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# SOUTHWEST HARBOR PROJECT

## Phase II Groundwater Confirmation Monitoring Program

### Water Quality Monitoring Plan

**Prepared for: Port of Seattle**

Project No. 990106-004-24 • October 6, 2008

***In Association with:***

**Windward Environmental, LLC**

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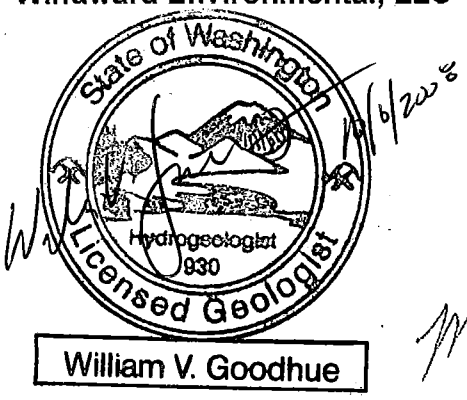


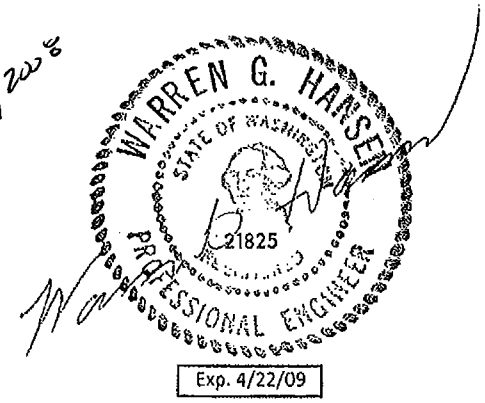


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***Index of Modifications to Final Southwest Harbor Project Water Quality Monitoring Plan - Pursuant to Ecology Comment Letter Dated September 5, 2008***

Prepared by Aspect Consulting LLC, October 6, 2008

**Comment 1**

Requires that an index of modifications (to the Draft Water Quality Monitoring Plan Dated March 2, 2007) be included with final Water Quality Monitoring Plan (WQMP).

*Modifications to Final WQMP:* Index included as this document.

**Comment 2**

Requires clarifying that three Estuarine Aquifer wells will be included in the sampling program.

*Modifications to Final WQMP:*

- Estuarine Aquifer wells MW-36, MW-44 and MW-308S added to planned sampling.
- Table 2.1 modified to include Estuarine Aquifer wells to be sampled.
- Figure 2.2 modified to show Estuarine Aquifer wells to be sampled.
- Reference to sampling Estuarine Aquifer wells added to Section 2.2, Section 2.3, Section 2.4, Section 3.2.2, and Section 5.1.
- Requirement for salinity correction to Estuarine Aquifer well groundwater elevations added to Section 3.2.2.
- Estuarine Aquifer well completion reports added to Appendix B.

**Comment 3**

Documents the conditional criteria to be evaluated for potentially dropping the Estuarine Aquifer wells from the program after the first year of sampling.

*Modifications to Final WQMP:* Added reference to scheduled water quality data review after the first year, and conditional criteria for dropping Estuarine Aquifer wells from the program, to Sections 2.4 and 5.1.

**Comment 4**

Documents Ecology's concurrence with the adequacy of the current wells proposed for the program. Confirms that the Port and Ecology agree to review of the adequacy of these wells after the first year of the program.

*Modification to Final WQMP:* Added language regarding review of monitoring network adequacy after the first year to Section 2.2.

**Comment 5**

Requires addition of Fill Aquifer MW-125 in RA-1 to the program.

*Modifications to Final WQMP:*

- Fill Aquifer well MW-125 added to planned sampling.
- Table 2.1 modified to include Fill Aquifer well MW-125.
- Figure 2.2 modified to show Fill Aquifer well MW-125.
- Reference to sampling Fill Aquifer well MW-125 added to Section 2.2.
- Fill Aquifer well MW-125 well completion report added to Appendix B.

**Comment 6**

Requires modification of Table 2.1 to reference specific plan figures, and clarify location of wells relative to individual RAs.

*Modifications to Final WQMP:* Table 2.1 modified to include reference to Figure 2.2, and to clarify hydrologic position of wells relative to individual RAs.

