248	SW-846 8082	LCS	140.9	25	Nonaqueous Liquid
PCB WATER LCS						
12672-29-6	Aroclor-1248	SW-846 8082	LCS	112.6	41.8	Aqueous
11096-82-5	Aroclor-1260	SW-846 8082	LCS	106.6	21.2	Aqueous
PCB SOIL LCS						
12672-29-6	Aroclor-1248	SW-846 8082	LCS	136.5	51.2	Soil
11096-82-5	Aroclor-1260	SW-846 8082	LCS	145	57.6	Soil
PCB WATER MS						
12672-29-6	Aroclor-1248	SW-846 8082	MS	109	10	Aqueous
11096-82-5	Aroclor-1260	SW-846 8082	MS	109	24	Aqueous
PCB SOIL MS						
12672-29-6	Aroclor-1248	SW-846 8082	MS	158.9	15.5	Soil
11096-82-5	Aroclor-1260	SW-846 8082	MS	167.3	10	Soil
PCB OIL MS						
11096-82-5	Aroclor-1260	SW-846 8082	MS	187.2	49.2	Nonaqueous Liquid
12672-29-6	Aroclor-1248	SW-846 8082	MS	196.4	21.5	Nonaqueous Liquid

TABLE 4

LABORATORY AND FIELD QA/QC LIMITS

Compounds	Name	Method	Type	UCL	LCL	Matrix
SVOC WATER SURROGATES						
321-60-8	2-Fluorobiphenyl <Surr>	SW-846 8270C	PS	111.2	10	Aqueous
367-12-4	2-Fluorophenol <Surr>	SW-846 8270C	PS	77.7	10	Aqueous
4165-60-0	Nitrobenzene-d5 <Surr>	SW-846 8270C	PS	104	11.1	Aqueous
1718-51-0	Terphenyl-d14 <Surr>	SW-846 8270C	PS	137.1	16.5	Aqueous
13127-88-3	Phenol-d5 <Surr>	SW-846 8270C	PS	54.9	10	Aqueous
118-79-6	2,4,6-Tribromophenol <Surr>	SW-846 8270C	PS	125.2	17.9	Aqueous
SVOC SOIL SURROGATES						
321-60-8	2-Fluorobiphenyl <Surr>	SW-846 8270C	PS	113.6	22.4	Soil
367-12-4	2-Fluorophenol <Surr>	SW-846 8270C	PS	110.5	10	Soil
118-79-6	2,4,6-Tribromophenol <Surr>	SW-846 8270C	PS	125.1	32.1	Soil
4165-60-0	Nitrobenzene-d5 <Surr>	SW-846 8270C	PS	112.6	18.6	Soil
1718-51-0	Terphenyl-d14 <Surr>	SW-846 8270C	PS	177.6	23.6	Soil
13127-88-3	Phenol-d5 <Surr>	SW-846 8270C	PS	126.7	10	Soil
SVOC OIL SURROGATES						
118-79-6	2,4,6-Tribromophenol <Surr>	SW-846 8270C	PS	132	34	Nonaqueous Liquid
1718-51-0	Terphenyl-d14 <Surr>	SW-846 8270C	PS	138	22	Nonaqueous Liquid
321-60-8	2-Fluorobiphenyl <Surr>	SW-846 8270C	PS	106	16	Nonaqueous Liquid
367-12-4	2-Fluorophenol <Surr>	SW-846 8270C	PS	120	10	Nonaqueous Liquid
4165-60-0	Nitrobenzene-d5 <Surr>	SW-846 8270C	PS	107	13	Nonaqueous Liquid
13127-88-3	Phenol-d5 <Surr>	SW-846 8270C	PS	133	10	Nonaqueous Liquid
VOC WATER SURROGATES						
2037-26-5	Toluene-d8 <Surr>	SW-846 8260B	PS	107.1	90.9	Aqueous
460-00-4	4-Bromofluorobenzene <Surr>	SW-846 8260B	PS	107.7	89.3	Aqueous
17060-07-0	1,2-Dichloroethane-D4 <surr>	SW-846 8260B	PS	122.3	77.7	Aqueous
1868-53-7	Dibromofluoromethane <Surr>	SW-846 8260B	PS	117.9	84.6	Aqueous
VOC SOIL SURROGATES						
2037-26-5	Toluene-d8 <Surr>	SW-846 8260B	PS	120	80	Soil
460-00-4	4-Bromofluorobenzene <Surr>	SW-846 8260B	PS	120	64.9	Soil
17060-07-0	1,2-Dichloroethane-D4 <surr>	SW-846 8260B	PS	130	70	Soil
1868-53-7	Dibromofluoromethane <Surr>	SW-846 8260B	PS	153.2	70.7	Soil
VOC OIL SURROGATES						
2037-26-5	Toluene-d8 <Surr>	SW-846 8260B	PS	120	80	Nonaqueous Liquid
460-00-4	4-Bromofluorobenzene <Surr>	SW-846 8260B	PS	120	80	Nonaqueous Liquid
17060-07-0	1,2-Dichloroethane-D4 <surr>	SW-846 8260B	PS	120	80	Nonaqueous Liquid
1868-53-7	Dibromofluoromethane <Surr>	SW-846 8260B	PS	120	80	Nonaqueous Liquid
PCB WATER SURROGATES						
Deca. PCB	Decachlorobiphenyl <Surr>	SW-846 8082	PS	134	10	Aqueous
Tetra. PCB	Tetrachloro-m-xylene <Surr>	SW-846 8082	PS	83.2	23.1	Aqueous
PCB SOIL SURROGATES						
Tetra. PCB	Tetrachloro-m-xylene <Surr>	SW-846 8082	PS	124.9	10	Soil
Deca. PCB	Decachlorobiphenyl <Surr>	SW-846 8082	PS	175.7	10	Soil
PCB OIL SURROGATES						
Deca. PCB	Decachlorobiphenyl <Surr>	SW-846 8082	PS	170	25	Nonaqueous Liquid
Tetra. PCB	Tetrachloro-m-xylene <Surr>	SW-846 8082	PS	150	25	Nonaqueous Liquid
METALS MS						
All analytes		SW-846 6010	MS	125	75	All
Mercury		SW-846 7470	MS	125	75	All
METALs WATER DUPLICATES						
All analytes		SW-846 6010	DUP	15		Aqueous
Mercury		SW-846 7470	DUP	15		Aqueous
METALs SOIL/OIL DUPLICATES						
All analytes		SW-846 6010	DUP	20		Solid
Mercury		SW-846 7470	DUP	20		Solid
FIELD DUPLICATES						
All analytes		All Methods	FD	35		Aqueous
All analytes		All Methods	FD	50		Solid

Attachment A

BLASLAND, BOUCK & LEE, INC.
engineers & scientists

Sample Handling, Packing, and Shipping Procedures

Attachment A

Sample Handling, Packing, and Shipping Procedures

I. Chain of Custody Procedures

1. Prior to collecting samples, complete the chain of custody form (Attachment A-3) header information by filling in the project number, project name, and the name(s) of the sampling technician(s). Please note that it is important that chain of custody information is printed legibly using indelible ink.

2. After sample collection, enter the individual sample information by filling in the following chain of custody fields:

   a. STA. NO. - Indicates the station number or location that the sample was collected from. Appropriate values for this field include well locations, grid points, or soil boring identification numbers (e.g., MW-3, X-20, SB-30, etc.).

   b. Date - Indicates the date that the sample was collected. The date format to be followed should be mm/dd/yyyy (e.g., 03/07/2000).

   c. Time - Indicates the time at which the sample was collected. The time value should be presented using the military format. For example, 3:15 P.M. should be entered as 15:15.

   d. Comp - This field should be marked with an "X" if the sample was collected as a composite.

   e. Grab - This field should be marked with an "X" if the sample was collected as an individual grab sample.

   f. Station Location - This field should represent the complete sample name. Although, in some instances it may be similar to the STA. NO. field. An example of a complete sample name is SB-3 (0.5-1.0), where the 0.5-1.0 represents the depth interval in feet from where the sample was collected. Please note that it is very important that the use of hyphens in sample names and the depth units (i.e., feet or inches) remain consistent for all samples entered on the chain of custody form. Sample names may also use the abbreviations "MS/MSD", "FB", "TB", and "DUP" as prefixes or suffixes to indicate that the sample is a matrix spike/matrix spike duplicate, field blank, trip blank, or field duplicate, respectively.

   g. Number of Containers - This field represents the number of containers that were collected at the sampling location to be submitted for analysis.

   h. Analytical Parameters - The analytical parameters that the samples are being analyzed for should be written legibly on the diagonal lines to the right of the "number of containers" column. The analytical parameters should be chosen from those presented in Table 1 of the FSP/QAPP. As much detail as

possible should be presented to allow the analytical laboratory to properly analyze the samples. For example, polychlorinated biphenyls (PCBs) analyses may be represented by entering "PCBs" or Method 8082." Multiple methods and/or analytical parameters may be combined for each column (e.g., PCBs/VOCs/SVOCs or 8082/8260/8270). These columns should also be used to present project specific parameter lists (i.e., Appendix IX excluding herbicides and pesticides). QA/QC information may also be entered in a separate column for each parameter (e.g., PCBs - MS/MSD) to identify a sample that the laboratory is to use for a specific QA/QC requirement. Each sample that requires a particular parameter analysis will be identified by placing an "X" in the appropriate analytical parameter column.

i. Remarks - The remarks field should be used to communicate special analytical requirements to the laboratory. These requirements may be on a per sample basis such as "extract and hold sample until notified" or may be used to inform the laboratory of special reporting requirements for the entire SDG. Reporting requirements that should be specified in the remarks column include: 1) turn around time, 2) required detection limits, 3) contact and address where data reports should be sent, 4) name of laboratory project manager, and 5) type of sample preservation that was utilized.

j. Relinquished By - This field should contain the signature of the sampling technician that relinquished custody of the samples to the shipping courier or the analytical laboratory.

k. Date - Indicates the date that the samples were relinquished. The date format should be mm/dd/yyyy (e.g., 03/07/2000).

l. Time - Indicates the time that the samples were relinquished. The time value should be presented using the military format. For example, 3:15 P.M. should be entered as 15:15.

m. Received By - This field should contain the signature of the sample courier or laboratory representative that received the samples from the sampling technician.

3. Complete as many chain of custody forms as necessary to properly document the collection and transfer of the samples to the analytical laboratory.

4. Upon completion of the chain of custody forms, forward two copies to the analytical laboratory and retain one for the field records. The field records copy should also be sent to Ms. Jessica Whisher at BBL by facsimile at (315) 449-0017.

II. Handling

1. After completing the sample collection procedures, record the following information in the field notebook with indelible ink:

- Project number and site name;
- Sample identification code and other sample identification information, if appropriate;
- Sampling method;

- Date;
- Name of sampler(s);
- Time;
- Location (project reference); and
- Any comments.

2. Fill in sample label (Attachment A-1) with the following information in indelible ink:

   - Sample matrix (e.g., groundwater);
   - Project number and site name;
   - Sample identification code and other sample identification information, if applicable;
   - Analysis required;
   - Date;
   - Time sampled;
   - Initials of sampling personnel;
   - Sample type (composite or discrete);
   - Tissue preparation procedure (biota; e.g., fillets, whole body), if applicable; and
   - Preservative added, if applicable.

3. Cover the label with clear packing tape to secure the label onto the container.

4. Check the caps on the sample containers to ensure that they are tightly sealed.

5. Wrap the sample container cap with clear packing tape to prevent it from becoming loose.

6. Place a signed custody seal label (Attachment A-2) over the cap such that the cap cannot be removed without breaking the custody seal. Alternatively, if shipping several containers in a cooler, custody seal evidence tape may be placed on the shipping container as described below.

III. Packing

1. Using duct tape, secure the outside and inside of the drain plug at the bottom of the cooler that is used for sample transport.

2. Place each container or package in individual polyethylene bags (resealable-type) and seal. If a cooler temperature blank is supplied by the laboratory, it should be packaged following the same procedures as the samples. If the laboratory did not include a temperature blank, do not add one, since the sample temperature will be determined by the laboratory using a calibrated infrared thermometer.

3. Place 1 to 2 inches of cushioning material (i.e., vermiculite) at the bottom of the cooler. See Section 6.

4. Place the sealed sample containers upright in the cooler.

5. Package ice or blue ice in small resealable-type plastic bags and place loosely in the cooler. Do not pack ice so tightly that it may prevent addition of sufficient cushioning material. Samples placed on ice will be cooled to and maintained at a temperature of approximately 4°C.

6. Fill the remaining space in the cooler with cushioning material.

7. Place the completed chain of custody forms (Attachment A-3) in a large resealable-type bag and tape the bag to the inside of the cooler lid.

8. Close the lid of the cooler and fasten with packing tape.

9. Wrap strapping tape around both ends of the cooler.

10. Mark the cooler on the outside with the following information: shipping address, return address, "Fragile" labels (Attachment A-4) on the top and on one side, and arrows indicating "This Side Up" (Attachment A-4) on two adjacent sides.

11. Place custody seal evidence tape (Attachment A-2) over front right and back left of the cooler lid and cover with clear plastic tape.

Note: Procedure numbers 2, 3, 5, and 6 may be modified in cases where laboratories provide customized shipping coolers. These coolers are designed so the sample bottles and ice packs fit snugly within preformed styrofoam cushioning and insulating packing material.

IV. Shipping

All samples will be delivered by an express carrier within 48 hours of sample collection. Alternatively, a laboratory courier may be used for sample pickup. If parameters with short holding times are being analyzed [e.g., VOCs (EnCore™ Sampler)], sampling personnel will take precautions to assure that the maximum holding times for these parameters will not be exceeded.

The following chain of custody procedures will apply to sample shipping:

- Relinquish the sample containers to the laboratory via express carrier or laboratory courier. The signed and dated forms should be included in the cooler. The express carrier will not be required to sign the chain of custody forms.

- When the samples are received by the laboratory, the laboratory personnel shall complete the chain of custody by recording the date and time of receipt of samples, measure and record the internal temperature of the shipping container, and then check the sample identification numbers on the containers to ensure that they correspond to the chain of custody forms.

Attachment A-1

BLASLAND, BOUCK & LEE, INC.
engineers & scientists

Sample Label

BBL
BLASLAND, BOUCK & LEE, INC.
engineers & scientists

PROJECT #		
SAMPLE I.D.		DATE
SAMPLE TYPE ☐ Soil/Sediment ☐ Water	COLLECTION MODE ☐ Composite ☐ Grab	TIME
ANALYSIS		
SAMPLER(S)	PRESERVATIVE	

Attachment A-2

BLASLAND, BOUCK & LEE, INC.
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Custody Seal Label

CUSTODY SEAL

BBL

BLASLAND, BOUCK & LEE, INC.
engineers & scientists

6723 Towpath Road, Box 66, Syracuse, N.Y. 13214-0066
TEL (315) 446-9120

SEALED BY

_____

DATE_____ TIME _____

Attachment A-3

BLASLAND, BOUCK & LEE, INC.
engineers & scientists

Chain of Custody Form

BLASLAND, BOUCK & LEE, INC.
engineers & scientists
6723 Towpath Road, P.O. Box 66
Syracuse, New York 13214-0066
TEL: (315) 446-9120

CHAIN OF CUSTODY RECORD

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

STA. NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION	Number of Containers	REMARKS

Relinquished by: *(Signature)*	DATE	TIME	Received by: *(Signature)*	Relinquished by: *(Signature)*	DATE	TIME	Relinquished by: *(Signature)*
Relinquished by: *(Signature)*	DATE	TIME	Received by: *(Signature)*	Relinquished by: *(Signature)*	DATE	TIME	Relinquished by: *(Signature)*
Relinquished by: *(Signature)*	DATE	TIME	Received for Laboratory by: *(Signature)*	DATE	TIME	Remarks:	

10/23/95
5951188L.CDR

Distribution: Original Accompanies Shipment; Copy to Coordinator Field Files

Attachment A-4

BLASLAND, BOUCK & LEE, INC.
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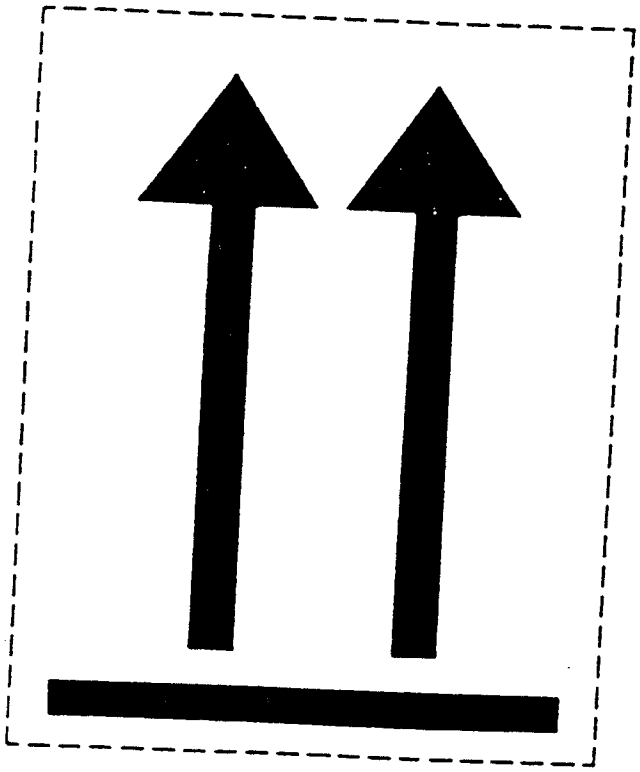
Shippers Certification for Restricted Articles


fragile
HANDLE
WITH CARE



Attachment B

BLASLAND, BOUCK & LEE, INC.
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Monitoring Well Installation Procedures

Attachment B

Monitoring Well Installation Procedures

I. Procedures - Monitoring Wells in Overburden

Prior to monitoring well installation, soil borings will be completedusing direct-push or with a rotary drill rig using the hollow-stem auger drilling method Attachment D. No oils or grease will be used on equipment introduced into the borehole. Soil samples will be continuously sampled with a direct-push soil coring system or 2-inch diameter split-spoon (using ASTM Method D1586) and, subsequently, field screened with a photoionization detector (PID). Grain-size analysis will be completed for each primary hydrogeologic unit at one location to verify visual lithologic characterizations.

At each new water table monitoring well location, a well will be completed at the water table and extend generally 5 to 7 feet into the saturated zone. Unless otherwise specified, the wells will be constructed of 1.5- or 2-inch-diameter, Schedule 40, machine-slotted polyvinyl chloride (PVC) with a 5- to 10-foot section of well screen. Water table wells will be constructed with a screen placed adjacent to the water table surface to allow for fluctuation in groundwater levels.

At those locations where the boring has been advanced beyond the well installation depth, chipped bentonite will be used to backfill the boring. Small amounts of sand (up to 5%) may be added to prevent bridging of the bentonite.

At well locations installed to evaluate the potential for DNAPL, a well will be completed at the upper contact of the first confining unit (e.g., silty-clay unit) within the investigation area. Unless otherwise specified, the DNAPL wells will be constructed of 2-inch-diameter stainless steel with a 5- or 10-foot section of well screen. Also, the well screens will be fitted with a 2-foot blank section (sump) at the bottom of the screen. DNAPL wells will be constructed with the blank section placed 2 feet into the confining unit such that the blank section is at or slightly below (0.5 feet) the upper confining unit contact, allowing DNAPL (if present) to collect in the sump.

All well casings and screens will be cleaned prior to installation using the procedures in Attachment H. The well-string, complete with a PVC cap, will be aligned to the selected depth. A washed silica sand filter pack will be installed to two feet above the screen, as appropriate (a shallow water table may necessitate a thinner sand pack). A 2-foot bentonite slurry seal will be tremied into place above the sand pack when the seal is below the water table. A 2-foot bentonite chip or pellet seal will be used above the water table, if possible (as with the sand pack, a shallow water table may necessitate a thinner seal). The seal will be hydrated and allowed to set for approximately 45 minutes. During placement of the sand pack and bentonite seal, frequent measurements will be made using a weighted tape measure. Above the bentonite seal, a bentonite/Portland cement grout will be tremied into place.

A typical aboveground well completion is shown in Attachment B-1. For stick-up wells, the riser will extend approximately two feet above grade. A 4-inch-diameter, vented, locking protective casing will be installed over the riser and will extend approximately 2.5 feet above grade and at least 1.5 feet bgs. A concrete pad, measuring approximately 2 feet by 2 feet and approximately 1 foot deep, will be installed around the protective casing to form a surface seal 0.5 feet above ground surface.

A typical flush-mounted well is shown in Attachment B-2. For flush-mounted wells, a 9-inch-diameter, water-tight protector will be installed complete with a sand drain. A lockable gripper plug will top the PVC casing.

A typical DNAPL monitoring well completion is shown in Attachment B-3.

After installation, the monitoring well will be labeled with the well identification and a reference point for water level and depth measurements will be marked on the well casing. The well will be allowed to sit for at least 24 hours prior to well development, and for one week between development and groundwater sampling. Monitoring wells installed for the RFI will be surveyed following their installation and prior to groundwater sampling.

II. Documentation of Well Design and Construction

The following information regarding the wells design and construction will be recorded:

- Date/time of construction;
- Drilling method;
- Surveyed well location;
- Borehole diameter and well casing diameter;
- Well depth;
- Drilling and lithologic logs;
- Casing materials;
- Screen materials and design;
- Screen slot size/length;
- Filter pack material/size, grain analysis;
- Filter pack volume calculations;
- Filter pack placement method;
- Sealant materials (percent bentonite);
- Sealant materials (lbs/gallon of cement);
- Sealant placement method;

- Surface seal design/construction;
- Well development procedure;
- Type of protective well cap; and
- Detailed drawing of well (include dimensions).

III. Equipment Cleaning

Drilling equipment and well materials (casing and screen) will be cleaned using high-pressure steam-cleaning equipment using (an approved laboratory analyzed) tap water source. Drilling equipment will be cleaned prior to use on the site, between monitoring well locations, and at the completion of the drilling program, prior to leaving the site.

IV. Well Development

Well development will be performed according to the guidelines defined in Attachment C, Well Development Procedures.

V. Disposal Methods

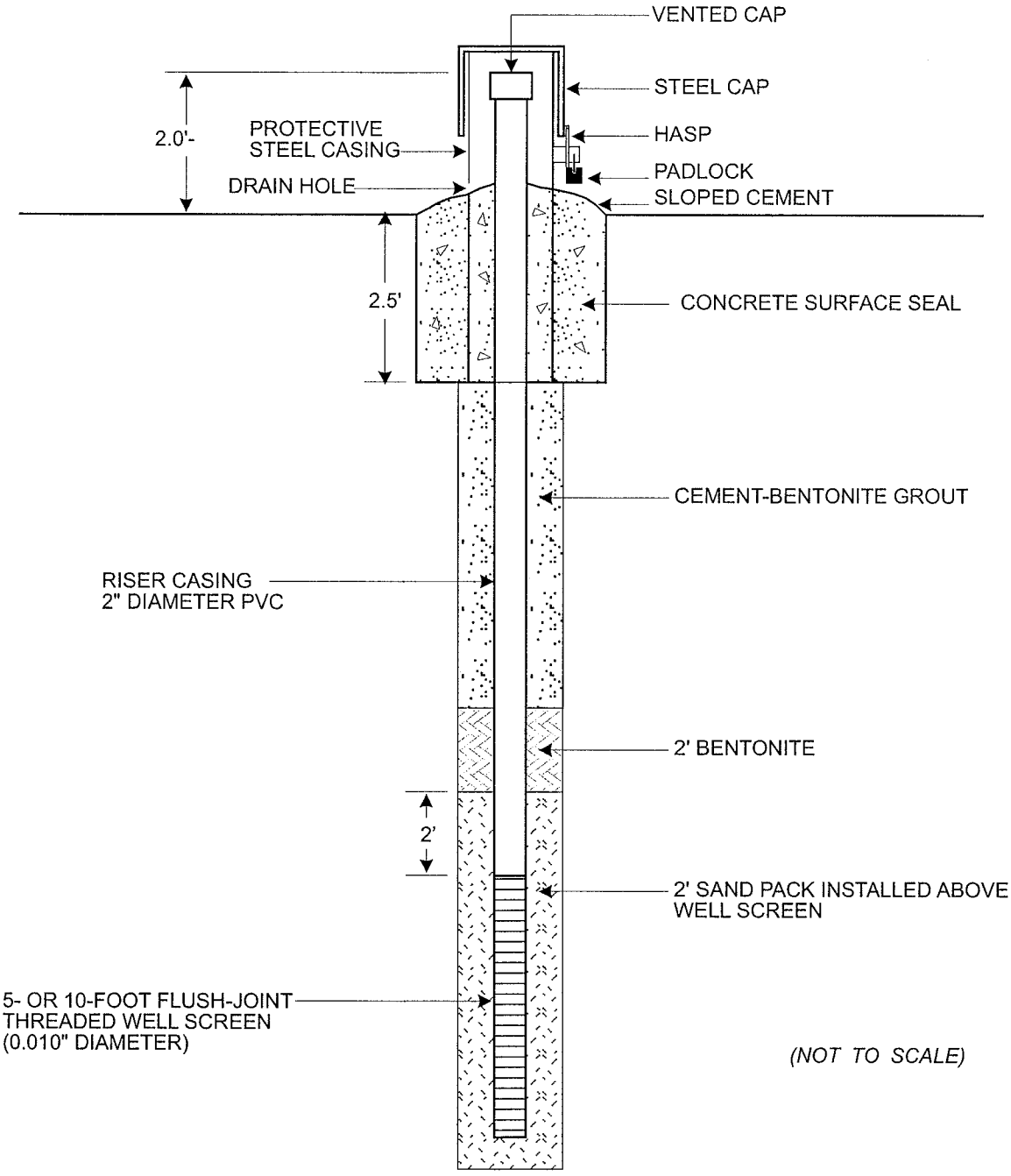
All water generated during cleaning procedures will be collected and contained on site for future analysis and appropriate disposal.

Personal protective equipment, such as gloves, disposable clothing, and other disposable equipment, resulting from personnel cleaning procedures and from monitoring well installation activities, will be placed in plastic bags. These bags will be transferred into appropriately labeled 55-gallon drums for appropriate disposal.

Attachment B-1

BLASLAND, BOUCK & LEE, INC.
engineers & scientists

Typical Aboveground Monitoring Construction Diagram

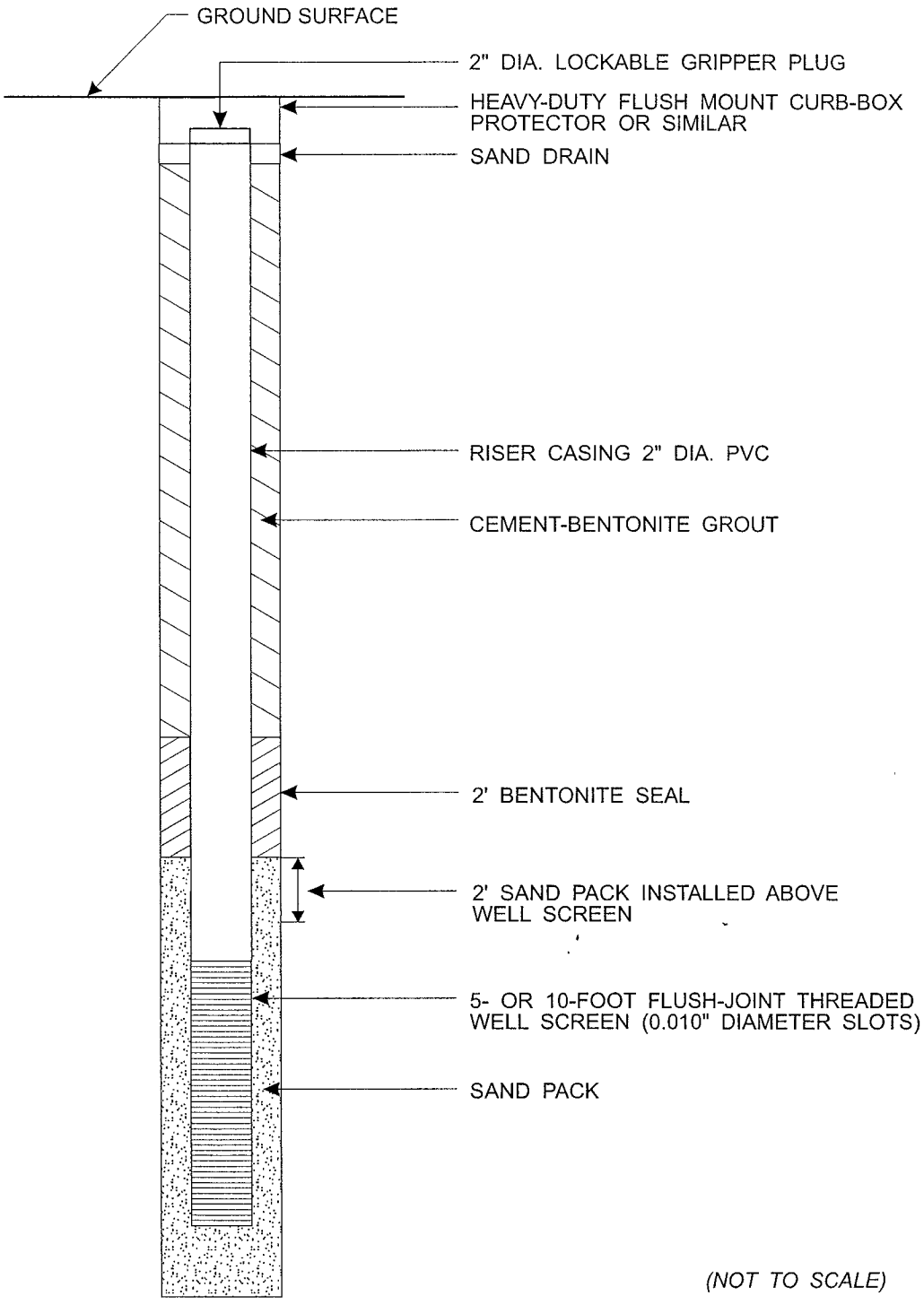


TYPICAL ABOVE GRADE
MONITORING WELL INSTALLATION

Attachment B-2

BLASLAND, BOUCK & LEE, INC.
engineers & scientists

Typical Flush-Mount Monitoring Well Construction Diagram

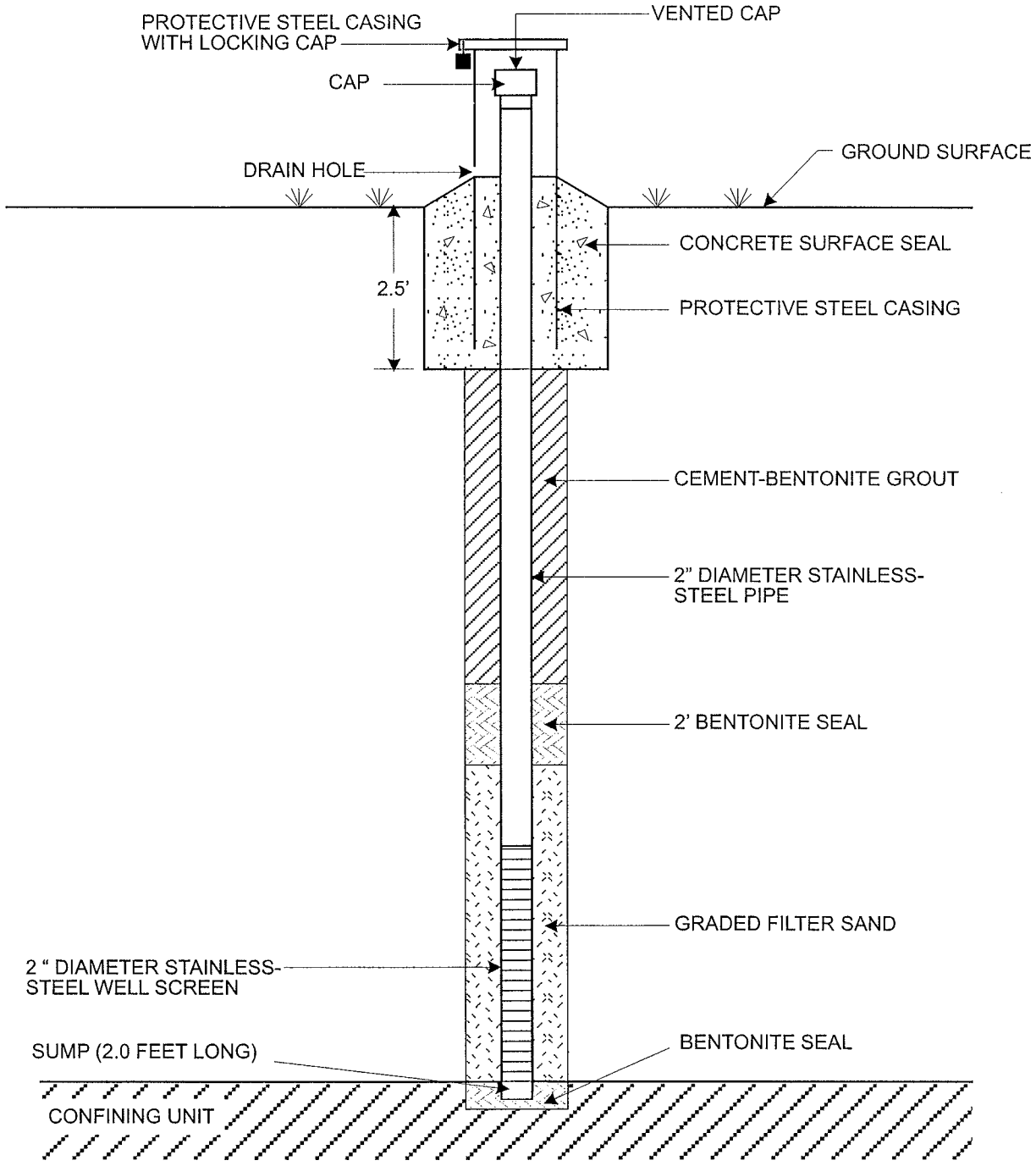


TYPICAL FLUSH MOUNT MONITORING WELL INSTALLATION

Attachment B-3

BLASLAND, BOUCK & LEE, INC.
engineers & scientists

Typical DNAPL Monitoring Well Installation



TYPICAL DNAPL
MONITORING WELL INSTALLATION

(NOT TO SCALE)

Attachment C

BLASLAND, BOUCK & LEE, INC.
engineers & scientists

Well Development Procedures

Attachment C

Well Development Procedures

I. Introduction

Before a newly constructed well can be used for water-quality sampling, measuring water levels, or aquifer testing, it must be developed. Well development refers to the procedure used to clear the well and formation around the screen of fine-grained materials (sands, silts, and clays) produced during drilling or naturally occurring in the formation. Well development continues until the well responds to water level changes in the formation (i.e., a good hydraulic connection is established between the well and formation) and the well produces clear, sediment-free water to the extent practical.

