UPLANDS PHASE II RI SAMPLING AND ANALYSIS PLAN

March Point (Whitmarsh) Landfill
Skagit County, Washington

Prepared for:

Whitmarsh Landfill PLP Group

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ACRONYMS AND ABBREVIATIONS

AMEC	AMEC Geomatrix, Inc.
ARI	Analytical Resources, Inc.
ASTM	ASTM International
bgs	below ground surface
BNSF	Burlington Northern Santa Fe
DO	dissolved oxygen
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management
FS	feasibility study
HASP	Health and Safety Plan
HSA	hollow-stem auger
NAVD88	American Vertical Datum of 1988
µL	microliter
µS/cm	microsiemens per cm
ml/minute	milliliters per minute
MS/MSD	matrix spike/matrix spike duplicates
MW	monitoring well
NTU	nephelometric turbidity units
ORP	oxidation reduction potential
PELs	permissible exposure limits
PID	photoionization detector
PLPs	Potentially Liable Parties
QAPP	Quality Assurance Project Plan
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
SAP	Sampling and Analysis Plan
SP	seep
SR 20	State Highway 20
SW	surface water
USCS	Unified Soil Classification System
VOCs	volatile organic compounds
WAC	Washington Administrative Code
Whitmarsh	March Point Landfill

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March Point (Whitmarsh) Landfill
Skagit County, Washington

1.0 INTRODUCTION

AMEC Geomatrix, Inc. (AMEC) has prepared this Uplands Phase II RI Sampling and Analysis Plan (SAP) on behalf of certain March Point (Whitmarsh) Landfill Potentially Liable Parties (PLPs). This SAP presents additional field investigations that will be conducted to support the remedial investigation/feasibility study (RI/FS) for the upland portion of the former landfill site, located at 9633 South March Point Road in Anacortes, Washington. This SAP presents the locations, methodology, and field procedures for soil borings and test pitting to characterize landfill content, monitoring well installation, multimedia sampling, and groundwater level measurements in the vicinity of the landfill. The results from the Phase II investigation (in conjunction with the Phase I results) will be used to further define the nature and extent of soils and groundwater contamination within and in the vicinity of the landfill as necessary to assess containment of hazardous substances within the landfill. A description of the sediment investigation is provided in the Sediment Investigation Work Plan (AMEC, 2008a).

1.1 BACKGROUND

The site is an irregularly shaped parcel consisting of approximately 14 acres of fill covering tidelands of Padilla Bay Lagoon (Figure 1). The landfill is bounded by South March Point Road to the southwest, Padilla Bay Lagoon and Padilla Bay to the northeast, and the Swinomish Indian Reservation to the east. State Highway 20 (SR 20) runs about 800 feet southeast of the site beyond South March Point Road. Aerial photos and historical maps indicate that no fill material was present on the site prior to 1947 and that the site at that time consisted of the tidelands of Padilla Bay Lagoon. The site was used as an unregulated public dump from the 1950s until 1961 (GeoEngineers, 2007). Skagit County operated the site as a public landfill from 1961 to 1973. In 1973, the landfill was closed, graded, covered with 2 to 3 feet of soil, and revegetated. Since the late 1980s, the majority of the site has been owned by and used for operation of a sawmill. Hog fuel, saw logs, and the sawmill facility now cover the northernmost two-thirds of the former landfill. The southernmost third of the former landfill is vacant and covered with light forest and scrub.

The remedial investigation (RI) work in the RI/FS Work Plan is divided into a Phase I and Phase II RI. A Revised Draft Phase I RI Report was submitted to Washington State Department of Ecology (Ecology) in September 2009 for review (AMEC, 2009). The scope of work for the Phase II RI is based on the conclusions and results of the Phase I RI. The

Phase II investigation is intended to fill data gaps, confirm the Phase I conceptual site model, and provide basic information needed to develop and evaluate remedial measures in the feasibility study. Additional work to be carried out as part of the Phase II RI is based on the conceptual site model developed in the Phase I investigation. This SAP describes the work to be performed during the Phase II RI.

1.2 OBJECTIVES AND SCOPE

The primary goal of the remedial investigation is to collect data necessary for completing a defensible Feasibility Study (FS) which leads to the selection of an appropriate remedy. The objectives of the Phase II Upland RI are to:

- Determine the depth to and thickness of the low-permeability bay mud layer that was identified during the Phase I RI field work;
- Determine the physical and geotechnical properties of the bay mud;
- Determine the thickness of bark debris present at the site;
- Determine the location of the contact between landfill refuse and native soils north, west, and south of monitoring well MW-03;
- Evaluate the content of the northern third of the landfill;
- Determine the location and nature of the “dike-like” feature identified along the east side of the landfill;
- Determine the direction of groundwater flow within the shallow groundwater present above the bay mud layer within the landfill; and
- Determine if groundwater below the bay mud along the eastern/southeastern side of the landfill (presumed to be the downgradient side) is impacted.

The following field tasks will be performed to gather the necessary data to meet these objectives.

- Excavate additional test pits in the northern portion of the landfill and near the margins of the landfill to determine the depth of the bark debris, and the depth to the underlying bay mud layer. Soil samples will be collected from the native and/or bay mud layer at locations MW-07, MW-08, and MW-10. These samples will be analyzed for chemical constituents in accordance with Table 1. These additions are:
    - Three test pits (G28 through G30) will be excavated near MW-03 to determine the location of the contact between the refuse and the surrounding native materials.

- Five test pits (G32 through G36) will be installed in accessible areas of the northern landfill areas.

- Four test pits (G15 through G18) will be installed along the length of the dike-like feature.

- Thirteen test pits (G12 through G14, G19 through G27, and G31) will be installed along the remaining perimeter of the landfill.

- Advance soil borings using a direct-push drill rig to determine the depth of the bay mud layer if the depth to the bay mud layer cannot be determined at a test pit locations described above.

- Install and develop seven additional groundwater monitoring wells (MW-05 through MW-11).

- Collect samples of bay mud outside the perimeter of the landfill (ST-01, ST-02, and ST-03) and/or the monitoring well (MW-07, MW-08, and MW-10) borings using Shelby tubes for analysis of physical and geotechnical properties.

- Install three new piezometers (PZ-01 through PZ-03) within the interior of the landfill above the bay mud to allow for one year of water level measurements to be used (in conjunction with the five new shallow monitoring wells and the existing monitoring well network) to evaluate groundwater flow directions within the landfill.

- Survey the elevation of the seven new monitoring wells and three piezometers; and,

- Install self-logging water level transducers in the three piezometers and in MW-03, MW-06, MW-08, MW-09, MW-10, and MW-11.

- Collect quarterly samples from the groundwater wells, surface water sites, and seeps for another three quarters.

- Conduct a tidal study of the uppermost aquifer within and upgradient of the landfill using the three new piezometers, the five new shallow monitoring wells, and the existing upgradient monitoring wells.

This SAP outlines how these tasks will be performed. Approximate sampling locations are shown on Figure 1.

1.3 ORGANIZATION

The names of the sampling contractor and the analytical laboratory are provided below:

<u>Sampling Contractor</u>
AMEC Geomatrix, Inc.
600 University Street, Suite 1020
Seattle, Washington 98101
Contact: Mr. David Haddock
Phone: (206) 342-1760

<u>Data Validation Contractor</u>
AMEC Geomatrix, Inc.
600 University Street, Suite 1020
Seattle, Washington 98101
Contact: Ms. Crystal Neirby
Phone: (206) 342-1760

<u>Analytical Laboratory for Soil and Groundwater</u>
Analytical Resources, Inc. (ARI)
4611 S. 134th Place
Tukwila, Washington 98168-3240
Contact: Mr. Mark Harris
Phone: (206) 695-6200

<u>Ecology's Contact for Sampling Coordination</u>
Mr. Panjini Balaraju, P.E.
Site Manager
Washington State Department of Ecology
Toxics Cleanup Program
300 Desmond Drive
Lacey, Washington 98504-7600
Phone: (360) 407-6161
email: pbal461@ecy.wa.gov

1.4 HEALTH AND SAFETY

The proposed field activities will be conducted in accordance with the revised Site-Specific Health and Safety Plan (HASP) included as Appendix A of this SAP.

2.0 INVESTIGATION METHODS

This section describes methods that will be used for field tasks to be performed during the Phase II RI. Table 1 summarizes the field activities to be conducted and samples to be collected. Locations for proposed field procedures are shown on Figure 1. More detailed AMEC Environmental Field Protocols are included in Appendix B.

2.1 SITE PREPARATION

Prior to the commencement of drilling and test pitting, the following procedures will be followed for site preparation.

- Inspect each potential drilling or test pitting location in the field for potential access problems (e.g., overhead obstructions or hazards, excessive slopes, soft ground, on-site materials or equipment obstructing access, etc.).
- Get approval from the saw mill owner for drilling or test pitting at the selected locations.
- Clear brush or debris that may be present from the drilling and test pit locations using mechanized equipment. If present, stockpiled logs and log waste may need to be relocated with heavy equipment to expose the cover soil beneath. Logs currently located on the landfill will be moved in coordination with the current site owner.
- Remove equipment or materials that may be stored in the immediate vicinity of the drilling and test pit locations.
- Mark the ground locations of the proposed drilling and test pit sites.
- Contract an independent service (and if necessary government agencies) to locate underground utilities in the vicinity of each proposed drilling or test pit location in the vicinity of the lumber mill. Based on the outcome of the search for underground obstructions, it may be necessary to modify the location of one or more proposed drilling or test pitting sites.

After the drilling and test pitting locations have been finalized, and any required permits have been obtained, AMEC will begin final site preparations. The following steps will be included.

- Grade or level the test pit or drilling locations, if necessary.
- Mark the final test pit or drilling locations on the ground.
- Set up receptacles for temporary storage of investigation-derived waste (IDW).

The drilling subcontractor will submit well construction notifications (start cards) to the Ecology at least 72 hours before beginning well construction. Each well will be uniquely numbered and coordinated with the site's current well numbering system. The well installation will be documented in accordance with Washington Administrative Code [WAC] 173-160 using Ecology’s required format.

2.2 TEST PIT INVESTIGATION

Test pits will be excavated to characterize the presence and depth of the bark debris, the depth of the underlying bay mud, and the possible presence of landfill debris or refuse. As recommended by our archaeologist in a February 20, 2009 letter (Appendix E of the Phase I RI Report), we plan to conduct an archaeological survey along the historic western shoreline of Padilla Bay at the edge of the landfill. We will also have an archaeologist present if landfilled material in contact with the natural tide flats is excavated. Archaeological work will be conducted by, or under the supervision of a registered Archaeologist. This section describes the methods that will be used to excavate test pits as part of the Phase II RI.

2.2.1 Test Pit Locations

The approximate locations of test pits are shown in Figure 1. Test pits are divided into three types: perimeter test pits, test pits near MW-3 to determine the nature and extent of landfill debris near this well location, and other northern landfill characterization test pits.

Most of the test pits are perimeter test pits and will be excavated along the perimeter of the landfill to determine the extent of the refuse within the landfill. Test pits G28, G29, and G30 will be excavated in the vicinity of MW-3 to evaluate the extent of refuse in the vicinity of this monitoring well. Tests pits G-32 through G-36 will be excavated to evaluate refuse around the saw mill and a limited number of soil samples will be collected for determining contamination present at the landfill.

Test pits G12, G13, G14, and G31 are located within 50 feet of the Burlington Northern Santa Fe (BNSF) railroad center line. All AMEC and subcontractor personnel must view BNSF’s contractor orientation training prior to the start of field activities (available at http://contractororientation.com). In addition, BNSF must be notified 10 business days prior to completing these test pits. None of the test pit activities are projected to take place any closer than 25 feet from the railway centerline. All field staff will be provided hard copies of the BNSF access agreement.

2.2.2 Field Procedures

Test pits will be excavated with a trackhoe/excavator capable of reaching a depth of 20 feet. An AMEC representative will be on site at all times during excavation activities to direct the work. The final depth of each test pit will be determined by the AMEC representative based on field observations during excavation. Test pits will be excavated to the depth of native soil, the groundwater table, depth to the bay mud, or a maximum depth of 20 feet, whichever is shallower. Test pits excavation will also be discontinued based on health and safety considerations. All test pit excavations will proceed in a manner consistent with the site-specific HASP.

At each test pit location, the top 1 to 2 feet of soil (anticipated to consist of clean cover soil or bark debris) will be carefully removed by the excavator and stockpiled separately. Material will be subsequently excavated in layers from each test pit and placed on plastic sheeting no closer than 2 feet from the edge of the test pit. Metal trench boxes, benching, and/or sloping of sidewalls will be used if necessary to stabilize the excavator or if entry into the excavation is required and the test pit depth exceeds 4 feet.

Health and safety factors may limit the depth of excavations. These factors include the presence of:

- hazardous materials in the test pit, such as landfill gases (hydrogen sulfide, volatile organic gases, or explosive gases);
- friable asbestos;
- compressed gas cylinders;
- potentially corrosive or caustic liquids; potentially explosive or combustible materials;
- punctured or rusted drums that may puncture easily; dust-releasing products;
- medical waste;
- other potentially hazardous materials.

Surface instability and/or subsidence that may present a hazard to heavy equipment, such as the excavator, will also be a factor limiting the final depth of the excavations.

As described in the HASP, breathing zone monitoring for volatile organic gases and work zone monitoring for explosive gases, will be conducted by the AMEC representative. If permissible exposure limits (PELs) are exceeded, or if explosive gases are detected between the lower and upper explosive limits, excavation will be discontinued. Test pit excavation will proceed only when gas concentrations have returned to an acceptable level.

After a test pit is completed, or if excavation problems prevent completion of the test pit, the excavation will be backfilled to grade with stockpiled excavation material from that location only. While not anticipated, if any containerized waste is removed from the test pit, these containers will be segregated for characterization and disposal. Using the excavator bucket, the backfill will be compacted at 2-foot intervals. The plastic sheeting on which the stockpiled material was placed will also be placed in the test pit during backfilling. The clean soil overburden that had been segregated will be used for the final lift of the backfill to grade.

The location and elevation of each test pit will be surveyed as described in Section 2.11.

2.2.3 Sample Collection and Preparation

Samples will be collected for analysis from selected soil horizons encountered during test pit excavation. The list of analytes for potential test pit soil samples is shown in Table 1. Refuse from the test pits will not be sampled; however, if industrial wastes are encountered, soil samples will be collected for analysis. In addition, samples of the underlying bay mud will be submitted for physical tests as outlined in Table 1. The preliminary screening levels for soil and groundwater are presented in Table 2 and Table 3, respectively.

Soil samples will be taken directly from the excavator bucket using stainless steel spoons. The material will be placed directly into precleaned glass jars supplied by the analytical laboratory. All sampling equipment will be properly decontaminated after each sample is collected, as discussed in Section 3. Excavations will be supervised and soil samples will be collected by a geologist licensed in the State of Washington.

Sample collection will proceed as follows.

- A trackhoe/excavator will be used to excavate soil at the desired depth from the bottom or sidewalls of the excavation.
- For each sample, a portion of soil will be collected from the excavator bucket and placed into a labeled, precleaned sample jar. Each sample jar will be sealed and stored on ice and transported to the contract laboratory.
- The sampling equipment will be decontaminated prior to excavation at each test pit location and between each sampling location using the decontamination procedures outlined in Section 3.
- The project geologist will document sample collection events in the field logbook. Documentation will include field observations, sample locations, test pit logs for each test pit deeper than 2 feet below ground surface (bgs), and any changes in sampling methods to address sampling difficulties encountered in the field.

The soil samples for chemical and physical testing will be delivered to ARI for analysis. Standard chain-of-custody procedures will be followed using chain-of-custody forms for all samples sent to the laboratory, as described in Section 2.10. Analyses will include a wide range of analytes (Table 1). Any asbestos samples selected by the project geologist will be delivered to and analyzed by NVL Laboratories, Inc., in Seattle, Washington.

2.2.4 Soil Lithologic Logging

All test pits will be logged by a field geologist to the test pit's total depth. The lithologic log for each test pit will be based on visual observation and description of the corresponding soil samples in accordance with ASTM International (ASTM) Standard D2488. Each sample lithologic description will contain the following information:

- Boring/test pit identifier;
- Sample depth interval, in feet bgs;
- Color (based on Munsell® color chart);
- Signs of weathering (e.g., rust-colored stains or coatings);
- Texture (particle size, angularity/roundness, and degree of sorting);
- Soil type, based on the Unified Soil Classification System (USCS) (ASTM D2487-98);
- Estimated moisture content (qualitative);
- Organic matter (e.g., plant detritus, woody or fibrous vegetative matter, shell fragments), if any;
- Photoionization detector (PID) reading;
- Noticeable odor, if any; and
- Sheen test results and observations regarding heaviness of the sheen or free product.

2.3 SOIL BORINGS

This section describes the methods that will be used to drill soil borings, collect and analyze soil samples, and characterize stratigraphy as part of the RI. Soil borings may be installed along the perimeter of the landfill and/or within the landfill footprint in conjunction with test pits. Soil borings will be installed at test pit locations to determine the depth to the Bay Mud unit if the depth to Bay Mud cannot be determined at a given test pit location. Soil borings will also be drilled for the installation of monitoring wells or piezometers. Approximate locations of test pits, monitoring wells, and piezometers are shown on Figure 1. Procedures for monitoring well and piezometer installation are described in Section 2.5.

2.3.1 Field Procedures

Soil borings will be advanced using a hollow-stem auger (HSA) rig or direct-push rig to reach the desired sample depth. Figure 1 shows the proposed sample locations at the site. Final well and piezometer locations will depend upon identifying and avoiding buried utilities and physical obstructions.

If necessary, soil samples will be collected using stainless steel spoons, and the material will be placed directly into precleaned glass jars supplied by the analytical laboratory. All sampling equipment will be properly decontaminated between each confirmation sample location, as discussed in Section 3.

Sample collection will proceed as follows.

- A direct-push or HSA rig will be used to perform soil sampling to the maximum desired depth at each subsurface soil sample location. Drilling will be completed by a driller licensed in Washington State. The drilling and soil sampling will be supervised by a geologist licensed in Washington State.
- For each sample, a portion of soil will be collected from the designated sample depth interval and placed into a labeled, precleaned sample jar. Each sample jar will be sealed and retained on ice until transported to the contract laboratory.
- If refusal is encountered at a sample location prior to reaching the target depth, the sample location will be moved approximately 1 foot away, as directed by the project geologist, and the boring will be repeated. If refusal is encountered during well installation, a new boring will be advanced approximately 5 feet away.
- The sampling equipment will be cleaned prior to conducting borings at the site, and decontaminated between each sampling location using the decontamination procedures outlined in Section 3.
- The project geologist will be responsible for noting any changes in sampling methods caused by sampling difficulties and for ensuring that field observations, sample locations, and lithologic logs of each boring deeper than 2 feet in depth are properly recorded in the field logbook.

A survey will be conducted to determine the elevation and location of each soil boring location, as discussed in Section 2.11.

The soil samples for chemical and physical analyses (as described in Table 1) will be delivered to Analytical Resources, Inc. (ARI), laboratory in Tukwila, Washington, for analysis. Standard procedures will be followed using chain-of-custody forms for all samples sent to the laboratory, as described in Section 2.10. Samples will be archived in case additional background analytes become necessary.

2.3.2 Soil Lithologic Logging

All subsurface borings will be logged continuously by a field geologist/engineer to the soil boring's total depth, following the procedures described for test pits in Section 2.2.4. The lithologic log for each boring will be based on visual observation and description of the corresponding soil samples in accordance with ASTM D2488.

2.4 BAY MUD SAMPLING

Samples of the bay mud outside the perimeter of the landfill are proposed to be collected in order to determine the hydraulic and physical properties of the bay mud in the inner lagoon and potentially underneath the landfill footprint. Due to the marshy ground in the inner lagoon, conventional drill rigs cannot be used to collect these samples. Additionally, a geoprobe rig can not drive or collect Shelby tube samples. Therefore, the samples of the inner lagoon bay mud will be collected at low tide using manually driven Shelby tubes. Bay mud samples will be collected beneath the landfilled material at locations MW-07, MW-08, and MW-10 if the bay mud unit is encountered during drilling. The proposed inner lagoon sample locations (located in the vicinity of the seep and the northern boundary of the dike-like feature) and the potential locations beneath the landfill are spread across the site as shown in Figure 1.

Samples will be tested to determine shear strength, triaxial permeability, as well as conventional physical parameters. These data can be used to evaluate the hydraulic properties of the Bay Mud underlying the site, which is presumed to serve as the aquitard beneath the site. Also, these data can be used in the preliminary design on future remedial options.

Each Shelby tube is an 18-inch long, 2-inch diameter steel tube, and includes a Shelby tube head assembly which can be attached to a length of steel rod for easier driving of the sampler. Shelby tube samples will be collected in the following manner.

- The sampling crew will access the sample location using lumber or plywood, if needed, to provide stable footing on the marshy ground.
- Any surface vegetation will be cleared from the Shelby tube sample location to expose the surface of the underlying sediment.
- The Shelby tube assembly (the tube and the attached head) will be driven manually into the sediment at a slow, steady rate until the top of the Shelby tube reaches the surface of the sediment. The Shelby tube will be pushed by a drill rig to the desired depth if the sample is collected underneath the landfilled material. The Shelby tube will be allowed to remain in the sediment for 20 minutes to allow the sample to adhere to the sides of the tube.
- The Shelby tube assembly will then be given a quarter-turn and the assembly withdrawn from the sediment in a slow but steady manner.
- Once the Shelby tube is withdrawn, a polyethylene cap will be immediately secured around the open end of the Shelby tube sampler, the sample tube will removed

from the sampler head, and a second polyethylene cap will be placed on the other end of the sampler. Both caps will be secured by tape to the sides of the Shelby tube and the sample labeled according to the procedures described in Section 2.10.

- If an incomplete sample is collected, the sampler will remove the Shelby Tube sample head after a second tube is driven into the sediment (for inner lagoon samples only), and apply the first polyethylene cap to the top end of the sampler to seal the upper end first. Then the sampler will retrieve the Shelby tube manually from the sediment and place a second cap on the lower end of the sample tube.

Placing the cap on the upper end of the sampler may make it easier to retain a complete sample. The sampler should estimate the amount of sample retained in the Shelby tube after the sample has been collected.

The sampling team will also collect additional material for analysis from the same location as the Shelby tube sample by using decontaminated steel spoons or small shovels to collect jars of bay mud for other physical testing as shown in Table 1. These samples can be collected while the Shelby tubes are being collected. Samples will be collected by first clearing surface vegetation away from the sample location, and then digging approximately 6 inches into the sediment to collect the sample. The sample will be placed in a decontaminated stainless steel bowl before being placed into the requisite bottles (See Table 1 for bottle requirements).

2.5 MONITORING WELL AND PIEZOMETER INSTALLATION

Seven new groundwater monitoring wells and three piezometers will be installed. This section describes the methods that will be used for well and piezometer installation, including site preparation and well installation procedures. The proposed wells and piezometers will be located as follows (Figure 1).

- **MW-05 and MW-07** will be located along the eastern/southeastern perimeter of the landfill, along the presumed location of the dike-like feature. Both MW-05 and MW-07 will be screened below the low-permeability bay mud. These wells will be located along the downgradient side of the landfill, and groundwater levels and water quality samples will be collected from these wells per Table 1.

- **MW-06** will be located along the southeastern perimeter of the landfill. Unlike MW-05 and MW-07, this well will be screened in the refuse. Groundwater levels and water quality samples will be collected from these wells per Table 1.

- **MW-08 through MW-11** will be located throughout the northern interior of the landfill, and will screened in the refuse above the bay mud layer. These wells will be located along the upgradient side of the landfill, and groundwater levels and water quality samples will be collected from these wells per Table 1.

- **PZ-01 through PZ-03** will be located throughout the southern interior of the landfill, and will be shallow water level measurement points screened in the refuse above the bay mud layer.

Borings will be advanced by HSA, using the appropriate sampler to obtain soil samples for lithologic logging, as described in Section 2.3.

2.5.1 Soil Lithologic Logging

All borings will be logged continuously by a field geologist to the boring's total depth, following the same procedures described for test pits in Section 2.2.4. The lithologic log for each boring will be based on visual observation and description of the corresponding soil samples in accordance with ASTM D2488.

2.5.2 Monitoring Well Construction

All drilling and well and piezometer installation will be performed by a licensed well drilling contractor in compliance with WAC 173-160 (Minimum Standards for Construction and Maintenance of Wells). A summary of the proposed well and piezometer construction specifications is presented in Table 4. Once the borehole has been advanced to the desired depth using an HSA, the well screen and riser will be installed. The riser, screen, and bottom cap will all be decontaminated immediately before assembly and installation unless they arrive already decontaminated from the manufacturer. The procedures for equipment decontamination are described in Section 3.

Because MW-05 and MW-07 will be installed below the low-permeability bay mud layer, a larger 12-inch-diameter auger will be drilled to the top of the bay mud layer. The auger will be withdrawn from the boring, and the boring will be filled with bentonite chips. The chips will be hydrated, and the 12-inch-diameter auger will be redrilled into the bentonite-filled boring to approximately 1-foot below the top of the bay mud. The larger auger casing will remain in-place and serve as a temporary conductor casing sealed into the bay mud by the bentonite. A smaller diameter HSA will be used inside of the larger auger to complete the remainder of the borehole. The well casings will be installed inside of the smaller augers. This same technique will be used when exploring the thickness of the bay mud unit at location MW-08 and MW-10 with the exception that no deep monitoring well will be constructed. Both MW-08 and MW-10 will be completed as shallow monitoring wells as described below.

Prior to well or piezometer installation, the total depth of the borehole will be verified using a weighted measuring tape. A 6-inch-thick base layer of filter sand will be placed at the base of the borehole. The depth of the top of the sand base will be verified using a weighted measuring tape.

The well will be assembled within the HSA by adding sections to the top of the riser until the screened section is set at the desired depth. For wells MW-05 and MW-07 AMEC may use either 2-inch-diameter, 5-foot screens or 2-inch-diameter, 10-foot screens in the wells. The top of the screen will be located 2 to 3 feet below the base of the bay mud layer. The top of the sand pack for this deeper wells will be placed no higher than the base of the bay mud.

For the three shallow piezometers and the five shallow monitoring wells, a 5-foot-long or a 10-foot-long screen will be used unless the depth to the bay mud does not allow for it. The top of the screen will be placed approximately 1 foot above the water table. Care will be taken to prevent any materials from entering the well during down-hole assembly. A well cap will be used to prevent materials from entering the well.

The uppermost section of the well riser will be precut so that when the well is in place, the top of the well riser will be approximately 3 feet above the ground surface for the stand pipe finish. The survey measuring point on the upper rim of the PVC riser will be permanently identified by cutting a double notch into the rim or by labeling the rim with a permanent marker.

The sand pack will be placed within the annular space surrounding the well screen while the HSA is removed simultaneously. The filter pack will be added slowly in order to prevent bridging of the sand between the riser and the auger. When adding the filter pack below the water table, a tremie pipe may be used. Frequent depth measurements will be taken using a weighted measuring tape to verify the effectiveness of this procedure. The augers or casings will be extracted in increments no greater than 2 feet to minimize the potential for native sediments to cave or slump into the annular space and thereby ensure all annular space is filled with filter pack. The well will be surged after the filter pack has been installed to eliminate any voids that may exist. Additional filter pack will be added after surging if the filter pack settles during surging.

The filter pack will extend to at least 2 feet above the top of the screen. An annular sealant of hydrated bentonite chips or bentonite grout will be placed directly above the filter pack while the augers or casing are removed in 2-foot increments. The seal will be extended a minimum of 2 feet above the top of the filter pack. The seal will be hydrated with potable water every 2 feet when placed in the unsaturated zone.

Depending on the conditions encountered in the field, prepacked well screens may be used; if prepacked well screens are used, sand will be added to the annulus between the sand pack to stabilize the well casing. This additional sand will be added slowly to prevent bridging of the sand between the well casing and the auger. If prepacked well screens are used, the well will not be surged during placement.

For MW-05 and MW-07 the seal will be placed to the top of the bay mud layer, and the innermost auger will be removed. The inside of the larger auger serving as a conductor casing will be removed slowly from the subsurface. The bentonite chips will be replenished within the augers as the flights are withdrawn, and maintained to within 1 to 2 feet of the land surface.

The seals for the piezometers and the shallow monitoring wells will be placed within the annular space between the well casing and the augers as the augers are withdrawn, and the seal will be extended to within 1 to 2 feet of the land surface.

All new wells and piezometers will be completed with locking, above-grade monuments and protective bollards.

2.5.3 Monitoring Well Development

Monitoring wells will be developed using a bailer and/or submersible pump combined with surging no sooner than 24 hours following monitoring well installation completion. The well will be surged for 5 minutes, after which two borehole volumes of water will be removed. Water quality parameters (temperature, pH, specific conductivity, dissolved oxygen [DO], oxidation reduction potential [ORP], and turbidity) of well development water will be measured and recorded, and another borehole volume of well water will be removed. Development will be considered complete when all of the following conditions are met.

1. A minimum of 10 borehole volumes of water have been removed.
2. The development water is free of sediment and turbidity compared to the beginning of development. If zero turbidity cannot be achieved, then a target of less than 10 nephelometric turbidity units (NTU) will be established.
3. Three consecutive measurements of all water quality parameters do not vary by more than 10 percent.

If parameters have not stabilized after 13 borehole volumes of water have been purged, then well development will be considered to be complete. In addition, well development will be considered complete if the well goes dry prior to removal of the minimum 10 borehole volumes. All well development water will be placed in containers and held on site pending testing to determine the appropriate disposal method. The bottom of the well will be “sounded” to verify that fine material has been removed from the interior of the well casing.

Bailers and surge blocks used to develop more than one well will be decontaminated by wiping with a detergent such as Simple Green, washing with an Alconox solution, followed by a tap water rinse and distilled water rinse. The outside of the pump tubing will be decontaminated by spraying with an Alconox solution and rinsing with distilled water. The interior of pumps and pump tubing will be decontaminated by pumping distilled water through the pump and tubing until the electrical conductance of the discharge water is equal to or less than 50 microsiemens per cm (µS/cm). All decontamination fluids will be containerized pending analytical testing to determine the appropriate disposal method.

Baseline sampling will proceed in the new wells no sooner than 48 hours following development.

2.6 GROUNDWATER SAMPLING

The seven new wells will be sampled initially for a complete suite of groundwater parameters then quarterly for the next two quarterly events when the existing groundwater monitoring wells are sampled. The groundwater samples from the new wells will be analyzed for the full suite of groundwater analytes as shown in Table 1.

Quarterly sampling of the existing groundwater monitoring wells will also be performed quarterly for three quarters. The groundwater samples from these wells will be analyzed for the focused suite of analytes shown in Table 1.

Sampling will be timed to occur as close to low tide as possible during the daylight hours. Sampling during low tide is preferred to optimize the influx of low-salinity groundwater in the area of the well, and minimize seawater influx. If water levels are too low in the well at low tide to properly purge the well and obtain enough sample volume, sampling will be conducted when the water level in the well is higher.

2.6.1 Manual Water Level Measurements

Water level measurements from the ten monitoring wells will be collected during quarterly groundwater sampling. Water levels will be collected using an electric water-level measurement device graduated in 0.01-foot intervals. When measuring a water level at each well, the well cap will be opened and the well will be allowed to vent for 20 minutes. An electric sounding tape and weight will be then lowered slowly into the water to prevent splashing. The end of the tape will be lowered into the well until contact with the water surface closes the circuit activating the indicator (light, buzzer, etc.). The tape will be raised and lowered a few inches at a time to best locate the point where the indicator is activated. The tape will then be held against the surveyed measuring point at the top of the well casing, as marked during surveying activities (see Section 2.11). The water level will be recorded on a water-level measurement form. The water-level measurement device will be decontaminated before and after each water level measurement by rinsing with a dilute Alconox solution, then rinsing with deionized water. Accuracy of the device is approximately 0.02 foot for depths of less than about 250 feet. Water level measurements will be collected during the hour prior to and following low tide to minimize tidal influence.

2.6.2 Sample Collection and Preparation

Groundwater will be collected using low-flow sampling techniques in order to collect samples representative of actual site conditions and to reduce the possibility of stripping volatile organic compounds (VOCs) from groundwater or mobilizing colloids that are immobile during normal groundwater flow conditions. The required sample jars for each analysis are listed in the Quality Assurance Project Plan (QAPP), included as Appendix B in the RI/FS Work Plan (AMEC, 2008b).

The following equipment will be needed to sample the groundwater monitoring wells:

- Well access equipment (key, socket set, etc.);
- An electric water-level indicator calibrated to 0.01 foot, and sufficiently long to reach the bottom of the well;
- A suitable, low-flow submersible pump (e.g., Grundfos or equivalent) and associated tubing;
- A sufficient number of containers to store all purge water;
- A calibrated flow-through water quality meter and calibration solutions to measure temperature, pH, specific conductivity, DO, turbidity, and ORP;
- In-line filters for dissolved metals analyses;
- Sampling containers, including containers for quality control samples;
- All required documentation;
- Personal protective equipment as described in the HASP; and
- Decontamination equipment, including Alconox or nonphosphate detergent and distilled or deionized water.

All reusable equipment in contact with the well or water samples will be decontaminated prior to its use, as outlined in Section 3.

Water levels will be measured prior to and during purging. Wells will be purged at a low rate (approximately 200 to 500 milliliters per minute [ml/minute]), and groundwater quality parameters (temperature, pH, specific conductivity, DO, ORP, and turbidity) will be monitored every 3 to 5 minutes for stabilization prior to sample collection. Stabilization will be considered reached when all parameters have been within +/-10 percent of each other for three consecutive readings. Once stabilization has been achieved, the groundwater samples will be collected directly from the sample discharge tube connected to the pump.

Groundwater samples from the new and existing wells will be analyzed for different suites of contaminants, as shown in Table 1. Samples for dissolved metals will be collected and filtered in the field using a 0.45-microliter (µL) filter. Sample preservation requirements and quality control sample collection methods are described in the QAPP (Appendix B of the RI/FS Work Plan). Samples will be analyzed for hardness cations if needed for calculating cleanup levels.

Where samples to be analyzed for total and dissolved metals are collected from the new wells, turbidity measurements and the presence of particulates in unfiltered water (as documented by photographs) will be used to determine whether total or dissolved metals are most representative of groundwater conditions in these wells.

Samples will be labeled and shipped following appropriate chain-of-custody procedures described in Section 2.10.

2.6.3 Landfill Gas Screening

The presence of landfill gas (LFG) in the waste will be assessed during the quarterly groundwater monitoring events. An LFG monitoring instrument (such as a GEM 500 4-gas monitor) will be utilized to measure landfill gas potentially present in the headspace within each monitoring well. Landfill gases to be monitored include methane, carbon dioxide, hydrogen sulfide and oxygen. The following procedures will be followed when testing for landfill gas in the monitoring wells:

- The LFG instrument will be warmed up and calibrated to the manufacturer’s guidelines and a reading of the ambient conditions in the vicinity of the monitoring well will be recorded,

- The instrument will be fitted with a long-neck sampling port which can be extended into the monitoring well in order to reduce sampling of ambient air,

- The well plug will be removed and the sampling port will be immediately extended down into the monitoring well,

- The LFG readings will be monitored until stabilized or until the readings start to decline upon which the highest observed reading of methane, carbon dioxide, hydrogen sulfide, and oxygen will be recorded on the field sampling form,

- The sampling port will be removed from the monitoring well and the instrument will be allowed to run while sampling ambient air for approximately one minute or until the instrument readings have returned to ambient levels.

A summary of the landfill gas monitoring will be included as part of the Phase II report.

2.7 SEASONAL AND TIDAL EFFECTS ASSESSMENT

Automatic water levels will be collected from existing well MW-03 and the wells (MW-06, MW-08, MW-09, MW-10, and MW-11) and piezometers (PZ-01, PZ-02, and PZ-03) that will be installed as described in Section 2.5. All of these water level monitoring points are screened in the uppermost aquifer and so are expected to be influenced by tidal water level fluctuations. Manual water level measurements have limited utility at tidally influenced sites, whereas automatic water levels can be used to determine the mean groundwater gradient for the shallow groundwater, as well as the groundwater flow directions at high and low tide.

Remote battery-powered transducer/loggers will be installed in the well and piezometer casings, and will collect water pressure readings which can be converted into a water level measurement using the top-of-casing elevation. These water levels will be downloaded from the transducers during the quarterly groundwater and surface water monitoring events.

Careful placement and installation of the transducer/loggers is necessary to ensure data quality. A table will be prepared showing the top-of-casing elevation, the screen interval depths, and assigned transducers numbers for each well or piezometer. The depth to water will be measured just prior to the installation of the transducer in each well.

Each transducer will be:

- Programmed on the same laptop computer with the internal clocks set to the same time;
- Programmed to collect data once an hour starting at the same time for each transducer;
- Suspended in each casing using stainless-steel chain attached to a “well-dock” ring sized to fit inside the outside diameter of PVC casing, but not the inside casing diameter; the stainless steel chain will be secured to the well dock ring with a length of stainless steel wire;
- Positioned within the well or piezometer screen at the approximate midpoint of the transducer measurement point to minimize error;
- Installed deep enough so that the transducer is not exposed during periods of low groundwater elevation; care must be taken to ensure the chain doesn’t go “slack” during installation, which may indicate that the transducer was installed in the incorrect well or piezometer.

Each transducer/logger is capable of logging up to 32,000 pressure readings. A separate barometric pressure transducer (barotroll) will be left on site in a secure location, and the barotroll will measure the atmospheric pressure changes on site. This transducer must be located outside of a building—either suspended within a well monument or well casing. The transducer/loggers are nonvented, so the wells will be fitted with replacement slip caps that have a small hole in the cap to allow the pressure in the well to equalize. The drainage around the subgrade wells (MW-02 and MW-04) will be modified to reroute surface flow away from the well.

The transducer readings will be downloaded during the quarterly sampling events using a mini-USB computer cable and appropriate software. Depth to groundwater will be measured before the transducer is removed from the well. These manual readings will be used to check the water levels calculated based on the transducer pressures. Once the data are downloaded from each transducer, the transducer will be re-installed in each well/piezometer.

Our experience at other Puget Sound sites as well as tests by other investigators has shown that a series of 71 consecutive hourly water level measurements can be used to calculate the mean hydraulic groundwater gradient at a site, while minimizing the influence of tidal variation (Serfes, 1991). Collecting water level data every 15 minutes is not required to evaluate tidal effects. This hourly water level information, collected over a period of several months, will also allow for determining the influence of seasonal water level variations on shallow groundwater flow.

2.8 SEEP SAMPLING

Seep sampling will be conducted at low tide to determine if groundwater is causing contaminants from the upland to impact the sediments of Padilla Bay and Padilla Bay Lagoon. Three seep locations (SP-01, SP-02, and SP-03) will be sampled quarterly. The seep samples will be analyzed for the suite of contaminants shown on Table 1.

2.8.1 Field Procedures

Seep samples will be collected at SP-01, SP-02, or SP-03. Dependent on the volume of flow coming from the seep, samples may be collected by submerging the sample container into the seep, or by using a peristaltic pump to collect a water sample. If there is sufficient flow, the lid of a clean sampling container will be removed, and the mouth of the jar submerged a few inches under the surface of the seep water. The sample will be taken in an area free of floating debris or disturbance caused by the movement of the field personnel. Each sample jar will be sealed and retained on ice until transported to the contract laboratory. If there is insufficient flow from the seep that submerging a sample jar would cause suspension of sediments, a peristaltic pump will be used to collect the water sample, as described in the RI/FS Work Plan (AMEC, 2008b).

2.8.2 Sample Collection and Preparation

Seep samples will be collected by directly filling labeled, precleaned sample jars. The required sample jars for each analysis are listed in the QAPP (Appendix B of the RI/FS Work Plan). Each sample jar will be sealed and retained on ice until transported to the contract laboratory.

The following equipment will be needed to sample the seeps:

- a calibrated flow-through water quality meter and calibration solutions to measure temperature, pH, specific conductivity, DO, turbidity, and ORP;
- sampling containers, including containers for quality control samples;
- all required documentation;
- personal protective equipment as described in the HASP; and
- decontamination equipment, including Alconox or nonphosphate detergent and distilled or deionized water.

All reusable equipment in contact with the sampling tubes or water samples will be decontaminated prior to use, as outlined in Section 3.0.

Seep samples will be analyzed for the focused suite of contaminants listed in Table 1. Sample preservation requirements and quality control sample collection methods are described in the QAPP (Appendix B of the RI/FS Work Plan). Samples will be analyzed for hardness cations if needed for calculating cleanup levels.

2.9 SURFACE WATER SAMPLING

Attempts will be made to collect surface water samples quarterly at surface water sample locations SW-01, SW-02, SW-03, SW-04, SW-05, SW-06, and SW-07 (Figure 1). Location SW-02 was not sampled during any of the earlier quarterly sampling events because surface water was not present. A sample was collected from SW-07 only during the December and April sampling events when surface water was present. We will continue to observe the conditions at locations SW-02 and SW-07 during future quarterly monitoring events at these locations, and if surface water is present a surface water sample will be collected.

2.9.1 Field Procedures

Surface water samples will be collected from the locations as shown on Figure 1, and as described above, providing that sufficient water is present at the sampling locations. The lid of a clean sampling container will be removed, and the mouth of the jar will be submerged a few inches under the surface to allow the surface water sample to fill the jar. The sample will be collected in an area free of floating debris or disturbance caused by movement of field personnel. If the surface water at a given location has low flow such that sampling by dipping a jar would cause suspension of sediments, a peristaltic pump will be used to purge the sample point and to collect the water sample, in a similar manner as described for groundwater sampling.

2.9.2 Sample Collection and Preparation

Surface water samples will be collected by directly filling labeled, precleaned sample jars. The required sample jars for each analysis are listed in Table 1. Each sample jar will be sealed and retained on ice until transported to the contract laboratory.

The following equipment will be needed to collect surface water samples:

- a calibrated water quality meter and calibration solutions to measure temperature, pH, specific conductivity, DO, turbidity, and ORP;
- sampling containers, including containers for quality control samples;
- all required documentation;
- personal protective equipment as described in the HASP; and
- decontamination equipment, including Alconox or nonphosphate detergent and distilled or deionized water.

All reusable equipment in contact with the water samples will be decontaminated prior to its use, as outlined in Section 3.0.

Surface water samples will be analyzed for the focused suite of contaminants listed in Table 1. Sample preservation requirements and quality control sample collection methods are described in the QAPP (Appendix B of the RI/FS Work Plan). Samples will be analyzed for hardness cations if needed for calculating cleanup levels.

2.10 SAMPLE LABELING AND CHAIN-OF-CUSTODY

A sample label will be affixed to each sample container for soil or water. Each label will include:

- sample number;
- sampling event location;
- date and time of sample collection;
- sample name;

- preservatives added to the sample (if required); and
- parameter(s) for which the sample is to be analyzed.

Samples will be named and numbered as follows. Each soil sample will be identified by the name of the boring or test pit from which it was collected, the depth of the bottom of the sample interval, and the month and year when the sample was collected. For instance, a sample taken from a sample interval of 4 to 5 feet at the boring for monitoring well MW-03 in September 2008 would receive the following identifier:

MW-03-5-0908

For Test Pit G12 at the same depth and height and collected during the same month, the sample identification would be:

G12-5-0908

Water samples will be labeled in a similar fashion, including the name of the surface water (SW), seep (SP), or monitoring well (MW) location, the month, and the year. A sample depth indicator is not required for water samples. For instance, surface water sample 1 collected in December 2008 would receive the following identifier:

SW-01-1208.

After sampling is completed for the day, all samples will be packed for shipping and placed in iced transport containers. The transport containers will consist of sturdy, insulated, commercially produced coolers. All bottle caps will be secured tightly. All glass containers will be placed secured into position within the shipping container to avoid breakage. Trip blanks will be included in all transport containers that carry water samples being analyzed for VOCs. The chain-of-custody form will be taped to the inside lid of the cooler or shipping container, unless the container is hand-delivered to the analytical laboratory.

During sample collection or at the end of each day and prior to shipping or storage, chain-of-custody forms will be completed for all samples collected by AMEC. The chain-of-custody form will include information such as sample names, sample times, sample dates, the type of media, and the analyses requested. Any necessary changes to chain-of-custody forms, sample container labels, or the field log book will be made by striking out the error with one line, initialing and dating the error, and re-entering the correct information. Samples with extra volume for laboratory quality control procedures (matrix spike/matrix spike duplicates [MS/MSD] and laboratory duplicates) will be designated as such on the chain-of-custody form. The field team will ensure that analyte method numbers and analyte lists required for the project are listed on the chain-of-custody form, attached to the chain-of-custody form, or referred to on the chain-of-custody form. Every person who takes possession of the samples while transporting the samples from the field to the laboratory will be required to sign the chain-of-custody form.

The samples collected will be maintained following chain-of-custody procedures and preservation requirement until delivery to the lab or an authorized courier service. Samples collected for geotechnical testing may not require cooling to 4 degrees Celsius (°C) (see Table 1). Upon receipt of the sample transport containers by the analytical laboratory, laboratory personnel will open the containers and examine the contents for problems such as damaged transport containers, broken custody seals, missing or broken sample bottles, chain-of-custody discrepancies, and documentation errors. Problems will be reported immediately to AMEC. After the samples are analyzed by the analytical laboratory, laboratory personnel will store the samples in a secure location at the laboratory for the remainder of their holding times.

2.11 SURVEYING

The horizontal position of all soil sampling locations (including test pits and/or direct-push locations) and the monitoring well or piezometer locations will be surveyed by a professional surveyor. Horizontal survey data will be based on the horizontal Washington State Plane coordinate system.

The ground surface at soil sample locations will be surveyed for elevation. The seven new groundwater monitoring wells and three piezometers will also be surveyed for elevation of the top-of-casing, and adjacent ground surface. Vertical survey data will be based on the North American Vertical Datum of 1988 (NAVD88). All survey data will be compatible with Environmental Information Management (EIM) submission requirements. The survey shall use such practices that result in horizontal errors no greater than 0.10 foot. A temporary benchmark will be established on the site to be used as a tie-in point for any future surveys that may be necessary.

3.0 DECONTAMINATION

Decontamination is performed as a quality assurance measure and a safety precaution to prevent cross-contamination between samples and to maintain a clean working environment. The purpose of decontamination is to remove contaminated materials clinging to gloves, boots, equipment, and sample containers prior to their removal from the work area. Decontamination also includes the removal and disposal of contaminated clothing and gloves.

Decontamination is achieved mainly by rinsing with soap or detergent solutions, tap water, and deionized water. Equipment will be allowed to air dry after being cleaned. Decontamination will be accomplished between each sample collection station and/or depth.

The following is a list of supplies needed to decontaminate equipment and personnel:

- Clean gloves: inner and outer;
- Cleaning liquids and dispensers: soap and/or a powdered detergent solution such as Alconox, tap water, and deionized water;
- Waste storage containers: drums, boxes, and plastic bags;
- Plastic ground cover;
- Chemical-free paper towels;
- Cleaning containers: plastic or stainless steel buckets and pans; and
- Cleaning brushes.

3.1 SAMPLING EQUIPMENT

At a minimum, sampling equipment will be decontaminated prior to initial use and after each sample is collected. Sampling equipment (i.e., spoons, bowls) decontaminated prior to field use will be wrapped in aluminum foil and stored in a sealed plastic bag to prevent contamination. Monitoring equipment (i.e., well probe, pH probe, tape measures) will be rinsed in distilled water and wiped dry with chemical-free paper towels. Decontamination procedures will include washing and scrubbing with an Alconox soap solution, rinsing with tap water, rinsing with distilled water, and air drying. If heavy, oily substances are found on sampling equipment, Simple Green, dilute acids, or acetone will be used to clean the equipment. Cross-contamination will be minimized by sequencing sampling events from areas expected to have lower concentrations of suspected contaminants to areas suspected of relatively higher concentrations.

3.2 PERSONNEL

It is expected that most field work will be conducted under Level D protection (disposable Tyvek coveralls, steel-toe boots, hard hat, and protective gloves). If Level C protective equipment is deemed necessary, the following steps will be used for personnel decontamination.

1. Wash boots and outer gloves with brush and detergent water, then rinse twice with tap water.
2. Remove disposable Tyvek coveralls, remove outer gloves, and place both coveralls and gloves in a disposal container.
3. Remove respirator for cleaning and storage.
4. Wash and remove inner gloves.
5. Wash and rinse face and hands with potable water or waterless cleaner.
6. Clean and sanitize respirator face piece after each day's use.
7. Discard respirator cartridges daily.
8. Shower and shampoo as soon as possible at end of each work day.

When Level D or modified Level C equipment is used, these steps will be appropriately modified.

3.3 DOWN-HOLE DRILLING TOOLS

HSA casing and sampling equipment will be on racks mounted on a support truck. The auger casing and sampling equipment will be decontaminated on the racks using a high-pressure steam cleaner. Spray curtains will be mounted on the periphery of the steam cleaning racks to prevent overspray from leaving the decontamination area. Decontamination water generated during steam cleaning will be collected in a sump below the racks on the support truck. Decontamination water will be transferred from the sump to storage drums pending analysis and disposal.

Well casing, screen, and well caps not delivered to the wellhead in the original packing box will be steam cleaned by the drillers prior to installation.

3.4 HEAVY EQUIPMENT

Contractors will be required to bring decontaminated equipment to the site. It is the responsibility of the site geologist/engineer to ensure that all heavy equipment (e.g., drill rigs, excavator) removed from the work area is properly decontaminated. An equipment decontamination area will be designated. Most heavy equipment (e.g., drill rigs, excavator) will be decontaminated by brushing, scraping, and hot water pressure washing. The heavy equipment decontamination area will be constructed to contain decontamination fluids and residuals. Decontamination fluids and residual will be collected and transferred to labeled drums pending analysis and disposal. Heavy equipment decontamination will be documented in the field notebook, which will become part of the permanent project files.

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4.0 ANALYTICAL PROCEDURES

A summary of the analyses to be conducted during the Phase II RI is presented in Table 1. The QAPP for the sampling work is provided as Appendix B of the RI/FS Work Plan (AMEC, 2008b). The analyses and applicable methods to be performed on all samples, including quality assurance samples to be collected, are described in the QAPP. The Quality Assurance Manual for ARI is provided in Appendix C.

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5.0 MANAGEMENT OF INVESTIGATION-DERIVED WASTE

The sampling methods described in this SAP will generate IDW that may include soil, decontamination water, and purge water. Based on site history and results of previous investigations, potential contaminants in IDW may include any of the constituents listed in Table 1. All IDW generated by field investigations will be properly handled and disposed of according to local, state, and federal laws.

All IDW generated during the field investigation will be temporarily stored in 55-gallon drums at the site, and appropriate disposal arrangements will be made after receipt of analytical results. Drums will be clearly labeled with the type of material contained, the date the drum was filled, and sample location numbers corresponding to the location where the IDW originated.

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6.0 SCHEDULE AND DELIVERABLES

The field activities are expected to take place during spring 2010, and quarterly sampling and water level collection will be conducted through fall 2010. The data collected from the test pits, borings, and wells during this phase of the RI will be validated by AMEC after receipt from the laboratory. The field observations, the results of the soil physical testing, results from the quarterly groundwater, surface water, and seep samples, and the evaluation of groundwater levels will be reported in the Phase II RI report. It is anticipated that the Phase II RI report will be submitted to Ecology by late January 2011.

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7.0 REFERENCES

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TABLES

TABLE 1

SAMPLE COLLECTION SUMMARY
March Point (Whitmarsh) Landfill
Skagit County, Washington

				Physical Testing Methods [1]					Chemistry Analytical Methods			
Investigation Method	Matrix	Approximate Number of Samples To Be Collected [2]	Anticipated Depth (feet)	Sieve and Hydrometer Particle Size ASTM D-421/422 [3]	Atterberg Limits ASTM D-4318	Moisture Content [4] ASTM D-2216	Unconfined Triaxial Compressive Strength (UU) ASTM D-2850	Flexible Wall Hydraulic Conductivity ASTM D-5084	Full Soil Suite [5,6,7]	Asbestos	Full Water Suite [6,7,8]	Reduced Water Suite [9]
Perimeter Test Pits (G12 to G28, and G31)	Soil (bay mud)	18	5 to 10	One 16-oz. Jar	One 16-oz. Jar	One 4-oz. Jar						
	Soil (related to suspicious or industrial waste)	up to 17	any						X	TBD		
MW-3-related Test Pits (G28 to G30)	Soil (bay mud)	3	5 to 10	One 16-oz. Jar	One 16-oz. Jar	One 4-oz. Jar						
	Soil (related to suspicious or industrial waste)	up to 3	any						X	TBD		
Northern Landfill Areas Test Pits (G32 through G36)	Soil (related to suspicious or industrial waste)	up to 5	any						X			
Shelby Tube Samples (ST-01, ST-02, MW-07, MW-08, and MW-10)	Soil	5	0 to 2	One 16-oz. Jar	One 16-oz. Jar	One 4-oz. Jar	One core needed	One core needed				
Direct Push Samples [10]	Soil (bay mud)	3	10 to 15	One 16-oz. Jar	One 16-oz. Jar	One 4-oz. Jar						
MW-05, MW-06, MW-07, MW-08, MW-09, MW-10, MW-11 Groundwater Samples	Soil (bay mud) [11]	3	10 to 15						X			
	Water	7 per quarter	Varies								X	
MW-02, MW-03, MW-04 Groundwater Samples [12]	Water	3 per quarter (including duplicate)	Varies									X
Seep Samples [13]	Water	3 per quarter	Varies									X
Surface Water Samples [12]	Water	up to 7 per quarter	Varies									X

Notes
1. Samples from each test pit or direct-push boring location will be submitted to the lab as "hold for analysis." The project engineer will consult with the project team as to which samples will be submitted for analysis using the methods indicated. The sampler should list these methods on the chain-of-custody and leave the box unchecked. Selection criteria will include representative areal distribution, representative vertical distribution, and representative soil type distribution.
2. One 8-oz archive soil sample, for potential D/F analysis, will be collected at every location where a soil chemistry sample is collected. These archive samples will be frozen at the laboratory.
3. The need for sieve and/or sieve and hydrometer testing will depend on the grain size of the sample
4. For moisture content the field crew must fill the jar completely and ensure the jar will seal by wiping excess sample from the rim of the jar.
5. The "full soil suite" consists of analyses for VOCs, SVOCs, phenols, PAHs, PCBs, OC pesticides, carbaryl, TPH-HCID, TPH-G, TPH-Dx, and metals.
6. For the full soil and water suites, the metals to be analyzed include antimony, arsenic, beryllium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, thallium, vanadium and zinc.
7. For the full soil and water suites, all TPH-Dx sample extracts will be treated prior to analysis using silica gel/acid wash procedures to minimize interferences from nonpetroluem organic matter. Field staff will annotate the chain-of-custody indicating the need for a silica gel/acid wash procedure.
8. The Full Water Suite consists of analyses for VOCs, SVOCs, phenols, PAHs, PCBs, OC pesticides, carbaryl, TPH-HCID, TPH-G, TPH-Dx, dissolved metals, total metals, pH, and TDS.
9. The Reduced Water Suite will consist of analyses for PCBs, OC pesticides, dissolved metals, total metals. The metals in the reduced water suite will be limited to arsenic, lead, mercury, and thallium.
10. Direct-push samples may be collected at Test Pit Locations G12 through G31 only if the bay mud is not encountered at the test pit location.
11. Bay mud soil samples will be collected from MW-07, MW-08, and MW-10 only.
12. The Reduced Water Suite for Groundwater and Surface Water will not include TPH-Dx, since detections of TPH-Dx were not detected above the PSLs.
13. Seep samples will be analyzed for the reduced water suite plus TPH-Dx. All seep water TPH-Dx samples will be treated prior to analysis using silica gel cleanup/acid wash procedures to minimize interferences from nonpetroluem organic matter. Field staff will annotate the chain-of-custody indicating the need for a silica gel/acid wash procedure.

Abbreviations
OC Pesticides = Organochlorine pesticides
PAHs = Polycyclic aromatic hydrocarbons
PCBs = Polychlorinated biphenyls
SVOCs = Semivolatile organic compounds
TBD = To be determined
TDS = Total dissolved solids
TPH = Total petroleum hydrocarbons
TPH-Dx = Total petroleum hydrocarbons, diesel and heavy oils range
TPH-G = Total petroleum hydrocarbons, gasoline range
TPH-HCID = Hydrocarbon identification
VOCs = Volatile organic compounds

TABLE 2

SUMMARY OF SOIL SCREENING LEVELS

March Point (Whitmarsh) Landfill
Skagit County, Washington

concentrations in milligrams per kilogram (mg/kg)

Analyte[1,2]	CAS No.	Analytical Method[3]	Target Reporting Limit (PQL)[4]	MTCA Method A, Unrestricted Land Use	MTCA Method B, Carcinogen	MTCA Method B, Noncarcinogen	MTCA Method B Protective of Groundwater as Marine Surface Water[5]	Sites that Qualify for Simplified TEE - Industrial or Commercial Site[6]	Puget Sound Soil Natural Background (Ecology, 1994)[7]	PSL[8]
Metals										
Aluminum	7429-90-5	EPA 6010B	5.0	--[9]	--	--	**N/A[10]**	**--**	32,600.00	**32,600.00**
Antimony	7440-36-0	EPA 6010B	5.0	--	--	32.00	**578.60**	**--**	--	**32.00**
Arsenic	7440-38-2	EPA 7060A	0.10	20.00	0.67	24.00	**0.06**	**20 [11]**	7.00	**7.00**
Barium	7440-39-3	EPA 6010B	0.30	--	--	16,000.00	**N/A**	**1,320.00**	--	**1,320.00**
Beryllium	7440-41-7	EPA 6010B	0.1	--	--	160.00	**4,267.00**	**--**	0.60	**160.00**
Cadmium	7440-43-9	EPA 6010B	0.2	2.00	--	80.00	**1.21**	**36.00**	1.00	**1.21**
Chromium	7440-47-3	EPA 6010B	0.5	2,000.00	--	120,000.00	**960.00**	**135.00**	117***	**135.00**
Copper	7440-50-8	EPA 6010B	0.2	--	--	3,000.00	**1.07**	**550.00**	36.00	**36.00**
Iron	7439-89-6	EPA 6010B	5.0	--	--	--	**N/A**	**--**	58,700.00	**58,700.00**
Lead	7439-92-1	EPA 6010B	2.0	250.00	--	--	**1,620.00**	**220.00**	24.00	**220.00**
Manganese	7439-96-5	EPA 6010B	0.1	--	--	11,000.00	**0.40**	**23,500.00**	1,200.00	**1,200.00**
Mercury	7439-97-6	EPA 7471A	0.05	2.00	--	24.00	**0.03**	**0.7 [12]**	0.07	**0.07**
Molybdenum	7439-98-7	EPA 6010B	0.5	--	--	400.00	**0.02**	**71.00**	--	**0.50**
Nickel	7440-02-0	EPA 6010B	1.0	--	--	1,600.00	**10.69**	**1,850.00**	48.00	**48.00**
Selenium	7782-49-2	EPA 6010B	5.0	--	--	400.00	**7.38**	**0.80**	--	**5.00**
Silver	7440-22-4	EPA 6010B	0.3	--	--	400.00	**4,420.00**	**--**	--	**400.00**
Strontium	7440-24-6	EPA 6010B	0.1	--	--	48,000.00	**0.004**	**--**	--	**0.10**
Thallium	7440-28-0	EPA 6010B	5.0	--	--	5.60	**0.67**	**--**	--	**5.00**
Titanium	7440-32-6	EPA 6010B	0.5	--	--	--	**No CLARC[13]**	**--**	--	**--**
Vanadium	7440-62-2	EPA 6010B	0.3	--	--	560.00	**N/A**	**--**	--	**560.00**
Zinc	7440-66-6	EPA 6010B	1.0	--	--	24,000.00	**100.80**	**570.00**	85.00	**100.80**
TPH										
TPH - Hydrocarbon identification	NA	Ecology NWTPH-HCID	100	--	--	--			--	
TPH - Diesel range	NA	Ecology NWTPH-Dx	5	2,000.00	--	--	**N/A**	**15,000.00**	--	**2,000.00**
TPH - Heavy oil range	NA	Ecology NWTPH-Dx	10	2,000.00	--	--	**N/A**	**--**	--	**2,000.00**
TPH - Gasoline range	NA	Ecology NWTPH-Gx	5	30.00	--	--	**N/A**	**12,000.00**	--	**30.00**
SVOCs										
1-Methylnaphthalene	90-12-0	EPA 8270D	0.067	--	--	24.00	**N/A**	**--**	--	**24.00**
2,4,5-Trichlorophenol	95-95-4	EPA 8270D	0.33	--	--	8,000.00	**129.60**	**--**	--	**129.60**
2,4,6-Trichlorophenol	88-06-2	EPA 8270D	0.33	--	91.00	--	**0.03**	**--**	--	**0.33**
2,4-Dichlorophenol	120-83-2	EPA 8270D	0.33	--	--	240.00	**1.33**	**--**	--	**1.33**
2,4-Dimethylphenol	105-67-9	EPA 8270D	0.067	--	--	1,600.00	**2.20**	**--**	--	**2.20**
2,4-Dinitrophenol	51-28-5	EPA 8270D	0.67	--	--	160.00	**14.00**	**--**	--	**14.00**
2,4-Dinitrotoluene	121-14-2	EPA 8270D	0.33	--	--	160.00	**0.02**	**--**	--	**0.33**
2,6-Dinitrotoluene	606-20-2	EPA 8270D	0.33	--	--	80.00	**N/A**	**--**	--	**80.00**
2-Chloronaphthalene	91-58-7	EPA 8270D	0.067	--	--	--	**4.00**	**--**	--	**4.00**

TABLE 2

SUMMARY OF SOIL SCREENING LEVELS
March Point (Whitmarsh) Landfill
Skagit County, Washington

concentrations in milligrams per kilogram (mg/kg)

Analyte[1,2]	CAS No.	Analytical Method[3]	Target Reporting Limit (PQL)[4]	MTCA Method A, Unrestricted Land Use	MTCA Method B, Carcinogen	MTCA Method B, Noncarcinogen	MTCA Method B Protective of Groundwater as Marine Surface Water[5]	Sites that Qualify for Simplified TEE - Industrial or Commercial Site[6]	Puget Sound Soil Natural Background (Ecology, 1994)[7]	PSL[8]
SVOCs (Continued)										
2-Chlorophenol	95-57-8	EPA 8270D	0.067	--	--	400.00	**38,150.00**	**--**	--	**400.00**
2-Methylnaphthalene	91-57-6	EPA 8270D	0.067	--	--	320.00	**N/A**	**--**	--	**320.00**
2-Methylphenol	95-48-7	EPA 8270D	0.067	--	--	4,000.00	**N/A**	**--**	--	**4,000.00**
2-Nitroaniline	88-74-4	EPA 8270D	0.33	--	--	--	**N/A**	**--**	--	**--**
2-Nitrophenol	88-75-5	EPA 8270D	0.33	--	--	--	**No CLARC**	**--**	--	**--**
3-Nitroaniline	99-09-2	EPA 8270D	0.33	--	--	--	**No CLARC**	**--**	--	**--**
3,3'-Dichlorobenzidine	91-94-1	EPA 8270D	0.33	--	2.20	--	**0.0005152**	**--**	--	**0.33**
4,6-Dinitro-2-methylphenol	534-52-1	EPA 8270D	0.67	--	--	--	**No CLARC**	**--**	--	**--**
4-Bromophenyl phenyl ether	101-55-3	EPA 8270D	0.067	--	--	--	**No CLARC**	**--**	--	**--**
4-Chloro-3-methylphenol	59-50-7	EPA 8270D	0.33	--	--	--	**No CLARC**	**--**	--	**--**
4-Chloroaniline	106-47-8	EPA 8270D	0.33	--	--	320.00	**N/A**	**--**	--	**320.00**
4-Chlorophenyl phenyl ether	7005-72-3	EPA 8270D	0.067	--	--	--	**No CLARC**	**--**	--	**--**
4-Methylphenol (p-cresol)	106-44-5	EPA 8270D	0.067	--	--	400.00	**N/A**	**--**	--	**400.00**
4-Nitroaniline	100-01-6	EPA 8270D	0.33	--	--	--	**No CLARC**	**--**	--	**--**
4-Nitrophenol	100-02-7	EPA 8270D	0.33	--	--	--	**No CLARC**	**--**	--	**--**
Acenaphthene	83-32-9	EPA 8270-SIM	0.067	--	--	4,800.00	**65.29**	**--**	--	**65.29**
Acenaphthylene	208-96-8	EPA 8270-SIM	0.067	--	--	--	**N/A**	**--**	--	**--**
Aniline	62-53-3	EPA 8270D	0.067	--	180.00	--	**N/A**	**--**	--	**180.00**
Anthracene	120-12-7	EPA 8270-SIM	0.067	--	--	24,000.00	**133,700.00**	**--**	--	**24,000.00**
Benzidine	92-87-5	EPA 8270D	0.67	--	0.0043	240.00	**0.0000008**	**--**	--	**0.67**
Benzo(a)anthracene	56-55-3	EPA 8270-SIM	0.067	--	--	--	**0.13**	**--**	--	**0.13**
Benzo(a)pyrene	50-32-8	EPA 8270-SIM	0.067	0.10	0.14	--	**0.35**	**300.00**	--	**0.10**
Benzo(b)fluoranthene	205-99-2	EPA 8270-SIM	0.067	--	--	--	**0.58**	**--**	--	**0.58**
Benzo(ghi)perylene	191-24-2	EPA 8270-SIM	0.067	--	--	--	**N/A**	**--**	--	**--**
Benzo(k)fluoranthene	207-08-9	EPA 8270-SIM	0.067	--	--	--	**0.43**	**--**	--	**0.43**
Benzoic acid	65-85-0	EPA 8270D	0.67	--	--	320,000.00	**N/A**	**--**	--	**320,000.00**
Benzyl alcohol	100-51-6	EPA 8270D	0.33	--	--	24,000.00	**N/A**	**--**	--	**24,000.00**
Bis(2-chloroethoxy)methane	111-91-1	EPA 8270D	0.067	--	--	--	**No CLARC**	**--**	--	**--**
Bis-(2-chloroethyl) ether	111-44-4	EPA 8270D	0.067	--	0.91	--	**0.002926**	**--**	--	**0.07**
Bis(2-chloroisopropyl) ether [2,2'-oxybis(1-chloropropane)]	108-60-1	EPA 8270D	0.067	--	--	3,200.00	**168.00**	**--**	--	**168.00**
Bis(2-ethylhexyl) phthalate	117-81-7	EPA 8270D	0.067	--	71.00	1,600.00	**4.85**	**--**	--	**4.85**
Butyl benzyl phthalate	85-68-7	EPA 8270D	0.067	--	--	16,000.00	**369.20**	**--**	--	**369.20**
Carbaryl	63-25-2	EPA 8270D	0.4	--	--	8,000.00	**N/A**	**--**	--	**8,000.00**
Carbazole	86-74-8	EPA 8270D	0.067	--	50.00	--	**N/A**	**--**	--	**50.00**
Chrysene	218-01-9	EPA 8270-SIM	0.067	--	--	--	**0.14**	**--**	--	**0.14**
Dibenzo(a,h)anthracene	53-70-3	EPA 8270-SIM	0.067	--	--	--	**0.65**	**--**	--	**0.65**
Dibenzofuran	132-64-9	EPA 8270D	0.067	--	--	160.00	**N/A**	**--**	--	**160.00**