**Comment 7**

Confirmed that Ecology considers EPA's comments to the Draft Water Quality Monitoring Plan to be outside the scope of the original plans (i.e.: the Conceptual Letter). Also confirmed that the Port will discuss providing EPA with access to conduct sampling of Port-owned wells.

*Modifications to Final WQMP:* None required.

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# 1 Introduction

This Water Quality Monitoring Plan (WQMP) describes procedures and protocols for completion of Phase II of the Southwest Harbor Project (SWHP) Groundwater Confirmation Monitoring Program (GWCMP). The purpose of the GWCMP is to confirm that the remedial actions for soil conducted under the individual Cleanup Action Plans for the SWHP remediation areas are protective of surface water quality for the site as a whole. Phase I of the GWCMP focused on characterizing the post-remediation groundwater flow system, and was completed in 2006. The resulting *Hydrologic Characterization Report* (Aspect Consulting, 2007) describes a significantly altered post-remediation groundwater flow system than that which existed prior to remediation and redevelopment activities. The report also noted that the findings of the Phase I GWCMP indicate that Fill Aquifer flow conditions at the site have equilibrated sufficiently to proceed with Phase II of the GWCMP.

This WQMP addresses the Phase II monitoring locations, analytical program, sampling schedule, sampling collection and handling procedures, and data management and analysis protocols. It was developed in accordance with a March 19, 1999 letter from the Port of Seattle to Ecology presenting the Port's conceptual approach to groundwater confirmation monitoring (the *Groundwater Conceptual Letter*), and Ecology's September 5, 2008 letter conveying comments on the Agency Review Draft WQMP Plan dated March 2, 2007.

## 1.1 Background

The SWHP is located along the base of the West Seattle highlands at the confluence of the West Waterway of the Duwamish River (West Waterway) and Elliott Bay. The site location is shown on Figure 1.1. The SWHP comprises approximately 185 acres of land generally bordered by Harbor Avenue and non-Port industrial and commercial properties on the west, SW Spokane Street and non-Port commercial properties on the south, Elliot Bay and Florida Street on the north, and the original Terminal 5 area on the east. Most of the SWHP overlies former tideflats that have been filled and used for various industrial purposes, including railroad yards, wood treatment, steel scrap storage, and municipal and wood waste landfilling.

The SWHP was divided into five "Remediation Areas" (RAs). Figure 1.2 shows the SWHP area and the boundaries of each RA. The five RAs within the SWHP are as follows:

- The Spokane Street Properties (RA-1),
- The former Salmon Bay Steel Property (RA-2),
- The former West Seattle Landfill and Purdy Scrap/former Seattle Steel Inc. property (RA-3),

- The Pacific Sound Resources Superfund site (RA-4), and
- The former Lockheed Yard 2 (RA-5).

To facilitate Port plans for redevelopment, the individual RAs were remediated in the mid to late 1990s. RA-1, RA-2, RA-3 and RA-5 were redeveloped under oversight by Ecology, while RA-4 was addressed under agreement with EPA.

The locations and histories of the individual RAs and specific remedial actions completed at each RA, are summarized below:

