Sampling and Analysis Plan (SAP)

Everett Smelter Cleanup Site
FSID 2744, ISIS Cleanup Site ID 4298
Lowland Area
Everett, Washington

for
Washington State Department of Ecology

September 27, 2012

GEOENGINEERS

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1.0 INTRODUCTION

This Sampling and Analysis Plan (SAP) has been prepared to describe the objectives and procedures to be performed to investigate the Everett Smelter Lowland Area (i.e., Lowland Area) located in Everett, Washington (Figure 1). The Lowland Area includes multiple separately owned property parcels and rights-of-ways located adjacent to the parcels (Figure 2). This SAP serves as the guide for the standard operating procedures that will be utilized to conduct the environmental investigation activities that will be completed to support the development of a Preliminary Feasibility Study for the Lowland Area.

Quality assurance and quality control for field and laboratory activities are discussed in a separate Quality Assurance Project Plan (QAPP). A separate site-specific Health and Safety Plan (HASP) will be used for field activities.

2.0 BACKGROUND

2.1. Site History

The Everett Smelter Lowland Area is part of the Everett Smelter Cleanup Site. The other area (the Upland Area) is being handled as a separate cleanup site. Historically, a smelter was located in the Upland Area, west of the Lowland Area. Historical activities included smelting and refinement of metal ores on a portion of the Upland Area from the mid 1890s until 1912. Beginning in the 1890s, the smelter produced lead, copper, gold, and silver from their ores. An arsenic extraction plant was added in 1901. The entire smelter was shut down by 1912 and dismantled by 1915.

The arsenic extraction plant area is where arsenic trioxide, comprised of 76 percent arsenic, was produced. This portion of the Everett Smelter Cleanup Site has been referred to as the former arsenic trioxide processing area and as the fenced area.[1] This area underwent environmental cleanup in approximately 2004 through 2006 to remove and consolidate soil that had been contaminated by smelter operations.

The historic smelting activities resulted in the release of metals including arsenic and lead to the soil, groundwater, and air. Byproducts from the smelting process were deposited within the Everett Smelter Cleanup Site (i.e., arsenic trioxide and slag), including on the Lowland Area. Additionally, air emissions from the former smelter stacks are likely to have resulted in deposition of particulates containing metals in the area surrounding the smelter. Elevated concentrations of metals have been found in soil and groundwater in the Lowland Area.

Historically, slag was poured down the bluff located on the east side of the Upland portion of the Everett Smelter Site and onto an adjacent property, currently known as the Benson Property. Slag

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[1] The former arsenic trioxide processing area has sufficiently high contamination that it was purchased by Asarco soon after the Site was rediscovered, the homes vacated, and the area fenced off.

present on the Benson Property was historically used for the manufacture of "rock wool". Additionally, slag was excavated from the Benson Property and transported for use on and off-site. Although slag was historically reused, not all of the slag was removed and slag still remains on the Benson Property and potentially in other areas of the Lowland Area.

Multiple soil and groundwater investigations have been performed in the Lowland Area since the 1990s related to the Everett Smelter contamination. Groundwater monitoring in the late 1990s identified metals-contaminated groundwater east of the former smelter in the Lowland Area groundwater aquifers (both upper and lower). In 2011 and 2012, GeoEngineers installed 20 wells (in ten well pairs - "shallow" and "deep" wells BP-01S/D through BP-10S/D) along the eastern portion of the Benson Property, and collected soil and groundwater samples from the borings/wells. Additionally, GeoEngineers collected groundwater samples from three existing wells (EV-20B and EV-22A/B). Soil and groundwater samples were analyzed for arsenic, lead, cadmium, mercury, antimony and thallium. The results indicate that soil and groundwater contain elevated concentrations of metals (predominantly arsenic and lead). Of note, the metals concentrations in groundwater identified in the late 1990s have not decreased significantly over time.

2.2. Site Description

The Everett Smelter Cleanup Site is divided into the Upland Area and Lowland Area. The focus of this investigation is the approximately 250 acre Lowland Area, located generally between East Marine View Drive and the Snohomish River (Figure 2). The area was historically an estuarine/wetland area of the Snohomish River. The area was filled with Snohomish River sediments and/or other fill material, and has been and is currently used for industrial purposes. The current and historical owners and users of property within the Lowland Area include Weyerhaeuser, Port of Everett, City of Everett, BNSF, and Benson. State Route 529 passes through/over the Lowland Area.

Based on the existing soil borings performed in the Lowland Area since site discovery in the early 1990s, the Lowland Area is generally comprised of three principal geologic units. They are, in increasing depth from the ground surface:

- **Fill/Slag unit:** This unit is generally comprised of grade fill (approximately 3 feet of sand with gravel, gravel with sand, and/or crushed rock) and fill dredged from the Snohomish River (up to 9 feet of fine to coarse sand). East of the former smelter, on a portion of the Benson Property, the fill is comprised largely of slag. Hydrogeologically, this fill/slag unit is considered the Shallow Aquifer. The fill over much of the Lowland was placed after the Everett Smelter operations ceased.
- **Silt/Channel Deposits:** This unit consists of approximately 4 to 12 feet of organic-rich estuarine clayey silt. Peat deposits up to approximately 1 foot in thickness have occasionally been encountered near the top of the silt/channel deposits. In places, the silt/channel deposits unit is replaced by sandy channel deposits and or slough deposits (generally silty sand). Where present, the silt/channel deposits unit forms a confining layer between the Shallow Aquifer and Deep Aquifer (described below). The top of the silt/channel deposits unit is thought to have been the historical native surface upon which smelter smoke stack emissions were deposited.

- **Alluvium:** Fine to coarse grained sand with gravel (alluvial deposits) are beneath the silt/channel deposits unit to depths of at least 100 feet below ground surface (bgs). Hydrogeologically, this unit represents the Deep Aquifer.

A limited number of explorations are planned in the Upland Area in order to accomplish the goal of identifying the nature and extent of possible source material for the contaminated groundwater in the Deep Aquifer. The Upland Area is generally comprised of three principal geologic units. They are, in increasing depth from the ground surface:

- **Fill/Weathered Till:** This unit is generally comprised of silt to cobble size material and is generally 2 to 6 feet in thickness. In the fenced area fill thickness can be as thick as several tens of feet. Where saturated, this unit is considered a shallow, perched aquifer.
- **Till:** This unit is comprised of Vashon Till, a dense mixture of silt to cobble sized material that is 3 feet to more than 90 feet in thickness. This unit forms a confining layer between the fill/weathered till unit above and the outwash unit (described below).
- **Outwash:** The Vashon Advance Outwash lies underneath the Vashon Till and is greater than several hundred feet thick. This unit is considered a deep aquifer. Vashon Advance Outwash consists of stratified, unconsolidated sand with occasional gravel and cobbles.

2.3. Investigation Goals

The overall goal of the investigation activities is to obtain data to fill gaps in the current site characterization to be able to develop a preliminary Feasibility Study to address contamination in the Lowland Area resulting from Everett Smelter activities.

Specific goals of the investigation include:

- Collect soil and groundwater in the potential source area to identify the nature and extent of arsenic contamination in groundwater.
- Collect soil samples from areas that are likely to have received air fallout from the historical smelter stack emissions.
- Collect soil samples from various soil horizons throughout the Lowland Area to determine metals concentrations at or near the historic native surface and within the depth of the monitoring well screened intervals. Identification of soil metals concentrations at or near the historic native surface and within monitoring well screened intervals will be important for helping to distinguish between contamination due to air fallout, smelter residuals, and other contamination.
- Collect groundwater samples from the Shallow and Deep aquifers throughout the Lowland Area to characterize groundwater metals concentrations.
- Identify the hydrogeological characteristics of the Shallow and Deep aquifers using grain size analyses, hydraulic conductivity testing, groundwater elevation measurements, and an evaluation of groundwater fluctuation resulting from changes in tidal elevation.
- Identify groundwater flow direction using groundwater elevation measurements.

- Collect surface water and sediment samples from surface water features within the Lowland Area to characterize surface water and sediment metals concentrations.
- Collect seep and outfall water and sediment samples on the west shoreline of the Snohomish River within the Lowland Area to characterize seep and outfall water and sediment metals concentrations. Note that seep and outfall water and sediment samples are only proposed where the concentrations of metals detected in groundwater and/or surface water adjacent to the seep and outfall water and sediment sampling locations is greater than screening levels.

This information is necessary to complete the preliminary Feasibility Study.

2.4. Investigation Activities

The investigation activities include the following:

- Install monitoring wells throughout the Lowland Area to monitor groundwater in the shallow and deep aquifers.
- Perform monitoring of groundwater in the shallow and deep aquifers including:
    - Groundwater sample collection,
    - Groundwater elevation measurements,
    - Groundwater elevation fluctuation measurement using transducers, and
    - Groundwater conductivity/drawdown testing/slug testing.
- Advance soil borings at the monitoring well locations and up to three other locations to collect soil samples from targeted subsurface soil horizons.
- Collect surface soil samples from steep slopes that were potentially exposed to the historical air emissions from the smelter operations.
- Collect surface water and sediment samples from surface water features located interior to the Lowland Area.
- Potentially collect seep/outfall and sediment samples along the Snohomish River. These samples will only be collected where metals concentrations exceed screening levels in groundwater and/or surface water adjacent to the seep and outfall water and sediment sampling locations. Where collected, the seep/outfall sampling will consist of:
    - Collect outfall and seep water samples along the west shoreline of the Snohomish River
    - Collect sediment samples on the west shoreline of the Snohomish River

Detailed procedures for each activity are in Section 3. Tables 1 through 5 of this SAP provide the rationale and investigation approaches for these activities.

2.5. Schedule

Field activities are scheduled to occur between October 2012 and April 2013. The final schedule will be determined after the final approval of the Sampling and Analysis Plan by Ecology. The general sequence of events and typical anticipated durations are summarized below.

■ Install monitoring wells	75 days
■ Develop wells and conduct first round of groundwater monitoring	65 days
■ Drawdown testing/slug testing	5 days
■ Conduct second round of groundwater monitoring	50 days
■ Soil borings and surface soil sample collection	45 days
■ Surface water/sediment sampling	55 days
■ Snohomish river seep/sediment sampling (if performed)	25 days

Days are expressed as calendar days. Note that each event below is followed by preparation of a draft and final technical memorandum, with a typical anticipated duration of approximately 60 days. Note also that there is overlap of durations for the majority of activities shown below.

3.0 FIELD PROCEDURES

The following sections describe the field procedures (i.e., Standard Operating Procedures – SOPs) that will be used to complete the Lowland Area investigation. See Figure 2 and Tables 1-5 for the approach and rationale for specific investigation locations.

3.1. Monitoring Well Installation

Up to 63 wells will be installed. Forty-two of the wells will be installed in the Lowland Area, while up to 14 wells will be initially installed in the Upland Area. An additional 7 Upland Area wells are contingent and will be installed if the field screening or groundwater sampling and analysis results from the adjacent new wells indicate a need to fill additional data gaps.

Many of the wells will be installed in pairs, with one “shallow” well installed in the Shallow Aquifer and one “deep” well installed in the Deep Aquifer. In general, deep wells will be screened near the top of the Deep Aquifer. However, up to three wells will be installed deeper in the Deep Aquifer to attempt to identify the bottom of the deep aquifer plume (i.e. to more completely define the nature and extent of contamination). These wells are to be installed along the path of the deep aquifer arsenic plume. Initially, one well will be installed deeper in the Deep Aquifer near existing BP-05S/D. The remaining two wells are considered “contingent,” based upon metals concentrations found in wells sampled during the first round of groundwater sampling.

All Lowland Area well screens will be installed with a minimum 1-foot separation from the historic floodplain/tide flat silt horizon, as described below. This minimum 1-foot separation is intended to reduce the potential for confounding groundwater analytical results related to fine grained materials associated with the historic floodplain/tide flat surface or broader silt horizon.

The length of well screen that will be installed at each Lowland Area shallow well location will be determined based on the observed thickness of the soil profile within the shallow aquifer interval and specified distances from the soil surface and top to the historic floodplain/tide flat surface to the top and bottom of the well screen. Based on the Minimum Standards for Construction and Maintenance of Wells (Chapter 173-160 WAC), the top of the well screen will be 3-feet below the surface at the well location (i.e., 1 foot of sand pack above the well screen, ½ feet of bentonite above the sand pack, and 1½ feet of concrete surface seal between the top of the bentonite and the Site surface). The bottom of the screened interval for each shallow well will be a minimum of approximately 1-foot above the historic floodplain/tide flat surface. Based on previous borings, the historic floodplain/tide flat surface is expected to be located approximately 5 to 15 feet bgs in the vicinity of the where monitoring wells are to be installed. A minimum 5-foot long well screen is desired. However, where the depth to the historic floodplain/tide flat surface is less than 9 feet (i.e., the distance that allows a 5-foot long well screen as well as; 1½-foot concrete seal, ½-foot bentonite seal, and 1-foot of sand pack above the well screen; and 1-foot of separation between the bottom of the well screen and the historic floodplain/tide flat surface), the well screen will be reduced in length to meet the specified distances from the Site surface and top of the historic floodplain/tide flat surface. Where the depth to the historic floodplain/tide flat surface is greater than 9 feet the well screen will increase in length up to a 10-foot long well screen. It should be noted that the actual construction of each well may be modified in the field in cooperation with the licensed driller to ensure completion of a monitoring well in accordance with applicable regulations.

The top of the screened interval for the majority of Lowland Area deep wells will be a minimum of approximately 1-foot below the bottom of the historic floodplain/tide flat silt horizon. Based on previous borings, the bottom of the historic floodplain/tide flat silt horizon is approximately 16 to 20 feet bgs. The well screen for the deep wells will be 10 feet long. Exceptions to this are at up to three deep well locations where 5-foot well screens may be installed at deeper depths to attempt to identify the bottom of the deep aquifer plume.

Two-inch diameter PVC wells will be installed. The slot size will be 0.010-inch. Following placement of the well screen and casing in the borehole, a filter pack will be installed around the well screen. The filter pack will extend from the bottom of the sump to 1 foot above the top of the well screen. The filter pack material will consist of commercially prepared 10-20 silica sand.

A bentonite annular seal will be placed above the sand pack to a depth of about 1½ feet bgs. Each well will be completed with a concrete surface seal, and a flush-mount or aboveground steel monument protecting the top of the well. The monument will be outfitted with a locking cap. The monument will be cemented in place by the driller. Bollards will be installed around wells that are to be completed as above ground steel monuments.

Drilling and construction of the monitoring wells will be conducted by a Washington State licensed driller in general accordance with the Minimum Standards for Construction and Maintenance of Wells (Chapter 173-160 WAC). Monitoring well borings will be drilled using a track- or truck-mounted hollow stem auger rig. The wells will be continuously sampled using decontaminated split-barrel samplers. Upon retrieval, the sampler will be opened and the soil in the sampler will be examined and logged. Photographs will be taken as appropriate and at the discretion of the geologist logging the well.

3.2. Soil Borings

Direct push soil borings will be advanced at up to 3 locations to allow collection of soil samples from areas where monitoring wells are not being installed. A truck- or track-mounted drill rig will be used to collect continuous samples at each of the planned locations using a direct push probe that is approximately 2 inches in diameter. Direct push intervals will be up to four feet each; sampling intervals may be reduced in an attempt to improve recovery if recovery is poor sampling in four-foot intervals. The sample probe will be lined with a disposable acetate sleeve to contain each soil sample interval. The sample sleeves will be cut open to allow access to the recovered soil for sampling and field logging purposes.

3.3. Soil Sample Collection

Soil samples will be collected during monitoring well installation activities (Section 3.1) and also during soil boring activities (Section 3.2). Where monitoring well pairs are installed, soil borings for installation of the deep wells will be advanced first at each location, and soil samples will only be collected from the boring advanced to install the deep wells. If soil samples are not able to be collected from shallow depths from the boring advanced to install the deep well, sampling of shallow soil will be performed from the boring advanced to install the shallow well. Soil samples in the Lowland Area will be collected from each of the four soil horizons described below.

1. **The Fill/Slag unit:** One sample will be collected from this Shallow Aquifer unit. Additional samples may be collected at the discretion of the field geologist.
2. **At the contact between the fill and the historic floodplain/tide flat surface:** One sample will be collected from this surface. The geologist collecting the sample will use judgment to identify a soil sample representative of the arsenic concentrations that resulted from stack emissions falling on the ground surface before fill was placed.
3. **From deeper in the historic floodplain/tide flat silt:** The floodplain/tide flat silt is described in previous studies as a clayey silt with abundant organic matter. An approximately 1-foot thick layer of peat lies above the silt in the southern portion of the Site. In areas the silt and/or peat has been replaced by channel deposits. Channel deposits consist of interbedded fine sand and silt. One sample will be collected from this silt. Additional samples may be collected at the discretion of the field geologist.
4. **From the Deep Aquifer in the alluvial sand:** One sample will be collected from the elevation of the deep well screen interval. Additional samples may be collected at the discretion of the field geologist.

The four soil horizons identified above may not be present at all investigation locations. The historic floodplain/tide flat silt may not be present in areas where channelization of the floodplain/tide flat has historically occurred. Areas of historic channelization are anticipated to be comprised of sand and gravel. At locations where the floodplain/tide flat silt is not present, soil samples will be collected from similar depth horizons (i.e., upper fill unit, contact between fill and the historic floodplain/tide flat surface, deeper in the historic floodplain/tide flat, and lower alluvial sand). Monitoring wells will also be installed within the same horizons (i.e., upper fill unit and lower alluvial sand).

Soil samples in Upland Area borings will be collected from each of the four soil horizons described below:

1. **The Fill/Weathered Till unit:** One sample will be collected from this shallow unit.
2. **At the contact between the Fill/Weathered Till Unit and the underlying native surface:** If the field geologist is able to identify a native surface upon which smelter air fallout may have occurred, a sample of this surface will be collected. Note however it is anticipated this historic surface may be difficult to identify or may have been excavated during development of the Upland Area.
3. **Vashon Till unit:** Up to two samples may be collected from the Vashon Till unit.
4. **Advance Outwash unit:** One sample will be collected from the elevation of the deep well screen interval. Additional samples may be collected at the discretion of the field geologist.

Visual field screening and/or screening using a field X-ray fluorescence (XRF) instrument will be performed on sample material present in the split-barrel samplers to identify the soil that is to be collected for chemical analysis. The sample to be collected from the historic surface will be selected to approximate the top 2 inches of the historic surface prior to filling unless an additional volume of sample material is needed to perform the analyses (i.e., the approximate top 2 inches is comprised of low-density materials such as organics and additional material is necessary to perform the sample analysis). If additional sample volume is needed, it will be collected from the next deeper 2-inch depth interval and combined with the initial 2-inch sample interval. The soil collected from the historic surface will be placed into a stainless steel bowl, homogenized, and then placed in clean sample containers provided by the analytical laboratory.