TABLE 2

SUMMARY OF SOIL SCREENING LEVELS

March Point (Whitmarsh) Landfill
Skagit County, Washington

concentrations in milligrams per kilogram (mg/kg)

Analyte^{1,2}	CAS No.	Analytical Method^{3}	Target Reporting Limit (PQL)^{4}	MTCA Method A, Unrestricted Land Use	MTCA Method B, Carcinogen	MTCA Method B, Noncarcinogen	MTCA Method B Protective of Groundwater as Marine Surface Water^{5}	Sites that Qualify for Simplified TEE - Industrial or Commercial Site^{6}	Puget Sound Soil Natural Background (Ecology, 1994)^{7}	PSL^{8}
SVOCs (Continued)										
Diethyl phthalate	84-66-2	EPA 8270D	0.067	--	--	64,000.00	**157.90**	**--**	--	**157.90**
Dimethyl phthalate	131-11-3	EPA 8270D	0.067	--	--	80,000.00	**288.00**	**--**	--	**288.00**
Di-n-butyl phthalate	84-74-2	EPA 8270D	0.067	--	--	8,000.00	**104.40**	**--**	--	**104.40**
Di-n-octyl phthalate	117-84-0	EPA 8270D	0.067	--	--	1,600.00	**N/A**	**--**	--	**1,600.00**
Fluoranthene	206-44-0	EPA 8270-SIM	0.067	--	--	3,200.00	**88.56**	**--**	--	**88.56**
Fluorene	86-73-7	EPA 8270-SIM	0.067	--	--	3,200.00	**553.00**	**--**	--	**553.00**
Hexachlorobenzene	118-74-1	EPA 8270D	0.067	--	0.63	64.00	**0.0004652**	**31.00**	--	**0.07**
Hexachlorobutadiene	87-58-3	EPA 8270D	0.067	--	13.00	16.00	**No CLARC**	**--**	--	**13.00**
Hexachlorocyclopentadiene	77-47-4	EPA 8270D	0.33	--	--	480.00	**4,406.00**	**--**	--	**480.00**
Hexachloroethane	67-72-1	EPA 8270D	0.067	--	71.00	80.00	**0.13**	**--**	--	**0.13**
Indeno(1,2,3-cd)pyrene	193-39-5	EPA 8270-SIM	0.067	--	--	--	**1.26**	**--**	--	**1.26**
Isophorone	78-59-1	EPA 8270D	0.067	--	1,100.00	16,000.00	**2.41**	**--**	--	**2.41**
Naphthalene	91-20-3	EPA 8270-SIM	0.067	5.00	--	1,600.00	**137.40**	**--**	--	**5.00**
Nitrobenzene	98-95-3	EPA 8270D	0.067	--	--	40.00	**2.88**	**--**	--	**2.88**
N-Nitrosodimethylamine	62-75-9	EPA 8270D	0.33	--	--	--	**0.01**	**--**	--	**0.33**
N-Nitrosodi-n-propylamine	621-64-7	EPA 8270D	0.330	--	0.14	--	**0.002285**	**--**	--	**0.33**
N-Nitrosodiphenylamine	86-30-6	EPA 8270D	0.33	--	200.00	--	**0.18**	**--**	--	**0.33**
Pentachlorophenol	87-86-5	EPA 8270D	0.33	--	8.30	2,400.00	**0.05**	**11.00**	--	**0.33**
Phenanthrene	85-01-8	EPA 8270-SIM	0.067	--	--	--	**N/A**	**--**	--	**--**
Phenol	108-95-2	EPA 8270D	0.067	--	--	48,000.00	**5,038.00**	**--**	--	**5,038.00**
Pyrene	129-00-0	EPA 8270-SIM	0.067	--	--	2,400.00	**3,546.00**	**--**	--	**2,400.00**
Pyridine	110-86-1	EPA 8270D	0.33	--	--	80.00	**N/A**	**--**	--	**80.00**
VOCs										
1,1,1,2-Tetrachloroethane	630-20-6	EPA 8260B	0.001	--	38.00	2,400.00	**0.02**	**--**	--	**0.02**
1,1,1-Trichloroethane	71-55-6	EPA 8260B	0.001	2.00	--	72,000.00	**148,500.00**	**--**	--	**2.00**
1,1,2,2-Tetrachloroethane	79-34-5	EPA 8260B	0.001	--	5.00	--	**0.02**	**--**	--	**0.02**
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	EPA 8260B	0.002	--	--	2,400,000.00	**N/A**	**--**	--	**2,400,000.00**
1,1,2-Trichloroethane	79-00-5	EPA 8260B	0.001	--	18.00	320.00	**0.09**	**--**	--	**0.09**
1,1-Dichloroethane	75-34-3	EPA 8260B	0.001	--	--	8,000.00	**0.02**	**--**	--	**0.02**
1,1-Dichloroethene	75-35-4	EPA 8260B	0.001	--	--	4,000.00	**N/A**	**--**	--	**4,000.00**
1,2,3-Trichlorobenzene	87-61-6	EPA 8260B	0.005	--	--	--	**No CLARC**	**--**	--	**--**
1,2,3-Trichloropropane	96-18-4	EPA 8260B	0.002	--	0.14	480.00	**N/A**	**--**	--	**0.14**
1,2,4-Trichlorobenzene	120-82-1	EPA 8260B	0.005	--	--	800.00	**2.67**	**--**	--	**2.67**
1,2,4-Trimethylbenzene	95-63-6	EPA 8260B	0.001	--	--	4,000.00	**N/A**	**--**	--	**4,000.00**
1,2-Dibromo-3-chloropropane	96-12-8	EPA 8260B	0.005	--	0.71	--	**N/A**	**--**	--	**0.71**
1,2-Dibromoethane	106-93-4	EPA 8260B	0.001	0.01	0.01	--	**N/A**	**--**	--	**0.01**
1,2-Dichlorobenzene	95-50-1	EPA 8260B	0.001	--	--	7,200.00	**15.26**	**--**	--	**15.26**

TABLE 2

SUMMARY OF SOIL SCREENING LEVELS

March Point (Whitmarsh) Landfill
Skagit County, Washington

concentrations in milligrams per kilogram (mg/kg)

Analyte[1,2]	CAS No.	Analytical Method[3]	Target Reporting Limit (PQL)[4]	MTCA Method A, Unrestricted Land Use	MTCA Method B, Carcinogen	MTCA Method B, Noncarcinogen	MTCA Method B Protective of Groundwater as Marine Surface Water[5]	Sites that Qualify for Simplified TEE - Industrial or Commercial Site[6]	Puget Sound Soil Natural Background (Ecology, 1994)[7]	PSL[8]
VOCs (Continued)										
1,2-Dichloroethane	107-06-2	EPA 8260B	0.001	--	11.00	1,600.00	**0.18**	**--**	--	**0.18**
1,2-Dichloropropane	78-87-5	EPA 8260B	0.001	--	15.00	--	**0.08**	**--**	--	**0.08**
1,3,5-Trimethylbenzene	108-67-8	EPA 8260B	0.001	--	--	4,000.00	**N/A**	**--**	--	**4,000.00**
1,3-Dichlorobenzene	541-73-1	EPA 8260B	0.001	--	--	--	**3.85**	**--**	--	**3.85**
1,4-Dichlorobenzene	106-46-7	EPA 8260B	0.001	--	42.00	--	**0.08**	**--**	--	**0.08**
2-Butanone	78-93-3	EPA 8260B	0.005	--	--	48,000.00	**N/A**	**--**	--	**48,000.00**
2-Chloroethyl vinyl ether	110-75-8	EPA 8260B	0.005	--	--	--	**No CLARC**	**--**	--	**--**
2-Hexanone	591-78-6	EPA 8260B	0.005	--	--	--	**No CLARC**	**--**	--	**--**
4-Chlorotoluene	106-43-4	EPA 8260B	0.001	--	--	--	**No CLARC**	**--**	--	**--**
4-Methyl-2-pentanone	108-10-1	EPA 8260B	0.005	--	--	6,400.00	**N/A**	**--**	--	**6,400.00**
Acetone	67-64-1	EPA 8260B	0.005	--	--	8,000.00	**N/A**	**--**	--	**8,000.00**
Acrylonitrile	107-13-1	EPA 8260B	0.005	--	1.90	80.00	**0.001**	**--**	--	**0.01**
Benzene	71-43-2	EPA 8260B	0.001	0.03	18.00	320.00	**0.13**	**--**	--	**0.03**
Bromobenzene	108-86-1	EPA 8260B	0.001	--	--	--	**No CLARC**	**--**	--	**--**
Bromodichloromethane	75-27-4	EPA 8260B	0.001	--	16.00	1,600.00	**0.09**	**--**	--	**0.09**
Bromoform	75-25-2	EPA 8260B	0.001	--	130.00	1,600.00	**0.93**	**--**	--	**0.93**
Bromomethane	74-83-9	EPA 8260B	0.001	--	--	110.00	**4.49**	**--**	--	**4.49**
Carbon disulfide	75-15-0	EPA 8260B	0.001	--	--	8,000.00	**N/A**	**--**	--	**8,000.00**
Carbon tetrachloride	56-23-5	EPA 8260B	0.001	--	7.70	56.00	**0.01**	**--**	--	**0.01**
Chlorobenzene	108-90-7	EPA 8260B	0.001	--	--	1,600.00	**13.86**	**--**	--	**13.86**
Chloroethane	75-00-3	EPA 8260B	0.001	--	350.00	32,000.00	**N/A**	**--**	--	**350.00**
Chloroform	67-66-3	EPA 8260B	0.001	--	160.00	800.00	**1.49**	**--**	--	**1.49**
Chloromethane	74-87-3	EPA 8260B	0.001	--	77.00	--	**0.54**	**--**	--	**0.54**
cis-1,2-Dichloroethene	156-59-2	EPA 8260B	0.001	--	--	800.00	**N/A**	**--**	--	**800.00**
cis-1,3-Dichloropropene	10061-01-5	EPA 8260B	0.001	--	--	--	**No CLARC**	**--**	--	**--**
Dibromochloromethane	124-48-1	EPA 8260B	0.001	--	12.00	1,600.00	**0.07**	**--**	--	**0.07**
Dichlorodifluoromethane	75-71-8	EPA 8260B	0.001	--	--	16,000.00	**N/A**	**--**	--	**16,000.00**
Diethyl ether	60-29-7	--	--	--	--	--	**--**	**--**	--	**--**
Ethylbenzene	100-41-4	EPA 8260B	0.001	6.00	--	8,000.00	**17.96**	**--**	--	**6.00**
Hexachlorobutadiene	87-68-3	EPA 8260B	0.005	--	13.00	16.00	**19.52**	**--**	--	**13.00**
Isopropylbenzene (cumene)	98-82-8	EPA 8260B	0.001	--	--	8,000.00	**N/A**	**--**	--	**8,000.00**
m,p-Xylenes	1330-20-7	EPA 8260B	0.001	9.00	--	16,000.00	**N/A**	**--**	--	**9.00**
Methyl tert-butyl ether	1634-04-4	EPA 8260B	0.001	0.10	560.00	69,000.00	**N/A**	**--**	--	**0.10**
Methylene chloride	75-09-2	EPA 8260B	0.002	0.02	130.00	4,800.00	**2.57**	**--**	--	**0.02**
n-Butylbenzene	104-51-8	EPA 8260B	0.001	--	--	--	**N/A**	**--**	--	**--**
n-Propylbenzene	103-65-1	EPA 8260B	0.001	--	--	--	**N/A**	**--**	--	**--**
o-Chlorotoluene	95-49-8	EPA 8260B	0.001	--	--	1,600.00	**N/A**	**--**	--	**1,600.00**
o-Xylene	95-47-6	EPA 8260B	0.001	--	--	160,000.00	**N/A**	**--**	--	**160,000.00**

TABLE 2

SUMMARY OF SOIL SCREENING LEVELS

March Point (Whitmarsh) Landfill
Skagit County, Washington

concentrations in milligrams per kilogram (mg/kg)

Analyte[1,2]	CAS No.	Analytical Method[3]	Target Reporting Limit (PQL)[4]	MTCA Method A, Unrestricted Land Use	MTCA Method B, Carcinogen	MTCA Method B, Noncarcinogen	MTCA Method B Protective of Groundwater as Marine Surface Water[5]	Sites that Qualify for Simplified TEE - Industrial or Commercial Site[6]	Puget Sound Soil Natural Background (Ecology, 1994)[7]	PSL[8]
VOCs (Continued)										
p-Isopropyltoluene	99-87-6	EPA 8260B	0.001	--	--	--	**No CLARC**	**--**	--	**--**
sec-Butylbenzene	135-98-8	EPA 8260B	0.001	--	--	--	**N/A**	**--**	--	**--**
Styrene	100-42-5	EPA 8260B	0.001	--	33.00	16,000.00	**N/A**	**--**	--	**33.00**
tert-Butylbenzene	98-06-6	EPA 8260B	0.001	--	--	--	**N/A**	**--**	--	**--**
Tetrachloroethene	127-18-4	EPA 8260B	0.001	0.05	1.90	800.00	**0.004173**	**--**	--	**0.004173**
Toluene	108-88-3	EPA 8260B	0.001	7.00	--	6,400.00	**190.00**	**--**	--	**7.00**
trans-1,2-Dichloroethene	156-60-5	EPA 8260B	0.001	--	--	1,600.00	**54.36**	**--**	--	**54.36**
trans-1,3-Dichloropropene	10061-02-6	EPA 8260B	0.001	--	--	--	**No CLARC**	**--**	--	**--**
Trichloroethene	79-01-6	EPA 8260B	0.001	0.03	2.50	24.00	**0.01**	**--**	--	**0.01**
Trichlorofluoromethane	75-69-4	EPA 8260B	0.001	--	--	24,000.00	**N/A**	**--**	--	**24,000.00**
Vinyl chloride	75-01-4	EPA 8260B	0.001	--	0.67	240.00	**0.02**	**--**	--	**0.02**
PCBs										
Aroclor 1016	12674-11-2	EPA 8082 low level	0.004	--	--	5.60	**0.01**		--	**0.01**
Aroclor 1221	11104-28-2	EPA 8082 low level	0.004	--	--	--	**No CLARC**		--	**--**
Aroclor 1232	11141-16-5	EPA 8082 low level	0.004	--	--	--	**No CLARC**		--	**--**
Aroclor 1242	53469-21-9	EPA 8082 low level	0.004	--	--	--	**No CLARC**		--	**--**
Aroclor 1248	12672-29-6	EPA 8082 low level	0.004	--	--	--	**No CLARC**		--	**--**
Aroclor 1254	11097-69-1	EPA 8082 low level	0.004	--	--	1.60	**0.0000068**		--	**0.0040**
Aroclor 1260	11096-82-5	EPA 8082 low level	0.004	--	--	--	**0.49**		--	**0.49**
Total polychlorinated biphenyls	1336-36-3	EPA 8082 low level	0.028	1.00	0.50	--	**0.000397**	**2.00**	--	**0.03**
Pesticides (Organochlorine)										
Aldrin	309-00-2	EPA 8081	0.0017	--	0.06	2.40	**0.0000492**	**0.17**	--	**0.0017**
Chlordane	57-74-9	EPA 8081	0.0017	--	2.90	40.00	**0.0006042**	**7.00**	--	**0.0017**
4,4'-DDD	72-54-8	EPA 8081	0.0033	--	4.20	--	**0.0002864**	**1.00**	--	**0.0033**
4,4'-DDE	72-55-9	EPA 8081	0.0033	--	2.90	--	**0.0003793**	**1.00**	--	**0.0033**
4,4'-DDT	50-29-3	EPA 8081	0.0033	3.00	2.90	40.00	**0.0029930**	**1.00**	--	**0.0033**
Dieldrin	60-57-1	EPA 8081	0.0033	--	0.06	4.00	**0.0000283**	**0.17**	--	**0.0033**
Endosulfan I	959-98-8	EPA 8081	0.0017	--	--	--	**No CLARC**	**--**	--	**--**
Endosulfan II	33213-65-9	EPA 8081	0.0033	--	--	--	**No CLARC**	**--**	--	**--**
Endosulfan sulfate	1031-07-8	EPA 8081	0.0033	--	--	--	**No CLARC**	**--**	--	**--**
Endrin	72-20-8	EPA 8081	0.0033	--	--	24.00	**0.0005152**	**0.40**	--	**0.0033**
Endrin aldehyde	7421-93-4	EPA 8081	0.0033	--	--	--	**No CLARC**	**--**	--	**--**
Endrin ketone	53494-70-5	EPA 8081	0.0033	--	--	--	**No CLARC**	**--**	--	**--**
Heptachlor	76-44-8	EPA 8081	0.0017	--	0.22	40.00	**0.0000153**	**--**	--	**0.0017**
Heptachlor epoxide	1024-57-3	EPA 8081	0.0017	--	0.11	1.00	**0.0027010**	**0.60**	--	**0.0027**
a-Hexachlorocyclohexane	319-84-6	EPA 8081	0.0017	--	0.16	--	**0.0001960**	**--**	--	**0.0017**
b-Hexachlorocyclohexane	319-85-7	EPA 8081	0.0017	--	0.56	--	**0.0007820**	**--**	--	**0.0017**
c-Hexachlorocyclohexane	319-86-8	EPA 8081	0.0017	--	--	--	**0.0001640**	**--**	--	**0.0017**

TABLE 2

SUMMARY OF SOIL SCREENING LEVELS

March Point (Whitmarsh) Landfill
Skagit County, Washington

concentrations in milligrams per kilogram (mg/kg)

Analyte[1,2]	CAS No.	Analytical Method[3]	Target Reporting Limit (PQL)[4]	MTCA Method A, Unrestricted Land Use	MTCA Method B, Carcinogen	MTCA Method B, Noncarcinogen	MTCA Method B Protective of Groundwater as Marine Surface Water[5]	Sites that Qualify for Simplified TEE - Industrial or Commercial Site[6]	Puget Sound Soil Natural Background (Ecology, 1994)[7]	PSL[8]
Pesticides (Organochlorine) (Continued)										
Lindane	58-89-9	EPA 8081	0.0017	0.01	0.77	24.00	**0.0012160**	**10.00**	--	**0.0017**
Methoxylchlor	72-43-5	EPA 8081	0.017	--	--	400.00	**0.0481200**	**--**	--	**0.05**
Toxaphene	8001-35-2	EPA 8081	0.17	--	0.91	--	**0.0003848**	**--**	--	**0.17**
Other										
Ammonia	7664-41-7	SM 4500-NH3 D-97	0.1	--	--	--	**0.14**	**--**	--	**0.14**
Phosphorus	7723-14-0	EPA 365.2/SM 4500-PB	0.4	--	--	1.60	**0.0004**	**--**	--	**0.40**

Notes

1. Shaded analytes have been previously detected at/around the site.
2. Analytes that have been detected at the site that are not listed in this table include chloride, sulfate, ferrous iron, DOC, total organic carbon, total suspended solids, total dissolved solids, calcium, magnesium, potassium, sodium, tellurium, and dibenzothiophene.
3. Method numbers refer to EPA SW-846 Analytical Methods, Washington State Department of Ecology (Ecology) recommended analytical methods, or Standard Methods (SM) for the Examination of Water and Wastewater.
4. Reporting limits based on wet weight and will be slightly higher on a dry weight basis, including matrix interference.
5. Calculated using fixed-parameter three-phase partitioning model, WAC 173-340-747(4).
6. TEE values are from Table 479-2 of the MTCA regulations (WAC 173-340-900).
7. *** Background level for chromium is level calculated for the Custom Plywood site.
8. PSL was chosen as the lower of the MTCA Method A cleanup levels, MTCA Method B cleanup levels, and TEE cleanup level for industrial and commercial sites, unless natural background concentration and/or available laboratory PQL values were higher. In those cases, PSL was set to the natural background concentration or the PQL. The PSL shown is the screening level used in Table 10.
9. -- = No value available.
10. N/A = No surface water screening levels in CLARC database (Ecology, 2008); no soil screening level calculated.
11. TEE values are for speciated arsenic; the lower value for arsenic (III) is used. The arsenic (V) value is 95 mg/kg.
12. TEE value is for organic mercury; inorganic mercury value is 9 mg/kg.
13. No CLARC = Analyte not listed in CLARC database.

Abbreviations

CAS = Chemical Abstracts Service
CLARC = Cleanup Levels and Risk Calculations
DOC = dissolved organic carbon
EPA = U.S. Environmental Protection Agency
MTCA = Model Toxics Control Act
PCBs = polychlorinated biphenyls
PQL = practical quantitation limit.
PSL = preliminary screening level
SIM = selective ion monitoring
SVOCs = semivolatile organic compounds
TEE = terrestrial ecological evaluation
TPH = total petroleum hydrocarbons
VOCs = volatile organic compounds
WAC = Washington Administrative Code

TABLE 3

SUMMARY OF GROUNDWATER AND SURFACE WATER SCREENING LEVELS

March Point (Whitmarsh) Landfill
Skagit County, Washington

Concentrations in micrograms per liter (µg/L)

Analyte[1,2]	CAS No.	Analytical Method[3]	Target Reporting Limit (PQL)	Groundwater MTCA Method A	Groundwater MTCA Method B, Carcinogen	Groundwater MTCA Method B, Non-Carcinogen	Aquatic Life - Marine/Chronic - Ch.173-201A WAC	Aquatic Life - Marine/Chronic - Clean Water Act 304	Aquatic Life - Marine/Chronic - National Toxics Rule 40 CFR 131	Human Health - Marine - Clean Water Act 304	Human Health - Marine - National Toxics Rule, 40 CFR 131	Surface Water MTCA Method B, Carcinogen	Surface Water MTCA Method B, Non-Carcinogen	PSL[4]
Dissolved Metals														
Aluminum	7429-90-5	EPA 6010B	50	--[5]	--	--	--	--	--	--	--	--	--	--
Antimony	7440-36-0	EPA 6010B	50	--	--	6.40	--	--	--	640.00	4,300.00	--	1,000.00	**640.00**
Arsenic	7440-38-2	EPA 6020	0.2	5	0.06	4.80	36.00	36.00	36.00	0.14	0.14	0.10	18.00	0.20
Barium	7440-39-3	EPA 6010B	3.0	--	--	3,200.00	--	--	--		--	--	--	--
Beryllium	7440-41-7	EPA 6010B	1.0	--	--	32.00	--	--	--	--	--	--	270.00	**270.00**
Cadmium	7440-43-9	EPA 6010B	2.0	5	--	8.00	9.30	8.80	9.30	--	--	--	20.00	**8.80**
Chromium	7440-47-3	EPA 6010B	5.0	50	--	24,000.00	--	--	--	--	--	--	240,000.00	**240,000.00**
Copper	7440-50-8	EPA 6010B	2.0	--	--	590.00	3.10	3.10	2.40	--	--	--	2,700.00	**2.40**
Iron	7439-89-6	EPA 6010B	50	--	--	--	--	--	--	--	--	--	--	--
Lead	7439-92-1	EPA 7421	1.0	15	--	--	8.10	8.10	8.10	--	--	--	--	**8.10**
Manganese	7439-96-5	EPA 6010B	1.0	--	--	2,200.00	--	--	--	100.00	--	--	--	**100.00**
Mercury	7439-97-6	EPA 7470A - Low level	0.02	2	--	4.80	0.03	0.94	0.03	0.30	0.15	--	--	**0.03**
Molybdenum	7439-98-7	EPA 6010B	5	--	--	80.00	--	--	--	--	--	--	--	--
Nickel	7440-02-0	EPA 6020	0.5	--	--	320.00	8.20	8.20	8.20	4,600.00	4,600.00	--	1,100.00	**8.20**
Selenium	7782-49-2	EPA 6010B	50	--	--	80.00	71.00	71.00	71.00	4,200.00	--	--	2,700.00	**71.00**
Silver	7440-22-4	EPA 6010B	3.0	--	--	80.00	--	--	--	--	--	--	26,000.00	**26,000.00**
Strontium	7440-24-6	EPA 6010B	1.0	--	--	9,600.00	--	--	--	--	--	--	--	--
Thallium	7440-28-0	EPA 7841	0.2	--	--	1.10	--	--	--	0.47	6.30	--	1.60	**0.47**
Titanium	7440-32-6	EA 6010B	5.0	--	--	--	--	--	--	--	--	--	--	--
Vanadium	7440-62-2	EPA 6010B	3.0	--	--	110.00	--	--	--	--	--	--	--	--
Zinc	7440-66-6	EPA 6010B	10	--	--	4,800.00	81.00	81.00	81.00	26,000.00	--	--	17,000.00	**81.00**
TPH														
TPH - Hydrocarbon Identification	NA	Ecology NWTPH-HCID	630	--	--	--	--	--	--	--	--	--	--	--
TPH - Diesel range	NA	Ecology NWTPH-Dx	250	500	--	--	--	--	--	--	--	--	--	--
TPH - Heavy oil range	NA	Ecology NWTPH-Dx	500	500	--	--	--	--	--	--	--	--	--	--
TPH - Gasoline	NA	Ecology NWTPH-Gx	250	800	--	--	--	--	--	--	--	--	--	--
SVOCs														
1-Methylnaphthalene	90-12-0	EPA 8270D	1.0	--	--	2.40	--	--	--	--	--	--	--	--
2,4,5-Trichlorophenol	95-95-4	EPA 8270D	5.0	--	--	800.00	--	--	--	3,600.00	--	--	--	**3,600.00**
2,4,6-Trichlorophenol	88-06-2	EPA 8270D	5.0	--	4.00	--	--	--	--	2.40	6.50	3.90	--	**5.00**
2,4-Dichlorophenol	120-83-2	EPA 8270D	5.0	--	--	24.00	--	--	--	290.00	790.00	--	190.00	**190.00**
2,4-Dimethylphenol	105-67-9	EPA 8270D	1.0	--	--	160.00	--	--	--	850.00	--	--	550.00	**550.00**
2,4-Dinitrophenol	51-28-5	EPA 8270D	10.0	--	--	32.00	--	--	--	5,300.00	14,000.00	--	3,500.00	**3,500.00**
2,4-Dinitrotoluene	121-14-2	EPA 8270D	5.0	--	--	32.00	--	--	--	3.40	9.10	--	1,400.00	**5.00**
2,6-Dinitrotoluene	606-20-2	EPA 8270D	5.0	--	--	16.00	--	--	--	--	--	--	--	--
2-Chloronaphthalene	91-58-7	EPA 8270D	1.0	--	--	640.00	--	--	--	1,600.00	--	--	1,000.00	**1,000.00**
2-Chlorophenol	95-57-8	EPA 8270D	1.0	--	--	40.00	--	--	--	--	--	--	97.00	**97.00**
2-Methylnaphthalene	91-57-6	EPA 8270D	1.0	--	--	32.00	--	--	--	--	--	--	--	--
2-Methylphenol	95-48-7	EPA 8270D	1.0	--	--	400.00	--	--	--	--	--	--	--	--
2-Nitroaniline	88-74-4	EPA 8270D	5.0	--	--	--	--	--	--	--	--	--	--	--
2-Nitrophenol	88-75-5	EPA 8270D	5.0	--	--	--	--	--	--	--	--	--	--	--
3-Nitroaniline	99-09-2	EPA 8270D	5.0	--	--	--	--	--	--	--	--	--	--	--
3,3'-Dichlorobenzidine	91-94-1	EPA 8270D	5.0	--	0.19	--	--	--	--	0.03	0.08	0.05	--	**5.00**
4,6-Dinitro-2-methylphenol	534-52-1	EPA 8270D	10.0	--	--	--	--	--	--	--	--	--	--	--
4-Bromophenyl phenyl ether	101-55-3	EPA 8270D	1.0	--	--	--	--	--	--	--	--	--	--	--
4-Chloro-3-methylphenol	59-50-7	EPA 8270D	5.0	--	--	--	--	--	--	--	--	--	--	--
4-Chloroaniline	106-47-8	EPA 8270D	5.0	--	--	32.00	--	--	--	--	--	--	--	--
4-Chlorophenyl phenyl ether	7005-72-3	EPA 8270D	1.0	--	--	--	--	--	--	--	--	--	--	--

TABLE 3

SUMMARY OF GROUNDWATER AND SURFACE WATER SCREENING LEVELS

March Point (Whitmarsh) Landfill
Skagit County, Washington

Concentrations in micrograms per liter (µg/L)

Analyte[1,2]	CAS No.	Analytical Method[3]	Target Reporting Limit (PQL)	Groundwater MTCA Method A	Groundwater MTCA Method B, Carcinogen	Groundwater MTCA Method B, Non-Carcinogen	Aquatic Life - Marine/Chronic - Ch.173-201A WAC	Aquatic Life - Marine/Chronic - Clean Water Act 304	Aquatic Life - Marine/Chronic - National Toxics Rule 40 CFR 131	Human Health - Marine - Clean Water Act 304	Human Health - Marine - National Toxics Rule, 40 CFR 131	Surface Water MTCA Method B, Carcinogen	Surface Water MTCA Method B, Non-Carcinogen	PSL[4]
SVOCs (Continued)														
4-Methylphenol (p-cresol)	106-44-5	EPA 8270D	1.0	--	--	40.00	--	--	--	--	--	--	--	--
4-Nitroaniline	100-01-6	EPA 8270D	5.0	--	--	--	--	--	--	--	--	--	--	--
4-Nitrophenol	100-02-7	EPA 8270D	5.0	--	--	--	--	--	--	--	--	--	--	--
Acenaphthene	83-32-9	EPA 8270-SIM	0.01	--	--	960.00	--	--	--	990.00	--	--	640.00	**640.00**
Acenaphthylene	208-96-8	EPA 8270-SIM	0.01	--	--	--	--	--	--	--	--	--	--	--
Aniline	62-53-3	EPA 8270D	1.0	--	7.70	--	--	--	--	--	--	--	--	--
Anthracene	120-12-7	EPA 8270-SIM	0.01	--	--	4,800.00	--	--	--	40,000.00	110,000.00	--	26,000.00	**26,000.00**
Benzidine	92-87-5	EPA 8270D	10.0	--	0.00	48.00	--	--	--	0.00	0.00	0.00	89.00	**10.00**
Benzo(a)anthracene	56-55-3	EPA 8270-SIM	0.01	--	--	--	--	--	--	0.02	0.03	--	--	**0.02**
Benzo(a)pyrene	50-32-8	EPA 8270-SIM	0.01	0.1	0.01	--	--	--	--	0.02	0.03	0.03		**0.02**
Benzo(b)fluoranthene	205-99-2	EPA 8270-SIM	0.01	--	--	--	--	--	--	0.02	0.03	--	--	**0.02**
Benzo(ghi)perylene	191-24-2	EPA 8270-SIM	0.01	--	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	207-08-9	EPA 8270-SIM	0.01	--	--	--	--	--	--	0.02	0.03	--	--	**0.02**
Benzoic acid	65-85-0	EPA 8270D	10.0	--	--	64,000.00	--	--	--	--	--	--	--	--
Benzyl alcohol	100-51-6	EPA 8270D	5.0	--	--	2,400.00	--	--	--	--	--	--	--	--
Bis(2-chloroethoxy)methane	111-91-1	EPA 8270D	1.0	--	--	--	--	--	--	--	--	--	--	--
Bis(2-chloroethyl) ether	111-44-4	EPA 8270D	1.0	--	0.04	--	--	--	--	0.53	1.40	0.85	--	**1.00**
Bis(2-chloroisopropyl) ether [2,2'-oxybis(1-chloropropane)]	108-60-1	EPA 8270D	1.0	--	--	320.00	--	--	--	65,000.00	170,000.00	--	42,000.00	**42,000.00**
Bis(2-ethylhexyl) phthalate	117-81-7	EPA 8270D	1.0	--	6.30	320.00	--	--	--	2.20	5.90	3.60	400.00	**2.20**
Butyl benzyl phthalate	85-68-7	EPA 8270D	1.0	--	--	3,200.00	--	--	--	1,900.00	--	--	1,300.00	**1,300.00**
Carbaryl	63-25-2	EPA 8270D	20	--	--	1,600.00	--	--	--	--	--	--	--	--
Carbazole	86-74-8	EPA 8270D	1.0	--	4.40	--	--	--	--	--	--	--	--	--
Chrysene	218-01-9	EPA 8270-SIM	0.01	--	--	--	--	--	--	0.02	0.03	--	--	**0.02**
Dibenzo(a,h)anthracene	53-70-3	EPA 8270-SIM	0.01	--	--	--	--	--	--	0.02	0.03	--	--	**0.02**
Dibenzofuran	132-64-9	EPA 8270D	1.0	--	--	32.00	--	--	--	--	--	--	--	--
Diethyl phthalate	84-66-2	EPA 8270D	1.0	--	--	13,000.00	--	--	--	44,000.00	120,000.00	--	28,000.00	**28,000.00**
Dimethyl phthalate	131-11-3	EPA 8270D	1.0	--	--	16,000.00	--	--	--	1,100,000.00	2,900,000.00	--	72,000.00	**72,000.00**
Di-n-butyl phthalate	84-74-2	EPA 8270D	1.0	--	--	1,600.00	--	--	--	4,500.00	12,000.00	--	2,900.00	**2,900.00**
Di-n-octyl phthalate	117-84-0	EPA 8270D	1.0	--	--	320.00	--	--	--	--	--	--	--	--
Fluoranthene	206-44-0	EPA 8270-SIM	0.01	--	--	640.00	--	--	--	140.00	370.00	--	90.00	**90.00**
Fluorene	86-73-7	EPA 8270-SIM	0.01	--	--	640.00	--	--	--	5,300.00	14,000.00	--	3,500.00	**3,500.00**
Hexachlorobenzene	118-74-1	EPA 8270D	1.0	--	0.06	13.00	--	--	--	0.00	0.00	0.00	0.24	**1.00**
Hexachlorobutadiene	87-58-3	EPA 8270D	1.0	--	--	--	--	--	--	18.00	50.00	30.00	190.00	**18.00**
Hexachlorocyclopentadiene	77-47-4	EPA 8270D	5.0	--	--	48.00	--	--	--	1,100.00	17,000.00	--	3,600.00	**1,100.00**
Hexachloroethane	67-72-1	EPA 8270D	1.0	--	3.10	8.00	--	--	--	3.30	8.90	5.30	30.00	**3.30**
Indeno(1,2,3-cd)pyrene	193-39-5	EPA 8270-SIM	0.01	--	--	--	--	--	--	0.02	0.03	--	--	**0.02**
Isophorone	78-59-1	EPA 8270D	1.0	--	46.00	1,600.00	--	--	--	960.00	600.00	1,600.00	120,000.00	**600.00**
Naphthalene	91-20-3	EPA 8270-SIM	0.01	160	--	160.00	--	--	--	--	--	--	4,900.00	**4,900.00**
Nitrobenzene	98-95-3	EPA 8270D	1.0	--	--	4.00	--	--	--	690.00	1,900.00	--	450.00	**450.00**
N-Nitrosodimethylamine	62-75-9	EPA 8270D	5.0	--	0.00	--	--	--	--	3.00	8.10	4.90	--	**5.00**
N-Nitrosodi-n-propylamine	621-64-7	EPA 8270D	5.0	--	--	--	--	--	--	0.51		0.82	--	**5.00**
N-Nitrosodiphenylamine	86-30-6	EPA 8270D	1.0	--	--	--	--	--	--	6.00	16.00	9.70	--	**6.00**
Pentachlorophenol	87-86-5	EPA 8270D	5.0	--	0.73	480.00	7.90	7.90	7.90	3.00	8.20	4.90	7,100.00	**5.00**
Phenanthrene	85-01-8	EPA 8270-SIM	0.01	--	--	--	--	--	--	--	--	--	--	--
Phenol	108-95-2	EPA 8270D	1.0	--	--	4,800.00	--	--	--	1,700,000.00	4,600,000.00	--	1,100,000.00	**1,100,000.00**
Pyrene	129-00-0	EPA 8270-SIM	0.01	--	--	480.00	--	--	--	4,000.00	11,000.00	--	2,600.00	**2,600.00**
Pyridine	110-86-1	EPA 8270D	5.0	--	--	8.00	--	--	--	--	--	--	--	--

TABLE 3

SUMMARY OF GROUNDWATER AND SURFACE WATER SCREENING LEVELS

March Point (Whitmarsh) Landfill
Skagit County, Washington

Concentrations in micrograms per liter (μg/L)

Analyte[1,2]	CAS No.	Analytical Method[3]	Target Reporting Limit (PQL)	Groundwater MTCA Method A	Groundwater MTCA Method B, Carcinogen	Groundwater MTCA Method B, Non-Carcinogen	Aquatic Life - Marine/Chronic - Ch.173-201A WAC	Aquatic Life - Marine/Chronic - Clean Water Act 304	Aquatic Life - Marine/Chronic - National Toxics Rule 40 CFR 131	Human Health - Marine - Clean Water Act 304	Human Health - Marine - National Toxics Rule, 40 CFR 131	Surface Water MTCA Method B, Carcinogen	Surface Water MTCA Method B, Non-Carcinogen	PSL[4]
VOCs														
1,1,1,2-Tetrachloroethane	630-20-6	EPA 8260B 10 mL purge	0.2	--	1.70	240.00	--	--	--	4.00	11.00	6.50	--	**4.00**
1,1,1-Trichloroethane	71-55-6	EPA 8260B 10 mL purge	0.2	200	--	7,200.00	--	--	--	--	--	--	420,000.00	**420,000.00**
1,1,2,2-Tetrachloroethane	79-34-5	EPA 8260B 10 mL purge	0.2	--	0.22	--	--	--	--	4.00	11.00	6.50	--	**4.00**
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	EPA 8260B 10 mL purge	0.2	--	--	240,000.00	--	--	--	--	--	--	--	--
1,1,2-Trichloroethane	79-00-5	EPA 8260B 10 mL purge	0.2	--	0.77	32.00	--	--	--	16.00	42.00	25.00	2,300.00	**16.00**
1,1-Dichloroethane	75-34-3	EPA 8260B 10 mL purge	0.2	--	--	800.00	--	--	--	7,100.00	3.20	--	23,000.00	**3.20**
1,1-Dichloroethene	75-35-4	EPA 8260B 10 mL purge	0.2	--	--	400.00	--	--	--	--	--	--	--	--
1,2,3-Trichlorobenzene	87-61-6	EPA 8260B 10 mL purge	0.5	--	--	--	--	--	--	--	--	--	--	--
1,2,3-Trichloropropane	96-18-4	EPA 8260B 10 mL purge	0.5	--	0.01	48.00	--	--	--	--	--	--	--	--
1,2,4-Trichlorobenzene	120-82-1	EPA 8260B 10 mL purge	0.5	--	--	80.00	--	--	--	70.00	--	--	230.00	**70.00**
1,2,4-Trimethylbenzene	95-63-6	EPA 8260B 10 mL purge	0.2	--	--	400.00	--	--	--	--	--	--	--	--
1,2-Dibromo-3-chloropropane	96-12-8	EPA 8260B 10 mL purge	0.5	--	0.03	--	--	--	--	--	--	--	--	--
1,2-Dibromoethane	106-93-4	EPA 8260B 10 mL purge	0.2	0.01	0.00	--	--	--	--	--	--	--	--	--
1,2-Dichlorobenzene	95-50-1	EPA 8260B 10 mL purge	0.2	--	--	720.00	--	--	--	1,300.00	17,000.00	--	4,200.00	**1,300.00**
1,2-Dichloroethane	107-06-2	EPA 8260B 10 mL purge	0.2	5	0.48	160.00	--	--	--	37.00	99.00	59.00	43,000.00	**37.00**
1,2-Dichloropropane	78-87-5	EPA 8260B 10 mL purge	0.2	--	0.64	--	--	--	--	15.00	--	23.00	--	**15.00**
1,3,5-Trimethylbenzene	108-67-8	EPA 8260B 10 mL purge	0.2	--	--	400.00	--	--	--	--	--	--	--	--
1,3-Dichlorobenzene	541-73-1	EPA 8260B 10 mL purge	0.2	--	--	--	--	--	--	960.00	2,600.00	--	--	**960.00**
1,4-Dichlorobenzene	106-46-7	EPA 8260B 10 mL purge	0.2	--	1.80	--	--	--	--	190.00	2,600.00	4.90	--	**4.90**
2-Butanone	78-93-3	EPA 8260B 10 mL purge	2.5	--	--	4,800.00	--	--	--	--	--	--	--	--
2-Chloroethyl vinyl ether	110-75-8	EPA 8260B 10 mL purge	1.0	--	--	--	--	--	--	--	--	--	--	--
2-Hexanone	591-78-6	EPA 8260B 10 mL purge	2.5	--	--	--	--	--	--	--	--	--	--	--
4-Chlorotoluene	106-43-4	EPA 8260B 10 mL purge	0.2	--	--	--	--	--	--	--	--	--	--	--
4-Methyl-2-pentanone	108-10-1	EPA 8260B 10 mL purge	2.5	--	--	640.00	--	--	--	--	--	--	--	--
Acetone	67-64-1	EPA 8260B 10 mL purge	2.5	--	--	800.00	--	--	--	--	--	--	--	--
Acrylonitrile	107-13-1	EPA 8260B 10 mL purge	1.0	--	0.08	8.00	--	--	--	0.25	0.66	0.40	86.00	**1.00**
Benzene	71-43-2	EPA 8260B 10 mL purge	0.2	5	0.80	32.00	--	--	--	51.00	71.00	23.00	2,000.00	**23.00**
Bromobenzene	108-86-1	EPA 8260B 10 mL purge	0.2	--	--	--	--	--	--	--	--	--	--	--
Bromodichloromethane	75-27-4	EPA 8260B 10 mL purge	0.2	--	0.71	160.00	--	--	--	17.00	22.00	28.00	14,000.00	**17.00**
Bromoform	75-25-2	EPA 8260B 10 mL purge	0.2	--	5.50	160.00	--	--	--	140.00	360.00	220.00	14,000.00	**140.00**
Bromomethane	74-83-9	EPA 8260B 10 mL purge	0.5	--	--	11.00	--	--	--	1,500.00	4,000.00	--	970.00	**970.00**
Carbon disulfide	75-15-0	EPA 8260B 10 mL purge	0.2	--	--	800.00	--	--	--	--	--	--	--	--
Carbon tetrachloride	56-23-5	EPA 8260B 10 mL purge	0.2	--	0.34	5.60	--	--	--	1.60	4.40	2.70	97.00	**1.60**
Chlorobenzene	108-90-7	EPA 8260B 10 mL purge	0.2	--	--	160.00	--	--	--	1,600.00	21,000.00	--	5,000.00	**1,600.00**
Chloroethane	75-00-3	EPA 8260B 10 mL purge	0.2	--	15.00	3,200.00	--	--	--	--	--	--	--	--
Chloroform	67-66-3	EPA 8260B 10 mL purge	0.2	--	7.20	80.00	--	--	--	470.00	470.00	280.00	6,900.00	**280.00**
Chloromethane	74-87-3	EPA 8260B 10 mL purge	0.2	--	3.40	--	--	--	--	--	--	130.00	--	**130.00**
cis-1,2-Dichloroethene	156-59-2	EPA 8260B 10 mL purge	0.2	--	--	80.00	--	--	--	--	--	--	--	--
cis-1,3-Dichloropropene	10061-01-5	EPA 8260B 10 mL purge	0.2	--	--	--	--	--	--	--	--	--	--	--
Dibromochloromethane	124-48-1	EPA 8260B 10 mL purge	0.2	--	0.52	160.00	--	--	--	13.00	34.00	21.00	14,000.00	**13.00**
Dichlorodifluoromethane	75-71-8	EPA 8260B 10 mL purge	0.2	--	--	1,600.00	--	--	--	--	--	--	--	--
Diethyl ether	60-29-7			--	--	1,600.00	--	--	--	--	--	--	--	--
Ethylbenzene	100-41-4	EPA 8260B 10 mL purge	0.2	700	--	800.00	--	--	--	2,100.00	29,000.00	--	6,900.00	**2,100.00**

TABLE 3

SUMMARY OF GROUNDWATER AND SURFACE WATER SCREENING LEVELS

March Point (Whitmarsh) Landfill
Skagit County, Washington

Concentrations in micrograms per liter (µg/L)

Analyte^{1,2}	CAS No.	Analytical Method^{3}	Target Reporting Limit (PQL)	Groundwater MTCA Method A	Groundwater MTCA Method B, Carcinogen	Groundwater MTCA Method B, Non-Carcinogen	Aquatic Life - Marine/Chronic - Ch.173-201A WAC	Aquatic Life - Marine/Chronic - Clean Water Act 304	Aquatic Life - Marine/Chronic - National Toxics Rule 40 CFR 131	Human Health - Marine - Clean Water Act 304	Human Health - Marine - National Toxics Rule, 40 CFR 131	Surface Water MTCA Method B, Carcinogen	Surface Water MTCA Method B, Non-Carcinogen	PSL^{4}
VOCs (Continued)														
Hexachlorobutadiene	87-68-3	EPA 8260B 10 mL purge	0.5	--	0.56	1.60	--	--	--	18.00	50.00	30.00	190.00	**18.00**
Isopropylbenzene (cumene)	98-82-8	EPA 8260B 10 mL purge	0.2	--	--	800.00	--	--	--	--	--	--	--	--
m,p-Xylenes	1330-20-7	EPA 8260B 10 mL purge	0.4	1,000	--	1,600.00	--	--	--	--	--	--	--	--
Methyl tert-butyl ether	1634-04-4	EPA 8260B 10 mL purge	0.5	20	24.00	6,900.00	--	--	--	--	--	--	--	--
Methylene chloride	75-09-2	EPA 8260B 10 mL purge	0.5	5	5.80	480.00	--	--	--	590.00	1,600.00	960.00	170,000.00	**590.00**
n-Butylbenzene	104-51-8	EPA 8260B 10 mL purge	0.2	--	--	--	--	--	--	--	--	--	--	--
n-Propylbenzene	103-65-1	EPA 8260B 10 mL purge	0.2	--	--	--	--	--	--	--	--	--	--	--
o-Chlorotoluene	95-49-8	EPA 8260B 10 mL purge	0.2	--	--	160.00	--	--	--	--	--	--	--	--
o-Xylene	95-47-6	EPA 8260B 10 mL purge	0.2	--	--	16,000.00	--	--	--	--	--	--	--	--
p-Isopropyltoluene	99-87-6	EPA 8260B 10 mL purge	0.2	--	--	--	--	--	--	--	--	--	--	--
sec-Butylbenzene	135-98-8	EPA 8260B 10 mL purge	0.2	--	--	--	--	--	--	--	--	--	--	--
Styrene	100-42-5	EPA 8260B 10 mL purge	0.2	--	1.50	1,600.00	--	--	--	--	--	--	--	--
tert-Butylbenzene	98-06-6	EPA 8260B 10 mL purge	0.2	--	--	--	--	--	--	--	--	--	--	--
Tetrachloroethene	127-18-4	EPA 8260B 10 mL purge	0.2	5	0.08	80.00	--	--	--	3.30	8.90	0.39	840.00	**0.39**
Toluene	108-88-3	EPA 8260B 10 mL purge	0.2	1,000	--	640.00	--	--	--	15,000.00	200,000.00	--	19,000.00	**15,000.00**
trans-1,2-Dichloroethene	156-60-5	EPA 8260B 10 mL purge	0.2	--	--	160.00	--	--	--	10,000.00	--	--	33,000.00	**10,000.00**
trans-1,3-Dichloropropene	10061-02-6	EPA 8260B 10 mL purge	0.2	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	79-01-6	EPA 8260B 10 mL purge	0.2	5	0.11	2.40	--	--	--	30.00	81.00	1.50	71.00	**1.50**
Trichlorofluoromethane	75-69-4	EPA 8260B 10 mL purge	0.2	--	--	2,400.00	--	--	--	--	--	--	--	--
Vinyl chloride	75-01-4	EPA 8260B 10 mL purge	0.2	0.2	0.03	24.00	--	--	--	2.40	530.00	3.70	6,600.00	**2.40**
PCBs														
Aroclor 1016	12674-11-2	EPA 8082 low level	0.01	--	--	1.10	--	--	0.03	--	--	--	0.01	**0.01**
Aroclor 1221	11104-28-2	EPA 8082 low level	0.01	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1232	11141-16-5	EPA 8082 low level	0.01	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1242	53469-21-9	EPA 8082 low level	0.01	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1248	12672-29-6	EPA 8082 low level	0.01	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1254	11097-69-1	EPA 8082 low level	0.01	--	--	0.32	--	--	0.03	--	--	--	0.00	**0.01**
Aroclor 1260	11096-82-5	EPA 8082 low level	0.01	--	--	--	--	--	0.03	--	--	--	--	**0.03**
Total polychlorinated biphenyls (PCBs)	1336-36-3	EPA 8082 low level	0.07	0.1	0.04	--	0.03	0.03	0.03	0.00	0.00	0.00	--	**0.07**
Pesticides (Organochlorine)														
Aldrin	309-00-2	EPA 8081 - Manchester	0.00083	--	0.00	0.24	0.00	--	--	0.00	0.00	0.00	0.02	**0.00**
Chlordane	57-74-9	EPA 8081 - Manchester	0.00083	--	0.25	8.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	**0.00**
4,4'-DDD	72-54-8	EPA 8081 - Manchester	0.00166	--	0.36	--	0.00	--	--	0.00	0.00	0.00	--	**0.00**
4,4'-DDE	72-55-9	EPA 8081 - Manchester	0.00166	--	0.26	--	0.00	--	--	0.00	0.00	0.00	--	**0.00**
4,4'-DDT	50-29-3	EPA 8081 - Manchester	0.00166	0.3	0.26	8.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	**0.00**
Dieldrin	60-57-1	EPA 8081 - Manchester	0.00166	--	0.01	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.03	**0.00**
Endosulfan I	959-98-8	EPA 8081 - Manchester	0.00083	--	--	--	--	--	--	--	--	--	--	--
Endosulfan II	33213-65-9	EPA 8081 - Manchester	0.00166	--	--	--	--	--	--	--	--	--	--	--
Endosulfan sulfate	1031-07-8	EPA 8081 - Manchester	0.00166	--	--	--	--	--	--	--	--	--	--	--
Endrin	72-20-8	EPA 8081 - Manchester	0.00166	--	--	4.80	0.00	0.00	0.00	0.06	0.81	--	0.20	**0.00**
Endrin aldehyde	7421-93-4	EPA 8081 - Manchester	0.00166	--	--	--	--	--	--	--	--	--	--	--
Endrin ketone	53494-70-5	EPA 8081 - Manchester	0.00166	--	--	--	--	--	--	--	--	--	--	--
Heptachlor	76-44-8	EPA 8081 - Manchester	0.00083	--	0.02	8.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	**0.00**
Heptachlor epoxide	1024-57-3	EPA 8081 - Manchester	0.00083	--	0.00	0.10	--	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
a-Hexachlorocyclohexane	319-84-6	EPA 8081 - Manchester	0.00083	--	0.01	--	--	--	--	0.00	0.01	0.01	--	**0.00**
b-Hexachlorocyclohexane	319-85-7	EPA 8081 - Manchester	0.00083	--	0.05	--	--	--	--	0.02	0.05	0.03	--	**0.02**
c-Hexachlorocyclohexane	319-86-8	EPA 8081 - Manchester	0.00083	--	--	--	--	--	--	0.04	--	--	--	**0.04**
Lindane	58-89-9	EPA 8081 - Manchester	0.00083	0.2	0.07	4.80	--	--	--	1.80	0.06	0.04	6.00	**0.04**
Methoxylchlor	72-43-5	EPA 8081 - Manchester	0.00833	--	--	80.00	--	0.03	--	--	--	--	8.40	**0.03**
Toxaphene	8001-35-2	EPA 8081	5.00	--	0.08	--	0.00	0.00	0.00	0.00	0.00	0.00	--	**5.00**

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SUMMARY OF GROUNDWATER AND SURFACE WATER SCREENING LEVELS

March Point (Whitmarsh) Landfill
Skagit County, Washington

Concentrations in micrograms per liter (µg/L)

Analyte[1,2]	CAS No.	Analytical Method[3]	Target Reporting Limit (PQL)	Groundwater MTCA Method A	Groundwater MTCA Method B, Carcinogen	Groundwater MTCA Method B, Non-Carcinogen	Aquatic Life - Marine/Chronic - Ch.173-201A WAC	Aquatic Life - Marine/Chronic - Clean Water Act 304	Aquatic Life - Marine/Chronic - National Toxics Rule 40 CFR 131	Human Health - Marine - Clean Water Act 304	Human Health - Marine - National Toxics Rule, 40 CFR 131	Surface Water MTCA Method B, Carcinogen	Surface Water MTCA Method B, Non-Carcinogen	PSL[4]
Other														
Ammonia	7664-41-7	SM 4500-NH3 D-97	10	--	--	--	35.00	--	--	--	--	--	--	**35.00**
Phosphorus	7723-14-0	EPA 365.2/SM 4500-PB	16	--	--	0.16	--	0.10	--	--	--	--	--	**16.00**

Notes

1. Shaded analytes have been previously detected at/around the site.
2. Analytes that have been detected at the site that are not listed in this table include chloride, sulfate, ferrous iron, DOC, total organic carbon, total suspended solids, total dissolved solids, calcium, magnesium, potassium, sodium, tellurium, and dibenzothiophene.
3. Method numbers refer to EPA SW-846 Analytical Methods, Washington State Department of Ecology (Ecology) recommended analytical methods, or Standard Methods (SM) for the Examination of Water and Wastewater.
4. PSL was chosen as the lower of the aquatic marine chronic WQC published in WAC 173-201A, aquatic marine chronic and human health (fish ingestion) WQC published in Section 304 of the Clean Water Act, aquatic marine chronic and human health (fish ingestion) WQC published in the National Toxics Rule (40 CFR 131), and MTCA Method B surface water cleanup levels (carcinogen and noncarcinogen). The PSL is the screening level used in Table 11.
5. -- = No value available.

Abbreviations

CAS = Chemical Abstracts Service
CFR = Code of Federal Regulations
DOC = dissolved organic carbon
EPA = U.S. Environmental Protection Agency
mL = milliliters
MTCA = Model Toxics Control Act
NA = not applicable
PCBs = polychlorinated biphenyls
PQL = practical quantitation limit
PSL = preliminary screening level
SIM = selective ion monitoring
SVOCs = semivolatile organic compounds
TPH = total petroleum hydrocarbons
VOCs = volatile organic compounds
WAC = Washington Administrative Code
WQC = water quality criteria

TABLE 4

PROPOSED WELL CONSTRUCTION SUMMARY

March Point (Whitmarsh) Landfill
Skagit County, Washington

Well ID	Drilling Technique	Approximate Ground Surface Elevation (ft amsl)	Estimated Total Borehole Depth (depth in feet)	Approximate Screened Interval[1] (depth in feet)	Filter Pack	Well Diameter (inches)	Well Material	Slot Size (inches)
MW-05	Hollow-Stem Auger	15	30	20-30	10/20 silica sand	2	Sch. 40 PVC	0.01
MW-06	Hollow-Stem Auger	10 to 15	15	10-15	10/20 silica sand	2	Sch. 40 PVC	0.01
MW-07	Hollow-Stem Auger	10 to 15	30	20-30	10/20 silica sand	2	Sch. 40 PVC	0.01
MW-08	Hollow-Stem Auger	10 to 15	15	10-15	10/20 silica sand	2	Sch. 40 PVC	0.01
MW-09	Hollow-Stem Auger	15	20	10-20	10/20 silica sand	2	Sch. 40 PVC	0.01
MW-10	Hollow-Stem Auger	15	20	10-20	10/20 silica sand	2	Sch. 40 PVC	0.01
MW-11	Hollow-Stem Auger	10 to 15	15	10-15	10/20 silica sand	2	Sch. 40 PVC	0.01
PZ-01	Hollow-Stem Auger	10 to 15	15	10-15	10/20 silica sand	2	Sch. 40 PVC	0.01
PZ-02	Hollow-Stem Auger	10 to 15	15	10-15	10/20 silica sand	2	Sch. 40 PVC	0.01
PZ-03	Hollow-Stem Auger	10 to 15	15	10-15	10/20 silica sand	2	Sch. 40 PVC	0.01

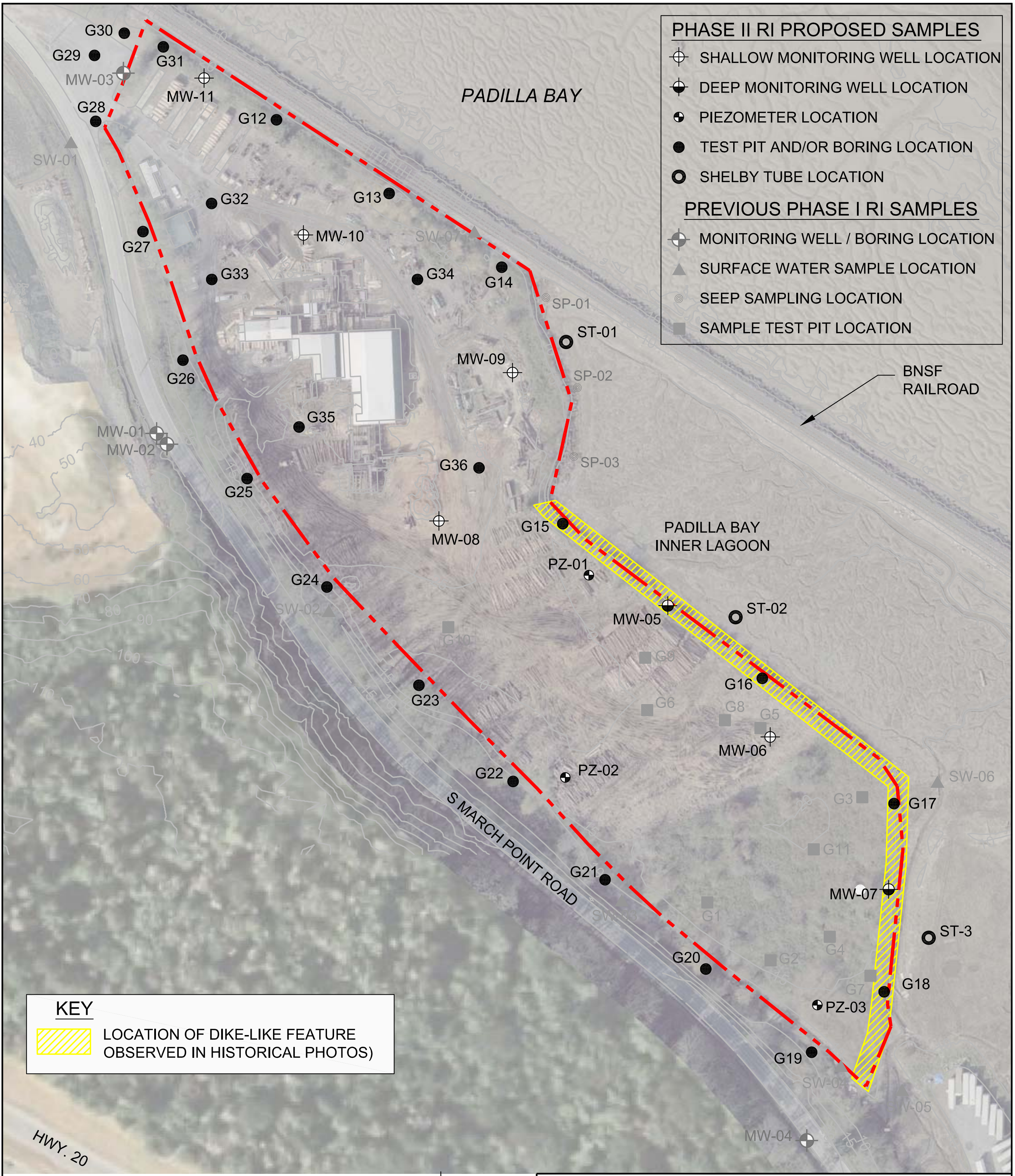
Notes

1. The screens for MW-05 and MW-07 to be set 2-3 feet below bottom of bay mud layer.
   The screens for the other monitoring wells and piezometers will be installed so that the majority of the screen is below the water table.

Abbreviations

ft amsl = feet above mean sea level.
Sch. 40 PVC = Schedule 40 polyvinyl chloride.

FIGURES



Aerial Photo Courtesy of USDA/FSA Aerial Photography Field office (2006) and Skagit County (2008)

Contours generated from Skagit County aerial photo, 2008. Vertical datum: MLLW

Note: No monitoring well was installed at MW-01 since deep groundwater was not encountered.

EXPLANATION

APPROXIMATE LANDFILL BOUNDARY

0 100 200
APPROXIMATE SCALE IN FEET

PROPOSED PHASE II SAMPLE LOCATIONS
March Point (Whitmarsh) Landfill
Skagit County, Washington

By: APS	Date: 03/31/10	Project No. 14159
AMEC Geomatrix		Figure 1

Plot Date: 03/31/10 - 12:00pm, Plotted by: adam.stenberg
Drawing Path: S:\14159\005_DRAFT-RI\, Drawing Name: Whitmarsh_Phase2SeepsGWdischargeMap_033110.dwg

APPENDIX A

Health and Safety Plan

SITE SPECIFIC HEALTH AND SAFETY PLAN PHASE II REMEDIAL INVESTIGATION

March Point (Whitmarsh) Landfill

Skagit County, Washington

Prepared for:

Skagit County Public Works
Mount Vernon, Washington

Prepared by:

AMEC Geomatrix, Inc.
600 University Street, Suite 1020
Seattle, Washington 98101
(206) 342-1760

April 2010

Project No. 0141590000.00006

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SITE-SPECIFIC HEALTH & SAFETY PLAN

March Point (Whitmarsh) Landfill
Skagit County, Washington

1.0 ADMINISTRATIVE INFORMATION

Project Name:	March Point (Whitmarsh) Landfill
Project Start Date:	October 2009
Project Number:	14159.000
Project Address:	9663 South March Point Road, Anacortes, Washington
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2.0 PURPOSE

This Site-Specific Health and Safety Plan (HASP) outlines the health and safety procedures that shall be followed during Phase II field work conducted on the uplands and intertidal sediments portion of the March Point (Whitmarsh) Landfill (the site) during the Remedial Investigation/Feasibility Study (RI/FS). The observance and practice of the procedures in this plan are mandatory for all AMEC Geomatrix, Inc. (AMEC), employees at the site. All contractors and site visitors shall be made aware of the requirements of this plan; however, contractors are responsible for the health and safety of their own employees and for following all applicable federal, state, and local regulations. All contractors shall develop their own HASPs as necessary to be in compliance with Washington Administrative Code (WAC) 296-843. AMEC will review their HASPs well in advance of fieldwork.

This plan defines site-specific hazards and controls to prevent injury and illness among AMEC personnel for tasks performed by AMEC. Its implementation is in concert with the written AMEC Accident Prevention Program.

This plan has been reviewed by the Project Manager and Project Health and Safety Officer. Prior to entering the site, AMEC personnel shall read this plan and be familiar with health and safety procedures required when working on site. A copy of the plan shall be available on site for inspection and review.

3.0 PROJECT DESCRIPTION

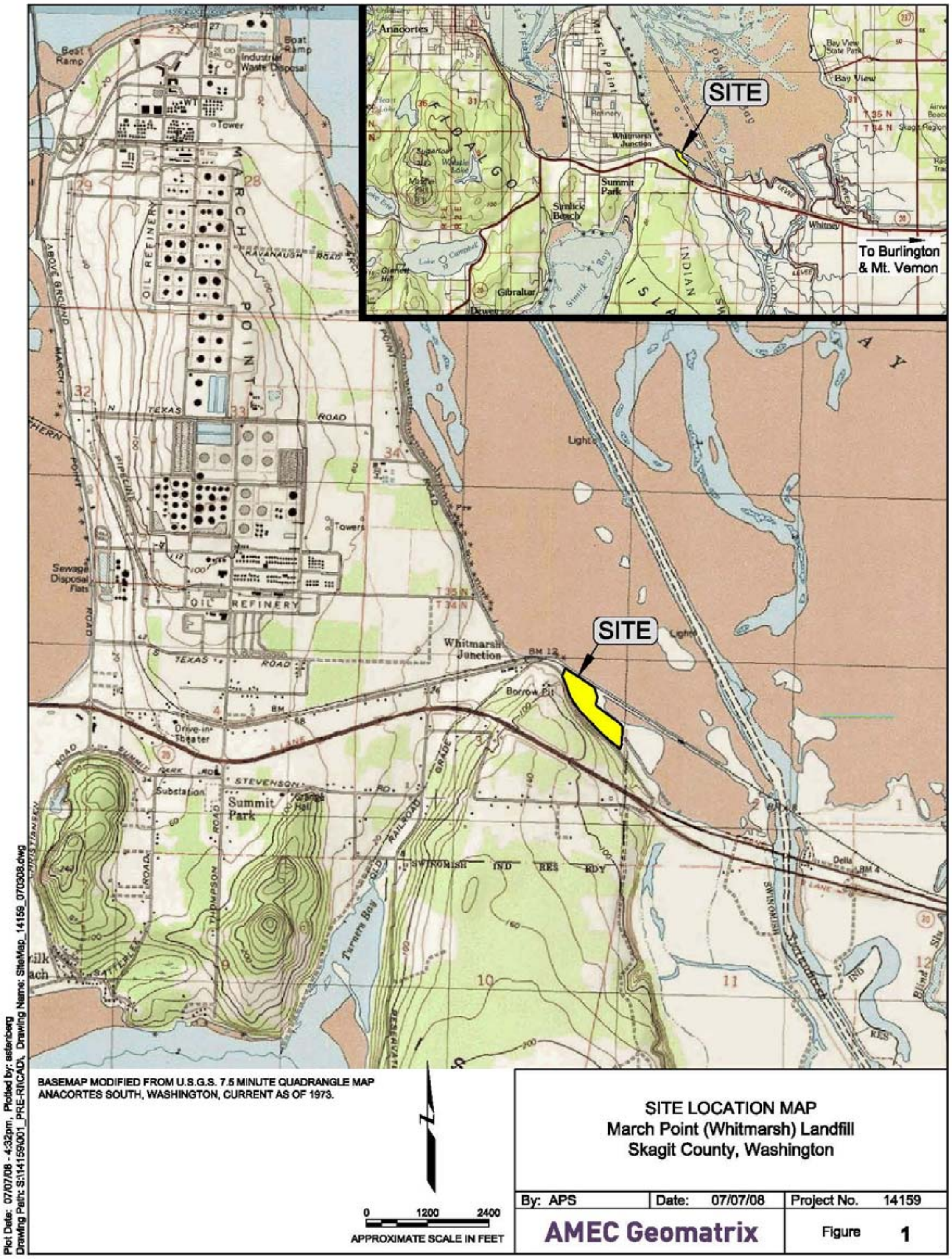
This HASP addresses the hazards associated with multiple tasks associated with the Phase II RI/FS for the uplands portion of the site (Figure 1), and for limited Shelby tube sampling for geotechnical parameter testing of the sediments in the intertidal and nearshore areas of the site. The property consists of an irregularly shaped parcel comprising of approximately 14 acres of fill covering the nearshore tidelands of Padilla Bay Lagoon. The site was used by the public as an unregulated dump site from the 1950's until 1961. Skagit County operated the site as a public landfill from 1961 to 1973. In 1973, the landfill was closed, graded, covered with 2 to 3 feet of soil of unknown source, and revegetated. Since the late 1980s, the majority of the site has been owned by and used for operation of a sawmill. Hog fuel, saw logs, and the sawmill facility now cover most of the site, except for the southernmost portion.