- **RA-1.** RA-1 consists of two disconnected land parcels (Figure 2.1). The narrow northern strip of land in RA-1 is the site of the former Buckley Yard, a rail car staging area for the dates from the 1920s. The portion of RA-1 south of the former Buckley Yard, is referred to as the Spokane Street Properties, which was historically occupied by an aluminum foundry, a chemical distribution warehouse, automotive repairs areas, a fuel oil distribution facility and retail food stores. Soil contamination associated with the Spokane Street Properties was remediated between 1994 and 1998. Low-level soil contamination associated with the Buckley Yard was left in place. Asphalt and concrete covers were placed over the Buckley Yard, except in the northern portion of the area east of RA-3, where 24 inches of ballast cover was placed under the railroad tracks. Presently, RA-1 is occupied by Burlington Northern Santa Fe (BNSF) rail spurs, the main access road into the intermodal yard facility, and office buildings.
- **RA-2.** RA-2 was referred to as the Salmon Bay Steel north area during the SWHP. The area is located north of Spokane Street and was used for slag and scrap storage associated with the steel mill south of Spokane Street from the early 1900s until the 1970s. The area also included two large warehouses, a scale, and railroad spurs. Beginning in the late 1800s, the tideflats on the property were gradually filled with dredge sediments, slag, and steel mill debris. This fill material is predominantly slag, and reaches depths of 25 feet in places. Between 1996 and 1998, a cleanup measure was implemented that involved covering a quarter of the site with a gravel ballast cap and the remainder of the site with an impermeable asphalt pavement cap. Prior to this effort, the contaminated soil from areas where the gravel ballast cover was to be placed was moved to areas where asphaltic cover would be emplaced. Presently, the western portion of RA-2 is occupied by the BNSF Rail Yard, and the eastern portion is occupied by the main entrance and south end of the intermodal yard. .
- **RA-3.** The former Seattle Steel Incorporated (SSI) property, RA-3, was the location of both the West Seattle Landfill and a scrap metal processing company. The West Seattle Landfill occupied 30 acres (approximately three-quarters of this remediation area) and was in operation from 1939 to 1966. The former landfill was almost entirely covered with slag, construction debris, steel mill debris, and an un-engineered soil cover. In the spring of 1995, near-surface refuse from the eastern portion of the landfill was relocated to a consolidation landfill area on the western portion of the site. An interim cover consisting of processed solid landfill material was placed over the property. Since this time, an engineered cover consisting of clean fill and a low-permeability geomembrane has been placed

over the former landfill, and an asphalt cover has been placed over the former SSI property south of the landfill. The Port operates a landfill gas collection and treatment system in the former landfill area. Presently, the asphalt-paved area on the consolidated landfill portion of RA-3 is utilized for tenant-lease activities including truck and vehicle parking, container chassis storage, and temporary construction lay down and component assembly for Sound Transit's light rail project.

- **RA-4**. RA-4, a former wood treating site referred to as the Pacific Sound Resources Superfund site, is being addressed separately under the Superfund process by EPA. Monitoring of groundwater downgradient of RA-4, for the purpose of verifying RA-4 cleanup action protection, is not included in the scope of the GWCMP. However, the portion of RA-4 south of Florida Street is being considered under this GWCMP in order to evaluate groundwater flow from RA-4 into the adjacent remediation areas.

  Until 1994, when remediation activity began, the north portion of RA-4 (north of the former Florida Street alignment) was occupied by wood treating operations, and the south portion was the location of a kiln building, laboratory area, saw mill, office building and storage areas for treated and untreated stock (Retec, 1994). Remediation involved limited removal of contaminated soils and the placement of a specially-designed low-permeability asphaltic concrete cap over the entire site. Wood waste from an area at the west side of the site was recycled off-site and the resulting excavation pit was backfilled with fill. A geotextile identifier layer was installed throughout the site between clean import fill and underlying contaminated soils. In addition, a groundwater containment slurry wall was built in the northern portion of the property to reduce tidal influence on groundwater in the site interior and limit migration of contaminants into Puget Sound. RA-4 is presently occupied by the northern end of the terminal 5 intermodal yard, the BNSF Storage Track Yard, and the Jack Block Public Shoreline Access and Park area.

- **RA-5.** RA-5 was originally a tideflat zone that has since been filled with dredge sediment, slag, and construction debris. The western portion of the remediation area, filled prior to 1936, was the site of Nettleton Lumber until the late 1960s. The eastern portion of the site was filled in the late 1950s, becoming the location of Lockheed Shipyard #2, which operated from 1956 to 1987 as a ship maintenance and refitting yard. In 1994, the area used for shipbuilding operations underwent excavation and treatment of contaminated soils. Pursuant to this cleanup effort, the shipyard-era storm drain system was removed or abandoned, and the associated contaminated storm drain sediments were disposed. In addition, an asphaltic concrete cap was placed over the entire site and a new stormwater drainage system was installed. Presently, RA-5 is used by the intermodal yard tenant for parking and interim container storage.

## 1.2 Purpose

The purposes of this WQMP are as follows:

- Describe data collection objectives and activities, sampling locations, sampling protocols, analytical methods, reporting requirements, and the schedule for the Phase II GWCMP.
- Present Quality Assurance/Quality Control (QA/QC) protocols for the Phase II GWCMP sampling, sample handling, sample analysis, and data management activities.
- Identify the anticipated Phase II GWCMP schedule.