For samples collected from the remaining horizons, if field screening indicates potential contamination within a particular zone within the soil horizon, the potentially contaminated soil zone will be selected for chemical analysis. If field screening results do not suggest obvious contamination, the approximate middle of the soil horizon will be selected for chemical analysis. An approximately 1-foot long portion of soil from the soil sampler will be collected from each soil horizon and placed into a stainless steel bowl, homogenized, and placed in clean sample containers provided by the analytical laboratory.

Sampling equipment will be decontaminated prior to sample collection. Decontamination procedures are described in the QAPP. Each sample container will be securely capped, labeled, and placed in a cooler with ice immediately upon collection as described in the QAPP. Each sample will be designated with a unique, sequential sample identification number.

The field geologist will visually classify the soil in accordance with ASTM International (ASTM) Method D 2488 and record soil descriptions and other relevant field screening details (e.g., staining, debris, odors, etc.) in the field log. ASTM Method D 2488 is the visual-manual soil description method that corresponds to laboratory ASTM Method D 2487 (Unified Soil Classification System method). Slag, if present, will be described in detail (i.e., color, grain size, friability [if coarse grained], and approximate percentage by volume represented in the sample).

Soil samples will be submitted to an Ecology-certified laboratory for analysis of metals. Additionally, selected samples from the Upland Area will be submitted for synthetic precipitation leaching procedure (SPLP).

SPLP analyses will be performed on selected samples to evaluate the mobility of metals present in soil at the Site. Samples comprising different fill and soil types and with a range of arsenic concentrations will be selected for analysis. Total metals analyses will be performed prior to SPLP analysis and the results of total metals analyses will be used to select samples for SPLP analysis. It is anticipated that up to 15 samples will be analyzed by SPLP.

3.4. Groundwater Monitoring

Two rounds of groundwater sampling will be performed that include all existing and newly installed wells. Wells MW1501-R, MW-1301R, MW-1203R, and MW-1202R are sampled quarterly by Weyerhaeuser. If possible, “split samples” will be collected to avoid duplication. Groundwater samples not collected by Weyerhaeuser will be collected using submersible or peristaltic pumps, and samples will be analyzed for total and dissolved metals. Additionally, groundwater elevation measurements will be completed at up to 36 new/existing wells to evaluate horizontal groundwater gradients. Pressure transducers will be placed in up to 12 new/existing wells to evaluate groundwater fluctuations. Drawdown testing or slug tests will be performed in up to 18 new/existing wells to evaluate hydraulic conductivities.

3.4.1. Groundwater Well Development

Each new and existing monitoring well not sampled in the past year will be developed. New wells will be developed to remove water introduced into the well during drilling (if any), stabilize the filter pack and formation materials surrounding the well screen and to restore the hydraulic connection between the well screen and the surrounding soil. Existing wells are being re-developed in the event that hydraulic connectivity between the well pack and formation has diminished since the wells were installed, and/or in the event sediment has accumulated in the bottom of the wells that can be removed. Well screen intervals will be gently surged with a decontaminated bailer or surge block and the wells will be purged of water. Development will continue until a minimum of five casing volumes of water have been removed and turbidity of the purge water is relatively low. Turbidity and the volume of groundwater removed will be recorded during well development. Depths to water in the monitoring wells will be measured prior to and following development.

3.4.2. Groundwater Sampling

Groundwater samples will be obtained using low-flow/low-turbidity sampling techniques to minimize the suspension of sediment in the samples. The wells will be purged and groundwater samples will be obtained from the wells using submersible well pumps or a peristaltic pump, and dedicated or disposable polyethylene tubing. Target groundwater purge rate will be 0.5 liters per minute, however lower flows may be used if recharge is slow. A Horiba U-22 (or similar) water quality measuring system with a flow-through cell will be used to monitor the following water quality parameters during purging: electrical conductivity, dissolved oxygen, pH, salinity, total dissolved solids, oxidation-reduction potential, and temperature. Turbidity will be measured using a Hach turbidimeter (or similar), and ferrous iron will be measured using Hach test kits (or similar). Samples will be collected from the wells after these parameters vary by less than 10 percent on three consecutive measurements and turbidity is relatively low. Target "low turbidity" will be less than 5 NTU. However, samples may be collected if three well volumes have been removed and parameters generally vary by less than 10 percent on three consecutive measurements. The field measurements will be documented on the field log.

Following well purging, the flow-through cell will be disconnected and groundwater samples will be collected in laboratory-prepared containers. Samples to be submitted for dissolved analyses will be filtered using a 0.45-micron filter. During the second round of sampling, samples may be collected for arsenic speciation; such samples may be collected under "zero-oxygen" conditions using an open-topped cooler containing dry ice. The dry ice will be allowed to sublimate to displace the majority of the oxygen in the cooler. Sample containers will be opened in this atmosphere and filled with sample.

The samples will be placed into a cooler with ice and logged on the chain-of-custody form using procedures described below. Samples will be submitted to an Ecology-certified laboratory for analyses of total and dissolved metals; selected samples during round two will be submitted to a laboratory for arsenic speciation.

3.4.3. Groundwater Elevation Measurements

During each round when field personnel are mobilized in the field to conduct groundwater sampling, a round of groundwater elevation measurements will be performed on up to 36 new/existing wells. These measurements will be performed by measuring depth-to-water in each well within a three-hour window. Personnel will open each well, measure and record depth to groundwater, close/secure the well, and decontaminate the electronic water level indicator before moving to the next well. Measurements will be made from the north rim of the PVC casing to the nearest 0.01 feet.

3.4.4. Transducer Study

Vented pressure transducers will be installed in up to 12 new/existing wells during the approximate time between the groundwater monitoring rounds (i.e. between sampling events, at least two months). Transducers will record temperature and pressure (depth) once each 15 minutes during the time they are installed in wells. Transducers will be suspended from non-elastic cord or cables, and the depth from the top of the well casing to the transducer will be recorded with an accuracy of within 0.1 vertical feet. At the end of the study, the transducers will be removed and the data will be downloaded. The data will be used along with survey data to monitor groundwater elevations/fluctuations.

3.4.5. Drawdown Tests / Slug Tests

Slug tests and drawdown tests will be performed to estimate the horizontal hydraulic conductivity of the aquifer based on induced groundwater flow. Slug tests will be performed at up to 18 wells (i.e., nine shallow and nine deep monitoring wells). Up to six drawdown tests will be performed based on field observations during well development and slug testing. A drawdown test will be performed at a specific well if field observations indicate that the results of slug testing may not provide adequate characterization of the hydraulic conductivity (i.e., groundwater immediately returns to the original elevation during slug testing).

Slug tests will be performed as follows:

1. Measure the static groundwater level before inserting a pressure transducer into the well.
2. Insert a pressure transducer into the well and secure it at a depth approximately 6 inches above the bottom of the well. Allow the groundwater level to return to the approximate static level measured in Step 1. Water level measurements will be recorded at approximately 0.1- to 15-second intervals during the tests.
3. Conduct the falling-head test by rapidly inserting a clean slug (weighted length of sealed PVC casing) of known volume into the well and recording the groundwater level until it falls to the approximate static level.
4. Conduct the rising-head test by rapidly removing the slug from the well and recording the groundwater level until it rises to the approximate static level.
5. Observe the transducer data on the laptop to verify the adequate data has been recorded and is usable for calculating hydraulic analysis.
6. Remove the slug and pressure sensor/data logger from the well.

Drawdown tests will be conducted in general accordance with the following procedures.

1. Measure the static groundwater level before inserting a pressure transducer into the well.
2. Insert a vented pressure transducer into the well and secure it at a depth approximately 6 inches above the bottom of the well. The vented pressure transducer shall be set to record water level measurements at approximately 0.1-second intervals during the tests. The vented pressure transducer will be connected to a laptop computer or equivalent data processor during the test.
3. Insert a decontaminated submersible groundwater pump into the well; the inlet of the pump (bottom of the pump) should be approximately 1 foot above the top of the vented pressure transducer.
4. Allow the groundwater level to return to the approximate static level measured in Step 1.
5. Turn the pump on and withdraw groundwater at a low-flow rate (approximately ½ to 5 gallons per minute) for up to 30 minutes. Contain the purge water for transport to a disposal drum or bulking facility (see Section 3.13).
6. After approximately 15 minutes observe the transducer data on the laptop to verify the correct data is being recorded and is usable for hydraulic analysis. If the groundwater level has stabilized, turn off the pump. If the groundwater level has not stabilized, continue the test for up to 30 minutes.
7. After the pump is turned off, the groundwater level recovery response will be monitored until the level returns to the approximate level measured in Step 1. Once an adequate amount of recovery has occurred, a manual measurement will be done prior to removing the transducer and pump from the well.

Water level data for slug test will be analyzed to provide aquifer parameters using the Bouwer and Rice (1976) or other appropriate methods and data from pumping test will be analyzed using Cooper-Jacob (1946) and Theis (1935).

3.5. Collect Surface Soil Samples from Steep Slopes

Up to seven surface soil samples will be collected from steep slopes along the northeast-facing slope northwest of East Marine View Drive. The purpose of the sampling is to characterize metals concentrations in soil suspected to have experienced little or no alteration since smelter air emissions may have impacted surface soils. The surface soil samples will be collected using hand tools from a depth of approximately 0 to 1 feet bgs. Sample collection will proceed as follows:

1. Remove the "duff" layer (i.e., the layer that consists of greater than 50 percent organic matter).
2. Measure and record the depth from the surface to the bottom of the duff layer.
3. Using a decontaminated shovel, hand auger, or other similar excavating tool, collect the top 0 to 1 foot of soil below the duff layer and place into a decontaminated mixing bowl. Record the actual depth interval sampled.
4. Homogenize the soil and distribute to sample containers.
5. Log the sample on the chain-of-custody form.
6. Record the GPS location of the sample. If GPS signal is obstructed, measure the location using tape measure and/or pacing the distance from fixed, mappable objects (roads, light poles, etc.).
7. Photograph the location, including a close-up of the excavation.
8. Backfill the excavation with the excavated material.

3.6. Surface Water/Sediment Samples Interior to the Lowland Area

Surface water samples will be collected from up to six locations using a peristaltic pump and disposable tubing. One sediment sample will also be collected from each surface water feature after the water sample is collected. Surface water samples will be collected as follows:

1. Insert the sample tubing just under the surface of the water, approximately 1 foot from the water's edge.
2. Fill a clean container to overflowing and record field parameters (pH, conductivity, dissolved oxygen, temperature, salinity, total dissolved solids, seawater potential and oxidation-reduction potential) using the water quality meter. Ensure that overflowing water discharges to the ground surface at least 3 feet from the water's edge.
3. Perform turbidity and ferrous iron testing with the field test kits (Hach or equivalent).
4. Collect samples, cap samples, place in cooler with ice, and log on chain-of-custody form.
5. Record sample information on the surface water sample collection form.
6. Place a visual marker (e.g., "delineation flag" or equivalent) at the water's edge near the sample location and photograph and record the GPS coordinates of the sample collection location.

After collecting the water sample, collect the surface sediment sample as follows:

1. Visually survey the water body to identify sediment deposits located in the general vicinity of the surface water sample location where sufficient sample volume that is representative of the general condition of the surface water body is located.
2. Position the sediment collection device (i.e., shallow hand auger, "cookie cutter", or similar) to collect sediment that is covered by water, approximately 1 foot measured horizontally from the water's edge, and collect the top 0-10 cm of sediment.
3. Place the sediment in a stainless steel bowl and homogenize the sediment using a stainless steel spoon until the sediment appears generally uniform in color and texture.
4. Photograph the sediment. Include in the camera's field of view a sheet of paper or white board with the sample name written in large black print.
5. Distribute the sample to appropriate sample containers and ensure that the samples are properly labeled and tightly closed.
6. Clean the exterior of the sample containers, store them in a cooler with ice and log on chain of custody.
7. Record sample observations on the surface sediment sample collection form.

3.7. Outfall and Seep Sampling

Outfall and/or seep samples may be collected at up to 14 locations to characterize metals concentrations in seep/outfall water emerging along the western shoreline of the Snohomish River. Sediment samples may also be collected after seep sampling is completed. Seep and outfall water and sediment samples are only proposed where the concentrations of metals detected in groundwater and/or surface water adjacent to the seep and outfall water and sediment sampling locations is greater than screening levels.

If collected, outfall sampling will be performed as follows:

1. If water is free falling from the end of an outfall, hold a clean container in the flow for measurement of field parameters (see Step 2). If water is trickling from the end of an outfall, attempt to press the container against a surface to allow the container to fill. Cease measurements if the flow rate appears to be less than approximately 100 mL per minute; at such low flows, sampling will take more than 10 minutes, and there are time constraints to collect a sufficient number of outfall, seep and sediment samples within tidal windows.
2. Fill the container to overflowing and record field parameters (pH, conductivity, dissolved oxygen, temperature, salinity, total dissolved solids, seawater potential and oxidation-reduction potential) using the water quality meter.
3. Perform turbidity and ferrous iron testing with the turbidimeter and field test kits (Hach or equivalent).
4. After recording field parameters, collect the sample. Hold the laboratory-supplied sampling container (or bailer for filtered samples) in the flow, or press against surface to fill containers.

If flow is a trickle and laboratory-supplied containers and/or bailer cannot be filled directly, use a clean glass container to collect flow and transfer to laboratory-supplied container/bailer.

5. Seal samples, place on ice and log on chain of custody.
6. Record following minimum observations about the outfall/flow:
    a. Where is the outfall in comparison to the ordinary high water mark?
    b. Estimated flow rate
    c. Water color
    d. Presence of any soil staining (e.g., oxidized iron etc.)
    e. Odor
    f. Any other unusual observations (presence of unique biological communities in flow path of outfall, etc.)
7. Photograph the outfall and soil in the flow path of the outfall and record the GPS coordinates of the outfall.

Seep samples are anticipated to be collected using a peristaltic pump and disposable tubing, generally in the following manner (if collected):

1. If there is a natural depression where seep water is pooling, insert the sample tubing just under the surface of the water. Otherwise, excavate a shallow depression (approximately 2 to 12 inches) and insert the sample tubing just under the surface of the water.
2. Set the flow rate on the peristaltic pump such that the water surface is not drawn down (i.e. the surface depression will not run dry).
3. Fill a clean container to overflowing and record field parameters (pH, conductivity, dissolved oxygen, temperature, salinity, total dissolved solids, seawater potential and oxidation-reduction potential) using the water quality meter. Ensure that overflowing water lands at least 3 feet downgradient from the depression to be sampled.
4. Perform turbidity and ferrous iron testing with the field test kits (Hach or equivalent).
5. Collect the sample, cap the sample, place in cooler with ice, and log on chain-of-custody form.
6. Record following minimum observations about the seep:
    a. Where is the seep in comparison to the ordinary high water mark?
    b. Water color
    c. Presence of any soil staining (e.g., oxidized iron etc.)
    d. Odor
    e. Any other unusual observations (presence of unique biological communities in flow path of seep etc.)
7. Place a visual marker (e.g., “delineation flag” or equivalent) at the seep sample locations and photograph and record the GPS coordinates of the seep.

3.8. River Sediment Sampling

Sediment samples may be collected at up to 14 locations to characterize metals concentrations in sediment along the western shoreline of the Snohomish River where seeps and/or outfalls have been identified. Sediment samples are only proposed where the concentrations of metals detected in groundwater and/or surface water adjacent to the sediment sampling locations is greater than screening levels. Sediment sampling work may be performed from land using hand tools where sampling location is accessible by foot, or using a Van Veen or similar grab sampler deployed from a boat if sampling locations are inaccessible from the shoreline at the time of sediment sampling.

Sediment samples that can be collected from land using hand tools will be collected as follows:

1. Delineate the general area that is impacted by seep/outfall water (i.e., in the case of an outfall, sediment in the flow path of outfall water as close to the outfall as possible; in the case of a seep, sediment through which seep water flows, or sediment across which seep water flows as close to the seep as possible) and of suitable grain size for sampling with a “cookie cutter”.
2. Position the cookie cutter and collect the upper 0 to 10 cm of sediment.
3. Place the sediment in a stainless steel bowl and homogenize the sediment using a stainless steel spoon until the sediment appears generally uniform in color and texture.
4. Distribute the sample to appropriate sample containers and ensure that the samples are properly labeled and tightly closed.
5. Clean the exterior of the sample containers, store in a cooler with ice, and log on the chain of custody.
6. Record sampling information on the surface sediment sampling form.
7. Photograph the sediment. Include in the camera’s field of view a sheet of paper or white board with the sample name written in large black print.

Sediment samples collected from a boat using a Van Veen or similar sampler will be collected as follows:

1. Maneuver the boat to the proposed sampling location, steady the boat, and verify location control using the GPS.
2. Record the location of the sample.
3. Prepare the sampler for deployment.
4. Deploy the sampler through the water column to the mudline at approximately 1 foot per second (fps). Verify that the sampler cable is relatively plumb (within approximately 5 degrees of vertical).
5. Record the sampling time and the depth to mudline below the water surface (using the lead-line).
6. Release the sampler and raise it to the vessel at approximately 1 fps.

7. Place the sampler on the work surface of the boat. Avoid jostling the sampler and/or disturbing the sample.
8. Examine the sample for the following sediment acceptance criteria:
    - The sampler jaw is closed.
    - The sampler is not overfilled so that the sediment surface presses against the top of the sampler.
    - Minimal leakage has occurred, as evidenced by overlying water on the sediment surface.
    - Minimal sample disturbance has occurred, as evidenced by limited turbidity in the overlying water.
    - A penetration of greater than 10 cm has been achieved. A depth greater than 10 cm shall be the target penetration depth in order to sample sediment that has not come into contact with the side of the sampler.
    - If any of the sediment acceptance criteria are not achieved, the sample will be rejected and the location resampled. If the proposed sampling location cannot be achieved after eight deployments, notify the Project Manager to determine an appropriate alternative location.
9. Siphon off standing water from the surface of the sediment using a hose primed with Site water. Do not disturb the surface of the sediment.
10. Collect the upper 10 cm of sediment from the sampler using a decontaminated stainless steel spoon. Do not collect sediment that has been in contact with the side of the sampler. Place the sediment into a decontaminated stainless steel homogenization bowl.
11. If sufficient sample volume was not collected, repeat the sampling process until sufficient volume is achieved. Successive deployments should be within an approximate 10-foot radius of the initial deployment.
12. Homogenize the sediment (from one deployment if adequate sediment volume was achieved, or from multiple deployments if multiple deployments were required) in the stainless steel bowl using the stainless steel spoon until the sediment appears generally uniform in color and texture.
13. Distribute the sample to appropriate sample containers identified in the QAPP and ensure that the samples are properly labeled and tightly closed.
14. Clean the exterior of the sample containers, store them in a cooler with ice and log on the chain of custody.
15. Record the required information on the surface sediment sampling form.
16. Photograph the sediment. Include in the camera's field of view a sheet of paper or white board with the sample name written in large black print.
17. Thoroughly rinse the interior of the sampler until all loose sediment has been washed off. Excess sediment will be returned to the water surface in the approximate location where the sample was collected.