Well development will be completed using a pumping and surging method. Surging of the well will be accomplished with a surge block or submersible pump.

After development, the well will not be sampled for at least one week.

II. Materials

Materials for monitoring well development using a pump include:

- Appropriate health and safety equipment
- Knife
- Power source (generator)
- Field book or logs
- Well keys
- Graduated pails
- Pump and tubing
- Surge block (optional)
- Cleaning supplies (including non-phosphate soap, buckets, brushes, laboratory-supplied distilled/deionized water, tap water, cleaning solvent, aluminum foil, plastic sheeting, etc.)
- Water level meter

- pH/temperature/conductivity meter
- Clear glass jars (e.g., drillers' jars)

III. Development Procedures

When developing a well using the pumping and surging method, clean, new polypropylene tubing from the pump is extended to the screened portion of the well and will be moved up and down the screened interval until the well yields clear water. A procedure that may be used for well development entails moving groundwater through the well screen using a centrifugal pump and/or a submersible pump. The centrifugal pump uses atmospheric pressure to lift water from the well and therefore can only be used where the depth to water is less than 25 feet. The submersible pump is attached to the end of the tubing that goes into the well, pushing the water to the surface, and is effective for all wells particularly where groundwater is greater than 25 feet below land surface. The pump will be manually lifted and lowered within the screened interval to pull in fine sand and silt (the pump may have a valve which opens when lowered and closes when lifted, which surges groundwater through the screen or a surge block attached, which is slightly smaller in diameter than the inside well casing diameter). To lift water from the well, the pump will be turned on forcing silty water up through the tubing. Surging will be repeated as many times as necessary within the well screen interval until the groundwater is relatively clear. Any tubing will be disposed of between wells. Clean, new tubing will be used at each well.

A detailed procedure for groundwater well development will be as follows:

1. Don appropriate safety equipment.
2. All equipment used for development purposes entering each monitoring well will be cleaned using a soapy wash, tap rinse, solvent rinse (methanol or hexane), and distilled/deionized water rinse.
3. Attach appropriate pump and lower tubing into well.
4. Turn on pump. If well runs dry, shut off pump and allow to recover.
5. Surging will be performed by raising and lowering the pump in the well to open and close the check valve in the pump several times to pull fine-grained material from the well. Collect the groundwater sample in a glass jar to determine relative turbidity, and measure and record the temperature, pH, and specific conductance.
6. Steps 4 and 5 will be repeated until groundwater is relatively silt-free; no further change is noted; the temperature, pH, and specific conductance readings have stabilized to within 10%; or 10 well volumes have been removed.
7. The developing equipment will be raised two feet and then Steps 4 and 5 will be repeated.
8. Step 6 will be repeated until entire well screen has been developed.

9. Record the approximate duration of pumping, volume of water removed, and other pertinent data in the field notebook.

IV. Disposal Methods

All water generated during cleaning and development procedures will be collected and contained on site in a labeled 55-gallon drums for future analysis and appropriate disposal.

Personal protective equipment, such as gloves, disposable clothing, and other disposable equipment, resulting from personnel cleaning procedures and from soil sampling and handling activities, will be placed in plastic bags. These bags will be transferred into appropriately labeled 55-gallon drums for appropriate disposal.

Attachment D

BLASLAND, BOUCK & LEE, INC.
engineers & scientists

Procedures for Soil Boring Completion and Sample Collection

Attachment D

Procedures for Soil Boring Completion and Sample Collection

I. Introduction

Soil borings typically will be completed using direct-push techniques (e.g., Geoprobe®) or using the hollow-stem auger drilling method. No oils or grease will be used on equipment introduced into the boring (e.g., drill rod, casing, or sampling tools, etc.). Prior to beginning work, all underground utilities will be delineated by GM or an independent underground utility locator service approved by GM.

II. Equipment Cleaning

Equipment will be cleaned prior to use on the site, between each drilling location, and prior to leaving the site. All drilling equipment and associated tools, including direct-push tooling, augers, drill rods, sampling equipment, wrenches, and other equipment or tools that may have come in contact with soils and/or waste materials, will be cleaned with steam-cleaning equipment using a potable water source. The drilling equipment will be cleaned in an area designated by the supervising engineer or geologist that is approved by GM. More detailed equipment cleaning procedures are provided in Appendix H.

III. Drilling Procedures, Equipment, and Records

All equipment and materials that may be required to advance the soil borings and sample encountered materials, as described, will be available during the boring and sampling operations. Required equipment and materials include drilling machinery in good working order equipped for the season of operation; sample containers and forms; sampling, screening, and cleaning equipment and supplies; and supplies and equipment to comply with all site and Health and Safety procedures.

The drilling contractor will be responsible for obtaining accurate and representative samples, informing the supervising geologist of changes in drilling conditions, and keeping a separate general log of soils encountered, including blow counts (i.e., the number of blows from a soil sampling drive weight [140 pounds] required to drive the split-barrel sampler in 6-inch increments). Records will also be kept of occurrences of premature refusal due to boulders or construction materials which may have been used as fill. Where a boring cannot be driven to the desired depth, equipment will be relocated in order to obtain the required sample. Multiple refusals may lead to a decision by the supervising geologist to abandon that sampling location.

The supervising geologist will be responsible for documenting drilling events using a daily field log (Attachment D-1) to record all relevant information in a clean and concise format. As an alternative, a bound field notebook may be used at the discretion of field personnel to document field activities, provided that the information shown on the Attachment D-1 is concisely presented in the notebook. The record of drilling events will include: 1) start and finish dates of drilling; 2) name and location of project; 3) project number, client, and site location; 4) sample number and depths; 5) blow counts and recovery; 6) depth to water; 7) type of drilling method; 8) auger size;

9) documentation of any elevated organic vapor emissions; 10) names of contractor's drillers, inspectors, or other people on site; and 11) weather conditions.

The direct-push drilling method also may be used to complete soil borings and monitoring wells. Examples of this technique include the Diedrich ESP vibratory probe system or AMS Power Probe™ dual-tube system. Environmental probe systems typically use a hydraulically operated percussion hammer. Depending on the equipment used, the hammer delivers 140 to 350 foot pounds of energy with each blow. The hammer, operated at 1,200 blows per minute, provides the force needed to penetrate very stiff/medium dense soil formations. The hammer simultaneously advances an outer steel casing which contains a dual tube liner for sampling soil. Depending on the system utilized, the outside diameter (OD) of the outer casing ranges from 1.75 to 2.4 inches, and the OD of the inner sampling tube ranges from 1.1 to 1.8 inches. The outer casing isolates shallow layers and permits the unit to continue to probe at depth. The double-rod system provides a borehole that may be tremie grouted from the bottom up. Alternatively, the inside diameter (ID) of the steel casing provides clearance for the installation of small diameter (e.g., 0.75- to 1.5-inch ID) wells. Upon completion of the borehole to the desired depth, the well is installed through the inner drill casing. The wells will consist of approximately 1.5-inch ID PVC slotted screen and blank riser. In areas of suspected DNAPL or highly chlorinated constituents, 2-inch stainless steel monitoring wells will be installed using conventional hollow-stem auger drilling methods.

Following the completion of soil sampling, all borings that are not being converted to monitoring wells will be tremie-grouted using neat cement and 5% bentonite mix. Also, if boring refusal is encountered and the boring location is abandoned, the boring will be tremie-grouted using neat cement and bentonite.

IV. Soil Sampling

Samples of subsurface materials encountered during the drilling of soil borings will be collected continuously with a 2-inch split-barrel (split-spoon) sampler (using ASTM Method D1586) or direct-push methods at select locations, as directed by the supervising geologist. Soil samples will be field screened with a PID.

Representative split-spoon or direct-push samples will be fully described on a soil boring description log (Attachment D-2) or in the field notebook.

Those samples selected for laboratory analysis will be handled, packed, and shipped in accordance with the procedures set forth in Attachment A.

Samples collected for Analysis of volatile organic compounds (VOCs) will be collected from the split-spoon using an EnCore™ Sampler as described in Attachment G. A geologist will be on site during drilling and sampling operations to fully describe each soil sample on the soil boring log including:

- Percent recovery;
- Structure and degree of sample disturbance;
- Soil type;

- Color;
- Moisture condition;
- Density;
- Grain size;
- Consistency; and
- Any other observations, particularly relating to the presence of waste materials or contaminants.

Particular care will be taken to fully describe any sheens observed, oil saturation, evidence of other organic chemicals, or unnatural materials.

V. Disposal Methods

All water generated during cleaning procedures will be collected and contained on site in labeled 55-gallon drums for future analysis and appropriate disposal.

Personal protective equipment, such as gloves, disposable clothing, and other disposable equipment, resulting from personnel cleaning procedures and from soil sampling and handling activities, will be placed in plastic bags. These bags will be transferred into appropriately labeled 55-gallon drums for appropriate disposal.

Soil materials will be placed in labeled sealed 55-gallon steel drums and stored in a secured area. Once full, the material will be analyzed to determine the appropriate disposal method.

Attachment D-1

BLASLAND, BOUCK & LEE, INC.
engineers & scientists

Daily Field Report

Date: _____

S	M	T	W	T h	F	S

PROJECT _____

JOB. NO. _____

CLIENT _____

CONTRACTOR _____

PROJECT MANAGER _____

WEATHER _____

TEMP. _____

WIND _____

HUMIDITY _____

FIELD TEAM	
NAME	REMARKS
NAME	REMARKS

VISITORS		
TIME	REPRESENTING	REMARKS

EQUIPMENT AT THE SITE

FIELD ACTIVITIES

BY _____ TITLE _____

6/2/97
1694840Q

Attachment D-2

BLASLAND, BOUCK & LEE, INC.
engineers & scientists

Soil Boring Log

Date Start/Finish: / Drilling Company: Driller's Name: Drilling Method: Bit Size: Auger Size : Rig Type: Spoon Size:	Northing: Easting: Well Casing Elev.: ft. Corehole Depth: ft. Borehole Depth: ft. Ground Surface Elev.: ft. Descriptions by:	Well No. Client: Site:

DEPTH / ELEVATION	Sample Depth / Sample Number	Sample/Int/Type	Blows/6 In.	N	Recovery (ft.)	PID (ppm) Headspace	Geotechnical Test	Geologic Column	Stratigraphic Description	Well Construction
gs elevation ft.									GROUND SURFACE	
5										
10										
15										

Remarks:

Water Levels		
Date / Time	Elevation	Depth

Project:

Script: BBL-wel2
Date: 10/15/98

Attachment E

BLASLAND, BOUCK & LEE, INC.
engineers & scientists

Photoionization Detector (PID), Air Monitoring, and Field Screening Procedures

Attachment E

Photoionization Detector (PID), Air Monitoring, and Field Screening Procedures

I. Introduction

Field screening with a photoionization detector (PID), such as an HNu, is a procedure to measure relative concentrations of volatile organic compounds (VOCs) and other compounds. The characteristics of the PID are presented in Attachment E-2, the compounds which it can detect are presented in Attachment E-3. Field screening will be conducted on the following:

- Work area air to assess exposure to on-site workers of air contaminants via the air pathway;
- Well headspaces as a precautionary measure each time the well cover is opened; and
- Headspace of soil samples to assess the relative concentration of volatile organics in the sample.

II. Materials

The following materials, as required, shall be available while performing PID field screening:

- Personal protective equipment (as required by the Health and Safety Plan);
- PID and operating manual;
- Calibration canisters for PID;
- Sample jars;
- Aluminum foil; and
- Field notebook.

III. PID Calibration

PID field instruments will be calibrated and operated to yield "total organic vapor" in ppm (v/v) as benzene. Operation, maintenance, and calibration shall be performed in accordance with the manufacturers instructions and entered on the PID calibration and maintenance log (Attachment E-4).

1. Don personal protective equipment (as required by the Health and Safety Plan).
2. Turn the FUNCTION switch to the BATTERY CHECK position. Check that the indicator is within or beyond the green battery arc. If indicator is below the arc or the red LED is lit, the battery must be charged.

3. Turn the FUNCTION switch to the STANDBY position and rotate the ZERO POTENTIOMETER until the meter reads zero. Wait 15 to 20 seconds to confirm the adjustment. If unstable, readjust.

4. Check to see that the SPAN POTENTIOMETER is adjusted for the probe being used (e.g., 9.8 for 10.2 electron volts (eV)).

5. Set the FUNCTION switch to the desired ppm range (0-20, 0-200, or 0-2,000). A violet glow from the UV source should be visible at the sample inlet of the probe/sensor unit.

6. Listen for the fan operation to verify fan function.

7. Connect one end of the sampling hose to the calibration canister regulator outlet and the other end to the sampling probe of the PID. Crack the regulator valve and take a reading after 5 to 10 seconds. Adjust the span potentiometer to produce the concentration listed on the span gas cylinder. Record appropriate information on the field calibration log (Attachment E-4 or equivalent).

8. If so equipped, set the alarm at desired level.

IV. Work Area Air Monitoring Procedure

1. Measure and record the background PID reading.

2. Measure and record breathing space reading.

V. Well Headspace Screening Procedure

1. Measure and record the background PID reading.

2. Unlock and open the well cover while standing upwind of the well.

3. Remove the well cap.

4. Place the PID probe approximately 6 inches above the top of the casing.

5. Record all PID readings and proceed in accordance with the site Health and Safety Plan.

VI. Equipment Cleaning

After each use, the readout unit should be wiped down with a clean cloth or paper towel.

The UV light source window and ionization chamber should be cleaned once a month in the following manner:

1. With the PID off, disconnect the sensor/probe from the unit.

2. Remove the exhaust screw, grasp the end cap in one hand and the probe shell in the other, and pull apart.

3. Loosen the screws on the top of the end cap and separate the end cap and ion chamber from the lamp and lamp housing.

4. Tilt the lamp housing with one hand over the opening so that the lamp slides out into your hand.

5. Clean the lamp with lens paper and HNu cleaning compound (except 11.7 eV). For the 11.7 eV lamp, use a chlorinated organic solvent.

6. Clean the ion chamber using methanol on a Q-tip^{R} and then dry gently at 50°C to 60°C for 30 minutes.

7. Following cleaning, reassemble by first sliding the lamp back into the lamp housing. Place ion chamber on top of the housing, making sure the contacts are properly aligned.

8. Place the end cap on top of the ion chamber and replace the two screws, tighten the screws only enough to seal the o-ring.

9. Line up the pins on the base of the lamp housing with pins inside the probe shell and slide the housing assembly into the shell.

Attachment E-1

BLASLAND, BOUCK & LEE, INC.
engineers & scientists

Response Factors for Organic Vapor Analyzer (OVA)

ATTACHMENT E-1
TABLE 1

RESPONSE FACTORS FOR ORGANIC VAPOR ANALYZER (OVA)

CHEMICAL COMPOUND	RESPONSE FACTOR (%)
Acetone	60
Acetonitrile	70
Acrylonitrile	70
Allyl Alcohol	30
Allyl Chloride	50
Benzene	150
2-Bromo-2-chloro-1,1,1-trifluoroethane (Halothane)	45
Bromomethane	75
1-Bromopropane	75
2-Butane	60
n-Butanol	50
2-Butanol	65
n-Butyl Acetate	80
n-Butyl Acrylate	60
2-Butyl Acrylate	70
n-Butyl Formate	50
2-Butyl Formate	60
n-Butyl Methacrylate	60
2-Butyl Methacrylate	80
Carbon Tetrachloride	10
Chlorobenzene	200
Chlorodifluoromethane (Freon 22)	40
Chloroform	65
1-Chloropropane	75
2-Chloropropane	90
2-Chloro-1,1,2-trifluoroethyl difluoromethyl ether (Ethane)	150
Cumene	100
Cyclohexane	85
Cyclohexanone	100
n-Decane	75
O-Dichlorobenzene	50
Dichlorodifluoromethane (Freon 12)	15

CHEMICAL COMPOUND	RESPONSE FACTOR (%)
1,1 Dichloroethane	80
1,2 Dichloroethane	80
trans-1,2-Dichloroethylene	50
Dichlorofluoromethane (Freon 21)	70
Dichloromethane	100
1,2-Dichloropropane	90
1,3-Dichloropropane	80
1,2-Dichloro 1,1,2,2-tetrafluoroethane (Freon 114)	110
Diethyl Ether	50
Diethyl Ketone	80
p-Dioxane	30
Ethane	80
Ethanethiol	30
Ethanol	25
Ethyl Acetate	65
Ethyl Acrylate	40
Ethyl Benzene	100
Ethyl Butyrate	70
Ethyl Formate	40
Ethyl Methacrylate	70
Ethyl Propionate	65
Ethylene Dibromide	50
Ethylene Dichloride	60
Ethylene Oxide	70
Fluorotrichloromethane (Freon 11)	10
Heptane	75
Hexane	70
Isoprene	50
Methane	100
Methyl Alcohol	12
Methyl Acetate	41
Methyl Acrylate	40
Methyl Cyclohexane	100
Methyl Cyclopentane	80
Methyl Ethyl Ketone	80
Methyl Isobutyl Ketone	80

CHEMICAL COMPOUND	RESPONSE FACTOR (%)
Methyl Methacrylate	50
Methyl Propyl Ketone	70
Nitromethane	35
1-Nitropropane	60
2-Nitropropane	70
Nonane	90
Octane	80
Pentane	65
Pentanol	40
Propane	80
n-Propanol	40
2-Propanol	65
n-Propyl Acetate	75
n-Propyl Ether	65
n-Propyl Formate	50
Pyridine	128
Styrene	85
1,1,1,2-Tetrachloroethane	100
1,1,2,2-Tetrachloroethane	100
Tetrachloroethylene	70
Tetrahydrofuran	40
Toluene	110
1,1,1 Trichloroethane	105
1,1,2 Trichloroethane	85
Trichloroethylene	70
Trichlorofluoroethane (Freon 113)	80
Triethylamine	70
Vinyl Acetate	50
Vinyl Chloride	35
Vinylidene Chloride	40
m-Xylene	111
o-Xylene	116
p-Xylene	116

Note:

[1] Response Factors for Foxboro Century OVA when instrument is calibrated to methane. For example, the instrument response factor for benzene is 150 percent and a 100 ppm concentration of benzene in air would register as 150 ppm on the instrument read-out.

Attachment E-2

BLASLAND, BOUCK & LEE, INC.
engineers & scientists

Characteristics of the Photoionization Detector (PID)

Attachment E-2

Characteristics of the Photoionization Detector (PID)

I. Introduction

Photoionization detectors (PIDs) are used in the field to detect a variety of compounds in air. PIDs can be used to detect leaks of volatile substances in drums and tanks, determine the presence of volatile compounds in soil and water, and make ambient air surveys. If personnel are thoroughly trained to operate the instrument and to interpret the data, these PID instruments can be a valuable tool. Its use can help in deciding the level of protection to be worn, assist in determining the implementation of other safety procedures, and in determining subsequent monitoring or sampling locations.

Portable PIDs detect the concentration of organic gases as well as a few inorganic gases. The basis for detection is the ionization of gaseous species. The incoming gas molecules are subjected to ultraviolet (UV) radiation, which ionizes molecules that have an ionization potential (IP) less than or equal to that rated for the UV source. Every molecule has a characteristic IP, which is the energy required to remove an electron from the molecule, thus yielding a positively charged ion and the free electron. These ions are attracted to an oppositely charged electrode, causing a current and an electric signal to the LED display. Compounds are measured on a parts per million (ppm) volume basis.

II. HNu PI-101

The HNu portable photoionizer detects the concentration of organic gases as well as a few inorganic gases. The basis for detection is the ionization of gaseous species. The incoming gas molecules are subjected to UV radiation, which is energetic enough to ionize many gaseous compounds. Each molecule is transformed into charged ion pairs, creating a current between two electrodes. Every molecule has a characteristic IP, which is the energy required to remove an electron from the molecule, yielding a positively charged ion and the free electron.

Three probes, each containing a different UV light source, are available for use with the HNu. Energies are 9.5, 10.2, and 11.7 electron volts (eV), respectively. All three probes detect many aromatic and large-molecule hydrocarbons. The 10.2 eV and 11.7 eV probes, in addition, detect some smaller organic molecules and some halogenated hydrocarbons. The 10.2 eV probe is the most useful for environmental response work, as it is more durable that the 11.7 eV probe and detects more compounds than the 9.5 eV probe. The 10.2 eV probe will be used for all PID screenings related to field activities at this site. A listing of molecules and compounds that the HNu can detect is presented in Attachment E-3. For 1,1,1-trichloroethane (ionization potential - 11.25 eV) a PID with a UV light source of 11.7 eV will be used for air monitoring and field screening of soil samples.

The primary HNu calibration gas is either benzene or isobutylene. The span potentiometer knob is turned to 9.8 for benzene calibration. A knob setting of zero increases the sensitivity to benzene approximately tenfold. Its lower detection limit is in the low ppm range. Additionally, response time is rapid; the dot matrix liquid crystal displays 90 percent of the indicated concentration in three seconds.

III. Limitations

The PID instrument can monitor several vapors and gases in air. Many non-volatile liquids, toxic solids, particulates, and other toxic gases and vapors, however, cannot be detected with PIDs. Since the PIDs cannot detect all the chemicals that may be present at a sample location, a zero reading on either instrument does not necessarily signify the absence of air contaminants.

The PID instrument is generally not specific, and their response to different compounds is relative to the calibration gases. Instrument readings may be higher or lower than the true concentration. This effect can be observed when monitoring total contaminant concentrations if several different compounds are being detected at once. In addition, the response of these instruments is not linear over the entire detection range. Therefore, care must be taken when interpreting the data. Concentrations should be reported in terms of the calibration gas and span potentiometer or gas-select-knob setting.

PIDs are small, portable instruments and may not yield results as accurate as laboratory instruments. PIDs were originally designed for specific industrial applications. They are relatively easy to use and interpret when detecting total concentrations of known contaminants in air, but interpretation becomes more difficult when trying to identify the individual components of a mixture. Neither instrument can be used as an indicator for combustible gases or oxygen deficiency.

This QAPP intends for the PIDs to be used only as a guide for work area air monitoring to establish action levels (as defined in the Health and Safety Plan).

Attachment E-3

BLASLAND, BOUCK & LEE, INC.
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Molecules and Compounds Detected by a Photoionization Detector (PID)

Attachment E-3

Molecules and Compounds Detected by a Photoionization Detector (PID)

Some Atoms and Simple Molecules

IP(eV)			IP(eV)
H	13.595	I_2	9.28
C	11.264	HF	15.77
N	14.54	HCl	12.74
O	13.614	HBr	11.62
Si	8.149	HI	10.38
S	10.357	SO_2	12.34
F	17.42	CO_2	13.79
Cl	13.01	COS	11.18
Br	11.84	CS_2	10.08
I	10.48	N_2O	12.90
H_2	15.426	NO_2	9.78
N_2	15.580	O_3	12.80
O_2	12.075	H_2O	12.59
CO	14.01	H_2S	10.46
CN	15.13	H_2Se	9.88
NO	9.25	H_2Te	9.14
CH	11.1	HCN	3.91
OH	13.18	C_2N_2	13.8
F_2	15.7	NH_3	10.15
Cl_2	11.48	CH_3	9.840
Br_2	10.55	CH_4	12.98

Paraffins and Cycloparaffins

Molecule	IP(eV)
methane	12.98
ethane	11.65
propane	11.07
n-butane	10.63
i-butane	10.57
n-pentane	10.35
i-pentane	10.32
2,2-dimethylpropane	10.35
n-hexane	10.18
2-methlypentane	10.12
3-methlypentane	10.08
2,2-dimethlybutane	10.06
2,3-dimethlybutane	10.02
n-heptane	10.08
2,2,4-trimethlypentane	9.86
cyclopropane	10.06
cyclopentane	10.53
cyclohexane	9.88
methlycyclohexane	9.85

Alkyl Halides

Molecule	IP(eV)
HCl	12.74
Cl_2	11.48
CH_4	12.98
methyl chloride	11.28
dichloroemethane	11.35
trichloromethane	11.42
tetrachloromethane	11.47
ethyl chloride	10.98
1,2-dichloroethane	11.12
1-chloropropane	10.82
2-chloropropane	10.78
1,2-dichloropropane	10.87
1,3-dichloropropane	10.85
1-chlorobutane	10.67
2-chlorobutane	10.65
1-chloro-2-methylpropane	10.66
2-chloro-2-methylpropane	10.61
Hbr	11.62
Br_2	10.55
methyl bromide	10.53
dibromomethane	10.49
tribromomethane	10.51
CH_2BrCl	10.77
$CHBr_2Cl$	10.59
ethyl bromide	10.29
1,1-dibromoethane	10.19
1-bromo-2-chloroethane	10.63
1-bromopropane	10.18
2-bromopropane	10.075
1,3-dibromopropane	10.07
1-bromobutane	10.13
2-bromobutane	9.98
1-bromo-2-methylpropane	10.09

Alkyl Halides

Molecule	IP(eV)
2-bromo-2-methylpropane	9.89
1-bromopentane	10.10
Hl	10.38
I_2	9.28
methyl iodide	9.54
diiodomethane	9.34
ethyl iodide	9.33
1-iodopropane	9.26
2-iodopropane	9.17
1-iodobutane	9.21
2-iodobutane	9.09
1-iodo-2-methylpropane	9.18
2-iodo-2-methylpropane	9.02
1-iodopentane	9.19
F_2	15.7
HF	15.77
$CFCl_3$ (Freon 11)	11.77
CF_2Cl_2 (Freon 12)	12.31
CF_3Cl (Freon 13)	12.91
$CHCIF_2$ (Freon 22)	12.45
$CFBR_3$	10.67
CF_2Br_2	11.07
CH_3CF_2Cl (Genetron 101)	11.98
$CFCl_2CF_2Cl$	11.99
CF_3CCl_3 (Freon 113)	11.78
$CFHBrCH_2Cr$	10.75
CF_2BrCH_2Br	10.83
CF_3CH_2I	10.00
n-C_3F_7I	10.36
n-$C_3F_7CH_2Cl$	11.84
n-$C_3F_7CH_2I$	9.96

Aliphatic Alcohol, Ether, Thiol, and Sulfides

Molecule	IP(eV)
H_2O	12.59
methyl alcohol	10.85
ethyl alcohol	10.48
n-propyl alcohol	10.20
I-propyl alcohol	10.16
n-butyl alcohol	10.04
dimethyl ether	10.00
diethyl ether	9.53
n-propyl ether	9.27
I-propyl ether	9.20
H_2S	10.46
methanethiol	9.440
ethanethiol	9.285
1-propanethiol	9.195
1-butanethiol	9.14
dimethyl sulfide	8.685
ethyl methyl sulfide	8.55
diethyl sulfide	8.430
di-n-propyl sulfide	8.30

Aliphatic Aldehydes and Ketones

Molecule	IP(eV)
CO_2	13.79
formaldehyde	10.87
acetaldehyde	10.21
propionaldehyde	9.98
n-butyraldehyde	9.86
isobutyraldehyde	9.74
n-valeraldehyde	9.82
isovaleraldehyde	9.71
acrolein	10.10
crotonaldehyde	9.73
benzaldehyde	9.53
acetone	9.69
methyl ethyl ketone	9.53
methyl n-propyl ketone	9.39
methyl i-propyl ketone	9.32
diethyl ketone	9.32
methyl n-butyl ketone	9.34
methyl i-butyl ketone	9.30
3,3-dimethyl butanone	9.17
2-heptanone	9.33
cyclopentanone	9.26
cyclohexanone	9.14
2,3-butanedione	9.23
2,4-pentanedione	8.87

Aliphatic Acids and Esters

Molecule	IP(eV)
CO_2	13.79
formic acid	11.05
acetic acid	10.37
propionic acid	10.24
n-butyric acid	10.16
isobutyric acid	10.02
n-valeric acid	10.12
methyl formate	10.815
ethyl formate	10.61
n-propyl formate	10.54
n-butyl formate	10.50
isobutyl formate	10.46
methyl acetate	10.27
ethyl acetate	10.11
n-propyl acetate	10.04
isopropyl acetate	9.99
n-butyl acetate	10.01
isobutyl acetate	9.97
sec-butyl acetate	9.91
methyl propionate	10.15
ethyl propionate	10.00
methyl n-butyrate	10.07
methyl isobutyrate	9.98

Aliphatic Amines and Amides

Molecule	IP(eV)
NH_3	10.15
methyl amine	8.97
ethyl amine	8.86
n-propyl amine	8.78
i-propyl amine	8.72
n-butyl amine	8.71
i-butyl amine	8.70
s-butyl amine	8.70
t-butyl amine	8.64
dimethyl amine	8.24
diethyl amine	8.01
di-n-propyl amine	7.84
di-i-propyl amine	7.73
di-n-butyl amine	7.69
trimethyl amine	7.82
triethyl amine	7.50
tri-n-propyl amine	7.23
formamide	10.25
acetamide	9.77
N-methyl acetamide	8.90
N,N-dimethyl formamide	9.12
N,N-dimethyl acetamide	8.81
N,N-diethyl formamide	8.89
N,N-diethyl acetamide	8.60

Other Aliphatic Molecules with N Atom

Molecule	IP(eV)
nitromethane	11.08
nitroethane	10.88
1-nitropropane	10.81
2-nitropropane	10.71
HCN	13.91
acetonitrile	12.22
propionitrile	11.84
n-butyronitrile	11.67
acrylonitrile	10.91
3-butene-nitrile	10.39
ethyl nitrate	11.22
n-propyl nitrate	
methyl thiocyanate	10.065
ethyl thiocyanate	9.89
methyl isothiocyanate	9.25
ethyl isothiocyanate	9.14

Olefins, Cyclo-ofefins, Acetylenes

Molecule	IP(eV)
ethylene	10.515
propylene	9.73
1-butene	9.58
2-methylpropene	9.23
trans-2-butene	9.13
cis-2-butene	9.13
1-pentene	9.50
2-methyl-1-butene	9.12
3-methyl-1-butene	9.51
3-methyl-2-butene	8.67
1-hexene	9.46
1,3-butadiene	9.07
isoprene	8.845
cyclopentene	9.01
cyclohexene	8.945
4-methylcyclohexene	8.91
4-cinylcylohexene	8.93
cyclo-octatetraene	7.99
acetylene	11.41
propyne	10.36
1-butyne	10.18

Some Derivatives of Olefins

Molecule	IP(eV)
vinyl chloride	9.995
cis-dichloroethylene	9.65
trans-dichloroethylene	9.66
trichloroethylene	9.45
tetrachloroethylene	9.32
vinyl bromide	9.80
1,2-dibromoethylene	9.45
tribromoethylene	9.27
3-chloropropene	10.04
2,3-dichloropropene	9.82
1-bromopropene	9.30
3-bromopropene	9.7
$CF_3CCl{=}CClCF_3$	10.36
$n\text{-}C_5F_{11}CF{=}CF_2$	10.48
acrolein	10.10
crotonaldehyde	9.73
mesityl oxide	9.08
vinyl methyl ether	8.93
allyl alcohol	9.67
vinyl acetate	9.19

Aromatic Compounds

Molecule	IP(eV)
benzene	9.245
toluene	8.82
ethyl benzene	8.76
n-propyl benzene	8.72
i-propyl benzene	8.69
n-butyl benzene	8.69
s-butyl benzene	8.68
t-butyl benzene	8.68
o-xylene	8.56
m-xylene	8.56
p-xylene	8.445
mesitylene	8.40
durene	8.025
styrene	8.47
alpha-methyl styrene	8.35
ethynylbenzene	8.815
napthalene	8.12
1-methylnapthalene	7.69
2-methylnapthalene	7.955
biphenyl	8.27
phenol	8.50
anisole	8.22
phenetole	8.13
benzaldehyde	9.53
acetophenone	9.27
benzenethiol	8.33
phenyl isocyanate	8.77

Aromatic Compounds

Molecule	IP(eV)
phenyl isothiocyanate	8.520
benzonitrile	9.705
nitrobenzene	9.92
aniline	7.70
fluoro-benzene	9.195
chloro-benzene	9.07
bromo-benzene	8.98
iodo-benzene	8.73
o-dichlorobenzene	9.07
m-dichlorobenzene	9.12
p-dichlorobenzene	8.94
1-chloro-2-fluorobenzene	9.155
1-chloro-3-fluorobenzene	9.21
1-chloro-4-fluorobenzene	8.99
o-fluorotoluene	8.915
m-fluorotoluene	8.915
p-fluorotoluene	8.785
o-chlorotoluene	8.83
m-chlorotoluene	8.83
p-chlorotoluene	8.70
o-bromotoluene	8.79
m-bromotoluene	8.81
p-bromotoluene	8.67
o-iodotoluene	8.62
m-iodotoluene	8.61
p-iodotoluene	8.50
benzotrifluoride	9.68
o-fluorophenol	8.66

Heterocyclic Molecules

Molecule	IP(eV)
furan	8.89
2-methyl furan	8.39
2-furaldehyde	9.21
tetrahydrofuran	9.54
dihydropyran	8.34
tetrahydropyran	9.26
thiophene	8.860
2-chlorothiophene	8.68
2-bromothiophene	8.63
pyrrole	8.20
pyridine	9.32
2-picoline	9.02
3-picoline	9.04
4-picoline	9.04
2,3-lutidine	8.85
2,4-lutidine	8.85
2,6-lutidine	8.85

Miscellaneous Molecules

Molecule	IP(eV)
ethylene oxide	10.565
propylene oxide	10.22
p-dioxane	9.13
dimethoxymethane	10.00
diethoxymethane	9.70
1,1-dimethoxyethane	9.65
propiolactone	9.70
methyl disulfide	8.46
ethyl disulfide	8.27
diethyl sulfite	9.68
thiolacetic acid	10.00
acetyl chloride	11.02
acetyl bromide	10.55
cyclo-$C_6H_{11}CF_3$	10.46
$(n\text{-}C_3F_7)(CH_3)C{=}O$	10.58
trichlorovinylsilane	10.79
$(C_2F_5)_3N$	11.7
isoprene	9.08
phosgene	11.77

Notes:
Reference: HNu Systems, Inc., 1985
IP = Ionization Potential

Attachment E-4

BLASLAND, BOUCK & LEE, INC.
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Photoionization Detector Calibration and Maintenance Log

PHOTOIONIZATION DETECTOR CALIBRATION AND MAINTENANCE LOG

INSTRUMENT MANUFACTURER _____
INSTRUMENT MODEL _____
IDENTIFICATION NUMBER _____
LAMP (Circle One) 9.5eV 10.2eV 11.7eV

			CALIBRATION STANDARD				
DATE/ TIME	INITIALS	BATTERY CHECK	SOURCE	TYPE	CONCENTRATION	SPAN POTENTIOMETER SETTING	COMMENTS

Attachment F

BLASLAND, BOUCK & LEE, INC.
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Oil-Water Shake Test Protocol

Attachment F

Oil-Water Shake Test Protocol

1. Visually observe split-spoon sample. Observe for sheens, odors, staining of soils, and/or visible signs of a separate phase. Record sample description in field notebook following normal protocol.