## 1.3 Sampling and Analysis Plan Organization

The major sections of this WQMP are as follows:

- **Section 2, Phase II Monitoring Program,** reviews findings of the Phase I GWCMP and identifies the Phase II GWCMP monitoring locations, analytes, and monitoring schedule.
- **Section 3, Field Protocols**, describes the field methods that will be used during Phase II GWCMP, including groundwater sample collection, and sample handling, and if necessary, supplemental groundwater well installation protocols.
- **Section 4, Laboratory Protocols and Data Management**, identifies the analytical requirements for collected samples, including target analytes, analytical methods, and reporting limit goals.
- **Section 5, Data Evaluation and Reporting**, identifies data evaluation methods, reporting deliverables, and schedule.
- **Appendix A**: **Phase II Equipment Specifications**, contains specifications for equipment to be used for well development and sampling.
- **Appendix B**: **Phase II Monitoring Well Completion Reports**, contains well completion reports for the Phase II monitoring wells.
- **Appendix C: Phase II Quality Assurance Project Plan**, describes the Phase II GWCMP Data Quality Objectives (DQOs), as well as the QA/QC procedures and data processing steps developed to meet the project DQOs.
- **Appendix D: Phase II Data Management Plan,** details complete data management protocols and data submittal requirements.

# 2 Phase II Monitoring Program

## 2.1 Site Hydrogeology

This section provides a brief summary of site hydrogeology under both pre-and post-redevelopment conditions. A complete assessment of historic and current groundwater flow conditions is provided in the *Hydrologic Characterization Report* (Aspect Consulting, 2007).

The local groundwater regime beneath the SWHP includes a Fill Aquifer and a deeper Estuarine Aquifer. The Fill Aquifer consists of groundwater occurring in various fill materials between depths of 20 and 40 feet below ground surface (bgs). A sandy silt to silty fine sand tideflat deposit, typically 1 to 10 feet in thickness, occurs between the Fill and Estuarine Aquifer zones over most of the site with the exception of the easternmost portion near the West Waterway, and in isolated areas near the former axis of Longfellow Creek along the eastern edge of RA-3. Where present, this low-permeability unit results in locally confined conditions in the Estuarine Aquifer zone. The Estuarine Aquifer is underlain by a lower permeability unit that occurs at depths ranging from 30 to 50 feet bgs. The Fill Aquifer/Estuarine Aquifer system is bounded to the north by Elliott Bay and to the east by the West Waterway. The aquifers thin to the south and west and terminate to the west against the West Seattle bluff, encountering deposits of the low-permeability Lawton Clay unit.

Redevelopment of the SWHP included tightlining of the former equalization basins along the Longfellow Overflow Line (LFOL). These former equalizations basins strongly influenced groundwater flow in the Fill Aquifer. Pre-redevelopment flow in the Fill Aquifer was laterally toward the LFOL equalization basins within much of RA-2 and RA-3, the southern portion of RA-4, and the western portion of the original Terminal 5 area. Much of the historic Fill Aquifer groundwater discharge from these areas occurred through the LFOL via the former equalization basins, with lesser discharge through documented pre-redevelopment leaks in the LFOL.

Tightlining of the former LFOL equalization basins has had a significant effect on Fill Aquifer flow conditions. Inland tidal influence in the area of the former equalization basins has been eliminated, and the LFOL currently appears to have little or no effect on the Fill Aquifer flow regime. Fill Aquifer groundwater no longer discharges to the LFOL through the former equalization basins, but instead flows north and east across the site along much longer flow paths, eventually discharging along the West Waterway and Elliot Bay. Figure 2.1 presents the 72-hour mean groundwater elevation contours for the Fill Aquifer on December 19, 2003.

Groundwater flow conditions within the Estuarine Aquifer were not affected appreciably by the SWHP redevelopment. Groundwater in the Estuarine Aquifer continues to flow generally from the southwest toward the northeast, with discharge to Elliot Bay and the West Waterway.

## 2.2 Monitoring Locations

The study area addressed in the GWCMP encompasses most of the SWHP site, including the former Buckley Yard and Spokane Street Properties (RA-1), former Salmon Bay Steel Property (RA-2), former West Seattle Landfill and SSI property (RA-3), and the former Lockheed Yard 2 (RA-5). Phase II of the GWCMP will involve sampling of Fill Aquifer monitoring wells within and/or downgradient of these RAs. The configuration of the entire Phase I monitoring well network, and interpreted directions of groundwater flow in the Fill Aquifer, are shown on Figure 2.1.