3.9. Surveying

The locations indicated below will be surveyed to within a horizontal accuracy of 0.1 feet and a vertical accuracy of 0.01 feet. The horizontal datum to be used is the Washington State Plane North coordinate system 83/91. The vertical datum to be used is NAVD 88 in US Survey feet.

- New monitoring wells (including ground surface, top of PVC and top of monument)
- Soil boring locations
- Surface soil sample locations

3.10. Field Screening

The potential presence of contamination in soil/sediment samples will be evaluated using field screening. The soil/sediment will be observed for any physical evidence indicative of possible contamination such as the presence of slag, or unusual color. A field XRF instrument may be used to screen samples for arsenic and/or lead concentrations. The field XRF measurements will be compared to the laboratory analytical results where collected from the same sample. Field screening results will be recorded on the field logs and the results will be used as a general guideline to delineate areas of possible contamination.

3.11. Decontamination

Drilling and non-disposable sampling equipment will be decontaminated using the procedures described in the QAPP.

3.12. Sample Handling

Sample handling procedures, including labeling, container and preservation requirements and holding times are described in QAPP.

3.13. Disposal of Investigation-Derived Waste

3.13.1. Soil/Sediment

Soil cuttings from monitoring wells, as well as excess core material from soil cores, will be placed in labeled and sealed 55-gallon drums. Soil generated from sampling at steep slopes will be backfilled into the hole from which it was excavated. Excess sediment will be returned to the ground/water surface.

Drums will be temporarily stored at a secure location within the Upland or Lowland Areas pending receipt of analytical results of soil samples and disposal at a permitted facility. If the results for a soil sample exceeds the “20 times” rule, the drum(s) containing the cuttings from the exploration from which the sample came will be analyzed using the Toxicity Characteristic Leaching Procedure (TCLP) to further evaluate disposal requirements. Each drum will be labeled with the following information:

- Material/media (i.e., soil) contained in the drum;
- Source of the material in the drum (i.e., investigation locations and depths where appropriate);
- Date material was generated; and

- Name and telephone number of contact person

3.13.2. Groundwater and Decontamination Water

Groundwater development and purge water removed from the monitoring wells and decontamination water generated during all sampling activities will be placed in labeled and sealed 55-gallon drums, or bulked in a storage container. Drums and/or containers will be located within the Upland or Lowland Area pending receipt of analytical results and off-site disposal at a permitted facility. Each drum will be labeled with the following information:

- Material/media (i.e., water) contained in the drum;
- Source of the material in the drum (i.e., investigation locations and depths where appropriate);
- Date material was generated; and
- Name and telephone number of contact person.

3.13.3. Incidental Waste

Incidental waste generated during sampling activities includes items such as gloves, plastic sheeting, sample tubing, paper towels and similar expended and discarded field supplies. These materials are considered *de minimis* and will be disposed of in a local trash receptacle or county disposal facility.

4.0 QUALITY ASSURANCE AND QUALITY CONTROL

Quality assurance/quality control (QA/QC) procedures and standards that will be implemented during investigation activities are presented in the QAPP. The purpose of the QAPP is to describe analysis and quality control procedures that will be implemented to produce chemical and field data that are representative, valid and accurate for use in characterizing soil and groundwater present at the Lowland Area.

Table 1

Proposed and Contingent Groundwater Monitoring Well and Associated Soil Sampling Rationale and Investigation Approach

Everett Smelter Cleanup Site - FSID 2744, ISIS Cleanup Site ID 4298 - Lowland Area
Everett, Washington

Investigation Location Designation	Investigation Location Type	Location Rationale	Investigation Approach
MW-1501R	Existing Shallow Aquifer Monitoring Well	• Characterize metals concentrations in shallow groundwater on west portion of Lowland Area approximately bounded by Marine View Drive, Highway 529, and the Snohomish River.	• Re-develop / purge, as necessary, prior to sample collection. • Collect groundwater sample from existing well using low flow groundwater sampling technique. (Note that this well is sampled quarterly by the property owner. If possible, sample "splits" will be collected) • Analyze groundwater samples for total and dissolved target list of metals.
MW-1301R	Existing Shallow Aquifer Monitoring Well	• Characterize metals concentrations in shallow groundwater on west portion of Lowland Area approximately bounded by Marine View Drive, Highway 529, and the Snohomish River.	• Re-develop / purge, as necessary, prior to sample collection. • Collect groundwater sample from existing well using low flow groundwater sampling technique. (Note that this well is sampled quarterly by the property owner. If possible, sample "splits" will be collected) • Analyze groundwater samples for total and dissolved target list of metals.
MW-1203R	Existing Shallow Aquifer Monitoring Well	• Characterize metals concentrations in shallow groundwater on west portion of Lowland Area approximately bounded by Marine View Drive, Highway 529, and the Snohomish River. • Characterize hydrogeology.	• Re-develop / purge, as necessary, prior to sample collection. • Collect groundwater sample from existing well using low flow groundwater sampling technique. (Note that this well is sampled quarterly by the property owner. If possible, sample "splits" will be collected) • Analyze groundwater samples for total and dissolved target list of metals.
LLMW-01D	New Deep Aquifer Monitoring Well at MW-1203R location	• Characterize soil metals concentrations within screened intervals, at the historic Lowland surface, and beneath the historic Lowland surface on northeastern portion of Lowland Area adjacent to Snohomish River. • Characterize metals concentrations in deep groundwater on west portion of Lowland Area adjacent to Snohomish River. • Characterize hydrogeology.	• Collect soil samples from boring advanced for monitoring well to be installed in deep aquifer. • Analyze soil samples for target list of metals. • Collect groundwater sample from monitoring well completed in deep aquifer using low flow groundwater monitoring technique. • Analyze groundwater samples for total and dissolved target list of metals. • Perform hydrogeologic testing.
MW-1202R	Existing Monitoring Shallow Aquifer Monitoring Well	• Characterize metals concentrations in shallow groundwater on west portion of Lowland Area adjacent to Snohomish River.	• Re-develop / purge, as necessary, prior to sample collection. • Collect groundwater sample from existing well using low flow groundwater sampling technique. (Note that this well is sampled quarterly by the property owner. If possible, sample "splits" will be collected) • Analyze groundwater samples for total and dissolved target list of metals.
MW-UNK	Existing Shallow Aquifer Monitoring Well	• Characterize metals concentrations in shallow groundwater on west portion of Lowland Area.	• Re-develop / purge, as necessary, prior to sample collection. • Collect groundwater sample from existing well using low flow groundwater sampling technique. • Analyze groundwater samples for total and dissolved target list of metals.
MW-1701	Existing Shallow Aquifer Monitoring Well (Weyerhaeuser West background well)	• Characterize metals concentrations in shallow groundwater on west portion of Lowland Area. • Characterize metals concentrations in shallow groundwater presumed to be downgradient of surface water feature previously containing elevated arsenic concentrations. • Characterize hydrogeology.	• Re-develop / purge, as necessary, prior to sample collection. • Collect groundwater sample from existing well using low flow groundwater sampling technique. • Analyze groundwater samples for total and dissolved target list of metals. • Perform hydrogeologic testing.
LLMW-02D	New Deep Aquifer Monitoring Well at MW-1701	• Characterize soil metals concentrations within screened intervals, at the historic Lowland surface, and beneath the historic Lowland surface on west portion of Lowland Area. • Characterize metals concentrations in deep groundwater on west portion of Lowland Area. • Characterize hydrogeology.	• Collect soil samples from boring advanced for monitoring well to be installed in deep aquifer. • Analyze soil samples for target list of metals. • Collect groundwater sample from monitoring well completed in deep aquifer using low flow groundwater monitoring technique. • Analyze groundwater samples for total and dissolved target list of metals. • Perform hydrogeologic testing.

Investigation Location Designation	Investigation Location Type	Location Rationale	Investigation Approach
LLMW-03S/LLMW-03D	New Shallow and Deep Aquifer Monitoring Well Pair	• Characterize soil metals concentrations within screened intervals, at the historic Lowland surface, and beneath the historic Lowland surface on north portion of Lowland Area. • Characterize metals concentrations in shallow groundwater downgradient of surface water feature previously containing elevated arsenic concentrations. • Characterize metals concentrations in groundwater north of area with elevated arsenic concentrations in groundwater. • Characterize hydrogeology.	• Collect soil samples from boring advanced for monitoring well to be completed in deep aquifer. • Analyze soil samples for target list of metals, TOC and grain size. • Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. • Analyze groundwater samples for total and dissolved target list of metals. • Perform hydrogeologic testing.
LLMW-04S/LLMW-04D	New Shallow and Deep Aquifer Monitoring Well Pair	• Characterize soil metals concentrations within screened intervals, at the historic Lowland surface, and beneath the historic Lowland surface on north portion of Lowland Area. • Characterize metals concentrations in shallow and deep groundwater presumed to be upgradient of surface water feature previously containing elevated arsenic concentrations. • Characterize metals concentrations in groundwater north of area with elevated arsenic concentrations in groundwater. • Characterize hydrogeology.	• Collect soil samples from boring advanced for monitoring well to be completed in deep aquifer. • Analyze soil samples for target list of metals and TOC. • Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. • Analyze for total and dissolved target list of metals. • Perform hydrogeologic testing.
EV-22A/EV-22B	New Shallow and Deep Aquifer Monitoring Well Pair	• Characterize metals concentrations in groundwater from shallow and deep aquifers adjacent to and downgradient of Everett Smelter Upland Area. • Characterize metals concentrations in groundwater north of area with elevated arsenic concentrations in groundwater. • Characterize hydrogeology.	• Re-develop / purge, as necessary, prior to sample collection. • Collect groundwater sample from existing well using low flow groundwater sampling technique. • Analyze groundwater samples for total and dissolved target list of metals. • Perform hydrogeologic testing.
LLMW-05S/LLMW-05D	New Shallow and Deep Aquifer Monitoring Well Pair	• Characterize soil metals concentrations within screened intervals, at the historic Lowland surface, and beneath the historic Lowland surface on east portion of Lowland Area. • Characterize metals concentrations in groundwater north of area with elevated arsenic concentrations in groundwater to evaluate the extent of elevated arsenic concentrations in groundwater. • Characterize metals concentrations in shallow and deep groundwater on east portion of Lowland Area adjacent to Snohomish River.	• Collect soil samples from boring advanced for monitoring well to be completed in deep aquifer. • Analyze soil samples for target list of metals and TOC. • Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. • Analyze groundwater samples for total and dissolved target list of metals.
LLMW-06S/LLMW-06D	New Shallow and Deep Aquifer Monitoring Well Pair	• Characterize soil metals concentrations within screened intervals, at the historic Lowland surface, and beneath the historic Lowland surface on east portion of Lowland Area. • Characterize metals concentrations in groundwater northeast of area with elevated arsenic concentrations in groundwater to evaluate the extent of elevated arsenic concentrations in groundwater. • Characterize hydrogeology.	• Collect soil samples from boring advanced for monitoring well to be completed in deep aquifer. • Analyze soil samples for target list of metals, TOC and grain size. • Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. • Analyze groundwater samples for total and dissolved target list of metals. • Perform hydrogeologic testing.
LLMW-07S/LLMW-07D	New Shallow and Deep Aquifer Monitoring Well Pair	• Characterize soil metals concentrations within screened intervals, at the historic Lowland surface, and beneath the historic Lowland surface on east portion of Lowland Area. • Characterize metals concentrations in groundwater northeast of area with elevated arsenic concentrations in groundwater to evaluate the extent of elevated arsenic concentrations in groundwater. • Characterize metals concentrations in shallow and deep groundwater on east portion of Lowland Area adjacent to Snohomish River.	• Collect soil samples from boring advanced for monitoring well to be completed in deep aquifer. • Analyze soil samples for target list of metals and grain size. • Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. • Analyze groundwater samples for total and dissolved target list of metals.
LLMW-08S/LLMW-08D	New Shallow and Deep Aquifer Monitoring Well Pair	• Characterize soil metals concentrations within screened intervals, at the historic Lowland surface, and beneath the historic Lowland surface on east portion of Lowland Area. • Characterize metals concentrations in groundwater northeast of area with elevated arsenic concentrations in groundwater to evaluate the extent of elevated arsenic concentrations in groundwater. • Characterize metals concentrations in shallow and deep groundwater on central portion of Lowland Area adjacent to Snohomish River. • Characterize hydrogeology.	• Collect soil samples from boring advanced for monitoring well to be completed in deep aquifer. • Analyze soil samples for target list of metals, TOC and grain size. • Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. • Analyze for total and dissolved target list of metals. • Perform hydrogeologic testing.

Investigation Location Designation	Investigation Location Type	Location Rationale	Investigation Approach
LLMW-09S/LLMW-09D	New Shallow and Deep Aquifer Monitoring Well Pair	• Characterize soil metals concentrations within screened intervals, at the historic Lowland surface, and beneath the historic Lowland surface on east portion of Lowland Area. • Characterize metals concentrations in groundwater east of area with elevated arsenic concentrations in groundwater to evaluate the extent of elevated arsenic concentrations in groundwater.	• Collect soil samples from boring advanced for monitoring well to be completed in deep aquifer. • Analyze soil samples for target list of metals. • Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. • Analyze groundwater samples for total and dissolved target list of metals.
LLMW-10S/LLMW-10D	New Shallow and Deep Aquifer Monitoring Well Pair	• Characterize soil metals concentrations within screened intervals, at the historic Lowland surface, and beneath the historic Lowland surface on east portion of Lowland Area. • Characterize metals concentrations in groundwater east of area with elevated arsenic concentrations in groundwater to evaluate the extent of elevated arsenic concentrations in groundwater. • Characterize hydrogeology.	• Collect soil samples from boring advanced for monitoring well to be completed in deep aquifer. • Analyze soil samples for target list of metals and TOC. • Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. • Analyze groundwater samples for total and dissolved target list of metals. • Perform hydrogeologic testing.
LLMW-11S/LLMW-11D	New Shallow and Deep Aquifer Monitoring Well Pair	• Characterize soil metals concentrations within screened intervals, at the historic Lowland surface, and beneath the historic Lowland surface on east portion of Lowland Area. • Characterize metals concentrations in groundwater east of area with elevated arsenic concentrations in groundwater to evaluate the extent of elevated arsenic concentrations in groundwater. • Characterize metals concentrations in shallow and deep groundwater on east portion of Lowland Area adjacent to Snohomish River. • Characterize hydrogeology.	• Collect soil samples from boring advanced for monitoring well to be completed in deep aquifer. • Analyze soil samples for target list of metals, TOC and grain size. • Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. • Analyze groundwater samples for total and dissolved target list of metals. • Perform hydrogeologic testing.
LLMW-12S/LLMW-12D	New Shallow and Deep Aquifer Monitoring Well Pair	• Characterize soil metals concentrations within screened intervals, at the historic Lowland surface, and beneath the historic Lowland surface on east portion of Lowland Area. • Characterize metals concentrations in groundwater east of area with elevated arsenic concentrations in groundwater to evaluate the extent of elevated arsenic concentrations in groundwater. • Characterize hydrogeology.	• Collect soil samples from boring advanced for monitoring well to be completed in deep aquifer. • Analyze soil samples for target list of metals and grain size. • Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. • Analyze for total and dissolved target list of metals. • Perform hydrogeologic testing.
LLMW-13S/LLMW-13D	New Shallow and Deep Aquifer Monitoring Well Pair	• Characterize soil metals concentrations within screened intervals, at the historic Lowland surface, and beneath the historic Lowland surface on east portion of Lowland Area. • Characterize metals concentrations in groundwater east of area with elevated arsenic concentrations in groundwater to evaluate the extent of elevated arsenic concentrations in groundwater. • Characterize hydrogeology.	• Collect soil samples from boring advanced for monitoring well to be completed in deep aquifer. • Analyze soil samples for target list of metals, TOC and grain size. • Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. • Analyze for total and dissolved target list of metals. • Perform hydrogeologic testing.
LLMW-14S/LLMW-14D	New Shallow and Deep Aquifer Monitoring Well Pair	• Characterize soil metals concentrations within screened intervals, at the historic Lowland surface, and beneath the historic Lowland surface on east portion of Lowland Area. • Characterize metals concentrations in groundwater east of area with elevated arsenic concentrations in groundwater to evaluate the extent of elevated arsenic concentrations in groundwater.	• Collect soil samples from boring advanced for monitoring well to be completed in deep aquifer. • Analyze soil samples for target list of metals and TOC. • Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. • Analyze groundwater samples for total and dissolved target list of metals.
LLMW-15S/LLMW-15D	New Shallow and Deep Aquifer Monitoring Well Pair	• Characterize soil metals concentrations within screened intervals, at the historic Lowland surface, and beneath the historic Lowland surface on east portion of Lowland Area. • Characterize metals concentrations in groundwater east of area with elevated arsenic concentrations in groundwater to evaluate the extent of elevated arsenic concentrations in groundwater. • Characterize hydrogeology.	• Collect soil samples from boring advanced for monitoring well to be completed in deep aquifer. • Analyze soil samples for target list of metals. • Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. • Analyze groundwater samples for total and dissolved target list of metals.
LLMW-16S/LLMW-16D	New Shallow and Deep Aquifer Monitoring Well Pair	• Characterize soil metals concentrations within screened intervals, at the historic Lowland surface, and beneath the historic Lowland surface on east portion of Lowland Area. • Characterize metals concentrations in groundwater east of area with elevated arsenic concentrations in groundwater to evaluate the extent of elevated arsenic concentrations in groundwater. • Characterize hydrogeology.	• Collect soil samples from boring advanced for monitoring well to be completed in deep aquifer. • Analyze soil samples for target list of metals and TOC. • Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. • Analyze groundwater samples for total and dissolved target list of metals. • Perform hydrogeologic testing.