Site characterization activities will be conducted as part of the RI/FS to develop a conceptual model of the site and characterize waste materials and the extent of site contaminants. AMEC will perform the following field tasks in the uplands portion of the site.

1. Remove brush and vegetation from key areas of the site.
2. Excavate test pits along the perimeter of the landfill boundary to assess fill material thickness and depth to native Padilla Bay mud unit.
3. Drill and install one groundwater monitoring well into the underlying Padilla Bay mud unit along the dike-like feature in the southeastern part of the site to further assess groundwater quality at the site.
4. Drill and install six groundwater monitoring wells into the landfill refuse to further assess groundwater quality at the site.
5. Install three piezometers throughout the site and automatically monitoring of these piezometers (and the on site groundwater monitoring wells) for groundwater elevations.
6. Limited drum removal and characterization, if needed.
7. Conduct groundwater, surface water, and seep sampling.
8. Conduct Shelby tube sampling for geotechnical parameter testing in the intertidal and nearshore areas off the northeast side of the site.

3.1 SITE BACKGROUND

The former landfill is located north of South March Point Road at the base of a bluff in the tidelands area of Padilla Bay (Figure 1). The former landfill is bounded by South March Point Road to the south, the Burlington Northern Santa Fe (BNSF) railroad and Padilla Bay to the



BASEMAP MODIFIED FROM U.S.G.S. 7.5 MINUTE QUADRANGLE MAP ANACORTES SOUTH, WASHINGTON, CURRENT AS OF 1973.

SITE LOCATION MAP
March Point (Whitmarsh) Landfill
Skagit County, Washington

By: APS	Date: 07/07/08	Project No. 14159
AMEC Geomatrix		Figure 1

Plot Date: 07/07/08 - 4:32pm, Plotted by: asfenberg
Drawing Path: S:\14159\001_PRE-RI\CAD\, Drawing Name: SiteMap_14159_070308.dwg

north and northeast, and the Swinomish Channel to the east and southeast. The property was originally undeveloped tidelands lying between the main Mount Vernon-Anacortes highway and the BNSF railroad, and it was originally owned by the state of Washington and managed by the Washington Department of Natural Resources (DNR).

Landfilling began in the 1950s when the site was used by the public as an unregulated dump site. In 1961, Skagit County applied for and received a lease from the state to operate the landfill as a regulated solid waste disposal site. The County operated the landfill as a “burn dump” and burned waste regularly until 1969. In 1969 or 1970, the County stopped burning activities and converted the facility to a “sanitary landfill operation”. From 1969 through 1973 the landfill was the County’s primary waste disposal facility. Skagit County Public Works records of waste accepted from 1970 to 1973 indicate that waste originated from the cities of Anacortes, Burlington, La Conner, Mt. Vernon, and Sedro-Woolley; rural Skagit County; Whidbey Island; and the Shell and Texaco refineries, among other sources.

Powdered vanadium catalysts have been reportedly dumped at the landfill. Other industrial wastes, including drummed wastes, are alleged to have been dumped at the landfill. In 1973 Skagit County opened the Inman Landfill and closed this facility. Closure consisted of grading the waste and capping it with 2 to 3 feet of soil.

The northern two-thirds of the former landfill is now occupied by a cedar log mill, which has operated in this location since the late 1980s. This portion of the former landfill contains buildings, equipment, and stored logs associated with the mill. The southern third of the former landfill is unoccupied and covered with light forest and grass.

Results of previous studies conducted at the site are summarized in the RI/FS. Contaminants that have been detected at the site are tabulated in Section 5.1. Both upland and offshore areas have been identified for further investigation due to potential exceedances of Model Toxics Control Act (MTCA) cleanup levels in soil, groundwater, and/or sediments.

3.2 ANTICIPATED FIELD WORK

The objectives of the work to be performed in Phase II are described in the Phase II Sampling and Analysis Plan (SAP).[1] These objectives include:

- perform a limited geotechnical investigation to assess the geotechnical properties of the inner lagoon sediments;

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[1] AMEC Geomatrix, Inc., Uplands Phase II RI Sampling & Analysis Plan, March Point (Whitmarsh) Landfill, Skagit County, Washington: Prepared for Skagit County Public Works, February 2010.

- perform test pitting along the landfill perimeter to characterize landfill content;
- Limited investigation derived waste characterization and disposal;
- conduct groundwater, surface water, and seep sampling and quarterly monitoring to evaluate tidal impacts of groundwater;

The following field tasks will be performed in Phase II to gather the necessary data to meet these objectives:

- Remove brush and vegetation from key upland areas;
- Excavate test pits along the perimeter of the landfill boundary to assess fill material thickness and depth to native Padilla Bay mud unit.
- Install and develop one groundwater monitoring well, which will be screened in the water bearing zones below the Padilla Bay mud unit, if identified;
- Install and develop six groundwater monitoring wells, which will be screened within the refuse;
- Install three piezometers on site and outfit these piezometers (and on site groundwater monitoring wells) with automatic groundwater level loggers;
- Excavate test pits along the landfill perimeter to characterize landfill waste and investigate vertical extent of landfill waste ;
- Conduct three quarters of groundwater sampling at the seven new monitoring wells and the three existing site wells;
- Conduct three quarters of surface water sampling at six surface water sampling locations;
- Conduct three quarters of seep sampling at three seep locations, as identified by during the Phase I investigation;
- Survey the elevation of the new monitoring wells and piezometers;
- Collect groundwater elevation data on a quarterly basis from automatic elevations loggers in the new piezometers and groundwater monitoring wells.

The Work Plan provides further details about how these tasks will be performed.

4.0 PRIMARY RESPONSIBILITIES

The field responsibilities of the primary representatives who will oversee health and safety during site activities are described in this section.

4.1 PROJECT MANAGER

The Project Manager (PM) will have overall responsibility for the success of the project, including the successful implementation of this HASP. The PM will review health and safety issues as needed and as consulted and will have the authority to reallocate resources and personnel to safely accomplish the field work.

In addition the PM shall:

1. Direct all AMEC personnel involved in investigative, monitoring, and remedial activities at the site and vicinity;
2. Make the Project Health and Safety Officer aware of all pertinent project developments and plans;
3. Make available the resources that are necessary for a safe working environment;
4. Maintain communications with the client, as necessary; and
5. Verify that all AMEC project personnel have received required training, are aware of the potential hazards associated with site operations, have been instructed in the work practices necessary for personal health and safety, and are familiar with the site HASP's procedures for all scheduled activities and for dealing with emergencies.

4.2 PROJECT HEALTH AND SAFETY OFFICER

The Project Health and Safety Officer (PHSO) shall:

1. Advise project manager and project personnel on all health and safety aspects of investigative, monitoring, and remedial activities conducted by AMEC personnel at the site and vicinity;
2. Specify required exposure monitoring to assess site health and safety conditions;
3. Review any accident/incident reports and make corrective action recommendations;
4. Modify the site HASP as required based on accidents/incidents and findings regarding site hazards and work practices;
5. Report all accidents/incidents and findings regarding personnel exposure, site hazards, and work practices to the PM; and

6. Suspend hazardous site work if the PHSO believes that AMEC or a contractor's personnel are or may be exposed to an immediate health hazard.

4.3 SITE SAFETY OFFICER

The Site Safety Officer (SSO) may be a person dedicated to this task, or the SSO functions may be a collateral duty of the Site Supervisor. The SSO shall:

1. Ensure that appropriate personal protective equipment is available for AMEC site personnel and enforce proper utilization of personal protective equipment by all on-site AMEC personnel;
2. Ensure that all AMEC personnel have received required training, are aware of the potential hazards associated with site operations, have been instructed in the work practices necessary for personal health and safety, and are familiar with the site HASP's procedures for all scheduled activities and for dealing with emergencies;
3. Observe AMEC's and contractor's procedures with respect to health and safety. If the SSO believes that AMEC or a contractor's personnel are or may be exposed to an imminent health hazard, the SSO shall suspend the hazardous site work. If site personnel do not have required protective equipment, the SSO shall consult with the PHSO before proceeding with the work;
4. Implement the site HASP and report any observed significant differences from the site conditions anticipated in the plan to the project manager;
5. Conduct daily site safety briefings and additional briefings as needed;
6. Calibrate monitoring equipment daily and properly record and file calibration and monitoring results;
7. Under direction of the PHSO perform required exposure monitoring;
8. Maintain monitoring equipment or arrange maintenance as necessary;
9. Assume other duties as directed by the PHSO; and
10. Prepare reports of any observed accidents/incidents or inadequate work practices and communicate them to the PM and PHSO.

4.4 SITE SUPERVISOR

The Site Supervisor (SS) shall:

1. Maintain control of the site and direct daily site operations to be consistent with applicable environmental and health and safety regulations, site work plans and this project HASP, and enforce safe work practices and proper utilization of personal protective equipment by all on-site AMEC and contractor personnel;

2. With guidance from the PHSO, observe AMEC and contractor's procedures with respect to health and safety. If the SS believes that AMEC or a contractor's personnel are or may be exposed to an imminent health hazard, the SS shall suspend the hazardous site work coordinating that suspension through the subcontractor's site supervisor. If site personnel do not have required protective equipment, the SS shall consult with the PHSO before proceeding with the work;
3. Implement the site HASP and report any observed significant differences from the site conditions anticipated in the plan to the project manager;
4. Conduct site safety briefings as needed;
5. Ensure that required personal protective, monitoring, and emergency equipment is provided and maintained in effective working condition at all times when work occurs on site; and
6. Report observed accidents/incidents or inadequate work practices to the project manager and the PHSO.

4.5 PROJECT PERSONNEL

Project personnel involved in on-site investigations and operations shall:

1. Take reasonable precautions to prevent injury to themselves and to their fellow employees;
2. Perform only those tasks that they can do safely and immediately report accidents and/or unsafe conditions to the SSO or PHSO;
3. Follow the procedures set forth in the site HASP and report to the SSO, SS, or PHSO any observed deviations by AMEC or contractor personnel from the procedures described in the plan; and
4. Inform the SSO and PHSO of any physical conditions that might affect their ability to perform the planned field tasks.

4.6 TRAINING REQUIREMENTS

All project personnel must comply with applicable regulations specified in WAC Chapter 296-843, hazardous waste operations (HAZWOPER), administered by the Washington State Department of Labor and Industries (L&I). These include completion of a 40-hour health and safety training course for HAZWOPER, an annual 8-hour refresher training, and participation in AMEC's medical surveillance program and respiratory protection program. In addition to the 40-hour course and 8-hour refreshers, the SS (and SSO, if performing the duties of the SS) will have completed an 8-hour course for hazardous waste site supervisors as required by WAC 296-843-20015. Workers using atmosphere-supplying respirators (self-contained breathing apparatus or airline respirators) will have at least

80 hours of training, with over 40 hours of the training focused on the hazards requiring the use of such respirators and associated chemical protective clothing.

Test pit excavation and drilling will be supervised by a competent person licensed as a geologist in the State of Washington. Should work in the exclusion zone (Section 8.1) occur that will inadvertently disturb preserved asbestos-containing material (PACM), the sampling location will be immediately covered, and an addendum will be developed to this HASP to address the methods of ensuring that asbestos is managed with appropriate personal and environmental controls.

At least one person on site will be current in CPR/First Aid. Documentation of all required training will be maintained on site by the SS. Each site worker will also have a minimum of 3 days of supervised field experience at hazardous waste sites before being allowed to work on site without close direct supervision.

Additional site-specific training that covers on-site hazards; personal protective equipment (PPE) requirements, use, and limitations; decontamination procedures; and emergency response information as outlined in this site HASP will be given by the PHSO or SSO before beginning on-site work. Site-specific training briefings should be documented on the “Project Health and Safety Field Meeting Form” provided at the end of this HASP.

4.7 MEDICAL SURVEILLANCE

All AMEC personnel on site shall participate in AMEC’s medical surveillance program, which includes annual audiometric and physical examinations for employees involved in HAZWOPER projects. It requires that all such personnel have medical clearance before being issued a respirator and participating in field activities. Frequency of medical examinations which comply with 29 CFR § 1910.120(f)(3) and WAC 296-843-21005 are:

1. Prior to performing field work;
2. At least once every 24 months;
3. At termination of employment;
4. Upon occurrence of possible unprotected overexposure to chemicals or harmful physical agents; and
5. More frequently if deemed necessary by a physician.

5.0 HAZARD ASSESSMENT

An assessment of the potential hazards that may be encountered during field activities at the site is summarized by field task in the table below and discussed further in this section. Task-specific Job Safety Analyses are included in Attachment A. These cover the hazards to AMEC staff only. Subcontractors have many additional hazards specific to their activities, which are identified and appropriate controls specified, in their HASP.

ANTICIPATED HAZARDS

	Anticipated Hazards														
Task	Chemical	Slip/Trip/Fall	Excavation	Drums	Biological	Heavy Equipment	Underground Utilities	Electrical	Noise	Heat Stress	Cold Stress	Sunburn	Sharp/Abrasion	Pinch points	Flammable liquids
Site grubbing and clearing		X			X	X			X	X	X	X	X	X	X
Test pit excavation/soil sampling	X	X	X	X		X	X	X	X	X	X	X	X	X	X
Hollow stem auger drilling, well installation, soil sampling	X	X			X	X	X	X	X	X	X	X	X	X	X
Drum characterization	X	X		X		X		X	X	X	X	X	X	X	X
Surface water & seep sampling	X	X			X	X		X			X	X	X	X	
Groundwater sampling	X	X			X	X		X			X	X		X	
Sediment sampling (geotechnical purposes)	X	X								X	X	X	X		

5.1 POTENTIAL CHEMICAL HAZARDS AT THE SITE

Listed below are hazardous substances that have been found at the site based on Phase I samples of groundwater, surface water, and soil. The presence of asbestos and polychlorinated dioxins and furans is expected based on the anecdotal evidence cited in Section 3.1, above, and sediment data from Padilla Bay. High levels of methane and VOCs are possible, but are considered less likely based on the age of the landfill and the lower rate of decomposition in landfills that have aged beyond the first decade. Available information on the detected and suspected chemicals, including their acute exposure effects, is summarized in the table below. Additional details are included at the end of this HASP.

DETECTED CHEMICAL ABOVE PSLS ON SITE

Chemical, Form	Maximum Concentrations Detected at Site (water samples)	Routes of Exposure[1]	Acute Exposure Symptoms
METALS (µg/L)			
Arsenic	21.3	**RIS**	Burning lips, throat constriction, abdominal pain, hemorrhagic gastritis, gastroenteritis, vomiting, diarrhea,
Copper	38	**RISE**	Irritation of nose and upper respiratory tract, sneezing, coughing, perforation of nasal septum, metal fume fever, nausea, skin irritation
Lead	24	**RI**	Liver injury, hemolysis, anorexia, vomiting, malaise
Manganese	782	**RI**	Respiratory irritation, metal fume fever
Molybdenum	40	**RIS**	Respiratory irritation
Nickel	72.2	**RISE**	Respiratory and nasal irritation, contact dermatitis or hypersensitivity, dizziness, giddiness, weakness, nausea, diarrhea
Zinc	150	**RIS**	Gastric and chest pain, nausea, diarrhea, shock, skin lesions
PCBs (µg/L)			
Total PCBs	0.14	**RISE**	Mild skin and eye irritation, gastrointestinal upset, headache, weakness
PESTICIDES (µg/L)			
4,4'-DDD	0.0082		
alpha-BHC	0.041		

Chemical, Form	Maximum Concentrations Detected at Site (soil samples)	Routes of Exposure[1]	Acute Exposure Symptoms
METALS (mg/kg)			
Arsenic	14	**RIS**	Burning lips, throat constriction, abdominal pain, hemorrhagic gastritis, gastroenteritis, vomiting, diarrhea,
Cadmium	2.7	**RIE**	Chest pain, cough with bloody sputum, difficulty breathing, sore throat, “metal fume fever” (shivering, sweating, body pains, headache), dizziness, irritability, weakness, nausea, diarrhea, abdominal pain, burning sensation, salivation, cramps
Copper	373	**RISE**	Irritation of nose and upper respiratory tract, sneezing, coughing, perforation of nasal septum, metal fume fever, nausea, skin irritation
Lead	238	**RI**	Liver injury, hemolysis, anorexia, vomiting, malaise
Mercury	6.9	**RISE**	Salivation, metallic taste, abdominal pain, respiratory irritation, shortness of breath, tremor, weakness, confusion, twitching, lethargy, nausea, diarrhea, difficulty swallowing, abdominal pain, dermatitis, skin irritation
Molybdenum	6	**RIS**	Respiratory irritation
Nickel	99	**RISE**	Respiratory and nasal irritation, contact dermatitis or hypersensitivity, dizziness, giddiness, weakness, nausea, diarrhea
Strontium	72		
Zinc	381	**RIS**	Gastric and chest pain, nausea, diarrhea, shock, skin lesions
SVOCs (µg/kg)			
Benzo(a)anthracene	270	**RSE**	Dermatitis, bronchitis, [potential occupational carcinogen]
Benzo(a)pyrene	240	**RSE**	Dermatitis, bronchitis, [potential occupational carcinogen]
Bis(2-ethylhexyl)phthalate	6000	**ISE**	Skin and eye irritation
Chrysene	320	**RSE**	Dermatitis, bronchitis, [potential occupational carcinogen]

Chemical, Form	Maximum Concentrations Detected at Site (soil samples)	Routes of Exposure[1]	Acute Exposure Symptoms
TPH (mg/kg)			
Gasoline-Range (TPH-G)	310	**RISE**	Irritation eyes, skin, mucous membrane; dermatitis; headache, lassitude (weakness, exhaustion), blurred vision, dizziness, slurred speech, confusion, convulsions; chemical pneumonitis (aspiration liquid); possible liver, kidney damage; [potential occupational carcinogen]
PCBs (µg/kg)			
Aroclor 1254	240	**RISE**	Mild skin and eye irritation, gastrointestinal upset, headache, weakness
Total PCBs	690	**RISE**	Mild skin and eye irritation, gastrointestinal upset, headache, weakness
PESTICIDES (µg/kg)			
Aldrin	390	**RISE**	Headache, dizziness, nausea, vomiting, malaise
delta-BHC	120	**RISE**	Eye irritation, headache, nausea, skin, nose, throat irritation.
Dieldrin	210	**RISE**	Headache, dizziness, nausea, vomiting, malaise
Methoxychlor	71	**RI**	In animals: fasciculation, trembling, convulsions.

Notes

1. Exposures routes: R = respiratory, I = ingestion, S = skin absorption, E = eyes.
2. ND = Not detected at site. Presence suspected due to available historical information.
3. J = Analyte was positively identified. Concentration shown is approximate.

Air monitoring requirements and action levels related to potential chemical hazards on the site are discussed in Section 6.0. Sampling for site contaminants in soils and groundwater is discussed in the SAPs.

5.2 POTENTIAL PHYSICAL HAZARDS AT THE SITE

Potential physical hazards listed in the table above are discussed below.

5.2.1 Slip, Trip, and Fall Hazards

Walking on uneven ground in the vicinity of equipment, tools, materials, and debris poses a significant trip hazard potential. Work items will be organized to minimize hazards, and holes or other trip hazards will be flagged as needed to alert workers. Wet conditions can pose a significant slip hazard. Appropriate nonskid footwear will be worn on site at all times. When sampling seeps near the shoreline, there is a significant engulfment hazard in mud flat areas. Intertidal mud will be probed for firmness, and plywood sheeting will be laid down to access the seep sampling locations if the depth to firm support exceeds 2/3 of the field team's boot height.

5.2.2 Excavation Hazards

The test pit survey will be performed only in the area of the former landfill to a maximum depth of 12 feet. Caution should be exercised when digging at greater than 10 feet. A qualified subcontractor will be engaged to perform the excavation under their own HASP. Excavation of the former landfill poses unique hazards related to both structural stability and potential contact with hazardous materials. For structural stability, a competent person will be on site to verify that the test pits are sloped or shored with a prefabricated metal trench box, if needed to maintain stable sidewalls. Test pits will not be made in the vicinity of foundations for aboveground structures. The excavator position will be monitored for structural support by a competent person as the excavation proceeds. Under no circumstances will the excavated pits be entered without proper sloping or shoring, or if an atmospheric hazard develops that exceeds the action limits specified in Section 6.0.

The excavator will have a fire extinguisher rated at least 4-A:80-B (or two with at least half those ratings) located within 50 feet of the excavation. The excavator will dig from a cross-wind or slightly upwind location (digging from directly upwind creates a vacuum in front of the excavator that can pull in potentially hazardous emissions). At each test pit location, overlaying wood waste and the top 1 to 2 feet of soil (anticipated to consist of clean cover soil) will be carefully removed by the excavator and stockpiled separately. Material will be subsequently excavated in 1-foot layers from each test pit and placed on plastic sheeting no closer than 2 feet from the edge of the test pit.

If three or more drums are encountered in a single test pit, further excavation in that pit will be discontinued. The drums and test pit will be covered or backfilled, and an addendum to the SAP will be written to delineate methods of characterization and disposal for large quantities of drums. If only one or two drums are encountered in a test pit, on-site AMEC personnel will only remotely inspect the drums to determine their condition and attempt to identify the contents or source of the drums. The qualified subcontractor will assess the structural integrity and attempt removal of the drums if they deem it safe to proceed, under their HASP.

If further excavation at any test pit presents a high risk of puncturing a drum or drums, excavation will be abandoned in order to avoid contaminant release, and the pit will be backfilled or covered until further remedial action is planned. If groundwater is encountered, excavation will also be abandoned, as groundwater is likely to be turbid and hamper further visual inspection of the test pit, impairing identification of containers that may contain hazardous material. If an explosive atmosphere is detected, further excavation will stop for that test pit.

After a test pit is completed, or if excavation problems prevent completion of the test pit, the excavation will be backfilled to grade with the stockpiled excavation material from that location only. If any containerized waste is removed from the test pit, these containers will be segregated for characterization and disposal by the qualified subcontractor under their HASP. Using the excavator bucket, the backfill will be compacted at 2-foot intervals. The plastic sheeting on which the stockpiled material was placed will also be placed in the test pit during backfilling. The clean soil overburden that had been segregated will be used for the final lift of the backfill to grade. Temporary fencing will be placed around areas where drums are stored.

Hazardous materials that may be encountered during excavation of test pits include:

- landfill gases (hydrogen sulfide, volatile organic gases, and explosive gases);
- friable ACM;
- flammable or combustible materials;
- compressed gas cylinders;
- toxic, corrosive, or caustic liquids;
- shock-sensitive, reactive, explosive, or radioactive materials;
- sharp materials;
- medical waste; and
- other potentially hazardous materials, including radiologically active materials.

Containerized wastes (such as drums and cylinders) will be assumed to be hazardous until proven otherwise. The precautions for drum hazards in this HASP will be observed.

If nonfriable or friable PACM is encountered the test pit location will be abandoned. Those locations that are abandoned because of the suspected presence of PACM will not be further evaluated unless an certified asbestos supervisor is present All work that disturbs buried, friable PACM is considered Class I asbestos work and will not occur until an addendum to this HASP is developed that includes a written compliance program specified by WAC 296-62. All applicable requirements of WAC 296-62 will be met.

5.2.3 Drum Hazards

Buried drums may be intact, leaking, open, or pressurized. Drums may contain any type of industrial product or waste, including flammable, combustible, corrosive, caustic, toxic, reactive to water or air, explosive, shock-sensitive, or radiologically active materials.

Because of the unknown contents and condition of drums, it is not anticipated that they will be handled by manual methods in this phase of the work. Test pit excavation in the former landfill area will be performed by qualified subcontractor, who is expected to be operating an excavator to a maximum depth of 20 feet. The depth will be limited to reaching the shallower of groundwater, native soil, or targeted subsurface features, such as drums. The excavator and all personnel within the vicinity of the excavation will be prepared to be outfitted in Level D PPE and their positions will be closely monitored with real-time instrumentation as new features are unearthed.

If drums are encountered, they will be documented by visual inspection (e.g., binoculars) or photography from outside of the excavation. If a drum appears intact, the excavator may be able to gently manipulate the drum using a drum-handling attachment to maneuver the drum into a position where it can be better evaluated by photography. Discovery of multiple adjacent drums in a single test pit will be cause for refilling the test pit with the excavated material and soil cover. If the excavator is used to remove an intact drum from a test pit, the qualified subcontractor will determine the safe methods for doing so and will follow those methods. Any drums removed from a test pit will be placed onto a staging area with secondary containment under cover for later characterization in accordance with the qualified subcontractor’s HASP.

5.2.4 Biological Hazards

Wildlife and insects may be encountered when clearing brush and debris from drilling sites and when surveying or sampling. Persons with known allergies to bees will alert the SSO and carry a personal anaphylactic shock kit as prescribed by a physician. Any wildlife encountered on site will not be approached by the field team.

5.2.5 Heavy Equipment Hazards

Personnel working on site in the vicinity of operating heavy equipment (trackhoe, drill rig, brush hog, plus log trucks, log-handling equipment, and forklifts from the sawmill operation) will wear high-visibility safety vests and maintain safe distances from the equipment to avoid contact with moving equipment parts, such as the drill rig or boom (be aware of swing radius), tires, and tracks. Site personnel will get positive acknowledgement that the equipment or truck operator approves of their location whenever they are within strike distance of the equipment.

Equipment and vehicles will be approached only from the front or side of the cab. Ground personnel will avoid unnecessary proximity to pressurized hydraulic lines, which can unexpectedly burst while working under load.

5.2.6 Underground Utility Hazards

An underground utility check via the Washington State Utilities and Transportation Commission (WUTC) shall be performed prior to initiating any subsurface investigation or work. The check will include:

X	WUTC Note:	WUTC must be notified at least 2 working days before any subsurface work begins (800-424-5555). The confirmation number will be recorded in project field notes.
X	Private Locator: APS Locating	(425) 888-2590
X	Plans Check. Facility Contact:	Stein Svendsen, Snow Mountain Mills: (360) 293-5812

5.2.7 Electrical Hazards

Whenever possible, site personnel will avoid working under overhead high-voltage lines. The SS is responsible for documenting a determination of the voltage and minimum approach distance to any potentially energized electrical distribution line. Lines will be confirmed to be deenergized when minimum approach distances cannot be met. The following are minimum clearances for overhead high voltage lines.

Minimum Clearances for Overhead High Voltage Lines

Normal Voltage (phase to phase)	Minimum Required Clearance (feet)
less than or equal to 50,000	10
more than 50,000	10 + 0.4 inch per kV

(Reference: WAC 296-24-963)

To prevent electrocution hazards from electrical utilization equipment, all electrical extension cords will be rated for the combined amperage of the equipment they power, and must be factory listed as rated SJOW or STOW (an "-A" extension is acceptable for either) and inspected prior to use for defects in the cord and plugs. Cords showing any reduction in the original jacket or evidence of overheating (cord discoloration or melting) will be destroyed and replaced as necessary. The following safe work practices will also be enforced.

- No exposed energized conductors operating above 50 volts to ground will be allowed on site unless properly guarded from contact by unqualified persons.
- Electrical distribution systems and repairs to utilization equipment operating above 50 volts to ground will be performed only by a qualified licensed electrician.
- All portable power tools will be inspected for defects before use and be a double-insulated design.
- Any generator brought on site will be grounded to a suitable earth and will be equipped with overcurrent protection.
- All extension cords running outside will be protected by a ground-fault circuit interrupter, which will be tested daily.
- No extension cords will be routed through walls, ceilings, doors, or windows.

5.2.8 Noise Hazards

Site personnel will wear hearing protection when working near large heavy equipment, such as drill rigs, or in other noisy conditions. Hearing protection will be worn when two people standing within 3 feet of each other cannot communicate at normal conversational voice levels. This is to prevent hearing loss that can occur when daily 8-hour time weighted average noise exposures meet or exceed 85 decibels (dBA) (WAC 296-817-20015). Work will be limited to the hours of 7 AM to 7 PM during which normal construction noise impacts are permitted.

5.2.9 Heat Stress Hazards

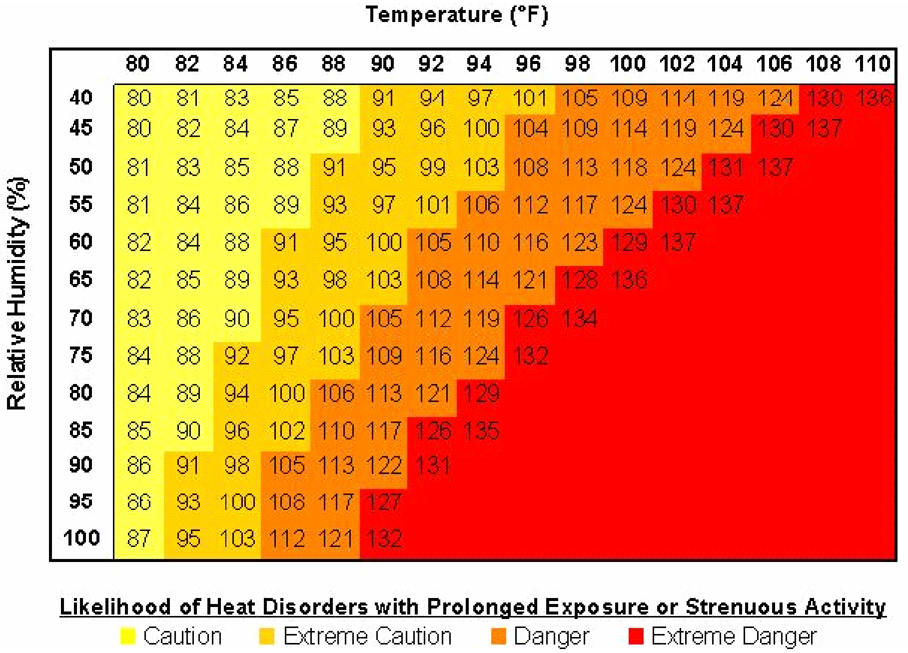
Heat stress is a moderate hazard during the summer months in the Pacific Northwest, but becomes a significant hazard for workers wearing protective clothing. To avoid heat stress, at least one quart of cool potable water will be readily available per person per hour, and site personnel will be encouraged to drink plenty of fluids and take periodic work breaks in hot weather. The signs, symptoms, and treatment of heat stress are listed below.

- Heat rash may result from exposure to heat or humid air.
- Heat cramps are caused by heavy sweating with inadequate electrolyte replacement. Signs and symptoms include muscle spasms and pain in the hands, feet, and abdomen. Persons experiencing these symptoms should rest in a cooler area, drink cool (not cold) liquids, and gently massage cramped muscles.

- Heat exhaustion involves increased stress on various body organs brought on by inadequate blood circulation due to cardiovascular insufficiency or dehydration. Signs and symptoms include pale, cool, moist skin; heavy sweating; dizziness; nausea; and fainting. Persons experiencing these symptoms should lie down in a cooler area, drink cool liquids with electrolytes (Gatorade, etc.), remove any protective clothing, and cool body with wet compresses at forehead, back and neck, and/or armpits.

- Heat stroke is the most serious form of heat stress. Temperature regulation fails and the body temperature rises to critical levels. Immediate action must be taken to cool the body before serious injury or death occur. Competent medical help must be obtained. Signs and symptoms are red, hot, usually dry skin; lack of or reduced perspiration; nausea; dizziness and confusion; strong, rapid pulse; and coma.

If site temperatures are forecast to exceed 85 degrees Fahrenheit and physically demanding site work will occur in impermeable clothing, the SSO will consult with the PHSO and a radial pulse monitoring method will be implemented to ensure that heat stress will be properly managed among the affected workers. The following chart indicates the relative risk of heat stress.



Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

🟨 Caution 🟨 Extreme Caution 🟧 Danger 🟥 Extreme Danger

Combined temperature and humidity conditions that result in a heat index exceeding 100 will trigger mandatory radial pulse monitoring and heat stress management.

5.2.10 Cold Stress Hazards

Exposure to even moderate levels of cold can cause the body’s internal temperature to drop to a dangerously low level (hypothermia). This is a significant hazard in the fall, winter, and spring months in the Pacific Northwest. Exposure to temperatures below freezing can cause frostbite of hands, feet, and face. Symptoms of hypothermia include:

- vague, slow, slurred speech;
- forgetfulness, memory lapses;
- inability to use hands;
- frequent stumbling;
- drowsiness.

To prevent hypothermia, site personnel will avoid unprotected exposure to wet conditions. Site personnel will wear outer clothing that is wind- and waterproof and inner layers sufficient to retain warmth (wool or polypropylene).

5.2.11 Sunburn Hazards

Skin exposure to ultraviolet radiation can result in sunburn. Site personnel will use long-sleeved shirts, hats, and sunscreen to protect against sunburn.

5.2.12 Sharp/Abrasion/Pinch Point Hazards

Site debris, equipment, tools and materials may have sharp edges or abrasive surfaces that pose a hazard to unprotected skin. Heavy leather gloves will be worn when handling such items. When applying force to sharp tools, the travel path of the tool will be anticipated and kept clear should the tool slip under pressure. Heavy items such as well covers and machinery such as drill rig equipment may pose pinch point hazards. Tools such as manhole keys will be used when possible to prevent exposure to the pinch hazard, and personnel will take care to keep hands away from other pinch hazards that cannot be guarded.

5.2.13 Flammable Liquid Hazards

Flammable and combustible liquid hazards may occur from fuels and lubricants brought on site to support generators and heavy equipment. Such products will be stored in containers approved by the Department of Transportation (DOT) in a location not exposed to strike hazards and provided with secondary containment. A minimum 2-A:20-B fire extinguisher will be located within 25 feet of the storage location, and where refueling occurs. Transfers of flammable liquids (e.g., gasoline) will occur only after making positive metal to metal connection between the containers. A bonding strap may be necessary to achieve this. Sources of ignition and combustible materials will be kept away from storage and fueling operations.

5.3 GENERAL SAFE WORK PRACTICES

In working with or around any hazardous or potentially hazardous substances or situations, site personnel should plan all activities before starting any task. Site personnel shall identify health and safety hazards involved with the work planned and consult with the PHSO or SSO as to how the task can be performed in the safest manner, if he/she has any uncertainties.

All field personnel will adhere to the following general safety rules.

1. Wear protective equipment and clothing specified for tasks.
2. Wear a hard hat and safety glasses in all construction areas.
3. Keep materials, equipment, ropes, lines, and debris organized, and flag trip hazards.
4. Do not eat, drink, or use tobacco or cosmetics in restricted work areas.
5. Prevent splashing of liquids containing chemicals, and minimize emissions of dust.
6. Prevent back injury by never lifting or carrying a load that is heavier than you can comfortably handle. When lifting heavy objects, first test the load and get assistance when necessary. Bend the knees, use the leg muscles, and avoid twisting with a load by positioning the feet.
7. Keep all heat and ignition sources away from combustible liquids, gases, or any flammable materials. When working in areas where combustible gases may be present, use only intrinsically safe (nonsparking) equipment. This includes cell phones.
8. Field personnel shall be familiar with the physical characteristics of the site, including:
    - wind direction in relation to restricted work areas;
    - accessibility of other personnel, equipment, and vehicles;
    - areas of known or suspected chemicals in soil and groundwater;
    - site access;
    - nearest water sources; and
    - location of communication devices.
9. When in doubt of your safety, it is better to overprotect.
10. Practice defensive driving.

6.0 AIR MONITORING

This section defines the air monitoring necessary to protect site workers and the adjacent public from overexposure to site contaminants, in accordance with L&I rules

6.1 TASK-SPECIFIC MONITORING

Site clearing and preparation, site surveys, and surface water and seep sampling will not require exposure monitoring. These activities are not expected to disturb the landfill (only the overlying wood waste and clean cover dirt), nor should they present significant inhalation exposures to site contaminants. More intrusive activities will require exposure monitoring, as described below.

6.1.1 Test Pit Excavation

Test pit excavation in the former landfill poses a slight hazard from dust, but a significant hazard from combustible gases, hydrogen sulfide, and VOCs. The test pits may encounter combustible gases and hydrogen sulfide. Action levels for combustible gases will be 10 percent of the lower explosive limit (LEL) outside the pit. Elevated levels of VOCs may be encountered. The landfill gases should be a highly diverse mixture of VOCs, and are unlikely to be dominated by particularly hazardous VOCs, such as vinyl chloride. Work areas will be monitored for VOCs using a photoionization detector (PID), such as an intrinsically safe Photovac Combi Pro 2020 with a 10.6 eV lamp. An interim action level for VOCs has been established based on the response factors for the instrument to the worst-case VOC, vinyl chloride.

6.1.2 Drum Characterization and Disposal

Drum characterization and disposal will be performed by a qualified subcontractor under their separate HASP. AMEC personnel in an oversight role will remain outside the EZ and perform upwind/downwind perimeter air monitoring, in Level C or B as dictated by the results of the air monitoring. The air monitoring scheme will be the same process an action levels as required for the test pit excavation with the exception of asbestos, oxygen deficiency, H_2S and combustible vapors, which are unlikely to be an issue at the EZ perimeter. Combustible vapors may be an issue within the EZ, and must be monitored by the drum characterization subcontractor.

6.1.3 Hollow-Stem Auger Drilling, Well Installation, Soil Sampling

Performing these activities around the perimeter of the former landfill pose a lower likelihood than test pit excavation of creating hazardous levels of dusts, combustible gases, hydrogen sulfide, VOCs, and possibly radionuclides. Combustible gases, hydrogen sulfide, and VOCs will be monitored as under the Test Pit activity above. Oxygen levels will not be monitored, except to confirm that there is sufficient oxygen for the combustible gas analyzer to function. Depending on the indications of real time screening measurements, personal and area monitoring may be conducted during well drilling and soil sampling for VOCs by Summa canister according to OSHA Method PV2120.

6.1.4 Groundwater Sampling

This activity poses a negligible hazard from dusts, friable asbestos, and radionuclides. Combustible gases, hydrogen sulfide, and VOCs may pose a hazard from accumulation within the well between sampling events. The well head will be monitored for these constituents upon removal of the cover, and the work area will be rechecked periodically and if odors become evident.

6.2 ACTION LEVELS

The applicable L&I permissible exposure limits (PELs) (both 8-hour and 15-minute short-term exposure limits, or STELs) and the American Conference of Governmental Industrial Hygienists (ACGIH) recommended Threshold Limit Values® (TLV®s) for the most likely chemicals of concern at the site are presented below.

APPLICABLE OCCUPATIONAL EXPOSURE LIMITS

Chemical	L&I PEL (8-hr/15-min. STEL)	ACGIH TLV® (8-hr/15-min. STEL)
Particulate not otherwise regulated (nuisance dust—total fraction)	10 mg/m^3 / 20 mg/m^3	10 mg/m^3 / 30 mg/m$^{3\ a}$
VOCs: Toluene	100 ppm / 150 ppm	100 ppm / 150 ppm
VOCs: Vinyl chloride	1 ppm / 5 ppm	1 ppm / --
Hydrogen Sulfide	10 ppm/ 15 ppm	10 ppm/ 15 ppm

Notes

1. Generic STEL—30 minute duration maximum exposure recommended.
2. -- = Not established.
3. f/cc = fibers per cubic centimeter

The lower of these two criteria will be applied, and the mixture exposure will be considered if the air monitoring action levels are exceeded and compound-specific monitoring occurs.

The SS and/or SSO will take the following actions when air monitoring indicates that concentrations exceed the following action levels (note that Level C respiratory protection will be in effect continuously in the exclusion zone during Test Pit excavation):

AIR MONITORING ACTION LEVELS

PID Monitor Reading >1 min. in breathing zone	Action
≤ 2 ppm	Continue periodic monitoring (each new area/every 30 minutes).
2 – 19 ppm	Collect sorbent tubes for vinyl chloride and benzene every 30 minutes; if > 1 ppm, abandon pit.
≥ 20 ppm	Abandon excavation in the area.
H_2S Monitor Reading >1 min. in breathing zone	**Action**
< 5 ppm	Continue periodic monitoring (each new area/every 30 minutes).
≥ 5 ppm	Stop work. Abandon excavation in the area.
Combustible Gas Reading (% of LEL) >1 min. in Work Area	**Action**
<5%	Continue periodic monitoring (each new area/every 30 minutes).
≥5%	Upgrade to Level B respiratory protection. Ventilate work area with intrinsically safe fan(s). Monitor every 5 minutes, and with each new lift from pit.
>10% in pit or work area	Stop work and evacuate personnel from pit or work area above 10%, eliminate ignition sources (shut off engines), ventilate work area with intrinsically safe fans and monitor continuously, consult PHSO.

If workers suspect significant chemical exposures (e.g., detect unusual odors, develop symptoms of occupational exposure to the site contaminants) or have other unexplained adverse health effects (e.g., dizziness, nausea), workers will stop work and notify the PHSO.

7.0 PERSONAL PROTECTIVE EQUIPMENT

Work will be conducted in Level D PPE. If an upgrade becomes necessary, then the work at that location will be abandoned. The following PPE is required, unless a change is approved by the PHSO.

PPE REQUIREMENTS BY TASK

Task	Steel Toe & shank boots	Safety glasses	Face shield	Ear plugs /muffs	Inner nitrile gloves	Outer leather gloves	Permeable Tyvek coverall	Impermeable coverall	High-visible vest	Full-face PAPR or APR^1, SAR
Site grubbing and clearing	X	X		X		Av			X	
Test pit excavation/soil sampling	X^3	X		X	X	Av	X	Av	X	Av
Drum characterization and disposal	X^3	X		Av	X	Av	X	Av	X	Av
Hollow stem auger drilling, well installation, soil sampling	X^3	X		Av	X	Av	X	Av	X	Av^2
Surface water & seep sampling	X	X			X	Av				
Groundwater sampling	X	X		Av	X	Av			X	Av
Sediment sampling (geotechnical purposes)	X	X			X	Av	Av			
Heavy equipment decontamination (pressure wash)	X	X^2	X	Av	X	Av	X	Av	X	

Key:
X = PPE Required
O = PPE Optional
Av = Have available at work site, use as needed
^{1} = Combination cartridge: N,R or P-100/OV-Combo (e.g., North 75SCP100)
^{2} = Required in sanitary portion of the landfill, available elsewhere
^{3} = Chemical-resistant or with chemical-resistant cover

8.0 SITE CONTROL

The purpose of site control is to minimize the potential exposure to site hazards, to prevent vandalism at the site and access by children and other unauthorized persons, and to provide adequate facilities for workers. A daily field log will be maintained by the SS. The field log will include a list of all persons present in the work areas, and will be updated with name and time whenever a visitor or contractor arrives or departs the site. The log will be used for an accurate roll call in the event of an emergency.

Work area controls and decontamination areas will be provided to limit the potential for chemical exposure associated with site activities. The support zone for the site is considered to be all areas outside the work area and decontamination areas. Readily available restroom and washing facilities (within 5 minutes) will be identified by the SS and maintained in hygienic conditions at all times.

8.1 WORK AREA

An exclusion zone (EZ) will be set up around each upland work area. Only authorized personnel shall be permitted access to the EZ. The EZ will be demarcated with barrier hazard tape or cones as needed to effectively limit unauthorized access. No eating, drinking, or smoking is allowed in the EZ. Egress from the EZ will only be through a contamination reduction zone (CRZ)—unless warranted for imminent hazards during an emergency. A buddy system will be implemented at all times when workers are in the EZ and CRZ. In this system, for each worker in the EZ or CRZ, either another worker in that zone will be designated to keep an eye on them and maintain alertness for imminent hazards and symptoms of distress, or a standby person in the appropriate PPE will be in the support zone and ready to immediately enter to assist the person in the EZ or CRZ. Any open excavation will be covered at the end of each shift. Any drums removed from the upland landfill will be surrounded by a locked fence to prevent unauthorized access to their contents while they await characterization and disposal.

8.2 COMMUNICATION

An AMEC field representative will contact the PM or office, and the mill site representative at the start and end of each day while on site. Upon initial mobilization to the site, cell phone signals will be checked for those phones available to the SS and SSO. On-site communications will be by voice, hand-held radio, or cell phone. Under noisy conditions on site, or when electronic systems are ineffective, a written system of hand signals will be established by the SS and reviewed with all site personnel to enable basic communications among field staff.

9.0 DECONTAMINATION

Decontamination procedures will be strictly followed to prevent off-site spread of site contaminants. At the CRZ, boots or equipment in contact with contaminated soil or sediments will be brushed off, washed with soapy water, and rinsed with clean water. Decontamination effectiveness will be evaluated by a visual inspection, with PID assessment if residual odors are evident. A PID reading that is 50 percent above background in the CRZ will be cause for further decontamination. Rinsate will be collected and containerized on site for disposal characterization.

9.1 PERSONNEL/HAND EQUIPMENT DECONTAMINATION PROCEDURES

The CRZ will be equipped with, if deemed necessary, a decontamination station including plastic sheeting, paper towels, trash bags, small broom, wash tub, rinse tub, Alconox detergent, long-handle brush and bucket, water sprayer, and alcohol solution respirator wipes. The following decontamination procedure will be followed.

1. Brush off residual soils at exit from EZ; drop equipment on plastic sheeting.

2. Wash and rinse outer gloves; remove them (may be reused on same project).

3. Wipe down equipment with soapy water-moistened paper towels, followed by clean water-moistened paper towels; place trash in bag.

4. Remove coveralls and place in trash bag; remove respirator cartridges and place in trash bag.

5. Remove respirator and decontaminate with wipes.

6. Remove inner gloves and place in trash bag.

9.2 DECONTAMINATION PROCEDURES FOR HEAVY EQUIPMENT/SAMPLING GEAR

Because the excavator and drill rig will be working from clean soil cover layer on the uplands, only the bucket and soil penetrating components of the drill rig, respectively, should become significantly contaminated. These components will be swept off and pressure-washed with soapy water into the disturbed area prior to replacing the landfill soil cover to minimize migration of soil-borne hazards, and will be swept off and pressure washed again with soapy water before leaving the site.

9.3 STORAGE OF INVESTIGATION-DERIVED MATERIAL

Any drums removed from the landfill and investigation-derived material will be labeled with appropriate identification information and left in the secured, covered secondary containment staging area until they are characterized for proper disposal. Any asbestos-contaminated materials will be double bagged and labeled as asbestos waste. Disposal of all waste and contaminated materials will be at the direction of the PM and in accordance with Washington State Department of Ecology rules for Dangerous Waste.

10.0 EMERGENCY RESPONSE

This section defines the emergency action plan for the site. It will be rehearsed with all site personnel and reviewed with visitors upon their initial site visit, and whenever the plan is modified or the SS or SSO believe that site personnel are unclear about the appropriate emergency actions.

A muster point of refuge will be identified by the SS and communicated to the field team each day. This point will be clear of adjacent hazards and preferably up- or cross-wind for the entire day. In an emergency, all site personnel and visitors will evacuate to the muster point for roll call versus the daily site log. It is important that each person on site understand their role in an emergency, and that they remain calm and act efficiently to ensure everyone's safety.

After every emergency is resolved, the entire project team will meet and debrief on the incident—the purpose is not to fix blame, but to improve the planning and response to future emergencies. The debriefing will review the sequence of events, what was done well, and what can be improved. The debriefing will be documented in a written format and communicated to the PHSO. Modifications to the emergency plan will be approved by the PHSO.

Reasonably foreseeable emergency situations include medical emergencies, accidental release of hazardous materials (such as asbestos, gasoline, or diesel) or hazardous waste, and general emergencies such as fire, thunderstorm, flooding, and earthquake. Expected actions for each potential incident are outlined below.

10.1 MEDICAL EMERGENCIES

In the event of a medical emergency, the following procedures should be used.

1. Stop any imminent hazard if you can safely do it.
2. Remove ill, injured or exposed person(s) from immediate danger if moving them will clearly not cause them harm, and no hazards exist to the rescuers.
3. Evacuate other on-site personnel to a safe place in an upwind or cross-wind direction until it is safe for work to resume.
4. If serious injury or life-threatening condition exists, call:

   911 – for paramedics, fire department, police

   Clearly describe the location, injury and conditions to the dispatcher. Designate a person to go to the site entrance and direct emergency equipment to the injured person(s). Provide the responders with a copy of this HASP, to alert them to chemicals of potential concern.

5. Trained personnel may provide first aid/cardiopulmonary resuscitation if it is necessary and safe to do so. Remove contaminated clothing and PPE only if this can be done without endangering the injured person.
6. Call the PHSO or PM.
7. Immediately implement steps to prevent recurrence of the accident.

A map showing the nearest hospital location is attached to this HASP (Attachment B).

Island Hospital
1211 24th Street
Anacortes, WA 98221
(360) 299-1311

Telephone number of nearest Poison Control Center: (800) 222-1222

Other emergency notifications and phone numbers: Stein Svendsen, Snow Mountain Mills, (360) 293-5812.

10.2 ACCIDENTAL RELEASE OF HAZARDOUS MATERIALS OR WASTES

1. Evacuate all on-site personnel to a safe place in an upwind direction until the PHSO determines that it is safe for work to resume.
2. Alert the mill point of contact of the situation.
3. Instruct a designated person to contact the PHSO and confirm a response.
4. Contain the spill, if it is possible and it can be done safely.
5. If the release is not stopped, contact 911 to alert the fire department.
6. Contact the Washington State Emergency Response Commission at 1-800-258-5990 to report the release.
7. Initiate cleanup.
8. The project manager will coordinate follow-up written reporting to the Washington State Department of Ecology in the event of a reportable release of hazardous materials or wastes.

10.3 GENERAL EMERGENCIES

In the case of fire, explosion, earthquake, or other imminent hazard, work shall be halted and all on-site personnel will be immediately evacuated to a safe place. The local police/ fire department shall be notified if the emergency poses a continuing hazard by calling 911.

- In the event of a thunderstorm, outdoor work will be discontinued until the threat of lightning has abated.
- During the incipient phase of a fire, the available fire extinguisher(s) may be used by persons trained in putting out fires, if it is safe for them to do so. Contact the fire department and mill point of contact as soon as feasible.

10.4 EMERGENCY COMMUNICATIONS

In the case of an emergency, the air horn or car horn will be used as needed to signal the emergency. One long (5-second) blast will be given as the emergency/stop work signal. If the air horn is not working, a vehicle horn and/or overhead waving of arms will be used to signal the emergency. In any emergency, all personnel will evacuate to the designated refuge area and await further instruction.

10.5 EMERGENCY EQUIPMENT

The following minimum emergency equipment will be readily available on site and functional at all times:

- First Aid Kit—Contents approved by the PHSO, including two bloodborne pathogen barriers;
- Sorbent material sufficient to contain the volume of the largest single container of hazardous materials (e.g., gas and diesel) brought on site;
- Portable fire extinguisher (2-A:10 B/C min);
- Two spare sets of PPE suitable for entering the EZ; and
- A copy of the current site-specific health and safety plan.

11.0 APPROVALS

Project Manager	Date
Project Health & Safety Officer	Date
Site Safety Officer	Date

PROJECT HEALTH AND SAFETY FIELD MEETING FORM

Date: __________________________ Time: _________________ Project No.: _______________

Project Name:____

Location: ____

Meeting Conducted by:____

Topics Discussed:
Physical Hazards:

Chemical Hazards:

Personal Protection:

Decontamination:

Other:____

Emergency Information:____

Hospital Location: ____

Attendees

Name/Company (printed)	Signature

Meeting Conducted by:____

Signature

ATTACHMENT A

Job Safety Analyses

amec

JOB SAFETY ANALYSIS

JSA #

Project Name:	March Point Landfill	Project No:	14159.000	Date:	7/16/08
Task:	Mobilization to and from site	Task Location:	Skagit County, WA		

For this Project and Task, this document is a Certification of Hazard Assessment

Completed by:	Z. Satterwhite	Reviewed by:	T. Reinhardt
Notes:			

Task	Hazard	Risk Control Method
Mobilization To Site	Driving accidents	Vehicle to be fit for the purpose and well maintained. If using your own vehicle, note that company insurance may not apply. Best to use a rental car or Flexcar, which are usually well maintained.
		Loads to be secure and not to exceed vehicle specifications or legal limits. If loading vehicle heavily or towing, check vehicle Gross Vehicular Weight Rating (GVWR) and towing limits for vehicle and hitch. Get instruction in proper hitch operation if unfamiliar with towing equipment.
		Driver to be currently licensed and medically fit.
		All occupants will wear their seat belts whenever traveling.
		Driver to be rested and alert. If driving long distances, take breaks to stretch and keep alert. Change drivers or park safely off the road to sleep if having difficulty staying awake.
		Minimize cell phone use. Use only a hands-free system, or park safely off the road to use the cell phone.
		Plan your route ahead of time. Have maps or turn directions at hand for reference; highlight them to show critical turns.
		Check driver attitude—Be relaxed, unhurried, and do not drive aggressively. Keep right except to pass, pass only where sufficient distance and visibility exist, and maintain a spacing buffer for other drivers to make mistakes.
		Driver must not be under the influence of alcohol, drugs, or medication that impairs the ability to drive vehicle.

JOB SAFETY ANALYSIS

JSA #

Project Name:	March Point Landfill	Project No:	14159.000	Date:	7/16/08
Task:	Site Grubbing and Clearing	Task Location:	Skagit County, WA		

For this Project and Task, this document is a Certification of Hazard Assessment

Completed by:	Z. Satterwhite	Reviewed by:	T. Reinhardt
Notes:			

Task	Hazard	Risk Control Method
Mobilization To Site	Driving accidents	Reference Mobilization JSA
Set Up Work Site	Site traffic/trucks	Notify site manager / owner of work activities and location.
		Demarcate work locations with traffic cones and flagging, maintain control of traffic in work areas.
		Wear high visibility vest at all times that potential trucks or material handling vehicles are in/near work areas.
	Uneven or unstable ground	Inspect work areas for unstable/uneven ground prior to entry.
Vegetation removal	Struck by:	Wear high visibility vest, boots, safety glasses and hardhat at all times.
		Make eye contact with operator before approaching equipment; approach from front or side and stay safely outside the equipment swing radius.
		Operators stay aware of personnel in the area; agree on and use proper hand signals before maneuvering.
		Stay out of range of swing range of vegetation handled by heavy equipment (trees, shrubs, blackberry canes).
	Underground Utilities:	Properly locate utilities with 1-call (ID # 52133) 800-424-5555 and private locator. Deenergize lines where feasible. If additional utilities are suspected, work with facility site contact to identify and locate them.
		Examine surface scrapings for utility backfill.
		Have subcontractor hand excavate or air knife within 2 feet of identified underground utilities.
	Utility contact:	Operators must use spotters and caution when equipment is within 15 feet of overhead utilities. Maintain safe distances.
	Slip, trip & fall	Keep vegetation, debris and equipment organized.
		Keep work surfaces dry where possible.
		Wear appropriate PPE including boots with non-slip soles.
		Stay aware of footing, look for holes/roots/exposed cables and debris and do not run.
	Heat / cold stress	Hot: take regular breaks and if feeling faint or overexerted. Cold: layer dress for water repellency and heat retention.
		Hot: Consume adequate liquids (water / sports drink).
		Adjust work schedule to avoid temperature extremes.
	Biological hazards: insects, vegetation	Do not put hands inside enclosures where view is obstructed. Stay away from brush during disturbance.
		Survey site for presence of biological hazards and maintain safe distance from wildlife. Communicate insect allergies to supervisor.
	UV exposure	Wear correct PPE (neck to toe clothing & sun block, as needed).

	Lifting heavy items	Gauge load. Get assistance for heavy or suspect items.
		Use proper bending / lifting techniques; use legs, not the back. Do not twist trunk and keep head up while lifting.
	Muscle strain injury	Pace work to avoid overexertion.
		Use correct manual lifting methods.
	Noise	Wear hearing protection (ear muffs or plugs) if normal conversation levels are difficult to hear at 3 feet distance.
	Sharps/Abrasion	Wear leather gloves when handling spiny vegetation and sharp or rough objects.
		Keep coworkers out of contact range when swinging hand tools, wear steel toe boots, anticipate and keep body parts out of trajectory of slipped or glancing blow by tool.
Refueling	Fire	Cool hot equipment before refueling.
		Bond when dispensing gasoline.
		Store fuel in proper containers protected from traffic or upset; have fire extinguisher readily available.

JOB SAFETY ANALYSIS

JSA #

Project Name:	March Point Landfill	Project No:	14159.000	Date:	7/16/08
Task:	Geophysical and Mapping Surveys	Task Location:	Skagit County, WA		

For this Project and Task, this document is a Certification of Hazard Assessment

Completed by:	Z. Satterwhite	Reviewed by:	T. Reinhardt
Notes:			

Task	Hazard	Risk Control Method
Mobilization To Site	Driving accidents	Reference Mobilization JSA
Set Up Work Site	Site traffic/trucks	Notify site manager / owner of work activities and location.
		Demarcate work locations with traffic cones and flagging, maintain control of traffic in work areas.
		Wear high visibility vest at all times that potential trucks or material handling vehicles are in/near work areas.
	Uneven or unstable ground	Inspect work areas for unstable/uneven ground prior to entry.
Site Surveying	Slip, trip & fall	Keep vegetation, debris and equipment organized.
		Keep work surfaces dry where possible.
		Wear appropriate PPE including boots with non-slip soles.
		Stay aware of footing, look for holes/roots/exposed cables and debris and do not run.
	Heat / cold stress	Hot: take regular breaks and if feeling faint or overexerted. Cold: layer dress for water repellency and heat retention.
		Hot: Consume adequate liquids (water / sports drink).
		Adjust work schedule to avoid temperature extremes.
	Biological hazards: insects, vegetation	Do not put hands inside enclosures where view is obstructed. Stay away from brush during disturbance.
		Survey site for presence of biological hazards and maintain safe distance from wildlife. Communicate insect allergies to supervisor.
	UV exposure	Wear correct PPE (neck to toe clothing & sun block, as needed).
	Lifting heavy items	Gauge load. Get assistance for heavy or suspect items.
		Use proper bending / lifting techniques; use legs, not the back. Do not twist trunk and keep head up while lifting.
	Muscle strain injury	Pace work to avoid overexertion.
		Use correct manual lifting methods.
	Sharps/Abrasion	Wear leather gloves when handling spiny vegetation and sharp or rough objects.
		Keep coworkers out of contact range when swinging hand tools, wear steel toe boots, anticipate and keep body parts out of trajectory of slipped or glancing blow by tool.

JOB SAFETY ANALYSIS

JSA #

Project Name:	March Point Landfill	Project No:	14159.000	Date:	7/16/08
Task:	Test Pit Excavation and Soil Sampling	Task Location:	Skagit County, WA		

For this Project and Task, this document is a Certification of Hazard Assessment

Completed by:	Z. Satterwhite	Reviewed by:	T. Reinhardt
Notes:			

Task	Hazard	Risk Control Method
Mobilization To Site	Driving accidents	Reference Mobilization JSA
Set Up Work Site	Site traffic/trucks	Notify site manager / owner of work activities and location.
		Demarcate work locations with traffic cones and flagging, maintain control of traffic in work areas. Establish zones based on potential hazardous conditions, including fire and atmospheric hazards.
		Wear high visibility vest at all times that potential trucks or material handling vehicles are in/near work areas.
	Uneven or unstable ground	Inspect work areas for unstable/uneven ground prior to entry.
Test Pit Excavation	Struck by:	Wear high visibility vest, boots, safety glasses or full-face respirator and hardhat at all times.
		Make eye contact with operator before approaching equipment; approach from front or side and stay safely outside the equipment swing radius.
		Operators stay aware of personnel in the area; agree on and use proper hand signals before maneuvering.
		Stay out of swing range of debris handled by heavy equipment.
	Underground Utilities:	Properly locate utilities with 1-call (ID # 52133) 800-424-5555 and private locator. Deenergize lines where feasible. If additional utilities are suspected, work with facility site contact to identify and locate them.
		Examine surface scrapings for utility backfill.
		Have subcontractor hand excavate within 2 feet of identified underground utilities.
	Utility contact:	Operators must use spotters and caution when equipment is within 15 feet of overhead utilities. Maintain safe distances.
	Excavation stability:	Bench, slope or shore excavations, with a competent person in charge. Maintain support for nearby structures. Keep spoil pile 2+ feet from pit edges.
Test Pit Excavation and Soil Sampling	Slip, trip & fall	Keep debris and equipment organized.
		Keep work surfaces dry where possible.
		Wear appropriate PPE including boots with non-slip soles.
		Stay aware of footing, look for holes/roots/exposed cables and debris and do not run.
	Heat / cold stress	Hot: take regular breaks and if feeling faint or overexerted. Cold: layer dress for water repellency and heat retention.
		Hot: Consume adequate liquids (water / sports drink).
		Adjust work schedule to avoid temperature extremes.

	Chemical hazards	Wear required PPE within EZ and CRZ. Stay up- or cross-wind when possible. Implement air monitoring and take action as specified in HASP.
		Dig in small lifts, be alert for exposed drums and hazardous debris. Avoid skin contact with all excavated material, and stockpile to prevent contaminant migration. Manage drums very carefully—assume they contain unstable shock-sensitive wastes. Rehearse response and plan to prevent fire/explosion and uncontrolled releases of hazardous contents. Do not open sealed drums. Manipulate them from a distance using shielded excavator or pole.
	UV exposure	Wear correct PPE (neck to toe clothing & sun block, as needed).
	Lifting heavy items	Gauge load. Get assistance for heavy or suspect items.
		Use proper bending / lifting techniques; use legs, not the back. Do not twist trunk and keep head up while lifting.
	Muscle strain injury	Pace work to avoid overexertion.
		Use correct manual lifting methods.
	Noise	Wear hearing protection (ear muffs or plugs) if normal conversation levels are difficult to hear at 3 feet distance.
	Sharps/Abrasion	Wear leather gloves when handling sharp or rough objects.
Refueling	Fire	Cool hot equipment before refueling.
		Bond when dispensing gasoline.
		Store fuel in proper containers protected from traffic or upset; have fire extinguisher readily available.

JOB SAFETY ANALYSIS

JSA #

Project Name:	March Point Landfill	Project No:	14159.000	Date:	7/16/08
Task:	Drilling, Well Installation and Soil Sampling	Task Location:	Skagit County, WA		

For this Project and Task, this document is a Certification of Hazard Assessment

Completed by:	Z. Satterwhite	Reviewed by:	T. Reinhardt
Notes:			

Task	Hazard	Risk Control Method
Mobilization To Site	Driving accidents	Reference Mobilization JSA
Set Up Work Site	Site traffic/trucks	Notify site manager / owner of work activities and location.
		Demarcate work locations with traffic cones and flagging, maintain control of traffic in work areas. Establish zones based on potential hazardous conditions, including fire and atmospheric hazards.
		Wear high visibility vest at all times that potential trucks or material handling vehicles are in/near work areas.
	Uneven or unstable ground	Inspect work areas for unstable/uneven ground prior to entry.
Drilling	Struck by:	Wear high visibility vest, boots, safety glasses or full-face respirator and hardhat at all times.
		Make eye contact with operator before approaching equipment; approach from front or side and stay safely outside the equipment swing radius.
		Operators stay aware of personnel in the area; agree on and use proper hand signals before maneuvering.
		Stay out of swing range of heavy equipment.
	Caught by:	Stay clear of rotating auger and equipment. Shut down rotating equipment before sampling.
	Underground Utilities:	Properly locate utilities with 1-call (ID # 52133) 800-424-5555 and private locator. Deenergize lines where feasible. If additional utilities are suspected, work with facility site contact to identify and locate them.
		Examine initial 10 feet of cuttings for utility backfill.
		Have subcontractor hand excavate or air knife within 2 feet of identified underground utilities.
	Utility contact:	Operators must use spotters and caution when equipment is within 15 feet of overhead utilities. Maintain safe distances.
Drilling, Soil Sampling and Well Installation	Slip, trip & fall	Keep debris and work area equipment organized.
		Keep work surfaces dry where possible.
		Wear appropriate PPE including boots with non-slip soles.
		Stay aware of footing, look for holes/roots/exposed cables and debris and do not run.
	Heat / cold stress	Hot: take regular breaks and if feeling faint or overexerted. Cold: layer dress for water repellency and heat retention.
		Hot: Consume adequate liquids (water / sports drink).
		Adjust work schedule to avoid temperature extremes.

	Chemical hazards	Wear required PPE within EZ and CRZ. Stay up- or cross-wind when possible. Implement air monitoring and take action as specified in HASP.
		Be alert for exposed hazardous materials in cuttings. Avoid skin contact with cuttings and soil samples.
	UV exposure	Wear correct PPE (neck to toe clothing & sun block, as needed).
	Lifting heavy items	Gauge load. Get assistance for heavy or suspect items.
		Use proper bending / lifting techniques; use legs, not the back. Do not twist trunk and keep head up while lifting.
	Muscle strain injury	Pace work to avoid overexertion.
		Use correct manual lifting methods.
	Noise	Wear hearing protection (ear muffs or plugs) if normal conversation levels are difficult to hear at 3 feet distance.
	Sharps/Abrasion	Wear leather gloves when handling sharp or rough objects, use tools for opening split spoon sampler or push tubes. Do not use excessive force, keep body parts clear of tool path should it slip.
	Pinch points	Keep body parts clear from pinch points when assembling and installing well pieces.
Refueling	Fire	Cool hot equipment before refueling.
		Bond when dispensing gasoline.
		Store fuel in proper containers protected from traffic or upset; have fire extinguisher readily available.