Figure 2.2 presents the 11 Fill Aquifer and 3 Estuarine Aquifer monitoring wells that will comprise the Phase II monitoring network. These wells will monitor groundwater quality within and/or downgradient of the target RAs, as follows:

- Well CMP-3 will monitor Fill Aquifer groundwater quality downgradient of RA-2 and the extreme southern portion of the former Buckley Yard (RA-1).
- Well CMP-4, located within the former Buckley Yard (RA-1), will monitor Fill Aquifer groundwater quality within this RA, and immediately downgradient of the central portion of RA-3.
- Well CMP-15 will monitor Fill Aquifer groundwater quality on flow paths that transect the central and/or northern portions of the former Buckley Yard (RA-1) and RA-3, the southern portion of RA-4, and the western portion of RA-5.
- Wells CMP-17 and MW-125will monitor Fill Aquifer groundwater quality downgradient of the former Spokane Street Properties (RA-1).
- Well MW-26R will monitor Fill Aquifer groundwater quality on flow paths that transect the central portions of the former Buckley Yard (RA-1) and RA-3, the southern portion of RA-4, and the eastern portion of RA-5.
- Well MW-308N will monitor Fill Aquifer groundwater quality downgradient of the northern portions of the former Buckley Yard (RA-1) and RA-3.
- Well MW-308S will monitor Estuarine Aquifer groundwater quality downgradient of the northern portions of the former Buckley Yard (RA-1) and RA-3.
- Well MW-44 will monitor Estuarine Aquifer groundwater quality on flow paths that transect the central portions of the former Buckley Yard (RA-1) and RA-3, the southern portion of RA-4, and the eastern portion of RA-5.
- Well MW-36 will monitor Fill Aquifer groundwater quality on flow paths that transect the central and/or northern portions of the former Buckley Yard (RA-1) and RA-3, the southern portion of RA-4, and the western portion of RA-5.

Four Phase II GWCMP wells will monitor background water quality upgradient of the target RAs, as follows:

- Background well CMP-5, located immediately upgradient of RA-3, will monitor groundwater quality along the flow path of recharge from the adjacent West Seattle highlands.
- Background well CMP-2 will monitor groundwater quality entering the SWHP from commercial/industrial areas located immediately southwest of RA-2.
- Background wells CMP-1 and FM-105 are located on the southern borders of RA-2 and RA-1, respectively. These wells will monitor the quality of groundwater that flows beneath the Nucor Steel facility and SW Spokane Street, and enters the SWHP from the south.
- The Phase II GWCMP monitoring network is currently comprised of monitoring wells sited for the Phase I groundwater flow characterization. It is possible that one or more of the wells may not prove to be optimal for Phase II water quality monitoring. The Port plans to carefully review the water quality data from all Phase II wells as the program progresses. After completion of the first year of groundwater monitoring during the Phase II GCWMP, the Port will evaluate the initial findings on post-redevelopment groundwater quality, and at that time may propose to Ecology the replacement or addition of wells to better meet the goals of the Phase II program.

## 2.3 Program Analytes

The Phase II groundwater samples will be analyzed in accordance with the analytical schedule included in the *Groundwater Conceptual Letter*. Specific required field parameters and laboratory analyses are as follows:

- All Phase II Wells
  - Field Parameters: pH, Conductivity, Dissolved Oxygen, and Temperature.
  - Inorganics: Arsenic and Lead.
  - Organics: cPAHs, PCBs, TPH (Diesel and Oil ranges) with silica gel cleanup, and Bis(2-ethyl hexyl) phthalate.
- Wells CMP-17 and FM-105 (Former Spokane Street Properties, RA-1)
  - Additional Organics: Chlorinated Ethanes and Ethenes (CEEs).
- Wells CMP-15, MW-26R, MW-36 and MW-44 (RA-5)
  - Additional Inorganics: Antimony, Chromium, Copper and Nickel.