Investigation Location Designation	Investigation Location Type	Location Rationale	Investigation Approach
LLMW-17S/LLMW-17D	New Shallow and Deep Aquifer Monitoring Well Pair	• Characterize soil metals concentrations within screened intervals, at the historic Lowland surface, and beneath the historic Lowland surface on east portion of Lowland Area. • Characterize metals concentrations in groundwater east of area with elevated arsenic concentrations in groundwater to evaluate the extent of elevated arsenic concentrations in groundwater. • Characterize metals concentrations in shallow and deep groundwater on east portion of Lowland Area adjacent to Snohomish River. • Characterize hydrogeology.	• Collect soil samples from boring advanced for monitoring well to be completed in deep aquifer. • Analyze soil samples for target list of metals and TOC. • Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. • Analyze groundwater samples for total and dissolved target list of metals. • Perform hydrogeologic testing.
LLMW-18S/LLMW-18 D	New Shallow and Deep Aquifer Monitoring Well Pair	• Characterize soil metals concentrations within screened intervals, at the historic Lowland surface, and beneath the historic Lowland surface on east portion of Lowland Area. • Characterize metals concentrations in groundwater east of area with elevated arsenic concentrations in groundwater to evaluate the extent of elevated arsenic concentrations in groundwater. • Evaluate arsenic species present in shallow and deep groundwater. • Characterize hydrogeology.	• Collect soil samples from boring advanced for monitoring well to be completed in deep aquifer. • Analyze soil samples for target list of metals, TOC and grain size. • Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. • Analyze groundwater samples for total and dissolved target list of metals. • Perform hydrogeologic testing.
PZ-2B	Existing Shallow Aquifer Monitoring Well (located outside of existing barrier wall)	• Characterize metals concentrations in shallow groundwater on east portion of Lowland Area.	• Re-develop / purge, as necessary, prior to sample collection. • Collect groundwater sample from existing well using low flow groundwater monitoring technique. • Analyze groundwater samples for total and dissolved target list of metals.
LL-19D	New Deep Aquifer Monitoring Well	• Characterize soil metals concentrations within screened intervals, at the historic Lowland surface, and beneath the historic Lowland surface on east portion of Lowland Area. • Characterize metals concentrations in groundwater east of area with elevated arsenic concentrations in groundwater to evaluate the extent of elevated arsenic concentrations in groundwater.	• Collect soil samples from boring advanced for monitoring well to be completed in deep aquifer. • Analyze soil samples for target list of metals. • Collect groundwater sample from monitoring well completed in deep aquifer using low flow groundwater monitoring technique. • Analyze groundwater samples for total and dissolved target list of metals.
PZ-3B	Existing Shallow Aquifer Monitoring Well (located outside of existing barrier wall)	• Characterize metals concentrations in shallow groundwater on southeastern portion of Lowland Area adjacent to Snohomish River.	• Re-develop / purge, as necessary, prior to sample collection. • Collect groundwater sample from existing well using low flow groundwater monitoring technique. • Analyze groundwater samples for total and dissolved target list of metals.
LL-20D	New Deep Aquifer Monitoring Well	• Characterize soil metals concentrations within screened intervals, at the historic Lowland surface, and beneath the historic Lowland surface on east portion of Lowland Area. • Characterize metals concentrations in groundwater east of area with elevated arsenic concentrations in groundwater to evaluate the extent of elevated arsenic concentrations in groundwater. • Characterize metals concentrations in deep groundwater on east portion of Lowland Area adjacent to Snohomish River.	• Collect soil samples from boring advanced for monitoring well to be completed in deep aquifer. • Analyze soil samples for target list of metals and TOC. • Collect groundwater sample from monitoring well completed in deep aquifer using low flow groundwater monitoring technique. • Analyze groundwater samples for total and dissolved target list of metals.
LLMW-21S/LLMW-21D	New Shallow and Deep Aquifer Monitoring Well Pair	• Characterize soil metals concentrations within screened intervals, at the historic Lowland surface, and beneath the historic Lowland surface on east portion of Lowland Area. • Characterize metals concentrations in groundwater east of area with elevated arsenic concentrations in groundwater to evaluate the extent of elevated arsenic concentrations in groundwater. • Characterize hydrogeology.	• Collect soil samples from boring advanced for monitoring well to be completed in deep aquifer. • Analyze soil samples for target list of metals. • Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. • Analyze groundwater samples for total and dissolved target list of metals. • Perform hydrogeologic testing.
LLMW-22S/LLMW-22D	New Shallow and Deep Aquifer Monitoring Well Pair	• Characterize soil metals concentrations within screened intervals, at the historic Lowland surface, and beneath the historic Lowland surface on east portion of Lowland Area. • Characterize metals concentrations in groundwater east of area with elevated arsenic concentrations in groundwater to evaluate the extent of elevated arsenic concentrations in groundwater. • Characterize metals concentrations in shallow and deep groundwater on east portion of Lowland Area adjacent to Snohomish River. • Characterize hydrogeology.	• Collect soil samples from boring advanced for monitoring well to be completed in deep aquifer. • Analyze soil samples for target list of metals. • Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. • Analyze groundwater samples for total and dissolved target list of metals. • Perform hydrogeologic testing.

Investigation Location Designation	Investigation Location Type	Location Rationale	Investigation Approach
LLMW-23S/LLMW-23D	New Shallow and Deep Aquifer Monitoring Well Pair	•Characterize soil metals concentrations within screened intervals, at the historic Lowland surface, and beneath the historic Lowland surface on east portion of Lowland Area. •Characterize metals concentrations in groundwater east of area with elevated arsenic concentrations in groundwater to evaluate the extent of elevated arsenic concentrations in groundwater. •Characterize metals concentrations in shallow and deep groundwater on east portion of Lowland Area adjacent to Snohomish River.	•Collect soil samples from boring advanced for monitoring well to be completed in deep aquifer. •Analyze soil samples for target list of metals. •Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. •Analyze groundwater samples for total and dissolved target list of metals.
BP-01S/BP-01D	Existing Shallow and Deep Aquifer Monitoring Well Pair	•Characterize metals concentrations in groundwater from the shallow and deep aquifers downgradient of the Upland Area and where smelter residuals (i.e., slag, etc.) are present in fill. •Characterize metals concentrations in groundwater from the shallow and deep aquifers where elevated arsenic concentrations have been measured in groundwater.	•Soil samples previously collected during well installation to characterize metals concentrations within screened intervals, at the historic Lowland surface, and beneath the historic Lowland surface. •Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. •Analyze groundwater samples for total and dissolved target list of metals.
BP-02S/BP-02D	Existing Shallow and Deep Aquifer Monitoring Well Pair	•Characterize metals concentrations in groundwater from the shallow and deep aquifers downgradient of the Upland Area and where smelter residuals (i.e., slag, etc.) are present in fill. •Characterize metals concentrations in groundwater from the shallow and deep aquifers where elevated arsenic concentrations have been measured in groundwater.	•Soil samples previously collected during well installation to characterize metals concentrations within screened intervals, at the historic Lowland surface, and beneath the historic Lowland surface. •Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. •Analyze groundwater samples for total and dissolved target list of metals.
BP-03S/BP-03D	Existing Shallow and Deep Aquifer Monitoring Well Pair	•Characterize metals concentrations in groundwater from the shallow and deep aquifers downgradient of the Upland Area and where smelter residuals (i.e., slag, etc.) are present in fill. •Characterize metals concentrations in groundwater from the shallow and deep aquifers where elevated arsenic concentrations have been measured in groundwater. •Characterize hydrogeology.	•Soil samples previously collected during well installation to characterize metals concentrations within screened intervals, at the historic Lowland surface, and beneath the historic Lowland surface. •Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. •Analyze groundwater samples for total and dissolved target list of metals. •Perform hydrogeologic testing.
BP-04S/BP-04D	Existing Shallow and Deep Aquifer Monitoring Well Pair	•Characterize metals concentrations in groundwater from the shallow and deep aquifers downgradient of the Upland Area and where smelter residuals (i.e., slag, etc.) are present in fill. •Characterize metals concentrations in groundwater from the shallow and deep aquifers where elevated arsenic concentrations have been measured in groundwater.	•Soil samples previously collected during well installation to characterize metals concentrations within screened intervals, at the historic Lowland surface, and beneath the historic Lowland surface. •Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. •Analyze groundwater samples for total and dissolved target list of metals.
BP-05S/BP-05D	Existing Shallow and Deep Aquifer Monitoring Well Pair	•Characterize metals concentrations in groundwater from the shallow and deep aquifers downgradient of the Upland Area and where smelter residuals (i.e., slag, etc.) are present in fill. •Characterize metals concentrations in groundwater from the shallow and deep aquifers where elevated arsenic concentrations have been measured in groundwater.	•Soil samples previously collected during well installation to characterize metals concentrations within screened intervals, at the historic Lowland surface, and beneath the historic Lowland surface. •Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. •Analyze groundwater samples for total and dissolved target list of metals.
BP-06S/BP-06D	Existing Monitoring Wells Completed in Shallow and Deep Aquifers	•Characterize metals concentrations in groundwater from the shallow and deep aquifers downgradient of the Upland Area and where smelter residuals (i.e., slag, etc.) are present in fill. •Characterize metals concentrations in groundwater from the shallow and deep aquifers where elevated arsenic concentrations have been measured in groundwater.	•Soil samples previously collected during well installation to characterize metals concentrations within screened intervals, at the historic Lowland surface, and beneath the historic Lowland surface. •Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. •Analyze groundwater samples for total and dissolved target list of metals.
BP-07S/BP-07D	Existing Shallow and Deep Aquifer Monitoring Well Pair	•Characterize metals concentrations in groundwater from the shallow and deep aquifers downgradient of the Upland Area and where smelter residuals (i.e., slag, etc.) are present in fill. •Characterize metals concentrations in groundwater from the shallow and deep aquifers where elevated arsenic concentrations have been measured in groundwater.	•Soil samples previously collected during well installation to characterize metals concentrations within screened intervals, at the historic Lowland surface, and beneath the historic Lowland surface. •Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. •Analyze groundwater samples for total and dissolved target list of metals.
BP-08S/BP-08D	Existing Shallow and Deep Aquifer Monitoring Well Pair	•Characterize metals concentrations in groundwater from the shallow and deep aquifers downgradient of the Upland Area and where smelter residuals (i.e., slag, etc.) are present in fill. •Characterize metals concentrations in groundwater from the shallow and deep aquifers where elevated arsenic concentrations have been measured in groundwater. Characterize hydrogeology.	•Soil samples previously collected during well installation to characterize metals concentrations within screened intervals, at the historic Lowland surface, and beneath the historic Lowland surface. •Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. •Analyze groundwater samples for total and dissolved target list of metals. •Perform hydrogeologic testing.

Investigation Location Designation	Investigation Location Type	Location Rationale	Investigation Approach
BP-09S/BP-09D	Existing Shallow and Deep Aquifer Monitoring Well Pair	•Characterize metals concentrations in groundwater from the shallow and deep aquifers downgradient of the Upland Area and where smelter residuals (i.e., slag, etc.) are present in fill. •Characterize metals concentrations in groundwater from the shallow and deep aquifers where elevated arsenic concentrations have been measured in groundwater.	•Soil samples previously collected during well installation to characterize metals concentrations within screened intervals, at the historic Lowland surface, and beneath the historic Lowland surface. •Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. •Analyze for total and dissolved target list of metals.
BP-10S/BP-10D	Existing Shallow and Deep Aquifer Monitoring Well Pair	•Characterize metals concentrations in groundwater from the shallow and deep aquifers downgradient of the Upland Area and where smelter residuals (i.e., slag, etc.) are present in fill. •Characterize metals concentrations in groundwater from the shallow and deep aquifers where elevated arsenic concentrations have been measured in groundwater.	•Soil samples previously collected during well installation to characterize metals concentrations within screened intervals, at the historic Lowland surface, and beneath the historic Lowland surface. •Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. •Analyze for total and dissolved target list of metals.
EV-6A/EV-6B	Existing Shallow and Deep Aquifer Monitoring Well Pair	•Characterize metals concentrations in groundwater from the shallow and deep aquifers downgradient of the Upland Area and where smelter residuals (i.e., slag, etc.) are present in fill. •Characterize metals concentrations in groundwater from the shallow and deep aquifers where elevated arsenic concentrations have been measured in groundwater.	•Soil samples previously collected from borings advanced to install well in the shallow and deep aquifers to characterize metals concentrations. •Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. •Analyze for total and dissolved target list of metals.
EV-20	Existing Deep Aquifer Monitoring Well	•Characterize metals concentrations in groundwater from the deep aquifer downgradient of the Upland Area and where smelter residuals (i.e., slag, etc.) are present in fill. •Characterize metals concentrations in groundwater from the deep aquifer where elevated arsenic concentrations have been measured in groundwater.	•Soil samples previously collected from borings advanced to install well in the shallow and deep aquifers to characterize metals concentrations. •Collect groundwater samples from monitoring well completed in deep aquifer using low flow groundwater monitoring technique. •Analyze groundwater samples for total and dissolved target list of metals.
EV-19B	Existing Deep Aquifer Monitoring Well	•Characterize metals concentrations in groundwater from the deep aquifer downgradient of the Upland Area and where smelter residuals (i.e., slag, etc.) are present in fill. •Characterize metals concentrations in groundwater from the deep aquifer where elevated arsenic concentrations have been measured in groundwater.	•Soil samples previously collected from borings advanced to install well in the shallow and deep aquifers to characterize metals concentrations. •Collect groundwater samples from monitoring well completed in deep aquifer using low flow groundwater monitoring technique. •Analyze groundwater samples for total and dissolved target list of metals.
LLMW-24S/LLMW-24D	New Shallow and Deep Monitoring Well Pair	•Characterize soil metals concentrations within screened intervals and at the historic native surface, and within the glacial till. •Characterize metals concentrations in groundwater from the shallow and deep aquifers upgradient of the Lowland Area.	•Collect soil samples from boring advanced for monitoring well to be completed in deep aquifer. •Field screen soil samples using XRF. •Analyze soil samples for target list of metals. •Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. •Analyze groundwater samples for total and dissolved target list of metals.
LLMW-25S/LLMW-25D	New Shallow and Deep Aquifer Monitoring Well Pair	•Characterize soil metals concentrations within screened intervals and at the historic native surface, and within the glacial till. •Characterize metals concentrations in groundwater from the shallow and deep aquifers upgradient of the Lowland Area. •Characterize hydrogeology.	•Collect soil samples from boring advanced for monitoring well to be completed in deep aquifer. •Field screen soil samples using XRF. •Analyze soil samples for target list of metals. •Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. •Analyze groundwater samples for total and dissolved target list of metals.
EV-13	Existing Shallow Aquifer Monitoring Well	•Characterize metals concentrations in groundwater from the shallow aquifer downgradient of the Upland Area and where smelter residuals (i.e., slag, etc.) are present in fill. •Characterize metals concentrations in groundwater from the shallow aquifer upgradient of the Lowland Area where elevated arsenic concentrations have been measured in groundwater.	•Soil samples previously collected from boring advanced to install well in the shallow aquifer to characterize metals concentrations. •Collect groundwater samples from monitoring wells completed in shallow aquifer using low flow groundwater monitoring technique. •Analyze groundwater samples for total and dissolved target list of metals.

Investigation Location Designation	Investigation Location Type	Location Rationale	Investigation Approach
LLMW-26D	Contingent Deep Aquifer Monitoring Well	•Characterize soil metals concentrations within screened intervals and at the historic native surface, and within the glacial till. •Characterize metals concentrations in groundwater from the shallow and deep aquifers upgradient of the Lowland Area where elevated arsenic concentrations have been measured in groundwater.	•Contingent monitoring well installation will be elected based on field screening, soil sampling or groundwater monitoring results in adjacent well locations. •Collect soil samples from boring advanced for monitoring well to be completed in deep aquifer. •Field screen soil samples using XRF. •Analyze soil samples for target list of metals. •Collect groundwater samples from monitoring well completed in shallow and deep aquifer using low flow groundwater monitoring technique. •Analyze groundwater samples for total and dissolved target list of metals.
LLMW-27S/LLMW-27D	New Shallow and Deep Aquifer Monitoring Well Pair	•Characterize soil metals concentrations within screened intervals and at various depths within the glacial till. •Characterize metals concentrations in groundwater from the shallow and deep aquifers upgradient of the Lowland Area where elevated arsenic concentrations have been measured in groundwater. •Characterize hydrogeology.	•Collect soil samples from boring advanced for monitoring well to be completed in deep aquifer. •Field screen soil samples using XRF. •Analyze soil samples for target list of metals and TOC. •Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. •Analyze groundwater samples for total and dissolved target list of metals. •Perform hydrogeologic testing.
LLMW-28S/LLMW-28D	Contingent Shallow and Deep Aquifer Monitoring Well Pair	•Characterize soil metals concentrations within screened intervals and at various depths within the glacial till. •Characterize metals concentrations in groundwater from the shallow and deep aquifers upgradient of the Lowland Area where elevated arsenic concentrations have been measured in groundwater.	•Contingent monitoring well installation will be elected based on field screening, soil sampling or groundwater monitoring results in adjacent well locations. •Analyze soil samples for target list of metals. •Collect soil samples from boring advanced for monitoring well to be completed in deep aquifer. •Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. •Analyze groundwater samples for total and dissolved target list of metals.
LLMW-29S/LLMW-29D	New Shallow and Deep Aquifer Monitoring Well Pair	•Collect soil samples to characterize metals concentrations within screened intervals and at the surface and within the glacial till. •Characterize metals concentrations in groundwater from the shallow and deep aquifers upgradient of the Lowland Area. •Characterize hydrogeology.	•Collect soil samples from boring advanced for monitoring well to be completed in deep aquifer. •Field screen soil samples using XRF. •Analyze soil samples for target list of metals and TOC. •Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. •Analyze groundwater samples for total and dissolved target list of metals. •Perform hydrogeologic testing.
LLMW-30S/LLMW-30D	Contingent Shallow and Deep Aquifer Monitoring Well Pair	•Characterize soil metals concentrations within screened intervals and at the historic native surface, and within the glacial till. •Characterize metals concentrations in groundwater from the shallow and deep aquifers upgradient of the Lowland Area.	•Contingent monitoring well installation will be elected based on field screening, soil sampling or groundwater monitoring results in adjacent well locations. •Collect soil samples from boring advanced for monitoring well to be completed in deep aquifer. •Field screen soil samples using XRF. •Analyze soil samples for target list of metals. •Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. •Analyze groundwater samples for total and dissolved target list of metals.
LLMW-31S/LLMW-31D	New Shallow and Deep Aquifer Monitoring Well Pair	•Characterize soil metals concentrations within screened intervals and at the historic native surface, and within the glacial till. •Characterize metals concentrations in groundwater from the shallow and deep aquifers upgradient of the Lowland Area.	•Collect soil samples from boring advanced for monitoring well to be completed in deep aquifer. •Field screen soil samples using XRF. •Analyze soil samples for target list of metals. •Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. •Analyze groundwater samples for total and dissolved target list of metals.