2. If any sheens, odors, staining of soils, or oils are observed, collect two drillers' jars of sample. Use one jar for the PID reading and the other for oil-water shake test.

3. In the sample jar designated for oil-water shake test, fill with distilled water so that sample is completely submerged. Shake vigorously. Observe for any sheens or signs of a separate phase (may be observed floating on water or within sample). Let sit for approximately 10 minutes to allow water to clear slightly and oil to separate out, observe again for any signs of sheen or oil.

4. Record any signs of oil in field notebook: color, density compared with water, amount present, and any other observations.

Attachment G

BLASLAND, BOUCK & LEE, INC.
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Soil Sampling Procedures for Analysis of Volatile Organic Compounds (VOCs)

Attachment G

Soil Sampling Procedures for Analysis of Volatile Organic Compounds (VOCs)

I. Introduction

This standard operating procedure (SOP) describes the field sampling procedures to collect soil samples for the analysis of volatile organic compounds (VOCs). Soil samples will be collected in a manner that will minimize the loss of VOCs through volatilization and biodegradation. This SOP presents the procedures to collect soil samples for low-level (sample concentrations less than 200 μg/Kg, wet weight) and high-level (sample concentrations greater than 200 μg/Kg, wet weight) VOC analyses using the EnCore™ Sampler, or equivalent sampler.

II. Materials

The following materials, as required, shall be available during soil sampling:

- Health and safety equipment (as required in the Health and Safety Plan);
- Photoionization detector (PID);
- Stainless steel spatula;
- EnCore™ Sampler;
- EnCore™ Sampler T-Handle;
- Field notebook;
- Appropriate sample containers (4-oz glass jar with Teflon®-lined cap or EnCore™ Sampler); and
- Appropriate transport containers (coolers) and appropriate labeling, packing, and shipping materials.

III. Field Sampling

1. Place EnCore™ Sampler into the EnCore™ T-handle.

2. Collect soil sample by pressing the EnCore™ Sampler into the soil to be collected.

3. Using the T-handle, cap and lock the EnCore™ Sampler for shipment.

4. If low-level VOC analysis is to be performed, repeat steps 1 through 3 two additional times to collect a total of three samples (high-level VOC analysis only requires one EnCore™ Sampler).

5. Collect additional soil in 40 mL vial for percent moisture determination. A decontaminated stainless steel spatula may be used to assist this procedure.

6. Place sample container in a transportation cooler on ice immediately after collection. Package and label the sample container following the procedures in Attachment A.

III. Field Cleaning Procedures

Cleaning of VOC sampling equipment (e.g., stainless-steel sampling tools) is to follow procedures presented in Attachment H. The sampling equipment is to be cleaned prior to the start of sampling activities, between samples, and following the completion of sampling activities.

IV. Disposal Methods

Rinse water, PPE, and other residuals generated during the equipment cleaning procedures will be placed in appropriate containers. Containerized waste will be disposed of by the appropriate party.

Attachment H

BLASLAND, BOUCK & LEE, INC.
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Equipment Decontamination Procedures

Attachment H

Equipment Decontamination Procedures

I. Introduction

Decontamination areas for smaller equipment to be washed by hand will generally be set up adjacent to the individual work areas, as described in the Site Health and Safety Plan (HASP). A steam-cleaning station and pad for containing rinse water will be set up within the Site in a peripheral location that will not interfere with sampling activities. The equipment decontamination procedures include pre-field, in the field, and post-field cleaning of sampling equipment. The sampling equipment includes all non-disposable equipment potentially coming in contact with contaminated materials. The nondisposable equipment will be decontaminated after the completion of each sampling event. All rinse water will be contained and appropriately disposed of.

II. Typical Equipment Decontamination Materials List

- Distilled/deionized water
- Non-phosphate soap
- Tap water
- Appropriate cleaning solvent (e.g., hexane, methanol)
- Nitric acid
- Wash basins
- Brushes
- Plastic sheeting
- Aluminum foil
- Large heavy-duty garbage bags
- Spray bottles
- Ziploc®-type bags
- Handiwipes
- Disposable gloves

III. Storage of Equipment

All sampling equipment will be stored in a clean environment and, where appropriate, the equipment will be covered in aluminum foil after cleaning prior to use.

IV. Safety Procedures During Equipment Decontamination

1. Personnel will wear the following safety equipment when cleaning smaller sampling equipment (e.g., split-spoons, trowels);

   - Safety glasses, goggles, and/or a splash shield;
   - Coveralls;
   - Waterproof cover boots; and
   - PVC or nitrile outer gloves.

   Additional personal protective equipment (PPE) may be required based on the results of field screening, as described in the HASP.

2. Personnel will wear the following additional safety equipment when cleaning larger equipment with a high-pressure water/stream cleaning unit (i.e., drilling rig backhoe):

   - Laminated-type Tyvek™ disposable coveralls (e.g., Saranex™); and
   - Chemical-resistant overboots.

3. All solvent rinsing will be conducted in an adequately ventilated area.

4. All solvent transported into the field will be stored and packed in appropriate containers with care taken to avoid extreme heat.

5. Handling of solvents will be conducted in accordance with the manufacturer's Material Safety Data Sheets (MSDSs).

V. Field Decontamination Procedures

1. Decontamination Station

   The steam-cleaning station will be located within the site in a peripheral area. In addition, wash stations for the decontamination of smaller equipment will be established as necessary outside of the individual work zones.

   All equipment, such as drill rigs and other mobile equipment, will receive an initial decontamination prior to use at the site. The frequency of subsequent decontamination while on site will depend on how the equipment is actually used in relation to taking environmental samples. All fluids and residues produced

from the decontamination procedures will be collected and stored on-site until analysis can be conducted and a decision is made regarding final disposition of the material pursuant to state and federal requirements.

2. Decontamination of Sampling Equipment

Sampling equipment (split-spoons, Hydropunch™ sampler, bailers, trowels, etc.) will be cleaned in accordance with the decontamination procedures listed in Attachment H-1. The first step, a soap and water wash, is completed to remove all visible particulate matter and residual oils and grease. (This step may be preceded by steam-cleaning to facilitate removal of residual materials.) When analyzing for organic constituents, this step will be followed by a tap water rinse to remove the detergent and a rinse sequence of solvent (e.g., hexane, methanol) and distilled/deionized water. When analyzing for inorganic constituents, the soap and water wash will be followed by a nitric acid rinse, a tap water rinse, and a distilled/deionized water rinse.

3. Decontamination of Heavy Equipment

Other equipment and materials associated with sampling tasks will be decontaminated prior to use. Items such as drill rigs and auger flights present potential sources of cross-contamination of environmental samples. These items may come into contact with the materials adjacent to the matrix being sampled or may be attached to sampling equipment which has been decontaminated in accordance with procedures set forth in Attachment H-1. Heavy equipment may potentially retain contaminants from other sources such as roadways or storage areas or have soil material from previous job sites that has not been removed. For these reasons, it is most important that these items be decontaminated prior to their use at the site.

Two options are available to accomplish decontamination of heavy equipment: steam-cleaning and manual scrubbing. The use of steam-cleaning can remove visible debris and has several advantages. Steam-cleaners provide high-pressure which is very effective for residuals removal. They are also efficient in terms of ease of handling and generate low volumes of wash solutions.

Steam-cleaning is the preferred method for decontamination of heavy equipment and will be used to decontaminate drill rigs and other heavy equipment whenever possible. Manual scrubbing of equipment will only be used if steam-cleaning fails to remove visible materials.

The drilling equipment will be thoroughly decontaminated by steam-cleaning or manual scrubbing upon initial arrival on site and between drilling locations. Drill rig items such as auger flights, drill rods, and drill bits will be decontaminated between borings.

4. Decontamination of Other Equipment

The water level probe used for water level measurements will be cleaned between each well with a soapy water wash and a distilled/deionized water rinse. The transducer and cable used during the in-situ hydraulic conductivity testing and the gamma ray logging instrument probe used during the borehole logging will be cleaned in the same manner.

Well development equipment will be cleaned with a soapy water wash, followed by a tap water rinse, a solvent rinse, and a distilled/deionized water rinse.

VI. Disposal Methods

All fluids generated during decontamination procedures will be collected and contained on site in 55-gallon drums for future analysis and appropriate disposal. Solids (e.g., disposable gloves, disposable clothing, and other disposable equipment) resulting from personal decontamination procedures will be placed in plastic bags and appropriately disposed of in 55-gallon drums or a covered roll-off container.

Attachment H-1

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Equipment Decontamination Procedure

Attachment H-1

Equipment Decontamination Procedure

The field sampling equipment decontamination procedures when analyzing for organic constituents are as follows:

1. Non-phosphate detergent and water wash;
2. Tap water rinse;
3. Solvent rinse (e.g., hexane, methanol);
4. Distilled water rinse; and
5. Wrap equipment completely with aluminum foil to prevent contact with other materials during storage and/or transport to the field, as appropriate.

The field sampling equipment decontamination procedures when analyzing for inorganic constituents are as follows:

1. Non-phosphate detergent and water wash;
2. Rinse equipment with at least a ten-percent nitric acid solution;
3. Tap water rinse;
4. Distilled water rinse; and
5. Wrap equipment with aluminum foil to prevent contact with other materials during storage and/or transport to the field.

Attachment I

BLASLAND, BOUCK & LEE, INC.
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Water Level Measurement Procedures

Attachment I

Water Level Measurement Procedures

I. Introduction

In an effort to avoid the influence of natural fluctuations in the potentiometric surface, to the extent practical, measurements will be made during a 24-hour period which has no major storm event. These data will be used in the development of potentiometric surface maps and for evaluating hydraulic gradients. The water levels will be obtained using an electric water level probe or a weighted steel tape.

II. Materials

The following materials, as required, shall be available during water level measurement activities:

- Personal protective equipment (as required by the Site Health and Safety Plan)
- Photoionization detector (PID) to measure headspace vapors
- Cleaning equipment (including non-phosphate soap and distilled/deionized water)
- Appropriate forms and field notebook
- Keys for wells
- Water level probe (Slope Indicator Co. or equivalent)
- Waterproof marker
- Hacksaw
- Measuring tape (engineer's 6-foot rule)
- Weighted steel tape

III. Procedures

1. Record the site and well number on the Water Level Record (Attachment I-1) or field notebook along with other appropriate information collected during the water level measurement.

2. Don personal protective equipment (as required by the Health and Safety Plan).

3. Clean the water level probe and cable with a soapy water wash and a distilled/deionized water rinse in accordance with the cleaning procedures in Attachment H.

4. Unlock and open the well cover while standing upwind of the well. Remove the well cap. Measure headspace vapors using a PID.

5. Locate the measuring reference point on the well casing. If one is not found, initiate a reference point by notching the inner and outer casings with a hacksaw or by using a waterproof marker. If a well has both inner and outer casings, use the top of the inner casing as the reference point. All downhole measurements will be taken from the reference points.

6. Measure and record, to the nearest hundredth of a foot, the distance from the reference point to ground level.

7. Measure and record, to the nearest hundredth of a foot, the inside diameter of the casings.

8. Lower the water level probe until it reaches the water surface. Measuring to the nearest hundredth of a foot, record the depth to water from the reference point.

9. Lower the water level probe or weighted steel tape to the bottom of well. Measure and record the depth of the well from the reference point to the nearest hundredth of a foot. Again, record the reference point used. If weights are suspended from the water level probe, adjust the recorded depth for the length of the weight.

10. Remove weighted steel tape or water level probe from the well.

11. Clean the water level probe and cable in accordance with the cleaning procedures in Attachment H.

12. Compare depth of well to previous records.

13. Lock the well when all activities are completed.

Attachment I-1

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Water Level Record

WATER LEVEL RECORD

Site: ______________________________ Sheet _____ of _____

Job Title ______________________________

Job No.: ______________________________

Date	Well No.	FID/PID Reading	Stickup Inner/ Outer	Well Depth	Water Depth	Time	Comments	Initials

Attachment J

BLASLAND, BOUCK & LEE, INC.
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Groundwater Purging/Evacuation and Sampling Procedures

Attachment J

Groundwater Purging/Evacuation and Sampling Procedures

I. Introduction

During precipitation events, groundwater sampling will be discontinued until precipitation ceases. In addition, no wells will be sampled until at least one week following the well development to allow equilibrium of the well with the aquifer.

II. Materials

The following materials shall be available, as required, during groundwater sampling:

- Photoionization detector (PID);
- Health and safety equipment (as required by the Health and Safety Plan);
- Cleaning equipment (as required in Attachment H);
- Plastic sheeting;
- Bailer stainless steel or Teflon®;
- Non-absorbent cord (polypropylene);
- Pump (if required);
- Water-level well probe;
- Measuring tape;
- Wrist watch;
- Pre-measured bucket (if required);
- Conductivity/pH and dissolved oxygen (DO) meter;
- Absorbent pads;
- Thermometer;
- Back-up temperature, pH, and conductivity meters;

- Blanks and fortifications (if required);
- Insulated coolers, ice or ice packs, and appropriate packing material;
- Ziploc® type bags;
- Large heavy-duty garbage bags;
- Sample labels;
- 55-gallon DOT-approved drums;
- Field notebook;
- 0.45 micron glass fiber filter(s);
- Field sampling form(s) and chain of custody forms;
- Relevant well sampling data;
- Water well handbook;
- Knife;
- Appropriate tools; and
- Keys to wells.

III. Procedures

1. Review materials checklist (Part II) to ensure the appropriate equipment has been assembled.
2. Identify site and well location on sampling log sheets, along with date, arrival time, and weather conditions. Identify the personnel and equipment utilized and other pertinent data requested on the logs (Attachment J-1, Groundwater Sampling Field Log).
3. Label all sampling containers with the date, time, well number, site location, and sampling personnel.
4. Don safety equipment as required by the Health and Safety Plan.
5. Put on a new pair of disposable gloves, as required. These gloves will be used for the entire sampling event and are well-specific.

6. Place a piece of plastic sheeting adjacent to well to use as a clean work area. Cut center of sheeting and place around well.

7. Set out on plastic sheeting all of the necessary sampling equipment that has been decontaminated. Do not let any soil or other material fall on the plastic sheeting, unless it comes from the well. If oil is present in the well, place absorbent pads on plastic sheet beside well to absorb oil which may be present when the bailer, pump, or probe is removed from the well.

8. Open the well cover while standing upwind of the well. Remove well cap and place on the plastic sheeting. Insert PID probe approximately 4 to 6 inches into the casing or the well headspace and cover with gloved hand. Record the PID reading in the field log. If the well headspace reading is above 5 PID units, proceed, else screen the air within the breathing zone. If the PID reading in the breathing zone is below 5 PID units, proceed. If the PID reading is above 5 PID units, move upwind from well for five minutes to allow the volatiles to dissipate. Repeat the breathing zone test. If the reading is still above 5 PID units, put on appropriate respiratory protection in accordance with the requirements of the Health and Safety Plan. Record the photoionization detector reading.

9. Obtain water-level depth and bottom of well depth following the procedures in Attachment C and record on sampling log sheet and in field log. Clean the well probe and steel tape after each use, following appropriate cleaning protocols for sampling equipment (Attachment H).

10. Calculate the number of gallons of water in the well using the length of the water column (in feet), multiplying by 0.163 for a 2-inch-diameter well or by 0.653 for a 4-inch-diameter well (for other diameters calculate the area of the inside of the well). Record the well volume on the groundwater sampling field log.

11. Field calibrate the pH/conductivity meter on a twice-daily (minimum) basis, in accordance with manufacturer's instruction manual, and record these calibrations on the field log. Calibration will occur more frequently as conditions and/or manufacturer's specifications dictate.

12. Remove the required purge volume for the well (a minimum of three well volumes and a maximum of five well volumes) by pumping or bailing the well. If the monitoring well is bailed or pumped dry, the groundwater samples may be collected when a sufficient volume of water has entered the well to permit sample collection. Acceptable pumps for purging the well include:

    - small diameter electric submersible pump (e.g., Grunfos Redi-flow pump);
    - small diameter positive-displacement pump (e.g., Geotech diaphragm pump); and
    - Waterra inertial pump.

    Well purging may also be performed using stainless steel, Teflon®, or dedicated disposable bailers. During well purging, especially with low-yielding wells, care should be exercised to prevent the well from being pumped dry. Place the pump intake (if used) near the water surface and slowly lower toward the bottom of the well. To limit the potential for disturbing any sediment accumulation in the bottom of the well,

maintain at least 1 foot between the pump intake and the well bottom. If the recharge rate causes the formation water to cascade down the sides of the well screen, the potential for sample degassing increases. Purging of the well by pumping will be performed using a consistent, low-flow rate to reduce the potential for excessive agitation of the formation water entering the well. If a bailer is used to purge the well, the bailer will be lowered slowly into the water column and not be allowed to free-fall such that there is a potential for increased volatilization of compounds in the formation water entering the well. All purge water will be contained in appropriately sized DOT-approved drums. Note the pumping rate and duration, or the bailer volume and number of bailers of water removed, on the field log. In addition, measure and record the temperature, specific conductance, dissolved oxygen, and pH of the purge water once each per well volume removed (Attachment K). If these parameters have stabilized after three or four volumes, discontinue purging. Alternatively, five well volumes may be removed without measuring the indicator parameters.

13. After the appropriate purge volume of groundwater has been evacuated from the well or the well has been bailed or pumped dry, groundwater samples will be obtained using a sampling pump or bailer. Appropriate sampling pumps include the following:

    - Grunfos Redi-Flo 2-inch submersible pump (stainless steel); and
    - ISCO or GEOPUMP2 sampling pump (peristaltic).

    Sampling may also be performed using either stainless steel, Teflon® bailers, or dedicated disposable bailers. If a well is pumped dry, the well will be allowed to recover and samples will be collected as soon as sufficient volume is available for each parameter to be sampled.

    Samples will be collected from the sampling device and carefully put into the appropriate sample container with proper label affixed, and cap tightly attached. The sample collection order (as appropriate) will be as follows:

    - Volatile organic compounds (VOCs) (samples will be collected with bailers and will not be pumped);
    - Semivolatile organic compounds (SVOCs);
    - polychlorinated biphenyls (PCBs); and
    - Metals.

    If sampling for metals, a filtered sample will be collected. Sample filtration will be performed in the field utilizing a pump prior to preservation. Install new medical-grade silicone tubing in the pump head. Place new Teflon® tubing into the sample mixing container and attach to the intake side of pump tubing. Attach (clamp) a new 0.45-micron filter to the discharge side of the pump tubing (noting the correct filter flow direction). Pump and dispense the filtered liquid directly into the laboratory sample bottles.

14. Note the time on the sample label and the groundwater sampling field log. Secure with packing material and store at 4°C on ice in a cooler (as described in Attachment A). Refrigeration and protection of samples should minimize any chemical alteration of samples prior to analysis.

15. If a sample is not collected as part of purging; remove an additional volume of groundwater after all sampling containers have been filled. Measure and record in the field log the physical appearance, pH, temperature, DO, and conductivity of the groundwater (Attachment K).

16. Replace well cap.

17. Clean sampling device, purge pump and lines, and/or bailer following appropriate protocols (Attachment H).

18. Place all disposable sampling materials (rope, gloves, plastic sheeting, hoses, etc.,) in a plastic garbage bag for appropriate disposal. Record the time sampling procedures were completed on the field logs.

19. Complete the procedures for packaging, shipping and handling, and for COC after each well sampling completion or at the end of each day of sampling (Attachment A).

The following procedures shall be utilized where low flow purging and sampling of monitoring wells is required according to the project-specific work plan.

1. Perform calibration of field instruments according to procedures in Attachment K.

2. Measure initial depth to groundwater prior to placement of pumps. If a submersible or bladder pump is being utilized, slowly lower pump, safety cable, tubing, and electrical lines into the well to a depth corresponding to the approximate center of the saturated screen section of the well. If a peristaltic pump is being utilized, slowly lower the sampling tubing into the well to a depth corresponding to the approximate center of the saturated screen section of the well. The pump intake or sampling tube must be kept at least two feet above the bottom of the well to prevent mobilization of any sediment present in the bottom of the well.

3. Measure the water level again with the pump in the well before starting the pump. Start pumping the well at 200 to 500 milliliters per minute. The pump rate should be adjusted to cause little or no water level drawdown in the well (less than 0.3 feet below the initial static depth to water measurement) and the water level should stabilize. The water level should be monitored every three to five minutes (or as appropriate) during pumping if the well diameter is of sufficient size to allow such monitoring. Care should be taken not to break pump suction or cause entrainment of air in the sample. Record pumping rate adjustments and depths to water. If necessary, pumping rates should be reduced to the minimum capabilities of the pump to avoid pumping the well dry and/or to ensure stabilization of indicator parameters. A steady flow rate should be maintained to the extent practicable. Groundwater sampling records from previous sampling events (if available) should be examined to provide an estimate of the optimum pumping rate and anticipated drawdown for the well in order to more efficiently reach a stabilized pumping condition.

   If the recharge rate of the well is very low, alternative purging techniques should be utilized, which will vary based on the well construction and screen position. For wells screened across the water table, the well should be pumped dry and sampling should commence as soon as the volume in the well has recovered sufficiently to permit collection of samples. For wells screened entirely below the water table, the well should be pumped until a stabilized level (which may be below the maximum displacement goal of 0.3 feet) can be maintained and monitoring for stabilization of field indicator parameters can commence. If a lower

stabilization level cannot be maintained, the well should be pumped until the drawdown is at a level slightly higher than the bentonite seal above the well screen. Sampling should commence after one well volume has been removed and the well has recovered sufficiently to permit collection of samples.

4. During purging, monitor the field indicator parameters (e.g., turbidity, temperature, specific conductance, pH, etc.) every three to five minutes (or as appropriate). Field indicator parameters will be measured using a flow-through analytical cell or a clean container such as a glass beaker. Record field indicator parameters on the groundwater sampling log (Attachment J-1). The well is considered stabilized and ready for sample collection when turbidity values remain within 10% (or within 1 NTU if the turbidity reading is less than 10 NTU), the specific conductance and temperature values remain within 3%, and pH remains within ± 0.1 units for three consecutive readings collected at three to five minute intervals. If the field indicator parameters do not stabilize within one hour of the start of purging, but the groundwater turbidity is below the goal of 50 NTU and the values for all other parameters are within 10%, the well can be sampled. If the parameters have stabilized, but the turbidity is not in the range of the 50 NTU goal, the pump flow rate should be decreased to a minimum rate of 100 mL/min to reduce turbidity levels as low as possible. During extreme weather conditions, stabilization of field indicator parameters may be difficult to obtain. Modifications to the sampling procedures to alleviate these conditions (e.g., measuring the water temperature in the well adjacent to the pump intake) will be documented in the field notes. If other field conditions exist which preclude stabilization of certain parameters, an explanation of why the parameters did not stabilize will also be documented in the field logbook.

5. Complete the sample label according to procedures in Attachment A and cover the label with clear packing tape to secure the label onto the container.

6. After the indicator parameters have stabilized, collect groundwater sample by diverting flow out of the unfiltered discharge tubing into the appropriate labeled sample container. If a flow-through analytical cell is being used to measure field parameters, the flow-through cell should be disconnected after stabilization of the field indicator parameters and prior to groundwater sample collection. Under no circumstances should analytical samples be collected from the discharge of the flow-through cell. When the container is full, tightly screw on the cap. Samples should be collected in the following order: VOCs; total organic carbon (TOC); SVOCs; metals and cyanide; others.

7. If sampling for metals, a filtered and unfiltered sample will be collected. Install an in-line, disposable 0.45-micron particle filter on the discharge tubing after the appropriate unfiltered groundwater sample has been collected. Continue to run the pump until an initial volume of "flush" water has been run through the filter in accordance with the manufacturer's directions (generally 100-300 mL). Collect filtered groundwater sample by diverting flow out of the filter into the appropriate labeled sample container. When the container is full, tightly screw on the cap.

8. Secure with packing material and store at 4°C in an insulated transport container provided by the laboratory.

9. Record on the field log (Attachment J-1) or bound field book the time sampling procedures were completed, any pertinent observations of the sample (e.g., physical appearance, the presence of, or lack of, odors, sheens, etc.), and the values of the stabilized field indicator parameters, as measured during the final reading during purging.

10. Remove pump and tubing from well, secure well, properly dispose of PPE and disposable equipment (see Section V).

11. If tubing is to be dedicated to a well, it should be folded to a length which will allow the well to be capped and also facilitate retrieval of the tubing during later sampling events. A length of rope or string should be used to tie the tubing to the well cap.

12. Complete the procedures for packaging, shipping, and handling with associated chain of custody (Attachment A).

13. Complete cleaning procedures for flow-through analytical cell and submersible pump, as appropriate (see Attachment H).

14. At end of day, perform calibration check of field instruments according to procedures in Attachment K.

IV. Duplicate Sample Collection

Field duplicates will be prepared by filling a composite container with water collected at the same time and depth and then two sets of sample jars. For VOCs, the samples will not be composited prior to placement in the sample jars. The duplicate sample will be labeled in such a way that the sample descriptions will not indicate the duplicate nature of the samples.

V. Disposal Methods

Materials generated during the groundwater sampling activities including disposable equipment will be collected and contained on site in labeled 55-gallon drums for future analysis and appropriate disposal.

Attachment J-1

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Example - Groundwater Sampling Field Log

GROUNDWATER SAMPLING FIELD LOG

Site: _____
Well No: _____

Sampling Personnel: _____
Date: _____
Time: _____
Weather: _____

I. Well Information

Well Depth: _____
Well Diameter: _____
Water Table: _____
Length of water column: _____
Top of Well Casing above grade: _____
Top of Riser above grade: _____

Measuring Point Elevation: _____
Approx. Ground Elevation: _____
Water Table Elevation: _____

Note - Measuring Point (MP) is: Well Casing/Riser (circle one)

II. Well Water Evacuation Information

Volume of water in well: _____
Pumping rate of pump: _____
Volume of bailer: _____

3 x water volume in well to be removed
Est. Minutes of pumping: _____
Number of bails: _____

III. Physical Appearance/Top of Water Column

Color: _____
Odor: _____

Turbid (?): _____
Film: _____

IV. Evacuation Information

Volume of water removed from well: _____
Did well go dry? _____

V. Well Sampling

Container

Analysis

VI. Groundwater Characteristics (Physical Appearance after Well Evacuation):

Color: _____
Temperature: _____
Conductivity: _____
pH: _____

Turbid (?): _____
Film: _____
Odor: _____

Notes:

Attachment K

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Field Procedure for Water Quality Measurements

Attachment K

Field Procedures for Water Quality Measurements

I. Introduction

Water quality parameters, such as dissolved oxygen (DO), specific conductance, pH, turbidity, and temperature, of natural waters are usually measured in the field. The pH and conductivity will be recorded using a portable meter with temperature-compensating pH and conductivity electrodes. Dissolved oxygen will be measured with a DO meter. The temperature will be measured with a glass, digital, bimetal thermometer, or combination temperature/pH/conductivity meter. In the case of sampling groundwater, hydrochemical parameters should be recorded initially, during purging, and after sampling. Attachments K-1 and K-2 contain the appropriate calibration and maintenance logs for the above-referenced meters.

II. Materials

The following materials, as required, shall be available during field measurement of water quality:

- Personal protective equipment (as specified in the Site Health and Safety Plan);
- Clean glass container;
- Temperature/pH/conductivity meter;
- Sodium chloride standard solution, 1,000 mg/L;
- pH buffers, 10.00, 7.00, and 4.00;
- DO meter;
- Spare Teflon® membranes;
- Cleaning equipment;
- Fine screwdriver (for meter calibration adjustments);
- Extra batteries for the meters;
- Distilled/deionized water; and
- Appropriate forms and field notebook.

III. Procedures for Measuring pH

Calibration Procedure

The pH meter will be calibrated daily.

1. Switch on instrument.
2. Connect electrode to meter via the BNC connector and remove protective cap from electrode.
3. Rinse end of electrode in distilled/deionized water.
4. Measure and record temperature of buffer solutions.
5. Immerse pH electrode in pH buffer 7.00, set the temperature adjust dial to that of the buffer 7.00, and allow sufficient time for the electrode to stabilize. Adjust the calibration dial for the correct readout.
6. Remove electrode from buffer and rinse with distilled/deionized water.
7. Immerse pH electrode in buffer 4.00, set the temperature control to that of the buffer 4.00, and allow sufficient time for the electrode to stabilize. Adjust the Slope Control for the correct readout.
8. Rinse electrode with distilled/deionized water. The meter is calibrated and ready for use.