The *Groundwater Conceptual Letter* noted that cyanide should be analyzed in wells downgradient of RA-1 if the adjacent ringwall structures were used for stormwater and/or treated wastewater disposal. The ringwall structures have not been used for this purpose, and therefore analysis of cyanide during Phase II is not necessary.

Provisions for potential modifications to the Phase II groundwater analytical program were incorporated into the *Groundwater Conceptual Letter*. Any proposed modifications will be based on an evaluation of the Phase II sampling results from no fewer than two sampling events. Potential modifications will be documented in writing and submitted to Ecology for approval prior to implementation.

The Phase II analytical schedule, by individual RA and Phase II monitoring well, is shown in more detail in Table 2.1. Additional information regarding Phase II sample analyses is provided in Section 4.

## 2.4 Monitoring Schedule

In accordance with the *Groundwater Conceptual Letter*, Phase II groundwater sampling will take place twice annually for 3 years. Sampling will take place during the periods of seasonal low (September/October) and seasonal high (December/January/February) groundwater levels.

- A *Groundwater Quality Monitoring Evaluation Report* will be prepared, as discussed in more detail in Section 5.2. Assessment of whether modifications to the monitoring network are warranted will occur on an ongoing basis as the program progresses. The Port will evaluate the initial findings after completion of the first year of groundwater monitoring, and may propose modifications to the monitoring network at that time. Water quality in the monitored Estuarine Aquifer wells will be evaluated after 1 year of monitoring. If no inorganic or organic constituents are detected in the Estuarine Aquifer wells above background levels during the first year, these wells will be dropped from the program and the assessment of the Estuarine Aquifer will be considered complete.

# 3 Field Protocols

The following sections detail Phase II GWCMP protocols field personnel will follow to access the Phase II monitoring wells, collect and handle groundwater samples, and manage investigation-derived waste.

## 3.1 Site Access

Access to Terminal 5 and the adjacent vicinity is controlled by several different entities including the Port, APL, and Burlington Santa Fe (BNSF). Access to each Phase II monitoring location will be as follows:

- Wells FM-105 and CMP-17: Access via SW Spokane Street and West Marginal Way SW, west of the main intermodal yard truck entrance.
- Wells CMP-1 and CMP-2: Access via a gravel road located off SW Spokane Street, west of the main APL gate.
- Well CMP-5: Well located in median turn lane on Harbor Avenue SW.
- Wells CMP-3 and CMP-4: Access through the main APL gate off Spokane Street.
- Wells MW-308N: Access through locked gate off the public shoreline access road. Access road entrance is located off Harbor Avenue SW north of Florida Street.
- Wells MW-26R and CMP-15: Access through the main APL gate off Spokane Street.

## 3.2 Phase II Groundwater Sampling Procedures

### *3.2.1 Well Redevelopment*

Each monitoring well was fully developed after installation. Prior to Phase II GWCMP sampling, each well will be redeveloped to remove any fine-grained material and algae that may have accumulated inside the well casing, and to ensure optimal hydraulic communication between the well screen and the surrounding aquifer formation. Well redevelopment will be performed using either a peristaltic pump and disposable tubing, or a decontaminated 12-volt submersible pump. The choice of method will be determined based on assessment of the volume of accumulated sediment in each well. Field parameters such as temperature, specific conductance, pH and turbidity will be monitored throughout the development period. Due to the nature of the analytes to be monitored, minimizing turbidity in groundwater samples is considered critical. Development goals will be 20 nephelometric units (NTUs) or less. Based on original development performance, this should be achievable in many of the proposed Phase II wells. For certain wells that have low yields or that have historically required extensive development (CMP-3, CMP-17, MW-26R), achieving the primary turbidity goal may be

problematic. If the primary goal of 20 NTUs or less is not achievable, a secondary goal of 100 NTUs or less will be used for these wells.

### 3.2.2 Water Level Measurements

Prior to purging and sampling, water levels will be measured in each well scheduled for sampling. All measurements will be made to the nearest 0.01 foot from the marked, surveyed reference point on the well casing. These measurements will be recorded in field notes, and then converted to elevations in the project database following each sampling event. The findings of Phase I of the GWCMP confirm that salinity corrections to the calculated Fill Aquifer groundwater elevations are not necessary. Estuarine Aquifer groundwater elevations will be corrected for salinity following procedures outlined in Section 6.2.1 of the *Hydrologic Characterization Report* (Aspect Consulting, 2007).