JOB SAFETY ANALYSIS

JSA #

Project Name:	March Point Landfill	Project No:	14159.000	Date:	7/18/08
Task:	Drum Characterization	Task Location:	Skagit County, WA		
For this Project and Task, this document is a Certification of Hazard Assessment					
Completed by:	T. Reinhardt	Reviewed by:	K. Tahghighi KT		
Notes:					

Task	**Hazard**	**Risk Control Method**
Mobilization To Site	Driving accidents	Reference Mobilization JSA
Set Up Work Site	Site traffic/trucks	Notify site manager / owner of work activities and location.
		Demarcate work locations with traffic cones and flagging, maintain control of traffic in work areas. Establish zones based on potential hazardous conditions, including fire and atmospheric hazards.
		Wear high visibility vest at all times that potential trucks or material handling vehicles are in/near work areas.
	Uneven or unstable ground	Inspect work areas for unstable/uneven ground prior to entry.
Drum Opening and Characterization	Struck by:	Wear high visibility vest, boots, safety glasses or full-face respirator and hardhat at all times.
		Make eye contact with operator before approaching equipment; approach from front or side and stay safely outside the equipment swing radius.
		Operators stay aware of personnel in the area; agree on and use proper hand signals before maneuvering.
		Stay out of swing range of debris handled by heavy equipment.
	Fire, explosion	Use nonsparking tools and equipment for opening drums
		Use remote, blast-shielded drum opening equipment for liquid or bulging drums, and minimize proximity and direct contact with drums.
		Perform perimeter air monitoring according to HASP and EZ air monitoring according to drum subcontractor's HASP
	Slip, trip & fall	Keep debris and equipment organized.
		Keep work surfaces dry where possible.
		Wear appropriate PPE including boots with non-slip soles.
		Stay aware of footing, look for holes/roots/exposed cables and debris and do not run.
	Heat / cold stress	Hot: take regular breaks and if feeling faint or overexerted. Cold: layer dress for water repellency and heat retention.
		Hot: Consume adequate liquids (water / sports drink).
		Adjust work schedule to avoid temperature extremes.
	Chemical hazards	Wear required PPE within EZ and CRZ. Stay up- or cross-wind when possible. Implement perimeter and EZ air monitoring and take respective appropriate actions as specified in HASP and subcontractor HASP.

		Dig in small lifts, be alert for exposed drums and hazardous debris. Avoid skin contact with all excavated material, and stockpile to prevent contaminant migration. Manage drums very carefully—assume they contain unstable shock-sensitive wastes. Rehearse response and plan to prevent fire/explosion and uncontrolled releases of hazardous contents. Do not open sealed drums. Manipulate them from a distance using shielded excavator or pole.
	UV exposure	Wear correct PPE (neck to toe clothing & sun block, as needed).
	Lifting heavy items	Gauge load. Get assistance for heavy or suspect items.
		Use proper bending / lifting techniques; use legs, not the back. Do not twist trunk and keep head up while lifting.
	Muscle strain injury	Pace work to avoid overexertion.
		Use correct manual lifting methods.
	Noise	Wear hearing protection (ear muffs or plugs) if normal conversation levels are difficult to hear at 3 feet distance.
	Sharps/Abrasion	Wear leather gloves when handling sharp or rough objects.
Refueling	Fire	Cool hot equipment before refueling.
		Bond when dispensing gasoline.
		Store fuel in proper containers protected from traffic or upset; have fire extinguisher readily available.

JOB SAFETY ANALYSIS

JSA #

Project Name:	March Point Landfill	Project No:	14159.000	Date:	7/16/08
Task:	Surface Water and Seep Sampling	Task Location:	Skagit County, WA		

For this Project and Task, this document is a Certification of Hazard Assessment

Completed by:	Z. Satterwhite	Reviewed by:	T. Reinhardt
Notes:			

Task	Hazard	Risk Control Method
Mobilization To Site	Driving accidents	Reference Mobilization JSA
Set Up Work Site	Site traffic/trucks	Notify site manager / owner of work activities and location.
		Demarcate work locations with traffic cones and flagging as needed to maintain control of traffic in work areas.
		Wear high visibility vest at all times that potential trucks or material handling vehicles are in/near work areas.
	Uneven or unstable ground	Inspect work areas for unstable/uneven ground prior to entry.
Surface Water and Seep Sampling	Slip, trip & fall	Keep debris and work area equipment organized.
		Keep work surfaces dry where possible.
		Wear appropriate PPE including boots with non-slip soles.
		Stay aware of footing, look for holes/roots/exposed cables and debris and do not run. Avoid steep slopes.
	Heat / cold stress	Hot: take regular breaks and if feeling faint or overexerted. Cold: layer dress for water repellency and heat retention.
		Hot: Consume adequate liquids (water / sports drink).
		Adjust work schedule to avoid temperature extremes.
	Chemical hazards	Wear required PPE within site zones.
		Be alert for exposed hazardous materials. Avoid skin contact with unrecognizable materials and water samples.
	UV exposure	Wear correct PPE (neck to toe clothing & sun block, as needed).
	Lifting heavy items	Gauge load. Get assistance for heavy or suspect items.
		Use proper bending / lifting techniques; use legs, not the back. Do not twist trunk and keep head up while lifting.
	Muscle strain injury	Pace work to avoid overexertion.
		Use correct manual lifting methods.
	Biological hazards: insects, vegetation	Do not put hands inside enclosures where view is obstructed. Proceed cautiously through dense brush areas. Avoid wildlife.
	Sharps/Abrasion	Wear leather gloves when handling sharp or rough objects.
Seep Sampling	Mud Entrapment	Probe intertidal mud areas for firm footing; use plywood sheeting support if mud is above 2/3 boot height.
	Pinch points	Use leather gloves and proper tool, and keep body parts clear of tool path if pounding tool slips.

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JOB SAFETY ANALYSIS

JSA #

Project Name:	March Point Landfill	Project No:	14159.000	Date:	7/16/08
Task:	Groundwater Sampling	Task Location:	Skagit County, WA		

For this Project and Task, this document is a Certification of Hazard Assessment

Completed by:	Z. Satterwhite	Reviewed by:	T. Reinhardt T Reinhardt
Notes:			

Task	**Hazard**	**Risk Control Method**
Mobilization To Site	Driving accidents	Reference Mobilization JSA
Set Up Work Site	Site traffic/trucks	Notify site manager / owner of work activities and location.
		Demarcate work locations with traffic cones and flagging as needed to maintain control of traffic in work areas.
		Wear high visibility vest at all times that potential trucks or material handling vehicles are in/near work areas.
	Uneven or unstable ground	Inspect work areas for unstable/uneven ground prior to entry.
Groundwater Sampling	Slip, trip & fall	Keep debris and work area equipment organized.
		Keep work surfaces dry where possible.
		Wear appropriate PPE including boots with non-slip soles.
		Stay aware of footing, look for holes/roots/exposed cables and debris and do not run. Avoid steep slopes.
	Heat / cold stress	Hot: take regular breaks and if feeling faint or overexerted. Cold: layer dress for water repellency and heat retention.
		Hot: Consume adequate liquids (water / sports drink).
		Adjust work schedule to avoid temperature extremes.
	Chemical hazards	Wear required PPE within site zones. Conduct air monitoring and take action according to HASP.
		Be alert for exposed hazardous materials. Avoid skin contact with unrecognizable materials and water samples.
	UV exposure	Wear correct PPE (neck to toe clothing & sun block, as needed).
	Lifting heavy items	Gauge load. Use tool for monitoring well cover. Get assistance for heavy or suspect items.
		Use proper bending / lifting techniques; use legs, not the back. Do not twist trunk and keep head up while lifting.
	Muscle strain injury	Pace work to avoid overexertion.
		Use correct manual lifting methods.
	Biological hazards: insects, vegetation	Do not put hands inside enclosures where view is obstructed. Proceed cautiously through dense brush areas. Avoid wildlife.
	Sharps/Abrasion	Wear leather gloves when handling sharp or rough objects.
	Pinch points	Use leather gloves and proper tool to manipulate well cover.

JOB SAFETY ANALYSIS

JSA #

Project Name:	March Point Landfill	Project No:	14159.000	Date:	7/16/08
Task:	Sediment Sampling	Task Location:	Skagit County, WA		

For this Project and Task, this document is a Certification of Hazard Assessment

Completed by:	Z. Satterwhite	Reviewed by:	T. Reinhardt
Notes:			

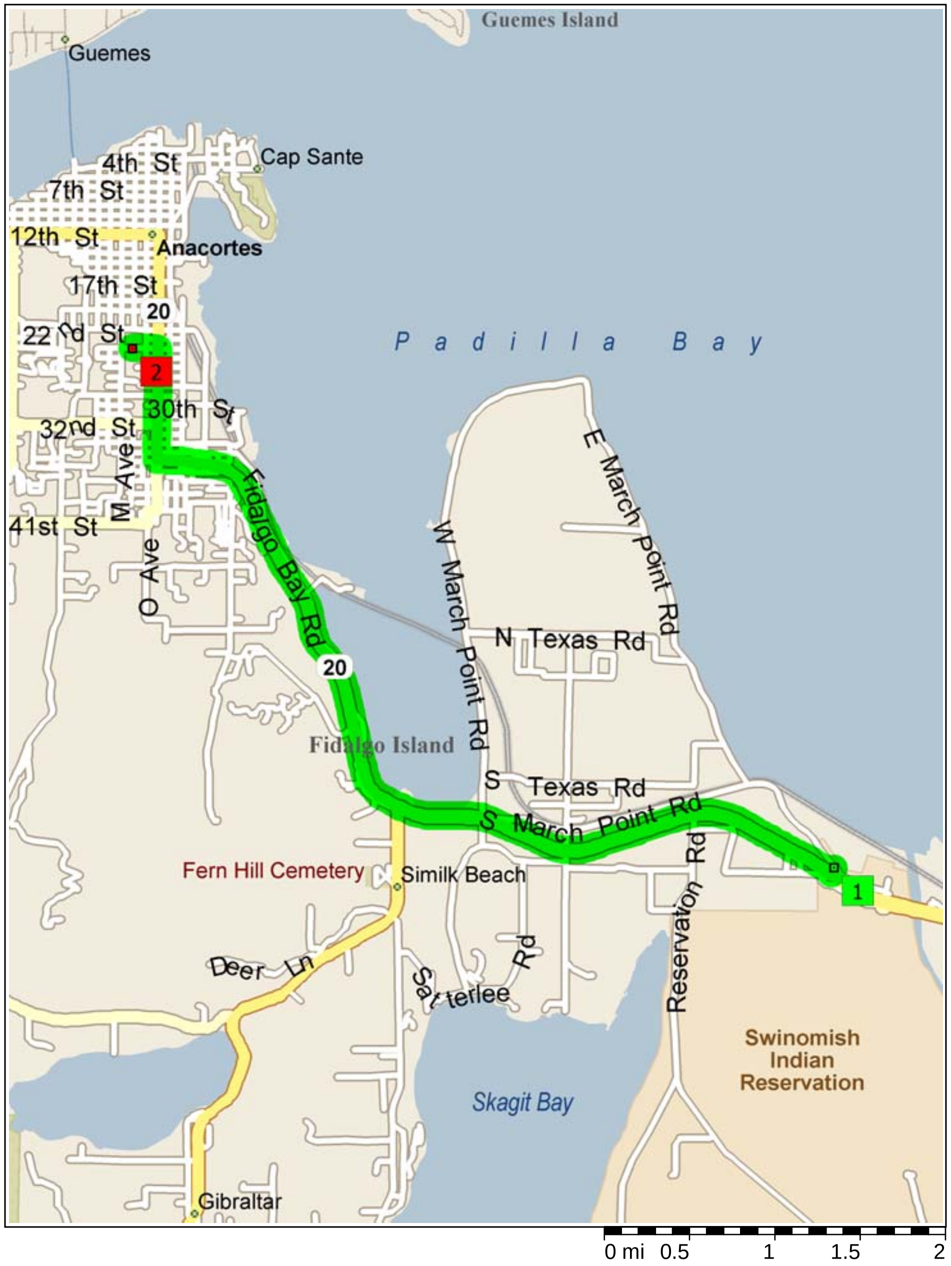
Task	Hazard	Risk Control Method
Mobilization To Site	Driving accidents	Reference Mobilization JSA
Set Up Work Site	Site traffic/trucks	Notify site manager / owner of work activities and location.
		Demarcate work locations with traffic cones and flagging as needed to maintain control of traffic in work areas.
		Wear high visibility vest at all times that potential trucks or material handling vehicles are in/near work areas.
	Uneven or unstable ground	Inspect work areas for unstable/uneven ground prior to entry.
Sediment Sampling	Slip, trip & fall	Keep debris and work area equipment organized.
		Keep work surfaces dry where possible.
		Wear appropriate PPE including boots with non-slip soles.
		Stay aware of footing, look for holes/roots/exposed cables and debris and do not run. Avoid steep slopes.
		Probe intertidal mud for support, and use appropriate footwear (e.g., "Mudders") to distribute weight over larger area if needed.
	Heat / cold stress	Hot: take regular breaks and if feeling faint or overexerted. Cold: layer dress for water repellency and heat retention.
		Hot: Consume adequate liquids (water / sports drink).
		Adjust work schedule to avoid temperature extremes.
	Chemical hazards	Wear required PPE within site zones.
		Be alert for exposed hazardous materials. Avoid skin contact with unrecognizable materials and sediment samples.
	UV exposure	Wear correct PPE (neck to toe clothing & sun block, as needed).
	Lifting heavy items	Gauge load. Get assistance for heavy or suspect items.
		Use proper bending / lifting techniques; use legs, not the back. Do not twist trunk and keep head up while lifting.
	Muscle strain injury	Pace work to avoid overexertion.
		Use correct manual lifting methods.
	Biological hazards: insects, vegetation	Do not put hands inside enclosures where view is obstructed. Proceed cautiously through dense brush areas. Avoid wildlife.
	Sharps/Abrasion	Wear leather gloves when handling sharp or rough objects.
	Pinch points	Use leather gloves and proper tool, and keep body parts clear of tool path if pounding tool slips.

ATTACHMENT B

Map and Directions to Nearest Hospital

Whitmarsh Landfill to Island Hospital

6.3 miles; 10 minutes



9:00 AM	0.0 mi	1 Depart near Whitmarsh Junction on S March Point Rd [March's Point Rd] (South) for 54 yds
9:00 AM	0.1 mi	Turn RIGHT (North-West) onto SR-20 for 2.7 mi
9:03 AM	2.8 mi	Keep STRAIGHT onto SR-20 Spur for 2.7 mi
9:08 AM	5.4 mi	Keep RIGHT onto Local road(s) for 65 yds
9:08 AM	5.5 mi	Bear RIGHT (North) onto SR-20 Spur [Commercial Ave] for 0.6 mi
9:09 AM	6.1 mi	Turn LEFT (West) onto 24th St for 0.1 mi
9:10 AM	6.3 mi	2 Arrive Island Hospital [1211 24th St, Anacortes WA 98221, (360) 293-3181]

APPENDIX B

AMEC Geomatrix Environmental Field Protocols

ENVIRONMENTAL FIELD PROTOCOLS

Submitted by:

AMEC Geomatrix, Inc.

October 2009

ENVIRONMENTAL FIELD PROTOCOLS
MARCH 1996

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SOIL PROTOCOLS

WATER PROTOCOLS

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(concluded)

PROTOCOL

DRILLING AND DESTRUCTION OF SOIL BORINGS

1.0 INTRODUCTION

This protocol describes the procedures to be followed during drilling and destruction of soil borings. The soil borings will provide information about geologic conditions, soil engineering properties, and/or soil quality. If the soil boring is utilized for well installation, the well will be installed in accordance with the protocol INSTALLATION OF WELLS.

The procedures presented herein are intended to be of general use and may be supplemented by a work plan and/or health and safety plan. As the work progresses and if warranted, appropriate revisions may be made by the project manager. Detailed procedures in this protocol may be superseded by applicable regulatory requirements.

If required, permits for drilling of soil borings will be acquired from the appropriate agency(s) before drilling is initiated, and an underground utility check will be conducted before drilling begins. An underground utility check will, at a minimum, consist of contacting a local utility alert service, if available.

2.0 DRILLING

A DAILY FIELD RECORD will be completed for each day of fieldwork, and the original will be kept in the project files.

The soil borings will be drilled using rotary, hollow stem auger, direct-push, or other appropriate method. In all rotary borings, compressed air will be filtered to remove oils before being circulated into the borehole. In mud rotary borings, appropriate drilling fluid additives, such as bentonite, will be used to maintain an open hole and to carry cuttings to the surface. However, organic drilling fluid additives will only be used with prior project manager approval. The drilling mud will be circulated into a settling tank or basin located near the boring. The viscosity of the drilling fluid will be assessed periodically by the driller and will be controlled throughout the drilling operation to achieve the required results (hole stability, sample return, and mud cake thickness along borehole wall). Only potable water will be used as makeup water for drilling fluid. Exploratory borings drilled using the hollow stem auger method generally do not require the use of drilling fluid. If required, potable water from a municipal supply will be used to maintain boring stability.

The planned depth of each soil boring will be determined by the project manager before drilling. The Geomatrix field geologist/engineer will specify to the drill rig operator the depth of soil sample collection, method of sample retrieval, and other matters pertaining to the satisfactory completion of the borings. Geomatrix staff will observe the volume of drill cuttings returned to assess whether significant cavitation has occurred. Drill cuttings, unused soil samples, and drilling fluids generated during drilling of soil borings will be stored properly for future disposal by the client, unless other arrangements have been made.

The drill rods, augers, hoses, bits, and other components that fluids and cuttings contact will be steam-cleaned before drilling each boring, as well as at the beginning of each project and at the completion of field activities. Drive samplers will be cleaned with Alconox and water or steam-cleaned before each sampling event. Only potable water from a municipal supply will be used for decontamination of drilling equipment. Decontamination rinsate will be collected and stored properly for future disposal by the client, unless other arrangements have been made.

3.0 SAMPLING AND LOGGING

3.1 OBTAINING SAMPLES

Borings will be continuously cored or sampled at depth intervals specified by the project manager, based on the intended use of the boring. Continuous sampling is recommended; however, samples and/or cuttings will be obtained for logging purposes at least every 5 feet for all borings. Drive samples will be used to log hollow stem auger borings if continuous cores are not collected. The samples and/or drill cuttings will be collected and described. A lithologic log of these samples will be made. Samples for chemical analysis will be collected in accordance with the protocol SOIL SAMPLING FOR CHEMICAL ANALYSIS.

3.1.1 Discrete Sampling

For discrete sampling of mud rotary or auger borings, sampling will be accomplished by driving or pushing a split-barrel sampler or Shelby tube. The field geologist/engineer will record information on the BORING LOG pertaining to the sampling, such as rate of penetration, hydraulic ram pressure or drive-hammer blow count, coring smoothness, and sample recovery.

In general, the split-barrel sampler will be opened for observation and logging of the retrieved core.

At selected depth intervals, the split-barrel sampler may be fitted with brass or stainless steel liners for collection of soil samples for possible subsequent chemical or physical testing. Samples may be retained for future review and/or preserved for chemical or physical testing, as specified by the project manager. The samples will be stored and labeled to show project number, boring number, and cored interval denoted either by depth or a sequential numbering system. Procedures for preservation and transport of soil samples retained for chemical analysis are presented in the protocol SOIL SAMPLING FOR CHEMICAL ANALYSIS.

3.1.2 Collecting Drill Cuttings

The field geologist/engineer may observe drill cuttings from the drilling fluid return for lithologic information to supplement discrete sampling. Sampling and logging cuttings will be performed as follows:

1. The height of the drilling table above ground surface, lengths of the drill bit, sub and drill collars, and length of drill rods should be taken into account in calculating the depth of penetration.
2. In mud rotary drilling, a small-diameter, fine mesh hand screen will be used to obtain a sample of the cuttings from the borings by holding the screen directly in the flow of the drill fluid return line. In air rotary drilling, cuttings will be collected after discharge from the cyclone.
3. In rotary drilling, a composite sample may be obtained from the return line by leaving the screen in place during the time it takes the driller to advance the boring to a preselected depth.
4. In rotary drilling, the travel time for cuttings to reach the surface may be estimated each time the driller adds a new length of drill rod by timing the first arrival of cuttings after circulation is resumed. This travel time can be used along with the depth of penetration to estimate the start and finish of each 5-foot sampling interval.

3.2 LOGGING OF EXPLORATORY BORINGS

The observations of the field geologist/engineer will be recorded on a BORING LOG OR WELL LOG at the time of drilling. The drill rig operator and the field geologist/engineer will discuss significant changes in material penetrated, drilling conditions, hydraulic pressure, drilling action, and drilling fluid circulation rate. The field geologist/engineer will be present during drilling of soil borings and will observe and record such changes by time and depth.

Drill cuttings and core samples will be observed in the field. A lithologic description will be recorded on the BORING LOG using the Unified Soil Classification System (USCS) as described in the American Society of Testing and Materials (ASTM) Standard D 2488-90. This description will include the USCS soil type, grain sizes and estimated percentages of each, moisture content, color according to the Munsell color charts (Kollmorgen Instruments Corp.), plasticity for fine-grained materials, consistency, and other pertinent information, such as degree of induration, calcareous content, presence of fossils and other distinctive materials.

The original field logs will be retained by the Geomatrix office for review by the responsible professional and for storage in the project files.

4.0 GEOPHYSICAL LOGS

Following completion of drilling, downhole geophysical logs may be performed after the drilling fluid has been circulated to decrease the amount of suspended sediment in the return fluid. Geophysical methods and equipment will be selected to provide stratigraphic or hydrogeologic data appropriate for the project. Geophysical logging will be done as quickly and promply after drilling as feasible, while the boring sidewall is still in stable condition, to reduce the possibility of bridging. Instruments on the logging unit will be adjusted to try to give the maximum definition of strata boundaries. All downhole geophysical equipment will be cleaned before and after use in each borehole.

5.0 FIELD SCREENING

Soil samples collected from the borings may be screened using a portable meter such as a photoionization detector (PID), a flame ionization detector (FID), a lower explosion limit (LEL) meter or other organic vapor meter. The meter may be used to assess the presence of volatile organic compounds (VOCs) or other gases in soil samples. Additional field screening techniques for chemical characterization of soils may include x-ray fluorescence (XRF) and thin-layer chromatography (TLC). Procedures for field screening are described in the protocol SOIL SAMPLING FOR CHEMICAL ANALYSIS.

6.0 DESTROYING SOIL BORINGS

Soil borings that are not completed as monitoring wells will be destroyed by filling the holes with a neat cement grout, cement/sand grout, or cement/bentonite grout. A high-solids bentonite grout may be used if appropriate. Geomatrix field staff will calculate the borehole volume and compare it to the volume of grout used to evaluate whether bridging has occurred. These calculations and the actual volume emplaced will be noted on the BORING LOG. The grout will be placed in continuous lifts from the bottom of the boring to a depth of 20 feet above the water table. The grout will be emplaced by pumping it through the hollow stem augers, drill pipe, tremie pipe, or flexible hose initially lowered to the bottom of the borings and raised incrementally as placement proceeds. If hollow stem augers are used, the augers should be raised incrementally as grout emplacement proceeds. Augers will not be raised in increments greater than 20 feet or greater than allowed by borehole stability. Borings that are terminated above the water table and not greater than 20 feet deep may be destroyed by continuous lifts originating at the ground surface. The grout will be pumped or poured until a return of fresh grout is visible at the surface. Additional grout may need to be added to the soil boring if significant settlement has occurred after the grout has set.

Attachments: Daily Field Record
Boring Log
Well Log

DAILY FIELD RECORD

Geomatrix

Page 1 of ___

Project and Task Number:	Date:
Project Name:	Field Activity:
Location:	Weather:

PERSONNEL: Name	**Company**	**Time In**	**Time Out**

PERSONAL SAFETY CHECKLIST

	Steel-toed Boots		Hard Hat		Tyvek Coveralls
	Rubber Gloves		Safety Goggles		1/2-Face Respirator

DRUM I.D.	**DESCRIPTION OF CONTENTS AND QUANTITY**	**LOCATION**

TIME	**DESCRIPTION OF WORK PERFORMED**

DAILY FIELD RECORD (continued)

Geomatrix

Page ____ of ____

Project and Task Number:

Date:

TIME	DESCRIPTION OF WORK PERFORMED

PROJECT:	**Log of Boring No.**	
BORING LOCATION:	ELEVATION AND DATUM:	
DRILLING CONTRACTOR:	DATE STARTED:	DATE FINISHED:
DRILLING METHOD:	TOTAL DEPTH:	MEASURING POINT:
DRILLING EQUIPMENT:	DEPTH TO WATER: FIRST	COMPL
SAMPLING METHOD:	LOGGED BY:	
HAMMER WEIGHT: DROP:	RESPONSIBLE PROFESSIONAL:	REG. NO.

DEPTH (feet)	SAMPLES			OVM Reading (ppm)	DESCRIPTION NAME (USCS Symbol): color, moist. % by weight, plast., consistency, structure, cementation, react. W/HCl, geo. inter. Surface Elevation:	REMARKS
	Sample No.	Sample	Blows/ Foot			

Project No.	**Geomatrix Consultants**	Figure

Geomatrix

PROJECT:	Log of Boring No.

DEPTH (feet)	SAMPLES			OVM Reading (ppm)	DESCRIPTION NAME (USCS Symbol): color, moist. % by weight, plast., consistency, structure, cementation, react. W/HCl, geo. inter.	REMARKS
	Sample No.	Sample	Blows/ Foot			

Project No.	**Geomatrix Consultants**	Figure

PROJECT:	**Log of Well No.**
BORING LOCATION:	ELEVATION AND DATUM:
DRILLING CONTRACTOR:	DATE STARTED: / DATE FINISHED:
DRILLING METHOD:	TOTAL DEPTH: / SCREEN INTERVAL:
DRILLING EQUIPMENT:	DEPTH TO WATER: FIRST COMPL / CASING:
SAMPLING METHOD:	LOGGED BY:
HAMMER WEIGHT: DROP:	RESPONSIBLE PROFESSIONAL: REG. NO.

DEPTH (feet)	SAMPLES			OVM Reading (ppm)	DESCRIPTION NAME (USCS Symbol): color, moist. % by weight, plast., consistency, structure, cementation, react. W/HCl, geo. inter. Surface Elevation:	WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS
	Sample No.	Sample	Blows/ Foot			

Project No.	**Geomatrix Consultants**	Figure

Geomatrix

PROJECT:

Log of Well No.

DEPTH (feet)	SAMPLES: Sample No.	SAMPLES: Sample	SAMPLES: Blows/ Foot	OVM Reading (ppm)	DESCRIPTION NAME (USCS Symbol): color, moist. % by weight, plast., consistency, structure, cementation, react. W/HCl, geo. inter.	WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS

Project No.

Geomatrix Consultants

Figure

PROTOCOL

SOIL SAMPLING FOR CHEMICAL ANALYSIS

1.0 INTRODUCTION

This protocol describes the procedures to be followed for collecting soil samples for chemical analysis and conducting soil field screening in conjunction with drilling soil borings and excavating soil. The laboratory must be certified by the appropriate regulating agency for the analyses to be performed.

If required, permits will be acquired from the appropriate agency, and an underground utility check will be performed before drilling or excavating begins. An underground utility check will, at a minimum, consist of contacting a local utility alert service, if available.

The procedures presented herein are intended to be of general use and may be supplemented by a work plan and/or health and safety plan. As the work progresses and if warranted, appropriate revisions may be made by the project manager. Detailed procedures in this protocol may be superseded by applicable regulatory requirements.

2.0 SAMPLE COLLECTION

Soil samples may be collected during drilling or excavating activities. The procedures for sample collection are discussed below.

2.1 SAMPLE COLLECTION DURING DRILLING

The drilling of soil borings will be conducted in accordance with the protocol DRILLING AND DESTRUCTION OF SOIL BORINGS. The soil sampler either will be washed with laboratory grade detergent-water solution to remove soil present and rinsed with potable water, or it may be steam-cleaned prior to and between sampling. Soil samples will be collected in clean brass or stainless steel liners that have been washed with detergent-water solution and rinsed with potable water or steam-cleaned. The liners will generally be placed in a 2-inch- or 2.5-inch-diameter split-spoon sampler and then driven or pushed into the soil at the selected sampling depth. The sample will be parted at the joints between the liners using a clean, sharp stainless steel knife or spatula. Alternatively, a subsample for chemical analyses may also be collected by driving a smaller-diameter liner into the center of the larger core sample, taking care to reduce the potential for sample disturbance and air space within the liner. If the soil sample is collected using a hand auger, a subsample should be collected from the core of the auger, again taking care to reduce the potential for sample disturbance and air space within the liner. If the sample is to be analyzed for non-volatiles only, a loose sample may be placed in a glass jar. Samples to be analyzed for metals may be homogenized before analysis either in the field or by the laboratory to provide results more representative of average concentrations in the sampling interval.

2.2 SAMPLE COLLECTION DURING EXCAVATION

Excavated soil will be sampled as required under the appropriate agency guidelines, if applicable, or as necessary to provide the data desired. The lateral and vertical dimensions of the excavation, as well as the sample location and depth, will be mapped, and the volume estimated. If possible, samples will be collected from the backhoe or excavator bucket without entering the excavation. Samples may be collected directly from the walls or floor of the excavation, provided Occupational Safety and Health Administration (OSHA) regulations are followed before entering an excavation.

Soil stockpiles also may be sampled after completion of excavation. If they are sampled, the stockpile location, dimensions, and sample locations will be mapped, and the stockpile volume will be estimated. If compositing of soil samples containing volatile compounds is required, it should be performed by the laboratory.

The soil from excavations or stockpiles should be sampled by scraping away 3 to 6 inches of surface soil or hand augering to a known depth. A clean glass jar, brass tube, or stainless steel tube will be forced into the soil to completely fill the container, or a clean hammer sampler may be used in conjunction with brass or stainless steel liners.

3.0 SAMPLE HANDLING AND PRESERVATION

Soil samples will be handled using the following procedures:

1. Clean gloves appropriate for the chemicals of concern will be worn by the sampler before touching the sample containers, and care will be taken to avoid contact with the sample.
2. The sample will be quickly observed for color, appearance, and composition. The ends of the liners will be immediately covered with Teflon® sheeting and/or

aluminum foil, capped with plastic end caps, and sealed with tape. Glass jars will be immediately sealed with a lid.

3. The sample container will be labeled before or immediately after sampling with a self-adhesive label having the following information written in waterproof ink:
    - Geomatrix
    - Project number
    - Sample ID number
    - Date and time sample was collected
    - Initials of sample collector
4. The sample will be placed in a chest, that contains ice or blue ice if required, for transport to the laboratory. Table 1 lists common analyses performed and the appropriate storage and handling requirements.

4.0 DOCUMENTATION

4.1 FIELD DATA SHEETS

A DAILY FIELD RECORD will be completed for each day of fieldwork. Locations and unique identification of soil samples collected from soil borings will be recorded on the BORING LOG or WELL LOG. Locations and unique identification of soil samples collected from excavations or stockpiles will be recorded on a DAILY FIELD RECORD, site map, and/or other appropriate form. Samples may also be recorded on a SAMPLE CONTROL LOG SHEET or in the DAILY FIELD RECORD as a means of identifying and tracking the samples. Following review by the project manager, the original field records will be kept in the project file.

4.2 CHAIN-OF-CUSTODY PROCEDURES

After samples have been collected and labeled, they will be maintained under chain-of-custody procedures. These procedures document the transfer of custody of samples from the field to the laboratory. Each sample sent to the laboratory for analysis will be recorded on a CHAIN-OF-CUSTODY RECORD, which will include instructions to the laboratory on the analytical services required.

Information contained on the triplicate CHAIN-OF-CUSTODY RECORD will include:

- Project number
- Signature of sampler
- Date and time sampled
- Sample I.D.
- Number of sample containers

- Sample matrix (soil, water, or other)
- Analyses required
- Remarks, including preservatives, special conditions, or specific quality control measures
- Turnaround time and person to receive laboratory report
- Method of shipment to the laboratory
- Release signature of sampler and signatures of all people assuming custody
- Condition of samples when received by laboratory (to be completed by the laboratory)

Blank spaces on the CHAIN-OF-CUSTODY RECORD will be crossed out between the last sample listed and the signatures at the bottom of the sheet.

The field sampler will sign the CHAIN-OF-CUSTODY RECORD and will record the time and date at the time of transfer to the laboratory or an intermediate person. A set of signatures is required for each relinquished/received transfer, including transfer within Geomatrix. The original imprint of the CHAIN-OF-CUSTODY RECORD will accompany the sample containers; a duplicate copy will be kept in the Geomatrix project file.

If the samples are to be shipped to the laboratory, the original CHAIN-OF-CUSTODY relinquishing the samples will be sealed inside a plastic bag within the ice chest, and the chest will be sealed with custody tape which has been signed and dated by the last person listed on the chain-of-custody. U.S. Department of Transportation shipping requirements will be followed and the sample shipping receipt will be retained in the project files as part of the permanent chain-of-custody document. The shipping company (e.g., Federal Express, UPS, DHL) will not sign the chain-of-custody forms as a receiver; instead the laboratory will sign as a receiver when the samples are received.

5.0 SOIL FIELD SCREENING

Soil will occasionally be screened using a field instrument or method. Readings should be recorded on the BORING LOG, WELL LOG, DAILY FIELD RECORD, or another form prepared for this purpose. Two screening methods are described below.

5.1 ORGANIC VAPOR METERS

A portable photoionization detector (PID), flame ionization detector (FID), lower explosive limit meter (LEL), or other type of organic vapor meter (OVM) may be used to screen soil. The purpose of the field screening is to assess the presence of volatile organic compounds (VOCs) in the soil. The meter measures total VOCs in the air in parts per million (ppm) by volume in reference to a selected standard. The meter will be calibrated each day prior to the soil sampling. The meter cannot specifically identify each volatile compound, but can be adjusted to be sensitive to selected volatile organics. Before choosing a meter, the response factor of the meter to the chemicals of concern at the site should be considered. Soil should be screened as soon as possible after being exposed to the atmosphere. The general procedure for screening is as follows:

1. Using a clean tool, dig a hole to expose fresh soil in a backhoe bucket or stockpile, or separate the brass liners from a driven sample.
2. Insert the probe of the OVM into the hole, taking care not to clog the probe with soil. Alternatively, headspace readings may be taken by placing soil in a covered (e.g., aluminum foil or Teflon® sheet) clear glass jar or plastic resealable bag, and after several minutes have elapsed, introducing the probe into the headspace area. No soil sample used for headspace screening will be submitted to the laboratory for chemical analysis.
3. Record the results in ppm for PIDs and FIDs, and in percent of the lower explosive limit for LELs.
4. Ensure that the instrument returns to a zero measurement before the next reading. If necessary, move to an area without measurable organic vapors to zero-out the instrument.

6.0 EQUIPMENT CLEANING

The sampler, brass or stainless steel liners, spatula, and tools used in assembly and disassembly of the soil sampler will be cleaned before and after each use. All soil will be removed from the tools and parts, and the tools will be steam-cleaned or washed in laboratory-grade detergent water with a brush, followed by rinsing in potable water. Decontamination rinsate will be collected and stored properly for future disposal by the client unless other arrangements have been made.

Attachments: Table: Water and Soil Analytical Methods and Sample Handling
Figures: Daily Field Record
Boring Log
Well Log
Chain-of-Custody Record
Sample Control Log Sheet

TABLE 1

WATER AND SOIL ANALYTICAL METHODS AND SAMPLE HANDLING

Parameter	Method	Water Containers[1]	Preservation[1]	Maximum Holding Time[1]
Total Petroleum Hydrocarbons:				
• as diesel	GCFID (3550)[2]	2 - 1 liter amber glass	cool on ice	14 days (unacidified water, 7 days)
• as gasoline	GCFID (5030)[2]	2 - 40 ml VOA glass	HCL to pH 2 in water samples: cool on ice	14 days (unacidified water, 7 days)
Benzene, Toluene, Xylene, and Ethylbenzene	EPA 8020	2 - 40 ml VOA glass	HCL to pH 2 in water samples: cool on ice	14 days (unacidified water, 7 days)
Volatile Organics with BTEX	EPA 8021[3]	2 - 40 ml VOA glass	HCL to pH 2 in water samples: cool on ice	14 days (unacidified water, 7 days)
Oil and Grease	5520 E & F (soil)[4] 5520 C & F (water)[4]	2 - 1 liter amber glass	H_2SO_4 to pH <2 in water samples: cool on ice	28 days
Volatile Organics	EPA 8010	2 - 40 ml VOA glass	cool on ice[6]	14 days (unacidified water, 7 days)
	EPA 8240[5]	2 - 40 ml VOA glass	HCl to pH 2 in water samples: cool on ice	14 days (unacidified water, 7 days)
Semi-volatile Organics	EPA 8270	2 - 1 liter amber glass	cool on ice	7 days for extraction, water 14 days for extraction, soil 40 days for analysis
Polynuclear Aromatic Hydrocarbons	EPA 8310	2 - 1 liter amber glass	cool on ice	7 days, water 14 days, soil
Metals (dissolved)	EPA 7000 series for specific metal	1 - 500 ml plastic	Water Samples: field filtration (0.45 micron filter) and field acidify to pH 2 with HNO_3 except: Cr^{+6} - cool on ice	6 months, except: Hg - 28 days Cr^{+6} - 24 hours, water; 24 hours after prep, soil

Notes:

[1] All soil samples should be collected in full, clean brass liners, capped with aluminum foil or Teflon and plastic caps, and sealed with tape. If soil samples are to be analyzed for metals, they may be placed in laboratory-prepared clean glass jars. Soil should be cooled as indicated under "preservation" and maximum holding times apply to both soil and water unless otherwise noted.

[2] For analysis in California, use California DHS recommended procedure as presented in LUFT manual using gas chromatography with a flame ionization detector. In other states, local requirements should be followed. Method 3660M is silica gel cleanup.

[3] EPA Method 8021 is equivalent to 8010/8020 in series.

[4] Method to be used in California Regional Water Quality Control Board North Coast and Central Valley Regions. In other areas, local requirements should be followed. Method 5520F is silica gel cleanup.

[5] Chloroethylvinylether may be detected at concentrations below 50 parts per billion due to degradation of HCl. EPA Method 8260B was formerly 8240.

[6] If EPA Methods 8010 and 8020 are to be run in sequence, HCl may be added. Check with the project manager before adding acid.

References:

U.S. EPA, 1986, Test Methods for Evaluating Solid Waste - Physical/Chemical Methods - SW-846, Third Edition, July, and final amendments.

California State Water Resources Control Board, 1989, Leaking Underground Fuel Tank (LUFT) Field Manual, Tables 3-3 and 3-4, October.

California Regional Water Quality Control Boards, North Coast, San Francisco Bay, and Central Valley Regions, 1990, Regional Board Staff Recommendations for Initial Evaluation and Investigation of Underground Tanks, 10 August.

DAILY FIELD RECORD

Geomatrix

Page 1 of ___

Project and Task Number:	Date:
Project Name:	Field Activity:
Location:	Weather:

PERSONNEL: Name	**Company**	**Time In**	**Time Out**

PERSONAL SAFETY CHECKLIST

	Steel-toed Boots		Hard Hat		Tyvek Coveralls
	Rubber Gloves		Safety Goggles		1/2-Face Respirator

DRUM I.D.	**DESCRIPTION OF CONTENTS AND QUANTITY**	**LOCATION**

TIME	**DESCRIPTION OF WORK PERFORMED**

DAILY FIELD RECORD (continued)

Geomatrix

Page ____ of ____

Project and Task Number:

Date:

TIME	DESCRIPTION OF WORK PERFORMED

Geomatrix

PROJECT:	Log of Boring No.
BORING LOCATION:	ELEVATION AND DATUM:
DRILLING CONTRACTOR:	DATE STARTED: DATE FINISHED:
DRILLING METHOD:	TOTAL DEPTH: MEASURING POINT:
DRILLING EQUIPMENT:	DEPTH TO WATER: FIRST COMPL
SAMPLING METHOD:	LOGGED BY:
HAMMER WEIGHT: DROP:	RESPONSIBLE PROFESSIONAL: REG. NO.

DEPTH (feet)	SAMPLES			OVM Reading (ppm)	DESCRIPTION NAME (USCS Symbol): color, moist. % by weight, plast., consistency, structure, cementation, react. W/HCl, geo. inter. Surface Elevation:	REMARKS
	Sample No.	Sample	Blows/ Foot			

Project No.	**Geomatrix Consultants**	Figure

PROJECT:

Log of Boring No.

DEPTH (feet)	SAMPLES			OVM Reading (ppm)	DESCRIPTION NAME (USCS Symbol): color, moist. % by weight, plast., consistency, structure, cementation, react. W/HCl, geo. inter.	REMARKS
	Sample No.	Sample	Blows/ Foot			

Project No.

Geomatrix Consultants

Figure

Geomatrix

PROJECT:	**Log of Well No.**
BORING LOCATION:	ELEVATION AND DATUM:
DRILLING CONTRACTOR:	DATE STARTED: / DATE FINISHED:
DRILLING METHOD:	TOTAL DEPTH: / SCREEN INTERVAL:
DRILLING EQUIPMENT:	DEPTH TO WATER: FIRST COMPL / CASING:
SAMPLING METHOD:	LOGGED BY:
HAMMER WEIGHT: DROP:	RESPONSIBLE PROFESSIONAL: REG. NO.

DEPTH (feet)	SAMPLES			OVM Reading (ppm)	DESCRIPTION NAME (USCS Symbol): color, moist. % by weight, plast., consistency, structure, cementation, react. W/HCl, geo. inter. Surface Elevation:	WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS
	Sample No.	Sample	Blows/ Foot			

Project No.	**Geomatrix Consultants**	Figure

PROJECT:	**Log of Well No.**

DEPTH (feet)	SAMPLES			OVM Reading (ppm)	DESCRIPTION NAME (USCS Symbol): color, moist. % by weight, plast., consistency, structure, cementation, react. W/HCl, geo. inter.	WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS
	Sample No.	Sample	Blows/ Foot			

Project No.	**Geomatrix Consultants**	Figure

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CHAIN-OF-CUSTODY RECORD

Nº

Date:

Page of

Project No.:

Samplers (Signatures):

			ANALYSES																			REMARKS				
Date	Time	Sample Number	EPA Method 8010	EPA Method 8020	EPA Method 8020 (BTEX only)	EPA Method 8240	EPA Method 8270	TPH as gasoline	TPH as diesel													Cooled	Soil (S), Water (W), or Vapor (V)	Acidified	Number of containers	Additional Comments

Turnaround time:

Results to:

Total No. of containers:

Relinquished by (signature):	Date:	Relinquished by (signature):	Date:	Relinquished by (signature):	Date:	Method of Shipment:
Printed Name:	Time:	Printed Name:	Time:	Printed Name:	Time:	Laboratory Comments and Log No.:
Company:		Company:		Company:		
Received by (signature):	Date:	Received by (signature):	Date:	Received by (signature):	Date:	
Printed Name:	Time:	Printed Name:	Time:	Printed Name:	Time:	Geomatrix
Company:		Company:		Company:		

Forms(PF).012b (Revised 12/95)

SAMPLE CONTROL LOG

Geomatrix

Project Name: ______________________ **Laboratory:** ______________________

Project and Task No.: ______________________ Page ____ of ____

Sampling Date	Sampling Time	Sample Number (ID)	C.O.C. Number	Analyses Requested	Turnaround Time, Sample Location, Handling Notes, Chain-of-Custody Remarks, etc. (Duplicate, Blank info, etc.)	Date Sent to Lab	Date Results Due

PROTOCOL

THIN LAYER CHROMATOGRAPHY

1.0 INTRODUCTION

This protocol describes procedures to be followed using thin layer chromatography (TLC) which is a field method to evaluate approximate concentrations of a petroleum hydrocarbon in a soil sample. TLC typically is used when the presence of heavy petroleum hydrocarbons such as diesel fuel or oil is suspected. The procedure involves comparing the intensity of an extract from the soil sample to that of laboratory-prepared standards.

The procedures presented herein are intended to be of general use and may be supplemented by a work plan and/or health and safety plan. As the work progresses and if warranted, appropriate revisions may be made by the project manager. Detailed procedures in this protocol may be superseded by applicable regulatory requirements.

The procedure for performing the TLC analysis is as follows:

1. Zero the balance and put on gloves.
2. Pour hexane into the dispenser. Set dispenser to discharge 5 milliliters (ml).

   CAUTION: Hexane is flammable and vapors can travel distances to an ignition source and flash back.
3. Discharge 15 ml of hexane into the jar labeled "clean-up."
4. Clean syringes with hexane by drawing the hexane from the "clean-up" jar into the syringe and dispensing the hexane in the jar labeled "waste." Do this three times. Perform this procedure each time you use a syringe. It is very important to clean the syringe every time you use a new standard and sample.

<u>TLC Slide Preparation</u>

5. Obtain a clean TLC slide and label it for the standards. Obtain another clean TLC slide and label it for samples. You can mark multiple standards or sample extracts on a slide (see Figure 1).
6. With the syringe, draw approximately 6 microliters (µl) of the standard or sample and dispose of it in the waste jar. Do this three times. It is important to purge the syringe with the new sample before it is placed onto the TLC slide.

7. Draw 5 µl of the same standard or sample and place it on a labeled TLC slide. It is important to place the 5 □l at the same rate for all standards and samples.

8. Perform Step 4 to clean the syringe and Steps 6 and 7 for each standard or sample extract placed on the TLC slide.

Preparation of Sample Extract

9. Zero the balance with one Teflon□ sheet on the scale. These sheets are the same sheets used for lining the ends of the brass tubes.

10. Weigh the Teflon□ sheet with 5 grams of soil sample by placing the soil sample on top of the Teflon□ sheet.

11. Place the soil sample into a 40-ml volatile organic analysis (VOA) vial and add 5 ml of hexane from the dispenser. Close the lid and shake the sample vigorously. Let the extract settle for five minutes.

12. Perform Steps 4, 6, and 7 for the sample; make sure to change your gloves every time you weigh out a new sample.

Quantitation

13. Place a TLC plate prepared with the standards and a TLC plate prepared with your soil sample extracts into a jar containing a few crystals of iodine and let the spots develop (about 2 to 5 minutes). Compare the intensity of the sample extract spots to the standard spots to quantify the approximate concentration of petroleum in the soil samples. If the spots are not clear, place the TLC plates under UV light to compare the intensities. Record results on a TLC SAMPLE LOG (attached).

Dilution

14. For concentrated sample extracts, it may be necessary to make dilutions to allow comparison of a sample extract's intensity to the intensity of available standards. For example, consider a sample extract spot that is extremely dark in color compared to the 1000 ppm standard intensity. Try diluting the sample by one-fifth by spotting only 1 µl of the sample on the plate, followed by 4 µl of hexane on the same spot, and then comparing its intensity to the 5-µl spots of the standards. If the sample intensity is comparable, for example, to the 1000-ppm standard intensity, the sample is approximately 5000 ppm [5x1000 ppm].

TLC Cleaning

15. Clean the syringe in hexane three times before inserting the needle into the sample extract to prevent cross-contamination. Do not touch the TLC plate on the front side without gloves because oil and grease from your hands will be observed on the plate when placed in iodine and/or under UV light.

16. Solutions and samples resulting from the TLC procedure will be collected and stored properly for future disposal by the client, unless other arrangements have been made.

FIGURE 1

EXAMPLE OF PREPARED TLC SLIDES USED FOR QUANTITATIVE PROCEDURE

Label each standard location in pencil with the concentration in ppm →

STD.	
50	100
υ	υ
150	200
υ	υ
500	1000
υ	υ

SAMPLE	
S-1	S-2
υ	υ
S-3	S-4
υ	υ
S-5	S-6
υ	υ
S-7	
υ	

← Label each soil sample location (e.g., S-1)

Attachments: TLC Sample Log

Geomatrix

TLC SAMPLE LOG

Page ______
of ______

Project Name: ______________________ Project No.: ______________

Date: ______________ Recorded by: ______________________

Sample I.D. Number: ______________________________

Standards: ______________________________

Sample No.	Standard Concentrations	Dilution	Sample Concentrations Estimate	Remarks

PROTOCOL

INSTALLATION AND DESTRUCTION OF WELLS

1.0 INTRODUCTION

This protocol describes the procedures to be followed during the installation or destruction of monitoring, groundwater extraction, and vapor extraction wells. Drilling and logging of soil borings for the well installation will be in conformance with the protocol DRILLING OF SOIL BORINGS. The procedures presented herein are intended to be of general use and may be supplemented by a work plan and/or health and safety plan. As the work progresses and if warranted, appropriate revisions may be made by the project manager. Detailed procedures in this protocol may be superseded by applicable regulatory requirements.

2.0 WELL INSTALLATION

A DAILY FIELD RECORD will be completed for each day of fieldwork, and the original will be kept in the project files. If required, permits will be acquired from the appropriate agency(s), and an underground utility check will be performed before drilling begins. An underground utility check will, at a minimum, consist of contacting a local utility alert service, if available.

After well installation, well completion report(s) will be completed and filed with the State Department of Water Resources or the appropriate agency.

Each groundwater monitoring well will be designed to enable measurement of the potentiometric surface and to permit water sampling of a specific water-bearing zone. Each vapor monitoring well will be designed to enable measurement of pressure conditions and permit sampling of a specific zone. The field geologist/engineer, in consultation with the project geologist or engineer, who will be licensed in the state in which the work is performed if required, will specify the screened interval using the lithologic log and geophysical log (if performed) and will select the well materials and techniques for well completion to be compatible with the subsurface conditions and the intended use of the well. Construction of all wells will be in conformance with the following provisions. A TYPICAL MONITORING WELL CONSTRUCTION DIAGRAM is attached.

2.1 WELL SCREEN AND CASING

The well casing will generally consist of threaded stainless steel or schedule 40 (minimum) polyvinyl chloride (PVC) casing. The inside diameter of the casing will be large enough to permit easy passage of an appropriate water-level probe and equipment for purging wells and water sample collection.

The well screen will generally consist of machine-slotted PVC or wire-wrapped stainless steel screen. The slot sizes will be compatible with the selected filter material. The screened sections will provide flow between the target zone and the well, allowing efficiency in well development and collection of representative samples.

2.2 FILTER MATERIAL

Filter material will be well-graded, clean sand (generally less than 2 percent by weight passing a No. 200 sieve and less than 5 percent by weight of calcareous material). The filter material will be either a standard sand gradation designed for a range of anticipated soil types or a sand gradation specifically designed to fit the soils collected from anticipated well completion zone.

2.3 SETTING SCREENS AND RISER CASING

Upon completion of drilling and/or geophysical logging, the boring will be sounded to verify the total depth, and the well casing will be assembled and lowered into the boring. Well casing materials will be measured to the nearest 0.1 foot and steam-cleaned before being lowered into the borehole. The well assembly will be designed so that the well screen is opposite the target zone. The bottom of the well will be fitted with a secure bottom-end cap. No PVC cement or other solvents will be used to fasten the well casing joints, well screen joints, or end caps. When installing wells in an open borehole, stainless steel centralizers will be used immediately above and below the well screen and approximately every 30 to 50 feet along the length of the casing. Centralizers need not be placed on well assemblies installed within augers or drill casings because the auger or drill casing will adequately center the well casing and screen in the borehole.

For borings drilled by the mud rotary method, potable water may be added to the drill mud and circulated in the borehole after completion of the boring. Circulation will continue until the suspended sediment in the return fluid has been decreased. If borehole conditions are relatively stable, the mud will be thinned before the casing assembly is lowered to the specified depth. This is preferred because it reduces the potential for clogging the well screen with thick mud.

Conversely, if borehole conditions are relatively unstable, the mud will be thinned after the casing is placed at the specified depth but prior to installation of annular fill materials. After installation of the well assembly, a slurry of filter sand and potable water will then be tremied into the annular space.

For borings drilled using the hollow stem auger method, the filter sand will be placed after the well assembly has been lowered to the specific depth through the augers. The augers will be incrementally raised as the filter sand is placed by free fall through the augers. The depth to the top of the filter pack will be measured after each increment to detect possible bridging. If bridging occurs, it will be broken by washing the filter materials into proper place with potable water or by repeatedly raising and lowering the augers slightly. The amount of water, if any, added to the borehole should be noted on the BORING LOG or DAILY FIELD RECORD.

For monitoring wells, the filter sand will be placed in a calculated quantity sufficient to fill the annular space to a level of about 1 to 2 feet above the top of the well screen. For extraction wells, the level of filter sand above the well screen will be based on site conditions. The depth to the top of the filter pack will be verified by measuring, using a tremie pipe or a weighted tape. Groundwater extraction wells or monitoring wells may be surged before placement of the transition seal to promote filter material settlement, as specified by the project manager.

Once the depth to the top of the filter material has been verified, bentonite or fine sand may be placed in the annular space as a transition seal between the filter material and the grout. A sufficient quantity of bentonite or fine sand will be poured to fill the annular space to a level of about 2 feet above the top of the filter pack. If bentonite is to be placed below standing water, a high-solids bentonite grout will be pumped through a tremie pipe, or pellets may be poured through the annulus. If bentonite is to be placed above standing water, a high-solids bentonite grout should be used or pellets may be placed in 6-inch lifts. Unless prohibited by well conditions, each lift should be hydrated using approximately 1 gallon of potable water per lift of pellets. The completed bentonite transition seal will be allowed to hydrate for at least 30 minutes prior to placing the grout. If a layer of fine sand is placed as the transition seal, the fine sand will be mixed with potable water and placed as a slurry through the tremie pipe or poured dry through the annulus. The depth to the top of the transition seal will be verified by measuring, using the tremie pipe or a weighted tape.

A neat cement grout, cement/sand grout, cement/bentonite grout, or high-solids bentonite grout will be placed from the top of the transition seal to the ground surface. The grout seal will be placed by pumping through a tremie pipe lowered to within 5 feet of the top of the transition seal in mud rotary borings. The grout seal will be placed in hollow stem auger borings by free fall through the augers as they are incrementally raised or by pumping through flexible hose or tremie pipe lowered to near the bottom of the zone to be grouted. The grout must be tremied if there is standing water in the augers above the transition seal. Grout/additive/water mixtures will be determined on a site-specific basis. Typical specifications of grout mixtures include: (a) neat cement/bentonite grout, consisting of a mixture of one sack (94 pounds) of Portland Type I/II cement, approximately 2 to 5 percent by weight (of cement) powdered bentonite, and approximately 6 to 8 gallons of water; (b) neat cement grout, consisting of one sack of Portland cement and approximately 5 to 6 gallons of water; and (c) cement/sand grout, consisting of no more than two parts sand to one part cement and approximately 7 gallons of water. Only potable water will be used to prepare the grout. No work will be done on the monitoring well until after the grout has set approximately 24 hours.

2.4 SURFACE COMPLETION

Upon completion of the well, a suitable slip-on cap, threaded end cap, or waterproof cap will be fitted on the top of the riser casing to reduce the potential for entry of surface runoff or foreign matter. Either a steel protective well cover (e.g., stovepipe) or a vault which may have a traffic-rated cover will be completed at the ground surface. All wells will be locked for security and will be designed to limit surface water infiltration.

2.5 DEVELOPMENT OF GROUNDWATER MONITORING OR EXTRACTION WELLS

When the well installation is complete and the grout has cured a minimum of 24 hours, the well will be developed by surging, bailing, and/or pumping, or other appropriate method as specified by the project manager. The objectives of well development are to remove sediment that may have accumulated during well installation, to consolidate the filter pack around the well screen, and to enhance the hydraulic connection between the target zone and the well. In most instances, a bailer will be used to remove sediment and turbid water from the bottom of the well. A surge block may then be used within the entire screened interval to flush the filter pack of fine sediment. Surging will be conducted slowly to reduce disruption to the filter pack and screen. The well will be bailed again to remove sediment drawn in by the surging process until suspended sediment is reduced.

Following bailing and surging, the well may be further developed using air-lift or pumping methods. A bailer may be used for low-yield wells. If possible, the well will be developed at a higher pumping rate than the anticipated rate of future purging. During development, the turbidity of the water will be monitored, and the pH, specific conductance, and temperature of the return water will be measured. Drawdown and recovery will be measured during and at the end of the development process, respectively, using an electric sounder. Well development will proceed until, in the judgment of the Geomatrix field personnel, the return water is of sufficient clarity. If the screened interval is too long to be developed adequately in one stage, multiple stages will be employed, in which the end of the pump intake will be raised or lowered to various depths, as required.

2.6 DOCUMENTATION

A well construction diagram for each well will be completed in the field on the WELL LOG by the field geologist/engineer and submitted to the reviewing geologist or engineer upon completion of each well. Well installation and construction data will be summarized on the DAILY FIELD RECORD or on a specialized form produced for this purpose. Well development notes and field measurements of water quality parameters will be summarized on a WELL SAMPLING AND/OR DEVELOPMENT RECORD. Following review by the project manager, the original records will be kept in the project file.

3.0 CLEANING OF DRILLING EQUIPMENT

Cleaning of the drill rig and associated drilling equipment will follow the procedures discussed in Section 2.0 of the protocol DRILLING AND DESTRUCTION OF SOIL BORINGS.

All well casing materials will be cleaned before they are installed. Well development equipment will be cleaned before use. The following cleaning procedure has been found to be effective and will be used or adapted as appropriate for general conditions of materials or equipment to be cleaned.

1. Steam-rinse with potable water or rinse in deionized or organic-free water.
2. Cover with clean plastic to protect materials and equipment from contact with chemical products, dust, or other contaminants.

Alternatively, well casing materials that have been steam-cleaned and sealed in individual airtight plastic bags by the factory can be used.

Decontamination rinsate will be collected and stored properly for future disposal by the client, unless other arrangements have been made.

4.0 WELL DESTRUCTION

Destruction of wells will be completed in accordance with applicable state and local requirements. If required, permits for destruction will be obtained from the appropriate regulatory agency. As part of destruction design and implementation, care will be taken to seal groundwater pathways between multiple aquifers and to limit surface water infiltration through the destroyed borehole.

If practical, the well casing will be removed from the borehole. If the well casing cannot be removed, the casing should be cut and/or pressure-grouted in accordance with regulating agency requirements. For shallow wells and if the well has been completed in the uppermost aquifer, the casing may be pulled from the borehole before auger entry. Alternatively, and if the well has been completed below the uppermost aquifer, the annular fill may be drilled out with hollow stem augers and the casing removed from the borehole through the augers. If the well casing is PVC or other similar material and cannot be removed as described above, it may be removed by drilling out the casing and annular fill using a tricone or drag bit and a rotary drilling method. The borehole will be redrilled to the same or a slightly larger diameter than the original borehole. The redrilled borehole will be plumb and adequately centered, and all of the well casing will be removed.

The borehole will be filled with a neat cement, cement/sand, cement/bentonite grout, or a high-solids bentonite grout. Before its initial set, the grout will be placed in one continuous pour from the bottom of the boring to the ground surface. The grout will be emplaced by pumping through a tremie pipe or flexible hose which is initially lowered to the bottom of the borehole. The augers should be raised incrementally as emplacement proceeds, but not exceed increments of 20 feet or increments greater than allowed by borehole stability. Boreholes that are terminated above the water table and are not greater than 20 feet deep may be grouted by a continuous pour originating at the ground surface. If the aquifer is confined and the head pressure is great, the grout may need to be placed under pressure.

The volume of sealing material used will be calculated and compared to the casing or borehole volume to ensure that bridging has not occurred during well destruction. If the well is in an urban area and if the casing remains in the borehole, a hole will be excavated around the well to a depth of 5 feet, and the casing will be removed to the bottom of the excavation. The sealing material will be allowed to spill over into the excavation to form a cap. The remainder of the excavation will be backfilled with either native material, grout, or concrete.

Attachments: Daily Field Record
Typical Monitoring Well Construction Diagram
Well Log
Well Sampling and/or Development Record

DAILY FIELD RECORD

Page 1 of ___

Project and Task Number:	Date:
Project Name:	Field Activity:
Location:	Weather:

PERSONNEL: Name	**Company**	**Time In**	**Time Out**

PERSONAL SAFETY CHECKLIST

	Steel-toed Boots		Hard Hat		Tyvek Coveralls
	Rubber Gloves		Safety Goggles		1/2-Face Respirator

DRUM I.D.	**DESCRIPTION OF CONTENTS AND QUANTITY**	**LOCATION**

TIME	**DESCRIPTION OF WORK PERFORMED**

DAILY FIELD RECORD (continued)

Geomatrix

Page ____ of ____

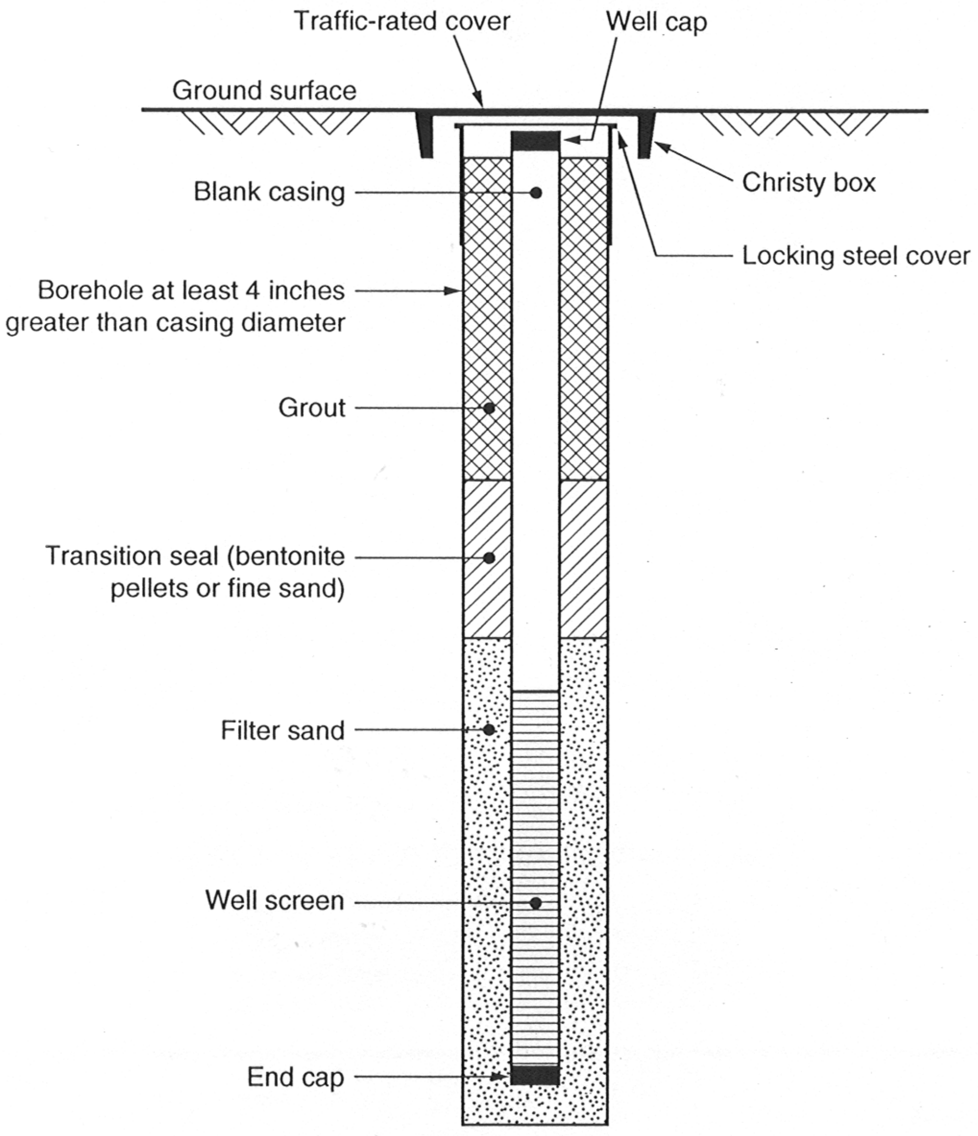
Project and Task Number:

Date:

TIME	DESCRIPTION OF WORK PERFORMED

Geomatrix

TYPICAL MONITORING WELL CONSTRUCTION DIAGRAM



Not to scale

Geomatrix

PROJECT:	**Log of Well No.**	
BORING LOCATION:	ELEVATION AND DATUM:	
DRILLING CONTRACTOR:	DATE STARTED:	DATE FINISHED:
DRILLING METHOD:	TOTAL DEPTH:	SCREEN INTERVAL:
DRILLING EQUIPMENT:	DEPTH TO WATER: FIRST COMPL	CASING:
SAMPLING METHOD:	LOGGED BY:	
HAMMER WEIGHT: DROP:	RESPONSIBLE PROFESSIONAL: REG. NO.	

DEPTH (feet)	SAMPLES			OVM Reading (ppm)	DESCRIPTION NAME (USCS Symbol): color, moist. % by weight, plast., consistency, structure, cementation, react. W/HCl, geo. inter. Surface Elevation:	WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS
	Sample No.	Sample	Blows/ Foot			

Project No.	**Geomatrix Consultants**	Figure

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PROJECT:	**Log of Well No.**

DEPTH (feet)	SAMPLES Sample No.	SAMPLES Sample	SAMPLES Blows/ Foot	OVM Reading (ppm)	DESCRIPTION NAME (USCS Symbol): color, moist. % by weight, plast., consistency, structure, cementation, react. W/HCl, geo. inter.	WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS

Project No.	**Geomatrix Consultants**	Figure

Geomatrix

WELL SAMPLING
AND/OR DEVELOPMENT RECORD

Well ID:

Sample ID: Duplicate ID:

Sample Depth:

Project and Task No.:

Project Name:

Date:

Sampled By:

Method of Purging:

Method of Sampling:

Initial Depth to Water:

Depth to Water after Sampling:

Total Depth to Well:

Well Diameter:

1 Casing/Borehole Volume:
(Circle one)

4 Casing/Borehole Volumes:
(Circle one)

Total Casing/Borehole Volumes Removed:

Time	Intake Depth	Rate (gpm)	Cum. Vol. (gal.)	Temp. (°C)	pH (units)	Specific Electrical Conductance (µS/cm)	Remarks (color, turbidity, and sediment)

pH CALIBRATION (choose two)

Buffer Solution	pH 4.0	pH 7.0	pH 10.0	
Temperature C				
Instrument Reading				

Model or Unit No.:

SPECIFIC ELECTRICAL CONDUCTANCE – CALIBRATION

KCL Solution (µS/cm=µmhos/cm)			
Temperature C			
Instrument Reading			

Model or Unit No.:

Notes:

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PROTOCOL

WATER LEVEL, WELL DEPTH, AND FLOATING PRODUCT MEASUREMENTS

1.0 INTRODUCTION

This protocol describes the procedures to be followed during water level, well depth, and free product measurements. The procedures presented herein are intended to be of general use and may be supplemented by a work plan and/or health and safety plan. As the work progresses and if warranted, appropriate revisions may be made by the project manager. Detailed procedures in this protocol may be superseded by applicable regulatory requirements.

2.0 WATER LEVEL AND WELL DEPTH MEASUREMENTS

A DAILY FIELD RECORD will be completed for each day of fieldwork. Water levels will be recorded on a WATER LEVEL MONITORING RECORD. Following review by the project manager, the original records will be kept in the project files.

Water level measurements at a site will be taken as quickly as practical, to best represent the potentiometric surface across the site at a single time. If pressure is suspected or has developed inside the well casing, the well will be allowed to stand without a cap for a few minutes or until the water level stabilizes before taking the water level measurement. Water level measurements will be recorded to the nearest hundredth (0.01) foot, and well depth measurements will be noted to at least the nearest half (0.5) foot. Equipment placed in the wells for water level and well depth measurements will be cleaned prior to reuse, as discussed in Section 4.0. Care will be taken not to drop foreign objects into the wells and not to allow the tape or sounding device to touch the ground around the well during monitoring.

2.1 WATER LEVEL MEASUREMENTS

Water level measurements will be performed by one of the following methods:

A. Wetted-Tape Method

A steel surveyor's tape will be prepared by coating several feet of the lower end of the tape with chalk or water-finding paste. A weight is attached to the lower end of the steel tape to keep it taut. The tape is lowered into the well until a foot or two of the chalked portion is submerged.