Operation Procedure

1. Calibrate pH meter.
2. Rinse probe in distilled/deionized water.
3. Fill two 100-mL plastic disposable beakers with water from the sample.
4. Measure and record temperature of sample. Adjust temperature dial for ambient water temperature.
5. Insert probe into one sample beaker and obtain a reading. The meter will read between 0 and 14, in 0.01 increments.
6. Rinse probe off with distilled/deionized water.
7. Repeat Steps 4, 5, and 6 in other beaker.
8. Log results in field notebook and the average will be the actual result.

9. Rinse probe off with distilled/deionized water.

Maintenance Procedures

1. Replace batteries on a regular basis.
2. Store electrode in protective casing when not in use.
3. Keep records of usage, maintenance, calibration, problems, and repairs.
4. After use, the meter will be inspected and the inspection recorded in the field notebook.
5. A replacement meter will be available on site or ready for overnight shipment.
6. pH meter will be sent back to manufacturer for service when needed.

IV. Procedures for Measuring Conductivity

Conductivity is the ability of a solution to pass an electric current. This current is carried by inorganic dissolved solids. The measurement of conductivity is useful to relate the chemical purity of the water and the amount of dissolved solids in a solution.

Calibration Procedure

The conductivity meter will be calibrated daily.

1. Be sure the probe is clean.
2. Soak the probe in distilled/deionized water for at least 30 minutes.
3. Remove the probe from the water and fling out drops clinging inside.
4. Immerse the probe to or beyond the vent holes in a beaker containing a 1,000 mg/L Sodium Chloride Standard Solution. Agitate vertically to remove entrapped air.
5. Repeat Steps 3 and 4 at least one more time.
6. Press the Power key and CND key. Verify that the LO BAT indication does not appear.
7. Press the 2 milliSiemens per centimeter (mS/cm) range key.

8. Check the reading on the display. It should be 1.990 mS/cm. If adjustment is needed, use a small screwdriver to adjust the CAL control next to the display. Counter clockwise adjustment increases the reading.

Operation Procedure

1. Calibrate the conductivity meter.
2. Rinse probe in distilled/deionized water.
3. Fill two 100-mL plastic disposable beakers with water from the sample.
4. Turn meter on to the 2 mS/cm scale.
5. Insert probe into sample beaker and obtain a reading. The meter will read between 0 and 2.0 mS/cm in 0.001 increments.
6. Repeat Step 5 with other beaker.
7. Record both results in the field notebook and average.
8. Rinse probe in distilled/deionized water.
9. If the electrodes become coated with foreign compounds, the probe should be cleaned with a detergent solution and then rinsed with distilled/deionized water.

Maintenance Procedures

1. Replace batteries on a regular basis.
2. Store electrode in protective casing when not in use.
3. Keep records of usage, maintenance, calibration, and of any problems and repair.
4. After use, the meter will be inspected and the inspection recorded in the logbook.
5. A replacement meter will be available on site or ready for overnight shipment.
6. Conductivity meter will be sent back to manufacturer for service when needed.

V. Procedures for Measuring Temperature

Temperature readings will be taken at each water sampling location to assist in pH and conductivity measurement. It will also assist in chemical and biological interpretations. A thermometer may be part of a pH/conductivity meter or separate.

Operation Procedure

1. Rinse thermometer in distilled/deionized water.

2. Immerse thermometer in the water sample and read it to the nearest degree Celsius (°C).

3. Record reading in the field notebook or relevant log.

Preventive Maintenance

1. Use of a Teflon®-coated thermometer lends extra strength and shock resistance to guard against accidental breakage.

2. Store in protective casing when not in use.

VI. Procedures for Measuring Dissolved Oxygen

The DO test is an important analysis in determining the quality of natural waters. The effects of wastes on rivers/streams, the suitability of water for fish and other organisms, and the progress of self-purification can be measured or estimated from the DO content.

Calibration Procedure

The DO meter will be calibrated daily using the air calibration method.

1. Prepare the probe with a thin Teflon® membrane stretched over the sensor.

2. Perform a battery check and obtain a barometric pressure reading from a daily weather report.

3. With the unit off, adjust the meter pointer to zero with the screw in the center of the meter panel.

4. Switch dial to ZERO and adjust pointer using the ZERO knob.

5. Switch dial to FULL SCALE and adjust pointer using the FULL SCALE knob. Check batteries if pointer cannot reach full scale.

6. Attach probe to unit and tighten.

7. Turn unit on.

8. Allow 15 minutes for optimum probe stabilization and polarization.

9. Switch dial to CALIB O_2.

10. Hold probe in the air for 10 minutes or until reading is stable.

11. Using the CALIB knob, set the pointer to the mark associated with the local barometric pressure and ambient air temperature. If barometric pressure is unknown, a correction value of 97% should be used.

Operation Procedure

1. Calibrate the DO meter.
2. Perform the battery check.
3. Set mode switch to operate and the operation switch to the desired range.
4. Place probe into water sample.
5. Take a water temperature measurement and adjust temperature dial.
6. Switch to DO content measurement and allow reading to stabilize.
7. Record water temperature and DO on appropriate form or in the field notebook.

Maintenance Procedures

1. Replace batteries on a regular basis, at a suggested interval of every six months or every 1,000 hours of operation.
2. Store electrode in protective casing when not in use.
3. Keep records of usage, maintenance, calibration, and of any problems and repair.
4. A replacement DO meter will be ready for overnight shipment.
5. DO meter will be sent back to manufacturer for service when needed.

VII. Procedures for Measuring Turbidity

The measurement of turbidity is useful in that it expresses the amount of suspended particles in the water samples.

Standardization Procedure

Standardization will be performed before each set of tests to ensure consistently accurate results.

1. Turn the instrument off and check the mechanical zero setting. Adjust to a zero NTU reading if necessary.
2. Turn power switch on and perform a battery check.

3. Place the focusing template into the cell holder. This will block all the light from reaching the detector and allow the instrument to be zeroed electronically in Steps 4 and 5.

4. Press the 1.0 range switch and adjust the Zero Control for a reading of zero NTU.

5. Press the 10.0 range switch to verify that the meter still indicates zero NTU. Readjust the Zero Control if necessary.

6. Remove the focusing template and place the appropriate Gelex secondary standard for the turbidity range to be used into the cell holder. Use the index mark on the standard to orient the vial in the same position each time, thereby eliminating variation due to rotation.

7. Place the light shield over the turbidity standard and allow the meter to stabilize.

8. Adjust the SPAN control for a meter reading equal to the value of the Gelex standard in the cell holder. Remove the light shield and turbidity standard. The instrument is now ready for use.

Calibration Procedures

Each range is calibrated at the factory, but should be checked from time to time against fresh Formazin turbidity standard dilutions. Three trimmer potentiometers on the amplifier circuit board provide an adjustment for each range. Check each range as described in the following procedure and make the appropriate adjustments when necessary, using the procedures described in Range Calibration.

1. With the instrument turned off, check the mechanical zero adjustment on the meter face. Adjust for a zero reading if necessary.

2. Turn the instrument on and perform a battery check. Change battery if needed.

3. Place the focusing template into the cell holder, press the 1.0 range switch, and adjust the Zero Control to obtain a zero NTU reading.

4. Remove the focusing template and insert a 0.75 NTU turbidity standard. Adjust the SPAN control for a corrected 0.75 NTU reading.

5. Remove the 0.75 NTU standard and replace it with a 10 NTU standard. Press the 10.0 range switch. The meter should indicate 10 ($\pm$0.2) NTU. If it does not. the 10.0 range potentiometer needs adjustment as described in the Range Calibration procedure. Adjust the SPAN control for a reading of exactly 10 NTU.

6. Remove the 10 NTU standard and replace it with the cell riser and 100 NTU standard. Press the 100 range switch. The meter should indicate 100 ($\pm$2) NTU. If it does not, the 100 range potentiometer needs adjustment as described in the Range Calibration procedure.

7. Remove the 100 NTU standard and cell riser and insert the 10 NTU standard. Press the 10.0 NTU range switch. Adjust the SPAN control for a reading of exactly 10 NTU.

8. Remove the 10 NTU standard and replace it with a 0.75 NTU standard. Press the 1.0 range switch. The meter should indicate the corrected value for the 0.75 NTU standard ($\pm$0.02). If it does not, the 1.0 range potentiometer needs adjustment as described in the Range Calibration procedure.

Range Calibration Procedures

In the event the range adjustment potentiometers on the amplifier circuit board require adjustment, remove the instrument from its case and proceed as follows:

1. With the instrument turned off, check the meter's mechanical zero adjustment. Adjust for a zero reading if necessary.

2. Turn on power and perform a battery check.

3. Place the focusing template into the cell holder, press the 1.0 range switch, and adjust the SPAN control fully counterclockwise.

4. Adjust the Zero Control clockwise to obtain a 0.05 NTU reading on the 1.0 scale.

5. Adjust the SPAN control clockwise to obtain a reading of 0.15 NTU on the 1.0 scale. Do not alter the SPAN control setting for the remainder of this procedure.

6. Press the 100 range switch and adjust the Zero Control for a zero reading.

7. Remove the focusing template and insert the cell riser and 100 NTU Formazin turbidity standard. Cover the standard with the light shield and allow the meter to stabilize. Adjust the 100 range adjustment potentiometer to obtain a full-scale reading.

8. Remove the 100 NTU standard and cell riser and insert the focusing template into the cell holder.

9. Press the 10.0 range switch and adjust the Zero Control for a zero reading.

10. Remove the focusing template and substitute the 10 NTU Formazin standard. Cover with the light shield and allow the meter to stabilize. Adjust the 10.0 range adjustment potentiometer to obtain a full-scale reading.

11. Remove the 10 NTU standard and insert the focusing template.

12. Press the 1.0 range switch and adjust the Zero Control for a zero reading.

13. Remove the focusing template and insert the 0.75 NTU Formazin turbidity standard. Cover with the light shield and allow the meter to stabilize. Adjust the 1.0 range adjustment potentiometer to obtain a reading equal to the corrected NTU value determined when adding the turbidity of the dilution water to the nominal value of the standard.

Measurement Procedures

1. Turn power switch on and perform a battery check.

2. Press the appropriate range switch: 0-1, 0-10, 0-100 NTU.

3. Place the focusing template into the cell holder and adjust the Zero Control for a reading of zero NTU. Remove focusing template.

4. Fill a clean sample cell to the white line with the sample to be measured and place it into the cell holder. Use the white dot on the sample cell to orient the cell in the same position each time. Cover sample with light shield and allow meter to stabilize.

5. Read and record the turbidity of the sample.

6. Perform a duplicate sample every 10 or set of samples, whichever is more frequent.

Maintenance Procedure

1. Recharge battery on a regular basis.

2. Store in protective casing when not in use.

3. Keep records of usage, maintenance, calibration, and of any problems and repair.

4. After use the meter will be inspected and the inspection recorded in the field notebook.

5. A replacement meter will be ready for overnight shipment.

6. Keep nephelometric sample tubes clean both inside and out. Replace them when they become scratched or etched. Do not handle the tubes in the region where the light beam enters them.

7. Clean lens periodically.

8. Nephelometer will be sent back to the manufacturer for service when needed.

Attachment K-1

BLASLAND, BOUCK & LEE, INC.
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Temperature/pH Conductivity Meter Calibration and Maintenance Log

TEMPERATURE/pH/CONDUCTIVITY METER CALIBRATION AND MAINTENANCE LOG

INSTRUMENT MANUFACTURER ______________________
INSTRUMENT MODEL ______________________
IDENTIFICATION NUMBER ______________________

DATE/TIME	INITIALS	TEMPERATURE	pH STANDARD USED/ EXPIRATION	CONDUCTIVITY STANDARD USED/ EXPIRATION	BATTERY CHECK	COMMENTS

Attachment K-2

BLASLAND, BOUCK & LEE, INC.
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Dissolved Oxygen Meter Calibration and Maintenance Log

DISSOLVED OXYGEN METER CALIBRATION AND MAINTENANCE LOG

INSTRUMENT MANUFACTURER ______________________

INSTRUMENT MODEL ______________________

IDENTIFICATION NUMBER ______________________

DATE/ TIME	INITIALS	WATER TEMPERATURE	ACTUAL D.O.	MEASURED D.O.	BATTERY CHECK	MEMBRANE CHECKED/ REPLACED	COMMENTS

Attachment L

BLASLAND, BOUCK & LEE, INC.
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Groundwater Sampling Procedure Low-Stress (Low-Flow) Purging and Sampling

Attachment L

Groundwater Sampling Procedure, Low-Stress (Low-Flow) Purging and Sampling

I. Scope and Application

This low-stress (or low-flow) purging and sampling procedure prescribes standard method for collecting low stress (low flow) groundwater samples from monitoring wells. Low-stress purging and sampling results in collection of groundwater samples from monitoring wells that are representative of groundwater conditions in the geological formation. This is accomplished by minimizing stress on the geological formation and minimizing disturbance of sediment that has collected in the well. The procedure applies to monitoring wells that have an inner casing with a diameter of 2.0 inches or greater, and maximum screened intervals of 10 feet unless multiple intervals are sampled. The procedure is appropriate for collection of groundwater samples that will be analyzed for volatile and semivolatile organic compounds (VOCs and SVOCs), pesticides, polychlorinated biphenyls (PCBs), metals, and microbiological and other contaminants in association with all USEPA programs.

This procedure does not address the collection of light or dense nonaqueous phase liquids (LNAPL or DNAPL) samples, and should be used for aqueous samples only. For sampling NAPLs, the reader is referred to the following EPA publications: *DNAPL Site Evaluation* (Cohen & Mercer, 1993) and the *RCRA Ground-Water Monitoring: Draft Technical Guidance* (EPA/530-R-93-001), and references therein.

II. Method Summary

The purpose of the low stress purging and sampling procedure is to collect groundwater samples from monitoring wells that are representative of groundwater conditions in the geological formation. This is accomplished by setting the intake velocity of the sampling pump to a flow rate that limits drawdown inside the well casing.

Sampling at the prescribed (low) flow rate has three primary benefits. First, it minimizes disturbance of sediment in the bottom of the well, thereby producing a sample with low turbidity (i.e., low concentration of suspended particles). Typically, this saves time and analytical costs by eliminating the need for collecting and analyzing an additional filtered sample from the same well. Second, this procedure minimizes aeration of the groundwater during sample collection, which improves the sample quality for VOC analysis. Third, in most cases the procedure significantly reduces the volume of groundwater purged from a well and the costs associated with its proper treatment and disposal.

III. Addressing Potential Problems

Problems that may be encountered using this technique include a) difficulty in sampling wells with insufficient yield; b) failure of one or more key indicator parameters to stabilize; c) cascading of water and/or formation of air bubbles in the tubing; and d) cross-contamination between wells.

Insufficient Yield

Wells with insufficient yield (i.e., low recharge rate of the well) may dewater during purging. Care should be taken to avoid loss of pressure in the tubing line due to dewatering of the well below the level of the pump's intake. Purging should be interrupted before the water level in the well drops below the top of the pump, as this may induce cascading

of the sand pack. Pumping the well dry should therefore be avoided to the extent possible in all cases. Sampling should commence as soon as the volume in the well has recovered sufficiently to allow collection of samples. Alternatively, groundwater samples may be obtained with techniques designed for the unsaturated zone, such as lysimeters.

Failure to Stabilize Key Indicator Parameters

If one or more key indicator parameters fails to stabilize after 4 hours, one of three options should be considered: a) continue purging in an attempt to achieve stabilization; b) discontinue purging, do not collect samples, and document attempts to reach stabilization in the logbook; c) discontinue purging, collect samples, and document attempts to reach stabilization in the logbook; or d) Secure the well, purge and collect samples the next day (preferred). The key indicator parameter for samples to be analyzed for VOCs is dissolved oxygen. The key indicator parameter for all other samples is turbidity.

Cascading

To prevent cascading and/or air bubble formation in the tubing, care should be taken to ensure that the flow rate is sufficient to maintain pump suction. Minimize the length and diameter of tubing (i.e., 1/4 or 3/8 inch ID) to ensure that the tubing remains filled with groundwater during sampling.

Cross-Contamination

To prevent cross-contamination between wells, it is strongly recommended that dedicated, in-place pumps be used. As an alternative, the potential for cross-contamination can be reduced by performing the more thorough daily decontamination procedures between sampling of each well in addition to the start of each sampling day (see Section VII, below).

Equipment Failure

Adequate equipment should be on hand so that equipment failures do not adversely impact sampling activities.

IV. Planning Documentation and Equipment

- Approved site-specific Field Sampling Plan/Quality Assurance Project Plan (QAPP). This plan must specify the type of pump and other equipment to be used. The QAPP must also specify the depth to which the pump intake should be lowered in each well. Generally, the target depth will correspond to the mid-point of the most permeable zone in the screened interval. Borehole geologic and geophysical logs can be used to help select the most permeable zone. However, in some cases, other criteria may be used to select the target depth for the pump intake. In all cases, the target depth must be approved by the USEPA hydrogeologist or USEPA project scientist.

- Well construction data, location map, field data from last sampling event.

- Polyethylene sheeting.

- Flame Ionization Detector (FID) and Photo Ionization Detector (PID).

- Adjustable rate, positive displacement groundwater sampling pump (e.g., centrifugal or bladder pumps constructed of stainless steel or Teflon). A peristaltic pump may only be used for inorganic sample collection.

- Interface probe or equivalent device for determining the presence or absence of NAPL.
- Teflon or Teflon-lined polyethylene tubing to collect samples for organic analysis. Teflon or Teflon-lined polyethylene, PVC, Tygon or polyethylene tubing to collect samples for inorganic analysis. Sufficient tubing of the appropriate material must be available so that each well has dedicated tubing.
- Water level measuring device, minimum 0.01 foot accuracy, (electronic preferred for tracking water level drawdown during all pumping operations).
- Flow measurement supplies (e.g., graduated cylinder and stop watch or in-line flow meter).
- Power source (generator, nitrogen tank, etc.).
- Monitoring instruments for indicator parameters. Eh and dissolved oxygen must be monitored in-line using an instrument with a continuous readout display. Specific conductance, pH, and temperature may be monitored either in-line or using separate probes. A nephalometer is used to measure turbidity.
- Decontamination supplies (see Section VII, below).
- Logbook (see Section VIII, below).
- Sample bottles.
- Sample preservation supplies (as required by the analytical methods).
- Sample tags or labels, chain of custody.

V. Sampling Procedures

Presampling Activities

1. Start at the well known or believed to have the least contaminated groundwater and proceed systematically to the well with the most contaminated groundwater. Check the well, the lock, and the locking cap for damage or evidence of tampering. Record observations.
2. Lay out sheet of polyethylene for placement of monitoring and sampling equipment.
3. Measure VOCs at the rim of the unopened well with a PID and FID instrument and record the reading in the field logbook.
4. Remove well cap.
5. Measure VOCs at the rim of the opened well with a PID and a FID instrument and record the reading in the field logbook.

6. If the well casing does not have a reference point (usually a V-cut or indelible mark in the well casing), make one. Note that the reference point should be surveyed for correction of groundwater elevations to the mean geodesic datum (MSL).

7. Measure and record the depth to water (to 0.01 ft) in all wells to be sampled prior to purging. Care should be taken to minimize disturbance in the water column and dislodging of any particulate matter attached to the sides or settled at the bottom of the well.

8. If desired, measure and record the depth of any NAPLs using an interface probe. Care should be taken to minimize disturbance of any sediment that has accumulated at the bottom of the well. Record the observations in the logbook. If LNAPLs and/or DNAPLs are detected, install the pump at this time, as described in step 9, below. Allow the well to sit for several days between the measurement or sampling of any DNAPLs and the low-stress purging and sampling of the groundwater.

Sampling Procedures

9. Install Pump: Slowly lower the pump, safety cable, tubing and electrical lines into the well to the depth specified for that well in the USEPA-approved QAPP or a depth otherwise approved by the EPA hydrogeologist or EPA project scientist. The pump intake must be kept at least 2 feet above the bottom of the well to prevent disturbance and resuspension of any sediment or NAPL present in the bottom of the well. Record the depth to which the pump is lowered.

10. Measure Water Level: Before starting the pump, measure the water level again with the pump in the well. Leave the water level measuring device in the well.

11. Purge Well: Start pumping the well at 200 to 500 milliliters per minute (mL/min). The water level should be monitored approximately every five minutes. Ideally, a steady flow rate should be maintained that results in a stabilized water level (drawdown of 0.3 ft or less). Pumping rates should, if needed, be reduced to the minimum capabilities of the pump to ensure stabilization of the water level. As noted above, care should be taken to maintain pump suction and to avoid entrainment of air in the tubing. Record each adjustment made to the pumping rate and the water level measured immediately after each adjustment.

12. Monitor Indicator Parameters: During purging of the well, monitor and record the field indicator parameters (turbidity, temperature, specific conductance, pH, Eh, and DO) approximately every five minutes. The well is considered stabilized and ready for sample collection when the indicator parameters have stabilized for three consecutive readings as follows (Puls and Barcelona, 1996):
    $\pm$0.1 for pH
    $\pm$3% for specific conductance (conductivity)
    $\pm$10 mv for redox potential
    $\pm$10% for DO and turbidity

    Dissolved oxygen and turbidity usually require the longest time to achieve stabilization. The pump must not be removed from the well between purging and sampling.

13. Collect Samples: Collect samples at a flow rate between 100 and 250 ml/min and such that drawdown of the water level within the well does not exceed the maximum allowable drawdown of 0.3 ft. VOC samples must

be collected first and directly into sample containers. All sample containers should be filled with minimal turbulence by allowing the groundwater to flow from the tubing gently down the inside of the container.

Groundwater samples to be analyzed for VOCs require pH adjustment. The appropriate USEPA Program Guidance should be consulted to determine whether pH adjustment is necessary. If pH adjustment is necessary for VOC sample preservation, the amount of acid to be added to each sample vial prior to sampling should be determined, drop by drop, on a separate and equal volume of water (e.g., 40 ml). Groundwater purged from the well prior to sampling can be used for this purpose.

14. Remove Pump and Tubing: After collection of the samples, the tubing, unless permanently installed, must be properly discarded or dedicated to the well for resampling by hanging the tubing inside the well.

15. Measure and record well depth.

16. Close and lock the well.

VI. Field Quality Control Samples

Quality control samples must be collected to determine if sample collection and handling procedures have adversely affected the quality of the groundwater samples. The appropriate USEPA Program Guidance should be consulted in preparing the field QC sample requirements of the site-specific QAPP.

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 should be collected during the sampling event:

- Field duplicates
- Trip blanks for VOCs only
- Equipment blank (not necessary if equipment is dedicated to the well)

As noted above, groundwater samples should be collected systematically from wells with the lowest level of contamination through to wells with highest level of contamination. The equipment blank should be collected after sampling from the most contaminated well.

VII. Decontamination

Nondisposable sampling equipment, including the pump and support cable and electrical wires which contact the sample, must be decontaminated thoroughly each day before use (daily decon) and after each well is sampled (between-well decon). Dedicated, in-place pumps and tubing must be thoroughly decontaminated using daily decon procedures (see #17, below) prior to their initial use. For centrifugal pumps, it is strongly recommended that non-disposable sampling equipment, including the pump and support cable and electrical wires in contact with the sample, be decontaminated thoroughly each day before use ("daily decon").

USEPA's field experience indicates that the life of centrifugal pumps may be extended by removing entrained grit. This also permits inspection and replacement of the cooling water in centrifugal pumps. All nondedicated sampling

equipment (pumps, tubing, etc.) must be decontaminated after each well is sampled ("between-well decon" see #18 below).

17. Daily Decon

A) Pre-rinse: Operate pump in a deep basin containing 8 to 10 gallons of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.

B) Wash: Operate pump in a deep basin containing 8 to 10 gallons of a non-phosphate detergent solution, such as Alconox, for 5 minutes and flush other equipment with fresh detergent solution for 5 minutes. Use the detergent sparingly.

C) Rinse: Operate pump in a deep basin of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.

D) Disassemble pump.

E) Wash pump parts:Place the disassembled parts of the pump into a deep basin containing 8 to 10 gallons of non-phosphate detergent solution. Scrub all pump parts with a test tube brush.

F) Rinse pump parts with potable water.

G) Rinse the following pump parts with distilled/ deionized water: inlet screen, the shaft, the suction interconnector, the motor lead assembly, and the stator housing.

H) Place impeller assembly in a large glass beaker and rinse with 1% nitric acid (HNO_3).

I) Rinse impeller assembly with potable water.

J) Place impeller assembly in a large glass bleaker and rinse with isopropanol.

K) Rinse impeller assembly with distilled/deionized water.

18. Between-Well Decon

A) Pre-rinse: Operate pump in a deep basin containing 8 to 10 gallons of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.

B) Wash: Operate pump in a deep basin containing 8 to 10 gallons of a non-phosphate detergent solution, such as Alconox, for 5 minutes and flush other equipment with fresh detergent solution for 5 minutes. Use the detergent sparingly.

C) Rinse: Operate pump in a deep basin of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.

D) Final Rinse: Operate pump in a deep basin of distilled/deionized water to pump out 1 to 2 gallons of this final rinse water.

VIII. Field Logbook

A field logbook must be kept each time groundwater monitoring activities are conducted in the field. The field logbook should document the following:

- Well identification number and physical condition.
- Well depth, and measurement technique.
- Static water level depth, date, time, and measurement technique.
- Presence and thickness of immiscible liquid layers and detection method.
- Collection method for immiscible liquid layers.
- Pumping rate, drawdown, indicator parameters values, and clock time, at 3- to 5-minute intervals; calculate or measure total volume pumped.
- Well sampling sequence and time of sample collection.
- Types of sample bottles used and sample identification numbers.
- Preservatives used.
- Parameters requested for analysis.
- Field observations of sampling event.
- Name of sample collector(s).
- Weather conditions.
- QA/QC data for field instruments.

IX. References

Cohen, R.M. and J.W. Mercer. 1993. *DNAPL Site Evaluation,* C.K. Smoley Press: Boca Raton, Florida.

Puls, R.W. and M.J. Barcelona. 1996. *Low-Flow (Minimal Drawdown) Groundwater Sampling Procedures*, EPA/540/S-95/504.

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USEPA Region II. 1989. *CERCLA Quality Assurance Manual.*

Attachment M

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Oil/Sludge Grab Sampling Procedures

Attachment M

Oil/Sludge Grab Sampling Procedures

I. Introduction

The general procedures utilized to obtain oil/sludge samples from sumps, pits, trenches, etc. are outlined below. The wide variety of conditions existing at different sampling locations requires that judgment be made regarding methodology and procedure for collection of representative samples.

This standard operating procedure (SOP) specifies the procedures for collecting oil/sludge grab samples for chemical analysis. Oil/sludge samples may be collected utilizing one or more of the following pieces of equipment: grab sampler (consisting of a wide mouth container attached to a telescoping pole), hand held dredge, peristaltic pump (equipped with silicone and teflon tubing), Lexan® tubing (with vacuum pump), hand bucket auger or other appropriate sampling device. The appropriate sampling method will be field determined at the time of sampling and will depend on the conditions encountered.

II. Equipment and Materials

The following materials will be available, as required, during oil/sludge grab sampling:

- Health and safety equipment (as required by the Health and Safety Plan);
- Field notebook;
- Appropriate sampling containers and forms;
- Appropriate preservatives as required;
- Cooler with ice or "blue ice"; and
- Appropriate sampling equipment.

III. Sampling Procedures

1. Identify grab sample location in the field notebook.
2. Don health and safety equipment (as required by the Health and Safety Plan).
3. Clean the sampling equipment in accordance with the procedures in Attachment H.
4. Collect sample with the appropriate field determined methodology.

5. Transfer the sample from the collection device to the appropriate sample container(s).

6. Secure the sample jar cap(s) tightly.

7. Label all sample containers as appropriate, as discussed in Attachment A.

8. Handle pack and ship the samples in accordance with the procedures in Attachment A.

IV. Equipment Cleaning

Equipment cleaning will occur at the beginning of each sampling event and between each sampling location as described in Appendix H.

V. Disposal Methods.

Rinse water, PPE, and other residuals generated during the equipment cleaning procedures will be placed in labeled 55-gallon drums for analysis and disposal.

Attachment N

BLASLAND, BOUCK & LEE, INC.
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Standard Operating Procedures for Shipment of Department of Transportation Hazardous Materials

Attachment N

Standard Operating Procedures for Shipment of Department of Transportation Hazardous Materials

I. Introduction

Selected materials collected and shipped to analytical laboratories during this project may be subject to the requirements of the United States Department of Transportation (USDOT) Hazardous Materials Regulations (HMR) and the International Air Transport Association (IATA) Dangerous Goods Regulations (DGR).

II. Hazardous Materials Shipment Summary

The procedures for shipping samples are summarized below:

- Determination of Proper Shipping Name and Material Classification for the Material.
- Identify Shipping Name and Shipping Requirements in List of Dangerous Goods.
- Determine Mode of Transport and Carrier.
- Determine Operator-/Carrier-Specific Requirements.
- Define Quantity Limitations for Materials to be Shipped.
- Identify Packing.
- Select Packaging Components and Package Material.
- Pack Samples and Verify Packaging Restrictions, Specifications, and Quantities.
- Implement Marking and Labeling Requirements for Package.
- Complete Shipper's Declaration for Dangerous Goods.
- Record Acceptance of Shipment by Dangerous Goods Transporter.

III. Procedures

1. **Determination of Proper Shipping Name and Material Classification for the Material:** Based on available information and characteristics of the material, a determination of the classification of the material into Dangerous Goods/Hazardous Materials Class must be made. Classification into one or more of the following classes shall be made:

Class 1 Explosives;
Class 2 Gases;
Class 3 Flammable Liquids;
Class 4 Flammable Solids (substances liable to spontaneous combustion. Substances which, in contact with water, emit flammable gases);
Class 5 Oxidizing Substances and Organic Peroxides;
Class 6 Toxic and Infectious substances;
Class 7 Radioactive material;
Class 8 Corrosives; and
Class 9 Miscellaneous Dangerous Goods (includes Polychlorinated Biphenyls).

2. **Identify Shipping Name and Shipping Requirements in List of Dangerous Goods Hazardous Materials Table:** Based on the classification of the material and the proper shipping name for the material, the specific entry in the List of Dangerous Goods (Section 4 of the IATA DGR) or USDOT Hazardous Materials Table (HMR 172.101) can be located and the specific shipping requirements for the sample can be identified.

3. **Determine Mode of Transport and Carrier:** In order to ensure compliance with specific modal and operator requirements, the selected means of transport and the carrier must be identified.

4. **Determine Operator-/Carrier-Specific Requirements:** Section 2 of the IATA DGR and USDOT HMR will be reviewed to determine carrier-specific requirements (i.e., Federal Express, Delta Airlines, etc.) and the List of Dangerous Goods/USDOT Hazardous Materials Table will be reviewed for modal-specific restrictions (i.e., cargo aircraft, passenger aircraft, etc.).

5. **Define Quantity Limitations for Materials to be Shipped:** The List of Dangerous Goods (Section 4 of the IATA DGR) or USDOT Hazardous Materials Table (HMR 172.101) entry shall be reviewed for the material being shipped and specific quantity limitations for the material (inner packaging limit/outer packaging limit) shall be identified.

6. **Identify Packing Procedure:** The List of Dangerous Goods/USDOT Hazardous Materials Table (HMR 172.101) shall be reviewed for the material and specific packing instructions for the material shall be identified.

7. **Select Packaging Components and Package Material:** Corresponding numbered packing instructions in Section 5 of the IATA DGR provide acceptable packaging configurations for each dangerous good. USDOT HMR (173) provide acceptable packaging configurations for hazardous materials to be shipped via domestic ground transportation.

8. **Pack Material and Verify Packaging Restrictions, Specifications, and Quantities:** Pack material in appropriate inner and outer packaging in accordance with numbered packing instruction in Section 5 of the IATA DGR or USDOT HMR (173). Verify that packaging restrictions, specifications, and maximum package quantities meet the requirements of the packing instruction.

9. **Implement Marking and Labeling Requirements for Package:** Prior to shipping the completed package must be marked and labeled in accordance with Section 7 of the IATA DGR or USDOT HMR. Markings and labels may include, but not be limited to: the shipper's name/identification, proper shipping name, UN identification number, hazard class, subsidiary hazards, and package orientation.

10. **Complete Shipper's Declaration for Dangerous Goods/Hazardous Materials Shipping Papers:** An executed shipper's declaration of dangerous goods/Hazardous Shipping Papers and/or carrier-specific air bill (for air transport) must be presented at consignment of shipment. The shipper's declaration for dangerous goods may include, but not be limited to: transport details, shipper's name/identification, nature and quantity of dangerous goods, proper shipping name, UN identification number, hazard class, packing group, subsidiary hazards, packing instruction number, type of packing, authorization, emergency contact number, and additional handling information.