Investigation Location Designation	Investigation Location Type	Location Rationale	Investigation Approach
LLMW-32S/LLMW-32D	Contingent Shallow and Deep Aquifer Monitoring Well Pair	• Characterize soil metals concentrations within screened intervals and at the historic native surface, and within the glacial till. • Characterize metals concentrations in groundwater from the shallow and deep aquifers upgradient of the Lowland Area. • Characterize hydrogeology.	• Contingent monitoring well installation will be elected based on field screening, soil sampling or groundwater monitoring results in adjacent well locations. • Collect soil samples from boring advanced for monitoring well to be completed in deep aquifer. • Analyze soil samples for target list of metals. • Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. • Analyze groundwater samples for total and dissolved target list of metals.
LLMW-33S/LLMW-33D	New Shallow and Deep Aquifer Monitoring Well Pair	• Characterize soil metals concentrations within screened intervals and at the historic native surface, and within the glacial till. • Characterize metals concentrations in groundwater from the shallow and deep aquifers upgradient of the Lowland Area.	• Collect soil samples from boring advanced for monitoring well to be completed in deep aquifer. • Analyze soil samples for target list of metals. • Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. • Analyze groundwater samples for total and dissolved target list of metals.
LLMW-34S/LLMW-34D	New Shallow and Deep Aquifer Monitoring Well Pair	• Characterize soil metals concentrations within screened intervals and at the historic native surface, and within the glacial till. • Characterize metals concentrations in groundwater from the shallow and deep aquifers upgradient of the Lowland Area.	• Collect soil samples from boring advanced for monitoring well to be completed in deep aquifer. • Analyze soil samples for target list of metals. • Collect groundwater samples from monitoring wells completed in shallow and deep aquifers using low flow groundwater monitoring technique. • Analyze groundwater samples for total and dissolved target list of metals.

Table 2

Proposed and Contingent Groundwater Monitoring Well and Associated Soil Sampling Activities

Everett Smelter Cleanup Site - FSID 2744, ISIS Cleanup Site ID 4298 - Lowland Area

Everett, Washington

Investigation Location Designation	Investigation Location Type	Soil Sampling Activities	Groundwater Activities			
		Maximum Number of Soil Samples to be Analyzed	Maximum Number of Groundwater Samples to be Analyzed[1]	Groundwater Gradients[2]	Hydraulic Conductivity[3]	Pressure Transducer / Tidal Influence
MW-1501R	Existing Shallow Aquifer Monitoring Well	0	2			
MW-1301R	Existing Shallow Aquifer Monitoring Well	0	2			
MW-1203R	Existing Shallow Aquifer Monitoring Well	0	2	X		
LLMW-01D	New Deep Aquifer Monitoring Well	4	2	X		
MW-1202R	Existing Shallow Aquifer Monitoring Well	0	2			
MW-UNK	Existing Shallow Aquifer Monitoring Well	0	2			
MW-1701	Existing Shallow Aquifer Monitoring Well	0	2	X		
LLMW-02D	New Deep Aquifer Monitoring Well	4	2	X		
LLMW-03S/LLMW-03D	New Shallow and Deep Aquifer Monitoring Well Pair	4	4	X	X	
LLMW-04S/LLMW-04D	New Shallow and Deep Aquifer Monitoring Well Pair	4	4	X		
EV-22A/EV-22B	New Shallow and Deep Aquifer Monitoring Well Pair	4	4	X	X	
LLMW-05S/LLMW-05D	New Shallow and Deep Aquifer Monitoring Well Pair	4	4			
LLMW-06S/LLMW-06D	New Shallow and Deep Aquifer Monitoring Well Pair	4	4	X		X
LLMW-07S/LLMW-07D	New Shallow and Deep Aquifer Monitoring Well Pair	4	4			
LLMW-08S/LLMW-08D	New Shallow and Deep Aquifer Monitoring Well Pair	4	4	X		
LLMW-09S/LLMW-09D	New Shallow and Deep Aquifer Monitoring Well Pair	4	4			
LLMW-10S/LLMW-10D	New Shallow and Deep Aquifer Monitoring Well Pair	4	4	X		
LLMW-11S/LLMW-11D	New Shallow and Deep Aquifer Monitoring Well Pair	4	4		X	X
LLMW-12S/LLMW-12D	New Shallow and Deep Aquifer Monitoring Well Pair	4	4		X	X
LLMW-13S/LLMW-13D	New Shallow and Deep Aquifer Monitoring Well Pair	4	4	X	X	X

Investigation Location Designation	Investigation Location Type	Soil Sampling Activities	Groundwater Activities			
		Maximum Number of Soil Samples to be Analyzed	Maximum Number of Groundwater Samples to be Analyzed[1]	Groundwater Gradients[2]	Hydraulic Conductivity[3]	Pressure Transducer / Tidal Influence
LLMW-14S/LLMW-14D	New Shallow and Deep Aquifer Monitoring Well Pair	4	4			
LLMW-15S/LLMW-15D	New Shallow and Deep Aquifer Monitoring Well Pair	4	4	X		
LLMW-16S/LLMW-16D	New Shallow and Deep Aquifer Monitoring Well Pair	4	4	X		
LLMW-17S/LLMW-17D	New Shallow and Deep Aquifer Monitoring Well Pair	4	4	X		
LLMW-18S/LLMW-18 D	New Shallow and Deep Aquifer Monitoring Well Pair	4	4			
PZ-2B	Existing Shallow Aquifer Monitoring Well (located outside of existing barrier wall)	0	2			
LL-19D	New Deep Aquifer Monitoring Well	4	2			
PZ-3B	Existing Shallow Aquifer Monitoring Well (located outside of existing barrier wall)	0	2			
LL-20D	New Deep Aquifer Monitoring Well	4	2			
LLMW-21S/LLMW-21D	New Shallow and Deep Aquifer Monitoring Well Pair	4	4	X		
LLMW-22S/LLMW-22D	New Shallow and Deep Aquifer Monitoring Well Pair	4	4	X	X	
LLMW-23S/LLMW-23D	New Shallow and Deep Aquifer Monitoring Well Pair	4	4			
BP-01S/BP-01D	Existing Shallow and Deep Aquifer Monitoring Well Pair	0	4			
BP-02S/BP-02D	Existing Shallow and Deep Aquifer Monitoring Well Pair	0	4			
BP-03S/BP-03D	Existing Shallow and Deep Aquifer Monitoring Well Pair	0	4			
BP-04S/BP-04D	Existing Shallow and Deep Aquifer Monitoring Well Pair	0	4			
BP-05S/BP-05D	Existing Shallow and Deep Aquifer Monitoring Well Pair	0	4	X	X	X
BP-06S/BP-06D	Existing Shallow and Deep Aquifer Monitoring Well Pair	0	4			
BP-07S/BP-07D	Existing Shallow and Deep Aquifer Monitoring Well Pair	0	4			
BP-08S/BP-08D	Existing Shallow and Deep Aquifer Monitoring Well Pair	0	4	X	X	X
BP-09S/BP-09D	Existing Shallow and Deep Aquifer Monitoring Well Pair	0	4			

Investigation Location Designation	**Investigation Location Type**	**Soil Sampling Activities**	**Groundwater Activities**			
		Maximum Number of Soil Samples to be Analyzed	**Maximum Number of Groundwater Samples to be Analyzed[1]**	**Groundwater Gradients[2]**	**Hydraulic Conductivity[3]**	**Pressure Transducer / Tidal Influence**
BP-10S/BP-10D	Existing Shallow and Deep Aquifer Monitoring Well Pair	0	4			
EV-6A/EV-6B	Existing Shallow and Deep Aquifer Monitoring Well Pair	0	4			
EV-20	Existing Deep Aquifer Monitoring Well	0	2			
EV-19B	Existing Deep Aquifer Monitoring Well	4	2			
LLMW-24S/LLMW-24D	New Shallow and Deep Monitoring Well Pair	5	4			
LLMW-25S/LLMW-25D	New Shallow and Deep Aquifer Monitoring Well Pair	5	4			
EV-13	Existing Shallow Aquifer Monitoring Well	0	2			
LLMW-26D	Contingent Deep Aquifer Monitoring Well	5	2			
LLMW-27S/LLMW-27D	New Shallow and Deep Aquifer Monitoring Well Pair	5	4	X	X	
LLMW-28S/LLMW-28D	Contingent Shallow and Deep Aquifer Monitoring Well Pair	5	4			
LLMW-29S/LLMW-29D	New Shallow and Deep Aquifer Monitoring Well Pair	5	4	X		
LLMW-30S/LLMW-30D	Contingent Shallow and Deep Aquifer Monitoring Well Pair	5	4			
LLMW-31S/LLMW-31D	New Shallow and Deep Aquifer Monitoring Well Pair	5	4			
LLMW-32S/LLMW-32D	Contingent Shallow and Deep Aquifer Monitoring Well Pair	5	4			
LLMW-33S/LLMW-33D	New Shallow and Deep Aquifer Monitoring Well Pair	4	4			
LLMW-34S/LLMW-34D	New Shallow and Deep Aquifer Monitoring Well Pair	4	4			
Total Number of Soil/Groundwater Samples Submitted / Wells Tested		153	196	72	18	12

Notes:

[1] Two rounds of groundwater monitoring are to be performed. Therefore 2 samples are indicated to be collected from investigation location designations that consist of one well, and 4 samples are indicated to be collected from investigation location designations that consist of well pairs.

[2] In general, groundwater elevations will be measured at every well that is opened for development, sampling, and drawdown/slug testing. The wells marked with an "X" in this column will all be opened within a three-hour window, once during each round of sampling, to evaluate horizontal

[3] The wells marked with an "X" in this column have been preliminarily selected for drawdown/slug testing. Note that actual wells will be selected based on observed behavior during well development.

Table 3

Seep and Outfall Water and Sediment Monitoring Location Rationale and Investigation Approach

Everett Smelter Cleanup Site - FSID 2744, ISIS Cleanup Site ID 4298 - Lowland Area

Everett, Washington

Investigation Location Designation	Investigation Location Type	Location Rationale	Investigation Approach
LLSP-01/LLSD-08	Shoreline Seep and Sediment	•Water observed discharging from shoreline at location during dry season, low tide (i.e., on August 8, 2012) indicating seep is likely present throughout year. •Seep and sediment located downgradient of north portion of Everett Lowland Area where surface soil is to be sampled to evaluate presence of metals.	•Sample seep and sediment at location if metals concentrations in groundwater in adjacent monitoring well location (i.e., MW-1501R) on west portion of Lowland Area exceeds screening levels. •Collect seep water sample where seep discharges to surface of shoreline. •Collect surface sediment sample from shoreline downgradient and adjacent to where seep discharges to surface of shoreline. •Analyze seep water and sediment for target list of metals.
LLO-01/LLSD-09	Outfall and Sediment	•Water observed discharging from outfall at location during dry season (i.e., on August 8, 2012) indicating groundwater is component of discharge from outfall. •Outfall and sediment located downgradient of west portion of Everett Lowland Area where surface soil is to be sampled to evaluate presence of metals.	•Sample outfall and sediment at location if metals concentrations in groundwater in adjacent monitoring well location (i.e., MW-1501R) on west portion of Lowland Area exceeds screening levels. •Collect outfall water sample where outfall discharges to surface at shoreline. •Collect surface sediment sample from shoreline downgradient and adjacent to where outfall discharges to surface of shoreline. •Analyze outfall water and sediment for target list of metals.
LLSP-02/LLSD-10	Shoreline Seep and Sediment	•Water observed discharging from shoreline at location during dry season, low tide (i.e., on August 8, 2012) indicating seep is likely present throughout year. •Seep and sediment located downgradient of west portion of Everett Lowland Area where groundwater is to be sampled to evaluate presence of metals.	•Sample seep and sediment at location if metals concentrations in groundwater in adjacent monitoring well locations (i.e., MW-1501R and MW-1301R) on west portion of Lowland Area exceeds screening levels. •Collect seep water sample where seep discharges to surface of shoreline. •Collect surface sediment sample from shoreline downgradient and adjacent to where seep discharges to surface of shoreline. •Analyze seep water and sediment for target list of metals.

Investigation Location Designation	Investigation Location Type	Location Rationale	Investigation Approach
LLSP-03/LLSD-11	Shoreline Seep and Sediment	•Water observed discharging from shoreline at location during dry season, low tide (i.e., on August 8, 2012) indicating seep is likely present throughout year. •Seep and sediment located downgradient of west portion of Everett Lowland Area where groundwater is to be sampled to evaluate presence of metals.	•Sample seep and sediment at location if metals concentrations in groundwater in adjacent monitoring well locations (i.e., MW-1203R, LLMW-01D, and MW-1202R) on west portion of Lowland Area exceeds screening levels. •Collect seep water sample where seep discharges to surface of shoreline. •Collect surface sediment sample from shoreline downgradient and adjacent to where seep discharges to surface of shoreline. •Analyze seep water and sediment for target list of metals.
LLSP-04/LLSD-12	Shoreline Seep and Sediment	•Water observed discharging from shoreline at location during dry season, low tide (i.e., on August 8, 2012) indicating seep is likely present throughout year. •Seep and sediment located downgradient of west portion of Everett Lowland Area where groundwater is to be sampled to evaluate presence of metals.	•Sample seep and sediment at location if metals concentrations in groundwater in upgradient monitoring well location (i.e., LLMW-03S/D) on west portion of Lowland Area exceeds screening levels. •Collect seep water sample where seep discharges to surface of shoreline. •Collect surface sediment sample from shoreline downgradient and adjacent to where seep discharges to surface of shoreline. •Analyze seep water and sediment for target list of metals.
LLO-02/LLSD-13	Outfall and Sediment	•Water observed discharging from outfall at location during dry season (i.e., on August 8, 2012) indicating groundwater is component of discharge from outfall. •Outfall and sediment located downgradient of west portion of Everett Lowland Area where groundwater and surface water is to be sampled to evaluate presence of metals.	•Sample outfall and sediment at location if metals concentrations in groundwater in upgradient monitoring well location (i.e., LLMW-03S/D) and/or upgradient surface water samples (i.e., LLSW-01 and LLSW-02) collected from upgradient surface water features on west portion of Lowland Area exceed screening levels. •Collect outfall water sample where outfall discharges to surface at shoreline. •Collect surface sediment sample from shoreline downgradient and adjacent to where outfall discharges to surface of shoreline. •Analyze outfall water and sediment for target list of metals.
LLSP-05/LLSD-14	Shoreline Seep and Sediment	•Water observed discharging from shoreline at location during dry season, low tide (i.e., on August 8, 2012) indicating seep is likely present throughout year. •Seep and sediment located downgradient of east portion of Everett Lowland Area where groundwater is to be sampled to evaluate presence of metals.	•Sample seep and sediment at location if metals concentrations in groundwater in adjacent monitoring well locations (i.e., LLMW-07S/D and LLMW-08S/D) on east portion of Lowland Area exceeds screening levels. •Collect seep water sample where seep discharges to surface of shoreline. •Collect surface sediment sample from shoreline downgradient and adjacent to where seep discharges to surface of shoreline. •Analyze seep water and sediment for target list of metals.

Investigation Location Designation	Investigation Location Type	Location Rationale	Investigation Approach
LLO-03/LLSD-15	Outfall and Sediment	•Water observed discharging from outfall at location during dry season (i.e., on August 8, 2012) indicating groundwater is component of discharge from outfall. •Outfall and sediment located downgradient of east portion of Everett Lowland Area where groundwater and surface water is to be sampled to evaluate presence of metals.	•Sample outfall and sediment at location if metals concentrations in groundwater in adjacent monitoring well location (i.e., LLMW-08S/D) and/or upgradient surface water samples (i.e., LLSW-06 and LLSW-07) collected from upgradient surface water features on east portion of Lowland Area exceed screening levels. •Collect outfall water sample where outfall discharges to surface at shoreline. •Collect surface sediment sample from shoreline downgradient and adjacent to where outfall discharges to surface of shoreline. •Analyze outfall water and sediment for target list of metals.
LLO-04/LLSD-16	Outfall and Sediment	•Water observed discharging from outfall at location during dry season (i.e., on August 8, 2012) indicating groundwater is component of discharge from outfall. •Outfall and sediment located downgradient of east portion of Everett Lowland Area where groundwater is to be sampled to evaluate presence of metals.	•Sample outfall and sediment at location if metals concentrations in groundwater in adjacent monitoring well locations (i.e., LLMW-11S/D and LLMW-17S/D) on east portion of Lowland Area exceed screening levels. •Collect outfall water sample where outfall discharges to surface at shoreline. •Collect surface sediment sample from shoreline downgradient and adjacent to where outfall discharges to surface of shoreline. •Analyze outfall water and sediment for target list of metals.
LLSP-06/LLSD-17	Shoreline Seep and Sediment	•Water observed discharging from shoreline at location during dry season, low tide (i.e., on August 8, 2012) indicating seep is likely present throughout year. •Seep and sediment located downgradient of east portion of Everett Lowland Area where groundwater is to be sampled to evaluate presence of metals.	•Sample seep and sediment at location if metals concentrations in groundwater in adjacent monitoring well locations (i.e., LLMW-17S/D, PZ-3B, and LLMW-20D) on east portion of Lowland Area exceeds screening levels. •Collect seep water sample where seep discharges to surface of shoreline. •Collect surface sediment sample from shoreline downgradient and adjacent to where seep discharges to surface of shoreline. •Analyze seep water and sediment for target list of metals.
LLO-05/LLSD-18	Outfall and Sediment	•Water observed discharging from outfall at location during dry season (i.e., on August 8, 2012) indicating groundwater is component of discharge from outfall. •Outfall and sediment located downgradient of east portion of Everett Lowland Area where groundwater is to be sampled to evaluate presence of metals.	•Sample outfall and sediment at location if metals concentrations in groundwater in adjacent monitoring well locations (i.e., PZ-3B and LLMW-20D) on east portion of Lowland Area exceed screening levels. •Collect outfall water sample where outfall discharges to surface at shoreline. •Collect surface sediment sample from shoreline downgradient and adjacent to where outfall discharges to surface of shoreline. •Analyze outfall water and sediment for target list of metals.