A tape without weight can be used if the well opening or pump casing clearance is too small and restricts the passage of the weight. The proper length to lower the tape may have to be determined experimentally. Measurement will be done as follows:

1. Lower and hold the tape at an even foot mark at the measuring point (MP) and note this tape reading.
2. Remove the steel tape from the well. Add or subtract the wetted length from the even foot mark noted in Step 1, as appropriate for your tape, and record this as water level below MP on the WATER LEVEL MONITORING RECORD.

B. <u>Electric Sounder Method</u>

An electric sounder consists of a contact electrode suspended by an insulated electric cable from a reel that has an ammeter, a buzzer, a light, or other closed circuit indicator attached. The indicator shows a closed circuit and flow of current when the electrode touches the water surface. Electric sounders will be calibrated periodically by measuring each interval and remarking them where necessary.

The procedure for measuring water levels with an electric sounder is as follows:

1. Turn sounder on, and check that it is working.
2. Lower the electric sounder cable into the well until the ammeter or buzzer indicates a closed circuit. Raise and lower the electric cable slightly until the shortest length of cable that gives the maximum response on the indicator is found.
3. With the cable in this fixed position, note the length of cable at the MP.
4. If the electric cable is not graduated between foot markings, use a pocket steel tape measure (graduated in hundredths of a foot) to interpolate between consecutive marks. Care must be taken to ensure that the tape measurements are subtracted from the graduated mark footage value when the water level hold point (determined in Step 3) is below the graduated mark and added when it is above the mark. Record the resulting value as water level below MP on the WATER LEVEL MONITORING RECORD.

2.2 WELL DEPTH MEASUREMENTS

The depth of a well will be measured by sounding with a weighted steel surveying tape or an electric sounding line, weighted when possible. Procedures to be followed are described below.

1. Measure the distance between the zero mark on the end of the measuring line and the bottom of the weight.

2. Lower the weighted measuring line into the well until the line becomes slack or there is a noticeable decrease in weight, which indicates the line is touching the bottom of the well. Raise the line slowly until it becomes taut (this may have to be done several times to determine the taut point) and, with the line in this fixed position, note the reading at the MP. Add the distance described in Step A to this reading, and record the resulting value as well depth. This procedure will be performed before and after initial well development or as necessary to determine well casing depth.
3. Record the well depth value on a WATER LEVEL MONITORING RECORD.

3.0 FLOATING PRODUCT MEASUREMENTS

Floating product level/thickness will be measured using an interface probe or steel tape and paste. The electric sounder and bailer method is limited to checking the wells for the presence or absence of floating product. Procedural details are provided below.

All floating product level measurements shall be recorded to the nearest hundredth foot (0.01 foot). All equipment placed in the wells for floating product level measurement will be cleaned prior to reuse, as discussed in Section 4.0. Care will be taken not to drop foreign objects into the wells and not to allow the measuring device to touch the ground around the well during monitoring.

3.1 INTERFACE PROBE METHOD

The floating product-water interface probe consists of a electrode suspended by a graduated tape from a reel that has a light and two-toned audible signals. Audible and visual signals occur when the electrode touches the floating product surface and then the water surface.

The procedure for measuring floating product levels using the interface probe is as follows:

1. Turn interface meter on, and check that it is working.
2. Lower the interface meter into the well slowly until the meter signals an interface. Note if the interface is oil or water.
3. Raise and lower the meter slightly until the shortest length of cable that gives the maximum response on the meter is found.
4. With the cable in this fixed position, note the length of cable at the measuring point.
5. If the interface recorded above was oil, slowly lower the meter until a water interface signal is given.
6. Repeat steps 3 and 4 above.
7. Turn the probe off and store in a case after cleaning.

3.2 ELECTRIC SOUNDER AND BAILER METHOD

The procedure for checking present of floating product using an electric sounder and an acrylic bailer is as follows:

1. Measure the water level with the electric sounder as described in Section 2.1.
2. Suspend a clean acrylic bailer on a line and slowly lower the bailer into the well until it partially intersects the groundwater surface.
3. Slowly pull the bailer to the surface.
4. Let the bailer stand for several minutes.
5. Observe the surface of the water within the bailer. Measure the thickness of the product in the bailer to the nearest 0.01 foot and record the value on the sampling record. If the product is less than 0.01 foot thick, the amount should be recorded as less than 0.01 foot. If only a sheen is observed or no floating product is seen, these observations should be recorded.

3.3 STEEL TAPE AND PASTE METHOD

1. Measure the water level with an electric sounder as described in Section 2.1.
2. Spread a thin layer of gasoline or oil-finding paste on one side of a steel surveyor's tape, beginning at the zero-foot mark and extending up the tape about 1-foot more than the anticipated thickness of the floating product.
3. Spread a thin film of water-finding paste on the opposite side of the tape, beginning at the zero-foot mark and extending up the tape about 1 foot.
4. Slowly lower the tape into the well until the zero-foot mark is located, about 6 inches below the water level (the tape reading at the measuring point should be 6 inches greater than the actual depth to water). Take care not to touch the sides of the well with the tape.
5. Slowly remove the tape from the well. The pastes will have changed color upon contact with the water or the floating product. The product thickness is the difference between the tape reading at the point where water-finding paste indicates the water level and the point where the gasoline or oil-finding paste indicates the top of the floating product.

4.0 EQUIPMENT CLEANING

Steel tapes, electric well sounders, and acrylic bailers will be cleaned after measurements in each well. Cleaning procedures will be as follows:

1. Wipe floating product off with disposable towels. Rinse probe or portion of instrument that was immersed in well water with a solution of laboratory-grade detergent and potable water.

2. Rinse with potable water.
3. Dry with a clean paper towel.
4. The interface probe may also be cleaned with acetone at this stage.

Solutions resulting from cleaning procedures will be collected and stored properly for future disposal by the client, unless other arrangements have been made.

Attachments: Daily Field Record
Water Level Monitoring Record

DAILY FIELD RECORD

Geomatrix

Page 1 of ___

Project and Task Number:	Date:
Project Name:	Field Activity:
Location:	Weather:

PERSONNEL: Name	**Company**	**Time In**	**Time Out**

PERSONAL SAFETY CHECKLIST

	Steel-toed Boots		Hard Hat		Tyvek Coveralls
	Rubber Gloves		Safety Goggles		1/2-Face Respirator

DRUM I.D.	**DESCRIPTION OF CONTENTS AND QUANTITY**	**LOCATION**

TIME	**DESCRIPTION OF WORK PERFORMED**

DAILY FIELD RECORD (continued)

Geomatrix

Page ____ of ____

Project and Task Number:

Date:

TIME	DESCRIPTION OF WORK PERFORMED

WATER LEVEL MONITORING RECORD

Geomatrix

Project Name: ______________________________ Project and Task Number: __________________________

Date: _____________ Measured by: __________________ Instrument Used: __________________________

Note: For you convenience, the following abbreviations may be used.

P = Pumping
I = Inaccessible
D = Dedicated Pump
ST = Steel Tape
ES = Electric Sounder
MP = Measuring Point
WL = Water Level

Well No.	**Time**	**MP Elevation (feet)**	**Water Level Below MP (feet)**	**Water Level Elevation (feet)**	**Previous Water Level Below MP**	**Remarks**

PROTOCOL

SAMPLING OF GROUNDWATER MONITORING WELLS AND WATER SUPPLY WELLS

1.0 INTRODUCTION

This protocol describes the procedures to be followed during sampling of groundwater monitoring wells and water supply wells for laboratory chemical analysis. The laboratory must be certified by the appropriate regulating agency for the analyses to be performed.

The procedures presented herein are intended to be of general use and may be supplemented by a work plan and/or health and safety plan. As the work progresses and if warranted, appropriate revisions may be made by the project manager. Detailed procedures in this protocol may be superseded by applicable regulatory requirements.

2.0 SAMPLING

2.1 SAMPLE COLLECTION

A. Monitoring Wells

Methods for purging and sampling monitoring wells with dedicated and non-dedicated equipment are described in this Section. When practical, the purging and sampling technique adopted for a given site will remain consistent from one sampling event to the next.

A.1 Purging Monitoring Wells

A submersible pump, diaphragm pump, positive displacement pump, which may contain a bladder, or a bailer will be used for evacuating (purging) the monitoring well casing. If the well is to be sampled using equipment that must be separately introduced into the well, the purge intake will be located near the top of the water column for removal of at least one casing volume to remove stagnant water above the screened interval in the well casing; the pump may then be moved to the midscreen interval to complete the purging progress, if required. If a bailer is used to purge the monitoring well, it will be gently lowered into the well to reduce the potential for aeration of water. Purging will progress at a rate intended to minimize differential drawdown between the interior of the well screen and the filter material to limit cascading water along the inside of the well casing. Procedures for purging slowly recharging wells are discussed in Section A.3.

A minimum of four well casing volumes or one saturated borehole volume, whichever is greater, will be removed to purge the well prior to collection of groundwater samples if the well will be purged with non-dedicated equipment. If a low-flow capacity pump is dedicated in the well, the micropurge method described in Section A.4 may be used to reduce the purge volume. If the well goes dry before four casing volumes are removed, the procedure discussed in Section A.3 will be followed. The saturated borehole volume is the volume of water in the well casing plus the volume of water in the filter pack. For a well with a dedicated pump and packer, a casing volume is defined as the volume of water in the well casing below the inflated packer.

Periodic observations of turbidity and measurements of temperature, pH, and specific electrical conductance (SEC) will be made with field equipment during purging to evaluate whether the water samples are representative of the target zone. Samples will be collected when: (1) a minimum of four sets of parameter readings have been taken; and (2) the temperature, pH, and SEC reach relatively constant values, and the turbidity has stabilized.

A.2 Sampling Monitoring Wells

The sampler will wear clean gloves appropriate for the chemicals of concern while collecting the sample. Samples will be collected directly in laboratory-prepared bottles from the sampling device.

Each sampling episode or day should generally begin with the well having the least suspected concentrations of target compounds. Successive wells should generally be sampled in sequence of increasing suspected concentration.

A Teflon® bailer, new disposable bailer, stainless steel positive displacement Teflon® bladder pump with Teflon® tubing, or a clean electric submersible pump with low-flow sampling capacity will be used to collect the water samples for laboratory chemical analysis.
If a bailer is being used to collect the sample, it will be gently lowered into the well below the point where the purge device was located. Samples will collected in the following order: (1) volatile organic compounds; (2) semi-volatile organic compounds; (3) metals; (4) other analytes.

If a bladder pump or electric submersible pump is being used to sample the well for volatile compounds, the flow rate will be adjusted to either 1) approximately 100 milliliters per minute; 2) a rate specifically selected for the well based on groundwater flow rates and well hydraulic conditions; or 3) as low as possible. This rate will be maintained until the discharge line has been purged and the sample collected.

A.3 Purging and Sampling Wells With Slow Recharge

Wells that recharge very slowly may be purged dry once, allowed to recharge, and then sampled as soon as sufficient water is available. In this case, at least two sets of parameter readings of field water quality should be taken, one initially and one after recharge.

A.4 Purging and Sampling Wells Using "Micropurge" Sampling Method

Based on current research, a low-flow-rate, reduced purge method may be used to purge and sample a well with a dedicated pump (Barcelona et al., 1994; Kearl et al., 1994). This method may be used if acceptable to applicable agencies. This method assumes the water within the screened interval is not stagnant, and a small change to the natural flow rate in the screened interval will result in samples with particulates and colloidal material representative of groundwater. The pump should be preset in the screen interval at least 24 hours before the sampling event. A minimum of two pump plus riser pipe volumes should be purged at a flow rate of approximately 100 milliliters per minute or as low as possible based on groundwater flow and well hydraulic conditions. Purging should progress until water quality parameters (pH, SEC, temperature) have reached relatively constant values. Dissolved oxygen readings are recommended, if practical.

B. Water Supply Wells

Water supply wells will be sampled by purging the wells for a period of time adequate to purge the pump riser pipe. Alternatively, if the volume of the riser pipe is unknown, the pressure tank will be drained until the pump cycles on, or the well may be purged until three successive field measurements performed 5 to 10 minutes apart have stabilized. If the well is currently pumping, the sample can be taken without purging the well. Water samples will then be collected from the discharge point nearest the well head. Samples will be collected directly into laboratory-prepared bottles.

C. Extraction Wells

Extraction wells will be sampled while extraction is occurring. Samples will be collected from an in-line sampling port after purging the sampling line. Samples will be collected directly into laboratory-prepared bottles.

A WELL SAMPLING AND/OR DEVELOPMENT RECORD will be used to record the following information:

- Sample I.D.
- Duplicate I.D., if applicable
- Date and time sampled
- Name of sample collector
- Well designation (State well numbering system for water supply wells, and unique sequential number for other wells)
- Owner's name, or other common designation for water supply wells
- Well diameter
- Depth to water on day sampled
- Casing volume on day sampled
- Method of purging (bailing, pumping, etc.)
- Amount of water purged
- Extraordinary circumstances (if any)
- Results of instrument calibration/standardization and field measurements (temperature, pH, specific electrical conductance) and observed relative turbidity
- Depth from which sample was obtained
- Number and type of sample container(s)
- Purging pump intake depth
- Times and volumes corresponding to water quality measurement

- Purge rate

2.2 SAMPLE CONTAINERS AND PRESERVATION

Appropriate pre-cleaned sample containers and preservatives for the analyses to be performed will be obtained from the subcontracted analytical laboratory. Frequently requested analyses and sample handling requirements are listed in Table 1.

2.3 SAMPLE LABELING

Sample containers will be labeled before or immediately after sampling with self-adhesive tags having the following information written in waterproof ink:

- Geomatrix
- Project number
- Sample I.D. number
- Date and time sample was collected
- Initials of sample collector

2.4 QUALITY CONTROL SAMPLES

In order to evaluate the precision and accuracy of analytical data, quality control samples, such as duplicates and blanks, will be periodically prepared. These samples will be collected or prepared and analyzed by the laboratory, as specified in the project Quality Assurance Project Plan (QAPP) or by the project manager.

2.5 HANDLING, STORAGE, AND TRANSPORTATION

Efforts will be made to handle, store, and transport supplies and samples safely. Exposure to dust, direct sunlight, high temperature, adverse weather conditions, and possible contamination will be avoided. Immediately following collection, samples will be placed in a clean chest that contains ice or blue ice (if cooling is required), and will be transported to the subcontracted laboratory as soon as practical, or in accordance with the project QAPP.

3.0 FIELD MEASUREMENTS

Field measurements of temperature, pH, and SEC will be performed on aliquots of groundwater that will not be submitted for laboratory analysis. Field water quality measurements and instrument calibration details will be recorded on the WELL SAMPLING AND/OR DEVELOPMENT RECORD.

3.1 TEMPERATURE MEASUREMENTS

Temperature measurements will be made with a mercury-filled thermometer or an electronic thermistor, and all measurements will be recorded in degrees Celsius.

3.2 PH MEASUREMENT

The pH measurement will be made as soon as possible after collection of the sample, generally within a few minutes. The pH will be measured by immersing the pH probe into an aliquot of groundwater.

The pH meter will be calibrated at the beginning of and once during each sampling day and whenever appropriate, in accordance with the equipment manufacturer's specifications, as outlined in the instruction manual for the specific pH meter used. Two buffers (either pH-4 and pH-7, or pH-7 and pH-10, whichever most closely bracket the anticipated range of groundwater conditions) will be used for instrument calibration.

3.3 SPECIFIC ELECTRICAL CONDUCTANCE MEASUREMENT

SEC will be measured by immersing the conductivity probe into an aliquot of groundwater. The probes used should automatically compensate for the temperature of the sample. Measurements will be reported in units of micro-Siemens (ΦS) per square centimeter (equivalent to micromhos or Φmhos) at 25 degrees Celsius.

The SEC meter will be calibrated at the beginning and once during each sampling day in accordance with the equipment manufacturer's specifications, as outlined in the instruction manual for the SEC meter used. The SEC meter will be calibrated with the available standardized potassium chloride (KCl) solution that is closest to the SEC expected in groundwater below the site.

4.0 DOCUMENTATION

4.1 FIELD DATA SHEETS

A DAILY FIELD RECORD will be completed for each day of fieldwork. A WELL SAMPLING AND/OR DEVELOPMENT RECORD will be used for each well to record the information collected during water quality sampling. Samples may also be recorded on a SAMPLE CONTROL LOG SHEET or in the DAILY FIELD RECORD as a means of identifying and tracking the samples. Following review by the project manager, the original records will be kept in the project file.

4.2 CHAIN-OF-CUSTODY PROCEDURES

After samples have been collected and labeled, they will be maintained under chain-of-custody procedures. These procedures document the transfer of custody of samples from the field to the laboratory. Each sample sent to the laboratory for analysis will be recorded on a CHAIN-OF-CUSTODY RECORD, which will include instructions to the laboratory for analytical services.

Information contained on the triplicate CHAIN-OF-CUSTODY RECORD will include:

- Project number
- Signature of sampler(s)
- Date and time sampled
- Sample I.D.
- Number of sample containers
- Sample matrix (water)
- Analyses required
- Remarks, including preservatives, special conditions, or specific quality control measures
- Turnaround time and person to receive laboratory report
- Method of shipment to the laboratory
- Release signature of sampler(s), and signatures of all people assuming custody.
- Condition of samples when received by laboratory

Blank spaces on the CHAIN-OF-CUSTODY RECORD will be crossed out between the last sample listed and the signatures at the bottom of the sheet.

The field sampler will sign the CHAIN-OF-CUSTODY RECORD and will record the time and date at the time of transfer to the laboratory or to an intermediate person. A set of signatures is required for each relinquished/reserved transfer, including transfer within Geomatrix. The original imprint of the chain-of-custody record will accompany the sample containers. A duplicate copy will be placed in the project file.

If the samples are to be shipped to the laboratory, the original CHAIN-OF-CUSTODY will be sealed inside a plastic bag within the ice chest, and the chest will be sealed with custody tape which has been signed and dated by the last person listed on the chain-of-custody. U.S. Department of Transportation shipping requirements will be followed and the sample shipping receipt will be retained in the project files as part of the permanent chain-of-custody document. The shipping company (e.g., Federal Express, UPS, DHL) will not sign the chain-of-custody forms as a receivor; instead the laboratory will sign as a receivor when the samples are received.

5.0 EQUIPMENT CLEANING

Bailers, sampling pumps, purge pumps, and other non-dedicated purging or sampling apparatus will be cleaned before and after sampling each well. Factory new and sealed disposable bailers may be used for sampling, but may not be reused. Thermometers, pH electrodes, and SEC probes that will be used repeatedly will be cleaned before and after sampling each well and at any time during sampling if the object comes in contact with foreign matter.

Purged waters and solutions resulting from cleaning of purging or sampling equipment will be collected and stored properly for future disposal by the client, unless other arrangements have been made.

Cleaning of reusable equipment that is not dedicated to a particular well will consist of the following:

- Bailers - the inside and outside of bailers will be cleaned in a solution of laboratory-grade detergent and potable water, followed by a rinse with deionized (DI) water. They may also be steam-cleaned, followed by a DI water rinse. If samples are to be collected for metals analysis, the Teflon[8] bailer may be rinsed with a pH2 nitric acid solution followed by a double DI rinse.

- Purge Pumps - All downhole, reusable portions of purge pumps will be steam-cleaned on the outside. If the pump does not have a backflow check valve, the inside of the pump and tubing also should be steam-cleaned. For a purge pump with a backflow check valve, the interior of the pump and tubing may be cleaned by pumping a laboratory-grade detergent and potable water solution through the system followed by a potable water rinse, or by steam-cleaning.

- Water Quality Meters - All meters will be cleaned by rinsing the probe portions in DI water, and allowing to air dry.
- Bailer Tripod - The tripod cable will be steam-cleaned or rinsed with DI water.

Sample bottles and bottle caps will be cleaned by the subcontracted laboratory using standard EPA-approved protocols. Sample bottles and bottle caps will be protected from contact with solvents, dust, or other contamination. Sample bottles will not be reused.

6.0 REFERENCES

Barcelona, M.J., et al., 1994, Reproducible Well-Purging Procedures and VOC Stabilization Criteria for Ground-Water Sampling: *Groundwater*, January-February.

Kearl, P.M., et al., 1994, Field Comparison of Micropurging vs. Traditional Ground Water Sampling: *Ground Water Monitoring Review*, Fall.

Attachments: Water and Soil Analytical Methods and Sample Handling
Well Sampling and/or Development Record
Daily Field Record
Chain-of-Custody Record
Sample Control Log Sheet

TABLE 1

WATER AND SOIL ANALYTICAL METHODS AND SAMPLE HANDLING

Parameter	Method	Water Containers[1]	Preservation[1]	Maximum Holding Time[1]
Total Petroleum Hydrocarbons:				
• as diesel	GCFID (3550)[2]	2 - 1 liter amber glass	cool on ice	14 days (unacidified water, 7 days)
• as gasoline	GCFID (5030)[2]	2 - 40 ml VOA glass	HCL to pH 2 in water samples: cool on ice	14 days (unacidified water, 7 days)
Benzene, Toluene, Xylene, and Ethylbenzene	EPA 8020	2 - 40 ml VOA glass	HCL to pH 2 in water samples: cool on ice	14 days (unacidified water, 7 days)
Volatile Organics with BTEX	EPA 8021[3]	2 - 40 ml VOA glass	HCL to pH 2 in water samples: cool on ice	14 days (unacidified water, 7 days)
Oil and Grease	5520 E & F (soil)[4] 5520 C & F (water)[4]	2 - 1 liter amber glass	H_2SO_4 to pH <2 in water samples: cool on ice	28 days
Volatile Organics	EPA 8010 EPA 8240[5]	2 - 40 ml VOA glass 2 - 40 ml VOA glass	cool on ice[6] HCl to pH 2 in water samples: cool on ice	14 days (unacidified water, 7 days) 14 days (unacidified water, 7 days)
Semi-volatile Organics	EPA 8270	2 - 1 liter amber glass	cool on ice	7 days for extraction, water 14 days for extraction, soil 40 days for analysis
Polynuclear Aromatic Hydrocarbons	EPA 8310	2 - 1 liter amber glass	cool on ice	7 days, water 14 days, soil
Metals (dissolved)	EPA 7000 series for specific metal	1 - 500 ml plastic	Water Samples: field filtration (0.45 micron filter) and field acidify to pH 2 with HNO_3 except: Cr^{+6} - cool on ice	6 months, except: Hg - 28 days Cr^{+6} - 24 hours, water; 24 hours after prep, soil

Notes:

[1] All soil samples should be collected in full, clean brass liners, capped with aluminum foil or Teflon and plastic caps, and sealed with tape. If soil samples are to be analyzed for metals, they may be placed in laboratory-prepared clean glass jars. Soil should be cooled as indicated under "preservation" and maximum holding times apply to both soil and water unless otherwise noted.

[2] For analysis in California, use California DHS recommended procedure as presented in LUFT manual using gas chromatography with a flame ionization detector. In other states, local requirements should be followed. Method 3660M is silica gel cleanup.

[3] EPA Method 8021 is equivalent to 8010/8020 in series.

[4] Method to be used in California Regional Water Quality Control Board North Coast and Central Valley Regions. In other areas, local requirements should be followed. Method 5520F is silica gel cleanup.

[5] Chloroethylvinylether may be detected at concentrations below 50 parts per billion due to degradation of HCl. EPA Method 8260B was formerly 8240.

[6] If EPA Methods 8010 and 8020 are to be run in sequence, HCl may be added. Check with the project manager before adding acid.

References:

U.S. EPA, 1986, Test Methods for Evaluating Solid Waste - Physical/Chemical Methods - SW-846, Third Edition, July, and final amendments.
California State Water Resources Control Board, 1989, Leaking Underground Fuel Tank (LUFT) Field Manual, Tables 3-3 and 3-4, October.
California Regional Water Quality Control Boards, North Coast, San Francisco Bay, and Central Valley Regions, 1990, Regional Board Staff Recommendations for Initial Evaluation and Investigation of Underground Tanks, 10 August.

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WELL SAMPLING
AND/OR DEVELOPMENT RECORD

Well ID: ____________________
Sample ID: __________ Duplicate ID: __________
Sample Depth: ____________________
Project and Task No.: ____________________
Project Name: ____________________
Date: ____________________
Sampled By: ____________________
Method of Purging: ____________________
Method of Sampling: ____________________

Initial Depth to Water:
Depth to Water after Sampling: ____________________
Total Depth to Well: ____________________
Well Diameter: ____________________
1 Casing/Borehole Volume: ____________________
(Circle one)
4 Casing/Borehole Volumes: ____________________
(Circle one)
Total Casing/Borehole Volumes Removed: ____________________

Time	Intake Depth	Rate (gpm)	Cum. Vol. (gal.)	Temp. (°C)	pH (units)	Specific Electrical Conductance (μS/cm)	Remarks (color, turbidity, and sediment)

pH CALIBRATION (choose two)				
Buffer Solution	pH 4.0	pH 7.0	pH 10.0	
Temperature C				
Instrument Reading				

Model or Unit No.:

SPECIFIC ELECTRICAL CONDUCTANCE – CALIBRATION			
KCL Solution (μS/cm=μmhos/cm)			
Temperature C			
Instrument Reading			

Model or Unit No.:

Notes:

DAILY FIELD RECORD

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Page 1 of ___

Project and Task Number:	Date:
Project Name:	Field Activity:
Location:	Weather:

PERSONNEL: Name	**Company**	**Time In**	**Time Out**

PERSONAL SAFETY CHECKLIST

	Steel-toed Boots		Hard Hat		Tyvek Coveralls
	Rubber Gloves		Safety Goggles		1/2-Face Respirator

DRUM I.D.	**DESCRIPTION OF CONTENTS AND QUANTITY**	**LOCATION**

TIME	**DESCRIPTION OF WORK PERFORMED**

DAILY FIELD RECORD (continued)

Geomatrix

Page ____ of ____

Project and Task Number:	Date:

TIME	DESCRIPTION OF WORK PERFORMED

CHAIN-OF-CUSTODY RECORD

Nº

Date:

Page of

Project No.:

Samplers (Signatures):

ANALYSES

REMARKS

Date	Time	Sample Number	EPA Method 8010	EPA Method 8020	EPA Method 8020 (BTEX only)	EPA Method 8240	EPA Method 8270	TPH as gasoline	TPH as diesel													Cooled	Soil (S), Water (W), or Vapor (V)	Acidified	Number of containers

Additional Comments

Turnaround time:

Results to:

Total No. of containers:

Relinquished by (signature):	Date:	Relinquished by (signature):	Date:	Relinquished by (signature):	Date:
Printed Name:	Time:	Printed Name:	Time:	Printed Name:	Time:
Company:		Company:		Company:	
Received by (signature):	Date:	Received by (signature):	Date:	Received by (signature):	Date:
Printed Name:	Time:	Printed Name:	Time:	Printed Name:	Time:
Company:		Company:		Company:	

Method of Shipment:

Laboratory Comments and Log No.:

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SAMPLE CONTROL LOG

Geomatrix

Project Name: ______________________ **Laboratory:** ______________________

Project and Task No.: ______________________ Page ____ of ____

Sampling Date	Sampling Time	Sample Number (ID)	C.O.C. Number	Analyses Requested	Turnaround Time, Sample Location, Handling Notes, Chain-of-Custody Remarks, etc. (Duplicate, Blank info, etc.)	Date Sent to Lab	Date Results Due

\\sf3\deptdata\FORMS\ETC & ES\Sample Control Log Form.doc

PROTOCOL

DISCRETE-DEPTH SAMPLING

1.0 INTRODUCTION

This protocol describes the procedures to be followed during collection of discrete-depth groundwater samples using either the Enviro Probe® or the HydroPunch®. These tools are generally used to collect groundwater samples for chemical analysis during groundwater screening programs, and in some cases to measure water levels or pore pressure at discrete depths.

A DAILY FIELD RECORD will be completed for each day of fieldwork, and the original will be kept in the project files after review by the project manager. Soil borings drilled in conjunction with the collection of discrete-depth groundwater samples will be in accordance with the protocol DRILLING and DESTRUCTION OF SOIL BORINGS. Groundwater samples collected for chemical analysis should be handled in accordance with the protocol SAMPLING OF GROUNDWATER MONITORING WELLS AND WATER SUPPLY WELLS.

The procedures presented herein are intended to be of general use and, where necessary, may be supplemented by a work plan and/or health and safety plan. As the work progresses, and if warranted, appropriate revisions may be made by the project manager. Detailed procedures in this protocol may be superseded by applicable agency requirements.

2.0 SAMPLING EQUIPMENT

The Enviro Probe® and HydroPunch® can be used with several subsurface exploration methods, including hollow stem auger drilling, mud rotary drilling, and cone penetrometer testing (CPT). Selection of the appropriate sampling tool should be based on anticipated field conditions such as the site hydrogeology (e.g., depth of sampling location below the water table, soil grain size, and estimated permeability) and type of subsurface exploration method employed. If required, permits for drilling soil borings will be acquired from the appropriate agency(s) before the drilling is initiated. An underground utility check will, at a minimum, consist of contacting a local utility alert service, if available.

2.1 ENVIRO PROBE®

The Enviro Probe® consists of a stainless steel drive point with a retractable outer sleeve, a stainless steel, wire-cloth filter, various viton rubber O-rings, and a flexible viton rubber seal (septum) at the upper end of the probe, as shown on the figure BAT ENVIRO PROBE® SCHEMATIC. The rubber septum provides a watertight seal that prevents water from readily entering or exiting the top of the probe. The filter is attached to the inside body of the probe and is protected by the retractable outer sleeve. The sample reservoir is part of a separate assembly, as discussed in Section 3.1. The tool can be disassembled readily for cleaning between sampling events.

2.2 HYDROPUNCH®

The HydroPunch® consists of a drive point, a stainless steel screen section, a sample reservoir integral with the tool body, and assorted O-rings and check valves to create watertight seals between the various components. Two models of the HydroPunch® have been developed, having slightly different designs and/or component parts as shown on the attached HydroPunch® I and II Schematics. All components are made of stainless steel, Teflon, or other relatively inert materials. The tool can be disassembled easily for cleaning between sampling events.

3.0 SAMPLING METHODS

Installation of the Enviro Probe® and HydroPunch® generally follows the same methods. A target sample interval (target zone) is usually identified prior to collecting a sample. When sampling while using conventional drilling methods, the soil boring is advanced to a depth immediately above the target zone prior to installing the sampling tool. The sampling tool is attached to one of several different types of standard drilling rods (minimum 1-inch inside diameter for the Enviro Probe®), lowered to the bottom of the existing borehole, and advanced (driven or pushed) approximately 2 to 4 feet into undisturbed formation. Internal seals and/or check valves create a water-tight sampling tool while in the closed position, so that the Enviro Probe® or HydroPunch® can be used in fluid-filled boreholes.

After the sampling tool is emplaced at the target sample depth, the outer sleeve is retracted approximately 1 to 1.5 feet (generally 1 foot of retraction for the Enviro Probe® and 1.5 feet of retraction for the HydroPunch®). As the outer sleeve is retracted, subsurface friction retains the drive point in place, exposing the screen section and allowing water to enter the sampling tool. When sampling while using CPT methods, the sampling tool can be attached directly to the uninstrumented CPT rods (for the HydroPunch®) or 1-inch-inside-diameter rods (for the Enviro Probe®) and pushed from the ground surface to the desired sampling depth. The retractable sleeve on both sampling devices ensures that the internal parts are sealed from cross-contamination as the tools are advanced.

3.1 ENVIRO PROBE® SAMPLING PROCEDURES

Groundwater samples are collected by lowering the appropriate groundwater monitoring system (GMS) tool down the drive rod (i.e., drill rod or CPT rod). The GMS tools consist of a pore pressure transducer unit (i.e., an in situ pressure transducer with a cable of appropriate length and an electronic data logger or other type of read-out unit) and a GMS groundwater sample collection kit. The GMS groundwater sample collection kit consists of sample vials, ranging in size from 35 to 1000 milliliters (ml), and a sample vial housing assembly. The sample vial(s) are sealed with a flexible viton rubber septum and cap similar to the upper end of the probe. Prior to collecting a groundwater sample, the pore pressure unit is connected in series with the sample vial housing via an arrangement of double-ended hypodermic needles. After the housing and pore pressure unit have been connected, the sample vial is evacuated with a hand vacuum pump. Sampling and pore pressure measurements are obtained by lowering the pressure transducer unit and housing assembly down the drive rod. The tools connect to the Enviro Probe® via a quick-coupling system through the hypodermic needles, which provides a temporary, closed-system, hydraulic connection. Groundwater samples are obtained directly from the Enviro Probe® into the pre-evacuated sample vials. The pressure transducer is used to monitor filling of the sample vial and to measure hydrostatic pressure of the formation after the sample vial has filled. If needed, the pore pressure unit or the GMS groundwater sampling unit can be used independently. The time allowed to fill the vial depends on the physical properties of the target formation and the groundwater pressure at the depth of the probe.

After the sample vial has filled, the sample housing is withdrawn from the drive rods and the sample vial removed. The Enviro Probe® is generally purged by removing one probe volume (approximately 15 ml) of groundwater prior to collecting a sample for preservation and transport to the laboratory. The probe can be sampled repeatedly at the same depth by repeating the sample collection procedures.

3.2 HYDROPUNCH® SAMPLING PROCEDURES

HydroPunch® I groundwater samples are usually collected under hydrostatic conditions, whereby groundwater flows from the formation through the screen section and into the sample reservoir. Accordingly, HydroPunch® I cannot be used at depths less than approximately 5 feet below the water table. The sample reservoir is allowed to fill until groundwater enters the drive rod. The water level inside the drive rod can be detected using a well sounder. The actual sample collection time at each depth depends upon the physical properties of the target zone and the fluid pressure outside the probe. Once the sample reservoir is filled, the HydroPunch® is returned to the surface. Although the sample reservoir is sealed at both ends by internal one-way check valves, care must be taken to avoid sample cross-communication with transmissive units or borehole fluids at a higher potentiometric head than the target zone. Before retrieving the tool, deionized water should be added to the drive rod to a level that exceeds the highest potentiometric surface in the borehole.

HydroPunch® II can be used below the water table, in a manner similar to HydroPunch® I, or it can be used at the water table in the "hydrocarbon mode." If HydroPunch® II is used in the "hydrocarbon mode," the sample is collected by lowering a narrow diameter bailer through the drive rod (minimum 1-inch-diameter) and bailing out the volume of groundwater required for analysis. The screen and drive point are left in the hole as the HydroPunch® II tool is removed.

When the sample is retrieved to the surface, it is decanted into laboratory-prepared sample containers suitable for the analysis desired. The HydroPunch® is then disassembled for decontamination and preparation for subsequent sampling depths. The HydroPunch® I can be continued in the same borehole to the next desired sampling depth.

4.0 EQUIPMENT DECONTAMINATION

The Enviro Probe® and HydroPunch® are cleaned by complete disassembly, including O-rings and/or check valves, followed by a laboratory-grade detergent and potable water wash and then followed by a deionized-water rinse. All decontamination rinsate will be collected and stored properly for future disposal by the client, unless other arrangements have been made. The condition of O-rings should be checked during each cleaning and replaced as necessary. The screen should be discarded after each use. The tool will be assembled after cleaning, following the instructions provided in the appropriate sampling kits.

5.0 EQUIPMENT CONSTRAINTS

The Enviro Probe® and its associated GMS assembly require drive rods of a minimum 1-inch inside diameter. HydroPunch® I and HydroPunch® II (in the "groundwater mode") require drive rods of sufficient diameter to allow passage of the well sounder, generally about 1/2-inch.

HydroPunch® II in the "hydrocarbon mode" (water table sampling) requires drive rods of a minimum 1-1/8-inch diameter to allow passage of the 1-inch-outside-diameter bailer.

As stated earlier, HydroPunch® I (and HydroPunch® II in the "groundwater mode") cannot be used at sampling depths less than 5 feet below the water table. HydroPunch® I, when full, holds 500 ml; HydroPunch® II, when full, holds 1250 ml. The Enviro Probe® system and HydroPunch® II in the "hydrocarbon mode" allow for collection of unlimited sample volumes. The HydroPunch® I can be assembled to allow samples to be bailed in a manner similar to hydrocarbon mode so that unlimited sample volume is available.

Attachments: Daily Field Record
BAT Enviro Probe® Schematic
HydroPunch® I Schematic

DAILY FIELD RECORD

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Page 1 of ___

Project and Task Number:	Date:
Project Name:	Field Activity:
Location:	Weather:

PERSONNEL: Name	**Company**	**Time In**	**Time Out**

PERSONAL SAFETY CHECKLIST

	Steel-toed Boots		Hard Hat		Tyvek Coveralls
	Rubber Gloves		Safety Goggles		1/2-Face Respirator

DRUM I.D.	**DESCRIPTION OF CONTENTS AND QUANTITY**	**LOCATION**

TIME	**DESCRIPTION OF WORK PERFORMED**

DAILY FIELD RECORD (continued)

Geomatrix

Page ____ of ____

Project and Task Number:

Date:

TIME	DESCRIPTION OF WORK PERFORMED

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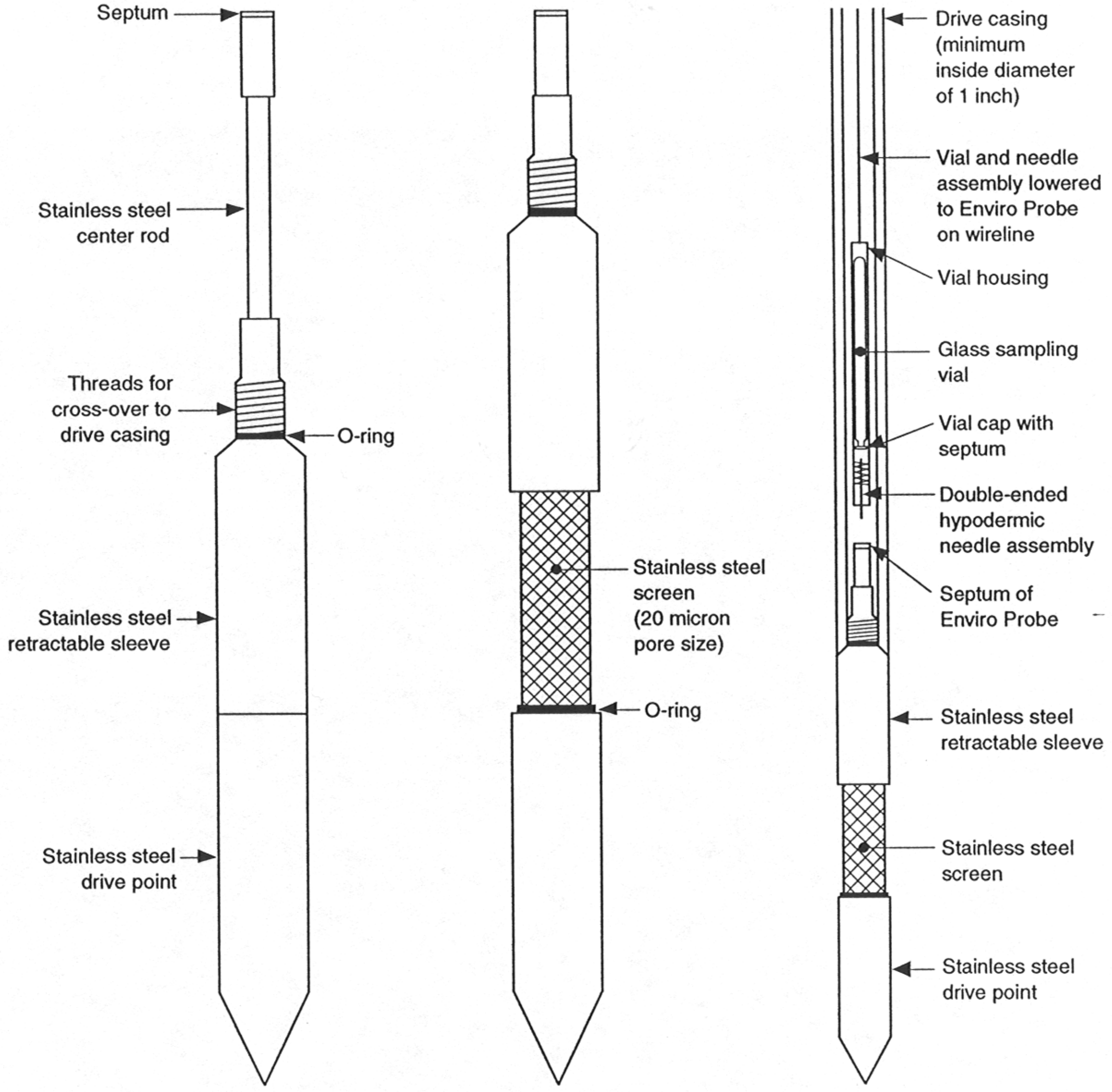
BAT ENVIRO PROBE SCHEMATIC

(Not to scale)



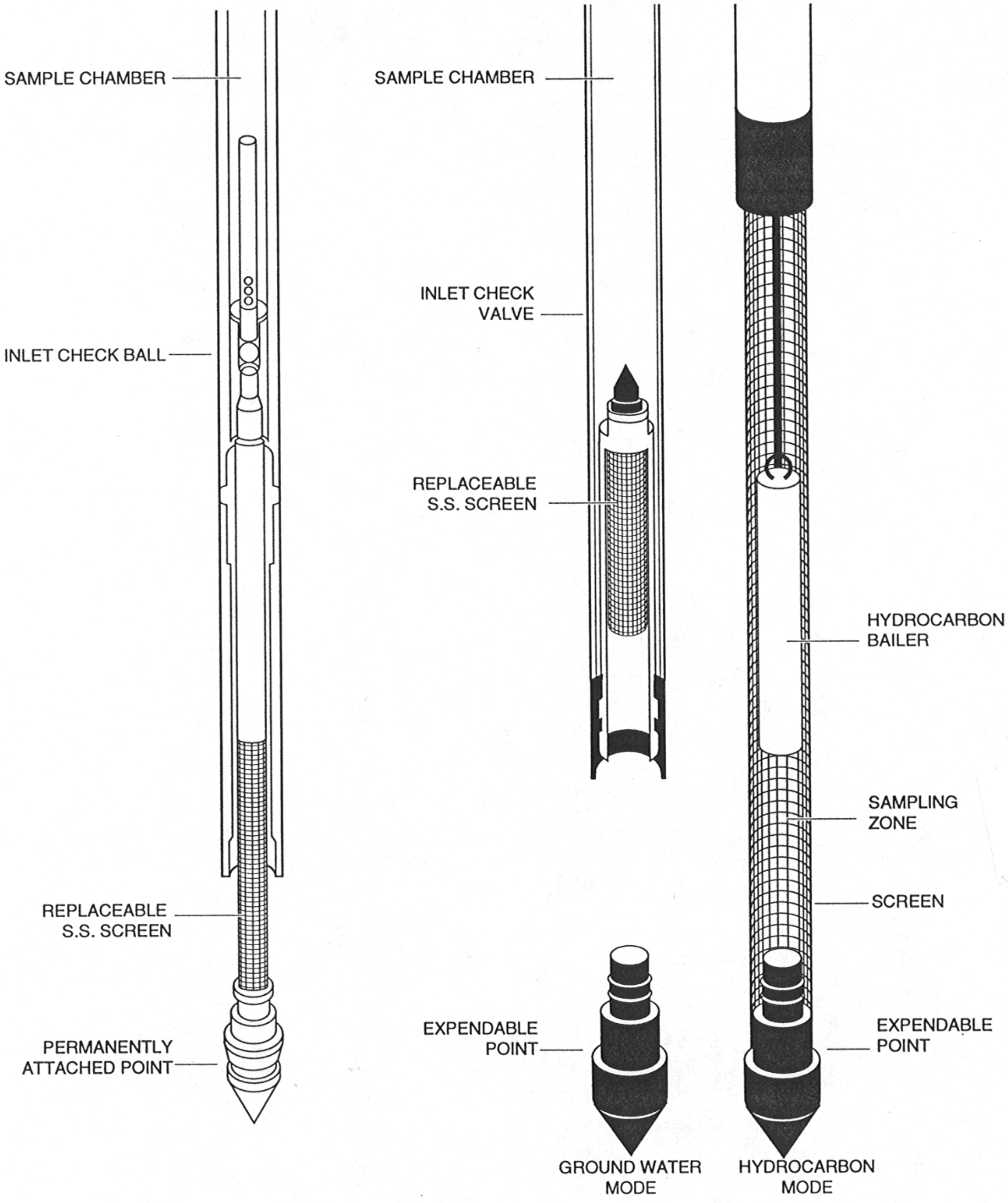
Enviro Probe: Closed Position

Enviro Probe: Open Position

Sample Collection Configuration

Geomatrix

HYDROPUNCH® I and II SCHEMATICS



HydroPunch® I

- Collects ground water samples only (not floating layer)
- Permanently-attached drive cone and screen (leaves nothing in the ground)
- Can be used with cone penetrometer or drill rig

HydroPunch® II

- Collects floating layer and ground water
- Replaceable cones and screens are left in ground (note: screens may be retrievable)
- Stronger for tough duty; used with drill ring

PROTOCOL

AQUIFER TESTING

1.0 INTRODUCTION

This protocol describes the procedures to be followed for conducting step-drawdown, constant discharge, and slug aquifer tests and specific capacity tests. The procedures presented herein are intended to be of general use and may be supplemented by a work plan and/or health and safety plan. As the work progresses and if warranted, appropriate revisions may be made by the project manager. Detailed procedures in the protocol may be superseded by applicable regulatory requirements.

A DAILY FIELD RECORD will be completed for each day of fieldwork. Weather conditions, proximity of surface water bodies, irrigation, or other observations that may affect results of the aquifer testing will be noted on the DAILY FIELD RECORD.

An AQUIFER TEST DATA FORM will be completed for each well observed during the test, during both drawdown and recovery phases. Alternatively, a data-logger may be used in each well, and the set-up parameters determined by the project hydrogeologist should be recorded on a form developed for this purpose. If a data-logger is used, data should be transferred to a computer as soon as possible after collection. As data is collected, it will be checked periodically in the field for accuracy and completeness.

During aquifer testing, care must be taken to contain or direct the discharged water to avoid recharge of the aquifer during the test. Water discharge from the aquifer will be collected and stored properly for future disposal by the client, unless other arrangements have been made.

2.0 STEP-DRAWDOWN TEST

The step-drawdown aquifer test is performed to estimate a maximum sustainable discharge rate for the pumping well. The pretest phase, conducted prior to the aquifer test, will consist of water level measurements taken in the pumped well and observation wells that are to be monitored throughout the duration of the test. The water level measurements will be taken using electric sounders or pressure transducers and a data logger, and will be recorded for the appropriate well.

The pumping phase of the step-drawdown test will consist of: (1) pumping the well at successively higher pumping rates (steps) specified by the responsible professional, with an approximate duration of two to four hours per step; (2) periodically and at similar times measuring the water levels in the pumped well and observation wells during each step; (3) measuring the instantaneous and cumulative discharge from the pumped well using a flow meter or other appropriate means; and (4) recording the time at which all measurements were taken.

The pumping rate for each step will be maintained relatively constant. The rate will be checked periodically (at least hourly) and adjusted if necessary. The accuracy of the flow meter also may be verified periodically using the sweep needle on the flow meter, if available, and a stopwatch. The accuracy of the flow meter will be checked using a container of known volume and a stopwatch.

The recovery phase of the step-drawdown test begins immediately after the pump is shut off at the completion of the final step of the pumping phase. Recovery water-level measurements will be made periodically in the pumped well and observation wells. Water level measurements will conclude when one of the following is satisfied: (1) the water level in the pumped well has recovered to pre-test level; (2) the water level in the pumped well has remained constant for at least 2 hours; or (3) 24 hours has elapsed since the time of pump shut-off.

3.0 CONSTANT DISCHARGE TEST

During the pretest phase, water level measurements will be taken in the pumped well and all observation wells that are to be monitored throughout the duration of the test. Water level measurements will be taken with electric sounders, pressure transducers with a data-logger, or a steel tape. All pretest water level measurements for the pumping well and observation wells will be recorded for the appropriate well.

3.1 PUMPING PHASE

During the pumping phase of the aquifer test, the following measurements will be made: (1) water levels in the pumped well and the observation wells; (2) instantaneous and cumulative discharge from the pumped well; and (3) time at which measurements are taken.

The duration of the pumping phase will be established prior to the start of the aquifer test. Time-drawdown curves for the observation wells may be plotted in the field on semi-logarithmic graph paper during the pumping phase to evaluate the progress of the test. If the plots indicate steady-state conditions in the aquifer, the test may be ended before its planned conclusion if approval is given by the responsible professional. Likewise, the pumping phase of the test may be extended at the discretion of the responsible professional.

The water levels in the pumped well and the observation wells will be measured simultaneously on a pre-determined time schedule. An example time schedule is outlined below.

Time Since Pump Started (min.)		Time Intervals Between Measurements (min.)
0-2		0.25
2-5		0.50
5-15		1
15-60		5
60-240	**(EXAMPLE)**	30
240-Conclusion		60

Discharge from the pumped well will be measured using a flow meter and a stopwatch or other appropriate methods. Accuracy of the flow meter may be verified periodically using the sweep needle, if available, and the stopwatch. Discharge will be maintained at a relatively constant rate. The discharge rate will be checked and adjusted (if necessary, at 10-minute intervals during the first hour of pumping and 1-hour intervals thereafter). Rate of discharge, cumulative gallons discharged, and time of measurement will be recorded.

3.2 ABORTED TEST

Failure of pumping operations (mechanical breakdown of generator, pump, etc.) for a period greater than 2 percent of the elapsed pumping time may require postponement of the test. The pumping phase of the test may be resumed when one of the following conditions has been reached: (1) the water level in the pumped well has recharged to within 5 percent of the pretest water level; or (2) the well has not been pumped for a period at least equal to the elapsed pumping time of the test before postponement.

3.3 RECOVERY PHASE

At completion of the pumping phase of the test, the pump will be shut off. In the recovery phase, water level measurements will be taken simultaneously in the pumped well and the observation wells immediately following pump shut-off according to a predetermined schedule. An example time schedule is presented below.

Time Since Pump Stopped (min.)		Time Intervals Between Measurements (min.)
0-2		0.25
2-5		0.50
5-15		1
15-60		5
60-240	**(EXAMPLE)**	30
240-Conclusion		60

Water level measurements will be concluded when one of the following conditions applies: (1) the water level in the pumped well has recovered to the pretest water level; (2) the water level in the pumped well has remained constant for at least 2 hours; or (3) 24 hours has elapsed from the time the pump was shut off.

4.0 SLUG TESTS

Slug tests involve a single well in which the response to an "instantaneous" raising or lowering of the water level is measured. Slug tests are generally of short duration, usually less than 5 minutes, with the first 30 seconds being most important. As such, measurement of water levels during the test should be measured using a pressure transducer and data logger. If the formation is relatively low yielding, the test period may be longer and manual measurement methods may be used.

During the pretest phase, the static water level is measured. Then a known volume of water is either bailed from or added to the well, or a weighted slug of known volume is lowered into or raised from the well. The water level is measured immediately after the slug or water is added or removed, and then the change in water level with time is measured in pre-determined increments. The water level measurements and time at which the measurements will be recorded.

5.0 SPECIFIC CAPACITY TESTS

A specific capacity test is a constant discharge-constant drawdown pumping test. The purpose of specific capacity testing is to determine the specific capacity (SC) of the pumping well and to estimate transmissivity (T) by using an established empirical relationship between SC and T (see Driscoll, 1986). These estimates can be used as a quick check on hydraulic parameters collected during long-term pumping tests or as a preliminary estimate of T when long-term pumping tests have not been performed.

The practical requirement of the field method is to achieve a stabilized drawdown in the pumping well at a constant pumping rate. The pumping rate should be low enough for the results to be indicative of aquifer properties and not overly influenced by losses due to well efficiency. The stabilized drawdown condition ("0.05 foot) should be achieved at a constant pumping rate for a duration of at least 30 minutes. Water levels are measured to the nearest 0.01 foot using an electric sounder or pressure transducer. Pumping rate is measured in gallons per minute (gpm). Cumulative gallons pumped should be recorded at the time water level measurements are taken. Time should be measured in seconds with a stopwatch. Pumping rate in gpm can be calculated after the test is completed. Static and pumping water levels, pumping rate and/or cumulative gallons removed, and time at which measurements were taken will be recorded.

6.0 REFERENCES

Driscoll, F.G., 1986, *Groundwater and Wells*, 2nd edition, Johnson Division.

Attachments: Daily Field Record
Aquifer Test Data Form

DAILY FIELD RECORD

Geomatrix

Page 1 of ___

Project and Task Number:	Date:
Project Name:	Field Activity:
Location:	Weather:

PERSONNEL: Name	**Company**	**Time In**	**Time Out**

PERSONAL SAFETY CHECKLIST

	Steel-toed Boots		Hard Hat		Tyvek Coveralls
	Rubber Gloves		Safety Goggles		1/2-Face Respirator

DRUM I.D.	**DESCRIPTION OF CONTENTS AND QUANTITY**	**LOCATION**

TIME	**DESCRIPTION OF WORK PERFORMED**

DAILY FIELD RECORD (continued)

Geomatrix

Page ____ of ____

Project and Task Number:

Date:

TIME	DESCRIPTION OF WORK PERFORMED

Geomatrix

AQUIFER TEST DATA

Page ______ of ______

Well No.: ____________ **Project Name:** ______________________ **Project No.:** ____________

Owner ______________________ Address ______________________ County ____________ State ______

Date ____________ Company Performing Test ______________________ Measured By ______________

Well No. ______________ Distance from Pumping Well ____________ Type of Test ______________ Test No. ______

Pumping Well _____ Observation Well _____ Measurement Equipment ______________________________

TIME DATA

Pump on: Date________ Time________ (t_0)

Pump off: Date________ Time________ (t'_0)

Duration of aquifer test:

Pumping ________ Recovery ________

WATER LEVEL DATA

Static Water Level ______________

Measuring Point ______________

Elevation of Measuring Point ______________

DISCHARGE DATA

How Q Measured ______________

Depth of Pump/Air Line ______________

Previous Pumping? Yes ______ No ______

Duration ________ End ________

Date	Clock Time	Time Since Pump Started t	Time Since Pump Stopped t'	t/t'	Water Level Measurement	Correction or Conversion	Water Level	Water Level Change s or s'	Discharge Measurement	Discharge Rate	Recorded By	COMMENTS ON FACTORS AFFECTING TEST DATA

PROTOCOL

SOIL VAPOR SAMPLING

1.0 INTRODUCTION

This protocol describes the procedures to be followed for soil vapor sampling associated with Soil Vapor Extraction (SVE) pilot tests, vapor extraction system operation, and soil gas surveys. Selected vapor samples may be submitted to a designated laboratory for chemical analysis. The laboratory must be certified by the appropriate regulating agency for the analyses they are to perform.

The procedures presented herein are intended to be of general use and may be supplemented by a work plan and/or health and safety plan. As the work progresses and if warranted, appropriate revisions may be made by the project manager. Detailed procedures in this protocol may be superseded by applicable regulatory requirements.

2.0 SAMPLING

2.1 SAMPLE COLLECTION

Soil vapor sampling is performed to evaluate the chemical composition of subsurface soil vapor. The well or probe to be sampled should be purged before sampling in order to obtain vapor that is representative of general subsurface conditions. If the sampling is being performed at vadose zone monitoring wells or probes that are not being operated as SVE wells, the well or probe should be purged and sampled as follows:

1. Connect a device that measures pressure/vacuum to the top of the well or probe to be sampled. A static pressure less than atmospheric indicates that air may have been flowing into the well or probe. Pressures greater than atmospheric indicate that soil vapor was probably venting or flowing out of the well or probe. Record the readings and time on a Field Data Sheet.

2. Connect the well or probe to be sampled to the extraction device. Purge at least enough vapor from the well to remove air from the sampling train and head space in the well, using estimated flow rates and volumes. The volume purged should be appropriate for the purpose of the testing and consistent in samples collected from the same site for the same purpose. Purged vapor should be routed through a treatment system, if necessary, to meet health and safety and/or discharge permit

requirements. Record pressure and, if available, vapor temperature and flow rates during the purging process.

3. Install a piece of new tubing compatible with the anticipated chemical compounds between the sample port on the well and the inlet of the sample chamber. When appropriate, the sampling end of the tubing should have a hydraulic quick-disconnect fitting attached. Attach the purging device/vacuum line to the tubing and purge the tube. Atmospheric air will not be allowed to enter the system upsteam of the sampling port. Disconnect the purging device. The hydraulic disconnect or suitable valve should seal the tube and prevent the introduction of fresh air to the sample line.

4. Connect the sample container (Tedlar bag, Summa canister, or sorbent tube) to the sample line. If using a Summa canister, open the valve and allow the canister to fill; you should be able to hear the canister fill. Close the Summa canister valve before disconnecting the tubing. Vacuum in the Summa cannister may be measured upon arrival at the laboratory. This pressure should be similar to the pressure measured during sampling. If using a Tedlar bag, place the bag in the sample chamber and connect it to the sample line with new tubing. Pump air from the sample chamber to fill the bag. Record pressure in the sampling train and, if available, vapor temperature and flow rates during the sampling process, if applicable. Care should be taken not to fill the Tedlar bag to capacity in order to protect the bag during shipment.

   If a sorbent tube is used, multiple tubes should be used in series to provide protection against saturation and breakthrough of a single tube during sampling. Measure flow rates at the beginning and end of sampling, at a minimum, and accurately record sample start and stop times. Sampling duration may be determined based on the anticipated analyte concentration range.

If sampling is being conducted on a well connected to an operating vapor extraction system, then proceed as above starting at Step 3. Stagnant portions in the piping used for sampling should be purged before sampling.

2.2 SAMPLE CONTAINERS

Appropriate sample containers (e.g., Tedlar bags, Summa canisters, or sorbent tubes) for the analyses to be performed will be obtained, precleaned or new, from the subcontracted analytical laboratory.

2.3 SAMPLE LABELING

Label sample containers before or immediately after sampling with a self-adhesive label or tag having the following information written in waterproof ink:

- Geomatrix
- Project number
- Sample ID number
- Date and time sample was collected
- Initials of sample collector

2.4 QUALITY CONTROL SAMPLES

In order to evaluate the precision and accuracy of analytical data, quality control samples such as duplicates, blanks, spikes, or site background samples may be included. These samples will be collected or prepared and analyzed by the laboratory as specified in the project Quality Assurance Project Plan (QAPP) or by the project manager.

2.5 HANDLING, STORAGE, AND TRANSPORTATION

Care must be taken to handle, store, and transport supplies and samples safely. Exposure to dust, direct sunlight, high temperature, or adverse weather conditions and possible contamination will be avoided. Samples collected in Tedlar bags should be stored in an opaque container to reduce the potential for photo chemical degradation. Therefore, immediately following collection, place Tedlar bag samples in a clean box or chest to protect them from damage and exposure to sunlight and transport them to the subcontracted laboratory as soon as possible, or in accordance with the project QAPP to meet holding time criteria.

3.0 DOCUMENTATION

3.1 FIELD DATA SHEETS

A DAILY FIELD RECORD will be completed for each day of fieldwork. Well operating conditions (vacuum or pressure, flow rate, temperature, PID reading, etc.) should be recorded, if possible, on the DAILY FIELD RECORD or another form created for this purpose. Sample identification and other information may be recorded on a SAMPLE CONTROL LOG or in the DAILY FIELD RECORD as a means of identifying and tracking the samples. Original field records will be kept in the project file, after review by the project manager.

3.2 CHAIN-OF-CUSTODY PROCEDURES

After samples have been collected and labeled, they will be maintained under chain-of-custody procedures. These procedures document the holding conditions and transfer of custody of samples from the field to the laboratory. Each sample sent to the laboratory for analysis will be recorded on a CHAIN-OF-CUSTODY RECORD, which will include instructions to the laboratory regarding the analytical services required.

Information contained on the triplicate CHAIN-OF-CUSTODY RECORD will include:

- Project number
- Signature of sampler
- Date and time sampled
- Sample I.D.
- Number of sample containers
- Sample matrix (vapor)
- Analyses required
- Remarks, including preservatives, special conditions, or specific quality control easures
- Turnaround time and person to receive laboratory report
- Release signature of sampler, and signatures of all people assuming custody
- Condition of samples when received by laboratory

Blank spaces on the CHAIN-OF-CUSTODY RECORD will be crossed out between last sample listed and signatures at the bottom of the sheet.

The field sampler will sign the CHAIN-OF-CUSTODY RECORD and will record the time and date at the time of transfer to the laboratory or an intermediate person. A set of signatures is required for each relinquished/received transfer, including transfer within Geomatrix. The original imprint of the CHAIN-OF-CUSTODY RECORD will accompany the sample containers. A duplicate copy will be retained by the field staff and placed in the Geomatrix project file.

If the samples are to be shipped to the laboratory, the original CHAIN-OF-CUSTODY relinquishing the samples will be sealed inside a plastic bag within the ice chest, and the chest will be sealed with custody tape which has been signed and dated by the last person listed on the chain-of-custody. U.S. Department of Transportation shipping requirements will be followed and the sample shipping receipt will be retained in the project files as part of the permanent chain-of-custody document. The shipping company (e.g., Federal Express, UPS, DHL) will not sign the chain-of-custody forms as a receiver; instead the laboratory will sign as a receiver when the samples are received.

Attachments: Daily Field Record
Chain-of-Custody Record
Sample Control Log Sheet

DAILY FIELD RECORD

Geomatrix

Page 1 of ___

Project and Task Number:	Date:
Project Name:	Field Activity:
Location:	Weather:

PERSONNEL: Name	**Company**	**Time In**	**Time Out**

PERSONAL SAFETY CHECKLIST

	Steel-toed Boots		Hard Hat		Tyvek Coveralls
	Rubber Gloves		Safety Goggles		1/2-Face Respirator

DRUM I.D.	**DESCRIPTION OF CONTENTS AND QUANTITY**	**LOCATION**

TIME	**DESCRIPTION OF WORK PERFORMED**

DAILY FIELD RECORD (continued)

Geomatrix

Page ____ of ____

Project and Task Number:	Date:

TIME	DESCRIPTION OF WORK PERFORMED

CHAIN-OF-CUSTODY RECORD

Nº

Date:

Page of

Project No.:

Samplers (Signatures):

			ANALYSES																		REMARKS				
Date	Time	Sample Number	EPA Method 8010	EPA Method 8020	EPA Method 8020 (BTEX only)	EPA Method 8240	EPA Method 8270	TPH as gasoline	TPH as diesel												Cooled	Soil (S), Water (W), or Vapor (V)	Acidified	Number of containers	Additional Comments

Turnaround time:

Results to:

Total No. of containers:

Relinquished by (signature):	Date:	Relinquished by (signature):	Date:	Relinquished by (signature):	Date:
Printed Name:	Time:	Printed Name:	Time:	Printed Name:	Time:
Company:		Company:		Company:	
Received by (signature):	Date:	Received by (signature):	Date:	Received by (signature):	Date:
Printed Name:	Time:	Printed Name:	Time:	Printed Name:	Time:
Company:		Company:		Company:	

Method of Shipment:

Laboratory Comments and Log No.:

Geomatrix

Forms(PF).012b (Revised 12/95)

SAMPLE CONTROL LOG

Geomatrix

Project Name: ________________________ **Laboratory:** ________________________

Project and Task No.: ________________________ Page ____ of ____

Sampling Date	Sampling Time	Sample Number (ID)	C.O.C. Number	Analyses Requested	Turnaround Time, Sample Location, Handling Notes, Chain-of-Custody Remarks, etc. (Duplicate, Blank info, etc.)	Date Sent to Lab	Date Results Due

\\sf3\deptdata\FORMS\ETC & ES\Sample Control Log Form.doc

APPENDIX C

ARI Environmental Laboratory Quality Assurance Manual

Analytical

Resources Inc.

Quality

Assurance

Plan

Analytical Resources Incorporated
Analytical Chemists and Consultants

Quality Assurance Plan

Analytical Resources, Inc.
4611 S. 134th Place, Suite 100
Tukwila, WA 98168-3240

Revision 12-010
1/4/08

Uncontrolled Copy

A web page is configured to inform you if this is the most recent version of ARI’s LQAP. Click on the link or type the URL into your web browser. No web access? Phone 206-695-6200

http://arilabs.com/cgi-bin/rcheck.cgi?f=LQAP&r=R12010

This Quality Assurance Plan is approved and authorized for release by:

Mark Weidner
Laboratory Director

David R Mitchell

David Mitchell
Quality Assurance Manager

Quality Assurance Plan

Analytical Resources Inc.

Table of Contents:

SECTION 1: INTRODUCTION

Quality Assurance Policy and Objectives

Analytical Resources, Inc. (ARI) is dedicated to providing accurate and reliable data in a timely and cost effective manner. The management of ARI is committed to analytical excellence and will provide the facilities and a professional environment to achieve this goal. The quality assurance program detailed in this document sets forth the policies and procedures that are followed by ARI to ensure that all reported results are both legally defensible and of the highest quality.

To ensure that data quality goals are achieved, the following characteristics must be considered:

Precision, Bias and Accuracy

For all analyses, there is a degree of uncertainty or error in the measurement process. This measurement error is generally one of two types: random error (precision) or systematic error (bias). Precision is a measure of agreement between replicate measurements. Bias is considered to be the difference between the expected value and the true value for a measurement or series of measurements. Accuracy is a determination of how closely a measurement is to the expected value. Both precision and bias are considered when determining the accuracy of measurements. Precision, bias and accuracy are evaluated through the use of method guidelines, and project and laboratory control limits.

Representativeness

Representativeness is an indicator of how closely one sample aliquot resembles another aliquot from the same bulk source or sample site. Sample representativeness is more easily obtained for particulate-free water samples than for solid samples or viscous liquids. Representativeness is an important consideration in achieving other data quality objectives.

Completeness

Completeness is an indicator of the number of valid (useable) data points compared with the overall number of data points obtained. Valid data are normally obtained when sample collection and analysis is performed in accordance with specified methods and procedures. Completeness is often expressed as a percentage: the higher the number of valid data points, the higher the overall completeness percentage. Conversely, fewer valid data points will result in an overall lower percentage of completeness. Project specifications will dictate the required level of completeness.

Comparability

Comparability is an indicator of how confidently one data set can be compared with another, as well as the consistency between data sets. Stable analytical conditions and adherence to standard procedures, combined with high levels of accuracy; help ensure that results obtained over a period of time will be comparable.

Timeliness

To ensure that the most accurate results possible are obtained, samples must be processed within specified time periods. Analytical holding times have been established to allow sufficient time for sample processing without compromising sample integrity. It is important that, while meeting timeliness requirements, other data quality objectives are still considered and met.

Documentation

Complete and accurate documentation is essential for verifying the integrity of analytical results. Achievement of other quality objectives cannot be used to substantiate data quality without full documentation of the analytical process. Documentation must be concise and readily available for subsequent review.