11. **Record Acceptance of Shipment by Dangerous Goods Transporter:** Upon consignment of the shipment to a dangerous goods carrier, a completed copy of the Declaration for Dangerous Goods/Hazardous Materials Shipping Papers will be maintained by the shipper and copies provided to any emergency contacts identified on the declaration.

Attachment O

BLASLAND, BOUCK & LEE, INC.
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Specific Capacity Testing Procedure

Attachment O

Specific Capacity Testing Procedure

I. Introduction

Specific capacity testing is a field method used to estimate the transmissivity and hydraulic conductivity of a saturated geologic medium surrounding the screened or open interval of a well. A specific capacity test involves pumping ground water from a well at an approximately constant rate and quantifying the pumping rate and the magnitude of drawdown inside of the tested well after a known duration of pumping. Specific capacity tests are also referred to as single well pumping tests or constant-rate tests.

The transmissivity is calculated based on the observed test pumping rates, the drawdown measured immediately before the end of pumping, the pumping duration that preceded the drawdown measurement, the effective radius of the well, and the estimated storativity of the formation. If the thickness of the effective water bearing zone transmitting ground-water to the well intake is assumed to be approximately equal to the saturated length of the intake, the hydraulic conductivity can be estimated by dividing the transmissivity by the length of the intake.

II. Materials

The equipment needed for specific capacity testing includes:

- A pump capable of pumping at a controlled rate, equipped with discharge line;
- A power source for the pump;
- A calibrated in-line totalizing flow meter or calibrated bucket;
- A stopwatch; and
- An electronic water-level indicator.

III. Pretest Set-Up

Prior to the installation of the pump into the well to be tested, the static water level inside the well is measured to the nearest 0.01 feet relative to a specified datum at the top of the well using the electronic water-level indicator. The water level and the time of the measurement are recorded in the field notebook. The water level is measured again several minutes after the initial measurement. This measurement and time are recorded. This procedure is repeated until two consecutive measurements are identical, indicating approximately static conditions. The static depth to water is recorded.

The pump is installed into the well to approximately 10 feet below the static water level, or within approximately 1 foot of the bottom of the well if the initial water column in the well is less than 11 feet. After the pump is installed but prior to pumping, the water level in the well is monitored until it has returned to within 0.01 feet of the static water level.

IV. Test Procedures

The specific capacity test is performed as follows:

1. Hold the water level probe in the well just above the static water level. If an in-line totalizing flow meter is used, record the pre-test volume measurement in the field notebook. If no in-line flow meter is available, place the end on the discharge line in one of the two calibrated buckets. Record the total volumetric capacity of each bucket.

2. Simultaneously start the pump and the stopwatch. Record the start time.

3. Immediately begin monitoring the water level in the well. If the drawdown rapidly approaches or passes 3 feet, quickly reduce the pumping rate until the drawdown is approximately 1 to 3 feet. All pumping rate adjustments should be completed in the early stages of pumping, after which no adjustment should be made other than minor adjustments that may be necessary to maintain a steady pumping rate.

4. Continue to pump, recording the water level in the well approximately every 5 minutes throughout the test. If an in-line flow meter is used, record the volume measurement on the totalizer gauge approximately every 5 minutes during the test. If a calibrated bucket is used to measure the pumping rate, record the time required for the water level in the bucket to reach a known volume. Repeat this procedure for the duration of the test.

5. The specific capacity test should ideally last for at least 10 to 20 minutes of pumping. A longer pumping period is not necessary to estimate transmissivity and hydraulic conductivity from the test. However, if practicable, a longer test may provide a slightly more reliable transmissivity and hydraulic conductivity estimate. Immediately before the termination of pumping, record final water level measurement plus the time of the measurement.

6. Calculate and record the total volume of ground water removed from the well during the test, and the total duration of the test. Divide the total volume (in gallons) by the total pumping duration (in minutes) to calculate and record the average test pumping rate (in gallons per minute).

V. Specific Capacity Test Data Reduction

Data from a specific capacity test are reduced to a transmissivity and hydraulic conductivity estimate for water-bearing formation surrounding the intake of the tested well based on ASTM (1994) or the following equation (Walton 1962):

$$Q/s = T / [264 \log(Tt/2693r_w^2S) - 65.5]$$

where Q/s is the specific capacity of the well in gallons per minute per foot, Q is the average test pumping rate in gallons per minute, s is the drawdown measured inside of the tested well after a known duration of pumping (t), T is the transmissivity of the water-bearing zone surrounding the intake of the tested well, S is the estimated storativity of the aquifer, r_w is the effective radius of the well, and t is the time in minutes between the start of

pumping and the time when the drawdown was measured. If the well screen is surrounded by a sand pack that may be assumed to be substantially more permeable than the formation, the effective radius and wetted length of the well are taken to be those of the borehole.

The value of S may be estimated without introducing serious error into the results. For confined aquifers, S can be estimated as 0.0001. For unconfined aquifers, the short-term storativity may be comparable to that of a confined aquifer. Only after a protracted pumping duration (several hours or more) does the storativity begin to approximately the aquifer specific yield of approximately 0.2 to 0.3 (Nwankwor et al., 1984). In the calculation of transmissivity from a specific capacity test of less than one-hour duration, therefore, an estimated storativity value of 0.01 is considered reasonable.

To obtain an estimate of the hydraulic conductivity of the water-bearing zone that transmits ground water to the well, the calculated transmissivity value may be divided by the estimated thickness of the water-bearing zone. In a stratified formation in which the horizontal hydraulic conductivity may be expected to greatly exceed the vertical hydraulic conductivity, the thickness of the water-bearing zone may be estimated as the length of the well intake to obtain an estimate of the hydraulic conductivity immediately surrounding the well intake.

VI. References

American Society for Testing and Materials (ASTM). 1994. *Standard Test Method for Determining Specific Capacity and Estimating Transmissivity at the Control Well.* Method D5472. January 1994.

Nwankwor, G.I., Cherry, J.A., and R.W. Gillham. 1985. A comparative study of specific yield determinations for a shallow sand aquifer, *Ground Water*, Vol. 22, No. 6, pp. 764-772.

Walton, W.C. 1962. Selected analytical methods for well and aquifer evaluation, Illinois State Water Survey Bulletin 19.

Attachment P

BLASLAND, BOUCK & LEE, INC.
engineers & scientists

Light Nonaqueous Phase Liquid (LNAPL) Sampling and Passive Oil Recovery Procedures

Attachment P

Light Nonaqueous Phase Liquid (LNAPL) Sampling and Passive Oil Recovery Procedures

I. Introduction

Light nonaqueous phase liquid (LNAPL) samples may be collected to facilitate laboratory characterization of these materials. Standard procedures for collecting LNAPL samples and passive oil recovery are presented in this Attachment. Oil encountered while performing water level/oil thickness measurement procedures will be recovered when quantities exceed amounts specified in the project-specific work plan.

II. Materials

The following materials will be available, as required, during LNAPL sampling:

- Photoionization detector (PID);
- Health and safety equipment (as required in the Health and Safety Plan);
- Cleaning equipment (as required in Attachment H);
- Plastic sheeting;
- Field book or appropriate log forms;
- Absorbent pads;
- Peristaltic pump and pump tubing or bailer (stainless steel or Teflon®);
- Non-absorbent cord (polypropylene);
- Sample containers provided by laboratory;
- Insulated coolers, ice, and appropriate packing material;
- Resealable type bags;
- Sample labels and chain of custody forms;
- Large heavy-duty garbage bags;
- Teflon® tubing;
- Oil/water interface probe;
- Monitoring well keys (if required); and
- Container for recovered oil.

III. LNAPL Sampling Procedures

1. Review checklist and verify that the appropriate equipment has been assembled.

2. Open well and perform water level/oil thickness measurement procedures in accordance with Attachment R.

3. Identify site and well location on sampling log sheets along with date, arrival time, and weather conditions. Identify the personnel and equipment utilized as well as other pertinent data requested on the logs (Attachment H-1).

4. Label all sample containers with date, time, well number, site location, and sampling personnel present.

5. Don a new pair of disposable gloves as required. These gloves will be used for the entire sampling event and are well specific.

6. LNAPL is to be sampled utilizing a Teflon® or stainless steel bailer decontaminated in accordance with Attachment H. Alternatively, it may be removed utilizing a peristaltic pump with new Teflon® tubing. If using a bailer, slowly lower bailer into the LNAPL layer and then slowly retrieve the bailer to minimize disturbances to the NAPL layer. If using a peristaltic pump, slowly lower the tubing into the LNAPL layer and begin pumping. When finished, slowly remove tubing from the well.

7. Obtain the LNAPL sample needed for analysis with the pump or bailer, and pour or pump the liquid directly from the sampling device into the appropriate container with proper label affixed and tightly screw on the cap.

8. Note the time on the sample label and sampling log.

9. Replace well cap and secure well.

10. Clean all sampling equipment in accordance with Attachment H or dispose of equipment (see Section V below).

11. Collect all PPE and other wastes generated for disposal (see Section V below).

12. Record required information on the appropriate forms and/or field notebook.

13. Handle, pack, and ship the samples in accordance with the procedures in Attachment A. LNAPL may require additional packaging and labeling procedures as specified in Attachment N.

IV. Passive Oil Recovery Procedures

1. Perform Water Level/Oil Thickness Measurement procedures in accordance with Attachment Q.

2. If LNAPL is present in well and exceeds action level quantity, it must be recovered for disposal.

3. Remove LNAPL utilizing a bailer or peristaltic pump and transfer material into a suitable container for disposal.

4. Collect all PPE and other wastes generated for disposal.

V. Disposal Methods

Waste materials generated during LNAPL sampling activities, including disposable equipment, will be disposed of in appropriate containers.

Attachment P-1

BLASLAND, BOUCK & LEE, INC.
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LNAPL Sampling Field Log

Example

LNAPL Sampling Field Log

Project: _____ Project No.: _____

Site Name: _____ Sampling Personnel: _____

_____

_____

_____

_____

Well No.: _____ Date: _____

Time: _____

HNU/PID Reading: _____ Background _____ Well

Weather: _____

I. WELL INFORMATION

Reference Point Marked on Casing: Y N
Length of inner casing: ____ above, below grade

Well Diameter: _____ TIC _____ TOC
Length of outer casing: _____ above, below grade

Well Depth
LNAPL Thickness -
Water Thickness -

Vol. LNAPL Removed _____

II. WELL SAMPLING

Lab Sample No.	Time Sampled	Material Sampled

III. MISC. OBSERVATIONS

_____

_____

_____

_____

_____

Attachment P-2

BLASLAND, BOUCK & LEE, INC.
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Passive Oil Recovery Field Log

Example

Passive Oil Recovery Field Log

Project: _____ Project No.: _____

Site Name: _____ Sampling Personnel: _____

Date: _____ _____

Time: _____ _____

Temperature: _____ _____

Weather Conditions: _____

Well ID	Depth to LNAPL	Depth to Water	LNAPL Thickness	Est. LNAPL Removed

Attachment Q

BLASLAND, BOUCK & LEE, INC.
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Water Level/Oil Thickness Measurement Procedures

Attachment Q

Water Level/Oil Thickness Measurement Procedures

I. Introduction

Monitoring well water levels and oil thicknesses will be determined, as appropriate, to develop piezometric maps and to monitor plume migration. The water levels and oil thickness will be obtained using an Oil/Water Interface Probe. The operating and maintenance instruction manual for the probe should be reviewed prior to commencement of work to assure safe and accurate operation. Standard procedures for determining water levels and oil thicknesses in monitoring wells are presented in this Attachment.

II. Materials

- Photoionization detector (PID) to measure headspace vapors;
- Health and safety equipment (as required by the Health and Safety Plan);
- Cleaning equipment (as required in Attachment H);
- Oil/Water interface probe and instruction manual;
- Plastic sheeting;
- Measuring tape;
- Watch (record time and day);
- Field notebook;
- Absorbent pads;
- Appropriate log forms; and
- Monitoring well keys (if required).

III. Procedures

1. Identify site and well number on Water Level/Oil Thickness Monitoring Field Log (Attachment Q-1) and/or field notebook along with other appropriate information collected during water level measurement.

2. Don personal protective equipment (as required by the Health and Safety Plan).

3. Clean the oil/water interface probe and cable in accordance with the cleaning procedures in Attachment H.

4. Place a piece of plastic sheeting adjacent to the well to use as a clean work area. Cut a hole in the center of sheeting and place the sheet around the well.

5. If oil is present in the well, place absorbent pads on plastic sheet beside the well to absorb oil which may be present when the oil/water interface probe is removed from the well.

6. Unlock and open the well cover while standing upwind of the well. Remove well cap. Insert PID probe approximately 4 to 6 inches into the casing or the well headspace and cover with gloved hand. Record the PID reading in the field log. If the well headspace reading is less than 5 PID units, proceed; if the well headspace reading is greater than 5 ppm, screen the air within the breathing zone. If the PID reading in the breathing zone is below 5 PID units, proceed. If the PID reading is above 5 PID units, move upwind from the well for five minutes to allow the volatiles to dissipate. Repeat the breathing zone test. If the reading is still above 5 PID units, don appropriate respiratory protection in accordance with the requirements of the Health and Safety Plan. Record all PID readings. For wells which are part of the regular weekly monitoring program and prior PID measurements have not resulted in a breathing zone reading above 5 PID units, PID measurements will be taken monthly.

7. Locate a measuring reference point on the well casing. If one is not found, initiate a reference point by notching the inner and outer casings with a hacksaw or by using a waterproof marker. All downhole measurements will be taken from the reference points. The acronym TIC will designate the top of inner casing and the acronym TOC will designate the top of the outer casing. If a well has both inner and outer casings, use the top of the inner casing as the reference point.

Note - The following steps describe the procedures for water level measurement and detection of immiscible layers. For wells subject to routine monitoring (e.g., weekly, monthly monitoring locations), determination of the depth of the well will be performed initially and at a maximum interval of annually thereafter.

8. Measure to the nearest hundredth of a foot and record the height of the inner and outer casing from reference point to ground level.

9. Record the inside diameter of the well casing on the field log.

10. Lower the oil/water interface probe into the well to determine the existence of any light immiscible layer. Carefully record the depths of the air/light phase and light phase/water interfaces (to the nearest 0.01 feet) to determine the thickness of the light phase immiscible layer (if present). If no light phase immiscible layer is present, record the depth of the air/water interface.

11. For wells in which DNAPL is to be monitored, lower the oil/water interface probe to the bottom of the well and carefully record the dense phase/water interface (if present) and the depth at which the bottom of the well is encountered. The probe will emit a different reading (whether audible or visual) to discern between oil and water interfaces. Record all interface and well depth measurements in the field book to the nearest 0.01 feet. The well depth will be determined to evaluate any silt accumulation or blockage in the well.

12. Remove cable or tape and probe from the well.

13. Between wells, when obtaining water level/oil thickness measurements at more than one location, clean the instrument with a non-phosphate soap and water wash followed by a distilled/deionized water rinse. Use an appropriate solvent rinse, if necessary, to remove oil deposits.

14. Close the well when all activities are completed.

15. Collect all PPE and other wastes generated for disposal (see Section IV below).

IV. Disposal Methods

Materials generated during water level/oil thickness measurement procedures, including disposable equipment, will be disposed of in labeled 55-gallon drums.

Attachment Q-1

BLASLAND, BOUCK & LEE, INC.
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Water Level/Oil Thickness Monitoring Field Log

Water Level/Oil Thickness
Monitoring Field Log

Well No. _____

Date: _____ Time: _____

Project: _____

Project No.: _____

Weather Conditions: _____

Temperature: _____

Field Personnel: _____

Photoionozation Detector Readings: Within Well - _____ ppm

Breathing Zone (Initial) - _____ ppm

I. Well Information

	Inner Casing	Outer Casing
Ground to Top of Casing Reference Point		
Inside Diameter of Casing		

II. Phase Thickness Information

	Feet
Reference Mark to Top of LNAPL	
Reference Mark to Water	
Reference Mark to Bottom of Well (if applicable)	

Attachment R

BLASLAND, BOUCK & LEE, INC.
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Magnetometer Survey Procedures

Attachment R

Magnetometer Survey Procedures

1. Introduction

The following methodologies will be utilized to perform magnetometer surveys.

II. Materials

The following equipment and materials will be available, as required, during magnetometer surveys.

- Health and safety equipment (as required in the Health and Safety Plan);
- Appropriate forms/field notebook; and
- Geometrics proton magnetometer, Model G-816/G826 or the equivalent.

III. Procedures

1. Identify the traverse location on the appropriate form (Attachment R-1) and on the field notebook along with other appropriate information.
2. Don personal protective equipment (as required by the Health and Safety Plan).
3. Establish grid system by standard surveying techniques to document the location of each grid point. The grid spacing will be sufficient to detail the site(s) location, boundaries, and survey targets.
4. Utilizing a Geometrics proton magnetometer, Model G-816/G826 or the equivalent, conduct the survey. Operate the magnetometer in accordance with the operating manual.
5. Establish a base station in an area with no known buried or surface ferrous-metallic objects. Record readings at the base station every hour and at the beginning and end of each day.
6. At each point of the grid system, record the time, station location, and magnetometer readings on a standard form (Attachment R-1), or in the magnetometer's digital memory.
7. The data from the magnetometer surveys will be corrected for drift using the base station measurements before plotting or reporting.

Attachment R-1

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Magnetometer Survey Form

MAGNETOMETER SURVEY

CREW_____ WEATHER_____ NOTES_____

DATE/TIME	STATION	READING

Attachment S

BLASLAND, BOUCK & LEE, INC.
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Ground-Penetrating Radar Procedures

Attachment S

Ground-Penetrating Radar Survey Protocol

I. Introduction

Ground-penetrating radar (GPR) is an effective geophysical system take transmits high frequency electromagnetic waves into the ground and detects the energy reflected back to the surface. GPR operates on a principle similar to seismic reflection except, instead of acoustic waves, electromagnetic waves of radio and microwave frequencies (80 MHz to 1,000 MHz) are used. Electromagnetic signals are reflected back to the surface from interfaces with differing electrical properties. Reflections typically occur at lithologic changes, subsurface discontinuities, and internal soil structures, such as:

- Top of bedrock surfaces;
- Soil and rock stratification;
- Water table;
- Seepage and leachate zones;
- Buried metal objects, such as drums and utilities;
- Open and water-filled voids;
- Bedrock fractures; and
- Archaeological structures.

The depth of GPR penetration is site-specific, limited by the attenuation of the electromagnetic energy. Signal attenuation is controlled by four different mechanisms listed below, any or all of which may be present at a site:

- Scattering losses;
- Conduction losses;
- Water losses; and
- Clay loss.

Energy losses due to scattering occur when signals are dispersed in random directions, away from the receiving antenna, by large, irregularly shaped objects, such as boulders and tree stumps.

Signal attenuation due to conduction is a function of the conductivity of a material, which varies with mineral composition, the amount of water, and the total dissolved solids (salt, heavy metals) within the water. The greater the electrical conductivity values of materials at a site, the more signal attenuation (hence, less penetration) there will be.

Energy losses attributed to water occur when water molecules polarize in the presence of the applied electromagnetic field. Electromagnetic energy is lost to the radar system when it is converted to kinetic and thermal energy as a result of the rotation of water molecules.

Signal attenuation due to clay losses occurs when electrochemically charged ions polarize along clay surfaces in the presence of the electromagnetic field induced by the radar system. The migration and subsequent collision of these charged particles cause electromagnetic energy to be converted to kinetic and thermal energy, which is lost to the radar system.

Signal penetration is also dependent on the frequency of the transmitting antenna used in the radar system. Higher frequency antennas produce waves with shorter wave lengths, which are attenuated more rapidly with depth, but give better resolution. Specially designed 2 MHz antennas have been used to detect the ice-rock boundary of a 2-kilometer (km) thick glacier. Penetration of up to 75 feet has been reported for water-saturated, clean sands in a Massachusetts glacial delta using a commercial antenna. Signal penetration in saturated clays, on the other hand, is on the order of magnitude of a few inches. Olhoeft (1986a) determined that even 5 percent clay added to a clean sand and gravel will cause a decrease in penetration by a factor of 20. Salt water is also a high loss substance, as signal penetration in sea water is less than one foot. It is important to note that in a layered medium, a single, highly reflective layer alone can limit signal penetration by preventing the propagation of energy through it. In this instance, the apparent loss of energy is caused by reflection rather than a single attenuation.

Applications

GPR is a shallow penetrating geophysical profiling system used where rapid and accurate surveys are desired. GPR has been used to locate underground pipes, buried drums, foundations, voids in rock and concrete, and lithologic contacts; to determine stratigraphy, depth to the water table, and depth to bedrock and to locate buried archaeological artifacts, excavations, filled pits and lagoons, and numerous other site-specific applications. GPR has been used successfully to delineate the lateral extent of contaminated plumes. Haeni, et al. (1985) used GPR to investigate the thickness, type, and extent of sediments beneath a frozen lake with an 80-MHz antenna. The

information acquired with GPR was used to help map the lateral extent of an aquiclude for, and better estimate inputs to, the mass balance equation for water budget calculations.

A GPR system can be used to determine depths to reflecting discontinuities by conducting a depth calibration. Typically, calibration is performed by moving the radar antenna over a metal target of known depth, such as a buried metal plate. Also, if transmitting and receiving antennas are housed in different units, designated as a bistatic antenna system, a common depth point (CDP) survey, identical to surveys conducted with seismic reflection, can be used to calculate the velocity of the medium and, hence, depth to the reflector. Sakayama and others (1988) describe another method to calculate velocity from bistatic antennas where the receiving antenna is continually moved away from the stationary transmitting antenna. The velocities of the direct arrival and the first strong reflector are recalculated from the inverse slope of the time-distance display (antenna separation) on the GPR record in a similar manner as seismic refraction.

The verify GPR results, other geophysical and ground truth methods can be used. Haeni, et. al., (1985) utilized seismic refraction to correlate calculated depths of stratigraphic horizons and water tables with radar reflections. Magnetometry and electromagnetic induction methods have been used to verify the lateral extent of conductive plumes. The depth to a particular reflector or target can also be verified by boreholes and/or test pit excavation.

II. Materials

The SIR System 3 ground-penetrating system consists of:

- AC/DC power supply;
- Control unit (pulse transmitter);
- Antenna(s);
- Graphic recorder;
- Digital recorder (optional);
- Magnetic tape recorder (optional); and
- Coaxial cable that connects the control unit to the antenna.

Typically, radar antennas contain both the transmitter and receiver within one fiberglass unit. Once a radar impulse is transmitted, the antenna switches to the receiver mode and records reflected radar impulses. The pulse receiver contains an amplifier that increases the amplitude of reflected signals. Bistatic antennas (transmitter and receiver are separate) allow the coverage of larger areas with one pass, and multi-receiver combinations allow the "stacking" of radar data, which increases the signal-to-noise ratio.

Field data are generally printed by a graphic recorder and can simultaneously be stored on magnetic tape or diskette. The graphic recorder produces a continuous time (vertical) versus distance (horizontal) profile of the subsurface for field quality control and qualitative interpretations. Radar impulses are synchronized with the swept-stylus type graphic recorder, producing a dark band proportional to the amplitude of a reflected radar signal. Because the antenna is moving, each pass of the stylus represents a slightly different antenna position. Gradually, as the recorder paper advances under the moving stylus, a pattern of reflective interfaces emerges.

Storing of data on diskette or magnetic tape provides an opportunity for additional printing and/or computer processing for the refinement of data. Deconvolution of stored data enhances stratigraphic reflections from the water table and soil structures (Olhoeft, 1988). Data migration allows easier resolution of metallic targets, such as buried drums, and delineation of excavations and sinkholes (Hogan, 1988).

Radar systems are designated to use antennas of various electrical characteristics. Selection of the antenna is dictated by the requirements of the survey. If high resolution, near-surface data is desired, a small, high-frequency antenna is used; if the survey requires deeper probing, a larger, lower-frequency antenna is used (80-, 120-, 250-, 300-, 400-, 500-, 900-, and 1,000- MHz antennas are commercially available). The drawback to using the lower-frequency antennas (less than 250 MHz) is that data resolution is sacrificed for penetration. Also, the low frequency antennas are generally not shielded, making them susceptible to overhead powerline noise and spurious reflections from passing cars. The 900- and 1,000-MHz antennas are used almost exclusively for short penetration projects, such as the detection of rebar in concrete, as their penetration is generally limited to 2 to 3 feet.

III. Procedures

The majority of time involved with any GPR survey is spent establishing survey lines in the area of investigation so that detected anomalies can be easily located. Survey lines will be set to maximize coverage, while maintaining a grid spacing proportional to the presumed target dimensions. A minimum survey line spacing of 10 feet is desired when looking for a 1,000-gallon fuel tank, while a larger spacing of 50 feet or more may be used to define the lateral extent of a conductive ground-water plume.

At the onset of any GPR survey, the radar control unit will be adjusted for the anticipated depth of penetration. Adjustments of the time window of exploration will be made by estimating the velocity of the medium and desired depth of penetration. Assuming a soil velocity of 0.4 times the speed of light and a target that is buried 10 feet below ground surface, a minimum time window of 50 nanoseconds is needed.

Accurate determination of the depth to any layer requires calibration of the radar system. The easiest way to calibrate the GPR system to specific settings is to bury a plate at a measured depth and move the antenna slowly along the survey line. The plate will produce on the GPR record a thick, dark band, parabolic or flat in shape, with many multiple reflections beneath it. Once a certain confidence level is attained from depth calibration, the survey is conducted by slowly pulling the antenna along survey lines. A slow walking pace increases the horizontal resolution, as radar signals are propagated in a 15 to 45 degree cone from the bottom of the antenna. A slow walking pace is recommended for hazardous waste investigations, as targets are better defined and easier to resolve. On the other hand, the radar antenna can be towed from the back of a car or truck at speeds of up to 10 miles per hour, if the target is a continuous reflector, such as the water table.

IV. Interpretation

The horizontal scale of the record is maintained by marking on the record the locations of survey stations as they are reached by the antenna. Accurate determination of the vertical scale (i.e., conversion of a time into a depth) requires calibrate of the radar system, as discussed in Section I. If the depth to a known reflector cannot be determined through, or verified using boreholes and test pits, the velocity of the medium can be approximated from relationships involving the velocity of the medium and the dielectric constant (real dielectric permittivity) of the medium. Values of the dielectric constant can be found in GSSI (1974) and Kutrubes (1986). The depth to the reflector can be calculated from time and velocity values. It is important to note that if the relationship is no longer valid, signal losses are great.

Interpreting of GPR data is subjective, even among experienced interpreters. The strength of a reflected signal and/or the continuity of that reflector across the record may be indicative of a stratigraphic contact or the water table in an unconfined sand and gravel deposit. Metallic objects, such as buried drums and pipes, also produce a characteristic parabolic signal on the record and sometimes produce a "ringing" noise denoted by the heavy, dark banding, as during readout.

Glossary

Bistatic antenna: An antenna system in which transmitting and receiver coils are housed in separate antenna units.

Deconvolution: A computer processing method. The process of undoing the effect of another filter (in this instance, the "earth"). A process that removes ringing, multiples, ghosts, and some background noise.

Dielectric Permittivity: A complex number consisting of a real and imaginary part, which uniquely describes the propagation and attenuation of electromagnetic energy in every material. The real dielectric permittivity (dielectric

constant) characterizes the propagation and reflection of EM waves, while the imaginary part (dielectric loss) characterizes the attenuation of EM signal (Kutrubes and Olhoeft, 1987). A measure of the capacity of a material to store charge when an electric field is applied (Sheriff, 1973).

Electromagnetic waves: One of the waves that are propagated by simultaneous periodic variations of electric and magnetic field intensity, including radio waves, infrared, visible light, ultraviolet, X-rays, and gamma rays.

Migration: Where velocity varies laterally, data will migrate (relative to the time versus antenna distance plot), and ray tracing is used to determine migrated positions (Sheriff, 1973).

Attachment T

BLASLAND, BOUCK & LEE, INC.
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CT&E Environmental Services, Inc.
Quality Assurance Plan - Michigan Division

QUALITY ASSURANCE PLAN
CT&E ENVIRONMENTAL SERVICES INC.
MICHIGAN DIVISION

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This quality assurance plan documents the procedures and methods used by CT&E Environmental Services Inc. Michigan Division to collect, store, analyze, and dispose of samples. This plan is also intended to inform our clients of the conditions and practices related to sample and data handling and the overall operations of the laboratory. The QAP is updated on an annual basis by the Quality Assurance Officer. After revisions have been completed, the plan is reviewed and signed by the General Manager and all Technical Directors.

Revision Date: September 15, 2000

Ben Gulizia, General Manager/Technical Director — Date 10/3/00

Peter J. Priniski, QA Officer — Date 10/3/00

Jason Asher, Project Manager/Technical Director — Date 10/3/00

Denise Califato, Laboratory Manager/Technical Director — Date 9/28/00

TABLE OF CONTENTS

I. Quality Assurance Policy Statement

"QUALITY IS OUR BUSINESS"

CT&E Environmental Services Inc. is totally committed to the policy of providing our client with QUALITY services and products, that conform to valid, mutually-agreed upon requirements, so that we are recognized as the leader in client satisfaction in each of our markets.

Every employee is personally responsible for the QUALITY of his or her own work. This means knowing and understanding the requirements of each task we undertake, doing the job right the first time, and initiating action to change requirements which are invalid or cannot be met.

To accomplish this we will:

1. Implement Total Quality Management practices and conform to the SGS Group "Code of Practice".

2. Regard QUALITY management as critical to business success, and hold employees at all levels accountable for QUALITY.

3. Continuously measure the progress we are making in meeting valid client requirements and expectations.

4. Provide the specific means by which all employees can freely identify and eliminate obstacles to improving the QUALITY of their own work.

5. Train all employees in the principles and methods of QUALITY improvements.

6. Involve all employees as active participants in a team effort, based on mutual trust and respect, to continuously improve our service and product QUALITY through Total Quality Management practices.

7. Recognize both individual and group QUALITY improvement achievements.

II. CODE OF CONDUCT AND DISCIPLINE

CT&E Environmental Services Inc. has a published document that outlines the code of conduct expected from every employee. This document is read and signed by each new employee. In the rare circumstance that an employee must be disciplined, there are three different levels of action. The first is a verbal warning that does not go into the employee's permanent file. The second level is a written warning that does get placed in the employee's file. The third action is termination. There are some reasons that are grounds for immediate termination, such as falsification of laboratory data.

III. CODE OF PRACTICE (SGS GROUP)

As the world leader in the inspection business, members of the SGS Group should project and live up to an image of an organization whose professionalism and integrity can be relied upon by the Clients we serve, the authorities in the countries in which we operate and by the financial and other institutions who handle our documents. The quality of our services must be of the highest order. This covers all aspects of our operations: Commercial, Administrative and Technical. Quality is a corporate commitment within the SGS Group. It is the individual joint responsibility of all employees of the SGS Group.

There are ten basic rules to remember at all times:

1. As leaders in our profession, we must not only think but also act as the best and therefore provide a superior Quality of service.

2. Minimizing risks and protecting Client's interests is our "raison d'être" (reason for existence).

3. Only work, which can be competently and professionally handled by the resources available to the organization, should be sought and accepted.

4. We must avoid the SGS Group's being placed into a position of conflict of interest when carrying out our tasks on behalf of Clients.

5. We must work to recognized standards, Company practices and respect all legitimate instructions from Clients.

6. We have to keep Clients informed without delay of all major developments and issue complete, factual and unambiguous reports promptly.

7. The confidentially of information must be respected at all times.

8. All employees must act loyally and honestly in carrying out the policy and instructions of the SGS Group and not undermine its image or reputation in any way.

9. We must rectify shortcomings and take action to correct situations that cause unsatisfactory performance.

10. To be and to remain the best, we have to be innovative and adapt our services to Client's needs without compromising the Quality of our services.

IV. CLIENT CONFIDENTIALITY

As stated in the SGS Group Code of Practice (Rule #7), the confidentiality of information must be respected at all times. CT&E ESI follows these guidelines:

- any paperwork that is waste and contains a client's name is shredded;
- all data obtained for a client is considered to be his/her property;
- no results are given via facsimile/verbally/electronically without client request and will contain a statement that the material is for the addressee only; and
- results will not be given to anyone other than the client without written/verbal approval from the client

- The data and samples are the property of the client. In the unlikely event that the laboratory is sold or goes out of business, arrangements will be made with the client to release their samples and data to them or a third party of their choice.

V. FACILITY DESCRIPTION

Physical Location
CT&E Environmental Services Inc. – Michigan Division operates from a 12,500 square foot laboratory located at 1200 Conrad Industrial Drive, Ludington, MI with satellite sales and field sampling offices located in Detroit, Flint, and Bay City, Michigan. The normal business hours at the laboratory are 8:00 a.m. – 5:00 p.m. Monday through Friday. Night and weekend work is performed as necessary.