### 3.2.3 Low Flow Purge and Sampling

Phase II GWCMP groundwater samples will be collected using low flow purging techniques, to provide for samples from wells that have experienced as little agitation, mixing, and other disturbances as possible, and therefore samples that are most representative of in-aquifer water.

Sampling of all Phase II wells, with the exception of CMP-17 and FM-105, will be conducted using a portable peristaltic pump with dedicated LDPE well tubing and disposable silicon pump tubing. Samples from wells CMP-17 and FM-105 will include analysis of CEEs, and therefore will be collected using dedicated Well Wizard bladder pumps and dedicated air supply and Teflon sampling tubings. Well Wizard pump specifications are provided in Appendix A.

Pump/tubing installation and sampling will proceed as follows:

- For wells equipped with dedicated bladder pumps, first position and install the dedicated pump and tubing with the pump intake set approximately 2 feet above the base of the screen.
- For purging and sampling using a portable peristaltic pump, position the ¼-inch LDPE tubing intake at the approximate midpoint of the water column if the water level is below the top of the screen, or at the approximate midpoint of the screen if the water level is above the top of the screen (copies of the Phase II monitoring well completion reports are included in Appendix B for reference). When adjusting the tubing in the well, carefully lower or raise the tubing to reduce mixing of stagnant water in the well casing above the screen and reduce the chance of re-suspending solids which have settled at the bottom of the well.
- Measure the static groundwater level with an electric sounder to the nearest 0.01 foot from the reference mark on the top of the well casing.
- Connect the pump discharge to the intake of a flow-through cell for measuring water quality parameters.
- Purge the well at low flow rates not to exceed approximately 0.5 liter (or 16 ounces) per minute. Monitor drawdown in the well using an electronic sounder and target a drawdown of 0.33 feet or less by adjusting the flow rate. Allow the

discharge to run into the flow-through cell. The purge water discharging from the flow-through cell should be directed away from the well to a bucket or other temporary storage container. Determine the flow rate by measuring the time to fill a container of known volume and adjust the flow rate as necessary.

- During purging, measure and record dissolved oxygen (DO), temperature, pH, and conductivity with a YSI 556 flow-through cell, and turbidity using a Hach 2100P field turbidimeter or equivalent. The YSI flow-through cell and Hach turbidimeter specifications are provided in Appendix A. Parameters should be measured every 3 to 5 minutes until they stabilize. Because DO is expected to take the longest to stabilize, stabilization is defined as three successive readings where DO varies by less than 10 percent. Additional stability criteria are 0.5$^{o}$ C for temperature, 10 percent for conductivity, and 0.1 units for pH. The turbidity stabilization criterion shall be three consecutive readings of 20 NTUs or less, unless 20 NTUs is not achievable and turbidity readings have stabilized at within 10 percent for three consecutive readings. Flow rate (and depth to water, if possible) should also be measured every 2 to 4 minutes. Record the time and all measurements on the field log for each set of readings. Any instance where purging criteria cannot practicably be met will be noted in the field log.
- Once purging is complete, collect the groundwater sample directly from the pump discharge line upstream of the flow-through cell by filling the laboratory-provided bottles, while maintaining the same low flow rate as during purging. In the event that a well is dewatered during the purging, an attempt will be made to sample the well after allowing it to recharge sufficiently for the required sample volume.

Completed details on required sample containers, preservatives, and holding times for the planned laboratory analyses are provided in Table 3.1. Samples to be analyzed for CEEs will be collected first into laboratory prepared VOA vials preserved with hydrochloric acid. The vials should be filled slowly, allowing the water to run down the inside wall of the vial. Fill the vial all the way to the top, with no head-space remaining. Cap the vial, turn it upside down and tap it a couple of times to see if any air bubbles are trapped in the vial. If there are no bubbles, the sample is acceptable. If bubbles are present, it will be necessary to remove the cap and add a little more water to force the bubbles out.