The quality assurance program at ARI has been developed to ensure that the specified data quality objectives are met for all reported results and the highest degree of completeness possible is achieved.

1.2 Ethics Policy on Data Quality and Confidentiality

To ensure that data quality or confidentiality is not compromised, ARI has established the following policy on corporate ethics. Following are steps that must be taken when the quality or confidentiality of data is suspected or known to be compromised. This policy applies to all ARI employees at every organizational level.

General

ARI's corporate commitment to integrity and honesty in the workplace is clearly stated in the ARI Employee's Handbook, under "Standards of Conduct". The Standards of Conduct statement is attached as Appendix O. The ARI commitment to excellence in data quality extends to and includes all aspects of data production, review and reporting.

Any attempt by management or any employee to compromise this commitment presents a case for serious disciplinary action. Any indications or allegations of waste, fraud or abuse will be rigorously investigated by ARI management, with the penalties for verified cases to be employment termination, and if appropriate, prosecution. In addition to these steps, any such charges related to data generated for the federal government will also be reported to the Inspector General of the appropriate department.

Circumstances

All ARI employees will immediately report to management any information concerning the misrepresentation or possible misrepresentation of analytical data (or any associated components).

Misrepresentation of data includes (but is not limited to) the following:

Altering an instrument, computer or clock to falsify time or output
Altering the content of a logbook or data sheet in order to misrepresent data
Falsifying analyst identity
Changing documents with correction fluid with the intent of falsifying information
Preparing or submitting counterfeit data packages or reports
Unauthorized release (either written or verbal) of confidential data
Illegal calibration techniques (peak shaving, fraudulent integrator parameters)
Any attempt to misrepresent data or events as they actually occur in the course of data production or reporting

Responsibilities

It is the responsibility of all ARI employees to report any situation which may be adverse to data quality or confidentiality, or which may impact the final data quality. All ARI employees have the obligation to discuss known or suspected violations of this policy with laboratory management, who in turn are obliged to inform the ARI Laboratory Manager. If a satisfactory resolution is not obtained or is not possible at laboratory level, all ARI employees have the right and responsibility to discuss the matter directly with the ARI Laboratory Manager.

It is the responsibility of the ARI Laboratory Manager to promptly investigate any reports of known or suspected violations. The ARI Laboratory Manager has the authority and responsibility to resolve all known or potential violations of the policy.

It is the responsibility of ARI management to provide all of its employees with the facilities, equipment, and training to achieve the quality goals stated in the policy. It is the responsibility of ARI to provide our clients with data of known and documented quality.

Documentation

To reaffirm an awareness of and commitment to the highest standards of data quality, excellence, and integrity, all employees are required to sign the following “Commitment to Excellence in Data Quality” statement:

“As an ARI employee, I have the right and responsibility to report any situation which may be adverse to quality or which may impact the final quality or integrity of data produced for our clients.”

“I will report immediately to management any information concerning the misrepresentation or possible misrepresentation of analytical data (or any of its associated components). Examples of this include (but are not limited to): alteration of an instrument computer or clock, alteration of the contents of logbooks and/or data sheets in order to misrepresent data, misrepresentation of analyst identity, intentional falsification of documents with correction fluid (“white-out”), preparation and submittal of counterfeit data packages, use of illegal calibration techniques (peak shaving, use of fraudulent integrator parameters, etc.), or any attempt to misrepresent data or events as they actually occur in the course of an analysis.”

“I will likewise alert management of any situation or activity which may be adverse to the confidentiality of clients’ data.”

“I will not knowingly participate in any such activity, nor fail to report such activities of which I may become aware. I understand that any voluntary participation on my part in such activities may result in the termination of my employment, and possible legal prosecution.”

“Where circumstances permit, I will report any actual or suspected violations of this policy to my lab or section supervisor. If a satisfactory resolution is not obtained or is not possible at that level, I have the right and obligation to discuss the matter directly with the ARI Laboratory Manager.”

Confidentiality

All information related to client projects, such as client work plans, documentation and analytical data will be considered confidential. This information will be released only to the client or an authorized representative. Should an outside agency request information related to a client project, the client will be contacted for approval prior to releasing any information.

Some programs or contractual agreements (such as the USEPA Contract Laboratory Program) may have specific requirements for protecting a client's confidentiality Project Managers will be responsible for strict control of access to any such confidential information or documentation. All data generated from the analysis of confidential samples will also be considered confidential.

SECTION 2.0: QA MANAGEMENT AND RESPONSIBILITIES

The principal tenet of the Quality Assurance Program at Analytical Resources Inc. (ARI) is that every employee knows she/he is a vital component of the program, and holds a responsibility to produce high-quality, defensible data in a timely manner. While production of quality data is a global philosophy, held by the entire laboratory, each section is responsible for ensuring that the data produced within that section meets the required quality objectives.

2.1 Overall Structure

The Board of Directors shall direct ARI′s QA Policy and shall determine the Philosophy of the QA Program. It shall be the responsibility of the Laboratory Director to translate this policy into practical procedures with respect to the business plan developed for ARI, and direct the Laboratory Manager and Section Managers regarding the incorporation of these procedures into daily laboratory activities.

The Laboratory Manager is responsible for coordination of laboratory activities to result in an integrated approach to quality data production. The Laboratory Manager will coordinate Client Services, Laboratory Section Management, Computer Services, and Data Services to ensure that project requirements and data quality objectives are met.

The Laboratory Section Managers and Supervisors shall hold the final authority in decisions concerning implementation of QA policy, with the contributions of the Laboratory Director, Laboratory Manager, QA Manager and Project Managers. Section Managers and Section Supervisors shall instruct employees in the proper employment of QA policies.

Each Section Supervisor will ensure that analyses are completed within required holding times, that data is submitted within required submission times, and all analyses are performed according to the current Standard Operating Procedures (SOPs). They will ensure that any client modifications or QA issues are well documented for each sample set and that all required documents are complete when submitted with each data set.

The analytical staff shall execute all methods following QA policies, and will write SOPs reflecting the methods exactly as performed. These SOPs will be reviewed for compliance by

Section Managers and the Laboratory Director, and once approved will be submitted to the Quality Assurance Program Manager (QAPM).

The QAPM will be responsible for controlling Company SOPs and other internal documents, overseeing the scheduling and completion of detection limit studies. The QAPM will coordinate the production of control charts and distribution of control limit data to all laboratory sections. The QAPM will administer the blind QA proficiency tests and performance samples as described in the QA Program. The QAPM will verify that QA policies and procedures are followed through out ARI.

Data reviewers will be responsible for ensuring that all samples have been analyzed by the approved and requested methods, that data calculations are performed correctly, and that analyses meet the Data Quality Objectives of the client. They shall also be responsible for ensuring that the documentation from each laboratory section is intact and complete.

Computer Services is responsible for ensuring that the Laboratory Information Management System (LIMS) correctly reflects the preparations and analyses performed and that the LIMS is updated with the current SOP, MDL, RL and QL data as submitted from the QAPM. Computer Services personnel are also responsible for ensuring that all electronic deliverables for clients are formatted correctly as requested by the Project Managers and that this data matches the hardcopy deliverables submitted.

Client Services (Project Management, Sample Receiving), shall be responsible for ensuring that the laboratories understand and can meet project specific analytical requirements and DQO.

2.2 Hierarchical Responsibilities

<u>Technical Director</u>

> *It shall be the responsibility of the Laboratory Director to translate QA policy into practical procedures with respect to ARI´s business plan, and to direct the Laboratory Manager and Section Managers in the implementation of these procedures in daily laboratory activities.*

The Director shall interpret overall QA Policy, and determine the broad practicality of policies based on methodologies, technological advances, and the current environmental market. It shall be the interpretation of these policies that will, in turn, direct the growth ARI, the addition or withdrawal of methods to ARI′s repertoire, and ARI′s marketing focus.

At a minimum of once a year the Technical Director shall include on the agenda of the Board of Directors meeting a discussion of ARI′s QA Policy. This discussion will include the reputation of ARI for producing quality analyses, the affect of QA policies on turn-around time, competitive edge and cost-of-analysis, needs for stricter or more flexible policies, and the response of employees to the QA policies in place at that time.

At a minimum of once every six the Director shall attend management meetings, which include on the agenda the subject 'QA Program'. This format will allow for the dissemination of information on any QA issues addressed in the laboratory or by the Board of Directors. Management shall also use these meetings to discuss requirements of clients that are not met by ARI′s present QA Program, and the appropriate response to these requirements.

The Technical Director may be required to act as a technical advisor at any impromptu meetings called by management to address QA issues that cannot be immediately resolved within a laboratory section.

It shall also be the Director's authority and responsibility to hold final review approval for all SOPs of ARI. Once an SOP has been updated and reviewed by the laboratory section, it shall go through the Section and Laboratory Managers for approval, and then to the Laboratory Director for final approval before the SOP is released.

Laboratory Manager

> *The Laboratory Manager is responsible for coordination of laboratory activities to result in an integrated approach to quality data production. It shall be the Laboratory Manager's responsibility to coordinate Client Services, Laboratory Management, Computer Services, and Data Services to ensure that QA Program requirements and data quality objectives are met.*

The Laboratory Manager is required to attend all management meetings, at which the QA Program will be an agenda item. Management shall use these meetings to discuss requirements of clients that are not met by ARI′s present QA Program, the appropriate response to these requirements, and dissemination of information on any QA issues addressed in the laboratory or by the Board of Directors.

It is the responsibility of the Laboratory Manager, along with the QA Manager, Laboratory Director, Section Managers and Client Services, to determine in which QA Proficiency Programs the Laboratory will participate, and those accreditations that ARI will pursue. It is the responsibility of the Laboratory Manager, with the Section Managers, to ensure that all laboratory sections perform the tasks required by the QA Manager to pursue each accreditation or to complete a scheduled audit.

The Laboratory Manager has the authority to direct Client Services to discontinue the bidding/contracting process for a new project, refuse samples, or to re-schedule projects based on Data Quality Objectives or current workload. The Laboratory Manager also shall evaluate staffing and equipment needs based on information from the Section Managers and Client Services and may elect to meet new project requirements by increasing staffing levels or purchasing additional equipment.

The Laboratory Manager serves as a senior-level technical reference for all laboratory activities, and as such will be brought in to advise on out-of-control events and trends, corrective actions, and/or other QA issues that require his/her expertise.

Laboratory Section Managers

> *The Section Managers shall hold the final authority in decisions concerning implementation of QA policy, with the contributions of the Laboratory Director, Laboratory Manager, QAPM and Project Managers. Section Managers are responsible for correcting out of control events within their respective laboratories. Section Managers and supervisors shall instruct employees in the proper employment of QA Policies.*

Laboratory Sections Managers shall have the final authority in decisions concerning QA policy. It is their expertise that will determine the final acceptable format of each method SOP, as they are the best resource to integrate methods into ARI′s philosophy.

Laboratory Section Managers are responsible for completing or delegating updates of laboratory procedures and quality assurance manual sections as scheduled by the QA Manager.

The Section Managers are best able to determine capacity of the Laboratory Sections. To ensure that analyses are completed within required hold times, the Section Managers will give

Supervisors the authority to balance employee workloads and modify employee work schedules. It is the Section Manager's responsibility to take reports from supervisors and work with the Laboratory Manager to increase staffing levels or reject samples as needed. It is the Section Manager's responsibility to work with the Laboratory Manager and the section supervisor and analysts to ensure that sample capacity does not affect the quality of data generated from that laboratory section.

It is the responsibility of the Laboratory Section Managers, along with the QA Manager, Laboratory Director, Laboratory Manager and Client Services, to determine in which QA Proficiency Programs the Laboratory will participate, and which accreditation processes ARI will pursue. It is the responsibility of the Section Managers, with the Section Supervisors, to ensure that all laboratory sections perform the tasks required by the QA Manager to pursue each accreditation or to complete a scheduled audit.

The Section Manager will be responsible for reviewing training records of analysts produced by the Section Supervisor. Training shall be the responsibility of the Section Supervisor, but it is the responsibility of the Section Manager to oversee this training.

It is the Section Managers' responsibility to work with the Section Supervisor and Project Manager to assure that Project Requirements are achievable and valid for the given methods. At times, ARI′s clients have requests or requirements for methods that are 1) not the method of choice in the laboratory, 2) not presently performed by the laboratory, or 3) unachievable by the instrumentation used in the laboratory. It is the responsibility of the Section Supervisor, Section Manager and Project Manager to work with the client to resolve these issues before samples are accepted.

Clients may also request modifications to the methods that must be approved by the Section Supervisor, the Section Manager and the QAPM. These modifications must be thoroughly documented and all pertinent information on modifications must be conveyed to the analysts, sample preparation sections, sample receiving, and computer services, as needed for implementation.

The Section Manager is responsible for resolution of out-of-control events that have not or cannot be resolved by the analysts or Section Supervisor.

The Section Manager has the authority to re-classify analysts or require additional training of analysts based on their performance.

The Section Manager has the responsibility of balancing client requests and requirements with the QA policies of ARI. It is the Section Manager's task to evaluate a client's Data Quality Objectives (submitted through Client Services), and with the Project Managers, Laboratory Supervisors and Quality Assurance Manager to determine the feasibility of laboratory performance. Feasibility will be based on the quality objectives requested, current QA Manual, present workload (in-house and scheduled/pending), the technology in place, and staffing levels available. Current workload in-house will be evaluated using reports from Computer Services, and scheduled/pending workload will be evaluated using written and verbal input from Client Services.

Section Supervisors

> *It is the responsibility of each section Supervisor to ensure that analyses are completed following the most current version of ARI's SOP, within required holding and turn around times, and assure that analyses meet the Data Quality Objectives of each project. They will ensure that any client modifications or QA issues are well documented for each sample set, and that all documentation is complete when submitted with each data set.*

To ensure that analyses are completed within required hold times, the Supervisors have the authority to balance employee workloads and modify employee work schedules. The Section Supervisors, with the input of the Section Manager, have the authority to request overtime from employees should the workload warrant the additional effort, or to modify employee schedules to extend the operating hours of the laboratory section.

The Section Supervisors shall oversee the day-to-day section operations, using LIMS printouts and verbal or written workload estimates and requests from Project Managers to adjust section efforts as needed. It is also the Section Supervisors' responsibility to inform management (Section Manager, Data Review, and Project Managers), when capacities are limited, so that the appropriate adjustments can be made to reduce workloads or increase laboratory capacities. At no time should sample capacity be allowed to affect the quality of data generated from any laboratory section.

It is the Section Supervisor's responsibility to assure that employees have the proper training for their positions. This training will include training in the methods, use of the LIMS system if applicable, training in correct documentation procedures, and all information necessary for adherence to the ARI QA Program. The Supervisor shall either perform the training personally, or designate the trainer for given methods or procedures. It is the Supervisor's responsibility to test each employee for each method or procedure, and to thoroughly document each employee's advances and current capabilities. The Supervisor shall have the authority to require further training or supervision for any employee, and shall be the authority to approve each employee for working without supervision. There will be a training record for each employee. These will be kept in the laboratory section; copies will be submitted to the QA Manager for record keeping.

It is the Supervisor's responsibility to work with the Section Manager and Project Manager to ensure that Project Requirements are achievable and valid for the given methods. At times clients have requests and/or requirements for methods that are 1) not the method of choice in the laboratory, 2) not presently part of the method as performed by the laboratory, or 3) unachievable by the instruments used in the laboratory. It is the responsibility of the Supervisor, Section Manager and Project Manager to work with the client to resolve these issues before samples are accepted.

It is the responsibility of the Section Supervisor to ensure that each analyst reads and understands all requirements submitted with each sample set, including those for any special analyte, calibration, or data deliverable. It is the Section Supervisor’s responsibility to clarify any issues, with the input of the Section Manager and the Project Manager for the client.

Clients also at times will request modifications to methods, which must be approved by the Supervisor and Section Manager. These modifications must be thoroughly documented and all pertinent information on modifications must be conveyed to the analysts, sample preparation sections, sample receiving, and computer services as needed for implementation.

It is the Supervisor's responsibility to ensure that each employee understands the requirements of all projects they work with. This may necessitate section meetings or project-specific cross-section teams to work with Project Managers for large, specialty projects to ensure that everyone has the same understanding of project requirements.

The Supervisor is responsible for resolution of out-of-control events that have not or cannot be resolved by the analysts, and for ensuring that the analysts complete all documentation. If the Supervisor and laboratory section analysts cannot resolve the issues in a timely manner, the Supervisor's will request the assistance of laboratory management to bring the section into compliance. The Supervisor will also inform Project Management and his/her Section Manager of possible delays, and inform Data Review of possible time constraints they may face in preparation of data submissions from the lab section.

The Section Supervisors shall have the authority, usually in consultation with Laboratory or Project Management to use professional judgment in requiring samples be re-prepared, and shall determine which analysts have the authority to require re-preparation of samples.

It is the responsibility of the Section Supervisor to inform the QAPM, Section Manager and the Computer Services section of any changes in methodologies that will require revision of SOPs, MDLs, Control Limits or the LIMS programming. This includes changes in spiking compounds, spiking levels, preparation methods and analytical methods.

Analysts

> *The analytical staff shall execute all methods following QA Policies, and will write SOPs reflecting the methods exactly as performed. These SOPs will be reviewed for compliance by Section Managers, the Laboratory Manager, and the Laboratory Director, and once approved will be submitted to the QA Manager.*

The analysts are responsible for following the current SOPs (with project-specific modifications if required) in preparing and analyzing client samples and quality control samples to meet the project specific Data Quality Objectives. It is the analyst’s responsibility to ensure that he/she understands all requirements of a project before proceeding with sample preparation or analysis.

Analysts are responsible for working with the Supervisor to ensure that all sample preparations and analyses are performed within required holding times and required turn-around times, and that all documentation is completed in a timely fashion. It is each analyst’s responsibility to bring any recurrent or anticipated problems to the attention of laboratory management.

It is each analyst's responsibility to correct his/her own errors, to document corrective actions thoroughly, to perform peer review, and to ensure that fellow employees within the section follow documentation procedures.

The Section Supervisor may give lead analysts responsibility for training and evaluation of new staff members. This training will include instruction in the methods, use of the LIMS system if applicable, correct documentation procedures, and all information necessary for adherence to the ARI QA Program. Analysts will be responsible for maintaining all instruments and equipment in optimum operating condition and documenting this maintenance as required by the QA Program.

It is the responsibility of each analyst to request the assistance of Supervisors or Managers in resolving out-of-control situations that cannot be corrected in a timely manner, and to perform the documentation of all corrective action activities.

Quality Assurance Program Manager (QAPM)

> *The QAPM will be responsible for controlling Company SOPs and other internal documents. The QAPM will oversee the scheduling and completion of detection limit studies and control charts. The QAPM will administer the training program, analyst's proficiency documentation and performance evaluation analyses as described in the QA Program. The QAPM will verify that QA policies and procedures are followed at all levels in the Company. The QAPM will produce a "Quality Assurance report to Management" each calendar year.*

The QAPM is responsible for the oversight of the QA Program as defined by the Board of Directors and interpreted by the Laboratory Director and Laboratory Managers.

Part of this oversight will be monitoring of the QA Program through submission of performance evaluation samples, blind QA samples and double-blind QA samples. It is the responsibility of the QAPM, along with the Laboratory Manager, Laboratory Director, Section Managers and Client Services, to determine in which QA Proficiency Programs the Laboratory will participate. The QAPM will be responsible for submitting these samples to the laboratory for analysis, overseeing submission of the results to the appropriate agencies, and for control of documented proficiency results.

The QAPM will be responsible for scheduling laboratory section SOP and procedural reviews and revisions, and section updates of the Quality Assurance Manual. It is the responsibility of the QAPM to work with each Section Manager to attempt to stagger these review schedules across the year within each laboratory section. The QAPM will also be responsible for maintaining document control of all SOPs, bench sheets, logbooks, and other forms used within the laboratory.

All laboratory sections, on an annual basis, will perform detection limit studies for each method used within each section. It is the responsibility of the QAPM to schedule, review, compile, and distribute the results of these studies.

The QAPM is responsible for evaluation of the laboratories' adherence to defined protocols through periodic audits of completed projects and of the laboratory facilities. Following the audit schedule (Appendix K), the QA Manager will perform the scheduled audit and prepare an evaluation that will be submitted to the Board of Directors in the Annual QA Report to Management.

The QAPM will be responsible for evaluation of outside accreditation requested by Client Services. The QA Manager will deliberate with the Laboratory Managers and Laboratory Director on the feasibility of pursuing accreditation based on the scope of the accreditation, the effort required to pursue accreditation and the scope of work that might become available once the accreditation is obtained. If a decision is made to pursue an accreditation, it is the responsibility of the QAPM to coordinate laboratory efforts towards the accreditation.

The QAPM will produce an annual "Quality Assurance Report to Management" to be distributed to ARI management personnel as described in Section 13 of this LQAP.

The QAPM will serve as a resource for quality-related issues for all Laboratory Sections, and will serve management in an advisory capacity.

The QAPM will have documented training in elementary statistics and Quality Systems theory.

Data Reviewers

> *Data reviewers will be responsible for ensuring that all samples have been analyzed by the approved and requested methods, that data calculations are performed correctly, and that analyses meet the Data Quality Objectives of the client. They shall also be responsible for ensuring that the documentation from each laboratory section is intact and complete.*

Data reviewers shall ensure that all samples are analyzed according to approved methods by reviewing the data released by each laboratory section. The data will be evaluated for compliance with all Data Quality Objectives as defined in the method SOP or in the project-specific quality assurance plan, including instrument tuning and calibration, holding time, spiking level, and spiking recovery criteria. Data reviewers will also verify 100% of manual calculations, spot check computer calculations, check electronic data for correct sample matching, and do a 100% check on any manually entered data. Analytical parameters, which have concentration interdependence, will be evaluated in relationship to each other.

Final reports generated will be evaluated to ensure that laboratories are using the current detection limit/reporting limit values and the current control limits. Data will be checked to ensure that all QA issues are addressed and fully documented. Reviewers are responsible for working with Laboratory Supervisors, Laboratory Managers and Project Managers when out-of-control events are incompletely documented, or if data is found to not meet Data Quality Objectives of a project without documentation.

It is the responsibility of data reviewers to work with Computer Services to ensure that the LIMS is updated to the current limits and methods used within the laboratory.

Computer Services

> *Computer Services is responsible for ensuring that the LIMS correctly reflects the preparations and analyses performed and that the LIMS is updated to include the current SOP, MDL, RL and QL data, as submitted by the QA Manager. Computer Services personnel are also responsible for ensuring that all electronic deliverables for clients are formatted correctly as requested by the Project Managers and that electronic data matches the hardcopy deliverables submitted.*

It is the responsibility of the Computer Services Manager to update, or to designate the task of updating, the LIMS as determined by Laboratory Management, including adjustment to current MDL/RL data, additions of analytes to methods, changes in method designations or changes in calculations for methodologies.

Computer Services will be responsible for generating the work list scripts required to allow analysts to enter data into the LIMS, and for generating the report scripts that produce final hardcopy or electronic reports for clients.

Computer Services Management and personnel are also responsible for generation and review of electronic data deliverables (EDD), as requested by clients through Project Management. Computer Services personnel will review the EDD for compliance with the Software Quality Assurance SOP before it is released to the client.

Computer Services will be responsible for informing laboratory Section Managers and Project Managers of any discrepancies found between the EDD and the hardcopy, and for following up on corrections to hardcopy and EDD as required.

Client Services

> *Client Services (CS) (Project Managers, Sample Receiving, and Sales Management) personnel are the primary interface between ARI's clients and the laboratory sections. CS staff shall be responsible, with the assistance of the Section Managers and Supervisors, for ensuring that the laboratories understand and can meet the Data Quality Goals and Requirements of each Project before committing laboratory services to the project. CS will monitor the quality of sample processing after they are received.*

Client Services Management and Project Managers shall ensure that the laboratories can meet the data quality objectives for a project. The Project Managers are responsible for knowing the capabilities of the laboratory, in order to develop project proposals or accept samples without consultation with laboratory management. It is the responsibility of Client Services to consult with the Laboratory Manager and Section Managers, or supervisors designated by Management, when data quality goals are not included in standard Company policies. Clients may, at times, request modifications to methods that must be approved by the Supervisor and Section Manager. These modifications must be thoroughly documented and all pertinent information on modifications must be conveyed to the analysts, sample preparation sections, sample receiving, and computer services as needed for verification of feasibility. Laboratory Management may determine that a project should not be pursued based on the specific Data Quality Objectives and on current or projected laboratory capacity.

Project Managers shall be responsible for ensuring that project requirements and analytical requests are submitted correctly to all laboratory sections. Once samples have been logged into the laboratory, it is the responsibility of the Project Managers to ensure that all information is available to the laboratories concerning the Data Quality Objectives and deliverables requirements. It is also the responsibility of the Project Managers to convey changes in client requirements to the laboratories and ensure that all paperwork reflects the changes if necessary.

It is the responsibility of Project Managers and Client Services Management to assure that specific EDD formats are submitted to Computer Services and approved as feasible before contracting with a client to provide the EDD.

It is the responsibility of Project Managers to notify clients of out-of-control events, “problem” samples, or anticipated turn-around time delays, as conveyed to them by Laboratory Management. It is also the responsibility of Project Management to work with Laboratory Management in setting priorities during times of heavy sample workloads.

Project Managers shall be responsible for coordinating data submissions and compiling hardcopy data for final submission to the client. This involves conducting a fourth level data review, from which any data which is found to contain errors that were not found earlier in the review process is returned to the Data Reviewer for correction and/or corrective action. The Project Manager will be responsible for compiling all analyst notes into a project narrative. This will include discussion of any sample receipt discrepancies, sample preparation and analysis difficulties or non-compliance, and any corrective actions that may have been required during processing. It will also discuss quality control analyses and results if applicable to the sample set.

Project Managers shall work with Laboratory Management in determination of the direction of growth for ARI, as the Project Managers are best able to define the analytical needs of clients based on new technologies and new environmental regulations.

SECTION 3: PERSONNEL QUALIFICATIONS AND TRAINING

The production of quality analytical data is dependent upon a laboratory staff with qualifications and training necessary to perform assigned tasks. All personnel employed by ARI will receive adequate training and instruction specific to their responsibilities. Prior to assigning a staff member full responsibility for performing a laboratory procedure, her/his skills will be evaluated and verified acceptable. It is the obligation of ARI′s supervisors and managers to ensure that personnel are qualified to successfully perform all assigned duties.

ARI′s training program is described in SOP 1017S (*Training and Demonstration of Proficiency*). The procedures described in this SOP assure that all ARI employees are proficient at the tasks required to produce quality analytical data. The SOP also provides for periodic review of each employees training and proficiency status, which may indicate any need for additional or remedial training. All training and review procedures are documented as described in the SOP. Appendix B of this document includes specific requirements of the training program and examples of the forms used to document training.

Basic elements of ARI′s training program are:

1. All employees are required to read and document their knowledge of non-technical documents that describe general policies in place at ARI. These documents include ARI′s *Employee Manual* and ARI′s *Chemical Hygiene Plan*.

2. All employees are required to read and document their knowledge of ARI′s *Laboratory Quality Assurance Plan* and quality assurance policies.

3. All new employees must attend a Quality Assurance Orientation during which ARI′s general and specific requirements for the production of quality analytical data are emphasized. A typical orientation agenda is included in Appendix B.

4. All new employees will attend a Technical Orientation conducted by their laboratory supervisor or manager. The technical orientation is used to provide specific information about laboratory operation to the employee and to assess the new employee’s education

and skill level. The section supervisor or manager is responsible for determining the level of training necessary for each staff member.

5. All employees will complete an ‘on the job’ training program designated by their supervisor. The training program will be laboratory, SOP and employee specific. Training programs follow the general outline provided in Appendix B. The training is incremental with each step documented in an employee Training File. While an analyst is in the training period, her/his supervisor or trainer must approve all analytical work. Upon completion of the training program the employee is considered proficient and may perform without supervision the SOPs listed in the training program.
6. The proficiency of each employee performing a given laboratory SOP will be continually monitored and documented as described SOP 1017S. An employee must continually generate data that meets all of ARI’s published acceptance criteria for a given SOP to be considered proficient. Unacceptable results or insufficient number of analyses performed in a calendar quarter will result in revocation of proficiency. This will result in a remedial training program.
7. Periodically, as described in SOP 1017S, internal and/or external Performance Evaluation (PE) samples will be used to document staff competency. Technicians and analysts will participate in the preparation and analysis of blind samples for all methods they routinely perform. Results of these blind samples will be evaluated to verify staff proficiency. Staff members associated with acceptable performance evaluation samples will be considered proficient for those methods. Conversely, unacceptable performance evaluation sample results may signal the need for additional or remedial training.
8. A training file is established for each technical employee. The file will document an employee′s experience, training and proficiency. The training file will document each specific PE sample analysis performed by an analyst. Either an employee′s supervisor or Quality Assurance Program personnel will update the training file. The training file will be maintained in the employee′s laboratory as outlined in SOP 1017S.

SECTION 4: FACILITIES AND EQUIPMENT

4.1 Facilities

ARI′s facilities have been designed to allow for efficient sample processing and analysis while maintaining consideration for the health and safety of the staff. The facility accommodates the following operations:

Sample receipt and storage
Sample container preparation and shipment
Sample preparation and analysis (organic and inorganic)
Project planning and management
Quality assurance
Data review and report generation
Computer programming and operations
Records storage
Instrument spare parts storage
Short-term hazardous waste storage

A detailed description of ARI′s facilities is included as Appendix C.

4.2 Security

Facilities

To ensure that security at ARI is maintained, access to the facilities is limited to employees and escorted visitors. Upon arrival, ARI visitors are required to register at the reception desk, and must sign out prior to leaving. Visitors will be escorted at all times. A receptionist constantly monitors the main entrance. Other laboratory entrances remain closed at all times and can only be opened from the outside by key. Key access to the facility is controlled; keys are issued on a limited basis depending on access needs.

As a result of controlled access and a monitored alarm system, the entire facility is considered a secure area. This eliminates the need for locked sample storage refrigerators, data storage areas or file cabinets.

Data Access

The Computer Services Manager controls security of, and access to, electronic data on the LIMS. Security measures are required to ensure data integrity, but must not be so restrictive as to prevent data accessibility. The security measures taken at ARI are to prevent intentional intrusion by outside parties. These measures include building security, limited computer system access, password systems, encryption, firewalls and the use of virus protection programs. ARI′s Intranet is protected from outside tampering by a proxy server (firewall) connection to the Internet.

LIMS - System Security

Building/Computer Room Security

Access to the building is restricted to employees, vendors with security passes, and escorted visitors. Room 203 contains the computer and main console for the LIMS system. This room is closed and locked at all times. Access to this room is limited to Computer Services personnel, escorted repair technicians, and escorted visitors. Only Computer Services personnel will be allowed access to the main console.

System Password Policy

User name and password restrict access to the LIMS computer. Remote access to the LIMS server is not allowed.

Database Access Restrictions

Interaction with the database is menu-controlled and allows the LIMS Manager to restrict access. Technicians may be given the ability to fill a limited number of work lists, with no authorization to distribute data. Some users may be given “read only” access to the database.

Users will be given access to the database only to complete tasks for those analyses for which they are responsible. No users are to be given access to the shell or command prompt unless 1) they have completed the appropriate training and 2) administrative access to the computer systems is required by their job function

4.3 Safety

Ensuring that all sample processing and analysis procedures are performed under safe conditions is an important consideration at ARI. While safety is the responsibility of all staff members, ARI′s Safety Committee meets monthly to review the safety activities of all laboratory sections and to ensure that all operations and equipment meet safety criteria. *The*

Chemical Hygiene Plan details those safety procedures and requirements that must be followed at ARI. *The Chemical Hygiene Plan* is reviewed annually and updated as needed to incorporate any changes to ARI′s safety program.

4.4 Instrumentation and Support Equipment

4.4.1 Instrumentation

Generation of quality data is dependent upon instrumentation and support equipment that is in optimum operating condition. All instrumentation and support equipment will be optimally maintained following method requirements and/or manufacturer's recommendations. Preventative maintenance is performed on a scheduled basis, with more frequent maintenance during periods of increased sample load or after analysis of highly contaminated samples. Separate, permanently bound logbooks are provided for and kept at or near each instrument. The logbooks are used to record all instrument maintenance, routine and non-routine. When non-routine maintenance is required the following information must be recorded:

1. A statement of the problem or symptom that requires correction.
2. Details of the maintenance procedure including listing the parts repaired or replaced.
3. Documentation that the instrument has returned to routine performance.

Spare parts are kept on hand when possible; necessary parts are ordered on an expedited basis to minimize downtime.

Currently available Laboratory Instrumentation is detailed in Appendix C.

4.4.2 Support Equipment

4.4.2.1 Thermometers in use at ARI are traceable to an NIST standard and are calibrated or verified annually. The procedures are described in SOP 1020S. When appropriate, thermometers are assigned a correction factor based upon the most recent calibration. ARI personnel must calculate and record corrected temperatures.

4.4.2.2 Water Bath temperatures are recorded before each use to assure the temperature is acceptable for its intended use.

4.4.2.3 Incubator temperatures (corrected) are recorded and at least twice a day while in use. The date and time of each observation is recorded.

4.4.2.3 Oven temperatures are recorded before and after each use.

4.4.2.4 Refrigerator and Freezer temperatures are recorded automatically every 30 minutes by ARI’s “ThermoLogger” computer system. The temperature of several refrigerators and freezers not conneted to “Thermologger” are recorded daily.

4.4.2.4 Balance accuracy is verified daily prior to use with two Class S weights that bracket the normal weighting range of the balance. A balance must be accurate to ±0.1% or ±0.5 mg whichever is smaller. All analytical balances are professionally cleaned and calibrated annually by an outside contractor. Class S weights are calibrated every five years by an outside contractor. Calibration reports are filed in the QA Office.

4.4.2.5 pH Meters are standardized prior to each use with at least two standards, one at 4.0 and one at 7.0 pH units. The meters are checked prior to each use with a pH 7.0 buffer.

4.4.2.6 Variable Volume Pipette accuracy is verified monthly following the procedure in SOP 1015S.

4.4.2.7 Sample Containers – Upon client request ARI supplies containers for collection of field samples. All containers supplied for organic and trace metals analyses are certified pre-cleaned by the manufacturer. When the maufacturer’s certified concentration is greater than ARI’s reporting limit for a specific project, a container is used to prepare a method (bottle) blank. ARI certifies that the containers from the same lot are suitable for sample collection when target analytes are not detected in the bottle blank. Containers for conventional analyses are not pre-cleaned and are certified internally by ARI following the procedures in Appendix 12.3 of ARI SOP 001S (Sample Receiving).

Container lot numbers are recorded when containers are sent to a client.

4.4.3 Chemical Standards and Reagents

4.4.3.1 Reagent Water Supply

ARI maintains a centralized water purification system. The quality of the water produced is monitored and documented daily in a bound logbbok. All reagent / de-ionized water used within the laboratory meet or exceed ASTM Type II Standards. Water used in the Volatile Organic Laboratory is also filtered through activated charcoal to remove organic compounds.

4.4.3.2 Chemical Standards

Most standards used to determine the concentration of target analyts are purchased as certified solutions. In general the standards are traceable to a National Institute of Standards & Technology standard. A Certificate of Analysis and/or traceability for quantitative standards is filed in the QA Section when available. All standards (traceable, non-traceable and those prepared by ARI) are verified by comparison with standard reference materials or existing standards in use. ARI documents the source, date of receipt, required storage conditions and an expiration date for all standards. Containers used to store standards are labeled with an expiration date. Receiving, storage and preparation of calibration standards is described in SOPs 526S (Metals Analysis), 620S (Conventional Analysis), 704S (Volatile Organic Analysis) and 1012S (GC and GC-MS Analyses).

4.4.3.3 Chemical Reagents

Many of the analytical processes in use at ARI require chemical reagents that are not directly used in the calibration process. These reagents are used for analyte preservation, adjustment of pH, formation of colorimetric indicators, etc. The reagents are purchased in a grade and purity sufficient for their intended use. The receipt of all reagents is recorded in the Chemical Receiving Logbook where a unique Inventory Number is assigned to each reagent. Each original reagent container is labeled with an Inventory Number, the date it is opened and an expiration date as appropriate. A Certificate of Analysis is obtained for reagents when available and archived in the QA Office.

Solutions prepared from reagents are recorded in the Reagent Preparation Logbook. The logbook includes a unique Reagent Number that is traceable to the Chemical Receiving

Logbook. Reagent containers are labeled with Reagent Number, date of preparation, expiration date, and preparer′s identification.

Procedures for Reagent Receiving and Preparation are detailed in SOP 1013S.

Trace Metals Acids

To ensure the quality of acids, nitric and hydrochloric, used for trace metals analyses, only the highest quality, certified “metals free” acids are purchased. Each lot received is analyzed for purity prior to use in the laboratory to assure that it is acceptable for use. Whenever possible, entire lots will be reserved for use exclusively by ARI. This minimizes the possibility of receiving contaminated or unacceptable acid.

Solvents

To ensure the quality of solvents used for sample preparation and analysis, the highest purity of solvents required for sample processing will be used. Purity checks will be performed on solvent lots received by the laboratory. Only those solvent lots determined acceptable will be used for sample processing. Whenever possible, entire solvent lots will be reserved for use. This minimizes the possibility of receiving contaminated or unacceptable solvents.

Compressed Gases

To reduce the possibility of system contamination, compressed gases and liquids used for operating analytical instrumentation will be of a specified purity level. Any cylinder suspected of introducing contamination into a system will be promptly replaced.

4.5 Computer Systems

ARI maintains several data systems. These are used to automate such diverse functions as accounting, payroll, sales and marketing, sample receiving, instrument data collection, production of hardcopy and electronic data deliverables, intra- and internet applications and project management. Specific information about these systems is contained in Appendix C and various SOPs.

ARI maintains a Laboratory Information Management System (LIMS) that stores analytical data, calculates final results and produces final reports (both hardcopy and electronic). The

LIMS system is the major data system used at ARI. A separate Software Quality Assurance Plan outlines the QA/QC procedures for the LIMS system.

SECTION 5: LABORATORY DOCUMENTATION AND RECORDS

All laboratory operations and procedures performed during sample processing are documented in logbooks, notebooks and on laboratory forms and bench sheets. Analytical data and copies of paper documents are also stored electronically. Consistent use of standard documents throughout the laboratory ensures that all activities will be traceable and serves as objective evidence of the work performed.

All procedures performed at ARI will be detailed in Standard Operating Procedures (SOPs). Sample preparation and analysis SOPs will reference approved analytical methods and detail the actual procedures followed by ARI staff. SOPs for non-analytical activities will detail the procedures developed specifically for use at ARI.

5.1 Responsibilities

All staff members are responsible for complete and accurate documentation of laboratory activities. Each laboratory section develops a comprehensive set of documents (bench sheets, forms, etc.) to record all activities performed in that section. All staff members are responsible for reviewing and understanding SOPs, and must sign a record to document this fact. The QAPM is responsible for maintaining control of laboratory documents and ensuring their consistent use.

To ensure that all documents, SOPs in particular, accurately reflect the activities performed at ARI, section supervisors and managers are required to review all documents annually and recommend changes to the QAP. The QAPM is responsible for coordinating document revisions and ensuring that all staff members have access to the most current laboratory documents.

5.2 Document Control

ARI′s Quality Assurance Program requires that all forms and SOPs used within the laboratory be monitored to ensure that only the currently approved version of the documents are in use, centrally organized, and readily available to all staff members. All documents will include a revision date. The LQAP and SOPs will also have an effective date. The time between the revision and effective dates will be used for training and orderly implementation of changes.

Electronic copies of laboratory documents will be maintained as part of the quality assurance files. Each laboratory section maintains working copies of pertinent forms and SOPs. The QAPM coordinates the generation of new forms or SOPs and modifications to existing documents. Log number assignments will be as follows:

Laboratory Section	Form Number	SOP Number
Client Services	0001 - 0999	001 - 099
Computer Systems	1000 - 1999	100 - 199
Data Services	2000 - 2999	200 - 299
Extractions	3000 - 3999	300 - 399
GC Laboratory	4000 - 4999	400 - 499
Metals Laboratory	5000 - 5999	500 - 599
Conventional Laboratory	6000 - 6999	600 - 699
Volatile Organic Laboratory	8000 - 8999	700 - 799
Semi-volatile Laboratory	7000 - 7999	800 - 899
Quality Assurance Monitoring	10000 - 10999	1000 - 1099
GeoTech Laboratory	11000 - 11999	1100 - 1199

Document numbers will be include an F for forms and an S for SOPs i.e. 101F or 1234S. Document Control Logs of all forms and SOPs, detailing the form name and number, revision number and revision date will be maintained by the QA Officer. Outdated documents will be maintained in an electronic archive file.

The QAPM will distribute new and revised documents to the appropriate laboratory sections. Section staff will replace outdated copies of the document with the revised version. Laboratory forms and SOPs will be generated or revised on an “as needed” basis, and will be reviewed and revised as at least annually. Only the latest version of a form or SOP will be available in each laboratory. Section supervisors will periodically review these documents and recommend changes to be implemented by the QAPM. A comprehensive review of all laboratory documentation will be performed annually at the direction of the QAPM.

To maintain document security, release of documents to clients or other outside agencies will be controlled by the QAPM. The QAPM will record the document to be released, revision number, person and agency receiving the document, and the release date. All documents generated by the laboratory will be considered proprietary. ARI permission must be obtained by anyone releasing the document to other agencies or including the document in a project or quality assurance plan.

5.3 Reference Documentation

To provide an understanding of the procedures employed to generate quality data, a comprehensive set of reference materials is available to staff members. All activities performed within the laboratory can be referenced to a method or SOP. The laboratory maintains copies of the following method compilations:

Code of Federal Regulations (Section 40)
Test Methods for Evaluating Solid Waste (USEPA SW-846)
USEPA Contract Laboratory Program Statement of Work for Organics Analysis
USEPA Contract Laboratory Program Statement of Work for Inorganic Analysis
Methods for Chemical Analysis of Water and Waste (USEPA 500 and 600 series methods)
Standard Methods for the Examination of Water and Wastewater
Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound (PSEP)
US Naval Facilities Engineering Support Activity –NFESC (formerly NEESA).
Hazardous Waste Remedial Actions Program (HAZWRAP)
State of Alaska Department of Environmental Conservation (ADEC)
Oregon Department of Environmental Quality (DEQ) Petroleum Hydrocarbon Methods
Washington Department of Ecology (WDOE) Guidance for Remediation of Releases from Underground Storage Tanks (Appendix L)
Washington State SARA
AFCEE Project Quality Assurance Plan
Washington State EPH/VPH Methods
National Environmental Laboratory Accreditation Conference
Department of Defense Quality Systems Manual
Washington State Sediment Sampling and Analysis Plan

Other methods followed within the laboratory are also available. Published modifications to analytical methods will be reviewed and incorporated into laboratory SOPs. If a method for a parameter is developed by ARI, it will be detailed in an SOP. SOPs will be available for all laboratory activities. Each laboratory section will maintain a file or notebook of SOPs pertinent to that section. A compilation of all laboratory SOPs is maintained as part of the Quality Assurance Program files. A listing of laboratory SOPs is included as Appendix E.

The Quality Assurance Manual provides an overview of the laboratory-wide Quality Assurance program. A copy of the Quality Assurance Manual is distributed to all laboratory sections. Distribution of the QAP is coordinated by the QAPM.

ARI maintains a file of various laboratory and environmental publications and reference texts. These reference materials are available to all staff members. Operation and maintenance manuals are available for all equipment and instrumentation used within the laboratory. Additionally, senior level staff members are available to serve as reference sources. These staff members have numerous years of pertinent experience and can provide insight and guidance for all procedures and laboratory activities.

5.4 Quality Assurance Policies

Quality Assurance Policies provide standards and procedures to guide ARI employees in proper implementation of the QA Program. Appendix P includes current QA Policies.

5.5 Worksheets and Logbooks

Use of Laboratory Forms and Logbooks

All activities noted on laboratory forms and logs are recorded in blue ink. Initials of the staff member performing the activity, as well as the date the activity is performed are noted on all forms and logs. Any supplementary information about the activity, such as unusual observations or suspected procedural errors are noted on the forms and logs. The QAPM or his/her designee prepares and controls laboratory logbooks.

Changes to existing information is annotated by drawing a single line through the original entry and initialing and dating the deletion. Correct information is written above the deleted entry. When appropriate to clarify the intent of the change a note describing the reason for the change is added. The use of correction fluids or other techniques that cover an entry in its entirety is forbidden on laboratory documents.

Since sample processing within an analytical laboratory involves many detailed steps, documentation can be quite extensive and varied. The following guidelines will be followed to encourage consistency in laboratory record keeping:

Standard Logbooks

Preparation of all stock and working standards is documented in the appropriate standards logbook. Each entry includes preparation date, initial and final concentrations (including solute and solvent amounts), standard ID number, expiration date and the identity of the person preparing the standard. Stock solution entries include standard lot number and supplier. Working solution entries include the stock solution ID number. Commercially prepared stock standards are recorded in the stock standard logbook.

Sample Storage Temperature Logs

The temperature of all refrigerators and freezers used for sample and standards storage is monitored daily. The temperature and recorder's initials are recorded on the temperature log attached to each unit. The acceptable temperature range for each unit is noted on the log sheet. Any out of control temperatures and/or corrective actions, must be noted on the log sheet and reported to appropriate personnel (Lab Supervisor and QA Manager)

Balance Calibration Logs

The true and measured values for each calibration check weight are recorded, along with the date and recorder's initials. Any actions taken, such as notifying the QAPM of malfunctions is indicated alongside the entry for that date.

Instrument Logs

The Instrument Run Logs must detail all samples analyzed on a given instrument for a given parameter. Instrument conditions, analysis date and time for each sample, analyst initials and standard or sample identifications in the analytical sequence must be recorded in the log. Comments related to sample analysis and minor maintenance are noted on the instrument logs. For GC/MS analyses, instrument performance is documented by recording internal standard response alongside the sample identification.

Sample Preparation/Analysis Worksheets

Sample preparation and analysis activities are documented on appropriate worksheets. Sample identifications, weights or volumes used, intermediate cleanups, final volumes, preparation dates and analyst initials will be noted as well as any observations about sample condition. Any issues encountered during sample preparation are also noted. Surrogate and spiking solution ID numbers, and concentrations added to the samples, must be indicated on the bench sheet.

For some parameters, analytical results are summarized on an analysis worksheet. Sample identifications, sample preparation information, sample results, quality control results, analysis date, analyst initials and reported detection limits must be indicated on the worksheet. Any necessary data qualifiers are also noted on the worksheet.

Maintenance Logs

All major maintenance performed on instrumentation or laboratory equipment must be documented. Maintenance performed, date and analyst performing the maintenance, and steps taken to verify that the maintenance was successful are detailed in the log. Routine maintenance of GC-MS instruments is documented on “maintenance cards” attached to each instrument. The demonstration that GC instruments are in-control following maintenance is documented in the instrument run log.

Individual Laboratory Notebooks

Staff members preparing USEPA CLP samples must maintain unique laboratory notebooks for these analyses. Each case submitted is documented on a separate, sequentially numbered page. A listing of all samples prepared as part of the case, the date and the preparer′s initials, and any notes specific to sample preparation must be annotated in the logbook. Individual notebooks are used only when required by a specific contract. All sample preparation information is recorded on a laboratory bench sheet.

5.5 Document /Data Storage and Archival

Logbooks

All active logbooks will remain in the appropriate laboratory sections. Completed logbooks will be forwarded to the QAPM for archival.

Magnetic Tapes and Diskettes

When instrument capabilities permit, all data generated is archived and stored on magnetic tapes or disks. The electronic media remains on file for approximately two years.

Chromatograms and Instrument Documentation

Electronic or paper copies of chromatograms, instrument calibrations, quantification reports and any other printed documentation generated during sample analysis are maintained as part of the permanent data files. All hardcopy data remain on file at ARI for five (5) years or longer as specified by contract.

Project Data and Documentation

Project data and support documentation, electronic or paper copies, will be filed a minimum of five (5) years, or as specified by contract.

SECTION 6: SAMPLE CONTROL

All samples analyzed by the laboratory will be monitored in accordance with sample control procedures. Sample control includes operations such as container preparation, sample collection, receipt and storage, and tracking of the sample throughout all processing steps. Documentation of all sample control activities and adherence to standard procedures is an important aspect of ensuring that data quality objectives are met.

6.1 Sample Collection

Production of quality analytical data begins with proper sample collection. Improper sampling procedures may result in inaccurate final results. Although the laboratory is not routinely involved with sample collection, it will minimize the possibility for error by providing clients with appropriate sample containers and sampling instructions for the requested parameters. If, upon receipt, sample integrity appears to be compromised, the client will be immediately notified to allow for re-sampling if necessary.

6.2 Sample Container Preparation and Shipment

To minimize the possibility of contamination from containers furnished by outside sources, the laboratory will furnish all necessary sample containers for client projects when requested by the client. Sample containers, pre-cleaned to EPA specifications, or certified clean by the manufacturer or ARI, are supplied for most parameters. Containers for special purposes may be acquired upon request. Lot numbers for containers are tracked to link bottle orders to lot numbers.

A blank sample label is affixed to each sample container prior sending the container to a client. The sample label allows for recording of the following information at the time of collection: client name, client sample identification, sampling site, date and time of sample collection, analytical parameters, and any preservatives used. Sample labels provided by ARI are coated to prevent bleeding of recorded information if labels become wet.

To ensure that the correct number of appropriate sample containers are prepared and submitted to the client, a Bottle Request is completed by a Client Services staff member or Project Manager at the time sample containers are ordered by the client. All necessary preservatives are also noted on the Bottle Request. The Bottle Request is then forwarded to appropriate personnel in the Sample Receiving Section for order preparation. All required containers will be gathered and preservatives added as specified. A copy of the Bottle Request accompanies the sample containers to allow the client to verify that the order is properly filled. Additional containers will be supplied for quality control purposes and in case of container breakage or sampling complications. A complete listing of containers and preservatives used within the laboratory is included as Appendix F.

To facilitate transportation of containers to the sampling site, sample containers will be placed in coolers along with appropriate packing material. The inclusion of packing materials, such as vermiculite or “bubblewrap”, is provided to minimize the possibility of container breakage and cross-contamination. Sample containers will be organized in the coolers per analytical or client specifications. Depending on client preference and project requirements, coolers and sample containers will be shipped to a specified location, delivered by ARI courier, or held at the laboratory for pick up. To ensure that sample identification, analytical parameters, and sample custody are properly documented, Chain of Custody records will accompany all sample container shipments. When appropriate, as for drinking water source sampling events or for parameters that require preservation in the field, sample collection instructions will also be included with shipments.

6.3 Sample Admission

All samples received by the laboratory are processed in a central Sample Receiving area. To ensure the safety of staff members receiving samples, coolers will be opened under a hood or in a well-ventilated area. Appropriate protection, such as disposable gloves, safety glasses and laboratory coats will be worn during sample receipt and log-in. Additionally, all general safety practices as specified in ARI’s Chemical Hygiene Plan will be employed.

Upon receipt, sample coolers will be inspected for general condition and custody seals. Time and date of sample receipt, as well as identification of the staff member receiving the samples, will be indicated on each Chain of Custody record accompanying the shipment. Cooler temperatures will be determined using an IR temperature measuring device or by placing a thermometer in the cooler immediately after the cooler is opened. If samples cannot be logged-in within 30 minutes after receipt, the sample coolers will be tagged and placed in the walk-in sample storage refrigerator for short-term storage. Chain of Custody records for the stored coolers will remain in Log-In to ensure that processing of the stored samples is not overlooked.

Samples to be processed will be removed from the coolers and organized by sample identification. The number and type of sample containers received will be verified against the Chain of Custody record. Each sample container will be examined to verify that the condition is acceptable and that sample integrity has not been compromised during shipment. Sample containers broken during shipment should be handled according to procedures detailed in the Chemical Hygiene Plan (Section 5, Waste Disposal Procedures).

After sample organization and initial inspection has been completed, sample information will be entered into the LIMS, and a Service Request will be generated for the sample set. The Service Request serves as a work order for the laboratory. The Service Request will contain the following information:

Client Name
Client Project Name and/or Number
Client Contact
Verified Time of Sample Receipt (VTSR)
Required Turnaround Time
Laboratory Job Number
Client Sample Identifiers(s)
Laboratory Sample Number(s)
Required Parameters
Additional Analytical Requirements/Comments

Also entered into the LIMS are the number of sample containers for each sample, sample conditions, and cooler temperatures.

A sequential laboratory job number will be assigned to each sample set. Laboratory sample numbers, determined by the job number and a sequential letter, will be assigned to each sample. Containers for each sample will also be numbered sequentially. The accuracy of sample container labeling is verified by a second person. These identifiers will be used to monitor the sample set and container throughout sample processing. All samples logged for the sample set and the analytical parameters required for each sample will be indicated on the Service Request. Client specific quality control requirements and any other pertinent information indicated on the Chain of Custody Record will also be noted. Discrepancies between the Chain of Custody record and sample containers will be noted, as well as discrepancy resolutions. To reduce the possibility of inaccurate sample processing, the sample receiving staff working with the Project Manager will resolve all noted discrepancies prior to releasing the samples to the analytical sections.

Upon completion of sample log-in, all documentation will be placed in a master folder and forwarded to the assigned Project Manager for review and approval. The master folder will be color-coded as follows:

Master File Color	Designation
Red	Accelerated Turnaround (≤ week)
Clear	Routine Turnaround

The Project Manager will review all aspects of the documentation, specify any additional analytical requirements and resolve any remaining discrepancies before sample processing begins. After Project Manager final approval has been obtained (indicated by the Project Managers initials and the date on the Service Request and laboratory-specific parameter sheets), the master file will be returned to Log-In for preparation of laboratory job folders. A job folder will be created for each laboratory section involved in sample processing for a given project. Laboratory job folders are color-coded as follows:

Job Folder Color	Designation
Red	Accelerated Turnaround (≤ 10 days)
Manilla	Normal Turnaround (11 to 14 days)
Blue	Accelerated Turnaround (≤ 7 days) for Fuels Analyzes (NWTPH, AK103 etc.)
Yellow	Extended Turnaround (>14 day TAT)
Other (Green, Purple,etc)	Client or Project Specific Analyzes

Copies of the Service Request and all pertinent laboratory-specific documentation required to accurately complete sample analysis will be placed in each laboratory job folder. Laboratory job folders will then be distributed to appropriate laboratory sections for analysis and incorporation into the section tracking system.

Subcontracting Policies

ARI may be required to subcontract work to other laboratories. The following policies are followed to assure that data produced by a subcontractor is high quality, defensible and will meet the client's expectations.

1. ARI's client must be made aware that samples will be subcontracted and what laboratory will perform the analyses.
2. Subcontractor laboratories must qualify to perform the analyses using the same criteria applied to ARI. When appropriate, subcontracted laboratories must submit proof of certification or accreditation, quality assurance plans, standard operating procedures, results of method detection limit studies, control limits to ARI. ARI may at its discretion perform an on-site assessment of subcontracted laboratories. Failure to submit requested documents or refusal of an on-site assessment will disqualify laboratories from subcontracting ARI sample analyses.
3. ARI will not subcontract Department of Defense work to be performed under the Quality Systems Manual (DoD-QSM) unless the subcontract lab is approved to perform DoD-QSM analyzes.
4. The sample information and analytical requirements are first entered into the ARI LIMS in the same way that samples for in-house analyses are processed. Subcontractor laboratories are contacted to verify their preparedness, and samples are then submitted to them using ARI chain-of-custody forms. These chain-of-custody documents are included in the master folder for the project.
5. ARI may request that subcontract laboratories analyze, on double blind performance testing (PT) sample obtained from commercial vendors at the subcontractor's expense.
6. The laboratory must be willing to maintain an annual contract with ARI, and must list ARI as a co-insured on the subcontract laboratory's liability insurance policies.
7. Financial stability is also evaluated on a lab-by-lab basis.

6.4 Sample Custody

To ensure the traceability of sample possession, chain of custody is documented from sample collection to completion of final analysis, and is maintained during sample storage in archive prior to disposal. This is achieved through completion of a written chain of custody record. Custody of all samples and extracts processed by the laboratory is documented at each step of the analytical process.

The National Enforcement Investigations Center (NEIC) of EPA defines custody in the following ways:

It is in your actual possession, or
It is in your view, after being in your physical possession, or
It was in your possession, then you locked or sealed it up to prevent tampering, or
It is in a secure area.

Sample handling may vary and specific custody procedures have been developed for each laboratory section.

Custody at Sample Log-in

A Chain of Custody Record must accompany all samples received by the laboratory. This record documents all sampling activities as well as persons handling the samples prior to receipt by the laboratory. Sample receiving staff assumes custody of samples upon receipt from the client or courier. Samples will remain in the custody of Sample receiving until the samples are delivered to a laboratory section. Should samples require shipment to a subcontracting laboratory, a separate Chain of Custody Record will be completed to document the sample transfer. Chain of Custody records will be included with sample data reports in the final analytical package submitted to the client. Copies of these records will be filed with project data.

Custody of Volatile Organic Analysis (VOA) Samples

Upon completion of sample the sample receiving process, samples requiring analysis for volatile organic analysis will be placed in the VOA refrigerator (freezer) designated for incoming samples and logged into the VOA sample receipt logbook. The samples are now in the custody of the VOA laboratory. To avoid possible cross-contamination of low level samples, those samples known or suspected to contain high levels of contaminants, such as underground storage tank (UST) samples, will be stored in a separate refrigerator prior to analysis.

VOA Laboratory analysts complete the receiving process and move the samples to a refrigerator designated for “active” samples. Samples removed from storage for analysis are considered to be in the custody of the analyst responsible for sample processing. All samples to be analyzed will be listed in the analytical logbook for the selected instrument. Laboratory and client sample identifications, the bottle number and Identification of the analyst performing the analysis will be indicated in the logbook. If it is necessary for sample custody to be transferred to another instrument or analyst, the second analyst will record this information. Thus, custody of a given sample can be traced throughout the analytical process, regardless of the number of instruments or analysts involved. Analysts will initial all raw data generated from sample analysis, to further document sample custody.

After completion of sample analysis, soil and intact water sample containers will be placed in the refrigerator designated for sample archival. Any water sample remaining in the container after completion of analysis will be considered compromised and will be discarded. The samples will remain in archive and in the custody of the VOA laboratory until final disposal.

Custody of Semi-volatile Organic Analysis (SVOA) Samples

Upon completion of sample log-in, samples requiring extraction for organic parameters will be placed in walk-in cooler number 5. All samples placed in the cooler will be logged into the *Walk-in Admission Logbook*. Removal of samples from the refrigerator for processing by Extractions or Conventional personnel must be indicated in the *Walk-in Admission Logbook*. Samples stored in this walk-in refrigerator remain in Log-In custody until removed to a laboratory for processing.

The analyst responsible for the custody and initial handling of samples within the sample preparation laboratory will be indicated on the Sample Preparation Worksheet. All analysts involved in the subsequent steps of sample processing will also be indicated on the worksheet. Residual sample volumes will be archived in the refrigerator designated for extractable organic samples. Transfer of residual samples to this refrigerator will be documented in the *Sample*

Archive Refrigerator Logbook. Transfer of prepared sample extracts to the appropriate analytical sections will be documented in the Extract Log in the preparation laboratory and in the Extract Log in the analytical section. Upon extract transfer, the analytical section receiving the extract assumes custody.

Extracts removed from storage for analysis are considered to be in the custody of the analyst responsible for analysis. Removal of extracts for analysis will be indicated in the Extract Log in the analytical section. All extracts to be analyzed will be indicated in the analytical logbook for the selected instrument. Laboratory and client sample identifications, as well as the analyst performing the analysis will be indicated in the logbook. Analysts will initial raw data generated from extract analysis to further document sample custody. After completion of analysis, extracts will be placed in the refrigerator designated for archive. Extracts will remain in storage and in the custody of the analytical section until final disposal.

Custody of Inorganic and Metals Samples

Upon completion of the sample receiving process, samples requiring preparation or analysis for inorganic parameters will be placed in the designated walk-in cooler. Selected samples such as those requiring a critical analysis are placed directly in the laboratory. Removal of samples from the refrigerators for digestion and/or analysis will be indicated in the *Walk-in Admission Logbook* for the appropriate refrigerator. Samples stored in the walk-in refrigerators remain in Log-In custody until the laboratory removes the samples for processing.

The analyst responsible for custody and initial handling of samples within the metals preparation laboratory will be indicated on the Sample Digestion Worksheet. All analysts involved in the subsequent steps of sample processing will also be indicated on the worksheet. Transfer of completed sample digests to the metals instrument (analysis) laboratory will be documented by the metals preparation laboratory. Upon transfer of digests, custody is considered to be the responsibility of the analytical section receiving the digests.

Digests removed from storage are considered to be in the custody of the responsible analyst. . All digests to be analyzed will be indicated in the analytical logbook for the selected instrument. Laboratory sample identifications and the analyst performing the analysis will be indicated in the logbook. If it is necessary for digest custody to be transferred to another instrument or analyst, the second analyst records this information. Thus, custody of a given digest can be traced throughout the analytical process, regardless of the number of instruments or analysts involved. Analysts will initial all raw data generated from digest and analysis to further document sample custody. After completion of analysis, digests will be stored by and remain in the custody of the analytical laboratory personnel until final disposal.

The analyst performing the sample analysis will remove samples requiring analysis for other inorganic (conventional) parameters from storage. Removal will be documented in the *Walk-in Admission Logbook*. Custody of the sample will be considered to be the responsibility of that analyst. All samples to be analyzed will be indicated on the worksheet for the required parameter. Laboratory sample identifications and the analyst performing the analysis will be indicated on the worksheet. If it is necessary for sample custody to be transferred to another instrument or analyst, the second analyst will record this information. Thus, custody of a given sample can be traced throughout the analytical process, regardless of the number of instruments or analysts involved. The analysts' initials will be indicated on the worksheet to further document sample custody.

Special Chain of Custody Requirements

Should a client project require additional or more detailed custody documentation, requirements will be incorporated into the procedures for that project. Samples processed as part of the USEPA Contract Laboratory Program require more stringent chain of custody procedures. For this program, removal of samples and extracts for analysis (or any reason) will be documented in the Sample Control Log. Date, time and reason for removal, and date and time of return, will be fully documented. Removal of samples or extracts for permanent archiving or disposal will also be fully documented in the Sample Control Log.

6.5 Sample Archival and Disposal

After completion of analysis, unused sample aliquots are routinely stored for a specified period of time: 30 days for water samples and 60 days for soil samples. Colored markers are placed on samples with specific storage requirements during the sample receiving process. The color-coding is defined in the following table:

Label Color	Storage Requirement
Red	Hold until further notice
Orange	Suspected Hazardous
Yellow	Shared Sample Containers
Blue	Samples to be frozen

Samples submitted for archival will be logged into the Sample Archive Logbook. Laboratory and client identifications, as well as archive date will be indicated in the logbook. The anticipated disposal date for the sample set will also be noted. The logbook will be reviewed several times during each week to determine samples scheduled for disposal. On or soon after the scheduled disposal date, the samples will be removed from archive storage and disposed.

In consideration of disposal requirements for hazardous samples, each sample processed by the laboratory will be evaluated for contamination levels based on final analytical results. Those samples containing analytes of interest at or above regulated disposal levels will be identified and handled as hazardous waste. A designated staff member coordinates periodic pickup and disposal of hazardous waste by an USEPA approved TSD (Treatment, Storage, and Disposal) Company and maintains hazardous waste disposal records. Specific guidelines for handling hazardous samples and waste are detailed in the Chemical Hygiene Plan (Section 5, Waste Disposal Procedures)

SECTION 7: PROJECT MANAGEMENT AND TRACKING

7.1 Project Management

Concise and accurate communication between a client and ARI, and within the laboratory, is an extremely important requirement for generating quality analytical results. All clients contracting with ARI will be assigned to a Project Manager. The Project Manager confirms that project requirements are consistent with laboratory capabilities, and coordinates with laboratory sections to provide analytical results within specified project timelines. Project organization, monitoring, and follow-up is the responsibility of Project Management staff.

Client project requirements and Project Managers' areas of expertise will be considered for client assignment. To ensure that all clients and projects receive the attention necessary for successful project completion, Project Manager workloads will also be considered. Project Managers will serve as the central focus for all project related activities and communications.

The Project Manager will review work plans and requirements for all pending projects. Any questions related to the work plan will be addressed prior to project commencement. The Project Manager will consult with appropriate analytical sections to clarify any issues regarding procedures and capabilities. Project deliverables requirements will also be addressed at this time. Upon receipt and log-in of project samples, the Project Manager will review all documentation to ensure that samples were properly logged in, and that analytical and QC requirements were correctly specified. The Project Manager will also provide any additional project related information that will assist the analytical sections with sample analysis. Laboratory sections will not process a sample until Project Manager approval has been given. Exceptions are parameters with critical (less than 48 hour) holding times or those that arrive on weekends or holidays when none of the Project Managers can be contacted.

Throughout the project, the Project Manager will monitor all analytical activities to help ensure that the project is completed and delivered on schedule. Any issues arising during sample processing will be promptly discussed with the client. Likewise, the analytical staff will be informed of any client concerns or project modifications. The Project Manager will also address any issues that arise during subsequent review of the analytical data by the client.

7.2 Project Tracking

Monitoring the laboratory workload ensures that adequate staffing and equipment will be available to produce quality analytical data and meet client needs. At the time a client project is tentatively scheduled, information regarding the project will be documented in the Project Management Database. Project particulars, sample quantities, parameters and anticipated sample delivery dates will be specified, as well as any prearranged analytical costs. Project work plans and any other project information will be kept on file with the Project Manager. Schedules for pending projects are communicated to the lab sections through periodic distribution of database printouts. Upon receipt of project samples, the project Inquiry number will be referenced to ensure project requirements are accurately specified. The original project documentation will be placed in the master folder as part of the project file.

Each laboratory section analyzing project samples will be responsible for ensuring that all analyses are accurately completed by the required date. All staff members are required to be aware of holding times, special analytical requirements, and required turnaround times. Analytical sections will remain in close communication with the Project Management staff so that any issues arising during sample analysis can be promptly addressed or discussed with the client.

Project Managers or their designee are responsible for monitoring project status. Sample status reports are generated as needed from LIMS and are distributed to lab sections and Project Managers. These reports allow the Project Managers to review project status and identify any samples which must be expedited to meet project timelines. Additionally, verbal communication between Project Managers and lab sections provides information about project status.

After sample analysis, report generation, and final review have been completed, data and final reports will be forwarded to the Project Manager. If requested, preliminary and interim results will be forwarded to the client. When all final data are available, the Project Manager will assemble the final package, verifying that all analyses were completed and project requirements met. A project narrative detailing the particulars of sample processing will be generated. After assembly and prior to shipment, the Project Manager will perform a final, cursory review of the package for any inconsistencies or incorrect information. The package will then be forwarded to clerical personnel for photocopying and shipment. The Project Manager will determine final analytical costs and submit this information to the Accounting department for invoicing. Upon completion, all raw data and documentation associated with each client project will be compiled and stored as part of the laboratory project files. A chart detailing laboratory workflow as described in this section is included as Appendix G.