Security
The laboratory has an ADT security system with keyless punch pad entry. The system arms all exits and has motion detectors. The security system is set every night and weekend. All laboratory personnel have keys to enter the laboratory and the code for the security system.

Laboratory Sections
The laboratory is comprised of four discrete sections dedicated to the analyses of Volatile and Semivolatile Organics, Metals and Wet Chemistry compounds for the matrices listed below. All sections of the laboratory provide adequate bench space, exhaust hoods, lighting and temperature control to perform analyses as required by the various methods and to meet internal safety requirements. The configuration of the laboratory is such as to avoid any potential contamination. The volatile section of the laboratory is kept under a positive pressure preventing any gases from the other sections of the laboratory being drawn into the volatile lab. Access to the volatiles laboratory is limited to select personnel to prevent cross-contamination. The laboratory has purchased an ICP/MS for metals analysis. This instrument has unique environmental requirements relating to venting and airflow. A separate room has been modified to accommodate this instrument. (see attached building diagram)

Testing Matrices
- *Aqueous* – any aqueous sample excluding Drinking water, or Saline water
  - surface water
  - groundwater
  - effluents.
- *Drinking Water* – any aqueous sample that has been designated a potable or potential potable water source.
- *Solids* – any matrix with greater than 15% settleable solids
  - soils
  - sediments
  - sludges
- *Saline* – any aqueous sample from a marine or salt water source
- *Air* – media used to retain the analyte of interest from an air sample such as sorbent tubes or summa canisters
- *Tissue* – any sample of a biological origin such as fish tissue, shellfish or plant material
- *Non-Aqueous Liquid* - any organic liquid with less than 15% settleable solids

- *Chemical Waste* – a product or by-product that of an industrial process that results in a matrix not defined above

VI. CERTIFICATIONS

Certifications are offered to environmental laboratories by various federal and state agencies. These certification programs can vary by the type of certification offered and the requirements by the different agencies. Certification is usually required when performing analysis for projects located within the jurisdiction of the agency. Currently, CT&E Environmental Services Inc. – Michigan Division maintains the following certifications:

State Certifications

- Michigan – Drinking Water
- Wisconsin – Wastewater
- Alaska – UST
- Illinois – Drinking Water, Waste Water, Hazardous Wastes
- Maryland – Drinking Water (Reciprocity Michigan)
- Indiana – Drinking Water (Reciprocity Michigan)

Federal Approvals

- Air Force Center for Environmental Excellence
- Army Corps of Engineers

National Certifications

- A2LA
- NELAP (in force after 1/1/2001)

VII. LABORATORY ORGANIZATION AND STAFF RESPONSIBILITIES

CT&E Environmental Services Inc., Michigan Division employs dedicated professionals who are highly trained and qualified in individual areas of expertise. The staff's collective experience in chemistry, microbiology, hazardous waste evaluation and field services is one of CT&E's most valuable resources. Our chemists have proven their ability to solve complex analytical problems associated with unknown chemical identification, characterization research and customized services. The CT&E Environmental Services Corporate and Michigan Division Organizational charts can be found as an attachment to this document. Responsibilities for the positions in environmental commercial laboratories can vary. Complete job descriptions for each employee are kept in the employee's file. The responsibilities for various "key" positions within the laboratory are summarized below:

General Manager

- Responsible for the analytical and operational activities of the laboratory
- Supervision of personnel employed by the laboratory
- Assuring that sample acceptance criteria are met
- Assuring that samples are logged into the sample tracking system
- The production and quality of data reported by the laboratory
- Designating laboratory supervisors
- Designating quality assurance officer
- Oversight of employee training
- Oversight of laboratory safety
- Laboratory financial concerns
- Defining the minimum level of qualification, experience and skills necessary for all positions in the laboratory
- Ensuring that all technical laboratory staff have demonstrated capability for the analysis

they are responsible for

- Ensuring that trained staff are kept up-to-date with current promulgated methods
- Developing a proactive program for prevention and detection of improper, unethical or illegal actions

Laboratory Manager

- Supervising analysts, analysts-in-training and technicians
- Reviewing and verifying data produced by an analyst-in-training
- Reviewing and verifying data produced by a technician
- Scheduling work to meet holding times and client TAT
- Maintaining and troubleshooting all equipment and instrumentation
- Ensuring all employees receive complete training
- Establishing and maintaining QC requirements
- Conducting weekly meeting
- Approving supply orders
- Conducting semi-annual reviews.

Project Manager

- Management of analytical and sampling projects
- Project consultation with clients
- Coordination of analytical work to meet client TAT and holding times
- Final report review and signature on all data delivered to client
- Prepare data deliverable package

QA/QC Officer

- Coordination and review of both the quality control data and the quality control requirements of the various methods.
- Maintaining and obtaining state certifications
- Coordinating blind in-house audits as needed
- Conducting annual analyst audits
- Works independently from laboratory operations
- Maintaining laboratory documentation
  - Method Detection Limit Studies
  - Standard Operating Procedures (new and archived)
  - Quality Assurance Plan
  - Laboratory Certifications
  - Laboratory Signature Log
  - Proficiency Testing Results and Corrective Actions
  - Corrective Action Reports
  - Control Limits/Charts
  - On-site Assessments and Responses
  - Methods (new and archived)
  - Monthly reports to management
  - Employee files including
    - Initial Demonstration of Capability (IDC)
    - Continuing Demonstration of Capability (CDC)
    - Training Approval Record (TAR)
    - Resume
      - Qualifications
      - Experience
      - Education

Absence

If the Technical Director or Quality Assurance Officer is absent, a project manager or the lab manager may perform these duties on a temporary basis.

Administration

Administration takes on various forms in the environmental laboratory.. The following positions and responsibilities are inclusive as part of Administration:

Login Supervisor

- Login client samples
- Inform project managers when sample acceptance criteria are not met
- Ship sample bottles to clients
- Subcontract samples
- Coordinate sample pickups

Administrative Supervisor

- Provide customer service to clients
- Supervise clerical staff

Sales Representative

- Develop and maintain client relations
- Prepare bid proposals

Clerical Staff

- Receptionist
- Accounting
- Building maintenance
- Data Entry

Computer Staff

- LIMS implementation and maintenance
- Recommend hardware, software and connectivity service upgrades

Analysts and Technicians

Analysts and technicians are in three sections of the laboratory: Organic, Inorganic and Sampling. The responsibilities include but are not limited to:

Laboratory Analysts/Technicians

- Create, review and update analytical standard operating procedures (SOPs) in conformance with published analytical methods.
- Analyze samples by approved SOPs
- Meet required client commitment dates
- Meet sample holding times
- Perform Initial Demonstration of Capability (IDC) prior to performing independent sample analysis
- Demonstrate ongoing proficiency by performing a CDC
- Meet all QA/QC requirements for the performed SOP.
- Document sample anomalies and communicate them to project manager and data reporting personnel.

Sampling Technicians

- Perform weekly, monthly, and quarterly scheduled sampling projects in accordance with SOPs
- Document sample specific information and communicate potential hazards to the laboratory.
- Collect samples according to client's Sampling Plan.
- Ship/transport samples to laboratory
- Maintain sample integrity through chain of custody

VIII. EMPLOYEE TRAINING

Training is an important aspect to the success of a commercial environmental laboratory. CT&E provides a rigorous training program to all new employees and the transfer of current employees to new positions.

- All training is conducted by an experienced analyst or the section supervisor utilizing the Training Approval Record (TAR) checklist:
  - Read Method
  - Read SOP
  - Sample Holding Times and Preservation
  - QC Requirements/Corrective Actions of the method
  - Standardization Procedures
  - Data Reduction and Evaluation
  - Equipment Operation Instructions/Maintenance
  - Chemical and Equipment Hazards
  - Safety Equipment and Procedures
  - Observe Test
  - Perform Test Under Supervision
  - Successful completion of the Initial Demonstration of Capability (IDC)
- The period for a new analyst to be under immediate supervision is a minimum of two weeks.
- The TAR is reviewed, completed and signed by all analysts and trainer prior to performing independent client sample analysis.
- The Initial Demonstration of Capability (IDC – raw data or summary) is attached to the TAR. (see individual SOP for specifics on how a IDC is performed)
- The TAR is reviewed and signed by the trainer, the section supervisor and a technical manager certifying that the analyst has sufficient background and training.
- The TAR is filed in the employee's file in the QAO office.
- To demonstrate on-going proficiency, the analyst must acceptably analyze at least one blind sample per year. Alternatively, quadruplicate analysis of a second source standard may be used to demonstrate both precision and accuracy acceptable by the method standard.
- All training documentation is maintained by the QAO and kept in the employee file.
- Analysts are assisted in increasing their technical abilities through specialized seminars, off-site training courses and college courses

IX. INSTRUMENTATION/EQUIPMENT

CT&E Environmental Services Inc. Michigan Division currently maintains the instrumentation below to analyze client samples for the requested analyses (see attached SOP list).

Equipment exposed to overload or misuse will be taken out of service and labeled as "out of service". The equipment will then be evaluated, repaired and certified acceptable before used on samples. All repair or modifications must be documented in the instrument repair logbook.

A. ANALYTICAL INSTRUMENTS

Volatile Organic Analysis

GC/MS: (2)

- Hewlett Packard 5972 MSD (ID H) with HP 5890 Series II Plus GC, Tekmar 3000 Concentrator and Tekmar ALS 2016 auto sampler.
- Hewlett Packard 5972 MSD (ID L) with HP 5890 Series II Plus GC, Tekmar 3000 Concentrator and Tekmar Aquatech (AA-70).

GC: (5)

- Varian GC Model 3400 (ID K) with FID/ PID detectors, O.I. Corp. 4460A Sample Concentrator and auto sampler.
- Varian GC Model 3400 (ID J) with Hall/PID detectors, Tekmar LSC 2000 Concentrator and Tekmar ALS 2016 auto sampler.
- Varian GC Model 3400 (ID I) with FID/PID detectors, Tekmar LSC 2000 Concentrator and Tekmar ALS 2016 auto sampler.
- Varian GC Model 3700 (ID B) with dual FID Manual injection
- Varian GC Model 3300 (ID P) with PID/FID detectors, Tekmar LCS 2000 Concentrator and Tekmar ALS 2016 auto sampler.

Semi-Volatile Organic Analysis

GC/MS: (2)

- Hewlett Packard 5970 B. MSD (ID E) with HP 5890A GC, HP 7673 Autosampler.
- Hewlett Packard 5971 A. MSD (ID F) with HP 5890 Series II GC, HP 7673 Autosampler.

HPLC: (1)

- Waters LC Module 1 Plus with Waters 474 Scanning Fluorescence Detector.

GC: (3)

- (2) Varian GCs Model 3400 (ID C & D) with dual ECD detectors and Varian 8100 auto sampler.
- Varian GC Model 3600CX (ID N) with dual FID and Varian 8200 auto sampler.

Miscellaneous Organic Instrumentation

- GPC Clean up, Auto Prep 1000
- Buck Scientific HC-404 Oil-in-Water Analyzer
- (3) Turbo Vap II, Automated Concentrator
- Fisher Scientific 550 Sonic Demembrator

Metals Analysis

ICAP/MS

- Perkin-Elmer – Elan 6100

ICAP

- Thermo Jarrell Ash Purged Simultaneous Spectrometer (ICAP - Inductively Coupled Argon Plasma)

Atomic Absorption

- Perkin-Elmer 4100ZL GTA - Zeeman Graphite Furnace Spectrometer
- Varian Spectra AA-400Z Zeeman Graphite Furnace Spectrometer
- Varian Spectra AA-20 Atomic Absorption Spectrometer with VGA-76 Automatic Vapor Generation System

Wet Chemistry

Lachat

- QuickChem 8000 Automated Ion Analyzer with Auto Sampler and Auto Diluter

UV Spectrometer

- Milton Roy 401 UV Spectrometer

TOC

- Dohrmann DC-80 Organic Carbon Analyzer

Miscellaneous Inorganic Instrumentation

- CEM MDS-2000 Microwave Sample Preparation System
- Corning pH/Ion Meter Model 710A
- Corning Checkmate 90 pH meter
- (2) Orion Expandable Ionanalyzer Model EA940

- Mettler AE 100
- Leachate Extraction Equipment

General Laboratory

- Barnstead NANO Pure II Deionizer equipped with Automatic Collection System
- Barnstead RO Pure LP Reverse Osmosis equipped with Automatic Collection System
- Various ovens, incubators, refrigerators, and freezers
- Thermometers, pipettes, Class A volumetric glassware

B. FIELD EQUIPMENT

Sampling Equipment

- ISCO Composite Samplers
- SP84 Keck Submersible Sampling Pump
- Teflon Bailers
- PVC Bailers
- Submersible Pumps
- Perstalic Pumps
- SKC Aircheck Sampling Pumps
- Coliwassa Barrel Samplers
- Particle Size Determination
- Sediment Sieves
- Hand Auger Sampling Probes – 5, 10 and 15 foot Global Positioning System (GPS)

Instrumentation

- H-NU Photoionization Meters
- Electric Water Level Indicators
- Conductivity Meters
- pH meters
- Oil/Water Interface Probe
- Explosimeter, CGS-20M
- Fisher TW6 Buried Cable and Pipe
- Locator
- C3A Model Sokkisha Surveyor
- Commercial Metal Detectors
- 5000 Watt Portable Generator

C. SAFETY EQUIPMENT

- EPA Guidelines for Monitor Well Installation
- Level B Safety Equipment
- First Aid Kits
- Full Body Protection Suits
- Hard Hats
- Steel Toed Boots
- Explosive, Toxic Gas Meter
- H-NU Gas Meter

X. CALIBRATION, VERIFICATION and MAINTENANCE

Instrumentation and equipment must be calibrated, verified and maintained in order to perform analyses compliant with method requirements. Calibration must be planned in such a way as to establish detection, and to determine the range of linear response of the instrument. Requirements for each method are highlighted in their respective SOP (see attached "Active SOPs"). The instrument must be labeled as "calibrated" when a

successful calibration is obtained.

Initial Calibration

Frequency

- As required by the approved analytical method
- As required to correct performance failures
- After major maintenance

Documentation

- Standards certificates are maintained by each section
- Standards utilized in the calibration curve are recorded in the Standard Reagent Logbook for each section
- The correlation coefficient must be documented on the raw data
- Calibration curves contain the following information
  - Date of analysis
  - Analyst
  - Instrument ID
  - Standard concentrations
  - Matrix type
  - Analytical test method
  - Analyte(s)
  - Instrument response

Requirements

- Number of standards in calibration curve by level of importance
  - Special requirements of client contract
  - Method requirements
  - Manufacturer's instructions
  - Laboratory default – 3 standards and a blank
- Standards are traceable to national standards (when available)
- Lowest standard should be at or near the reporting detection limit (RDL)
- Separate calibration curve for aqueous, solid matrices, and in some cases oil (waste), tissue and wipes.

Linearity Test

- Correlation coefficient of linear regression $\geq$ 0.995 for Inorganic parameters
- Correlation coefficient of linear regression $\geq$ 0.990 for Organic parameters
- %RSD of response factors $\leq$15%
- %RSD of calibration factors <30%

Corrective Action

- Perform instrument maintenance
- Re-prepare the calibration standards

Reporting

- Results can be reported for all values within the linear range of the calibration curve provided interference is not suspected.
- Any sample result over the calibration curve must be diluted and reanalyzed unless test method allows otherwise
- Utilize linear regression when correlation coefficient meets criteria
- Utilize the average response factor when response factor criteria is met
- Utilize the average calibration factor to determine analytical results when calibration criteria is met

Calibration Verification (Initial & Continuing)

Frequency

- Analyze immediately following initial calibration
- Analyze at the frequency stated in method/SOP
- Default frequency 10%

Source

- Use source different from initial calibration standard

Requirements

- Mid-range concentration of the calibration curve
- Acceptance limits are 90-110% for inorganic constituents unless method requirements are specified
- Method specific acceptance limits for organic constituents

Corrective action

- Re-prepare and reanalyze
- Recalibrate instrument
- All samples associated with a failed QC must be reanalyzed

Documentation

- Standard certificates are maintained by the section
- Standards utilized for calibration checks are recorded in the Standard reagent logbook for each section

Corrective Action

- Perform instrument maintenance
- Re-prepare calibration standards

Calculation

- Results are reported as percent recovery using the following calculation

$$\frac{\text{CC Result}}{\text{True Value}} \times 100\% = \text{Percent Recovery}$$

Additional Inorganic Calibration Requirements – see method SOP for requirements
ICSA/ICSAB
Check Standard (ICP)

Additional Organic Calibration Requirements – see method SOP for requirements
GC/MS Tune
Performance Evaluation Mixture (PEM)

Equipment Calibration & Frequency

Environmental laboratories must calibrate various pieces of equipment. This equipment is utilized for the analysis of various methods as well as for safety.

The laboratory has at least two reference thermometers that are certified NIST traceable by an independent vendor on an annual basis. These thermometers are only used to evaluate other thermometers. These evaluations are posted near the thermometer use area. A master copy of the comparison and the thermometer logbook is kept in the QA office. The laboratory also maintains one set of weights that hold NIST traceable calibration. These weights are used to evaluate other weights and evaluate the calibration of our balances.

Exhaust Hoods

- Check monthly
- Flow rates recorded in logbook
- There is at least one operable exhaust hood per section of the laboratory

Conductivity Meter

- Must be calibrated daily
- Analyze QC check daily
- Error not exceeding 1% or one umhos/cm, whichever is greater

pH Meters

- Performs temperature measurement to make correction for pH measurement
- Calibrate daily with pH buffers (2-3) in the range of measurement
- Analyze additional buffer as quality control check
- Accuracy of buffers must be $\pm$ 0.1 pH S.U. of true value

Refrigerators/Freezers/Incubators/Ovens/water baths

- Unique identification of each refrigerator/freezer/incubator/oven/water baths
- One calibrated (annually with NIST-traceable thermometer) thermometer per unit with unique identification
- Temperatures checked and recorded daily in thermometer logbook
  - Thermometer identification
  - Refrigerator/freezer/incubator/over identification
  - Date
  - Temperature
  - Acceptance range
  - Corrective action
  - Comments
  - Analyst initials checking temperature
- Corrective action taken when temperature outside acceptance range
  - Adjust temperature
  - Re-check temperature
  - Make adjustments until required temperature is reached
  - Document in logbook corrective action and record final temperature reading

Pipettes

- Mechanical pipettes are checked gravimetrically on a daily basis and after any adjustment
- All checks are documented in the pipette logbooks located in each applicable section of the laboratory
- Accuracy must be within the range established in the logbook for each pipette.

Balances

- Checked and recorded daily using ASTM Class 2 weights covering range of use
- Annual inspection and certification by a qualified technician service
- Store on a stable table
- Acceptance range for tolerance of Class 2 weights below

Normal Value	Tolerance
0.010 g Polished weight	0.014 mg
1.0 g Polished weight	0.054 mg
10.0 g Polished weight	0.074 mg
50.0 g Polished weight	0.12 mg

VERIFICATION

In order to ensure that data continues to be valid, quality control samples are incorporated into the Standard Operating Procedure (SOP) for each analytical method and instrument.

Calibration check

- Refer to page 12

Instrument Blank

- Analyze prior to sample analysis and at the frequency stated in method/SOP
- Analyte-free reagent water or clean solvent for SVOC

- Check for contamination in the instrument caused from:
  - sample carryover
  - standard carryover
  - contaminated carrier gas
  - contaminated replacement parts
- |Concentration| of any **analyte of concern** should not be higher than the highest of either:
  1) Method Detection Limit or
  2) 5% of the regulatory limit for that analyte or
  3) 5% of the measured concentration in the sample
- Corrective action for a failed instrument blank is the following:
  - Reanalyze
  - Prepare and analyze a second blank
  - Check instrument for maintenance
- Refer to Blank Contamination SOP for effect on sample data

MAINTENANCE

Routine preventative maintenance is conducted to minimize the occurrence of instrument failure and other system malfunctions. A preventative maintenance schedule is posted on all instruments. Designated laboratory employees regularly perform routine scheduled maintenance and repair of, or coordinate with the vendor for the repair of, all instruments. All maintenance that is performed shall be documented in the instrument maintenance logbook.

The maintenance log book shall include:

- Name of the Equipment
- Manufacturers Name
- Serial number
- Date received
- Condition received
- Date placed into service
- Location of equipment
- Location of manufacturer instructions
- History of repair or modification including problem and resolution

All laboratory instruments are maintained in accordance with manufacturer's specification. Emergency repair or scheduled manufacturer's maintenance are provided by factory representatives. Common instrument maintenance may include but is not limited to:

- *ICP/MS*
  - Inspect/Clean Filters – Monthly
  - Check Roughing Pumps – monthly
  - Check Gas Flows – daily
  - Inspect/clean Sample Introduction System – daily
  - Empty waste – as needed
  - Clean torch assembly – as needed
- *Inductively Coupled Plasma (ICP)*
  - Clean filters – monthly
  - Check gas flow – daily
  - Change tubing – weekly
  - Clean nebulizer – as needed
  - Check autosampler and tubing – daily
  - Make rinse – as needed
  - Empty waste – as needed
  - Clean torch assembly – as needed

- *Atomic Absorption Furnace*
  - Clean furnace windows – daily
  - Check plumbing connections – daily
  - Change graphite tube – as needed
  - Check gases – daily
  - Check auto-sampler and tubing – daily
- *Lachat*
  - Clean auto-sampler surface – daily
  - Clean auto-dilutor surface – daily
  - Replace pump tubes – as needed
  - Replace tubing – as needed
- *Gas Chromatograph/Mass Spectrometer*
  - Change septum – monthly as needed
  - Check carrier gas – daily
  - Change carrier gas – when pressure reaches 500 psi
  - Change gas filters – semi-annually as needed
  - Change trap on Tekmar – as needed/poor sensitivity
  - Change GC column – as needed/poor sensitivity/selectivity
  - Clean MS source – as needed/poor sensitivity
  - Check pump for leaks – as needed
  - Leak check septum – as needed/when leak suspected
  - Check gas flow – as needed
  - Clean VOA purge glassware – as needed
  - Cut capillary column – as needed
  - Replace liner – as needed/contamination suspected
  - Replace BNA seal – as needed/contamination suspected
- *Gas Chromatograph*
  - Change septum – as needed
  - Check carrier gas – daily
  - Change carrier gas – when pressure reaches 500 psi
  - Change in-line filters – as needed
  - Remove first foot of capillary column – as needed
  - Clean ECD – as needed
  - Check system for gas leaks – at each column change
  - Replace column – as needed
  - Clean FID/PID – as needed
  - Replace capillary injection port seal – at column change or as needed
  - Measure gas flow – after changing column
  - Check syringe – daily
  - Change syringe – as needed

EQUIPMENT CONTINGENCY

In the CT&E Environmental Services Laboratory, when equipment fails we have the capability to repair the equipment if there is time before the due date. If this is not the case, we switch to other instruments, switch protocols or sub-contract the work out to an approved laboratory at the client's discretion.

Most GC and GC/MS systems have a backup system. Atomic Absorption also have back-up capabilities in most cases. Many of the preparation areas also have redundant systems. If these back up capabilities are to be pursued, the manager and sales staff are appraised of the work slow down and the estimated down time. This is so that the laboratory does not get over-committed while the

capacity of the lab is limited.

If both the primary and redundant systems come off line, and the repair of the equipment appears to be protracted, the project managers are informed of the trouble and they, in turn, discuss options with the client. Options that may be pursued include moving the expected date of completion, alternate techniques or subcontracting the work to an approved laboratory.

Apparatus that do not have back up capabilities, expeditious repair is pursued and the lab manager and sales staff are notified. If holding times may be jeopardized, then the project managers are notified so that they can discuss options with their clients. Options that may be pursued include moving the expected date of completion, alternate techniques or subcontracting the work to an approved laboratory.

XI. QUALITY CONTROL PROCEDURES

Quality control procedures apply to all areas of testing and are used to monitor and maintain essential quality control for the various methods. Not all QC samples apply to all parameters analyzed in the laboratory. Specific QC requirements may be found in the individual SOP for that analysis (see attached "Active SOPs"). The following are the tools used to evaluate the data:

- Positive and negative controls
- Variability
- Detection limits
- Quality of standards and reagents
- Test Conditions
- Control Limits

Equipment and supplies must meet the quality requirements of the methods involved before samples may be analyzed. Records of acceptable vendors are maintained in the business office.

A. POSITIVE AND NEGATIVE CONTROLS

Positive controls:

Laboratory Control Sample (LCS/D)

- Analyte-free sample of testing matrix spiked with compound(s) representative of the target analytes
- Spiked prior to preparation steps
- Used to document laboratory performance
- Extracted/digested for every batch of no more than twenty samples, or daily, whichever is more frequent
- Required for every analyses with a preparation step
- Spiked at a known concentration – typically mid-range
- Same source as the matrix spike
- Results are calculated as percent recovery
- Calculation

$$\frac{\text{LCS Result}}{\text{True Value}} \times 100\% = \text{Percent Recovery}$$

units must match

- Laboratory established acceptance limits (found in analytical method SOP)
  - By matrix type
  - Updated annually
- Corrective action when results outside acceptance limits:
  - Evaluate MS/D. If MS/D is acceptable and a review of data is acceptable (ie.

Surrogates are acceptable) no corrective action may be necessary.
- Reanalyze LCS
- Re-digest/re-extract entire preparation batch (if possible)
- If unable to re-digest/re-extract, all samples in the preparation batch must be qualified accordingly.

Matrix Spike (MS/D)
- An aliquot of randomly selected sample, spiked with a known concentration of target analytes (See method SOP).
- Extracted/digested for every matrix batch of no more than twenty samples
- Used to assess the effect a matrix can have on the accuracy of the analysis
- Sample selection
  - Based on which one appears to be most representative (matrix) of the batch
  - Sample size/volume available for MS/MSD
- The samples is spiked prior to sample preparation and analysis
- The recovery is reported as percent recovery

Calculation

$$\frac{\text{MS Result} - \text{Sample result}^*}{\text{Spike Value}} \times 100\% = \text{Percent Recovery}$$

* Sample result must be adjusted for the amount of sample used (e.g. typical sample size 100 ml but 50 ml used for spike – divide sample result by 2)
units must match

- Laboratory established acceptance limits (see method SOP)
  - By matrix type
  - Updated annually
- Corrective action when results outside acceptance limits
  - LCS passes – data is qualified as matrix interference
  - LCS fails – entire preparation batch is re-digested/re-extracted if possible
  - LCS fails and batch can not be re-prepared – data is qualified

Calibration check (CC)
- See page 12

Surrogate Standards
- Organic compounds are selected that are not normally found in environmental samples and have similar behavior to target analytes. These compounds are added to each standard, blank and sample.
- Should elute within the retention time window of the analytes of interest
- Added to samples requiring GC and/or GC/MS analysis
- The analytes chosen as surrogates are given in the methods
- Used to assess matrix effects on recovery
- Serve a function similar to a matrix spike and are evaluated in the same manner
- Acceptance limits are method specific or laboratory generated (found in SOP)
  - Updated annually
  - By matrix type
- Corrective action for surrogates outside acceptance limits can be found in the method Standard Operating Procedure

Analytical Spike (AS/Post Digestion spike)
- Adding a known concentration of the analyte of interest to a digested field sample
- Used to verify any matrix interference
- Primarily used for metals analyses
- Performed when all samples in a given batch are <10xMDL or when the result of the dilution test is not within the acceptance criteria
- Acceptance criteria for the AS is 85-115%.
- The corrective action for a failed AS is that all the samples in the batch must be analyzed by

Method of Standard Addition (MSA).

Method of Standard Addition (MSA)

- Adding a series of three known concentrations of an analyte to a field sample.
- The samples are then analyzed and instrument response is plotted (vertical axis) against the known concentration of the added analyte (horizontal axis).
- Adding a known concentration of the analyte of interest to a digested field sample
- The plot is then extrapolated back to zero instrument response.
- The point of interception on the abscissa is the concentration of the unknown analyte. The abscissa on the left of the ordinate is scaled the same as on the right side, but in the opposite direction. The following limitations should be noted:
  - Instrument response must be linear over the range of concentration used. For best results, the slope of the standard addition plot should be nearly the same as the slope of the calibration curve.
  - The effect of the interference should not vary as the concentration changes, and the standard addition should respond in a manner similar to the analyte.

Negative Controls:

Instrument Blanks (IB)

- See page14

Method Blank (MB)

- A method blank is analyte free water that has been extracted/digested with every batch of no more than twenty samples or daily whichever is more frequent.
- |Concentration| of any **analyte of concern** should not be higher than the highest of either:
  1) Method Detection Limit or
  2) 5% of the regulatory limit for that analyte or
  3) 5% of the measured concentration in the sample
- Corrective action for a failed method blank should be taken according to the analytical method or Standard Operating Procedure.

Trip Blank

- A trip blank is a preserved sample containing laboratory grade water that is transported to the sampling site.
- The sample is carried unopened through all phases of the sampling process and is transported with the actual samples that are collected.
- The purpose of the trip blank is to reveal any sample contamination that occurs during collection or transport.
- Trip Blank results are reported to the client with the sample analytical data package.
- Corrections to the analytical data are not performed in the laboratory based on analysis of the trip blank.

  ***Note:** Trip Blanks are project-specific and are done when included in the sampling plan or required by the analytical method.*

Field Blank

- A field blank is a sample of laboratory grade water that is prepared in the field at the sampling site and is treated exactly as the samples being collected.
- The purpose is to detect possible background contamination that may affect the sample concentration.
- Results of the field blank analysis are reported to the client with the sample analytical data package.
- Corrections to the analytical data are not performed in the laboratory based on analysis of the field blank.

  ***Note:** Field Blanks are project-specific and are only done when included in the sampling plan.*

Equipment Blank

- A sample of analyte-free media which has been used to rinse the sampling equipment.
- It is collected after completion of decontamination and prior to sampling.
- This blank is useful in documenting adequate decontamination of sampling equipment.

  ***Note:** Equipment Blanks are project-specific and are only done when included in the sampling plan.*

B. VARIABILITY

Matrix Duplicate (MD)

- Used to assess the effect that the matrix has on the precision of an analysis
- Analyzed every batch of 20 samples or daily
- A field sample is divided into two separate parts analyzed identically, but separately, and the results compared to give a measure of the precision
- The results are reported as a relative percent difference (RPD) using the following calculation:

$$\frac{|\text{sample result} - \text{matrix duplicate result}|}{(\text{sample result} + \text{matrix duplicate result})/2} \times 100$$

- Laboratory established acceptance limits
  - Updated annually
  - By matrix type
- If the RPD is not within established limits, corrective action is taken according to the analytical method or SOP.

Matrix Spike Duplicate (MSD)

- A field sample that has been divided into two parts – each of which is spiked with a known concentration of the analyte of interest
- Used to assess the precision and accuracy of an analysis
- Extracted/digested for every batch of no more than twenty samples
- Acceptance limits for MSD are the same as for the MS (found in SOP)
- Results are expressed as Relative Percent Difference (RPD) and % Recovery
- If Sample Spike and Sample Spike Duplicate recoveries and RPD's do not meet QA criteria the results of the Laboratory Control Sample (LCS) are reviewed
  - If the LCS meets QA criteria, matrix interference is suspected
  - If the LCS doesn't meet QA criteria, the entire batch is re-prepared and reanalyzed

Dilution Test

- The dilution test is another technique utilized to assess the potential for interference within a given sample matrix.
- Dilution tests are performed for metals analytes.
- One sample from every preparation batch is analyzed using a dilution test.
- The concentration of the analyte should be at least 25x the estimated detection limit.
- The corrected result of the diluted sample must be within 10% of the undiluted sample.
- If this criteria is not met, an Analytical Spike is performed.