Investigation Location Designation	Investigation Location Type	Location Rationale	Investigation Approach
LLSP-07/LLSD-19	Shoreline Seep and Sediment	•Water observed discharging from shoreline at location during dry season, low tide (i.e., on August 8, 2012) indicating seep is likely present throughout year. •Seep and sediment located downgradient of east portion of Everett Lowland Area where groundwater is to be sampled to evaluate presence of metals.	•Sample seep and sediment at location if metals concentrations in groundwater in adjacent monitoring well location (i.e., PZ-2B and LLMW-19D) on east portion of Lowland Area exceeds screening levels. •Collect seep water sample where seep discharges to surface of shoreline. •Collect surface sediment sample from shoreline downgradient and adjacent to where seep discharges to surface of shoreline. Analyze seep water and sediment for target list of metals.
LLO-06/LLSD-20	Outfall and Sediment	•Water observed discharging from outfall at location during dry season (i.e., on August 8, 2012) indicating groundwater is component of discharge from outfall. •Outfall and sediment located downgradient of east portion of Everett Lowland Area where groundwater is to be sampled to evaluate presence of metals.	•Sample outfall and sediment at location if metals concentrations in groundwater in adjacent monitoring well location (i.e., LLMW-23S/D) on east portion of Lowland Area exceed screening levels. •Collect outfall water sample where outfall discharges to surface at shoreline. •Collect surface sediment sample from shoreline downgradient and adjacent to where outfall discharges to surface of shoreline. •Analyze outfall water and sediment for target list of metals.
LLSP-08/LLSD-21	Shoreline Seep and Sediment	•Water observed discharging from shoreline at location during dry season, low tide (i.e., on August 8, 2012) indicating seep is likely present throughout year. •Seep and sediment located downgradient of east portion of Everett Lowland Area where groundwater is to be sampled to evaluate presence of metals.	•Sample seep and sediment at location if metals concentrations in groundwater in adjacent monitoring well location (i.e., LLMW-23S/D) on east portion of Lowland Area exceeds screening levels. •Collect seep water sample where seep discharges to surface of shoreline. •Collect surface sediment sample from shoreline downgradient and adjacent to where seep discharges to surface of shoreline. •Analyze seep water and sediment for target list of metals.

Table 4

Surface Water and Sediment Monitoring Location Rationale and Investigation Approach

Everett Smelter Cleanup Site - FSID 2744, ISIS Cleanup Site ID 4298 - Lowland Area

Everett, Washington

Investigation Location Designation	Investigation Location Type	Location Rationale	Investigation Approach
LLSW-01/LLSD-01	Lowland Surface Water and Sediment	•Surface water feature located on west portion of Lowland Area where elevated concentrations of arsenic were previously detected in water. •Surface water feature and associated water and sediment located downgradient of Upland Area and north of area where elevated metals concentrations have been detected in soil and groundwater.	•Collect surface water sample from bank of surface water feature. •Collect surface sediment sample from bank below the water line adjacent to where surface water sample is collected. •Analyze surface water and sediment for target list of metals.
LLSW-02/LLSD-02	Lowland Surface Water and Sediment	•Surface water feature located on west portion of Lowland Area where elevated concentrations of arsenic were previously detected in water. •Surface water feature and associated water and sediment located downgradient of Upland Area and north of area where elevated metals concentrations have been detected in soil and groundwater.	•Collect surface water sample from bank of surface water feature. •Collect surface sediment sample from bank below the water line adjacent to where surface water sample is collected. •Analyze surface water and sediment for target list of metals.
LLSW-03/LLSD-03	Lowland Surface Water and Sediment	•Surface water feature located on east portion of Lowland Area adjacent to Snohomish River. •Surface water feature and associated water and sediment located downgradient of Upland Area and east of area where elevated metals concentrations have been detected in soil and groundwater.	•Collect surface water sample from bank of surface water feature. •Collect surface sediment sample from bank below the water line adjacent to where surface water sample is collected. •Analyze surface water and sediment for target list of metals.
LLSW-04/LLSD-04	Lowland Surface Water and Sediment	•Surface water feature located on Benson Property portion of Lowland Area where elevated concentrations of arsenic were previously detected in water. •Surface water feature and associated water and sediment located downgradient of Upland Area and within area where elevated metals concentrations have been detected in soil and groundwater.	•Collect surface water sample from bank of surface water feature. •Collect surface sediment sample from bank below the water line adjacent to where surface water sample is collected. •Analyze surface water and sediment for target list of metals.
LLSW-05/LLSD-05	Lowland Surface Water and Sediment	•Surface water feature located on Benson Property portion of Lowland Area where elevated concentrations of arsenic were previously detected in water. •Surface water feature and associated water and sediment located downgradient of Upland Area and within area where elevated metals concentrations have been detected in soil and groundwater.	•Collect surface water sample from bank of surface water feature. •Collect surface sediment sample from bank below the water line adjacent to where surface water sample is collected. •Analyze surface water and sediment for target list of metals.

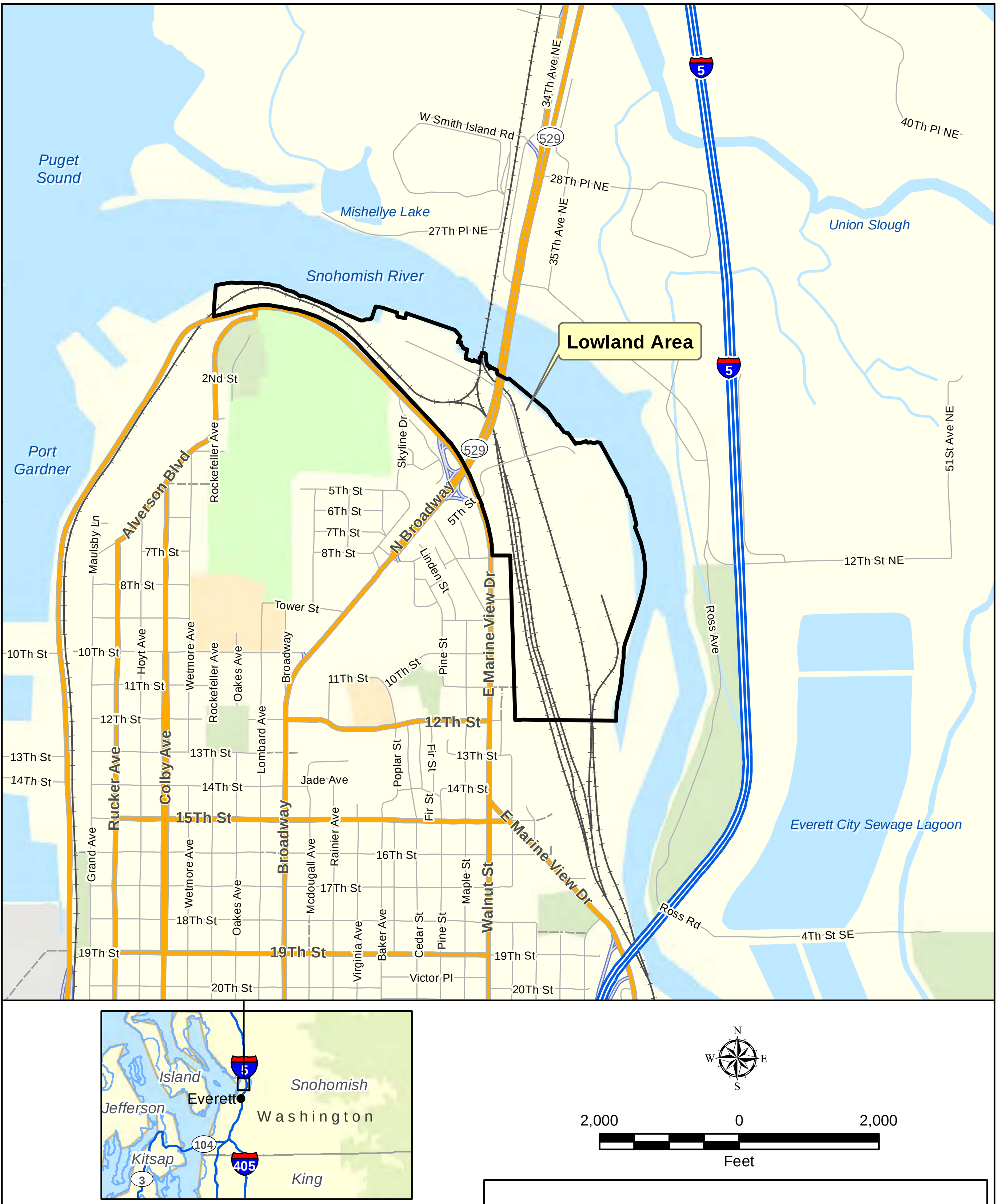
Investigation Location Designation	Investigation Location Type	Location Rationale	Investigation Approach
LLSW-06/LLSD-06	Lowland Surface Water and Sediment	•Surface water feature located on east portion of Lowland Area where elevated concentrations of arsenic were previously detected in water. •Surface water feature and associated water and sediment located downgradient of area where elevated metals concentrations have been detected in soil and groundwater.	•Collect surface water sample from bank of surface water feature. •Collect surface sediment sample from bank below the water line adjacent to where surface water sample is collected. •Analyze surface water and sediment for target list of metals.
LLSW-07/LLSD-07	Lowland Surface Water and Sediment	•Surface water feature located on east portion of Lowland Area where elevated concentrations of arsenic were previously detected in water. •Surface water feature and associated water and sediment located downgradient of area where elevated metals concentrations have been detected in soil and groundwater.	•Collect surface water sample from bank of surface water feature. •Collect surface sediment sample from bank below the water line adjacent to where surface water sample is collected. •Analyze surface water and sediment for target list of metals.

Table 5

Soil Sample Location Rationale and Investigation Approach

Everett Smelter Cleanup Site - FSID 2744, ISIS Cleanup Site ID 4298 - Lowland Area
Everett, Washington

Investigation Location Designation	Investigation Location Type	Location Rationale	Investigation Approach
LLS-01	New Surface Soil Sample	Collect surface soil sample on north portion of Lowland Area where surface soil may represent historic Lowland surface.	Analyze soil samples for target list of metals.
LLS-02	New Surface Soil Sample	Collect surface soil sample on north portion of Lowland Area where surface soil may represent historic Lowland surface.	Analyze soil samples for target list of metals.
LLS-03	New Surface Soil Sample	Collect surface soil sample on north portion of Lowland Area where surface soil may represent historic Lowland surface.	Analyze soil samples for target list of metals.
LLS-04	New Surface Soil Sample	Collect surface soil sample on north portion of Lowland Area where surface soil may represent historic Lowland surface.	Analyze soil samples for target list of metals.
LLS-05	New Surface Soil Sample	Collect surface soil sample on north portion of Lowland Area where surface soil may represent historic Lowland surface.	Analyze soil samples for target list of metals.
LLS-06	New Surface Soil Sample	Collect surface soil sample on north portion of Lowland Area where surface soil may represent historic Lowland surface.	Analyze soil samples for target list of metals.
LLS-07	New Surface Soil Sample	Collect surface soil sample on north portion of Lowland Area where surface soil may represent historic Lowland surface.	Analyze soil samples for target list of metals.
LLS-08	New Surface Soil Sample	Collect surface soil sample on north portion of Lowland Area where surface soil may represent historic Lowland surface.	Analyze soil samples for target list of metals.
LLSB-01	New Soil Boring	Collect soil samples to characterize metals concentrations at the historic Lowland surface and beneath the historic Lowland surface as well as within the screened interval depths of downgradient wells on north portion of Lowland Area.	Analyze soil samples for target list of metals.
LLSB-02	New Soil Boring	Collect soil samples to characterize metals concentrations at the historic Lowland surface and beneath the historic Lowland surface as well as within the screened interval depths of downgradient wells on north portion of Lowland Area.	Analyze soil samples for target list of metals.
LLSB-03	New Soil Boring	Collect soil samples to characterize metals concentrations at the historic Lowland surface and beneath the historic Lowland surface as well as within the screened interval depths of downgradient wells on north portion of Lowland Area.	Analyze soil samples for target list of metals.



Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. can not guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
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Data Sources: ESRI Data & Maps

Projection: NAD 1983 UTM Zone 10N

Vicinity Map

Everett Smelter - Lowland Area

GeoEngineers

Figure 1

Path: \\sea\projects\0\0504068\GIS\050406800_VicinityMap_Lowland.mxd Map Revised: 24 August 2012 amanza

Path: \\sea\projects\0\0504068\GIS\050406800_LowlandProposedInvestigationLocations.mxd   Map Revised: 26 September 2012   amanza

Legend

▭	Lowland Area
▭	Snohomish County Parcel Boundary
○	Existing Shallow Aquifer Monitoring Well
✚	Existing Deep Aquifer Monitoring Well
⊕	Existing Shallow and Deep Aquifer Monitoring Well Pair

Proposed Investigation Locations

⊕	Proposed Shallow and Deep Aquifer Monitoring Well Pair
⊕	Contingent Shallow and Deep Aquifer Monitoring Well Pair
✚	Proposed Deep Aquifer Monitoring Well
✚	Contingent Deep Aquifer Monitoring Well
⊕	Proposed Deeper Deep Well (to determine vertical extent)
■	Proposed Surface Soil Sample
✚	Proposed Soil Boring (Subsurface Sample)
▲	Proposed Surface Water and Sediment Sample
▲	Contingent Seep Water and Sediment Sample
▲	Contingent Outfall Water and Sediment Sample

Notes:
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Data Source: Aerials Express Seattle, 2009. Snohomish County GIS, 2012.

N
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700 0 700

Feet

Proposed Lowland Area Investigation Locations

Everett Smelter - Lowland Area

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DRAFT

Quality Assurance Project Plan (QAPP)

Everett Smelter Cleanup Site
FSID 2744, ISIS Cleanup Site ID 4298
Lowland Area
Everett, Washington

for
Washington State Department of Ecology

September 27, 2012

GEOENGINEERS

Plaza 600 Building
600 Stewart Street, Suite 1700
Seattle, Washington 98101
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Quality Assurance Project Plan (QAPP)

Everett Smelter Cleanup Site
FSID 2744, ISIS Cleanup Site ID 4298
Lowland Area
Everett, Washington

Project No. 0504-068-00

September 27, 2012

Approved By:

Signature: Date: September 27, 2012

John M. Herzog, PhD, Principal, GeoEngineers, Inc.

Signature: Date: September 27, 2012

Iain H. Wingard, Principal, GeoEngineers, Inc.

Signature: Date: September 27, 2012

Garrett R. Leque, Field Coordinator, GeoEngineers, Inc.

Signature: Date: September 27, 2012

Mark J. Lybeer, Quality Assurance Leader, GeoEngineers, Inc.

GRL:JMH:IHW:cn:csv

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Table of Contents

LIST OF TABLES

1.0 INTRODUCTION

This Quality Assurance Project Plan (QAPP) has been prepared for field and laboratory activities at the Everett Smelter Cleanup Site Lowland Area (i.e., Lowland Area) located in Everett, Washington (see Sampling and Analysis Plan [SAP] Figure 1). The Lowland Area includes multiple separately owned property parcels and rights-of-ways located adjacent to the parcels (SAP Figure 2). This QAPP serves as the primary guide for the integration of quality assurance (QA) and quality control (QC) functions into the investigation activities. The QAPP presents the objectives, procedures, organization, and specific QA and QC activities designed to achieve data quality goals established for the project. Environmental measurements will be conducted to produce data that are scientifically valid, of known and acceptable quality and that meet established objectives. QA/QC procedures will be implemented so that the precision, accuracy, representativeness, completeness and comparability (PARCC) of the data generated meet the specified data quality objectives.

The objective of the investigation and sampling procedures are presented in a separate Sampling and Analysis Plan (SAP). See the SAP for the following information:

- Project background including a site history and description
- Investigation goals and activities
- Project schedule summary

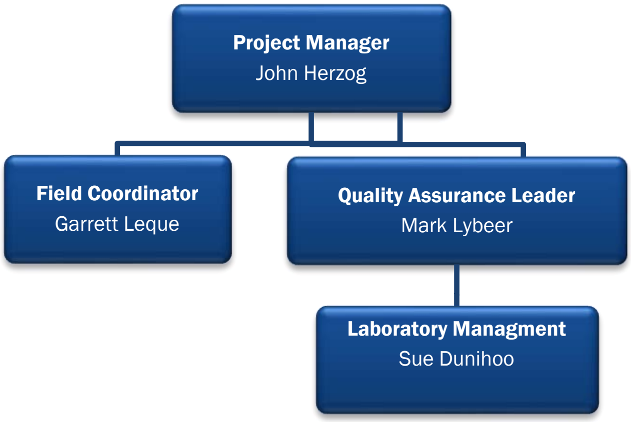
A site-specific Health and Safety Plan (HASP) will be used for field activities.

2.0 PROJECT MANAGEMENT

2.1. Project Organization and Responsibilities

Descriptions of the responsibilities, lines of authority and communication for the key positions providing QA/QC are shown in the Project Organization Chart provided below. The project organization facilitates the efficient production of project work, allows for an independent quality review, and permits resolution of any QA issues.

Project Organization Chart



2.1.1. Project Manager

John Herzog is the Project Manager and can be reached at 206.406.6431. The Project Manager has overall responsibility for executing the project in accordance with contractual requirements. The Project Manager is also responsible for selecting project team members, assigning and coordinating project tasks, determining subcontractor participation, establishing and adhering to budgets and schedules, providing technical oversight, and coordinating production and review of project deliverables.

2.1.2. Field Coordinator

Garrett Leque is the Field Coordinator and can be reached at 253.312.7958. The Field Coordinator is responsible for the daily management of activities in the field. Specific responsibilities include the following:

- Provides technical direction to the field staff.
- Develops schedules and allocates resources for field tasks.
- Coordinates data collection activities to be consistent with information requirements.
- Supervises the compilation of field data and laboratory analytical results.
- Assures that data are correctly and completely reported.
- Implements and oversees field sampling in accordance with project plans.
- Supervises field personnel.
- Coordinates work with on-site subcontractors.
- Schedules sample shipment with the analytical laboratory.
- Monitors that appropriate sampling, testing, and measurement procedures are followed.
- Coordinates the transfer of field data to the Project Manager for data reduction and validation.
- Participates in QA corrective actions as required.

2.1.3. Quality Assurance Leader

Mark Lybeer is the QA Leader and can be reached at 206.239.3227. The QA Leader is responsible for coordinating QA/QC activities as they relate to the acquisition of field data. Specific responsibilities include the following:

- Serves as the official contact for laboratory data QA concerns.
- Reviews and approves the laboratory QA Plan.
- Responds to laboratory data QA needs, answers laboratory requests for guidance and assistance, and resolves issues.
- Monitors laboratory compliance with data quality requirements.
- Ensures that appropriate sampling, testing, and analysis procedures are followed and that proper QC checks are implemented.

- Reviews the implementation of the QAPP and the overall quality of the analytical data generated.
- Maintains the authority to implement corrective actions as necessary.

2.1.4. Laboratory Management

Sue Dunnihoo at Analytical Resources, Inc. (ARI) will provide laboratory analytical services for the project. Sue Dunnihoo is the Laboratory's QA Coordinator for the project and can be reached at 206.695.6200.