SECTION 8: ANALYTICAL METHODS

To ensure that all data generated are consistent and comparable, clearly defined procedures will be followed for all aspects of sample processing, control and management. Standard Operating Procedures (SOPs) provide detailed guidelines for completing a procedure. Document control procedures and periodic audits will ensure that operations are performed in accordance with the most current SOPs. All routine deviations from published will be noted in the SOPs. Analysis specific deviation will be noted in Analyst Notes and in the Analytical Narrative.

8.1 Responsibilities

It is the responsibility of staff members to perform all procedures in accordance with the guidelines specified in the Standard Operating Procedures. Laboratory management is responsible for ensuring that SOPs are followed throughout the laboratory. The QAPM is responsible for coordinating periodic review and revision of existing SOPs and generation of additional SOPs. The QAPM is also responsible for maintaining SOP document control and ensuring that the most current versions of all SOPs are available to staff members.

8.2 Methods

Laboratory procedures may reference any established methods specified in the following publications:

1. *Code of Federal Regulations (Section 40)*
2. *Test Methods for Evaluating Solid Waste (USEPA SW-846)*
3. *USEPA Contract Laboratory Program Statement of Work for Organic Analysis*
4. *USEPA Contract Laboratory Program Statement of Work for Inorganic Analysis*
5. *Methods for Chemical Analysis of Water and Waste (USEPA 500 and 600 series)*
6. *Standard Methods for the Examination of Water and Wastewater*
7. *Protocols for Measuring Selected Environmental Variables in Puget Sound (PSEP)*
8. *Navy Installation Restoration Laboratory Quality Assurance Guide(February 1996)*
9. *Hazardous Waste Remedial Actions Program (HAZWRAP)*
10. *State of Alaska Department of Environmental Conservation (ADEC)*
11. *Oregon Department of Environmental Quality (DEQ) Petroleum Hydrocarbon Methods*
12. *Washington Department of Ecology (WDOE) Guidance for Remediation of Releases from Underground Storage Tanks (Appendix L)*
13. *The Department of Defense Quality Systems Manual (DoD-QSM)*
14. *Washington State Sediment Sampling and Analysis Plan*

The laboratory will adhere to established methods whenever possible. Occasionally, however, procedures determined to provide more accurate final results will be incorporated into the method. Should the laboratory procedures deviate from the established method, all modifications will be detailed in the associated SOP. A listing of laboratory SOPs is included as Appendix E.

8.3 Standard Operating Procedures

Standard Operating Procedures (SOPs) are detailed, step-by-step instructions for completing a laboratory operation. An SOP is available for all procedures within the laboratory, from initial project identification to final data archival. SOPs are generated for procedures developed within the laboratory and for those that follow established methods.

To ensure consistency in defining procedural guidelines, all SOPs that describe analytical procedures will contain the following sections:

1) Method, matrix or matrices, detection limit, scope & application, components to be analyzed
2) Summary of the test method
3) Definitions
4) Interferences
5) Safety
6) Equipment and supplies
7) Reagents and standards
8) Sample collection, preservation, shipment and storage
9) Quality control
10) Calibration and standardization
11) Procedure
12) Data analysis and calculations
13) Method performance
14) Pollution prevention
15) Data assessment and acceptance criteria for quality control measures
16) Corrective actions for out of control data
17) Contingencies for handling out-of-control or unacceptable data
18) Waste management
19) References
20) Appendices,tables, diagrams, flowcharts and validation data.

SOPs will be monitored through the laboratory document control system. Each SOP will be assigned a document control number as detailed in Section 5.2 of this LQAP. SOPs are revised whenever a laboratory procedure is changed or modified. All SOPs are reviewed and revised as necessary at least once a year. Personnel normally performing the procedure or analysis perform the review. SOPs will be generated for each new procedure implemented within the laboratory. Review, modification, new SOP generation, and distribution will be coordinated through the QAPM. The QAPM will periodically audit the laboratory sections to verify that the most current versions of all SOPs are in use. Document release will be controlled as detailed in section 5.2.

8.4 Method Selection and Use

Method selection will be based on availability of analytical instruments and equipment, chemical standards, expected method performance and marketability. Methods that are defined and accepted by regulatory agencies and familiar to ARI's clients are preferred. The Laboratory Manager and QAPM in consultation with marketing, client service, and laboratory supervisory staff are responsible for selecting appropriate methods. Client or project-specific methods may be used when appropriate.

The most recently promulgated method will be used for all procedures. Non-promulgated methods will be investigated if requested by a client. Section supervisors and managers are responsible for ensuring that the procedures in use reflect the requirements of the promulgated methods. Any modifications made to the method must be documented in the SOPs. Method modifications may be acceptable, provided all acceptance criteria specified in the method are met.

Section supervisors and managers review newly promulgated methods. SOPs will be modified as necessary to reflect the new methods. When possible, the annual SOP review will be coordinated with anticipated method promulgation dates. This is especially useful for large method compilations, such as SW-846. If the annual SOP review and method promulgation cannot be coordinated, SOPs will be revised as soon as possible after a method has been promulgated, especially when method changes are significant.

SOPs will be generated to reflect the most commonly used methods and protocols. If more than one method is used for an analysis, separate SOPs should be generated. Several methods may be incorporated into one SOP, provided that each method is clearly identified and defined in the SOP. Method modifications or special requirements for ongoing projects, or for specific programs (Navy, CLP, etc.), will be incorporated into the SOP. These requirements will be annotated to indicate that they are project/program specific. Analysts and technicians will be responsible for ensuring that, when required, project or program specific procedures are followed. SOPs will be controlled as specified in section 5.2.

8.5 Method Performance

Method performance must be demonstrated for all new methods prior to using methods for sample analysis. Section supervisors and managers are responsible for ensuring that method performance is demonstrated and support procedures have been performed.

Method performance will be demonstrated in the following manner:

A draft SOP will be generated for the method. The SOP must provide sufficient detail to perform the analysis and must accurately reflect the published method. Any steps in the method for which analyst discretion is allowed must be clearly defined.

A method detection limit (MDL) study must be performed for the method. Method detection limits must be verified to be at or lower than any method-specified detection limits. Method detection and reporting limits must be established.

Method precision and accuracy must be evaluated. This may be determined using an MDL or IDL study. Replicates will be evaluated for precision; analyte values will be compared with spike amounts to determine accuracy. Any method-specified precision and accuracy criteria must be met.

All method performance results will be reviewed and compiled by the section supervisor. Results will be filed with the QA section. A final SOP will be generated and distributed.

SECTION 9: INSTRUMENT CONTROL

9.1 Detection Limits

To verify that reported limits are within instrument and method capabilities, three levels of detection have been established: instrument detection limits, method detection limits, and reporting limits. Instrument and method detection limits are statistically based values, determined from replicate analyses of analytical standards. Reporting limits are based upon the experience and judgment of an analyst. Reported values will be qualified based on the established limits. All limits will be summarized and controlled by the QAPM and are included as Appendix I.

Instrument Detection Limits

The instrument detection limit (IDL) is considered to be the smallest signal above background noise that an instrument can reliably detect. This limit reflects whether or not the observed signal has been caused by a real signal or is only a random fluctuation of noise from the blank. The IDL does not take into consideration the performance or efficiency of analytical methods.

Instrument detection limits are determined annually, or when ever a major change has been made, for each instrument in the metals analysis laboratory. Seven replicates, of a blank, or standards containing analytes at levels three to five times the expected IDLs are analyzed on three non-consecutive days. The IDL value for an analyte is three times the average of the standard deviations from the three replicate sets of analyses.

Method Detection Limits

The method detection limit (MDL) is considered to be the lowest concentration of an analyte that a method can detect with 99% confidence. Method detection limits will be established for all analytical parameters according to the guidelines specified in the Code of Federal Regulations, Section 40. Seven replicate samples are fortified with target analytes at levels that are one to five times (but not exceeding 10 times) the expected detection limits. The MDL for an analyte is determined to be the standard deviation of the replicates times the appropriate student’s t-test value. More than seven replicates may be processed, but all replicates must be used in the MDL determination. MDLs are verified by analyzing a sample spiked at a concentration 3 to 5 times the calculated MDL concentration. When the analyte(s) are detected the MDL is verified. When the analytes is not detected, the concentration in the verification sample is increased until it is detected. The concentration at which the analytes is first detected then becomes the MDL.

Laboratory supervisors or managers review all statistically determined MDLs for accuracy and validity. The section supervisor or manager is responsible for ensuring that any unusable MDL studies are reprocessed. Once accepted, MDL study results and associated raw data will be forwarded to the QA section for further review and additional approval. MDLs approved by both section management and QA will be considered final and acceptable for use. Finalized MDL values are forwarded to Computer Services for incorporation into ARI’s LIMS.

MDL studies will be conducted for all analyses performed by the laboratory on representative water, sediment and, tissue samples when appropriate and suitable sample matrices are available. MDL studies will be performed on all instruments used for sample analysis. To allow for reevaluation of method performance, MDL studies will be performed on an annual basis. The QAPM is responsible for ensuring that all MDL studies are performed at least annually. Section supervisors and managers are responsible for determining if and when additional MDL studies should be performed due to changes in analytical methods, instrumentation or personnel.

Reporting Limits

Reporting Limits (RL) are the lowest quantitative value routinely reported. Analytical results below the RL will be expressed as “less than” the reporting limit. RLs are estimated values based upon the MDLs, experience and judgment of the analyst, method efficiency, and analyte sensitivity. No reporting limit will be lower than its corresponding MDL. RLs will be verified on a regular basis either by having a calibration standard at the limit or by analyzing a standard at the RL immediately following initial calibration.

Analytical Standards

Generation of high quality results is dependent upon the use of accurately prepared analytical standards. Many stock standards used within the laboratory are commercially prepared solutions with certified analyte concentrations. Neat standards used for stock standard preparation are of the highest purity obtainable. Standard preparations are fully documented in appropriate logbooks.

Responsibilities

It is the responsibility of each laboratory employee involved with standards preparation to ensure that all standards are correctly and accurately prepared through the use of good laboratory practices and analytical verification. It is also the responsibility of these staff members to properly document the receipt and/or preparation of all standards. Management is responsible for ensuring that all staff members follow specified standards preparation and inventory procedures. The QAPM is responsible for periodically auditing standard preparation records to verify compliance with the laboratory Quality Assurance Program.

Organic Standards Preparation

Two types of standards are utilized for extractable organic compounds: neat standards from which stock solutions are prepared, and commercially prepared stock solutions from which working solutions are prepared. The type of standard depends upon availability. Commercially prepared standards are preferred when available.

Preparation of stock solutions will be documented in the Stock Solutions Log. To ensure traceability, commercially prepared stock solutions will also be documented in the Stock Standard Solutions Log. Each solution will be assigned a unique stock number determined by the page number and entry number on the page, preceded by “S” to indicate the solution is a stock, volatile stock standard are labeled “VS”. For example, the third entry on page 44 will be assigned the stock number S44-3. For stock solutions prepared from neat standards, the compound, supplier, lot number, preparation schematic, preparation date, expiration date, and analyst initials will be recorded. After preparing the standard, another analyst should review the preparation information to verify accuracy. For commercially prepared stock solutions, the compound, supplier, lot number and expiration date will be recorded. As a stock solution is not actually prepared in-house for these commercial solutions, it is not necessary to record or verify a preparation schematic.

Preparation of working solutions (including spike and surrogate solutions) will be documented in the Working Standard Solutions Logbook. Each solution will be assigned a working standard number determined by the page number and entry number on the page. For example, the second entry on page 73 will be assigned the working standard number 73-2. For volatile organic standards, the working standard number is preceded by “VW”. The compound, stock solution reference, preparation schematic, preparation date, expiration date, and analyst initials will be recorded. After preparing the standard, another analyst will review the preparation information to verify accuracy. After analyzing the standard and confirming that it is acceptable, analytical verification will be documented in the logbook.

Discarded or consumed standards will be annotated in the logbook by drawing a single line through the entry, indicating “discarded” or “consumed” above the line with confirming initial and date. Existing standard numbers will not be reused. Instead, each new stock or working solution made will be assigned a new number.

Standards preparation will be performed in accordance with good laboratory practices. Syringes, glassware and other preparation equipment will be thoroughly cleaned prior to and after use. Standard material weights and solution volumes will be accurate to ± 3%. Neat standards that are less than 97% pure must be corrected for concentration. Standard solutions will be stored in amber bottles with Teflon-lined caps. Each standard solution will be labeled with the solution number, compound, analyst initials and expiration date. Stock solutions will be stored in the appropriate standards freezer; working solutions will be stored in the appropriate standards refrigerator.

Metals Standard Preparation

Commercially prepared single element stock solutions are used for all elements. Preparation of working solutions from these single element stocks will be documented in the Solutions Logbook. Preparation of check standards will also be documented in the Solutions Logbook. The element, preparation schematic, preparation date, expiration date, and analyst initials will be recorded. Working calibration standards are prepared weekly for furnace and ICP analyses and as needed for ICP-MS. Calibration verification standards are prepared daily for GFA analyses and as needed for ICP and ICP-MS analyses.

Standards preparation will be performed in accordance with good laboratory practices. All preparation equipment will be thoroughly cleaned prior to and after use.

Inorganic (Wet Chemistry) Standard Preparation

Working standards for wet chemistry parameters will be prepared on a daily basis, prior to starting an analysis. Stock and check standard solutions will be replaced as solutions expire or are consumed. Stock and check standard solutions will be labeled with the compound, preparation data (weight and volume), units of concentration, preparation date, expiration date, and analyst initials.

Standards preparation will be performed in accordance with good laboratory practices. Glassware and other preparation equipment will be thoroughly cleaned prior to and after use. Standard material weights and solution volumes will be accurate to ± 3%. Stock standards will be stored in containers appropriate for the parameter.

9.3 Calibration

Instrumentation and equipment used for sample processing and analysis must be operating optimally to ensure that accurate analytical results are generated. Verification of optimum operation is accomplished through various tuning and calibration procedures. Criteria for determining the accuracy of calibration are specified for all instrumentation and equipment. Prior to sample analysis, calibrations will be analyzed and evaluated against specified acceptance criteria. Acceptance criteria are either published as part of the method or generated at ARI using control charts. Calibration verifications will also be analyzed throughout an analytical sequence to ensure that instrument performance continues to meet acceptance criteria.

Gas Chromatography/Mass Spectrometry (GC/MS)

All GC/MS systems will be evaluated through analysis of an instrument performance check solution and calibration standards. The composition of the standards varies depending on the analysis performed on the system. System evaluation will be performed prior to sample analysis. Evaluation criteria used for GC/MS analyses are as specified for the SW846 methods.

> Instrument Performance Check Solution - Prior to analysis, the system will be evaluated to ensure that mass spectral ion abundance criteria are met. Bromofluorobenzene (BFB) is analyzed for volatile organic analyses and Decafluorotriphenylphosphine (DFTPP) is analyzed for semi-volatile organic analyses. All ions must meet method-specified criteria.
>
> The instrument performance check solution will be analyzed at a minimum of every 12 hours during the analytical sequence. Each analysis of the check solution will be verified against the specified criteria.
>
> Calibration - After instrument performance has been verified, each GC/MS system will be calibrated to verify response linearity. For volatile organic analyses, up to eight standards ranging from 1 to 200 µg/L will be analyzed. For semi-volatile organic analyses, five to seven standards ranging from 2 to 80 µg/L will be analyz. The standard levels evaluated will vary depending on the compound. Initial calibration results will meet percent relative standard deviation acceptance criteria.
>
> A continuing calibration verification standard at a mid-level concentration (routinely 50 µg/L for VOA and 250 µg/L for SVOA) will be analyzed at a minimum of every 12 hours during the analytical sequence. For continuing calibrations, minimum response factor and percent difference criteria will be considered in evaluating the acceptability of the calibration. Initial and continuing calibration acceptance criteria

for volatile and semi-volatile organic analyses are presented in Appendix J. All calibration data printouts will include the following documentation:

Date of calibration,
Identification of standard used
Identification of person performing the calibration

The analyst performing the calibration will include documentation of any problems encountered during the calibration analyses with the data, and will also note any corrective actions taken. The calibration data will be tabulated, and summary statistics will be generated. These results will be kept on file with the raw data in the Data Services section.

Internal Standard Responses - Internal standard responses and retention times in all standards will be evaluated immediately after analysis. This will serve as a baseline from which all sample internal standard responses and retention times will be evaluated.

Gas Chromatography (GC)

Each GC and HPLC system will be calibrated to verify response linearity. Depending on the parameter, five to seven standards at concentrations covering the linear range of the instrument will be analyzed. Percent relative standard deviations for initial calibrations will not exceed SW-846 limits or 25% when those limits are not applicable.

A continuing calibration standard at mid-range concentration will be analyzed after every 10 samples or more frequently if the method or conditions warrant. Percent differences between initial and continuing calibrations will not exceed SW-846 limits or 25% when those limits are not applicable.

Calibration for organochlorine pesticides will follow SW-846 guidelines. The initial calibration sequence specifies the analysis of Resolution Check, Performance Evaluation, five-point initial calibration, individual standards and instrument blanks. Criteria for evaluating these standards are as follows:

Performance Evaluation - The Performance Evaluation standard will be analyzed immediately following the Resolution Check standard. All standard peaks will be completely resolved. Individual breakdowns of DDT and Endrin will be less than or equal to 15% on both columns. A Performance Evaluation standard will also be analyzed at the end of the calibration sequence.

Initial Calibration - An initial calibration consisting of levels of standard concentrations will be analyzed immediately following the analysis of aroclor 1660 curve and individual aroclor and Toxaphene standards. The percent relative standard deviation (RSD) will not exceed SW-846 guidelines or 20% on each column.

Continuing Calibration - A midpoint Aroclor 1660 and or a midpoint pesticide standard along with a performance evaluation standard are analyzed after every ten (10) sample analyses. The continuing calibration standards will be within 85 - 115% of the initial calibration. The Performance Evaluation standard will meet previously specified criteria.

The analytical sequence may continue indefinitely, provided that calibration criteria are met throughout the sequence. Additionally, retention times for all compounds will fall within the retention time windows established by the initial calibration sequence of the three standard concentration levels.

All calibration data printouts will include the following documentation:

Date of calibration,
Identification of standard used, and
Identification of person performing the calibration.

The analyst performing the calibration will include documentation of any problems encountered during the calibration analyses with the data, and will note any corrective actions taken. The calibration data will be tabulated, and summary statistics will be generated.

Metals

Analytical instrumentation for metals will be evaluated through the analysis of calibration standards, calibration blanks, and calibration verification standards. Initial calibrations will be performed prior to sample analysis.

Inductively Coupled Plasma Atomic Emission Spectrometry (ICP)

Initial standardization is performed daily, or more frequently as required, by analyzing a blank and four multiple element standards with a single concentration for each analytical wavelength. The calibration is immediately verified with the analysis of an initial calibration verification standard (ICV) obtained from a source independent from the IC standard. The calibration will then be verified throughout the analytical sequence by analyzing a continuing calibration verification standard (CCV) after every 10 sample analyses. The calibration check standard values will be within ± 10% of the true value.

After initial calibration, a calibration blank (ICB) will be analyzed to check for baseline drift or carryover. The level of analyte in the calibration blank should be ±2 RL. Calibration blanks (CCB) will be analyzed immediately following each calibration verification standard analysis.

Following calibration verification a standard at the reporting limit (CRI) is analyzed for all elements. Warning limits have been set at ±1RL and any sample determined to have a concentration below this standard will be reported as undetected.

The upper limit of the calibration range, linear dynamic range, is established for each analytical wavelength using standards of increasing concentrations. These standards are analyzed against the normal calibration curve and must be within 10% of their true value to verify linearity. At a minimum this upper range will be checked every six months or whenever major changes are made to the instrument. Any sample analyzed with a concentration above this linear dynamic range will be diluted and reanalyzed.

Also to verify the inter-element correction equations, inter-element correction standards (ICS) are analyzed both at the start and end of the analytic run. Both the major interfering and the interfered with elements are evaluated.

Atomic Absorption Spectroscopy (Graphite Furnace and Cold Vapor)

Atomic absorption instrumentation is initially calibrated using a minimum of three standards of varying concentrations and a calibration blank. Initial calibration is performed daily or more frequently if conditions warrant. The calibration is immediately verified with the analysis of an independent source initial calibration verification standard (ICV). The calibration will then be verified throughout the analytical sequence by analyzing a continuing calibration verification standard (CCV) after every 10 sample analyses. The initial calibration verification standard value will be within ± 10% of the true value whereas the CCV will be considered in control if it is within ±10% for Graphite Furnace analysis or ±20% for Cold Vapor analysis.

After initial calibration, a calibration blank (ICB) will be analyzed to check for baseline drift or carryover. The level of analyte detected in the calibration blank should be ±1 RL. Calibration blanks (CCB) will be analyzed immediately following each calibration verification standard analysis.

Following calibration verification a standard at the reporting limit is analyzed for all elements. Warning limits have been set at ±1RL and any sample determined to have a concentration below this standard will be reported as undetected. Any sample determined to have a concentration above the high calibration standard will be diluted and reanalyzed.

Inductively Coupled Plasma Mass Spectrometry (ICP-MS)

Initial standardization is performed daily, or more frequently as required, by analyzing a blank and four multiple element standards. The calibration is immediately verified with the analysis of an independent source initial calibration verification standard (ICV). The calibration will then be verified throughout the analytical sequence by analyzing a continuing calibration verification standard (CCV) after every 10 sample analyses. The calibration check standard values will be within ± 10% of the true value.

After initial calibration, a calibration blank (ICB) will be analyzed to check for baseline drift or carryover. The level of analyte in the calibration blank should be ±1 RL. Calibration blanks (CCB) will be analyzed immediately following each calibration verification standard analysis.

Following calibration verification a standard at the reporting limit (CRI) is analyzed for all elements. Warning limits have been set at ±1RL and any sample determined to have a concentration below this standard will be reported as undetected.

The upper limit of the calibration range, linear dynamic range, is established for each analytical wavelength using high level standards. These standards are analyzed daily, or as necessary, against the normal calibration curve and must be within 10% of their true value to verify linearity. Any sample analyzed with a concentration above this linear dynamic range will be diluted and reanalyzed.

Also to verify the inter-element correction equations, inter-element correction standards (ICS) are analyzed both at the start and end of the analytic run. Both the major interfering and the interfered with elements are evaluated.

Inorganic Analyses other than Metals (Conventional Analyses)

Instrumentation and equipment used in analyzing samples for conventional wet chemical parameters (predominantly inorganic anions and aggregate organic characteristics) will be evaluated through the analysis of either internally prepared primary standards or externally derived Standard Reference Materials.

Depending upon the analysis, calibration is based upon direct stoichiometric relationships, regression analysis, or a combination of the two. Stoichiometry generally involves standardization of a titrant against a known primary standard and then the use of that titrant for determining the concentration of an unknown analyte (e.g. the use of sodium thiosulfate in the iodometric titration of dissolved oxygen). Regression analysis involves the determination of the mathematical relationship between analyte concentration and the response produced by the measurement being employed. Regression analysis is used for colorimetric determinations, ion specific electrode analysis and ion chromatography. The curve of response versus concentration is fit by the method of least squares using linear, polynomial or logarithmic regression dependant upon the pattern of response being measured.

Calibration is repeated for each analytical batch. Immediately following calibration, the standardized titrant or the calibration curve will be verified by the analysis of an Initial Calibration Verification standard (ICV) and Initial Calibration Verification Blank (ICB). The verification standard will be derived from a source other than that used for standardization or development of the standard curve. The ICV must return a value within 10% of its known concentration. The ICB must be less than the Reporting Limit (RL) or the lowest point on the standard curve, whichever is less. Initial calibration verification must be successfully completed prior to the analysis of any samples.

Calibration verification will be repeated after every ten samples processed during an analytical run. This Continuing Calibration Verification (CCV) will validate the method performance through an analytical sequence. If the continuing calibration values for either the standard or blank are out-of-control, the analyst will verify the outlying condition and, if verified, the analysis will stop and the method will be re-calibrated. All samples run between the outlying CCV and the preceding in-control CCV will be re-analyzed. In-control verification standards and blanks must bracket all samples within an analytical run.

Initial calibration depending upon the analysis is based on either a direct stoichiometric relationship, a linear regression analysis or a combination of the two. Stoichiometry generally involves standardization of a titrant and use of that titrant for determining the concentration of an unknown analyte (e.g. the use of thiosulfate in iodometric determination of dissolved oxygen). Regression analysis involves the determination of the mathematical relationship between the analyte concentration and the response produced by the measurement being employed. The curve is fit by the method of least squares using a linear, polynomial or logarithmic regression depending on the response being measured. The regression coefficient will be greater than or equal to 0.995 for the calibration to be considered acceptable.

Initial calibration curve is verified throughout the analytical sequence by analyzing a calibration verification standard after every 10 sample analyses. The calibration verification standard value will be within ± 10% of the initial calibration.

After initial calibration, a calibration blank will be analyzed to determine target analyte concentration levels. The level of analyte detected in the calibration blank will be less than the lowest standard concentration in the initial calibration.

SECTION 10: DATA VALIDATION and REVIEW

One hundred percent (100%) of laboratory data generated at ARI are subjected to a four level validation (review) process prior to release from the laboratory. The four levels of review are:

1. Analyst review
2. Peer review
3. Supervisory review
4. Administrative review

The data review process is outlined below and detailed in SOPs 200S through 206S.

In addition, Quality Assurance Personnel review 10% or more of all completed data packages for technical accuracy, project compliance and completeness. The data validation outlined below is completed in addition to the initial project review explained in Section 7 and QA specific reviews outlined in Section 11. If it is determined at any point during the analysis, reporting, or review process that data are unacceptable, prompt and appropriate corrective action must be taken. The corrective action will be determined by the situation. It is the responsibility of all staff members involved in data reporting and review to be aware of the quality control requirements and to be able to identify occurrences that require corrective action.

Analyst review:

Each analyst is responsible for producing quality data that meets ARI′s established requirements for precision and accuracy and is consistent with a client′s expectation.

Prior to sample preparation or analysis an analyst will verify that:

1. Sample holding time has not expired.
2. The condition of the sample or extract is described accurately on the laboratory bench sheet.
3. Specified methods of analysis are appropriate and will meet project required Data Quality Objectives.

4. Equipment and Instrumentation are in proper operating condition.
5. Instrument calibration and/or calibration verification are in control.

During sample preparation or analysis an analyst will:

1. Verify that Method Blanks and Laboratory Control Samples are in control.
2. Verify that QC (replicate, matrix spike analyses, SRM, etc.) samples meet precision and accuracy requirements.
3. In addition to verifying that quality control requirements are met, the analyst will review each sample to determine if any compound of interest is present at levels above the calibrated range of the instrument.
5. Check for data translation or transcription errors
6. Record all details of the analysis in the appropriate bench sheet or logbook.
7. Note any unusual circumstances encountered.

Following the analysis or sample preparation an analyst will:

1. Examine each sample and blank to identify possible false positive or false negative results.
2. Determine whether any sample requires reanalysis due to unacceptable quality control.
3. Review data for any unusual observances that may compromise the quality of the data, such as matrix interference
4. Review and verify that data entry and calculations are accurate and no transcription errors have occurred.
5. Document anomalous results or other analytical concerns on the bench sheet, corrective action form or Analyst Notes for incorporation into the case narrative.
6. Note data with qualifying flags as necessary.

7. Enter reviewed data into LIMS as appropriate, incorporate all necessary sample and quality control information into the data package and forward it for further review.

Peer review:

A second analyst trained in the appropriate SOPs will complete a peer review. Peer review will include at a minimum:

1. Verification that all QA (holding times, calibrations, method blanks, LCS, spiked sample analyses, etc.) criteria are in control.
2. Examination the data for possible calculation and transcription errors.
3. Review bench sheets and analyst notes for completeness and clarity.
4. Approve the analytical results or recommend corrective action to the laboratory supervisor.

When a second trained analyst is not available a peer review is not completed.

Supervisory Review:

Following analyst and peer review the data is forwarded to the laboratory section supervisor for review. The supervisor will:

1. Review the data package for completeness and clarity.
2. Follow-up on the peer review recommendations.

Designated reviewers normally perform the peer and supervisory reviews for GC-MS data. The reviewers are identified on the organizational chart in Appendix A.

Administrative Review:

The results of all analyses are reviewed for compliance with quality control criteria and technical correctness before data is released to the Project Manager for distribution to clients. Designated reviewers in the Metals, Conventional and Organic laboratories perform administrative reviews. Personnel responsible for administrative reviews are noted in the Organizational Chart in Appendix A to this LQAP.

Administrative review is the final data validation process. Personnel performing the administrative review are responsible for the final sign-off and release of the data. Following administrative review the data is released to Project Managers for incorporation into the final data deliverable package.

Administrative review will:

1. Verify that the analytical package submitted for reporting is complete and contains all necessary information and documentation.

2. Verify that appropriate and necessary data qualifying flags (Listed in Appendix N) have been used.
3. Verify that method blank and LCS data are acceptable, quality control requirements were met for surrogates in all samples and blanks, and that all necessary re-analyses or dilutions were performed.
4. Check the technical validity (i.e. are total metal > dissolved metals, is the cation/anion balance correct, etc.) of the complete data set.
5. Verify that all necessary final data reports have been generated and that all necessary data and documentation are included in the package.
6. Approve data reports for release.

10.2 Quality Assurance Review

10% (1 out each 10) final data packages are reviewed by ARI′s QA staff for compliance with ARI′s QA Program. This assessment includes, but is not limited to, review of the following areas:

1. Reporting and analysis requirements
2. Initial and continuing calibration records
3. Quality control sample results (method blank, LCS, spikes, replicates, reference materials)
4. Internal and surrogate standard results
5. Detection and reporting limits
6. Analyte identifications.

Data review activities are summarized and documented by the reviewer. The review notes are filed with the associated raw data in the project file. Any QA-related deficiencies identified during the data review will be forwarded to the QAPM for corrective action.

SECTION 11: QUALITY CONTROL SAMPLE ANALYSIS AND EVALUATION

<u>Routine analysis of quality control (QC) samples is necessary to validate the quality of data produced in ARI's laboratory.</u> ARI routinely utilizes the following quality control analyzes as defined in Section 11.3:

1. method blank (MB)
2. holding blank (HB)
3. surrogate standard analyzes (SS)
4. laboratory control sample (LCS)
5. laboratory control sample duplicate (LCSD)
6. standardized reference material (SRM)
7. sample(matrix) replicate (MD)

8 matrix spike (MS)

9. matrix spike duplicate (MSD)

The number and type of QC analyses depend on the analytical method and/or the QA/QC protocol required for a specific project. A range of acceptable result is defined for each type of QC analysis. When all quality control sample results are acceptable, the analysis is considered to be "in-control" and the data suitable for its intended use. Conversely, quality control sample results that do not meet the specified acceptance criteria indicate that the procedure may not be generating acceptable data and corrective action may be necessary to bring the process back "in-control".

Detailed information concerning sample preparation batches, QC analyses and surrogate standards follow:

11.1 Sample Preparation Batch

<u>All QC samples will be associated with a discrete sample preparation batch.</u> A preparation batch is defined as 20 or fewer field samples of similar matrix processed together by the same analysts, at the same time, following the same method and using the same lot of reagents. Additional batch requirements are detailed in ARI's method specific standard operating

procedures. Each preparation batch will be uniquely identified. All samples, field and QC, will be assigned an ARI LIMS ID number and will be linked to their respective preparation batch. Each sample batch will contain all required QC samples in addition to a maximum of twenty field samples.

ARI will accommodate client, QC protocol or QAPP specific sample batching schemes.

11.2 QC Sample Requirements

Each preparation batch will include, at a minimum, a method blank (MB) and a laboratory control sample (LCS). Additional QC samples will be analyzed based upon the specific QC protocol required, data deliverable requirements or client request. ARI recommends that QC samples used to measure analytical precision also be included in each sample batch. These may include: a matrix spike and a matrix spike duplicate pair; a sample duplicate and a matrix spike pair or an LCS duplicate (LCSD) for comparison with the LCS.

11.3 QC Sample Definitions

11.3.1 Method Blank (MB)

A method blank is an aliquot of water or solid sample matrix that is free of target analytes and is processed as part of a sample batch. The MB is used to verify that contaminants or compounds of interest are not introduced into samples during laboratory processing. MBs will be spiked with surrogate standards for all organic analyses.

ARI defines an acceptable MB as one that contains no target analytes at a concentration greater than one-half ARI’s reporting limit or 5% of an appropriate regulatory limit or 10% of the analyte concentration in the sample which ever is greatest.

A minimum of one method blank will be included in each preparation batch. A maximum of twenty samples may be associated with one method blank. An acceptable MB is required prior to analysis of field samples from a preparation batch. For methods not requiring pre-analysis sample preparation, a minimum of one method blank will be analyzed immediately prior to sample analysis, periodically throughout the analytical sequence, and also at the end of the sequence.

The results of the MB analysis will be reported with the sample results.

11.3.2 Holding Blank (HB)

Holding blanks are organic-free water samples that are placed in each volatile organic sample storage refrigerator to monitor for possible cross-contamination of samples within the storage units. A holding blank from each refrigerator will be analyzed every 14 days. Holding Blank analyses will be reviewed by laboratory management and archived in ARI's electronic document archive.

11.3.3 Laboratory Control Sample (LCS)

An LCS is processed as part of each preparation batch, and is used to determine method efficiency. An LCS is an aliquot of water or solid matrix free of target analytes to which selected target analytes are added in known quantities. The analytes spiked into LCS samples are listed in ARI's method specific SOPs. LCS will be spiked with surrogate standards for all organic analyses.

Following analysis the percent recovery of each added analyte is calculated and compared to historical control limits. Current control limits are listed in Appendix K of this document. When calculated recovery values for all spiked analytes are within specified limits, the analytical process is considered to be in control. Any recovery value not within specified limits requires corrective action prior to analysis of any field samples from the associated preparation batch.

A minimum of one LCS will be prepared for each sample preparation batch. LCS analysis for those methods not requiring pre-analysis sample preparation will be performed after each continuing calibration. The results of all LCS performed will be reported with the sample results. A maximum of twenty samples may be associated with one LCS.

Specific clients or QA protocol may require the analysis of a duplicate LCS. When LCS duplicates are analyzed the failure of any analyte in either LCS to meet QC limits must trigger a corrective action.

11.3.4 Replicate Analysis

Replicate analyses are often used to determine method precision. Replicates are two or more identical analyses performed on subsamples of the same field sample at the same time. Replicate analyses should be performed on samples that are expected to contain measurable concentrations of target analytes.

The calculated percent difference between replicates must be within specified limits or corrective actions are required. Percent differences exceeding the specified limit signal the need for procedure evaluation unless the excessive difference between the replicate samples is clearly matrix related.

For inorganic analyses, a minimum of one replicate set should be processed for each analytical batch. Replicate sample analyses are not routinely performed for organic parameters. Instead, analytical precision is evaluated through the analysis of a duplicate matrix spike sample (MSD).

In order to perform replicate analyses, ARI's must receive sufficient volume to prepare the replicate aliquots.

Field replicates submitted to the laboratory will be analyzed as discrete samples.

11.3.5 Matrix Spike

A matrix spike is an environmental sample to which known quantities of selected target analytes have been added. The matrix spike is processed as part of an analytical batch and is used to measure the efficiency and accuracy of the analytical process for a particular sample matrix. The analytes spiked into MS samples are listed in ARI's method specific SOPs. MS samples will be spiked with surrogate standards for all organic analyses.

Following MS analysis the percent recovery of each spiked analyte is calculated and compared to historical control limits. If recovery values for the spiked compounds fall within specified limits, the analytical process is considered to be in control. When calculated recovery is outside of historical limits corrective action is recommended.

Matrix spike duplicate (MSD) analyses are often used to measure method precision and accuracy. In this case the relative percent difference for recovery of spiked compounds is calculated and compared to established criteria.

Unless directed otherwise, ARI's policy is to prepare a matrix spike and a duplicate with each batch of samples for inorganic analysis and an MS/MSD set for each batch of samples for organic analyses. Analyte recovery and RPD values are reported with sample data.

11.3.6 Standardized Reference Material (SRM)

An SRM is material analyzed and certified by an outside organization to contain known quantities of selected target analytes independent of analytical method. SRMs are normally purchased from outside suppliers outside of ARI and are supplied with acceptance criteria. Analysis of SRM is used to assess the overall accuracy of ARI's analytical process. SRM are routinely analyzed with each batch of samples for wet chemistry (conventionals analysis) samples. External reference samples are analyzed after instrument calibration and prior to sample analysis. Compound recovery values not within the specified limit signal the need to evaluate either the calibration standards or instrumentation.

11.3.7 Other Quality Indicators

In addition to analyzing the quality control samples outlined previously, various indicators are added to environmental samples to measure the efficiency and accuracy of ARI's analytical process. Surrogate standards are added to extractable organic samples prior to extraction to monitor extraction efficiency. Surrogate standards will also be added to volatile organic samples prior to analysis to monitor purging efficiency. Internal standards are added to metals digestates for ICP-MS analyses and to organic samples or extracts prior to analysis to verify instrument operation.

The calculated recovery of surrogate analytes is compared to historical control limits to aid in assessing analytical efficiency for a given sample matrix.

11.4 Control Limits

To provide a means for evaluating whether or not a process is in control, acceptance limits have been established. These are based on internal, historical data for organic analyses and method specified limits for inorganic analyses. Samples associated with a specific program or contract (such as the USEPA Contract Laboratory Program) will be evaluated against program/contract-specified criteria. Routine samples will be evaluated against internally generated control limits. Project specific control limits will be used as required provided they have been reviewed for feasibility and approved by laboratory management.

Results of QA analyses are transferred from the LIMS to a control limit and chart generation program. The QAPM coordinates control chart and control limit generation. Control limits will be generated for LCS compound recoveries, surrogate recoveries, and matrix spike compound recoveries, on a method and matrix specific basis. Advisory control limits will be utilized for analyses performed on an infrequent basis until a sufficient number of usable data points are collected. Control limits are updated at least annually, but may be updated more frequently if method or instrument changes have been made. Laboratory control and acceptance limits are detailed in Appendix K.

Two levels of control limits are utilized in evaluating process control: warning limits and action limits. Limits are statistically determined from values obtained from LCSs or other control samples. Warning limits, within which 95% of all results are expected, equal ± two standard deviations from the average result. Action limits, within which 99.7% of all results are expected, are equal to ± three standard deviations from the average result. Mean values, warning limits, and action limits are necessary for thorough evaluation of process control.

11.5 Control Charts

Control charts, in conjunction with other control sample analyses, are useful in verifying that an analytical procedure is performing as expected. The control chart provides a pictorial representation of how closely control sample results approximate expected values, as well as showing analytical trends. Indicated on the control chart are the mean and upper and lower warning and action limits. The warning and action limits are used to determine whether or not an analytical process is in control. The mean is used to determine whether results obtained for a procedure are trending upward or downward, which may ultimately affect the accuracy of sample results.

The QA Officer will coordinate generation of control charts based on laboratory data at least semi-annually. These control charts will be distributed to and reviewed by section supervisors and managers. Any significant trends or variations in results will be identified, and the source of the trend corrected. Copies of control charts will remain on file in the QA section. At the bench/instrument level, individual results from quality control samples are evaluated against the limits.

SECTION 12: CORRECTIVE ACTIONS AND REESTABLISHMENT OF CONTROL

To produce quality data, it is important that all aspects of the analytical process are under control and that all specified quality control criteria are met. On occasion, however, procedures, reagents, standards, and instrumentation can fail to meet specified criteria. Should any of those situations occur, the quality of data produced may be compromised. When procedures no longer appear to be in control, sample processing will be halted and appropriate actions will be taken to identify and rectify any instrument malfunctions or process-related issues. Prior to resuming sample analysis, verification of control will be made through the analysis of various control samples. Actions taken and observations made during reestablishment of control will be fully documented on the bench sheet or as an Analyst Note. Only when control has been regained and all actions documented will sample processing resume. This ensures that no results generated during the suspect period will be reported.

12.1 Responsibilities

It is the responsibility of all laboratory personnel involved with sample processing to be able to determine whether or not a procedure is in control and to verify that all data are produced under conditions that are “in control”. It is at the analytical level that unacceptable conditions are most easily detected and addressed. These personnel are also responsible for employing and documenting all necessary corrective actions taken to regain control of a procedure. Samples processed during suspect periods will be reprocessed, and suspect data will be appropriately annotated to indicate that it is of questionable quality. The analytical staff will verify that all data submitted for review has been generated under acceptable conditions. All anomalies will be documented on the Analyst Notes form and will include such information as: type and source of anomaly, reasons for the anomaly, and actions taken to correct the problem. All personnel involved with subsequent and final data review are responsible for verifying that data were generated under acceptable conditions. If suspect data are identified at the review level, responsible analysts should be contacted to determine whether additional actions (such as reanalysis) will be taken. In addition, reviewers will confirm that anomalies noted by the analyst were indeed addressed and that appropriate corrective actions were taken.

On occasion, it is not possible to generate data that meet all Quality Control Standards. This may be due to sample volume limitations or sample matrix effects. It is the responsibility of the analytical and data review staff to document these situations and to maintain communication with the Project Management staff. The Project Management staff, in turn, is responsible for notifying the client or specifying additional actions to be taken. Project Managers are further responsible for ensuring that clients fully understand which data are questionable and the reasons why acceptable results could not be generated.

It is the responsibility of the QAPM to perform regular reviews of corrective action procedures to ensure that unacceptable conditions or suspect data will be identified prior to releasing results. Section managers and supervisors are responsible for ensuring that appropriate corrective action procedures are in place and that all staff members are trained to identify and act upon “out of control” situations.

12.2 Corrective Actions

There are various stages of the analytical process where the procedure may fall out of control and require corrective action. In general, all procedures and equipment will be monitored to verify that control is maintained during sample processing. The following details those stages as well as the actions taken to reestablish and verify control.

Sample Preparation

During sample preparation, all glassware associated with a specific sample will be clearly labeled to eliminate the possibility of sample mix-up or mislabeling. Laboratory staff will ensure that sample-identifying labels are accurately completed and that correct sample identification is maintained at all times. If a sample appears to have been misidentified or mixed with another sample during preparation, the suspect samples will be discarded and new aliquots taken. If there is insufficient sample for a second preparation, the situation will be documented on the bench sheet and the Project Manager will be immediately notified.

Addition of surrogate standards or matrix spiking solutions will be carefully monitored to ensure that all samples are accurately fortified. Volumes and standard solution numbers of all standards added to samples will be recorded on the bench sheet. If there is suspicion that a sample has been incorrectly spiked a new sample aliquot should be prepared. If there is insufficient volume for re-preparation, the bench sheet will be annotated to indicate which samples may be inaccurately fortified.

If sample matrix hinders processing per standard procedures, the section supervisor or manager will be consulted for guidance on appropriate actions. Preparation of smaller sample aliquots or employment of different procedures may be necessary. Any deviations from normal protocols will be documented on the bench sheet.

If at any time during sample preparation sample integrity is compromised or a procedural error is noted, the sample will be discarded and re-prepared. If insufficient sample volume is available for re-preparation, the situation will be documented on the bench sheet and the Project Manager will be immediately notified.

Calibration and Tuning

Prior to sample analysis, all instrumentation will be calibrated and tuned to ensure that equipment meets all criteria necessary for production of quality data. Equipment must meet the calibration criteria specified in the section entitled “Calibrations”, per manufacturer specifications or per project/contract requirements. If these criteria are not met, corrective actions must be employed. Any corrective actions taken will be fully documented in the appropriate logbook, indicating the problem, the actions taken, and verification. Samples will not be analyzed until initial verification of system performance has been made. In the event that continuing calibration results do not meet criteria, sample analysis will not resume until corrective actions have been employed or the system has been re-calibrated.

> GC/MS Analyses - Analysis of the instrument performance check solution (BFB or DFTPP) will meet the specified ion abundance criteria. Initial calibration standards at a minimum of five concentrations will meet specified response factor and percent relative standard deviation criteria. It criteria are not met for initial calibration, the system will be inspected for malfunction. The initial tuning and calibration will be repeated, with all necessary corrective actions taken, until calibration criteria are met.
>
> A check of the calibration curve will be performed at a minimum of once every 12 hours. All response factor criteria will be met. Additionally, the percent difference between the initial and continuing calibrations will meet specified criteria. If criteria are not met, the system will be inspected for malfunction. The initial tuning and calibration verification will be repeated, with all necessary corrective actions taken, until calibration criteria are met.
>
> Internal standard responses and retention times for standards will meet specified criteria. Any sample not meeting internal standard criteria will be reanalyzed. If reanalysis yields the same response and the instrument is determined to be functioning correctly, the failure to meet criteria will be attributed to sample matrix interference. No further re-analyses will be required.
>
> GC Analyses - Organochlorine pesticide calibrations will be evaluated using either USEPA CLP or SW-846 guidelines. The Resolution Check standard will meet

resolution criteria and Endrin and DDT breakdown in the Performance Evaluation standard will meet breakdown criteria. Initial calibrations will meet percent relative standard deviation criteria. If, during the initial calibration sequence, criteria are not met, the system will be inspected for malfunction and the initial calibration be reanalyzed. Samples will not be analyzed until all initial calibration criteria are met.

Continuing calibrations of either the mid-level calibration standard or Performance Evaluation standard will be analyzed every 12 hours. If continuing calibration criteria are not met, the system will be inspected for malfunction and corrective actions will be taken to bring the system back into compliance. If, after corrective actions, the system is still not in compliance, re-calibration will be performed. After the system has been successfully corrected or re-calibrated, all samples previously analyzed between the acceptable and unacceptable continuing calibration will be reanalyzed.

If, during the analytical sequence, retention time shifting occurs, the system will be inspected for malfunction and corrective actions will be taken to bring the system back into compliance. If, after corrective actions, the system is still not in compliance, re-calibration will be performed. After the system has been successfully corrected or re-calibrated, all samples with retention times outside the specified windows will be reanalyzed.

For all other analyses, initial calibration standards analyzed at a minimum of five concentrations will meet percent relative standard deviation criteria. If criteria are not met for initial calibration, the system will be inspected for malfunction. The calibration will be repeated, with all necessary corrective actions taken, until calibration criteria are met.

A check of the calibration curve will be performed after every 10 samples. All percent differences between the initial and continuing calibrations will meet specified criteria. If criteria are not met, the system will be inspected for malfunction and re-calibration will be performed. Samples analyzed between an acceptable and unacceptable calibration check will be reanalyzed.

Metals and Inorganic Analyses - Initial calibrations will be verified by analyzing a calibration check standard immediately after calibration. The percent differences between the initial calibration and calibration check standard will meet specified percent difference criteria. If criteria are not met, the system will be inspected for malfunction. The initial calibration and calibration check will be reanalyzed until acceptance criteria are met.

The calibration check standard analyzed after every 10 samples will meet percent difference criteria. If the calibration check standard is not acceptable, the system will be inspected for malfunction and re-calibration will be performed as necessary. Samples analyzed between acceptable and unacceptable calibration check standards will be reanalyzed.

Instrument Blanks

Prior to sample analysis, instrument and/or calibration blanks may be evaluated for the presence of target analytes. If analytes are detected, the concentrations must be below the reporting limits for those analytes. If analytes are detected at levels above the reporting limits, the source of contamination will be identified. Sample analysis will not commence until analyte levels in instrument and calibration blanks are below the reporting limits. Instrument and calibration blanks are analyzed for VOA analysis only if sample carryover is suspected.

Instrument and calibration blanks will also be analyzed throughout the analytical sequence. These will not contain target analytes at levels above the method detection limits for organic parameters or the reporting limit for inorganic parameters. If one or more analytes exceed the RL, an additional blank will be analyzed. If analyte levels are still above the method detection limits, the system will be inspected for malfunctions and the source of contamination will be identified. Sample analysis will not resume until instrument and calibration blank analyte levels are below the RL. Organic samples analyzed between acceptable and unacceptable blanks will be evaluated to determine the need for reanalysis per the following guidelines:

> If no target analytes are detected in the samples, reanalysis will not be required.
>
> If sample target analyte levels are above the method detection limits, samples will be reanalyzed at analyst discretion. Reanalysis will be dependent upon the analyte levels and whether or not there is likelihood that analytes detected are a direct result of system contamination.
>
> If the analytes present at unacceptable levels in the instrument blank are not of interest or concern in the associated samples, reanalysis will not be required. This is often a consideration for ICP analyses where analytes of concern may be only a subset of the possible analytes.

Methods for the analysis of inorganic analytes require that all samples associated with an out of control blank be re-analyzed.

Method Blanks

Prior to sample analysis, method blanks will be evaluated for the presence of target analytes. Ideally, no target analytes should be present in the method blank. If analytes are detected at or above the Reporting Limit, the method blank will be reanalyzed to verify that the contamination is not a result of instrument carryover or malfunction. If the presence of target analytes is confirmed, the concentrations must be below the RL for those analytes.

Several volatile and semi-volatile compounds and certain elements are considered to be common laboratory contaminants. Concentrations of these common laboratory contaminants may exceed the method detection limits, but may not be present at concentrations greater than five times the method reporting limits. Target analytes considered to be common laboratory contaminants are:

Volatile Organic Compounds

Methylene Chloride
Acetone
2-Butanone

Semi-volatile Compounds

Dimethylphthalate
Diethylphthalate
Di-n-butylphthalate
Butylbenzylphthalate
bis-(2-Ethylhexyl) phthalate
Di-n-octylphthalate

If target analyte concentrations in the method blank exceed the acceptable levels and instrument malfunction or contamination has been ruled out, the method blank and all associated samples will be re-prepared and reanalyzed. If there is insufficient sample volume remaining for reprocessing, the Project Manager will be notified. If it is necessary to report results associated with an unacceptable method blank, the results will be qualified to indicate possible laboratory contamination.

In the event that an analyte detected in the samples ≥ 20 times the method blank levels re-preparation and reanalysis is not required. It is assumed that any contamination in the method blank is insignificant and will not affect final quantified results.

Laboratory Control Samples

Prior to sample analysis, the laboratory control sample (LCS) will be evaluated to verify that recovery values for all spiked compounds are within the specified acceptance limits. If LCS recoveries are out of control, corrective action is required. Corrective actions may include anything from a written explanation in the case narrative up to re-preparation and reanalysis of the entire sample batch.

Internal Standards

For volatile and semi-volatile organic analyses, internal standard results will be evaluated after each analytical run to verify that the values are within acceptance limits. Internal standard values will be within -50% to +100% of the internal standard values in the continuing calibration. If any internal standard does not meet the criteria, the system will be evaluated to confirm that all instrumentation is operating properly. The sample will then be reanalyzed. If the reanalysis results do not meet acceptance criteria, it will be assumed that the sample matrix is affecting internal standard values. Further reanalysis will not be required.

Surrogate

Surrogate recovery values will be evaluated after each analytical run to verify that the values are within acceptance limits. If recovery values are outside acceptance limits, the system will be evaluated to confirm that all instrumentation is operating properly. Documentation and bench sheets will be reviewed to verify that the concentrations of surrogate spike solutions added are accurate. For extractable organic analysis, bench sheets will be reviewed to determine if any additional dilutions or concentrations were performed. Bench sheets will also be reviewed for any explanatory notes about the sample.

If no system documentation, solution preparation or spiking errors are identified, the following considerations will be made:

> When a volatile organic surrogate recovery value is outside of acceptable limits, the sample will be reanalyzed. If the reanalysis results are within acceptance limits, it will be assumed that the initial analysis was in error. If the reanalysis results are not within acceptance limits, it will be assumed that sample matrix is affecting surrogate recovery. Further reanalysis will not be required.
>
> For semi-volatile organic analysis, one acid and one base/neutral surrogate recovery may be outside acceptance limits with no corrective action required provided the recoveries are at least 10%. If more than one acid or base surrogate standard is outside acceptance limits, or if any surrogate recovery value is less than 10%, the sample will be re-extracted and reanalyzed. If the reanalysis results are not within acceptance limits, it will be assumed that sample matrix is affecting surrogate recovery assuming all other QC analyses are acceptable. Further reanalysis will not be required. *Matrix spikes will not be re-extracted for unacceptable surrogate recovery values.*
>
> For other extractable organic analysis, if a surrogate recovery value is outside of acceptance limits, the data will be reviewed to determine if the unacceptable surrogate is a result of matrix effect. If matrix interference is determined, the sample will be re-extracted or if re-extraction is not deemed useful, fully documented in the analytical narrative associated with the analyses. If a surrogate recovery is too low, based on the opinion of the final QA Data Reviewer, the sample will be re-extracted and reanalyzed.

Matrix Spikes

Matrix spikes will be evaluated to verify that recovery values for all spiked compounds are within the specified acceptance limits. If unacceptable results are obtained, the system will be evaluated to confirm that all instrumentation is operating properly. Documentation and bench sheets will be reviewed to verify that the concentrations of spike solutions added are accurate.

Sample preparation bench sheets will be reviewed to determine if any additional dilutions or concentrations were performed. Bench sheets will also be reviewed for any explanatory notes about the sample.

If no system, documentation, solution preparation, or spiking errors are identified, the following considerations will be made:

Organic Analyses:

> If a matrix spike recovery value is outside the acceptance limits, but the LCS meets recovery acceptance criteria, re-extraction will not be required. It will be assumed that the unacceptable recovery value is a result of matrix effect.
>
> If both LCS and matrix spike recovery values are outside the acceptance limits, the sample batch will be re-extracted and reanalyzed. This indicates the possibility of a systematic error that may affect the accuracy of final results.

Inorganic analyses:

> Matrix spikes with unacceptable recovery values will be re-prepared and reanalyzed. If the reanalysis results are not within acceptance limits, it will be assumed that the sample matrix is affecting the recovery values. Further reanalysis will not be required.
>
> A post-digestion spike analysis will be performed for all metals analyses processed following EPA-CLP guidelines.

Sample and Matrix Spike Replicates

Sample and matrix spike replicates will be evaluated to verify that percent differences between the replicates are within acceptable limits. Percent differences for metals and inorganic sample replicates will be within ±20%. When percent difference criteria are not met, the system will be evaluated to confirm that all instrumentation is operating properly. Documentation and bench sheets will be reviewed to verify that the concentrations of spike solutions added are accurate. Sample preparation bench sheets will be reviewed to determine if any additional dilutions or concentrations were performed. Bench sheets will also be reviewed for any explanatory notes about the sample.

If no system, documentation, solution preparation, or spiking errors are identified, the following considerations will be made:

> If percent difference values between sample replicates for metals and inorganic analyses do not meet acceptance criteria the Project Manager in consultation with ARI’s client will determine weather to re-analyze the samples or flag the analytical results. If the samples are reanalyzed and results are not within acceptance limits, it will be assumed that the sample is not homogeneous, causing the poor analytical precision. Further re-analyses will not be required.

> Replicate sample analyses are not routinely performed for organic parameters.
>
> If percent difference values between matrix spike replicates do not meet acceptance criteria, but spike recovery values are acceptable, no re-extraction or analysis will be required. It will be assumed that the sample is not homogeneous, causing the poor analytical precision.
>
> If percent difference values between matrix spike replicates do not meet acceptance criteria and recovery values in one or both replicates are not acceptable, the sample and associated matrix spike replicates will be re-prepared and reanalyzed. If the reanalysis results are not within acceptance limits, it will be assumed that the sample is not homogeneous, causing the poor analytical precision. Further re-analyses will not be required.

Samples

In addition to monitoring sample quality control indicators, ARI evaluates samples to determine the need for reanalysis. Conditions considered while evaluating samples are:

> If a target analyte detected in a sample exceeds the upper limit of the instrument calibration range, the sample is diluted and reanalyzed. Dilution and reanalysis continues until the analyte concentration falls within the linear range of calibration. If the sample requires dilution to such a level that surrogates are no longer detectable and analytical accuracy is questionable, the sample will be re-prepared using a smaller sample aliquot.
>
> Samples will be evaluated for matrix interference that may affect analyte detection and quantification. Appropriate cleanup procedures will be employed to remove interference. Samples will be diluted and reanalyzed as required to minimize background interference. If it is not possible to remove all interference, reported results will be qualified as necessary.
>
> If low-level analytes detected in a sample are suspected to be a result of instrument carryover, the sample will be reanalyzed. If analyte levels remain approximately the same the initial results will be considered valid. If analytes are not detected during reanalysis, it will be assumed that the initial detection was due to carryover, and the initial results will not be reported.
>
> If an instrument malfunction or procedural error occurs during analysis, all affected samples will be reanalyzed. If the malfunction appears to be an isolated incident, it will not be necessary to inspect the analytical system. If the malfunction appears to be an ongoing problem, the system will be inspected and necessary maintenance/corrective actions will be taken prior to resuming analysis.

Sample Storage Temperatures

Every sample storage unit's temperature will be evaluated at the beginning of each day. Temperatures will be between 2 and 6 °C for refrigerators and < -10 °C for freezers. If a temperature is outside the specified range, the unit's temperature will be adjusted to bring the temperature back within limits. The Temperature Log will be annotated to document the adjustment.

If adjustment does not bring the temperature within range, or if adjustment is not possible, the Laboratory Supervisor will be notified and will take corrective action. The Temperature Log will be annotated to document the action. If the temperature fluctuation is chronic or extreme, the samples will be removed from the unit and placed in another storage unit until the malfunctioning unit is repaired or replaced.

Balance Calibrations

Balances are serviced once a year by a certified technician. The service includes preventative maintenance and calibration.

Balance accuracy will be verified prior to balance use. The recorded weight will be within the acceptance criteria specified on the Calibration Log. If the recorded weight is not within the acceptance limits, the QAPM will be notified. The Calibration Log will be annotated to document the action. The balance will not be used until it can be verified that acceptance criteria can be met.

Water Supply System

The water supply for the volatile organic and inorganic laboratories will be monitored daily for the presence of contaminants through the analysis of method and/or instrument blanks. Organic contaminants, especially chloroform, are early indicators of the need for preventative maintenance. If organic or other contaminants are detected, the system filters will be changed. After filters have been changed, an additional aliquot of water will be analyzed to confirm that contaminants are no longer present.

The water supply for the metals laboratory will be monitored daily. When the resistivity falls below 18 megaohm, system maintenance will be performed.

Section 13: LABORATORY EVALUATION AND AUDITS

Routine evaluations of the laboratory ensure that all necessary quality control activities have been implemented and are being effectively utilized. It is the responsibility of the QAPM to ensure that quality control activities are periodically evaluated for compliance. Findings from these evaluations allow the laboratory to address and modify any procedures that are not in accordance with the laboratory Quality Assurance Program or accreditation program requirements.

A number of tools are available for monitoring laboratory performance. ARI evaluates the quality of laboratory performance through the use of

Internal QA Audits
Technical System Audits
Data Quality Reviews
Audits by Outside Agencies (External Audits)
Performance Evaluation Analyses
Annual Management Review

Each audit provides an objective evaluation of laboratory performance. All internal audits and reviews are conducted according to specified guidelines. In addition, a collective review of audit findings provides an overall evaluation of the laboratory. Deficiencies noted during the course of an audit or performance evaluation will be addressed, a root cause analysis performed, and appropriate corrective actions will be taken. Follow-up audits will be conducted to verify that corrective actions have been satisfactorily implemented.

Internal QA Audits

The Quality Assurance Officer regularly evaluates quality control activities within the laboratory to verify accuracy and compliance. The QAPM or designee routinely audits the following activities:

Balance verification records
Sample storage cooler temperature records
Oven, incubator and water bath temperature records
Chain of Custody records
Standard preparation records
Documentation and Response to Client Complaints
Chain of Custody Procedures

Documentation of Computer and Software Revisions

Checklists are utilized to ensure consistent and complete audits. The checklists are included in SOP 1005S. Internal QA audit results will be summarized and reported to both staff and management. Corrective actions will be initiated as necessary. A schedule of internal QA audits is provided in Appendix L.

When an audit finding indicates possible errors or deficiencies in analytical data, ARI will correct the error and notify all affected clients within 2 working days.

Technical System Audits

An audit of technical systems within the laboratory will be conducted at least annually. The audit will focus on the quality control and data generation/collection systems. The QAPM will conduct the audit with assistance from section managers and data reviewers. This evaluation will address areas such as:

Calibration records
Maintenance records
Control charts
Computer vs. hard copy data
Adherence to SOPs and methods
Support system records (DI water, balances, pipettes, etc.)

In addition, audit results from the past year will be reviewed to verify that all necessary corrective actions have been addressed and implemented.

Data Quality Reviews

Reviews of final data packages by the QAPM or his/her designee. The Data quality review verifies that the final data deliverables meet project and quality systems specifications

Audits by Outside Agencies (External Audits)

As a requirement for many accreditation programs, on-site review of laboratory facilities and operations are conducted by clients or other outside agencies. The laboratory may be periodically audited by the following agencies:

State of Washington Department of Ecology
A United States Department of Defense Agency (US Army, US Navy or US Air Force)
State of Oregon Environmental Laboratory Accreditation Program (ORELAP) as an Accrediting Body for The NELAP Institute.

External audits are beneficial in that they provide an independent evaluation of the laboratory without internal influence or bias. The laboratory will be available for evaluation at the convenience of the auditing agency. Laboratory personnel will be available during the audit to address questions or provide information regarding laboratory procedures. All comments, deficiencies, and areas of potential improvement noted by the auditor will be reviewed, and appropriate corrective actions will be taken to resolve the noted issues. A listing of laboratory accreditations is included as Appendix M.

Performance Evaluations

Performance Evaluation (PE) sample analysis is a means of evaluating individual performance as well as the overall analytical system. In addition to the external audit, PE sample (PES) analysis is a requirement of many certification and accreditation programs. The laboratory routinely participates in the following performance evaluation programs:

Analytical Standards, Inc.(ASI) Performance Evaluation Studies
USEPA Water Pollution (WP) Performance Evaluation Studies (Commercial Supplier)
USEPA Water Supply (WS) Performance Evaluation Studies (Commercial Supplier)
USEPA Contract Laboratory Program Quarterly Performance Evaluations (as required)

A PES is a sample containing specific analytes in concentrations unknown to analysts. Comparison of the laboratory result to the "true" value determines the accuracy of the reported result and indicates the laboratory's ability to perform a given analysis. These results are also used to verify individual analyst proficiency. The QAPM will periodically submit internal “blind” performance evaluation samples to the laboratory sections for analysis. Values obtained by the laboratory will be compared to expected or true values. Parameters with reported values outside of the specified acceptable ranges will be evaluated by the analytical staff to determine the source of error. All necessary corrective actions will then be documented and implemented.

Quality Assurance Reports to Management and Staff

In order to ensure that laboratory managers are kept apprised of quality related activities and laboratory performance, a “Quality Assurance Report to Management” the QAPM will be produced annually and distributed to ARI management. The report will, at a minimum include:

1. Information concerning current and ongoing internal and external audits
2. Status and results of current or ongoing internal or external proficiency analyses
3. Identification of Quality Control problems in the laboratory
4. Information on all ongoing Corrective Actions
5. Current status of external certifications
6. Current status of the Staff Training Program
7. Outline of new and/or future Quality Assurance Program initiatives

The QAPM is responsible for follow-up and resolution of any deficiencies discussed in the report. Unresolved issues will remain on subsequent reports until addressed. Information such as performance evaluation results and audit reports will be distributed to the laboratory staff.

The application of these combined activities provides comprehensive monitoring and assessment of laboratory performance, and ensures that all data produced by ARI will be of the highest possible quality.

Annual Management Review

In the last quarter of each year, executive management will perform a comprehensive review of ARI quality system and analytical procedures to assess their continued suitability and effectiveness. Management will consider the following during the review pocess:

Suitability of policies and procedures
Reports fro management and supervisory personnel
Results of internal audits
Corrective and preventative actions
Results of recent external quality systems audits
PT results
Changes in volume and type of analyzes performed
Client Feedback
Complaints

Other relevant factors such as quality control activities, available resources and analyst training

Section 14: APPENDICES

A. Laboratory Organization and Key Personnel Resumes
B. Training and Demonstration of Proficiency
C. Laboratory Facilities
D. Laboratory Instrumentation
E. Standard Operating Procedures
F. Sample Collection Containers and Preservatives
G. Laboratory Workflow
H. Analytical Methods
I. Method Detection Limits and Reporting Limits
J. Tuning and Calibration Criteria, Volatile and Semi-volatile Organics
K. Quality Control Recovery Limits
L. Internal Audit Schedule
M. Laboratory Certification and Accreditation
N. Data Reporting Qualifiers
O. Personal Conduct Statement
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Q. Modification to ARI’s LQAP

Appendix A

Laboratory Organization Chart
and
Key Personnel Resumes

KEY PERSONNEL RESUMES

Mark Weidner

Laboratory Director

Profile

Mr. Weidner co-founded Analytical Resources, Inc., along with Brian Bebee, Sue Dunnihoo and David Mitchell. Prior to his co-founding of ARI in 1985, Mr. Weidner was the Head Mass Spectroscopist at Michigan State University and an instructor at the Finnigan Institute. As Laboratory Director, Mr. Weidner is responsible for overall laboratory performance, as well as facility expansion and major purchasing. Mr. Weidner is intimately familiar with all operational and analytical aspects of ARI and initiated many of the procedures currently in use.

Education:

M.S., Medicinal Chemistry, Purdue University, W. Lafayette, IN (1978).
B.S., Biochemistry, Michigan State University, E. Lansing, MI (1975).

Experience:

Laboratory Director/Co-founder, Analytical Resources, Inc., Seattle, WA (1985 to present).
Senior Chemist, City of Seattle, Seattle, WA (1981 to 1985).
Instructor, Finnigan Institute, Cincinnati, OH (1979 to 1981).
Mass Spectroscopist, Michigan State University (1978 to 1979).

Brian Bebee

Laboratory Manager

Administrative Services Manager

Profile:

Mr. Bebee co-founded Analytical Resources, Inc., along with Mark Weidner, Sue Dunnihoo, and David Mitchell. Prior to his co-founding of ARI, Mr. Bebee had gained extensive GC/MS experience as a GC/MS Chemist at the Municipality of Metropolitan Seattle, (METRO). When he co-founded ARI in 1985, Mr. Bebee became the Organics Division Manager until 1993, when he assumed the position of Laboratory Manager. As Laboratory Manager, Mr. Bebee is responsible for the day to day flow of all laboratory operations, including personnel, instrument, and procedural concerns. He is also responsible for the direct supervision of the Volatile and Semivolatile Laboratories.

Education:

A.A., Oceanography, Marine Biology, Biology, Shoreline Community College (1973).

Experience:

Laboratory Manager, Analytical Resources, Inc., Seattle, WA (1987 to present).

Organics Division Manager/Co-founder, Analytical Resources, Inc., Seattle, WA (1985 to 1987).

GC/MS/DS Operator, Municipality of Metropolitan Seattle, Seattle, WA (1980 to 1985).

Senior Water Quality Technician, Municipality of Metropolitan Seattle (METRO), Seattle, WA (1976 to 1980).