C. DETECTION LIMITS

All results are evaluated against a detection limit. There are various types of detection limits. Detection limits can be statistically calculated, arbitrarily determined, set at the low standard in the calibration curve or program established. CT&E ESI provides all clients with their required detection limits. The Reporting Detection Limit is reported for all compounds of interest when no detection limits are required. A list of detection limits can be found as highlighted in the SOP #146 "Detection Limits"

- *Method Detection Limit (MDL)*
  - Minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from

analysis of a sample in a given matrix containing the analyte
  - Analyzed annually or when there is an update to the equipment or methodology
  - The MDL study is performed in accordance with 40 CFR Part 136 Appendix B
- *Practical Quantitaion Limit (PQL)*
  - The PQL is equal to the MDL x 10/3
- *Reporting Detection Limit (RDL)*
  - A number determined by the laboratory that can be reliably achieved
  - This number is typically 5-10 times the MDL
  - For many analytes, the RDL is the lowest non-zero standard in the calibration curve.
- *Limit of Detection (LOD)*
  - Used for Wisconsin reporting
  - Equal to the Method Detection Limit (MDL).
- *Limit Of Quantitation (LOQ)*
  - Used for Wisconsin reporting
  - Equal to the MDL*10/3
- *Instrument Detection Limit (IDL)*
  - The lowest concentration of an analyte detected in a series of dilutions of a standard
  - Only performed for metals analysis
  - Used to determine a spike level for MDLs

D. QUALITY OF STANDARDS/REAGENTS

- All standards used in the laboratory are traceable to a national standard such as NIST, when available.
- All standards/reagents received into the laboratory are tracked according to the SOP for Chemical Tracking
- Certificates of accuracy/purity for standards/reagents are maintained by the section
- Any solutions/standards that are not consumed the day prepared must be stored and labeled appropriately
  - Solution/standard
  - Concentration
  - Date prepared
  - Expiration date
  - Analyst initials
  - CT&E lot number
- The Laboratory Manager and/or the Safety Officer must review all new chemicals received into the laboratory
- Material Safety Data Sheets (MSDS) shall be kept on file for all chemicals used
- All hazards shall be noted, communicated, and labeled if necessary
- No reagents shall be disposed of without the approval of the Laboratory Safety Officer.

Standards

- All standards used in the laboratory are documented traceable to a national standard (when available)
- Standard solutions prepared by analysts for in-house use are recorded in a log book containing the following information
  - Supplier
  - Lot number
  - Grade
  - Concentration (and all values used to make the calculation)
  - Method of preparation
  - Preparer's name
  - Date of preparation
  - Expiration date

- Standard solutions are then validated prior to use
- Standard solutions are monitored for deterioration and discarded when the following are detected:
  - color changes
  - precipitation
  - concentration changes
- Solutions known or found to be light sensitive are stored in amber glass bottles.

Reagents

- All reagents are reagent grade (AR) or better that are used in quantitative analysis
- All reagents upon arrival into the laboratory are logged into a reagent logbook including the following information:
  - Supplier
  - Lot number
  - Grade
  - Concentration
  - Date received
  - Expiration date
- Reagents must be dated and initialed when opened

E. TEST CONDITIONS

- The configuration of the laboratory is such as to avoid any potential contamination

Volatile Section

- The volatile section of the laboratory is kept under a positive pressure to prevent any gases from the other sections of the laboratory being drawn into the volatile lab
- All samples requiring volatile analyses are stored in a refrigerator in the volatile section of the laboratory
- A refrigerator blank is stored in the volatile refrigerator at all times.
- The blank is stored in the refrigerator for 2 weeks prior to analysis.
- After the two weeks, the refrigerator blank is analyzed by a GC/MS Volatile scan for 8260 compounds.
- A new blank is then prepared and placed in the volatile refrigerator for another 2 week period.
- All results are reported to the QC Officer.
- Any detectable results prompt an immediate corrective action.

TCLP

- Other conditions must be maintained within the laboratory to assure that accurate measurements and adherence to method requirements are met
- The temperature of the TCLP preparation laboratory is maintained at 23 $\pm$ 2°C
- The temperature of the room is measured by a minimum/maximum thermometer and recorded in the TCLP prep logbook every day samples are prepped

Miscellaneous

- All balances are placed on sturdy tables away from any drafts
- Glassware washing procedures are put in place for all sections of the laboratory and posted in the individual sections
- All volumetric glassware utilized in the laboratory for quantitative analyses is ASTM Class A.

DI Water

- Deionized water is monitored on a monthly basis for:
  - Conductivity
  - pH
  - Residual chlorine
  - Heterotrophic plate count

- The conductivity of deionized water is checked daily and must be less than 2 umhos/cm at 25°C. If this criterion is not met, the deionization cartridges must be changed.
- The water is also monitored on an annual basis for total metals (Pb, Cd, Cr, Cu, Ni and Zn)
- The bacteriological suitability is no longer required since the laboratory uses Colilert and pre-sterilized bottles are used for Coliform analyses
- The results from the monthly and annual analyses are verified against the criteria established in the Manual for the Certification of Laboratories Analyzing Drinking Water.

G. CONTROL LIMITS

- Derived to document the statistical control of the measurement process
- Describe measurement proficiency
- The laboratory utilizes the control limits for the verification of method precision, accuracy, and for establishing acceptance limits for the specific parameter
- Control limits are reviewed every 30 data points per matrix type, and updated annually
- The Grubbs test is used to determine out-liers for calculating control limits
- The control limits and warning limits are calculated using the average and standard deviation
- The control limits are the average $\pm$ 3 times the standard deviation
- The warning limits are calculated by the average $\pm$ 2 times the standard deviation
- Whenever a result is outside of the established the control limits, a corrective action is initiated by the analyst.
- The SOP #214 "Control Limits" defines where the values are routinely kept
- Calculation for Standard Deviation

$$s = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(Xi - \overline{X})^2}$$

Where s is standard deviation of a quantity X measured n times.

XII RECORD KEEPING, DATA REVIEW & REPORTING PROCEDURES

Record Retention

- All documentation retained for a minimum period of five years
- Records will be kept longer if for litigation purposes or upon client request
- Administrative Supervisor monitors access to the archived data
- Data must be signed out when removing from the storage unit
- Archived data is stored in a secured facility
- All data is boxed and labeled with the contents
- Data is available for review by clients and regulatory agencies
- All documentation generated/used during sample collection through all phases of analysis and reporting through the final laboratory report and sample disposal are archived including but not limited to:

  Report records

  - Final reports
  - Data deliverables
  - Chain of custody
  - Data sheets
  - Field reports
  - Client correspondence/complaints
  - Data review sheets
  - Subcontract work

- Courier shipping forms

Laboratory records

- Analytical methods (current/obsolete)
- Standard Operating Procedures (current/obsolete)
- Data sheets/Raw data
- Data review sheets
- Control limits
- Lab notebooks

Logbooks

- Maintenance logbooks
- Preparation logbooks
- Run logbooks
- Temperature logbooks
- Calibration logbooks
- Sample disposal record
- Signature logbook
- Standard/Reagent logbooks

Employee records

- Personnel resumes
- Training records
- Initial Demonstration of Capability (IDC)
- Continuing Demonstration of Capability (CDC)

Corrective Action Reports

On-site Audits/Responses

PE sample results/Corrective Actions

Report records

Final Reports

When the final report is printed, it contains the date of printing (which becomes the issue date once the report is signed) and an area for the Project Manager or QA Officer to sign indicating approval. Final reports are reviewed by the Project Manager according to the SOP for Final Report Review including but not limited to:

- Historical data
- Data make sense
- Units match matrix
- Reporting Detection Limits
- Project specific requirements
- Holding times met

After a complete review, the Project Manager signs the report. The report is then faxed and/or mailed to the client. The final report contains the following information:

- Name/address/phone number/accreditation number of the laboratory
- Client name and address
- Client project name/number
- The title "Laboratory Results"
- Issue date
- LIMS generated CT&E Project Number (unique ID)
- Total number of pages and page number of each page
- Sample ID
- ID of Container used
- Sample description (when provided)
- Sample collection date/time
- Sample receipt date/time

- Test method used for analysis
- Sample results
- Analyst initials
- Units
- Preparation method (where applicable)
- Preparation date/time
- Analysis date/time
- Data qualifiers (where applicable)
- Sample receipt check list
- Chain of custody
- Subcontract lab ID (when applicable)
- Any narrative information that may be required based on condition of sample upon receipt
- Signature by project manager and/or Quality Assurance Officer
- Data deliverable (when requested)

If after review of the report, the client/project manager finds some inconsistencies and a correction must be made, the following steps are taken.

- Corrective action report filled out by PM, analyst, section supervisor, QAO
- Discrepancy looked in to by Lab Manager, QAO
- Internal audit performed (when deemed necessary by GM/QAO)
- Report corrected
- Revised report issued (labeled as a "revised report")
- Client notified immediately of any errors which would change report

Data Deliverables

CT&E is dedicated to ensuring that all analyses performed produce legally defensible data. Accuracy and precision are met through strict adherence to State and EPA protocol and comprehensive internal review procedures. CT&E provides six levels of data deliverable packages. These levels are highlighted in the SOP #236. CT&E also provides electronic deliverables. Data can be supplied in most word processor, spreadsheet or database format desired. Data can be transported by a diskette mailer and/or transmitted by modem. Because of this versatility CT&E ESI can customize digital formats to meet individual needs.

Chain of Custody

- The objectives of sample custody are to maintain the integrity of physical evidence which has been collected from a site and to maintain the defensibility of that evidence and the results obtained by analysis
- The laboratory considers the sample to be in our custody when the samples are checked against the CoC at log in. This custody continues until the sample is relinquished or disposed of.
- A sample is considered to be in the possession of a person if
  - it is in that person's physical possession
  - it is in view of that person after that person has accepted receipt of it and has physical possession of it
  - that person has placed it in a secure area.
- The three previous items are all qualifiers until that person has relinquished custody to someone else who fulfills any of the above requirements
- Accompanies all samples/projects arriving at the laboratory
- Contains the following information which should be filled out by the sampling technician and/or client
  - Client name and address
  - Project name and number
  - Name and address of person to submit results to

- How to submit results (fax and /or mail)
- Sampler's signature
- State in which the samples were collected
- Type of containers and preservation used
- Container ID
- Client sample ID
- Laboratory sample ID
- Sample date and time
- Number of samples
- Required analyses
- Method of collection (sampling SOP)
- Matrix
- Temperature of cooler contents
- Comments
- Signature of persons involved in the chain-of-custody

Internal Chain of Custody

- Available for clients upon request although it is not presently a standard operating procedure at CT&E Environmental Services
- A notation is made on the labels that are on the sample bottles
- The analysts then make an entry in the Internal COC logbook located outside of the walk-in cooler
- The logbook contains the following information
  - project number;
  - sample number;
  - bottle size;
  - preservative;
  - analysis;
  - analyst taking sample;
  - date and time the sample is taken from the walk-in cooler;
  - analyst returning sample; and
  - date/time sample returned to walk-in cooler.

Data Sheets/Raw Data

All data produced by the laboratory must contain the following information

- Date of analysis
- Analyst
- Instrument analysis performed on
- Samples analyzed
- Correlation coefficient (manually calculated or electronic)
- All calculations used to produce results
- Instrument operating conditions
- Any other information regarding instrument/sample behavior

Field Reports

- The responsibility for collecting and transporting samples to CT&E Environmental Services resides with the client
- In cases where the sampling is performed by CT&E Environmental Services personnel, a sampling plan is first reviewed and approved by the client
- Sampling proceeds in conformance with approved sampling SOPs
- Data quality is directly related to proper sampling procedures
- CT&E will provide consultation and assistance in designing sampling protocols to see that field procedures ensure the following:
  - That samples contain no foreign material and accurately represent the site from where the samples are extracted

  - That samples are
    - of adequate size
    - collected in containers appropriate for the sample and the analysis being requested
    - properly preserved in terms of pH and temperature during transport
  - That contamination does not occur during transport
  - That accurate records are generated and kept regarding on-site conditions, such as maps of sampling sites, labeling of samples and weather conditions
  - That monitoring instruments are working properly
  - That sampling containers are properly cleaned
  - Sample tags shall be completed for each sample with waterproof ink
  - That samples arrive at CT&E in a timely manner.
- The client will supply label information which must match the information on the Chain-of-Custody
- Sample holding times begin at the time of sampling
- Information regarding holding times, appropriate containers, preservative solutions and minimum sample volumes or weights may be found in various SOPs

Client Correspondence/Complaints

Complaints made by clients are typically directed to the project manager and/or sales personnel. The project manager/sales personnel investigates the compliant with the help of the laboratory/general manager. The findings of this investigation is documented as described in SOP #249. A corrective action report may be filled out if applicable. If necessary, an internal audit is conducted based on the compliant by the project managers/QA officer/laboratory manager and general manager. The internal audit report is given to the general manager and QA officer. A resolution is achieved and discussed with the client. If no agreement can be reached, the issue is taken to the Vice President of the company.

Data Review Sheets

The analyst submits the analytical data to a qualified peer and/or supervisor who has also been trained to perform the analysis being reviewed. The second review consists of the following checks:

- Required QC samples analyzed
- QC samples within established acceptance criteria
- Method holding times met
- Calculations correct
- Analysis complete
- Corrective actions required

Once the secondary review has been completed, the data is then turned over to the project manager for an additional review. The QA Officer reviews a random sampling of reports for anomalies and tracks all generated CARs to verify appropriate qualifiers. If clients require, up to 10% of sample groups are checked by the QA Officer. The results are then released for submittal into the final report.

All raw data must contain the following information:

- Date of analysis
- Analyst initials (Upon joining CT&E ESI all employees must sign and initial a signature log. The signature log may be used to verify the employee performing the analysis or correcting data.)
- Preparative and analytical Method
- Matrix

Subcontract Work

- CT&E provides an abundant number of tests for clients. However, occasionally it is requested that we perform a certain analysis that we don't have the resources for.

In such cases, CT&E utilizes a reference laboratory to perform the required analyses. Selection of a subcontractor is based on the specific project requirements. The subcontractor lab must be certified by the appropriate regulatory agency, submit a QAPP and be able to provide all data required to generate a QA report.

- When subcontracting of samples is required, the laboratory proceeds according to the SOP for Subcontracting. Generally, the client is notified in writing, the sample is split and assigned a new sample number. A chain of custody is completed linking the subcontracted sample to the original sample/project. The sample is then packed on ice in a cooler with the COC and sent to the subcontract laboratory.

Courier Shipping Forms

Most samples are shipped to CT&E by courier. Courier shipping forms are included in the final report when requested.

Laboratory records

Analytical Methods

All analytical methods performed by the laboratory are approved by the USEPA. The laboratory performs analytical methods from the following references:

- Test Methods for Evaluating Solid Waste Physical/Chemical Methods SW-846 November 1986 and updates
- Methods for Chemical Analysis of Water and Wastes; EPA-600/4-79-020; March 1983
- Standard Methods for the Examination of Water and Wastewater, 19th Edition, 1995
- Methods for the Determination of Organic Compounds in Drinking Water, Supplements I and II; EPA/600/4-88/039; EPA/600/4-90/020 and EPA/600/R-92/129, respectively
- Methods for the Determination of Metals in Environmental Samples – Supplement I; EPA-600/R-94-111, May 1994
- Methods for the Determination of Inorganic Substances in Environmental Samples; EPA-600/R-93-100, August 1993
- Various ASTM, NIOSH and other methodologies that are identified in the Standard Operating Procedure logbook

Methods are updated on a regular basis. Once updates have been promulgated, the laboratory reviews the new methods. The laboratory then takes the following steps to introduce the new method into the laboratory.

- A new SOP is written
- The analyst completes a Training Approval Record form with the newest method listed
- The method is thoroughly reviewed by the analyst performing the analysis and the supervisor of the section
- If the change is significant:
  - Employee performs an initial demonstration of capability (IDC) based on the method changes
  - A new MDL is analyzed

Standard Operating Procedures (SOP)

- Written for all laboratory analyses as well as administrative functions
- Reviewed on an annual basis by analyst and the section supervisor
  - Once the SOPs have been reviewed and there are no corrections, the analyst and section supervisor sign the SOP review page (page 2 of all SOPs), and submit a copy of the signature page to the QA Officer for filing.
  - If there are corrections, the SOP is revised to incorporate the changes
  - The SOP is reviewed by the analyst, section supervisor, senior project manager and general manager and then released to the associated laboratory for implementation
  - The implementation date is that of the last approval signature. At that point, the revised SOP becomes the active SOP.
- Controlled copies of all SOPs are kept in logbooks in the section of the laboratory in

which they apply
- The original signed SOP is filed in the QA/QC Office
- When revised SOPs are distributed, the old SOPs are collected by the QAO and thrown away
- The QAO keeps all the original SOPs (new and old revisions)
- The SOPs are based on approved methodologies performed for various analyses
- Modifications can be made to the methods if criteria is met
  - Chemical ratios are the same
  - PE samples pass
  - All other QC criteria is met
- The laboratory director and QA/QC Officer must approve all method modifications
- All analytical SOPs include the following information:
  - Scope and Application
  - Method Summary
  - Comments (Interferences)
  - Safety Issues
  - Sample Collection, Preservation, Containers and Holding Times
  - Apparatus
  - Instrument Maintenance
  - Reagents & Standards
  - Procedure
  - QA/QC Requirements
  - Calculations
  - Reporting
  - References
  - Method Modifications
  - Waste Disposal
  - Definitions
  - Header information
    - SOP number
    - Revision number
    - Release date
    - Current page number
    - Total number of pages
- All SOPs are sequentially numbered and maintained in a SOP logbook (Appendix B) containing:
  - SOP number
  - name of the SOP
  - method number
  - revision number of the SOP
  - release date of the SOP
  - SOP is active or inactive

Control Limits: See page 22

Logbooks
Lab Notebooks
Maintenance logbooks
Preparation logbooks
Run logbooks
Temperature logbooks
Calibration logbooks

Standard/Reagent logbooks

Employee records – all employee records are kept in the employee file in the QA Office
Employee Resume
Training Records
Initial Demonstration of Capability (IDC)
The initial demonstration of capability is performed by every analyst, prior to the analysis of any samples, for each test method performed.
The analyst must meet the method requirements (when available) or laboratory established requirements.
The IDC is a part of the training of employees when hired into the laboratory.
Continuing Demonstration of Capability (CDC)
The CDC is required for each analyst and for each parameter they are responsible for analyzing. The CDC may consist of successfully performing a single blind sample or summary of 4 independent standards for precision and accuracy.

Corrective Action Reports (CAR)

- Initiated whenever nonconformance is detected in any analytical or preparatory system
- A corrective action report is initiated by the person identifying the nonconformance
- The CAR is copied to the section supervisor, project manager and QA/QC Officer
- The appropriate section manager then investigates the problem with the QA/QC Officer and the Laboratory Director
- The issue is resolved and the action taken documented
- The QA/QC Officer monitors the frequency of nonconformance
- An example corrective action report is found in the SOP #189 "Corrective Action Reports.
- Items that may lead to a CAR include, but are not limited to:

Nonconformance	Corrective Action
Missed holding times	Contact client for decision
Detection levels above project requirements	Contact client for decision
QC data outside acceptance criteria	Rerun batch; qualify data
Blank contamination	Rerun batch; qualify data
Invalid calibration/tune	Reanalyze
Incorrect/incomplete data reported to client	Revise report
Insufficient sample for analysis	Contact client for decision
Sample lost during extraction/digestion	Contact client for additional sample

XII LABORATORY AUDITS

On-site Audits/Responses
CT&E Environmental Services Inc. Michigan Division is involved in a rigorous audit program including internal and external audits.

Internal Audits
CT&E Environmental Services conducts the following internal audits:

- System and performance audits are performed by the Quality Assurance Officer.
- To help verify deficiencies corrected from an external audit, single and/or double blind audit samples are sent through the laboratory
- Analyst audits are conducted on an annual basis by the QAO.

External Audits

Unknown check samples (potable and non-potable water) are submitted to the laboratory by Environmental Resource Associates (ERA) for analysis. The purpose of these external audits is to identify those laboratories that can generate acceptable analytical data. Results of these audits are evaluated by the testing agency and must fall within an acceptable range of analytical performance. Failure to obtain acceptable results can result in de-certification.

PE sample results/Corrective Actions

Proficiency Testing:

Proficiency testing is required by state certifications.
CT&E ESI participates in the following PT programs.
Wisconsin State Laboratory of Hygiene (GRO and DRO) – Single Blind
ERA – semiannual drinking water study – MI certification
ERA – semiannual water pollution study – NELAP, A2LA, Wisconsin, Alaska
ERA (annual – UST soil/water – AK certification)
ASI quarterly inter-laboratory study – client requested all parameters
Analytical Standards Inc. – Quarterly client program – Single Blind

Data Reduction

- Instrument response is directly related to concentrations of several standards. A calibration curve is generated. The calibration curve must meet an established correlation coefficient of 0.990 for organic analyses and 0.995 for inorganic analyses. Once the curve has been approved, the analyst calculates the concentrations of analytes in the field sample either in mass/mass (mg/Kg; ug/Kg) or mass/volume (mg/L or ug/L) ratios. The analyst must take into consideration any dilutions that may have been applied during preparation. In addition to these calculations, the analyst checks to make sure:
- Gravimetric techniques arrive at the final form of data through calculations based on initial and final weights of the sample throughout the analytical process.
- Titrimetric results are calculated by a calculation utilizing the normality of the standard that is being used for the titration.
- Some results are reduced through a direct read of the instrument. No additional calculations are required. Results from this type of analyses typically have their own special units (NTU, S.U., etc.)

XIII. LOGIN PROCEDURES

Sample Receipt/Sample Acceptance

- Samples submitted to the laboratory must be accompanied by the chain-of-custody form
- This form is completed and included with the sample transport container and is to be opened and examined by the laboratory sample receiving technician
- All entries on the chain-of-custody form must coincide with the corresponding sample bottle labels
- The sample receiving technician reviews the project samples in accordance with the SOP #126 "Sample Login" and uses the checklists found in that SOP.
- If there are any problems with the samples, a corrective action report is generated and given to the corresponding CT&E project manager immediately
- In turn, the CT&E PM notifies the client of the situation and how the data will be qualified/affected
- The client will make a decision how to proceed with the project

- The CT&E PM documents all conversations with the client.

Sample Log in

- Once samples are accepted, the sample receiving technician will enter the project into the Laboratory Information Management System (LIMS)
- The LIMS assigns a unique project ID (CT&E reference number) to the sample group and each sample within the project is assigned a sequential sample number
- All bottles need to have a unique identifier
- All information about the samples and analyses needed are entered into the LIMS including:
  - client sample ID
  - sampling location
  - collection dates
  - sample collector name
  - matrix type
  - preservative
  - analysis to be performed
  - project identification
  - special instructions/requests
  - sample container description
  - any notes about the samples and their condition
- The LIMS produces gummed durable labels which contain information such as CT&E reference numbers, lab sample numbers, client sample ID, and date collected
- These labels are placed on the corresponding sample container
- Additionally, any samples which require immediate analysis such as pH, BOD, Nitrate, etc., and any samples that require a quick turn around are delivered directly to the laboratory which performs the analysis.

Sample Storage

- The samples are stored in the appropriate storage location
- Samples are stored in a controlled storage cooler separate from reagents and standards
- Samples are stored in one of 2 locations throughout the laboratory
- All volatile samples are stored in a refrigerator located in the volatile laboratory
- Any samples suspected of high levels of contaminants are stored in a separate container within the walk-in cooler
- Samples requiring special custody arrangements may be locked into one of the laboratory refrigerators. The sample receipt clerk will be the gate keeper and record sample transfer to technician/analyst.
- All other samples are stored in the walk-in cooler.
- The walk-in cooler is maintained at 4°C $\pm$ 2°C
- The temperature of the walk-in cooler is measured and recorded on a daily basis
- All VOC samples are stored in a separate cooler in the volatile analysis laboratory with the same temperature criteria
- Samples must be returned to the cooler upon completion of preparation or analysis
- The standard storage period for a sample is 60 days after the final report has been submitted to the client
- Longer storage periods are available upon request.

Sample Receipt Review

- An open order report is produced daily by the LIMS and reviewed by the project managers and login supervisor for accuracy and completeness
- Projects that have been reviewed and accepted are then activated in the LIMS under the guidance of the login supervisor
- A daily log of samples received is printed for records
- Once a project is activated, work boards are printed and distributed to section supervisors

- Work In Progress Reports (WIP) are produced daily for each method and distributed to each section
- The WIP report contains information about projects with outstanding analyses
- The section supervisors are responsible for delegating the work to the analysts within the section
- Status reports are printed and reviewed daily in a meeting by the General Manager, Laboratory Manager and Project Managers

Laboratory Information Management System (LIMS)
CT&E ESI maintains a Laboratory Information Management System (LIMS) capable of monitoring laboratory operations. This LIM System coordinates several data management functions by tracking and monitoring sample log-in, preparation, analysis and reporting (finals, data deliverables). Quality reports may be generated that include information on blanks, LCS/D, MS/D and calibration check summary. Customized management reports can also be produced to monitor a variety of sample conditions. Data storage capabilities allow the integration of sample information and instrument data to generate final reports and data deliverables.

XIV. DATA QUALITY OBJECTIVES

There are qualitative and quantitative measurements that are performed to assure data quality. The qualitative measurements are precision, accuracy and completeness. The quantitative measurements are representativeness and comparability. Precision and accuracy are established by internal policies of the laboratory and EPA guidelines. In no instance would the precision criteria of the laboratory be less than those defined by EPA guidelines. Completeness and representativeness of data are established in conjunction with the client who supplies the samples. Representativeness is intimately tied with the sampling protocol used by the client. Comparability is ensured by the calibration procedures instituted for each instrument and method.

Quantitative

Precision
The agreement between a set of replicate measurements without an assumption of knowledge of the true value. It is a measure of the variability in repeated measurements of the sample compared to the average value. The precision assessment should represent the variability of sampling, sample handling, preservation and storage of the environmental measurement data.

$$RPD = \frac{D1 - D2}{(D1 + D2)/2} X100\%$$

Where RPD = relative percent difference
D1 = sample value and D2 = sample duplicate value

Accuracy
A measure of how close an individual measurement or an average of a number of measurements is to the true value.

$$\%R = \frac{(SSR - SR)}{SA} \times 100\%$$

Where %R = the percent recovery
SSR = the analytically determined spiked sample concentration
SR = the analytically determined sample concentration
SA = the true concentration of the spike

Completeness
The measure of how the amount of valid data obtained from a measurement system compares to the expected amount. Completeness is calculated after the study has been completed and is expressed as a decimal or as percent usable data (percent usable data = usable data divided by total possible data).

$$\text{Completeness} = \frac{\text{valid data obtained}}{\text{total data planned}} \times 100$$

Qualitative
Representativeness
The degree to which data accurately represents a particular characteristic of a population or an environmental parameter.

Comparability
The confidence with which one data set can be compared to another data set.

XV. QUALITY ASSURANCE REPORTS TO MANAGEMENT

Quality Assurance Reports to management are intended to keep management abreast of Quality Assurance Program developments. Reports are submitted on a monthly basis and will generally include:

- Results of external and internal audits
- Performance evaluation scores
- Problems encountered and corrective action taken
- Results of site visits by regulatory agencies and clients
- Performance on contracts
- Holding time violations
- Client complaints
- Recommendations

XVI. SAFETY PROCEDURES

CT&E Environmental Services Inc. Michigan Division is committed to providing employees with the training and equipment to promote safe working conditions. Material Safety and Data Sheets (MSDS) shall be kept on file for all chemicals. Lab coats, safety glasses, and gloves shall be worn at all times while working in the laboratory. Analysts are responsible to work safely for protection of themselves and those around them. All laboratory personnel are responsible for reading and following the laboratory Health and Safety Manual.

Safety Protection
Two of the major hazards in an analytical laboratory are the potential for physical injury and exposure to hazardous chemicals. These two hazards are controlled by the use of personal protective equipment and a strict protocol for material handling.

Personal Protection Equipment

- Safety glasses will be worn at all times in the laboratory
- Chemical splash goggles and/or face shields will be worn when handling hazardous liquids
- Respirators will be worn when handling highly hazardous chemicals
- Gloves will be worn when handling hazardous materials
- Wearing contact lenses is strictly prohibited in the lab.

Laboratory Operating Procedures

- Materials spilled onto the floors will be cleaned up immediately using approved disposal protocols
- Obstructions from movement will not be allowed in walkways or working areas that may cause tripping, falling, or any harm to an individual.
- Hazard warning signs will be posted at all locations where there is a potential safety or health hazard
- All personnel will be informed of the hazards in their work places
- Hazardous materials will be handled in containment devices such as fume hoods or fume absorbers
- Laboratory personnel will not store food, eat, drink, or smoke in the laboratory.

Safety Equipment

The following requirements are intended to ensure that laboratory equipment is operated and handled so as to prevent injury.

- All electrical equipment should be grounded
- Multiple extension outlets must not be overloaded(total amperage demand)
- Electrical cords will be selected so as to prevent overloading
- All cylinders of compressed gas will be secured to prevent falling and will be only transported on transport dollies
- All belts and pulleys will be covered or shielded from personal contact
- All cylinders and transfer lines containing flammable gases will not be tampered with or overridden at any time
- Fume hood face velocities will be recorded monthly in a log and corrective action will be taken if they indicated less than 100 cfm

Fire Safety

- Fire extinguishers (A,B,C, and Halon) will be placed in all laboratory and chemical storage areas
- Fire extinguishers will be checked annually and refilled if necessary
- Flammable liquids will be stored in the flammable storage area or in flammable liquid storage cabinets in laboratory areas
- No more than 60 gallons of flammable liquid may be stored in a cabinet or in the laboratory
- Water reactive chemicals and oxidizers will be stored separately
- Waste flammable liquids will not be allowed to accumulate in the laboratory but will be placed in appropriate drums in the hazardous waste shed
- Flammable liquids will not be handled near open flame or other ignition sources
- Evacuation route diagrams will be posted

All employees receive basic safety awareness training immediately upon hire. Supervisors are required to conduct monthly safety meetings to review pertinent topics and discuss any employee concerns. CT&E Michigan employees are trained to treat all samples as potential hazards and follow all safety guidelines and policies as stated in

CT&E Michigan Chemical Hygiene Manual.

Safety Training
All personnel will receive monthly training via seminars, professional training programs or videotapes in the following areas:

- Hazardous chemical handling
- General safety (multiple topics)

XVII. DISPOSAL PROCEDURES

CT&E Environmental Services Inc. Michigan Division's waste disposal program is designed to safely and legally dispose of expired environmental samples and chemical waste generated by the laboratory. Samples shall be labeled with the known hazard and disposed of in accordance with CT&E's Chemical Hygiene Plan.

Aqueous Waste Disposal
Aqueous waste such as diluted standards, digestates, and distillates are neutralized to a pH of 5 to 7 before they are discarded into the sewage system. No raw Mercury waste of any kind is discharged into the sewage system. All Mercury waste is segregated in appropriate drum in the hazardous waste shed and disposed of according to proper protocol.

Solvent Waste Disposal
Solvent waste is generated during sample and standard preparation. Solvent waste is segregated and placed in 55 gallon drums for pickup and disposal. Solvent from extracts are collected into the appropriate solvent waste container. Solvent extractions of aqueous samples are allowed to separate and the water phase is poured into the sink. The solvent is then placed in the appropriate waste disposal drum.

Solid Waste Disposal
Solid waste is divided into hazardous and non-hazardous waste streams. This is determined by sample analysis and by noting which chemicals were used during analysis. Solids which are determined to be hazardous are placed into the appropriate waste drums for disposal. Solids which are considered inert or non-hazardous are disposed of by conventional means. Sample containers are rinsed and disposed of by conventional means.

Laboratory Chemical Waste Disposal
Laboratory waste which does not fit into the aforementioned categories is disposed of by contacting a third party who is qualified in the disposal of such materials.

Waste Disposal Documentation
Waste stored in 55 gallon drums is maintained in compliance with MDNR, RCRA, and OSHA regulations for safe disposal of waste. The laboratory analyzes a sample from each waste stream to the specifications imposed by the waste disposal company.

XIII Bibliography

SGS/CT&E Handbook
NELAC Standards 1999
ILEPA Rules and Regulations Part 186
SW-846
40 CFR
Wisconsin Rules

XIX Definitions

ACCURACY:	The closeness of agreement between an observed value and an accepted reference value. When applied to a set of observed values, accuracy will be a combination of a random component and of a common systematic error (or bias) component.
BATCH:	A group of samples which behave similarly with respect to the sampling or the testing procedures being employed and which are processed as a unit. For QC purposes, if the number of samples in a group is greater than 20, then each group of 20 samples or less will all be handled as a separate batch.
CALIBRATION CHECK (CC):	A QC sample introduced into a process to monitor the performance of the system.
CONTINUING DEMONSTRATION OF CAPABILITY (CDC)	Evaluation of the proficiency of trained analysts. Consists of passing a single blind PE sample or the summary of quadruplicate analyses of an independent standard to Determine accuracy and precision. Performed annually.
INITIAL DEMONSTRATION OF CAPABILITY (IDC)	The quadruplicate analysis of an independent standard summarized to determine the average % recovery and analytical precision. The precision and accuracy values must meet the acceptance criteria established for the method by the laboratory or defined by the promulgated method. Performed by new analyst, method or with new equipment.
INSTRUMENT (IB):	A blank that does not go through the preparation process. BLANK The instrument blank is used to prove the system and solutions are free from interference.
LABORATORY CONTROL SAMPLE:	A known matrix spiked with compound(s) representative of the target analytes. This is used to document laboratory (LCS) performance.
MATRIX SPIKE (MS):	An aliquot of sample randomly selected from available client samples is spiked with a known concentration of target analyte(s). The spiking occurs prior to sample preparation and analysis. The number of analytes in the spike depends on the number of analytes in the test analyzed. Less than 10 analytes in the test has a MS containing all analytes. 10 to 20 analytes contain at least 80% of the analytes in the spike. More than 20 analytes contain at least 60% of the analytes in the spike. A matrix spike is used to document the bias of a method in a given sample matrix.
MATRIX SPIKE DUPLICATE (MSD):	Intralaboratory split samples spiked with identical concentrations of target analyte(s). The spiking occurs prior to sample preparation and analysis. The analytes spiked are the same as that of the MS. They are used to document the precision and bias of a method in a given sample matrix.