The subcontracted laboratory conducting sample analyses for this project are required to obtain approval from the QA Leader before the initiation of sample analysis to assure that the laboratory QA plan complies with the project QA objectives. The Laboratory's QA Coordinator administers the Laboratory QA Plan and is responsible for QC. Specific responsibilities of this position include:

- Ensure implementation of the QA Plan.
- Serve as the laboratory point of contact.
- Activate corrective action for out-of-control events.
- Issue the final QA/QC report.
- Administer QA sample analysis.
- Comply with the specifications established in the project plans as related to laboratory services.
- Participate in QA audits and compliance inspections.

2.2. Health and Safety

A Site-specific health and safety plan (HASP) will be used for field activities. The Field Coordinator will be responsible for implementing the HASP during sampling activities. The Project Manager will discuss health and safety issues with the Field Coordinator on a routine basis during the completion of field activities.

The Field Coordinator will terminate any work activities that do not comply with the HASP. Companies providing services for this project on a subcontracted basis will be responsible for developing and implementing their own HASP.

3.0 DATA QUALITY OBJECTIVES

The quality assurance objective for technical data is to collect environmental monitoring data of known, acceptable, and documentable quality. The QA objectives established for the project are:

- Implement the procedures outlined herein for field sampling, sample custody, equipment operation and calibration, laboratory analysis, and data reporting that will facilitate consistency and thoroughness of data generated.

- Achieve the acceptable level of confidence and quality required so that data generated are scientifically valid and of known and documented quality. This will be performed by establishing criteria for precision, accuracy, representativeness, completeness, and comparability, and by testing data against these criteria.

The sampling design, field procedures, laboratory procedures, and QC procedures are set up to provide high-quality data for use in this project. Specific data quality factors that may affect data usability include quantitative factors (bias, detection limits, precision, accuracy and completeness) and qualitative factors (representativeness and comparability). The measurement quality objectives (MQO) associated with the data quality factors are summarized in Tables 1 through 3 and are discussed below.

3.1. Detection Limits

Analytical methods have quantitative limitations at a given statistical level of confidence that are often expressed as the method detection limit (MDL). Although results reported near the MDL provide insight to site conditions, quality assurance dictates that analytical methods achieve a consistently reliable level of detection known as the practical quantitation limit (PQL), which is typically demonstrated with the lowest point of a linear calibration. The contract laboratory will provide numerical results for all analytes and report them as detected above the PQL or undetected at the PQL.

The target reporting limits (TRLs) for metals are presented in Table 2 for soil and sediment and Table 3 for water (groundwater and surface water). These TRLs were obtained from an Ecology-certified laboratory (Analytical Resources, Inc. [ARI]). The reporting limits presented in Tables 2 and 3 are the laboratory PQLs that are considered target reporting limits because several factors may influence final reporting limits. First, moisture and other physical conditions of soil affect detection limits. Second, analytical procedures may require sample dilutions or other practices to accurately quantify a particular analyte at concentrations above the range of the instrument. The effect is that other analytes could be reported as undetected but at a value higher than a specified TRL. Data users must be aware that high non-detect values, although correctly reported, can bias statistical summaries and careful interpretation is required to correctly characterize Site conditions.

3.2. Precision

Precision is the measure of mutual agreement among replicate or duplicate measurements of an analyte from the same sample and applies to field duplicate or split samples, replicate analyses, and duplicate spiked environmental samples (matrix spike duplicates). The closer the measured values are to each other, the more precise the measurement process. Precision error may affect data usefulness. Good precision is indicative of relative consistency and comparability between different samples. Precision will be expressed as the relative percent difference (RPD) for spike sample comparisons of various matrices and field duplicate comparisons.

This value is calculated by:

$$RPD(\%) = \frac{|D_1 - D_2|}{(D_1 + D_2)/2} X\ 100,$$

Where

D_1 = Concentration of analyte in sample.

D_2 = Concentration of analyte in duplicate sample.

The calculation applies to split samples, replicate analyses, duplicate spiked environmental samples (matrix spike duplicates), and laboratory control duplicates. The RPD will be calculated for samples and compared to the applicable criteria. Precision can also be expressed as the percent difference (%D) between replicate analyses. Persons performing the evaluation must review the pertinent document (USEPA, 2004) that addresses criteria exceedances and courses of action. Project RPD goals for all analyses are 35 percent for water samples and 50 percent for soil samples, unless the primary and duplicate sample results are less than 5 times the MRL, in which case RPD goals will not apply for data quality assessment purposes.

3.3. Accuracy

Accuracy is a measure of bias in the analytic process. The closer the measurement value is to the true value, the greater the accuracy. This measure is defined as the difference between the reported values versus the actual value and is often measured with the addition of a known compound to a sample. The amount of known compound reported in the sample, or percent recovery, assists in determining the performance of the analytical system in correctly quantifying the compounds of interest. Since most environmental data collected represent one point spatially and temporally rather than an average of values, accuracy plays a greater role than precision in assessing the results. In general, if the percent recovery is low, non-detect results may indicate that compounds of interest are not present when in fact these compounds are present. Detected compounds may be biased low or reported at a value less than actual environmental conditions. The reverse is true when recoveries are high. Non-detect values are considered accurate while detected results may be higher than the true value.

For this project, accuracy will be expressed as the percent recovery of a known surrogate spike, matrix spike, or laboratory control sample (blank spike), concentration:

$$Recovery\ (\%) = \frac{Spiked\ Result - Unspiked\ Result}{Known\ Spike\ Concentrat\ ion} X\ 100$$

Persons performing the evaluation must review the pertinent document (USEPA, 2004) that addresses criteria exceedances and courses of action. Accuracy criteria for surrogate spikes, matrix spikes, and laboratory control spikes are found in Table 1 of this QAPP.

3.4. Representativeness

Representativeness expresses the degree to which data accurately and precisely represent the actual Site conditions. The determination of the representativeness of the data will be performed by completing the following:

- Comparing actual sampling procedures to those delineated within the SAP and this QAPP.
- Comparing analytical results of field duplicates to determine the variations in the analytical results.
- Invalidating non-representative data or identifying data to be classified as questionable or qualitative.

Only representative data will be used in subsequent data reduction, validation, and reporting activities.

3.5. Completeness

Completeness establishes whether a sufficient amount of valid measurements were obtained to meet project objectives. The number of samples and results expected establishes the comparative basis for completeness. Completeness goals are 90 percent useable data for samples/analyses planned. If the completeness goal is not achieved an evaluation will be made to determine if the data are adequate to meet study objectives.

$$\textit{Completeness} = \frac{\textit{number of valid measurements}}{\textit{total number of data points planned}} \times 100$$

3.6. Comparability

Comparability expresses the confidence with which one set of data can be compared to another. Although numeric goals do not exist for comparability, a statement on comparability will be prepared to determine overall usefulness of data sets, following the determination of both precision and accuracy.

3.7. Holding Times

Holding times are defined as the time between sample collection and extraction, sample collection and analysis, or sample extraction and analysis. Some analytical methods specify a holding time for analysis only. For many methods, holding times may be extended by sample preservation techniques in the field. If a sample exceeds a holding time, then the results may be biased low. Holding times are presented in Table 4.

3.8. Field Blanks

As metals are the only analysis to be performed, field blanks will not be analyzed. Laboratory blanks are discussed below.

3.9. Special Training Requirements/Certification

The Superfund Amendments and Reauthorization Act of 1986 required the Secretary of Labor to issue regulations providing health and safety standards and guidelines for workers engaged in hazardous waste operations. Occupational Safety and Health Administration (OSHA) regulations (29 CFR 1910.120) require training to provide employees with the knowledge and skills necessary to enable them to perform their jobs safely and with minimum risk to their personal health. All sampling personnel will have completed the 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) training course and 8-hour refresher courses, as necessary, to meet OSHA regulations.

4.0 DOCUMENTATION AND RECORDS

4.1. Field observations

Field documentation provides important information about potential problems or special circumstances surrounding sample collection. Field personnel will record information for each boring on field logs and will record a daily field report. Entries in the field logs will be made on water-resistant paper, and corrections will consist of line-out deletions.

At a minimum, the following information will be recorded during the collection of each sample:

- Sample location and description
- Sampler's name(s)
- Date and time of sample collection
- Sample matrix (soil or water)
- Type of sampling equipment used
- Field instrument (e.g., electronic water level indicator or XRF) readings
- Field observations and details that are pertinent to the integrity/condition of the samples (e.g., weather conditions, performance of the sampling equipment, sample depth control, sample disturbance, etc.)
- Preliminary sample descriptions (e.g., lithology, field screening results)
- Sample preservation
- Sample transport/shipping arrangements
- Name of recipient laboratory

In addition to the sampling information, the following specific information will also be recorded in the field log for each investigation location or in a daily field report:

- Sampling team members
- Time of arrival/entry on Site and time of Site departure
- Other personnel present at the Site

- Summary of pertinent meetings or discussions with contractor personnel
- Deviations from sampling plans, QAPP procedures, and HASP
- Changes in field personnel and responsibilities with reasons for the changes
- Levels of safety protection

The handling, use, and maintenance of field logs and reports are the Field Coordinator's responsibility.

4.2. Analytical Chemistry Records

Laboratories will be responsible for internal checks on data reporting and will correct errors identified during the QA review. All laboratories must be accredited by Ecology for the required analytical methods. Close contact will be maintained with the laboratories to resolve any quality control problems in a timely manner. The laboratories will be required to provide the following:

- **Project narrative –** This summary, in the form of a cover letter, will present any problems encountered during any aspect of analysis. The summary will include, but not be limited to, a discussion of QC, sample shipment, sample storage, and analytical difficulties. Any problems encountered by the laboratory, and their resolutions, will be documented in the project narrative.
- **Records –** Legible copies of the chain-of-custody (COC) forms will be provided as part of the data package. This documentation will include the time of receipt and the condition of each sample received by the laboratory. Additional internal tracking of sample custody by the laboratory will also be documented.
- **Sample results –** The data package will summarize the results for each sample analyzed. The summary will include the following information, as applicable:
    - Field sample identification code and the corresponding laboratory identification code
    - Sample matrix
    - Date of sample extraction/digestion
    - Date and time of analysis
    - Weight and/or volume used for analysis
    - Final dilution volumes or concentration factor for the sample
    - Total solids in the samples
    - Identification of the instruments used for analysis
    - MDLs and RLs
    - All data qualifiers and their definitions
- **QA/QC summaries –** These summaries will contain the results of all QA/QC procedures. Each QA/QC sample analysis will be documented with the same information as that required for the sample results (see above). The laboratory will make no recovery or blank corrections. The required summaries are listed below.

- The calibration data summary will contain the concentrations of the initial calibration and daily calibration standards and the date and time of analysis. The response factor, percent standard deviation (%RSD), RPDs, and retention time for each analyte will be listed, as appropriate. Results for standards analyzed at the RL to determine instrument sensitivity will be reported.
- The internal standard area summary will report the internal standard areas, as appropriate.
- The method blank analysis summary will report the method blank analysis associated with each sample and the concentrations of all compounds of interest identified in these blanks.
- The surrogate spike recovery summary will report all surrogate spike recovery data for organic analyses. The names and concentrations of all compounds added, percent recoveries, and QC limits will be listed.
- The matrix spike (MS) recovery summary will report the MS or MS duplicate (MSD) recovery data for analyses, as appropriate. The names and concentrations of all compounds added, percent recoveries, and QC limits will be included in the data package. The RPD for all MS/MSD analyses will be reported.
- The laboratory replicate summary will report the RPD for all laboratory replicate analyses. The QC limits for each compound or analyte will be listed.
- The laboratory control sample (LCS) analysis summary will report the results of the analyses of the LCS. The QC limits for each compound or analyte will be included in the data package.
- The relative retention time summary will report the relative retention times for the primary and confirmational columns of each analyte detected in the samples, as appropriate.

EQuIS four-file format electronic data deliverables will be obtained from the laboratory and data will be submitted into Ecology's Environmental Information Management (EIM) system after data quality assessments are completed.

4.3. Data Reduction

Data reduction is the process by which original data are converted or reduced to a specified format or unit to facilitate the analysis of the data. For example, a final analytical concentration may need to be calculated from a diluted sample result. Data reduction requires that all aspects of sample preparation that could affect the test result, such as sample volume analyzed or dilutions required, be taken into account in the final result. The laboratory personnel will reduce the analytical data for review by the Quality Assurance Leader and Project Manager.

During chemical analysis, samples are occasionally diluted after the initial analysis if the estimated concentration curve for one or more of the target analytes is above the calibration curve. In these instances, concentrations from the initial analysis will be identified as the "best result" for all target analytes other than the chemical(s) that was originally above the calibration range. The "best result" for this qualified analyte(s) will be taken from the diluted sample.

5.0 DATA GENERATION AND ACQUISITION

5.1. Sample Process Design

Soil and groundwater sampling will be conducted by GeoEngineers' field personnel. Soil, groundwater, surface water/seep and sediment samples are to be analyzed for metals including arsenic, lead, cadmium, antimony, thallium and mercury.

5.1.1. Soil Sampling

Soil samples will be collected by a licensed geologist from borings. Sample procedures and sample frequencies are described in the SAP.

5.1.2. Groundwater Monitoring

Following the completion of monitoring well installation and development, groundwater samples will be obtained from the wells. The location of the wells are shown in the SAP.

5.1.3. Surface Water/Seep Sampling

Surface water samples will be collected from fresh water and potentially from marine areas identified in the SAP. Sample procedures are described in the SAP.

5.1.4. Sediment Sampling

Fresh water and potentially marine sediment will be sampled from locations identified in the SAP. Sample procedures are described in the SAP.

5.2. Sample Methods

5.2.1. Sampling Equipment and Decontamination Procedures

Soil samples will be collected using hollow stem auger drilling equipment, direct push drilling equipment, or using hand tools. Groundwater samples will be collected from monitoring wells using dedicated submersible pumps or peristaltic pumps, using low-flow sampling procedures.

Reusable sampling equipment that comes in contact with soil, groundwater, surface water or sediment will be decontaminated before each use. Decontamination procedures for this equipment will consist of the following:

1. Washing with a brush and non-phosphate detergent solution (e.g., Liqui-Nox and distilled water),
2. Rinsing with distilled water, and
3. Wrapping or covering the decontaminated equipment with aluminum foil. Field personnel will limit cross-contamination by changing gloves between sampling locations.

Soil samplers which come into contact with soil will be decontaminated before each use. Drilling auger will be decontaminated between locations. Decontamination procedures for this equipment will consist of the following:

1. Washing with pressurized hot-water,

2. Wash with brush and non-phosphate detergent solution, and
3. Rinse with potable water.

Wash water used to decontaminate the reusable sampling equipment will be collected and stored on-site in 55-gallon drums or a bulking container.

5.2.2. Field Screening Procedures

The potential presence of contamination in samples collected from soil, groundwater, surface water and sediment will be evaluated using field screening techniques. Field screening results will be recorded on the field logs and the results will be used as a general guideline to delineate areas of possible contamination. Visual screening methods consisting of observations for the presence of slag, unusual color and/or staining indicative of possible contamination will be used during investigation activities. XRF may be used on selected soil samples.

5.2.3. Sample Containers and Labeling

The Field Coordinator will establish field protocol to manage field sample collection, handling, and documentation. All samples will be placed in appropriate laboratory-prepared containers. Sample containers and preservatives are listed in Table 4.

Sample containers will be labeled with the following information at the time of sample collection:

- Project number
- Sample name
- Sampling depth interval (if applicable)
- Date and time of collection

The sample collection activities will be noted on the field logs. The Field Coordinator will monitor consistency between sample containers/labels, field logs, and chain-of-custody (COC) forms.

5.3. Sample Handling and Custody

5.3.1. Sample Storage

Samples will be placed in a cooler with ice after they are collected. The objective of the cold storage will be to attain a sample temperature of 2 to 6 degrees Celsius. Holding times (Table 4) will be observed during sample storage.

5.3.2. Sample Shipment

Samples will be transported and delivered to the analytical laboratory in the sample coolers. The samples will either be transported by field personnel, laboratory personnel, or by courier service. The Field Coordinator will ensure that the cooler has been properly secured using clear plastic tape and custody seals.

5.3.3. Chain-of-Custody Records

Field personnel are responsible for the security of samples from the time the samples are collected until the samples have been received by the courier service or laboratory personnel. A COC form will be completed for each group of samples being shipped to the laboratory. Information to be included on the COC form includes:

- Project name and number;
- Sample identification numbers;
- Date and time of sampling;
- Sample matrix (soil or groundwater), preservative, and number of containers for each sample;
- Analyses to be performed;
- Names of sampling personnel;
- Project manager name and contact information including phone number; and
- Shipping information including shipping container number, if applicable.

The original COC form will be signed by a member of the field team. Field personnel will retain copies and provide the original and remaining copies to the laboratory or courier.

5.3.4. Laboratory Custody Procedures

The laboratory will follow their standard operating procedures (SOPs) to document sample handling from time of receipt (sample log-in) to reporting. Documentation will include, at a minimum, the analyst's name or initials, time, and date.

5.4. Analytical Methods

The methods of chemical analysis are identified in Tables 2 and 3. All methods selected represent standard methods used for the analysis of these analytes in soil, groundwater, surface water/seep and sediment. The laboratory project manager will determine the remedy to be used if the project RLs cannot be attained, in consultation with GeoEngineers Quality Assurance Leader.

5.5. Quality Control

Table 5 summarizes the types and frequency of QC samples to be analyzed, including both field QC and laboratory QC samples.

5.5.1. Field Duplicates

Field duplicates serve as a measure for precision. Under ideal field conditions, field duplicates (sometimes referred to as splits), are created by thoroughly mixing a volume of the sample matrix, placing aliquots of the mixed sample in separate containers, and identifying one of the aliquots as the primary sample and the other as the duplicate sample. Field duplicates measure the precision and consistency of laboratory analytical procedures and methods, as well as the consistency of the sampling techniques used by field personnel.

One field duplicate will be collected for every 20 samples collected or during each sampling event, as shown in Table 5.

5.5.2. Trip Blanks

Trip blanks accompany samples for volatile organic compound (VOC) analysis during field sampling and delivery to the laboratory. Trip blanks will not be analyzed during this investigation because VOC analyses are not part of the sampling and analysis plan.

5.5.3. Equipment Rinsate Blanks

Rinsate blanks will not be analyzed during this investigation.