Water Quality Technician, Municipality of Metropolitan Seattle (METRO), Seattle, WA (1973 to 1976)

David Mitchell

Quality Assurance Program Manager

Profile:

Mr. Mitchell co-founded Analytical Resources, Inc., along with Mark Weidner, Sue Dunnihoo, and Brian Bebee. Prior to his co-founding of ARI, Mr. Mitchell had gained extensive experience in the environmental chemistry field as Senior Chemist and Trace Organics Laboratory Supervisor at the Municipality of Metropolitan Seattle (METRO). His responsibilities include the management of ARI's Quality Assurance/Quality Control Program.

Education:

Graduate Work in Chemistry (Organic/Biological), University of Wyoming, Laramie, WY (1970 to 1974).

B.S., Chemistry, Upper Iowa College, Fayette, IA (1970).

Experience:

Quality Assurance Manager, Analytical Resources Inc., Seattle, WA (1998 to Present)
Client Services Manager, Analytical resources Inc., Seattle WA (1987 to 1998)
Vice President/Co-founder of Analytical Resources, Inc., Seattle, WA (1985 to 1987).
Senior Chemist, METRO Trace Organics Laboratory, Seattle, WA (1979 to 1985).
Research Associate, Northwestern University Medical School (1974 to 1979).

Susan Dunnihoo

Computer Services Manager
Administrative Services Manager

Profile:

Ms. Dunnihoo co-founded Analytical Resources, Inc., along with Mark Weidner, Brian Bebee, and David Mitchell. Prior to her co-founding of ARI, Ms. Dunnihoo had gained extensive experience in the environmental chemistry field through her work at Laucks Testing Laboratories, the City of Tacoma, and the Municipality of Metropolitan Seattle (METRO). As Computer Services Manager, Ms. Dunnihoo is responsible for the supervision of the Computer Services Section. She is also responsible for LIMS administration, which includes testing the LIMS for data integrity, as well as ensuring that client deliverable requirements are met.

Education

Graduate work in Chemistry, University of Washington.

B.A., Chemistry, Augsburg College, Minneapolis, MN (1976)

Experience

Computer Services Manager/Secretary, Analytical Resources, Inc., Seattle, WA (1985 to present)

Chemist, Laucks Testing Laboratories, Seattle, WA (1983 to 1985)

Chemist, City of Tacoma, Plant II, Tacoma, WA (1982 to 1983)

GC/MS/DS Operator, METRO TPSS Lab, Seattle, WA (1980 to 1982)

Jay Kuhn

Inorganic Division Manager

Profile:

Mr. Kuhn oversees ARI's Inorganic Division, which includes the Metals Sample Preparation, Metals Analysis, and Conventional Wet Chemistry sections. He has extensive experience in the environmental chemistry field, with an emphasis in inorganic analyses. Mr. Kuhn is experienced with in-house and EPA standard methods and protocols, as well as the operation, maintenance, and repair of ICP-MS, ICAP, CVAA, and Graphite Furnace instruments.

Education

Graduate work in Environmental Chemistry, University of Washington, Seattle, WA.

B.S. Chemistry, University of California at Santa Barbara (1980)

Experience

Inorganic Division Manager, Analytical Resources, Inc., Seattle, WA (1992 to present)

Metals Division Manager, Analytical Resources, Inc., Seattle, WA (1990 to 1992)

Research Technologist III and Laboratory Manager, UW College of Forest Resources Chemical Analysis Cost Center (1985-1990)

Research Technologist, UW College of Forest Resources Chemical Analysis Cost Center (1981 to 1985)

Appendix B

Training

Qualification Requirements

In addition to on-the-job training, ARI recommends a specific level of education and experience for the following positions:

GC/MS Laboratory Supervisor

A Bachelor's degree in chemistry or scientific/engineering discipline, three years experience operating GC/MS systems and one year supervisory experience.

GC Laboratory Supervisor

A Bachelor's degree in chemistry or scientific/engineering discipline, three years experience operating GC systems and one year supervisory experience.

Sample Preparation Laboratory Supervisor

A Bachelor's degree in chemistry or scientific/engineering discipline, three years experience in organic sample preparation and one year supervisory experience.

Data Systems/LIMS Manager

A Bachelor's degree with four or more computer-related courses and three years experience in systems management or programming. A minimum of one year experience with software utilized for laboratory report generation is also recommended.

Programmer Analyst

A Bachelor's degree with four or more computer-related courses and two years experience in systems or application programming. A minimum of one year experience with software utilized for laboratory report generation is also recommended.

Quality Assurance Officer

A Bachelor's degree in chemistry or a scientific/engineering discipline and three years of laboratory experience, including one year of applied experience with quality assurance.

Project Manager

A Bachelor's degree in chemistry or a scientific/engineering discipline and three years of laboratory experience, including one year of applied experience with quality assurance.

GC/MS Chemist

A Bachelor's degree in chemistry or a scientific/engineering discipline and at least one year experience operating a GC/MS system. Three years of GC/MS operations and spectral interpretation experience may be substituted in lieu of educational requirements.

Mass Spectral Interpretation Specialist

A Bachelor's degree in chemistry or a scientific/engineering discipline and participation in training course(s) in mass spectral interpretation. Also, at least two years of experience in mass spectral interpretation is recommended.

Purge and Trap Expert

A Bachelor's degree in chemistry or a scientific/engineering discipline and one year experience operating a purge and trap type liquid concentrator interfaced to a GC/MS system.

GC Chemist

A Bachelor's degree in chemistry or a scientific/engineering discipline and at least one year experience operating a GC system. Three years of GC operations and maintenance experience may be substituted in lieu of educational requirements.

Pesticide Analysis Expert

A Bachelor's degree in chemistry or a scientific/engineering discipline and at least one year experience operating a GC system. Three years of GC operations and spectral interpretation experience may be substituted in lieu of educational requirements.

ICP Spectroscopist

A Bachelor's degree in chemistry or a scientific/engineering discipline and Four years of applied experience with ICP analysis of environmental samples. Four years of ICP experience may be substituted in lieu of educational requirements.

ICP Operator

A Bachelor's degree in chemistry or a scientific/engineering discipline and one year of experience operating and maintaining ICP instrumentation. Three years of ICP experience may be substituted in lieu of educational requirements.

Atomic Absorption (AA) Operator

A Bachelor's degree in chemistry or a scientific/engineering discipline and one year of experience operating and maintaining graphite furnace and cold vapor AA instrumentation. Three years of AA experience may be substituted in lieu of educational requirements.

Conventionals (Classical Chemistry) Analyst

A Bachelor's degree in chemistry of a scientific/engineering discipline and one year of experience with classical chemistry procedures. Three years of classical chemistry experience may be substituted in lieu of educational requirements.

Sample Preparation Expert

A high school diploma and one college level course in chemistry. One year of experience in sample preparation is also recommended.

Appendix C

Laboratory Facilities

ANALYTICAL RESOURCES INC. occupies a total of 23,500 square feet of floor space located at 4611 S. 134th Place in Tukwila, Washington. The laboratory facility, constructed between September 2001 and June 2002, includes:

- State-of-the-art heating, ventilation and air conditioning (HVAC) systems to assure a clean comfortable working environment while maintaining air flow balance designed to minimize the possibility of sample cross contamination between laboratory areas.
- A central service area provides space for three walk-in coolers (356 sq. ft. total), two walk-in freezers (760 cubic ft.), eight reach-in freezers, and sample cooler storage.
- A data network linking all workstations to a centralized server room. All connections are made to managed switches and hubs and are protected by the latest firewall technology and uninterruptible power supplies.
- Distribution systems to deliver pressurized Air, Zero Grade Air, Argon, Helium, Hydrogen, Nitrogen and Argon/Hydrogen to the laboratory areas from a central location.
- A system to deliver ASTM Type 1 water directly to sinks in each laboratory area. Water is purified by filtration, ion exchange and reverse osmosis and continuously re-circulated through a filtration + ion exchange + UV radiation polishing loop that delivers water directly to the laboratories.
- An isolated and ventilated hazardous waste storage area.
- An electronic repair shop and storage room.
- Alarm monitored fire sprinkler and intrusion detection systems

The facilities are divided into five functionally-distinct sections as detailed below:

1) The Organics Division features three main laboratory areas as described below:
    - The <u>Organics Extraction Laboratory</u> (2400 sq. ft.) is utilized to isolate and concentrate organic compounds from various environmental sample matrices. The laboratory contains approximately 200 linear feet of bench space and nine fume hoods. It is equipped with two gel permeation chromatographs, an accelerated solvent extractor (ASE) and a gas chromatograph for extract screening purposes. The laboratory includes a separate area for extraction of aqueous samples, a glassware cleaning area and individual workstations for the laboratory supervisor and analyst.
    - The <u>Semivolatile Organics Analysis Laboratory</u> (3000 sq. ft) has 124 linear feet of instrument bench space plus personal workstations. The Laboratory is equipped with seven Gas Chromatographs (GCs) with six GC-MS instruments, one High Performance Liquid Chromatograph (HPLC) and a fume hood for preparation of standard solutions and dilution of samples. Each gas chromatograph is individually vented to the outside for removal of heat and potentially contaminated GC exhaust gases.
    - The <u>Volatile Organics Analysis (VOA) Laboratory</u> (2500 sq. ft) houses seven GC-MS and two GC-PID instruments dedicated to volatile organics analysis. Each instrument is vented to the outside. The laboratory area includes two fume hoods, a sample/standards preparation area, a TCLP preparation/tumbler room and sample holding refrigerators. The HVAC system maintains a positive air pressure in the laboratory using filtered air from outside of the building. This eliminates the possibility of cross contamination of samples with solvents from other areas of the laboratory.

2) The Inorganic Division includes a Trace Metals Laboratory and the Conventional Analyses Laboratory:
    - Trace Metals Laboratory (3000 square feet)
        - The <u>Metals Preparation Laboratory</u> (1200 sq. ft) contains five fume hoods including two 8-foot polypropylene. An additional eight foot polypropylene laminar flow fume hood is housed in a separate class 1000 clean room. The lab

is equipped with tumblers, hot-plates, digestion blocks, facilities for glassware cleaning, and a spectrophotometer for cold vapor analysis of mercury, a TCLP tumbler room, and storage areas.

    - The Metals Instrument Laboratory (1300 sq. ft) features two atomic absorption spectrometers for graphite furnace analyses, two inductively coupled argon plasma spectrometers (ICP) for simultaneous analysis of metals species, and an ICP-mass spectrometer for analysis of metals species at low detection levels.
    - A 500 sq. ft. Office provides desk area for Trace Metals laboratory personnel.
- The Conventional Analyses (Wet Chemistry) Laboratory (2500 sq. ft.) contains approximately 200 linear feet of bench space, eight fume hoods and includes a separate microbiology room. Instruments in this lab include two Rapid-Flow Analyzers, two TOC analyzers, an ion chromatograph, two uv/visible spectrophotometers, and various other equipment necessary for the evaluation of inorganic parameters.

3) The Geotechnical Laboratory includes 2500 square feet of space with special areas and equipment for soil testing, treatability studies, and soil/sediment leaching studies. The Laboratory includes approximately 50 feet of linear bench space and 5 fume hoods.

4) The Sample Receiving Facility consists of an area to accept and log-in samples to ARI's Laboratory Information Management System (LIMS) and an area to prepare and ship sampling supplies.

- The Sample Receiving Facility (1000 sq. ft.) is equipped with two fume hoods, and 70 feet of bench space. Four computer terminals are available to log samples into ARI's LIMS.
- The Sampling Containers Facility (500 sq. ft.) is used to prepare sampling containers for shipment to ARI's client designated locations.

4) Administrative Areas (8600 sq. ft.) include:

    - The Quality Assurance Section
    - Executive Offices
    - Project Management Section
    - The Human Resources Section
    - The Computer Services Section
    - Two Conference Rooms
    - A Lunch Room
    - Several Storage Areas

Appendix D

Instrumentation and Computers

INSTRUMENTATION and COMPUTER SYSTEMS

Organic Extractions Equipment

(ASE 1) Accelerated Solvent Extractor (1998) – Dionex ASE 200

(GPC 1) Gel Permeation Chromatograph (1985) – Fluid Metering Inc. pump and ISCO UA-5 UV detector equipped with a 16 position autosampler used for clean-up of samples prior to final analysis.

(GPC 2) Gel Permeation Chromatograph (2003) – Fluid Metering Inc. pump and ISCO UA-5 UV detector equipped with a 16 position autosampler used for clean-up of samples prior to final analysis.

Zymark Turbo-Vap LV (1999) - (2 – 24 place)

Gas Chromatograph - Mass Spectrometers (GC/MS)

(FINN I) Finnigan MAT Incos 50 (1993) – A GC-MS system networked with a Hewlett Packard Unix Server running Thruput Target 3.5 data analysis software. System includes an HP 5890 GC, a Tekmar LSC 2000 Purge and Trap and a Delta Perspective PTA-30 autosampler for VOA analysis of either aqueous or solid samples.

(FINN III) Finnigan MAT Incos 50 (1987) - A GC-MS system networked with a Hewlett Packard Unix Server running Thruput Target 3.5 data analysis software. System includes a Varian 3400 GC, a Tekmar LSC 2000 Purge & Trap and a Delta perspective PTA-30 autosampler for VOA analysis of aqueous samples.

(FINN V) Finnigan MAT Incos 50 (1989) - A GC-MS system networked with a Hewlett Packard Unix Server running Thruput Target 3.5 data analysis software. System includes an HP 5890 GC, a Tekmar LSC 2000 Purge & Trap and a Delta Perspective PTA-30 autosampler for VOA analysis of either aqueous or solid samples.

(NT I) Hewlett Packard (1994) - A GC-MS system networked with a Hewlett Packard Unix Server running Thruput Target 3.5 data analysis software. The system includes a Hewlett Packard 5890 Series II Plus GC, an HP 5972A MSD and a HP 7673 autosampler.

(NT 2) Hewlett Packard (1999) – A GC-MS system networked with a Hewlett Packard Unix Server running Thruput Target 3.5 data analysis software. System includes an HP 6890 GC, an HP 5973 MSD, an HP 7683 autosampler and an APEX Prosep 800 large volume injector.

(NT3) Hewlett Packard (1999) – A GC-MS system networked with a Hewlett Packard Unix Server running Thruput Target 3.5 data analysis software. System includes an HP 6890 Plus GC, an HP 5973 MSD, a Tekmar LSC 2000 Purge/Trap and a Dynatech Precision Sampling PTA 30 autosampler for VOA analysis of aqueous or solid samples.

Gas Chromatograph - Mass Spectrometers (GC/MS) (continued)

(NT4) Hewlett Packard (2001) – A GC-MS system networked with a Hewlett Packard Unix Server running Thruput Target 3.5 data analysis software. The system includes an HP 6890-Plus GC, an HP 5973 MSD, an HP 6890 autosampler and an APEX Prosep 800 large volume injector.

(NT5) Hewlett Packard (2002) – A GC-MS system networked with a Hewlett Packard Unix Server running Thruput Target 3.5 data analysis software. The system is equipped with an HP 6890N GC, an HP 5973N MSD, a Tekmar LCS 2000 Purge and Trap and a Dynatech PTA 30 autosampler for VOA analysis of aqueous or solid samples.

(NT6) Hewlett Packard (2002) – A GC-MS system networked with a Hewlett Packard Unix Server running Thruput Target 3.5 data analysis software. The system includes an HP 6890 Plus GC, an HP 5973 MSD and an HP 7683 autosampler.

Gas Chromatographs

Hewlett Packard 5890 Series II (2003) – A GC system equipped with both FID and ECD detectors, capillary injectors, an autosampler and integrator. Used for screening samples before full extraction.

(ECD 1) Hewlett Packard 5890 Series II (2004) - A GC system equipped with dual ECD detectors, two capillary injectors, a HP 7673A autosampler and HP Chem Station data system.

(ECD 2) Hewlett Packard 5890 Series II (2003) – A GC system equipped with dual ECD detectors, two Cool on column capillary injectors, an HP7673A autosampler and ChromPerfect data system.

(ECD 3) Hewlett Packard 5890 Series II (1991) – A GC system equipped with Dual ECD detectors, two Cool on column capillary injectors, an HP7673 autosampler and ChromPerfect data system.

(ECD 4) Hewlett Packard 5890 Series II (1994) – A GC system equipped with dual ECD detectors, a split/splitless capillary injector, HP7673 autosampler and ChromPerfect data system.

(FID 2) Hewlett Packard 5890 Series II (2004) – A GC system equipped with an FID detector, a capillary injector, an HP 7673A autosampler and HP Chem Station data system.

(FID 3 A, B) Hewlett Packard 6890 (1996) – A GC system equipped with dual FID detectors, two capillary injectors, a dual tower HP 6890 autosampler, and HP Chem Station data system. A Restek GC Racer has been added to enhanced performance.

(FID 4 A, B) Hewlett Packard 6890 (1996) – A GC system equipped with dual FID detectors, two capillary injectors, a single tower HP 6890 autosampler, and HP Chem Station data system. A Restek GC Racer has been added to enhanced performance.

(PID 1) Hewlett Packard 5890 Series II (2002) – A GC system equipped PID and FID detectors in series, an Dynatech PT30 autosampler and Tekmar LCS 2000 Sample Concentrator with ChromPerfect data system.

(PID 2) Hewlett Packard 5890 Series II – (2005) –A GC system equipped with dual PID detectors, one in series with an FID, a Dynatech PT30 autosampler, a Tekmar 2000 sample concentrator and HP Chem Station data system.

(PID 3) Hewlett Packard 5890 Series II – (2006) –A GC system equipped with PID and FID detectors in series, a Dynatech PT30 WS autosampler, a Tekmar 2000 sample concentrator and HP Chem Station data system.

(ECD 5) Hewlett Packard 6890 Plus Micro – (2002) – A GC system equipped with dual ECD detectors, two capillary column injectors, a dual tower HP 7683 autosampler, an APEX Prosep 800 large volume injector and an HP Chem Station data system.

(FID 5) Hewlett Packard 5890E Series II (2005) – A GC system equipped with dual FID detectors, an HP 7683 autosampler and HP Chem Station data aquisition system.

(FID 6) Hewlett Packard 5890 Series II (2005) – A GC system equipped with FID and TCD detectors, an HP 7694 Headspace Sampler and HP Chem Station data aquisition system.

Inorganic Instrumentation

Perkin-Elmer SCIEX ELAN 6000 ICP-MS (1996) - A completely automated ICP-Mass Spectrometer with autosampler and multitasking software. Computer controlled using ELAN NT Windows based software.

Perkin-Elmer Optima 4300 ICP (2001) - A completely automated dual view simultaneous ICP with auto-sampler and multitasking software.

Varian 300Z (1992) - A single channel atomic absorption graphite furnace instrument equipped with Zeeman background correction, and an auto-sampler.

Varian 300Z (1991) - A single channel atomic absorption graphite furnace instrument with Zeeman background correction, equipped with an auto-sampler.

CETAC M-6000A Mercury Analyzer (2000) – A fully automated high sensitivity cold vapor atomic absorption instrument dedicated to trace and ultratrace Mercury analysis. System is computer controlled with windows base software and an auto-sampler.

Dionex Ion Chromatography DX 500 (1997) - Fully automated system with an auto-sampler for quantitative anion analyses. The system is computer controlled using Peaknet software.

Thermo Genesys 10 (2003) - UV-VIS Spectrophotometer used for quantitative conventionals analysis.

Thermo Genesys 10 (2005) - UV-VIS Spectrophotometer used for quantitative conventionals analysis.

Lachat QuickChem 8000 Flow Injection Analyzer (2003) – Automated flow injection instrument dedicated to low level nutrient analysis

Lachat QuickChem 8500 Flow Injection Analyzer (2007) – Automated flow injection instrument dedicated to low level nutrient analysis

Dohrmann Apollo 9000 (2001) - Total Organic Carbon (TOC) Analyzer. Includes an autosampler for water analysis

Dohrmann DC190 TOC Analyzer with Boat Sampler (1994) – Combustion/IR system dedicated to soil and sediment TOC analysis.

Kontes Midi-Vap Cyanide Distillation Systems (1995) – Each of the two systems is capable of simultaneously distilling up to 10 samples for cyanide analysis using small sample aliquots.

Centrifuge (1987) - Beckman Model GP with swinging bucket rotor and inserts for 250 ml bottles and scintillation vials

Aim 500 Block Digestion System (2006) with Controller

Environmental Express Hot Block digestion blocks (9 ea) (1999-2006) for digestion of samples prior to trace metals analysis.

Hach COD Digestion Blocks (2)

Hach Ratio Nephelometer

Incubators: Lab-Line Ambi Hi-Lo Chamber and **Thermolyne 41900.**

GeoTech Laboratory Equipment

Trautwein Soil Equipment 12 position flexible wall permeability station,

Soil Test Load frame, with 500, 2,000 and 10,000 pound load cells for QU, UU, and CU triaxial tests, with pore pressure.

Consolidation apparatus, 16 tsf

Geocon direct shear apparatus

Biosciences BI-1000, 8 position electrolytic respirometer

Microtox photo-luminescence toxicity tester

Beckman JP-21 refrigerated centrifuge with 6 x 500 ml fixed angle head

IEC DRP-6000 refrigerated centrifuge with a 4 x 1,000 ml swinging bucket head

Plas-Labs anaerobic test chambers

U.S. Army Corps of Engineers column settling; column and batch leaching apparatus

Network Servers

ARI’s central laboratory computer is a Dell PC Server running Microsoft Windows. This system is home to ARI’s Laboratory Information Management System (LIMS) database developed by Northwest Analytical of Portland, OR. The LIMS receives electronic data from all lab sections and produces hardcopy and electronic deliverables. In addition, the LIMS stores sample demographic data while providing a common tracking mechanism for all laboratory information.

The LIMS is connected to two sub-networks. Data is transferred electronically from the instrument data systems to the LIMS database. This key process enhances data integrity by reducing manual entry and manipulation of instrument output.

The metals section uses an Intel PC Server with the Windows 2000 Server operating system. This system runs as a file server for dBASE IV and MS Access 2000 database applications. Once data is collected by the metals instrument computers, dBASE is used to process the data and transfer it to the LIMS database. The MS Access software has been customized by ARI’s metals data supervisor to generate metals CLP forms and other internal reports.

The organics section uses an HP Unix Server with HP-UX 10.20 operating system. This system runs Target 3.4 data analysis software. All GC/MS and other GC instruments are networked to this system. In addition to providing one common platform for organics data processing, the Target software produces CLP forms for organics data packages.

The conventional analysis laboratory uses PC Workstations with MS Excel for data reduction. Data is manually entered into the LIMS systems using customized work lists.

Note: Extensive in-house replacement parts are available for lab instruments and computers, including spare circuit boards. A majority of all service maintenance is performed by ARI employees.

Appendix E

ARI Active Standard Operating Procedures (SOP)

A list of ARI's current Standard Operating Procedures (SOPs) is available on ARI's web site at:

http://www.arilabs.com/portal/downloads/ARI-SOPs.zip

SOPs are updated periodically. Assure that you have ARI's current SOPs by downloading the files at the time of use.

Appendix F

Sample Containers, Preservation and Holding Times

A summary of sample containers, preservatives and holding times is available on ARI's web site at:

http://www.arilabs.com/portal/downloads/

The summary is updated periodically. Assure that you have ARI's current document by downloading the files at the time of use.

Appendix G

Laboratory Workflow


Initial Client Contact
Workload Assignment Project Manager Assignment
Laboratory Notification
Entry into Client Service Database
Sample Containers Shipped to Client
Sample Receipt
Sample Receiving
Log-in to LIMS
Generation of Master Data Folder
Project Manager Review
Client Notified of Sample Receipt
Lab Notified through Workload Tracking System
Laboratory Analysis
Laboratory QA Review
Sample and Extracts to Storage
Laboratory Data Reduction
Peer Review of Data
Data Transferred to LIMS
Submission of Data to QC Review
QC Review
Report Generation
Data Reports Submitted to Project Manager for Review
Data Package Compiled
Project Manager Final Review and Approval
Invoice Submitted to Accounting
Original Reports Signed and Delivered to Client
Copy of Final Data Package Archived

Appendix H

Analytical Methods

ORGANIC ANALYSES

Parameter	Methods	Technique
Volatiles (GC/MS)	524.2/624/8260B	GC/MS
	Low Level Vinyl Chloride & 1,1 – Dichloroethene	GC-MS-SIM
Volatiles (GC)		
Volatile Aromatics	602/8021B	GC/PID
Semivolatiles (GC/MS)		
Semivolatile Organics	625/8270D	GC/MS
Polynuclear Aromatic Hydrocarbons (PNA/PAH)	625/8270D	GC/MS (SIM)
Isotope Dilution Semivolatiles	1625	GC/MS
Butyl Tin Species	Krone (1988)	GC/MS-SIM
Pesticides/GC Analyses		
Chlorinated Pesticides	608/8081A	GC/ECD
Aroclors/PCBs	608/8082	GC/ECD
PCB Congeners	ARI Method	GC/ECD
Phenols	604/8041	GC/FID
Chlorinated Phenols	8041 (mod)	GC/ECD
Pentachlorophenol	8151A (mod)	GC/ECD
Organophosphorous Pesticides	614/8141A	GC/NPD
Polynuclear Aromatic Hydrocarbons (PNA/PAH)	610/8100	GC/FID
Chlorinated Hydrocarbons	612/8121	GC/ECD
Herbicides	615/8151A	GC/ECD
Glycols	ARI Method(SOP 426S R2)	GC/FID
Hydrocarbon ID	NWTPH-HCID	GC/FID
Gasoline Range Hydrocarbons	(N)WTPH-G/AK101/WI-GRO	GC/FID
Diesel Range Hydrocarbons	(NWTPH-D/AK102/WI-DRO)	GC/FID
Extractable Petroleum Hydrocarbons	ARI Method	GC/FID
Volatile Petroleum Hydrocarbons	ARI Method	GC/PID
Organic Sample Preparation and Clean Up		
TCLP / SPLP Extraction		1311 / 1312
Sonication		3550B
Soxhlet		3540C
Accelerated Solvent Extraction (ASE)		3545B
Separatory Funnel		3510C
Continuous Liquid-Liquid		3520C
Alumina Clean-up		3610B
Florisil Clean-up		3620B
Gel Permeation (GPC)		3640A
Silica Gel		3630C
Sulfur Clean-up		3660B

Sulfuric Acid Clean-up	3665A

INORGANIC ANALYSES

Parameter	**Methods**	**Technique**
Wet Chemistry		
Acidity	2310/305.1	Titrimetric
Alkalinity	2320/310.1	Titrimetric
Ammonia	4500NH$_3$H/350.1	AutomatedPhenate/ISE
Biological Oxygen Demand-BOD		
Carbonaceous – BOD	5210.B/405.1	5-day Winkler Titration
Bromide	4500Br.B	Phenol Red Colorimetric
Anions	300.0	Ion Chromatography
Cation Exchange Capacity	9080	Neutral Ammonium Acetate
Chemical Oxygen Demand	5220.D/410.4	Closed Reflux, Colorimetric
Chromium Hexavalent (Cr6+)	3500Cr-D/7196A	Diphenylcarbazide
Chloride	4500Cl.E/325.2	Automated Ferricyanide
Chlorophyll a	10200.H	Spectrophotometric
Coliform, Total / Fecal	9222.B/D	Membrane Filtration
Color	2120.B/110.2	Visual Comparison
Conductivity	2510/120.1	Electrometric
Corrosivity (CaCO3 Saturation)	2330	Calc. (pH, Alk, TDS, Ca)
Cyanide, Total	4500CN.C/335.2/9010	PBA, Colorometric
Cyanide, Amenable	4500CN.G/335.1	Alkaline Chlorination
Cyanide, WAD	4500CN.I	Weak Acid Distillation
Dissolved Oxygen	4500-O.C/360.2	Winkler Titration
Fats/Oils/Grease	5520.B/413.1/9070A	Gravimetric
Fluoride	4500F.C/340.2	Ion Specific Electrode
	300.0	Ion Chromatography
Formaldehyde	ASTM D-19 P216	Colorimetric
Hardness, Calculation	2340.B/6010B	Ca, Mg Calculation
Heterotrophic Plate Count	9215.D	Membrane Filtration
Iron (II) ferrous	3500Fe.D	Phenanthrolene
Nitrate + Nitrite	4500NO$_3$F/353.2	Automated Cd Reduction
Nitrate	4500NO$_3$F/353.2	Calculated
	300.0	Ion Chromatography
Nitrite	4500NO$_3$.F/353.2mod	Automated Colorimetric
	300.0	Ion Chromatography
Oil & Grease, Solids	5520.D/907	Gravimetric
Oil & Grease, Polar/Non Polar	5520.F	Gravimetric
PH	150.1	Electrometric
Phenols	5530.D/420.1/9065	4-AAP w/ Distillation
Phosphorous, Total	4500P.B/365.2	Colorimetric w/ digestion
Phosphorous, Ortho (SRP)	4500P.B/365.2	Colorimetric
	300.0	Ion Chromatography
Salinity	2520	Conductimetric
Silicate	4500Si.E/370.1	Heteropoly Blue
Total Kjeldahl Nitrogen (TKN)	4500N.org/351.4	Block Digest/ISE
Total Solids	2540.B/160.3	Gravimetric, 104^{o}C
Total Suspended Solids (TSS)	2540.D.160.2	Gravimetric, 104^{o}C
Total Dissolved Solids (TDS)	2540.C/160.1	Gravimetric, 180^{o}C

Total Volatile Solids (TVS)	2540.E/160.4	Gravimetric, 550^{o}C
Settleable Solids	2540.F	Volumetric
Streptococcus, Fecal	9230.C	Membrane Filtration
Sulfide	4500S^{2}.E/376.1/9034	Iodometric
Sulfide, Low Level	4500S^{2}.D/376.2	Methylene Blue
Sulfide, Acid Volatile	4500S^{2}.D/376.2	Methylene Blue
Sulfate	4500SO$_{4}^{2}$.F/375.2/9036	Auto. Methylthymol Blue
	300.0	Ion Chromatography
Sulfite	4500SO$_{3}^{2}$.B.377.1	Iodometric
Total Organic Carbon (TOC)	5310.B415.1/PSEP	Combustion NDIR
Turbidity	2130.B/180.1	Nephelometric
Total Lipids in Tissue	Bligh & Dyer (mod)	Gravimetric

Trace Metals Analyses

Inductively Coupled Plasma (ICP):

Ag, Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Si, Sn, Sr, Th, Ti, Tl, V, (Li, Th, U, W - special request only)	Zn200.7 / 6010B	ICP

Graphite Furnace (GFAA):

Ag, As, Cd, Sb, Pb, Se, Tl	200 Series / 7000 Series	GFAA

Cold Vapor (CVAA):

Hg	7470A/7471A	CVAA

Inductively Coupled Plasma/Mass Spectroscopy (ICP-MS):

Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Th, Tl, U, V, Zn	200.8/ 6020 Mod.	ICP/MS

Trace Metals Sample Preparation

Toxicity Characteristic Leaching Procedure	1311
Synthetic Precipitation Leaching Procedure	1312
Digestion for Total Recoverable or Dissolved Metals	3005A
Digestion of Aqueous Samples for Total Metals by ICP	3010A
Digestion of Aqueous Samples for Total Metals by GFAA	3020A
Digestion of Sediment, Sludge and Soil	3050B

Appendix I

Method Detection Limits
Reporting Limits

Summaries of method specific MDL studies and reporting limits are available on ARI's web site at:

http://www.arilabs.com/portal/downloads/ARI-MDLs.zip

MDL's and reporting are updated periodically. Assure that you have ARI's current detection limit data by downloading the files at the time of use.

Appendix J

Quality Control Limits

Method specific control limits are available on ARI's web site at:

http://www.arilabs.com/portal/downloads/ARI-CLs.zip

Control limits are updated periodically. Assure that you have ARI's current control limits by downloading the files at the time of use.

Appendix K

Internal Audit Schedule

Schedule of Laboratory Quality Assurance Audits

Process To Be Audited	**Frequency**
Verify Effectiveness of Correctiive Actions	Monthly
Verify Refrigerator and Freezer Temperature Logs	Monthly*
Verify Oven and Incubator Temperature Logs	Monthly*
Verify That Balance Records Are Complete	Quarterly*
Verify That Standard Records are Complete	Monthly#
Verify That Logbooks Are Reviewed	Monthly#
Verify That SOPs Are Current and Availabnle in Labs	Monthly#
Review Chain of Custody Documentation	Monthly#
Audit Internal Technical Systems	Annually
Post-Completion Project Review	Monthly**

* all sections will be audited

\# one section will be audited each month

** frequency may be contract specific i.e. 10% of NFESC projects must be audited

Appendix L

Laboratory Accreditations

Laboratory Accreditations

Analytical Resources Inc. is currently certified to perform environmental analysis by the the National Environmental Laboratory Accreditation Program (NELAP), the State of Washington Department of Ecology and the State of Alaska Department of Ecology. ARI is approved to perform analyzes for the US Navy and the US Army Corps of Engineers following the Department of Defense Quality Systems Manual (DoD-QSM)

ARI's laboratory QA/QC Program has been audited and approved by The Boeing Company and Battelle Pacific Northwest Laboratories.

ARI analyzes drinking water, waste water and solid matrix performance testing (PT) samples semiannually.

List of Accreditations

1) State of Washington, Department of Ecology - Environmental Laboratory Accreditation Program
2) The Alaska State Department of Environmental Conservation - Laboratory Approval Program
3) United States Army Corps of Engineers (US ACOE)
4) United States Naval Facilities Engineering Service Center (NFESC) (formerly known as NEESA)

Continuing Contracts Resulting from On-Site Laboratory Audits

1) The Boeing Company Corporate Environmental Affairs Division
2) Battelle Northwest Laboratories
3) The City of Seattle
4) The Port of Seattle

Appendix M

Data Reporting Qualifiers

Data Reporting Qualifiers

Effective 12/28/04

Inorganic Data

U	Indicates that the target analyte was not detected at the reported concentration
*	Duplicate RPD is not within established control limits
B	Reported value is less than the CRDL but ≥ the Reporting Limit
N	Matrix Spike recovery not within established control limits
NA	Not Applicable, analyte not spiked
H	The natural concentration of the spiked element is so much greater than the concentration spiked that an accurate determination of spike recovery is not possible
L	Analyte concentration is ≤5 times the Reporting Limit and the replicate control limit defaults to ±1 RL instead of the normal 20% RPD

Organic Data

U	Indicates that the target analyte was not detected at the reported concentration
*	Flagged value is not within established control limits
B	Analyte detected in an associated Method Blank at a concentration greater than one-half of ARI’s Reporting Limit or 5% of the regulatory limit or 5% of the analyte concentration in the sample.
J	Estimated concentration when the value is less than ARI’s established reporting limits
D	The spiked compound was not detected due to sample extract dilution
NR	Spiked compound recovery is not reported due to chromatographic interference
E	Estimated concentration calculated for an analyte response above the valid instrument calibration range. A dilution is required to obtain an accurate quantification of the analyte.
S	Indicates an analyte response that has saturated the detector. The calculated concentration is not valid; a dilution is required to obtain valid quantification of the analyte
NA	The flagged analyte was not analyzed for
NS	The flagged analyte was not spiked into the sample

M	Estimated value for an analyte detected and confirmed by an analyst but with low spectral match parameters. This flag is used only for GC-MS analyses
M2	The sample contains PCB congeners that do not match any standard Aroclor pattern. The PCBs are identified and quantified as the Aroclor whose pattern most closely matches that of the sample. The reported value is an estimate.
N	The analysis indicates the presence of an analyte for which there is presumptive evidence to make a “tentative identification”
Y	The analyte is not detected at or above the reported concentration. The reporting limit is raised due to chromatographic interference. The Y flag is equivalent to the U flag with a raised reporting limit.
C	The analyte was positively identified on only one of two chromatographic columns. Chromatographic interference prevented a positive identification on the second column
P	The analyte was detected on both chromatographic columns but the quantified values differ by ≥40% RPD with no obvious chromatographic interference

Geotechnical Data

A	The total of all fines fractions. This flag is used to report total fines when only sieve analysis is requested and balances total grain size with sample weight.
F	Samples were frozen prior to particle size determination
SM	Sample matrix was not appropriate for the requested analysis. This normally refers to samples contaminated with an organic product that interferes with the sieving process and/or moisture content, porosity and saturation calculations
SS	Sample did not contain the proportion of “fines” required to perform the pipette portion of the grain size analysis
W	Weight of sample in some pipette aliquots was below the level required for accurate weighting

Appendix N

Standards for Personal Conduct

Standards of Conduct

Since effective working relationships depend upon each of us, ARI expects certain minimum standards of personal conduct.

This list highlights general Company expectations and standards and does not include all possible offenses or types of conduct which may result in discipline or discharge. Management reserves the absolute right to determine the appropriate degree of discipline, including discharge, warranted in individual cases.

Employees engaged in the following activities, or similar activities deemed equally serious, will normally be terminated:

theft or embezzlement
disclosure of trade secrets or industrial espionage;
willful violation of safety or security regulations;
conviction of a felony;
working for a competitor or establishing a competing business.

In addition, dismissal may result from other serious offenses such as:

being intoxicated, under the influence or in possession of illegal drugs on the job;
falsification of records;
abuse, destruction, waste or unauthorized use of equipment, facilities or materials;
gambling on the premises;
chronic tardiness or absenteeism;
insubordination;
unwillingness to perform the job;
unauthorized requisition of materials from vendors.

There may be no alcoholic beverages on the Company premises, other than at times designated as Company functions. At such times, non-alcoholic beverages will be provided as well.

Personal and corporate honesty and integrity have built the character of ARI. This good character is fundamental to our well-being, future growth and progress. It is vitally important that we avoid both the fact and the appearance of conflicts of personal interest with that of the firm, its clients, and any other professional contacts.

This policy requires that ARI employees have no relationships or engage in any activities that might impair their independence of judgment. Employees must not accept gifts, benefits, or hospitality that might tend to influence them in the performance of their duties. It is expected that there will be no employment by any competing company, nor any

employment by any outside interest or engagement in outside activity which might impair an employee's ability to render the full-time service to the company that employment involves.

If any possible conflict of interest situation arises, the individual concerned must make prior disclosure of the facts so that action may be taken to determine whether a problem exists and, if so, how best to eliminate it. Likewise, any financial interest in an organization doing business with ARI or which competes with us should be revealed to Company management. (Excluded from this requirement is ownership of securities traded in major stock exchanges or other recognized trading markets.)

Our standards are those generally expected of employees in any well-regarded, ethical business organization.

ARI further expects that each employee will:

> Be dressed and groomed appropriately for a business office. Employees in the laboratory areas are expected to dress in compliance with established safety procedures. Specific standards will be discussed with each employee during Health and Safety orientation. Your supervisor and the Administrative Services Manager always are available to answer questions.

Standards of Personnel Conduct – continued

> Maintain the confidential nature of Company information. Removal of Company documents, records, stored materials, computer printouts, or any similar information, or copies of such material or information

from the office without specific permission is prohibited. Likewise, revealing confidential information to an unauthorized person or using such information in an unauthorized way is prohibited. If there could be any possible question about the applicability of this requirement to a given circumstance, ask your supervisor.

Use Company computer capabilities and facilities only for authorized business at authorized times and locations; observe strictly all computer security measures and precautions; enter, alter or delete no computer instructions or stored material apart from that required by faithful performance of assigned duties; remove, copy, use or permit to be used no computer software developed for, purchased by, or otherwise used by ARI except as required by faithful performance of assigned duties.

Conduct business dealings with clients and members of the public in a courteous manner.

Appendix O

Quality Assurance Policies

QUALITY ASSURANCE POLICY

POLICY NUMBER: 1

SUBJECT: CORRECTIONS TO DATA/BENCHSHEETS

DATE: 8/2/96

Manual corrections made on any raw data, bench sheet, logbook or document used during sample processing will be made in the following manner:

1. Draw a single line through the information to be deleted or corrected. The original information must remain readable.
2. Enter any new information, preferably above the original information.
3. Initial and date the correction.

QUALITY ASSURANCE POLICY

POLICY NUMBER: 2

SUBJECT: LINING OUT UNUSED BENCHSHEET PORTIONS

DATE: 8/2/96

All unused portions of logbook pages and benchsheets will be lined through so that information cannot be added at a later date. This will be completed in the following manner:

1. Line out unused portions of a logbook page or benchsheet by drawing a single line or "Z" through the unused portions.
2. Initial and date the page beside the lineout.
3. Do not line out a page or section until it is certain that no additional information will be added to the unused portions.

QUALITY ASSURANCE POLICY

POLICY NUMBER: **3**

SUBJECT: **STOP WORK ORDERS**

DATE: **8/28/96**

It is the responsibility of all staff members to address situations that may require the issuance of a "stop work order". Potential and actual "stop work orders" will be handled as follows:

1. If an analyst or technician observes a situation which will or may have a negative impact on data quality, that person will notify her/his section supervisor immediately.

2. The section supervisor will assess the situation. If it appears that a "stop work order" may be required, the section supervisor will notify the appropriate manager (inorganic or organic).

3. The supervisor and manager will then decide if a "stop work order" should be issued. The manager will make a final decision on whether or not to issue a "stop work order". The incident will be reported to the Quality Assurance Program Manager using a Corrective Action Request form.

4. If a "stop work order" is issued, the manager will inform the Project Managers and the QA section. The section supervisor will notify section staff of the order.

5. The laboratory manager involved will oversee the development and implementation of a Corrective Action Plan (CAP). Upon completion of the CAP the "stop work order" may be rescinded.

6. Prior to rescinding a "stop work order", verification must be made that control has been regained and that work may begin. Only the inorganic or organic manager may rescind a "stop work order".

7. When the "stop work order" is rescinded, the Project Managers, analytical staff and QA section will be notified. The QA section will require documentation verifying that the procedure is back in control.

QUALITY ASSURANCE POLICY

POLICY NUMBER:	**4**
SUBJECT:	**SOP Review**
DATE:	**9/3/96**

All Standard Operating Procedure (SOP) documents will be reviewed and updated at least annually by qualified staff members. Laboratory management will review and approve all modifications to the SOPs.

QUALITY ASSURANCE POLICY

POLICY NUMBER: 5

SUBJECT: Reporting Dilutions

DATE: 9/11/96

Dilution factors will be recorded as whole numbers followed by "X" (i.e., 5X, 10X, etc.). This reporting convention will be used on run logs, bench sheets, raw data and final reports for all diluted samples, extracts or digestates or standards.

QUALITY ASSURANCE POLICY

POLICY NUMBER: 6

SUBJECT: Formatting for SOPs – Computer Related

DATE: 1/31/00

Conventions for formatting computer-related instructions in SOPs

Commands should be indented and formatted as **`bold courier`** and one or two font sizes smaller:

```
USE PARAMS ORDER PARAMS
BROW
```

Many systems and languages are *case-sensitive*, and case should match the syntax and/or stylistic standards of the language.

If only one command, like ***`SET CENTURY ON`***, is needed, it can be included in the rest of the text, so long as it is also italicized.

If the user must substitute a particular value in place of a general descriptor, italicize the descriptor, make it lowercase, and *do not make it bold*:

```
USE PARAMS ORDER PARAMS
COPY TO TEMPARM FOR JOB = ‘job’ .AND. SAMPLE = ‘sample’
```

In general, keywords, variable names, formatting codes, and descriptors should be in `courier` and *`italicized`*.

QUALITY ASSURANCE POLICY

POLICY NUMBER: **7**

SUBJECT: **Manual Adjustment of Data**

DATE of IMPLEMENTATION: **1/1/01**

Modern chromatographic instruments include computer software to identify a detector response as a chromatographic peak, characterize that peak and determine the relative height or area of the signal. The software utilizes parameters (threshold, slope, etc) that are adjusted by the instrument operator to optimize the results.

A single set of operator controlled settings that determine peak characteristics for an entire data file is defined as an "automated procedure". An automated procedure often characterizes chromatographic peaks incorrectly. ARI requires that trained analysts identify and resolve these errors using an alternate automated procedure or a "manual adjustment" of the data. Manual adjustment is defined as the process used by an analyst to adjust an individual peak or a subset of data in a chromatographic file.

1. The settings for a routine automated procedure normally used to process chromatographic data must be described in the method Standard Operating Procedure (SOP).

2. Trained analysts may substitute one automated procedure for another in order to optimize peak characteristics. The use of an alternate automated procedure must be permanently documented using either a software generated log file or analyst notes.

3. Manual adjustment of chromatographic peak characteristics will be used to correct the results of an automated procedure that, in a trained analyst's opinion, are clearly incorrect and will result in erroneous peak identification, integration or quantification.

4. Manual adjustment will be implemented in a reasonable and consistent manner. Guidelines for performing manual adjustment will be documented in method SOPs.

5. All manually adjusted data will be clearly identified for approval in the data review process. A permanent record of all manual adjustments will be maintained in both electronic and hardcopy versions of the raw data.

6. Manual adjustment of chromatographic files will not be used to falsify data for any purpose. Falsification of data through the use of manual peak adjustment is unethical, unlawful and will result in termination of the offending analyst.

Approval:

Quality Assurance Program Manager Date

QUALITY ASSURANCE POLICY

POLICY NUMBER:	**8**
SUBJECT:	**Performance Evaluation Samples**
IMPLEMENTATION DATE:	**1/1/01**

Performance Evaluation Samples (PES) will be analyzed on a periodic basis to monitor laboratory performance and/or meet the requirements of an external accreditation program. PES samples contain target analytes in concentrations unknown to laboratory personnel. PES may be submitted by a third party or prepared internally under the direction of ARI's QA personnel.

PES will be submitted blind to the laboratory whenever possible.

PES will be logged-in, prepared, analyzed and reported as a routine sample without special consideration.

QUALITY ASSURANCE POLICY

POLICY NUMBER:	**9**
SUBJECT:	**Modifications to Analytical Methods Procedures or Reports**
DATE of IMPLEMENTATION:	**8/24/05**

This Policy defines the processes used to initiate and validate modifications to analytical processes, QA/QC protocol, data processing programs and algorithms, data reporting formats or other changes to analytical procedures or SOPs at Analytical Resources Inc. (ARI). The procedures outlined will also be used to validate project specific changes to analytical protocol and new analytical methods.

Changes to analytical procedures must be approved by ARI's Management (Managers and/or Supervisors) and be well documented using the following procedure:

1. Modification may be requested by any staff member. The modification must be requested using ARI's Corrective Actions Tracking System. Corrective Action requests for changes to analytical protocol or reports will assigned to the appropriate manager or supervisor by the initiator. As an alternative the request may be assigned to the QA Section. The Corrective Actions assignee may approve the project or re-assign the request for approval to a third party. The QA Section will monitor the progress of all requests.

2. The requestor must detail and justify the proposed modifications or additions when initiating a Corrective Action issue. Modifications must be approved by ARI management prior to any work performed to establish the modification.

3. The following must be in place before final approval and/or implementation of the proposed modification.

   A. A new or revised SOP as appropriate including the modification or new protocol.
   B. An Initial Demonstration of Proficiency as defined in ARI SOP 1018S for new or modified analytical procedures.
   C. An MDL study following the procedure in ARI SOP 1018S for new or modified analytical procedure.
   D. When appropriate, successful analysis of a blind Performance Evaluation Sample using new or modified procedures or data processing protocol.
   E. Documentation that new or modified software provides the desired result.

4. ARI staff must have sufficient training to implement the procedural changes.

5. Notification of the modifications must be distributed to all affected personnel including appropriate client personnel.

QUALITY ASSURANCE POLICY

POLICY NUMBER:	**10**
SUBJECT:	**Reporting of Target and Spiked Analytes For Dual Column GC Analyses**
DATE of IMPLEMENTATION:	**8/24/05**

Analytical Resources Inc. uses single injection, dual column gas chromatographs to simultaneously identify and confirm the presence of target or spiked analytes in some GC analyses. Only one quantitative value is reported for each target or spiked analyte. ARI's policy for deciding which value to report is outlined as follows:

1. ARI considers each column equally valid for compound identification and quantification. Both GC columns must be compliant with all quality assurance parameters outlined in ARI's SOPs and LQAP. Both GC columns must produce valid initial and continuing calibrations using the same calibration model.

2. The analytical value reported will be determined by comparison of the quantitative results of confirmed analytes as follows.

   a. The relative percent difference (RPD) between the results on the two columns (R_1 & R_2) is calculated using the formula:

$$RPD = \frac{|R_1 - R_2|}{\left(\frac{R_1 + R_2}{2}\right)} \times 100$$

   b. If the RPD is less than 40% the greater of the two values is reported for both target analytes and spiked compounds. When required by specific QA protocol, by contract or client request the lower value will be reported for target analytes.

   c. If the RPD is greater than 40%, ARI's analyst must examine the chromatogram for anomalies (overlapping peaks, incorrect integration, negative peaks) and either correct the anomalies (i.e. perform manual integrations) or report the most appropriate target analyte value. The higher value will be reported for spiked analytes. ARI's analyst must provide a written evaluation of all analyses where an RPD exceeds 40% and this information must be passed on to ARI's client or the data user.

Appendix P

Modifications to the LQAP

Modifications to ARI’s LQAP

New Revision	Date	Modifications
12-010	1/4/08	1. Edit Sections 4.4.1, 4.4.2, 4.4.3.2, 5.5, 6.3 (subcontracting), 8.3, 9.1 (MDLs) and 13 for Navy CAP. 2. Transferred Containers, Preservative & HT Table from Appendix F to Web
12-009	7/21/07	1. Updated SOP list in Appendix E 2. Updated Instrument List in Appendix D 3. Updated Accreditations Appendix L 4. Removed SOP table to web-site
12-008	12/20/06	1. Added Methane, Ethane & Ethene Info to Appendix F Table 2. Updated SOP Table in Appendix E 3. Modified Internal Audit Schedule 4. Archived SOP 355S and removed it from list in Appendix E 5. Updated Instrument / Equipment List in Appendix D
12-007	4/11/06	1. Removed Appendix J – Tuning Criteria are in the SOP 2. Changed BOD RL from 1 to 2 ppm 3. Integrated all SVOA Soil/Sediment MDLs into One Table 4. Added SIM Analysis to Soil/Sediment SVOA MDL Table 5. Added SIM Analysis to Water SVOA MDL Table 6. Updated MDL for SVOA in Water 7. Updated MDLV for Pesticides in Soil (25g to 5mL) 8. Updated MDLV for Pesticides in Soil (12g to 4mL) 9. Updated MDLV for PCB in Water (500 to 1mL) 10. Updated MDLV for PCB in Water (500 to 5mL) 11. Updated MDLV for Chlorinated Phenols in Water (500 to 50mL) 12. Removed Appendix I – MDL & RL Summaries 13. UpdatedMDL for SIM-PNA 14. Updated MDLV for SIM-PNA 15. Removed Appendix K – Control Limits
12-006	1/16/06	1. Updated MDL for TBT in Pore Water 2. Updated MDL and MDLV for Toxaphene in Soil/Sediment 3. Updated MDLV for VOA 8260B 20 mL Purge 4. Added IDL, MDL & RL for Low RL Mercury 5. Updated all Metals MDL Verifications 6. Updated MDLV for Water VOA using 5 mL purge 7. Updated MDLV for PCB in Soil with Soxhlet Extraction 8. Updated MDLV for SVOA (8270D) Analysis of Water using SepFunnel 9. Updated MDL for GC-MS-SIM Analysis of Skydrol & BHT in Water 10. Updated MDL for Chlorophenols (8041) in Soil 11. Modified RL for Chlorophenols in Soil & Tissue 12. Added Headspace GC (FID5) to Instrument List 13. Updated Footnotes on Glycols RL Table 14. Modified RL for 1,4-Dioxane in Water Method 8270D 15. Updated MDL for Analysis of Soil for VOA 16. Updated MDL for Analysis of Soil for JP-8 17. Updated MDL for Analysis of Sediment for TBT 18. Updated MDLV for Analysis of TBT in Water and Tissue 19. Added MDL for Analysis of PCB in Tissue with 4 ppb RL 20. Updated MDLV for PCB Analysis of Soil (Soxhlet) and Tissue (4 ppb) 21. Updated MDLV for Manchester Analysis of PCB in Water 22. Updated MDLV for Analysis of Gasoline in Soil and Water 23. Updated MDLV for Analysis of BTEX in Soil and Water 23. Updated MDLV for Analysis of Motor Oil in Soil and Water 24. Upadted MDLV for Analysis of VOA-SIM in Water 25. Upadted MDLV for Analysis of VOA (20 mL) in Water 26. Updated MDL Table for Convntionals 27. Updated MDLV for Pesticides in Water (500 to .5 mL) 28. Updated MDLV for PCB Analysis of Soil 29. Updated MDLV for Chlorophenols (8041) in Soil 30. Updated MDLV for JP4 in Water and Soil

		31. Updated MDLV for JP8 in Soil 32. Updated MDLV for VOA (8260B) in Water 5 mL & 20 mL Purge Volumes 33. Updated MDL for PCB in Soil – Standard Analysis & Medium Level 34. Updated MDL for Pesticides in Water – Standard Analysis 35. Updated MDL for SVOA in Water – Liq-Liq Extraction 36. Updated MDLV for Chlorophenols in Water
12-005	10/24/05	1. Added MDL for Chlorinated Phenol Analysis of Tissue (Method 8041) 2. Modified QA Policy 10 3. Established Implementation Date for QA Policies 09 & 10 4. Updated MDLV for TBT in Water 5. Corrected MDL Value for bis-(2-Ethylhexyl)-phthalate in SVOA Tissue 6. Updated MDL for Pesticides in Soil 7. Modified Title Format of Selected MDL Tables 8. References to 8270 or 8270C changed to 8270D 9. Deleted MDL Tables for SVOA Analyses of Tissue 10. Updated MDLs for SIM-PNA in Water (SepFunnel) and Soil 11. Updated MDLV for Metals 12. Updated MDLV for Manchester Pesticides 13. Updated MDLV for TPH-D In Soil 14. Updated MDLV for SIM-PNA in Water with Liq-Liq Extraction 15. Updated MDLV for JP-4 in Soil 16. Updated MDLV for VOA Water 5 mL Purge 17. Corrected MTCA RL for Methoxyclor & Manchester RL for all Pesticides 18. Updated MDL for Manchester Beta-BHC to reflect latest MDLV 19. Corrected Tissue Pesticide RLs 20. Updated MDLV for LVI-SIM-PNA in Water with Liq-Liq Extraction 21. Updated MDL for VOA-SIM Analysis of Aqueous Samples 22. Updated MDLV for PCB in Water (500 to 5 mL) 23. Updated MDLV for Diesel in Water (NWTPH-D & AK102) 24. Updated MDLV for Chlorophenols in Aqueous Samples 25. Updated MDLV for Chlorophenols in Tissue Samples 26. Removed & Archived Modifications to LQAP for 2002 & 2003 27. Updated MDL for Skydrol/BHT Analysis in Water Using 8270-SIM 28. Removed Direct Aqueous Injection MDLs RL Table. 29. Updated SOP Table (Appendix E)
12-004	8/19/05	1. Added "A" Flag for GeoTech to Appendix N. 2. Updated MDL for JP-4 in Soil 3. Updated MDL for Pesticides in Tissue 4. Updated MDLV for JP-4 in Soil 5. Updated MDLV for Pesticides in Soil 6. Updated MDLV for Pesticides in Water 7. Updated MDLV for PCB in Soil (25g to 1 mL) 8. Updated MDLV for PCB in Water (500 to 5 mL) 9. Updated MDLV for TPH-D in Water 10. Updated MDLV for PNA-SIM in Water (Liq-Liq Extraction) 11. Updated MDLV for VOA in Water (5 mL 8260B) 12. Updated MDLV for VOA in Water (20 mL 8260B) 13. Updated MDL for PSDDA SVOA in Sediment 14. Updated Appendix E – SOP List 15. Corrected MDL for Pesticides in Soil Information (IA-80 not GU-32) 16. Corrected Reporting Limits for TBT in Water, Sediment & Tissue 17. Added Control Limits for 1,4-Dioxane to SVOA List 18. Added low level RLs for BTEX Compounds 19. Updated MDLV for TBT in Pore Water 20. Updated MDLV for BTEX Water & Soil 21. Updated MDLV for TPH-G in Water & Soil 22. Updated Appendix E SOP Table 23. Updared MDLV for Motor Oil in Soil Using ASE 24. Updared MDLV for Motor Oil in Soil Using MicroTip 25. Updared MDLV for Motor Oil in Water Using SepFunnel 26. Updared MDLV for JP-4 in Water Using SepFunnel
12-003	7/15/05	1. Added MDLV for 5 mL VOA Analysis of Water – Method 8260B

		2. Updated MDL for MTCA PCB in Water Samples 3. Added MDL for Soxhlet Extraction of PCBs 4. Removed Aroclor 1242 from MDL Table 5. Control Limits for HEM Changed to Equal Those in SOP 648S 6. Updated MDL for PSDDA PCB Analysis. 7. Added MDL for TBT in Tissue 8. Updated MDL for 20 mL 8260B 9. Updated MDLV for SIM-VOA 10. Updated MDL for Pesticides in Soil 11. Updated MDLV for TPH-D in Soil 12. Added MDLV for PSEP Level Pesticides in Sediment 13. Updated (added missing compounds) PSDDA SVOA MDLs 14. Updated & Corrected Appendix F (Containers & Preservatives) 15. Added "A" Flag for GeoTech to Appendix N.
12-002	6/9/05	1. Updated Motor Oil MDL (NWTPH-Dext & AK103) for Soil 2. Documented MDLV for Gasoline in Soil (Methods NWTPH-G & AK101) 3. Corrected units for DRO & RRO MDL for water from mg/kg to mg/L 4. Added MDL for JP-4 in Water using Sep Funnel Extraction 5. Updated MDL for Sediment Analysis (Krone) of TBT using Sonication 6. Updated MDL for SVOA Water SepFunnel 7. Noted that BTEX –SIM MDL in Table was Medium Level Extraction 8. Added MDL Verification Information for ICP Metals 9. Updated MDL for TBT in Water and Pore Water – SepFunnel 10.Updated MDLV for TPH-D Water – SepFunnel 11. Added EPH and VPH RL Tables 12. Added MDLV for JP-4 Analysis of Water – Sep Funnel 13. Added MDLV for BTEX analysis of Soil 14. Added MDLV for SVOA Water - SepFunnel 15. Added MDLV for TBT Sediment 16. Updated MDL for PSEP Pesticides in Sediment/Soil 17. Updated MDL for Chlorinated Phenols in Water 18. Updated MDL for Pesticides in Water – SepFunnel 19. Added MDLV for 524.5 20. Added MDLV for Metals 21. Updated MDL for Manchester Pesticides 22. Added Appendices to the Table of Contents 23. Added MDL for PCB Analysis of Tissue
12-001	4/5/05	1. List of SOPs (Appendix E) Modified & Updated as Appropriate 2. MDL Verification for DRO in Soil Added 3. MDL Verification for PCB Water Standard Analysis (HO-24) Added 4. AK-101 Removed from BTEX MDL Table for Water 5. Metals IDLs & MDLs Updated 6. BTEX MDL for Analysis of Water and Soil Updated 7. RL for 1,4-Dioxane in SVOA Analysis of Water Changed from 1.0 to 5.0 8. Control Limits for BTEX and Gasoline updated 9. MDL for Gasoline in Soil Updated 10.MDL for Diesel and Motor Oil in Soil Updated. 11. Split TPH-G Table into Aqueous and Soil Table & added MDLV for Water 12. Entered updated MDLs for SIM-LVI-PNA 13. Changed RL for 20 mL 1,2-Dibromo-3-Chloropropane from 2 to 0.5 ppb 14. Updated MDLs for 524.2 15. Updated Conventionals MDLs 16. Updated MDLs for 5 mL VOA analysis of Water Samples (8260B) 17. Modified MDL Table for TPH-D Analysis of Water 18. Updated TPH-D and TPH-Dext MDL for Water Analyses. 19. Removed EPH and VPH MDLs from the LQAP
11-028	12/31/04	1. Modified definition of "Y" flag in Appendix N 2. Updated MDL for TPH-D Soil 3. Updated Appendix M - Laboratory Certification and Accreditation
11-027	12/15/04	1. Updated SOP List in Appendix E. 2. Added AK-101 to BTEX/GRO Control Limit Table. 3. Lowered RL for Benzene in MDL Summary for Method 8021B

		4. Added Additional Surrogates to VOA-SIM BTEX Control Limit Table 5. Corrected BTEX MDLs for 8260-SIM to Reflect Sample Conc. Not On-Column values 6. Updated SOP Table in Appendix E 7. Modified VOA 5 mL Water RLs - Acrylonitrile & 1,2,3-Trichloropropane 8. Modified VOA mL Soil RL – 4-Methyl-2-Pentanone 9. Corrected MDL Value for Methoxychlor in PSDDA Sediment Analysis. 10.Modified definition of “Y” Flag in Appendix N 11.Updated MDL for BTEX Water PID-2 12.Updated MDL for Pesticides MTCA Analysis of Water 13.Updated MDL for PSDDA SVOA Analysis 14.Updated MDL for VOA Soil 15.Updated MDL for SVOA, Water, Liq-Liq 16.Updated MDL for Various PCB (1660) Analyses 17.Updated MDL for TPH-G – Water & Soil 18.Updated MDL for SVOA Soil Micro Sonication 19.Added MDL for Manchester Aroclor 1254 20.Modified Control Limits for EPH Analyses 21.Deleted MDL Table for SVOA, Soil, MacroTIp Extraction 22.Deleted MDL for Soil Skydrol/BHT, GC-MS-SIM 23.Updated Instrumentation Listing (Appendix D)
11-026	11/02/04	1. Updated Control Limits for SIM-PNA 2. Added Control Limit Table for Full Scan PNA Analysis (Method 8270D) 3. Updated SIM-PNA Water MDL for NT-1 4. Updated Appendix E – SOPs 5. Modified PCB MDL Table –Remove Manchester & Combine PSEP/Low Level Sediment MDLs 6. Updated MDL for VOA SIM Water NT3 7. Updated MDL Table for SIM Skydrol/BHT in Water 8. Updated SOP Table in Appendix E.
11-025	9/16/04	1. Added new Appendix N listing Data Qualifiers & changed designations for Appendices N, O & P to O,P & Q respectively 2. Updated MDL Table for PCB Analyses. 3. Combined MDL tables for SVOA Water & Deleted Sep Funnel Table 4. Updated PCB & TPH-D MDL Tables 5. Updated Equipment List (Appendix D) & added GeoTech Equipment 6. Revised MDL Table for FID Analysis of Polar SVOA (EPA Method 8015) 7. Updated MDLs for Pesticide analysis of soil. 8. Sediment Pesticide MDLs added to Soil Table, Sediment Table Deleted 9. Control Limit for MS Recovery of Pyrene in Sediment Corrected 10.Updated Cyclohexanone MDL (Finn 1, 20 mL purge) 11.Updated SIM-PNA Soil MDL for NT-1 12. Edited MDL Tables for SVOA for consistency and accuracy 13. Modified EPH Reporting Limits 14. Revised formatting on most MDL tables. 15. Corrected dates for VOA Control Limit data 16. Deleted analytes except cyclohexanone from VOA MDL Table for Project Specific Analytes. 17. Added BTEX in Soil to VOA-SIM MDL Table 18. Added Manchester MDL to PCB Table 19. Updated Skydrol/BHT Control Limits
11-024	7/19/04	1. Revised and Updated MDL Tables for TPH Analyses of Soil/Sediment. 2. Revised and Updated MDL Tables for PCB Analyses. Combined All PCB MDL into One Table. 3. Deleted all other MDL tables 4. Updated MDL for VOA analysis of Soil using ARI’s In-house Method. 5. Added 1-Methylnaphthalene to SIM-PNA MDL Tables for Water & Soil 6. Updated Appendix D (Lab Equipment) and added GeoTech Section 7. Combined Water & Soil SIM-PNA MDL Tables into One Table 8. Deleted Water-SF & Soil SIM-PNA MDL Tables 9. Updated MDLs for Pesticide – Manchester Extraction 10. Revised VOA Water Control Limits Table

		11. Updated MDLs for VOA analysis of Water-8260B-5mL purge
11-023	7/6/04	1. Corrected Conventionals MDL/RL Table 2. Corrected Control Limit for TPH-D MS Recovery in Water Samples. 3. Updated MDLs for NWTPH-D Soil ASE & MicroTip. 4. Removed HPLC MDL Table for analysis of PNA. 5. Removed MDL Table for HCID 6. Removed FID-3B from TPH MDL Tables 7. Updated MDLs & Modified Table for SVOA-PSEP analysis of Sediments 8. Revised Section 11 9. Updated MDL for VOA (524.2) analysis of Water 10. Removed MDLs for VOA-SIM analysis of Soil 11. Updated MDL Table for VOA-Water 20 mL 12. Updated MDL Table for VOA-Water 5 mL
11-022	5/17/04	1. Corrected Extract Final Volume in MDL table for Sediment PCB 2. Deleted FINN 8 from all MDL Tables 3. Corrected RL for Hg in Water.
11-021	5/07/04	1. Implemented default control limits for EPA Method 524.2 2. Decreased RL for Aroclor 1221 to level of other Aroclors 3. Eliminated Control Limits for VOA using ARI SOP 804S. 4 Updated VOA 8260B full scan control limits for water & sediment/soil 5. Updated 10 mL purge VOA-SIM control limits for water 6. Changed effective date for VOA-SIM BTEX control limits 7. Updated 8270-SIM-PNA control limits for water & sediment/soil 8. Updated BTS control limits for water & soil.
11-020	4/26/04	1. Updated MDL (PID1 & 2) for BTEX in water 2. Updated MDL (PID 1) for gasoline in water 3. Deleted MDL Table for ASE extraction of chlorinated pesticides 4. Updated MDL for VOA water 5 mL purge 8260B on NT3 5. Updated MDL for pesticide in water separatory funnel on ECD3 6. Added MDL Table for VPH in water and soil 7. Deleted Control Limit Table for HPLC PNA 8. Updated PCB control limits 9. Updated Herbicide control limits 10. RL for Sulfate to 2.0 & 20.0 ppm for water & solids respectively 11. Updated TPH-D Control Limits 12. Updated Chlorinated Phenols Control Limits 13. Updated BTEX & TPH-G Control Limits 14. Corrected Pesticide MTCA MDL Table 15. Corrected RL for GC-ECD analyses of HCBD & HCB
11-019	3/11/04	1. Revised holding time for Total Solids in soil & sediment from 7 days to 14 days. 2. Updated MDLs for SVOA water L/L NT4 & NT 6. 3. Updated Metals IDLs and MDLs 4. Added QA Policy 9 – Modifications to method, protocol or reports 5. Updated Conventionals MDLs 6. Added QA Policy 10 – Reporting of dual column GC analytes
11-018	1/21/04	1. Revised Control Limits for GC-MS analysis of SVOA 2. Revised Control Limits for Chlorinated pesticides 3. Updated Appendix E – Table of SOPs 4. Updated and Revised Appendix F – Sample Containers, Preservation and Holding Times 5. Modified Sign-of Sheet to include only QA manager
11-017	1/4/04	1. Minor revisions to Section 13 2. Revisions to subcontracting language in Section 6.3