METHOD BLANK (MB):	An analyte-free matrix to which all reagents are added in the same volumes or proportions as used in sample processing. The method blank should be carried through the complete sample preparation and analytical procedure. The method blank is used to document contamination resulting from the analytical process.
METHOD DETECTION LIMIT (MDL):	The minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a seven samples in a given matrix type containing the analyte.
PRECISION:	The agreement among a set of replicate measurements without assumption of knowledge of the true value. Precision is estimated by means of duplicate/replicate analyses.
REPORTING DETECTION LIMIT:	A number established by the laboratory that sample results could be reliably achieved. For many analytes the Reporting (RDL) Detection Limit is the lowest non-zero standard in the calibration curve.
RELATIVE PERCENT DIFFERENCE (RPD):	A calculation between a result and duplicate result. This result is used to determine the homogeneity of the sample.

Table 1 Analyte/Method

Analyte	Reference Method
Acidity	SM 2310B
Acidity	EPA 305.2
Alkalinity	SM 2320B
BOD5	SM 5210B
Carbon,Total Organic (TOC)	EPA 415.1
COD, w,ww	Hach method
Chloride	EPA 325.2
Chloride	SM 4500Cl-B
Chlorine, Residual	SM 4500Cl-G
Chromium, Hexavalent	SW 7196A
Chromium, Hexavalent	SM 3500Cr-D
Coliform, Fecal, MF	SM 9222D
Coliform, Total, PA	SM 9223
Conductance, Specific	EPA 120.1
Cyanide, Distillation	SW 9010B
Cyanide, Total	SW 9014
Cyanide, Total	EPA 335.2
Cyanide, Ammenable to Chlorination	EPA 335.1, 335.2, SW 9010
Density	ASTM D1475/SM2710F
Detergents, MBAS	EPA 425.1
Fluoride	SM 4500F C
Fluoride	EPA 340.2
Glycols	Analyst, Evans & Davis
Glycols	SW 8015 modified
Hardness, calcium	EPA 200.7 / SW 6010
Hardness	SM 2340B
Heterotrophic Plate Count	SM 9215B
Nitrogen, Ammonia	EPA 350.1
Nitrogen, Total Kjeldahl (TKN)	EPA 351.2
Nitrogen, Nitrate	EPA 353.2
Nitrogen, Nitrite	EPA 353.2
Nitrogen, Nitrate-Nitrite	EPA 353.2
Oil & Grease	EPA 413.1
Oil & Grease, Total Recoverable Petroleum Hydrocarbons	EPA 418.1
Oil & Grease	SW 9070
Oil & Grease	SW 9071
Oil & Grease (TPH), Hexane Extractable	SW 1664
Oxygen, dissolved	EPA 360.2
pH	EPA 150.1
pH, sw	SW 9045B
Phenolics, Total	EPA 420.1
Phenolics, Total Recoverable, sw	SW 9065
Phosphate, Ortho	EPA 365.1
Phosphorus, Total	EPA 365.1
Solids, Dissolved (TDS)	EPA 160.1
Solids, Suspended (TSS)	EPA 160.2
Solids, Total (180c)	SM 2540C
Solids, Ash	SM 2540E
Solids, Percent	SM 2540G

Solids, Total (TS)	EPA 160.3
Solids, Volatile	EPA 160.4
Solids, Settleable	EPA 160.5
Sulfate	EPA 375.2
Sulfate	EPA 375.4
Sulfide	EPA 376.1
Sulfide, sw	SW 9030B
Sulfite	EPA 377.1
Turbidity	EPA 180.1
Digestion, GFAA, liquids	SW 3020A
Digestion, GFAA, Solids	SW 3050B
Digestion, FGAA, As, Se	SW7060/SW7740
Digestion, ICP	SW 3010A
Digestion, Microwave, Oils	SW 3051
Dilution, Waste	SW 3580A
Chromium, Hexavalent	SM 3500CR, SW 7196A
Lithium, FAA	SW 7430
Mercury, CVAA	EPA 245.1
Mercury, CVAA, solids	EPA 245.5
Mercury, CVAA	SW 7470, SW 7471
Potassium, FAA	SW 7610
	EPA 200.7 / SW 6010A & B (I)
	EPA 200.8 / SW 6020 (MS)
	SM3113 (G)
Aluminum	I, MS
Antimony	I, MS, G
Arsenic	I, MS, G
Barium	I, MS
Beryllium	I, MS
Cadmium	I, MS, G
Calcium	I
Chromium	I, MS, G
Cobalt	I, MS
Copper	I, MS, G
Iron	I
Lead	I, MS, G
Magnesium	I
Manganese	I, MS
Molybdenum	I, MS
Nickel	I, MS
Selenium	I, MS, G
Silver	I, MS, G
Sodium	I
Strontium	I, MS
Thallium	I, MS, G
Vanadium	I, MS
Zinc	I, MS
Acrylonitrile and Acrolein	SW 8260B

Benzene, Toluene, Ethyl Benzene, Xylene (BTEX)	SW 8021B
	EPA 624
	SW 8260B
Gasoline Range Organics (GRO)	EPA 602 / SW8015B / SW 8021B
Gasoline Range Organics (GRO)	AK 101
Gasoline Range Organics (GRO)	Wis GRO
Purgeable Aromatic Hydorcarbons	EPA 602
	SW 8021B
Purgeable Halocarbons	EPA 601
	SW 8021B
Purgeable Volatiles	SW 8021B
Volatile Organics by GC-MS, drinking water	EPA 524.2
Total Trihalomethanes	EPA 524.2
Volatile Organics by GC/MS	EPA 624
Volatile Organics by GC/MS	SW 8260B
MTBE	SW 8021B modified
MTBE	SW 8260B modified
Liquid-liquid extraction	SW 3510C
Sonication Extraction	SW 3550B
Waste Dilution	SW 3580A
Florisil Column Clean Up	SW 3620B
Sulfur Clean Up	SW 3660B
Soxhlet Extraction	SW 3540C
Sulfuric Acid Clean Up	SW 3665A
Acid Extractables	EPA 625
	SW 8270C
Base Neutral Extractables	EPA 625
	SW 8270C
Diesel Range Organics (DRO)	EPA 8015B / SM 3541
Diesel Range Organics (DRO)	AK 102
Diesel Range Organics (DRO), Wisconsin	WIS DRO
Residual Range Organics (RRO)	AK 103
PCBs	EPA 608
	SW 8082
Pesticides/PCBs	EPA 608
Pesticides	SW 8081A
	EPA 608
Polynuclear Aromatic Hydrocarbons (PAH)	EPA 625
	SW 8270C
	SW 8310
Spent Solvents	SW 8015B/SW 8260B/SW 8270V
Corrosivity	SW 7.2
Corrosivity	SW 9040, SW 9045
Flash Point	SW 1010
Ignitability	SW 1010, SW 1020
Paint Filters Liquid Test	SW 9095

Reactive Cyanide	SW 7.3.3.2
Reactive Sulfide	SW 7.3.4.2
Synthetic Precipitation Leaching Procedure	SW 1312
TCLP Extraction	SW 1311
Volatile Matter Content	D 2369-87

Table 2. Sampling and Preservative Requirements

INORGANIC SAMPLE COLLECTION

PARAMETER	MINIMUM SAMPLE SIZE	CONTAINER	PRESERVATION	BOTTLE LABEL COLOR	HOLDING TIMES
Acidity	100 ml	P, G	4°C	Black	14 Days
Alkalinity	100 ml	P, G	4°C	Black	14 days
Biochemical Oxygen Demand (BOD)	1000 ml	P, G	4°C	Black	48 Hours
Carbonaceous BOD (C-BOD5)	1000 ml	P, G	4°C	Black	48 Hours
Chemical Oxygen Demand (COD)	2-40 ml	EPA Vial	4°C, H_2SO_4	Blue	28 Days
Chloride (Cl-)	100 ml	P, G	NP	Black	28 Days
Chlorine, Total Residual	200 ml	Amber	NP	Black	ASAP
Coliform, Fecal	100 ml	Bacti Bottle	4°C	Black	24 hours
Coliform, Total	100 ml	Bacti Bottle	4°C	Black	30 hours
Conductivity	50 ml	P, G	4°C	Black	28 Days
Cyanide Total/Amenable (liquid)	250 ml	Plastic	4°C, NaOH	Brown	14 Days
Cyanide (solid)					
Amenable	40 grams	Soil Jar	4°C	Black	14 Days
Reactive	10 grams	Soil Jar	4°C	Black	14 Days
Total	10 grams	Soil Jar	4°C	Black	14 Days
Total (extractable)	50 grams	Soil Jar	4°C	Black	14 Days
Flash Point/Ignitability					
Water	100 ml	Plastic	NP	Black	-
Soil	25 grams	Glass	NP	Black	-
Fluoride (F-)	1000 ml	Plastic	NP	Black	28 Days
Glycols	50 ml	Plastic	4°C	Black	-
Heterotrophic Plate Count	100 ml	Bacti Bottle	4°C	Black	24 hours
Nitrogen					
Ammonia	1000 ml	P, G	4°C, H_2SO_4	Blue	28 Days
Kjeldahl	100 ml	P, G	4°C, H_2SO_4	Blue	28 Days
Nitrate	50 ml	P, G	4°C	Black	48 Hours
Nitrate + Nitrite	100 ml	P, G	4°C, H_2SO_4	Blue	28 Days
Nitrite	50 ml	P, G	4°C	Black	48 Hours
Organic (TKN-NH3)	1000 ml	P, G	4°C, H_2SO_4	Blue	28 Days
Inorganic (NH3+NO3+NO2)	1000 ml	P, G	4°C, H_2SO_4	Blue	28 Days
Total (TKN+NO3+NO2)	500 ml	P, G	4°C, H_2SO_4	Blue	28 Days
Oil & Grease					
Water	1000 ml	Glass	4°C, HCl or H_2SO_4	Purple/Blue	28 Days
Soil	30 grams	Soil Jar	4°C	Black	28 Days
Oxygen, Dissolved	300 ml	DO Kit	DO Kit	-	8 Hours
Paint Filter	100 grams	P, G			
pH	50 ml	P, G	NP	Black	ASAP
Phenolics, Total Recoverable	1000 ml	Amber	4°C, H_2SO_4	Blue	28 Days
Phosphorus					
Ortho (PO4)	100 ml	P, G	4°C, filter immed.	Black	48 Hours
Total (P)	100 ml	P, G	4°C, H_2SO_4	Blue	28 Days
Solids (Residue)					
Dissolved (Filterable)	500 ml	P, G	4°C	Black	7 Days
Fixed	100 ml	P, G	4°C	Black	7 Days
Percent	100ml/15grams	P, G	4°C	Black	7 Days
Settleable	1000 ml	P, G	4°C	Black	48 Hours
Suspended (Non-Filterable)	500 ml	P, G	4°C	Black	7 Days
Total	500 ml	P, G	4°C	Black	7 Days
Volatile	200 ml	P, G	4°C	Black	7 Days
Specific Gravity	100 ml	Plastic	NP	Black	-
Sulfate (SO4)	100 ml	P, G	4°C	Black	28 Days
Sulfide, Total - water	500 ml	P, G	4°C, Zinc Acetate+ NaOH to pH>9	Black	7 Days

Sulfide - solid					
Total	10 grams	Soil Jar	4°C	Black	-
Reactive	10 grams	Soil Jar	4°C	Black	-
Sulfite	100 ml	P, G	4°C	Black	ASAP
Surfactants (MBAS)	500 ml	P, G	4°C	Black	48 hours
Total Organic Carbon (TOC)	2-40 ml	EPA Vials	4°C, H_2SO_4	Blue	28 Days
Turbidity	50 ml	P, G	4°C	Black	48 hours
METALS					
Chromium, Hexavalent - water	100 ml	P, G	4°C	Black	24 hours
Chromium, Hexavalent - soil	100 grams	Soil Jar	4°C	Black	24 hr aft ext
Mercury – water	250 ml	Plastic	HNO_3	Red	48 hours
Mercury – solid	15 grams	Soil jar	4°C	Black	48 hours
Metals - liquid (all except Cr^{6+} & Hg)	250 ml	Plastic	HNO_3	Red	6 months
Metals - soil (all except Cr^{6+} & Hg)	15 grams	Soil jar	4°C	Black	6 months

ORGANIC & TCLP SAMPLE COLLECTION

PARAMETER	MINIMUM SAMPLE SIZE	CONTAINER	PRESERVATION	BOTTLE LABEL COLOR	HOLDING TIMES
VOLATILE					
Volatile Organic Compounds - water	2-40 ml	EPA Vials	4°C, HCl [1]	Purple	14 Days
Volatile Organic Compounds - soil	2-120 ml	VOC Jars	4°C, Methanol	Black	14 Days
Volatile Organic Compounds - DW	4-40 ml	EPA Vials	4°C, HCl [1]	Purple	14 Days
Tot. Pet. Hydrocarbons-water(GRO-WI)	2-40 ml	EPA Vials	4°C, HCl	Purple	14 Days
Tot. Petroleum Hydrocarbons-soil (CA)	2-120 ml	VOC Jars	4°C	Black	14 Days
Tot. Petroleum Hydrocarbons-soil(GRO-WI)	2-60 ml	VOC Jars	4°C, Methanol	Green	21 Days

[1] Sodium Thiosulfate is also used for waters that have residual chloride.

SEMI-VOLATILE					
Pesticides - water	1000 ml	Amber	4°C	Black	*
Pesticides - soil	30 grams	Soil Jar	4°C	Black	*
PCBs - water	1000 ml	Amber	4°C	Black	*
PCBs - soil	30 grams	Soil Jar	4°C	Black	*
PCBs - oil	0.1 grams	Glass Vial	4°C	Black	*
Herbicides - water	1000 ml	Amber	4°C	Black	*
Herbicides - soil	50 grams	Soil Jar	4°C	Black	*
Base Neutral/Acid Extractables - water	1000 ml	Amber	4°C	Black	*
Base Neutral/Acid Extractables - soil	30 grams	Soil Jar	4°C	Black	*
Polynuclear Aromatic Hydrocarbons-water	1000 ml	Amber	4°C	Black	*
Polynuclear Aromatic Hydrocarbons-soil	30 grams	Soil Jar	4°C	Black	*
Phenols - water	1000 ml	Amber	4°C	Black	*
Phenols - soil	30 grams	Soil Jar	4°C	Black	*
Total Petroleum Hydrocarbons - WI DRO	1000 ml	Amber	4°C, HCl	Purple	*
CA Method, 418.1	1000 ml	Amber	4°C	Black	*
Total Petroleum Hydrocarbons-soil (418.1)	10 grams	Soil Jar	4°C	Black	*
TRPH WI, CA Method	30 grams	Soil Jar	4°C	Black	*
DRO WI**	30 grams	Soil Jar	4°C	Black	*

* The holding times for semi-volatiles (water) is 7 days until extraction and 40 days after extraction. The holding times for semi-volatiles (soils) is 14 days until extraction and 40 days after extraction.

** 10 days from the date of sample collection for solvent addition, 40 days for extraction and then analysis.

TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP)

	SOLIDS: MINIMUM SAMPLE SIZE		LIQUIDS: MINIMUM SAMPLE SIZE	
SAMPLE	WITH SPIKE	WITHOUT SPIKE	WITH SPIKE	WITHOUT SPIKE
Full TCLP	500 grams	200 grams	3 liters & 3 EPA vials	2 liters & 3 EPA vials
Metals + Semi-Vol	250 grams	200 grams	1 liters	1 liters
Metals	100 grams	100 grams	1 liter	1 liter
Volatiles (ZHE)	25 grams	25 grams	3 EPA vials	3 EPA vials

NOTE:
1. Soils, sludges, and solids are to be collected in hazardous waste jars (500 ml) or soil jars (250 ml).
2. Liquid samples should be collected in amber glass bottles.
3. Usually 1 hazardous waste jar of soil/sludge will provide enough sample for a full TCLP analysis with spike. Paper or other light materials may require 3-4 hazardous waste jars or more.

TCLP Holding Times

Volatiles	Semi-Volatiles	Mercury	Metals (except Mercury)	
From Field Collection to TCLP Extraction:	14 days	14 days	28 days	180 days
From TCLP Extraction to Preparative Extraction:	NA	7 days	NA	NA
From Preparative Extraction to Analysis:	14 days	40 days	28 days	180 days
28 days	61 days	56 days	360 days	

SOP#	SOPDescription
4	Significant Figures for the Reporting of LOD's and Results
5	Synthetic Precipitation Leaching Procedure Extraction (Method 1312)
6	pH Electronic Measurement (SW-846 Method 9045C)
7	Specific Conductance (EPA Mehod 120.1)
8	Total Organic Carbon (TOC) [EPA Method 415.1]
10	Biochemical Oxygen Demand (BOD) [Standard Methods 5210B]
12	Fluoride [EPA Method 340.2]
13	Total Coliform [Standard Method 9221D]
14	Total Recoverable Petroleum Hydrocarbons [EPA Method 418.1]
16	Suspect Asbestos Containing Material [ACM]
18	Dissolved Oxygen [EPA Method 360.2]
20	Gasoline Range Organics
24	Sulfate [EPA Method 375.4]
27	Lithium by Flame Emission [SW-846 Method 7430]
28	Purchasing
29	Organic Nitrogen
30	Inorganic Nitrogen
31	Total Nitrogen
32	Chemical Oxygen Demand (COD) [Hach Method 8000]
34	Non-Filterable Residue [EPA Method 160.2]
35	Total Residue [EPA Method 160.3]
36	Volatile Residue [EPA Method 160.4]
37	Oil & Grease Analysis [EPA Method 413.1]
38	Alkalinity [Standard Methods 2320B]
39	Mercury in Solid Material [EPA Method 245.5, SW-846 Method 7471]
40	Acidity [Standard Method 2310B]
42	Resistivity [EPA Method 120.1]
45	Glycols [Analyst, Evans & Dennis]
46	Percent Solids [Standard Methods 2540G]
48	Total Recoverable Phenolics [EPA Method 420.1, SW-846 Method 9065]
49	Trip Blank Preparation
51	Separatory Funnel Liquid-Liquid Extractions [SW-846 Method 3510C]
52	Sonication Extraction [SW-846 Method 3550B]
53	Hexavalent Chromium [Standard Methods 3500D]
54	Semivolatile Organic Compounds [EPA Method 625]
55	Semivolatile Organic Compounds [SW-846 Method 8270C]
56	Sulfur Clean-up - Copper Technique [SW-846 Method 3660D]
57	Florisil Column Cleanup [SW-846 Method 3620B]
58	Cyanide Analysis [SW-846 Method 9014]
60	Fecal Coliform by Membrane Filtration [Standard Methods 9222D]
61	Volatile Organic Analyses [SW-846 Method 8260B]
63	Methelene Blue Active Substances (Colorimetric) [Method 425.1]
64	Mercury Analysis [EPA Method 245.1, SW-846 Method 7470A]
66	Heteroprophic Plate Count via the Pour Plate Method [Standard Methods 9215B]
67	Graphite Furnace Atomic Absorption Spectroscopy
73	Inductively Coupled Argon Plasma [EPA Method 200.7]
80	Volatile Organic Analyses [EPA Method 524.2]
87	Metals Digestion-GFAA [Method 3020A]

SOP#	SOPDescription
88	Metals Digestion-GFAA & ICP Acid Digestion for Sediments, Soils and Sludges [SW-846 Metho
89	Total Sulfide in Solids [SW-846 Method 9030B]
90	Reactive Cyanide [Method 7.3.3.2]
91	TCLP Extraction [SW-846 Method 1311]
92	Thermometer Calibration
93	Total Phosphorus [EPA Method 365.1]
94	Total Residual Chlorine [Standard Methods 4500-Cl G]
95	Biology Dishwashing
97	Modified Diesel Range Organics [Wisconsin DRO]
99	Microwave Assisted Acid Digestion of Sediments, Soils, Sludges and Oils [SW-846 Method 305
100	Subsampling Soil Samples
101	Hazardous Sample Disposal
103	Acid/Base/Water Reactivity
104	Aromatic Volatile Organics [EPA Method 602, SW-846 Method 8021B]
107	Turbidity [EPA Method 180.1]
108	Total Sulfide for Liquids [EPA Method 376.1]
109	Volatile Organic Analyses [EPA Method 624]
110	Metals Digestion - ICP [Method 3010A]
111	Bottle Preparation
114	Chain of Custody
117	Standards and Chemical Tracking for Organic Laboratories
119	Acid Handling
120	Trace Metals by FLAAS
121	Flashpoint [SW-846 Method 1010]
122	Paint Filters Liquid Test [SW-846 Method 9095]
123	Standards and Chemical Tracking for Wet Chemical Laboratory
124	Standards and Chemical Tracking for Metals Laboratory
126	Sample Log-in
128	Polynuclear Aromatic Hydrocarbons by High Performance Liquid Chromatography [SW-846 Me
129	Volatile Matter Content [ASTM Method D 2369-87]
130	Density [ASTM Method D 1475-85]
131	Specific Gravity/Density - Pycnometer
132	Sulfite [EPA Method 377.1]
133	Settleable Solids [EPA Method 160.5]
134	% Ash [Standard Methods 2540E]
135	Corrosivity [SW-846 Chapter 7.2]
136	Density - Mass Displacement
137	Total Amenable Cyanide Distillation [EPA Method 335.1 and 335.2, SW-846 Method 9010]
138	Oil and Grease Hexane Extractable Material [EPA Method 1664A]
139	Data Qualifiers
140	Chloride [EPA Method 325.2]
141	Archiving, Storage and Retrieval of Analytical Data
142	pH Electrometric [EPA9040B/150.1]
143	Sub-contracting
144	Sample Storage
145	Reactive Sulfide [SW-846 Method 7.3.4.2]
146	Detection Limits
148	Standards and Chemical Tracking

SOP#	SOPDescription
160	Graphite Furnace Atomic Absorption [SM3113]
161	Sulfuric Acid Cleanup [SW-846 Method 3665A]
162	Nitrate-Nitrite; Nitrogen [EPA Method 353.2]
163	Fluoride Analysis [Standard Method 4500F-C]
164	Sulfate [EPA Method 375.2]
165	Cyanide Distillation [SW-846 Method 9010B]
166	Logging Out Projects
167	LIMS Invoicing
168	Filing
170	TCLP Hazardous Verification
171	Sample Shipment
172	Ammonia [EPA Method 350.1]
174	Glassware Cleaning
179	Determination of Diesel Range Organics [Alaska Method AK 102.0]
180	Determination of Gasoline Range Organics [Alaska Method AK 101.0]
182	Second Person Data Review
183	Hardness [Standard Methods 2340B, EPA Method 200.7, SW-846 Method 6010]
189	Corrective Action Reports
190	Arsenic and Selenium Digestion (GFAA) [SW-846 Methods 7060A and 7740]
191	Analyst Training
193	Graphite Furnace Atomic Absorption Spectroscopy [SW-846 7000 Series]
204	Manual Intergration
205	Inductively Coupled Plasma [SW-846 Method 6010A, AFCEE Methodology]
206	Total Kjeldahl Nitrogen [EPA 351.2]
207	Total Desolved Solids Dried at 180C [Standard Methods 2540 C]
211	Total Petroleum Hydrocarbons - Semivolatile Fraction [CS LUFT, Iowa OA-2]
212	Total Petroleum Hydrocarbons - Volatile Fraction [CA LUFT, Iowa OA-1]
213	Hexavalent Chromium [SW-846 Method 7196A]
214	Control Limits
216	Balance Maintenance
217	Temperature Monitoring
218	Operation and Maintenance of the Electric Sterilmatic Sterilizer Autoclave
221	Waste Dilution [SW-846 Method 3580A]
222	Aromatic and Halogenated Volatiles by GC [SW-846 Method 8021B]
223	Organochlorine Pesticides by Gas Chromatography [EPA Method 608, SW-846 Method 8081]
224	Polychlorinated Biphenyls by Gas Chromatography [EPA Method 608, SW-846 Method 8082]
225	Aromatic and Halogenated Volatiles by GC [EPA Methods 601/602]
226	o-Phosphorus [EPA 365.1]
227	Residual Range Organics [AK Method 103]
229	Document Control
230	Reagent Control
231	Pipettor Calibration and Maintenance
232	Inductively Coupled Plasma [SW-846 Method 6010B, Army Corps of Engineers]
233	Standard Operating Procedures
234	Standard Preparation
235	Internal QA/QC Audits
236	Data Reporting and Package Assemply
237	Laboratory Notebook Use

SOP#	SOPDescription
238	Data Report Review
239	Project Coordination
240	Software Validation and Control
241	Chain of Custody Tracking
242	Electronic Infromation Security
243	Project Acceptance
244	Personnel Backup
245	QA System Review
246	Method Validation
247	Dispositition of Laboratory Waste Materials
248	Electronic Information Backup
249	Customer Complaint Tracking
250	Trace Metals by ICP/MS [SW-846 6020]
251	Trace Metals by ICP/MS [EPA 200.8]
252	Aqueous Field Sampling
253	Solids Field Sampling
254	Miscellaneous Field Sampling

Attachment U

BLASLAND, BOUCK & LEE, INC.
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Dense Nonaqueous Phase Liquid (DNAPL) Sampling Procedures

Attachment U

Dense Nonaqueous Phase Liquid (DNAPL) Sampling Procedures

I. Introduction

Dense nonaqueous phase liquid (DNAPL) samples may be collected to facilitate laboratory characterization of these materials. Standard procedures for collecting DNAPL samples are presented in this attachment.

II. Materials

The following materials will be available, as required, during DNAPL sampling:

- Photoionization detector (PID);
- Health and safety equipment (as required in the Health and Safety Plan);
- Cleaning Equipment (as required in Attachment H);
- Plastic sheeting;
- Field book or appropriate log forms;
- Absorbent pads;
- Peristaltic pump and pump tubing or bailer (stainless steel or Teflon®);
- Non-absorbent cord (polypropylene);
- Sample containers provided by laboratory;
- Insulated coolers, ice, and appropriate packing material;
- Resealable type bags;
- Sample labels, and chain-of-custody (COC) forms;
- Large heavy-duty garbage bags;
- Teflon® tubing;
- Oil/water interface probe; and
- Monitoring well keys (if required).

III. Procedures

Step 1 - Review checklist and verify that the appropriate equipment has been assembled.

Step 2 - Open well and perform water level/oil thickness measurement procedures in accordance with Attachment Q.

Step 3 - Identify site and well location on sampling log sheets along with date, arrival time, and weather conditions. Identify the personnel and equipment utilized as well as other pertinent data requested on the logs.

Step 4 - Label all sample containers with date, time, well number, site location, and sampling personnel present.

Step 5 - Don a new pair of disposable gloves as required. These gloves will be used for the entire sampling event and are well specific.

Step 6 - DNAPL is to be sampled utilizing a peristaltic pump with new Teflon® tubing or a Teflon® bailer. The tubing should be slowly lowered through the overlying water column and into the DNAPL layer. When finished sampling, slowly remove tubing from the well to minimize disturbances to the NAPL layer. If the DNAPL lies below the effective depth at which a peristaltic pump can draw liquid, a weighted Teflon® bailer or alternative pumping method (e.g., down-hole pump) should be used to collect the sample.

Step 7 - Obtain sample needed for analysis with the pump or bailer and pour or pump the liquid directly from the sampling device into the appropriate container with proper label affixed and tightly screw on the cap.

Step 8 - Note the time on the sample label and sampling log.

Step 9 - Replace well cap and secure well.

Step 10 - Clean all sampling equipment in accordance with Attachment H or dispose of equipment (see Section IV below).

Step 11 - Collect all PPE and other wastes generated for disposal.

Step 12 - Record required information on the appropriate forms and/or field notebook.

Step 13 - Handle, pack, and ship the samples in accordance with the procedures in Attachment A.

IV. Disposal Methods

Waste materials generated during DNAPL sampling activities, including disposable equipment, will be disposed of in appropriate containers. Containerized waste will be disposed of by GM consistent with its ongoing disposal practices.

Attachment U-1

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DNAPL Sampling Field Log

Example

DNAPL Sampling Field Log

Project: _____ Project No.: _____
Site Name: _____ Sampling Personnel: _____

_____

_____

_____

_____

Well No.: _____ Date: _____

Time: _____

HNU/PID Reading: _____ Background _____ Well

Weather: _____

I. WELL INFORMATION

Reference Point Marked on Casing: Y N
Length of inner casing: ____ above, below grade

Well Diameter: _____ TIC _____ TOC
Length of outer casing: _____ above, below grade

Well Depth
LNAPL Thickness - Vol. LNAPL Removed _____
DNAPL Thickness - Vol. LNAPL Removed _____
Water Thickness -

II. WELL SAMPLING

Lab Sample No.	Time Sampled	Material Sampled

III. MISC. OBSERVATIONS

_____

_____

_____

_____

_____

Attachment V

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Test Pit Excavation Procedures

Attachment V

Test Pit Excavation Procedures

Test pits will be excavated using a decontaminated, rubber-tired backhoe. Test pits may be performed based on the need to identify subsurface structures, facilitate the collection of soil samples that cannot be collected by soil borings, and areas requiring subsurface characterization for interim measure (IM) design or implementation. Personnel should stand upwind of the excavation area to the extent possible. Continuous air monitoring will be conducted as indicated in the HASP. Excavating will be conducted at the selected locations that have been cleared for utilities, until either significant source materials, groundwater, or bedrock is encountered, or to within the physical limits of the backhoe. Test pit materials will be visually observed and described with respect to depth. Photographs of the soil will be taken for future reference.

Where necessary to characterize soil conditions, soil will be collected in one of two manners. If the excavation is less than 3 feet deep, the sample may be collected directly from the sidewall of the test pit with a decontaminated stainless-steel shovel, scoop, or hand auger. If the test pit is deeper than 3 feet, the soil sample will be collected from the backhoe bucket, either directly or with a decontaminated stainless-steel scoop or trowel. Samples should be homogenized, if appropriate. Samples collected for VOC analysis will be collected following the procedures in Attachment G.

Material removed from the test pit during excavation will be placed on polyethylene sheeting. Visually clean soils, if any, will be segregated from soils that may contain source materials. Upon completion, the materials from the test pits will be placed back in the excavation. The visually clean soils, if any, will be used to cover the source materials in the excavation. To facilitate surveying, the location of the pit will be marked with stakes after it has been backfilled. Stakes should be placed at the ends of the test pit, or and at any significant bend or corner, as appropriate.

Attachment W

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Water-Column (Surface Water) Sampling Procedures

Attachment W

Water-Column (Surface Water) Sampling Procedures

The following materials will be available, as required, for water-column (surface water) sampling:

- Health and safety equipment (as required by the Health and Safety Plan);
- Cleaning equipment;
- Pyrex graduated beaker;
- Thermometer;
- Large glass mixing container;
- Teflon stirring rod;
- Field notebook;
- Conductivity/temperature meter;
- pH meter;
- Turbidity meter;
- Appropriate transport containers and packing, labeling, and shipping materials (coolers) with ice;
- Appropriate water sampler (e.g., stainless steel bailer sampler or peristaltic pump and tubing); and
- Appropriate sample containers and forms.

Water column samples will be collected using a stainless steel or Teflon® bailer water sampler or peristaltic pump with new Teflon® tubing similar sampler according to the following procedure:

1. Identify sampling location in field notebook, along with other appropriate information.

2. Use health and safety equipment (as required by the Health and Safety Plan).

3. Clean the sampling equipment as described in Attachment H.

4. Measure the total depth of the water column.

5. Lower the water sampler (e.g., bailer or pump tubing) into the water column with minimal disturbance.

6. Raise the water sampler from the water column with minimal disturbance.

7. Remove the cover from the appropriate sample container and slightly tilt the mouth of the container below the sampling device.

8. Allow the sample stream to flow gently down the side of the large glass beaker with minimal entry turbulence.

9. After sampling containers have been filled, take meter readings for pH, temperature, conductivity, and turbidity and record results in the field notebook.

10. Secure all sample jar caps tightly.

11. Label all sample containers.

12. Place filled sample containers on ice in a cooler.

13. Follow procedures for preserving samples, and packing, handling, and shipping with associated chain-of-custody procedures.

14. Record required information on the appropriate forms and/or field notebook.