5.6. Laboratory Quality Control

Laboratory QC procedures will be evaluated through a formal data quality assessment process. The analytical laboratory will follow standard analytical method procedures that include specified QC monitoring requirements. These requirements will vary by method, but generally include:

- Method blanks
- Internal standards
- Instrument calibrations
- Matrix spike/matrix spike duplicates (MS/MSD)
- Laboratory control samples/laboratory control sample duplicates (LCS/LCSD)
- Laboratory replicates or duplicates
- Surrogate/Labeled compounds

5.6.1. Laboratory Blanks

Laboratory procedures utilize several types of blanks, but the most commonly used blanks for QC monitoring are method blanks. Method blanks are laboratory QC samples that consist of either a soil-like material having undergone a contaminant destruction process, or reagent (contaminant-free) water. Method blanks are extracted and analyzed with each batch of environmental samples undergoing analysis. If a substance is detected in a method blank, then one (or more) of the following occurred:

- Sample containers, measurement equipment, and/or analytical instruments were not properly cleaned and contained contaminants.
- Reagents used in the process were contaminated with a substance(s) of interest.

It is difficult to determine which of the above scenarios took place if blank contamination occurs. However, it is assumed that the conditions that affected the blanks also likely affected the project samples. If target analytes are detected in method blanks, data validation guidelines assist in determining which substances in project samples are considered "real," and which ones are attributable to the analytical process. Furthermore, the guidelines state, "there may be instances where little or no contamination was present in the associated blank, but qualification of the sample is deemed necessary. Contamination introduced through dilution water is one example."

5.6.2. Calibrations

Several types of instrument calibrations are used, depending on the analytical method, to assess the linearity of the calibration curve and assure that the sample results reflect accurate and precise measurements. The main calibrations used are initial calibrations, daily calibrations, and continuing calibration verification.

5.6.3. Matrix Spike/Matrix Spike Duplicates (MS/MSD)

MS/MSD samples are used to assess influences or interferences caused by the physical or chemical properties of the sample itself. For example, extreme pH can affect the results for semivolatile organic compounds. Or, the presence of a particular compound may interfere with accurate quantitation of another analyte. MS/MSD data is reviewed in combination with other QC monitoring data to determine matrix effects. In some cases, matrix effects cannot be determined due to dilution and/or high levels of related substances in the sample. A matrix spike is evaluated by spiking a project sample with a known amount of one or more of the target analytes, ideally at a concentration that is 5 to 10 times higher than the sample result. A percent recovery is then calculated by subtracting the un-spiked sample result from the spiked sample result, dividing by the known concentration of the spike, and multiplying by 100.

MS/MSD samples will be analyzed at a frequency of one MS/MSD per analytical batch. The samples for the MS/MSD analyses should be collected from a sampling location that is believed to have only low-level contamination. A sample from an area of low-level contamination is needed because the objective of MS/MSD analyses is to determine the presence of matrix interferences, which can best be achieved with low levels of contaminants. Additional sample volume will be collected for the MS/MSD analyses as required by the laboratory.

5.6.4. Laboratory Control Sample/ Laboratory Control Sample Duplicates (LCS/LCSD)

Also known as blanks spikes, laboratory control samples (LCS) are similar to MS samples in that a known amount of one or more of the target analytes are spiked into a prepared sample medium, and a percent recovery of the spiked substances is calculated. The primary difference between LCS and MS samples is that the LCS uses a contaminant-free sample medium. For example, reagent water is typically used for LCS water analyses. The purpose of an LCS is to help assess the overall accuracy and precision of the analytical process including sample preparation, instrument performance, and analyst performance.

5.6.5. Laboratory Replicates/Duplicates

Laboratories utilize MS/MSDs, LCS/LCSDs, and/or replicates to assess precision. Replicates are a second analysis of a field-collected environmental sample. Replicates can be split at varying stages of the sample preparation and analysis process and most commonly consist of a second analysis on the extracted media.

5.6.6. Surrogates/Labeled Compounds

Surrogate spikes are used to verify proper extraction procedures and the accuracy of the analytical instrument. Surrogates are substances with characteristics similar to the target analytes. A known concentration of surrogate is added to the project sample and passed through the instrument and the percent recovery is calculated. Each surrogate used has acceptance limits (i.e., an acceptable range) for percent recovery. If a surrogate recovery is low, sample results may be biased low and depending on the recovery value, a possibility of false negatives may exist. Conversely, when recoveries are above the specified acceptance limits, a possibility of false positives exist, although non-detect results are considered accurate.

5.7. Instrument Testing, Inspection and Maintenance

The field coordinator will be responsible for overseeing the testing, inspection, and maintenance of all field equipment. The laboratory project manager will be responsible for laboratory equipment testing, inspection, and maintenance requirements. The calibration methods used in calibrating the analytical instrumentation are described in the following section.

5.8. Instrument Calibration and Frequency

5.8.1. Field Instrumentation

The calibration and calibration checks facilitate accurate and reliable field measurements. The calibration of field instruments used on the project will be checked and adjusted as necessary in general accordance with the manufacturer's recommendations. Methods and intervals of calibration checks and instrument maintenance will be based on the type of instrument, stability characteristics, required accuracy, intended use, and environmental conditions. The basic calibration check frequencies are described below.

5.8.2. Laboratory Instrumentation

For chemical analytical testing, calibration procedures will be performed in general accordance with the analytical methods used and the laboratory’s SOPs. Calibration documentation will be retained at the laboratory.

All instrument calibrations and their appropriate chemical standards are to comply with the specific methods within EPA SW-846, Test Methods for Evaluating Solid Waste, Physical and Chemical Methods, 3rd Edition, December 1996 and the Laboratory SOPs. Calibration documentation, initial (ICALs) and continuing (CCALs), will be retained at the Laboratory.

5.9. Inspection of Supplies and Consumables

Supplies and consumables for the field sampling effort will be inspected upon delivery and accepted if the condition of the supplies is satisfactory. For example, jars will be inspected to ensure that they are the correct size and quantity and were not damaged in shipment.

5.10. Data Management

Laboratories will report data in formatted hardcopy and digital formats. Analytical laboratory measurements will be recorded in standard formats that display, at a minimum, the field sample identification, the laboratory identification, reporting units, data qualifiers, analytical method, analyte tested, analytical result, extraction and analysis dates, and quantitation limits. Each sample delivery group will be accompanied by sample receipt forms and a case narrative identifying data quality issues. Laboratory electronic data deliverable (EDD) requirements will be established by GeoEngineers, Inc. with the contract laboratory. The laboratory will send final analytical testing results to the Project Manager.

Following completion of the soil sampling and analysis and groundwater monitoring, the relevant data generated as part of the project will be reported to Ecology.

6.0 ASSESSMENT AND OVERSIGHT

6.1. Assessment and Response Actions

6.1.1. Review of Field Documentation and Laboratory Receipt Information

Documentation of field sampling data will be reviewed periodically for conformance with project QC requirements described in this QAPP. At a minimum, field documentation will be checked for proper documentation of the following:

- Sample collection information (date, time, location, matrices, etc.);
- Field instruments used and calibration data;
- Sample collection protocol;
- Sample containers, preservation, and volume;
- Field QC samples collected at the frequency specified;
- COC protocols; and
- Sample shipment information.

Sample receipt forms provided by the laboratory will be reviewed for QC exceptions. The final laboratory data package will describe (in the case narrative) the effects that any identified QC exceptions have on data quality. The laboratory will review transcribed sample collection and receipt information for correctness prior to delivering the final data package.

6.1.2. Response Actions for Field Sampling

The Field Coordinator, or a designee, will be responsible for correcting equipment malfunctions throughout the field sampling effort and resolving situations in the field that may result in nonconformance or noncompliance with the QAPP. Corrective measures will be documented in the field report.

6.1.3. Corrective Action for Laboratory Analyses

Laboratories are required to comply with their current written SOPs. The laboratory project manager will be responsible for ensuring that appropriate corrective actions are initiated as required for conformance with this QAPP. All laboratory personnel will be responsible for reporting problems that may compromise the quality of the data to the laboratory project manager. A narrative describing the anomaly, the steps taken to identify and correct it, and the treatment of the relevant sample batch (i.e., recalculation, reanalysis and re-extraction) will be submitted with the data package.

7.0 DATA VALIDATION AND USABILITY

7.1. Data Review, Verification and Validation

The data validation and usability elements of the QAPP as detailed below address the QA/QC activities that occur after data collection and/or data generation is complete. Implementation of these elements ensures that the data conform to the specified criteria and will achieve the project objectives.

The data are not considered final until validated. All data, including laboratory and field QC sample results, will be summarized in a data validation report. The data validation report will focus on data that did not meet the MQOs specified in Table 1. The data validation reports will be included as an appendix to the final report. The data report will also describe any deviations from this QAPP and actions taken to address those deviations.

Level III laboratory data packages will be obtained for all soil and groundwater samples. These data will be reviewed for the following QC parameters:

- Holding times and sample preservation
- Method blanks
- MS/MSD analyses
- LCS/LCSD analyses
- Surrogate spikes
- Duplicates/replicates
- Field/Lab duplicates
- Calibrations (initial and continuing)
- Internal standards
- Instrument tunes

In addition to these QC parameters, other documentation such as sample receipt forms and case narratives will be reviewed to evaluate laboratory QA/QC.

7.2. Verification and Validation Methods

Hard-copy laboratory reports will be generated providing the analysis-specific information including final sample analytical results, reportable field and laboratory QA/QC analytical results, MDLs and MRLs. The laboratory data will also be reported via electronic media using the tabular outputting capabilities of standard software formats.

The term “reporting limit” will be used interchangeably with “quantitation limit” to mean the lowest concentration at which an analyte can be quantified subject to the quality control criteria of the analytical method. These terms are different from "MDL," which refers to the lowest concentration that the analytical method can ideally detect.

Data validation qualifiers including "U," "J,", and "R" will be used following the reported laboratory results to explain data quality issues affecting the laboratory data to the data user. These qualifiers are explained as follows:

- "U" indicates that a compound was analyzed for but not detected. The associated numerical value is the estimated sample quantitation limit, which is corrected for dilution and percent moisture.
- "J" indicates that a compound was detected below the reporting limit and the value is estimated or the value was estimated by the validator because the of instrument bias reasons.
- If any target analytes are found in a laboratory method blank, it will be regarded as blank contamination. In these cases, the result of a given analyte in the method blank will be compared to any positive result of the same analyte in the associated field samples. If a field sample result is less than five times (ten times for common laboratory contaminants like acetone, phthalates, etc.) the result that is reported in the method blank, the result will be considered blank contamination. Accordingly, the result will be qualified as not-detected "U" at the elevated reporting limit. Otherwise the positive result in the field sample will be considered real.
- "R" indicates results should not be used. If there are two analyses reported by the laboratory for one sample (as in the case of dilutions), the validator will use the method described in Section 4.3 of this QAPP to make the final assessment. As there should be only one reported result per analyte for a given sample, any extraneous results will be qualified as not-reportable, "R", and will not be used.

7.3. Reconciliation with User Requirements

A data quality assessment will be conducted by the project Quality Assessment Leader to identify cases where the projects MQOs were not met.

8.0 REFERENCES

United States Environmental Protection Agency (USEPA, 2004), "Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, OSWER 9240.1-45, EPA 540-R-04-004." October 2004.

Table 1

Measurement Quality Objectives

Everett Smelter Cleanup Site - FSID 2744, ISIS Cleanup Site ID 4298 – Lowland Area

Everett, Washington

		QC Check Standards (Laboratory Control Samples & Matrix Spike Samples) Limits			Surrogate Standards (SS) %R Limits	Field Duplicate Samples RPD Limits[2]	
				RPD			
Laboratory Analysis	**Analytical Method**	**Soil/Sediment %R[1]**	**Water %R[1]**	**Soil/Sediment/Water**	**Soil/Sediment/Water**	**Soil/Sediment**	**Water**
Metals (Soil/Sediment/Water)	EPA 6000/7000	75%-125%	75%-125%	≤20%	NA	≤50%	≤35%
Arsenic Speciation[3] (Water)	IC-ICP-DRC-MS or 1632	NA	65%-135%	≤30%	NA	NA	≤35%
SPLP (for Arsenic and Lead)	EPA 1312/EPA 6000	75%-125%	75%-125%	≤20%	NA	≤50%	≤35%
Total Organic Carbon (TOC) (Soil)	EPA 9060	75%-125%	NA	≤20%	NA		NA
Grain Size (Soil)	ASTM D421/D422	NA	NA	≤10%	NA	NA	NA

Notes:

[1] Percent recovery limits are compound-specific and based on laboratory studies. The surrogate %R and laboratory control/matrix spike sample %R control limits presented are the ranges for all of the individual analytes in the identified analysis. The individual control limits will be provided with the laboratory report for each analysis.

[2] Project RPD goals are 35 percent for water samples and 50 percent for soil samples, unless the primary and duplicate sample results are less than 5 times the Minimum Reporting Limit (MRL), in which case RPD goals will not apply for data quality assessment purposes.

[3] Arsenic speciation will be performed on a subset of samples and will typically include analyzing for As(III), As(V), and methylated arsenics.

SPLP = Synthetic Precipitation Leaching Procedure

%R = Percent recovery

RPD = Relative Percent Difference

NA = Not applicable

Table 2

Methods of Analysis and Target Reporting Limits for Soil and Sediment Samples

Everett Smelter Cleanup Site - FSID 2744, ISIS Cleanup Site ID 4298 – Lowland Area

Everett, Washington

Analyte	Analytical Method	Screening Level[1] (mg/kg)	Target Reporting Limit (mg/kg)[2]
Arsenic	EPA 6010B	7	5
Lead	EPA 6010B	17	2
Cadmium	EPA 6010B	1	0.2
Antimony	EPA 6010B	32	5
Thallium	EPA 6010B	5.6	5
Mercury	EPA 7471A	0.07	0.05
Total Organic Carbon (TOC)	PSEP 1986	NA	0.01%
Grain Size	ASTM D421/422	NA	0.1%

Notes:

[1] Screening level provided for the purposes of identifying laboratory target reporting limits. Screening levels based on MTCA Method A or B cleanup levels, natural background for Washington State ("Natural Background Soil Metals Concentrations in Washington State," Ecology Publication #94-115, October 1994), and Sediment Management Standard (SMS) Sediment Quality Standards (SQS).

[2] Laboratory reporting limits were obtained from Analytical Resources, Inc., an Ecology-approved laboratory.

mg/kg = Milligram per kilogram

NA = Not applicable

Table 3

Methods of Analysis and Target Reporting Limits for Water Samples

Everett Smelter Cleanup Site - FSID 2744, ISIS Cleanup Site ID 4298 – Lowland Area

Everett, Washington

Analyte	Analytical Method	Screening Level[1] (µg/l)	Target Reporting Limit (µg/l)[2]
Arsenic	EPA 200.8 / 1312 (for SPLP)	5	0.5
Lead	EPA 200.8 / 1312 (for SPLP)	2.5	0.1
Cadmium	EPA 200.8	0.25	0.1
Antimony	EPA 200.8	6	0.2
Thallium	EPA 200.8	0.5	0.2
Mercury	EPA 7470A (low level)	0.012	0.02
Arsenic Speciation[3]	IC-ICP-DRC-MS or EPA 1632 (Hydride Generation)	NA	0.008

Notes:

[1] Screening level provided for the purposes of identifying laboratory target reporting limits. Screening levels based on MTCA Method A or B cleanup levels, surface water criteria, and natural background for Washington State.

[2] Laboratory reporting limits were obtained from Analytical Resources, Inc., an Ecology-approved laboratory.

[3] Arsenic speciation analysis for As(III) and As(V)

µg/l = Microgram per liter

NA = Not applicable

Table 4

Test Methods, Sample Containers, Preservation and Hold Times

Everett Smelter Cleanup Site - FSID 2744, ISIS Cleanup Site ID 4298 – Lowland Area

Everett, Washington

		Soil				**Groundwater**			
Analysis	**Method**	**Minimum Sample Size**	**Sample Containers**	**Sample Preservation**	**Holding Times**	**Minimum Sample Size**	**Sample Containers**	**Sample Preservation**	**Holding Times**
Metals[1]	EPA 6000/7000 (and EPA 1312 for SPLP)	8 oz	8 oz glass widemouth with Teflon-lined lid	Cool 4°C	180 days/ 28 days for Mercury	500 mL	500 mL poly bottle	HNO_3 - pH<2	180 days (28 days for Mercury)
Arsenic Speciation	EPA 1632 or IC-ICP-DRC-MS	NA	NA	NA	NA	250 mL	250 mL HDPE	HCl pH<2	28 days
Total Organic Carbon (TOC)	PSEP 1986	50 g	2 oz glass widemouth with Teflon-lined lid	Cool 4°C Freeze <-18°C	14 days to prep 6 months	NA	NA	NA	NA
Grain Size	ASTM D421/D422	200 g	16 oz HDPE or ziploc bag	Cool 4°C	6 months	NA	NA	NA	NA

Notes:

[1] **Includes total metals and Synthetic Precipitation Leaching Procedure (SPLP) tests**

Extraction Holding Time is based on elapsed time from date of sample collection.

oz = ounce

mL = milliliter

Table 5

Quality Control Samples - Type and Frequency

Everett Smelter Cleanup Site - FSID 2744, ISIS Cleanup Site ID 4298 – Lowland Area
Everett, Washington

Samples Collected for Chemical Analytical Testing	Field QC		Laboratory QC			
	Field Duplicates	Trip Blanks	Method Blanks	LCS	MS/MSD	Lab Duplicates
Soil[1]	1 per every 20 samples	NA	1/batch	1/batch	1/batch	1/batch
Soil - SPLP	1 per every 20 samples	NA	1/batch	1/batch	1/batch	1/batch
Sediment[2]	1 per sampling event	NA	1/batch	1/batch	1/batch	1/batch
Groundwater[3]	1 per every 20 samples	NA	1/batch	1/batch	1/batch[5]	1/batch
Surface Water[4]	1 per sampling event	NA	1/batch	1/batch	1/batch[5]	1/batch

Notes:

[1] "Soil" includes soil samples collected from borings and from steep slopes.

[2] "Sediment" includes up to seven sediment samples to be collected from surface water features interior to the Lowland Area. One field duplicate will be collected during this sampling event. Up to 14 sediment samples may potentially be collected from the west bank of the Snohomish River. If samples are collected, one field duplicate will be collected during this sampling event.

[3] "Groundwater" includes samples collected during two rounds of groundwater monitoring.

[4] "Surface water" includes up to seven surface water samples to be collected from surface water features interior to the Lowland Area. One field duplicate will be collected during this sampling event. Up to 14 seep/outfall samples may potentially be collected from the west bank of the Snohomish River. If samples are collected, one field duplicate will be collected during this sampling event.

[5] Two times the sample volume will be collected to provide adequate sample volume to perform MS/MSD analyses.

An analytical batch is defined as a group of samples taken through a preparation procedure and sharing a method blank, LCS, and MS/MSD (or MS and lab duplicate).

No more than 20 field samples can be contained in one batch.

LCS = Laboratory control sample

MS = Matrix spike sample

MSD = Matrix spike duplicate sample

NA = Not Applicable