Samples to be analyzed for total metals will be placed into laboratory prepared 500 milliliter (ml) poly bottles preserved with nitric acid. Samples for total petroleum hydrocarbons (TPH) and polychlorinated biphenyls (PCB) analyses will be placed into separate laboratory prepared 500 ml amber glass bottles. Samples for PCB analysis will be placed into laboratory prepared, 1,000 ml amber glass bottles

All samples designated for laboratory analysis will be placed into laboratory-supplied containers (e.g., picnic coolers) in which a temperature of 4$^{o}$ Celsius is maintained.

Field QC samples should be collected at the frequency noted in Appendix C, and in the same manner as other samples. If possible, the sample containers for the “original” and the field “duplicate” sample will be filled by alternating the discharge line from one sample’s container to the other until both are filled.

After sampling at each well, the tubing for that well will either be left in the well, placed in a dedicated bag labeled for that well for reuse, or disposed of.

### 3.2.4 Sample Labeling

The following information for each sample collected in the field will be recorded in the appropriate sample field log and on the sample label:

- Project name and number.
- Sampling location.
- A unique sample number which will include the monitoring well location (written without dashes) and the sample date in the form "-yymmdd" (e.g., CMP15-070315, a groundwater sample collected from well CMP-15 on March 15, 2007).
- Date and time of collection.
- Initials of sampling personnel.
- Preservatives added, if any.
- Analyses requested.
- Any special observations or problems pertaining to the sample.

In order to prevent misidentification of samples, each sample will be securely labeled on-site with a plastic-coated, waterproof, non-disintegrating label that will retain waterproof ink markings when wet.

### 3.2.5 Sample Handling

Samples are to be collected and handled in such a manner as to minimize the possibility of samples becoming contaminated or samples being lost. All samples are to be kept chilled at a maximum temperature of $4^{o}$ Celsius from the time of collection until time of analysis by the laboratory. Field personnel will keep samples cold until delivery at the laboratory by using coolers filled with ice or re-usable ice packs.

Chain-of-custody forms will be filled out and will accompany project groundwater samples at all times to document the history of sample custody from the time of collection to the time of final disposition. When the possession of samples transfers, the individuals relinquishing and those receiving the samples will sign, date, and note the time on the record.

A sample is considered to be in custody if:

- It is in one's actual physical possession;
- It is in one's view, after being in one's physical possession;
- It is in one's physical possession and then locked or otherwise sealed so that tampering will be evident; or
- It is kept in a secure area, restricted to authorized personnel only.

Custody documentation will be initiated with the sample collection effort. The specific information reported on the form includes: project information, sample medium, number

of sample containers, relinquishing individual, receiving party, and date and time of sample transfer. Ecology- or EPA-approved analytical methods will also appear on the chain-of-custody record to document which analytical methods are to be employed for chemical analysis.

Following completion of the sampling event and custody documentation, the samples will be delivered either by courier or by Aspect personnel to the laboratory for analysis. A copy of the chain-of-custody record will accompany each cooler, another copy will be retained by the Aspect personnel delivering the samples (and forwarded to the project manager), and one copy will be sent by the lab with the laboratory report. The method of shipment and other pertinent information will be entered in the "Comments" section on the custody record and custody seals will be placed across the packaging prior to transport of the samples off-site.

A designated laboratory sample custodian will accept custody of the shipped samples, verify that the information on the sample labels matches that on the chain-of-custody records, and record any sample temperature or chain-of-custody irregularities. The custodian will enter the sample label data into the sample tracking system of the laboratory. Samples will then be transferred to the proper analyst or stored in the appropriate secure area at the laboratory. When sample analysis and the necessary quality assurance checks have been completed in the laboratory, the unused portion of the sample and the sample container will be disposed of properly. All identifying tags, data sheets, chain-of-custody, and laboratory records shall be retained as documentation. Laboratory personnel are responsible for the care and custody of samples from the time they are received until the sample is exhausted or properly disposed.

## 3.3 Equipment Decontamination

Decontamination of dedicated groundwater sampling equipment will not be necessary, unless substitutions of non-dedicated equipment are made. Any reusable or non-dedicated development or sampling equipment will undergo an Alconox (or functionally equivalent product) wash, followed by triple rinsing. The first two rinses may be off-site potable water; the third should be deionized water, preferably provided by the laboratory.

## 3.4 Investigation-Derived Waste Management

Unless heavy contamination is encountered, which under this program is not expected, decontamination residuals such as gloves, tubing and Tyvek will be disposed as solid waste. Development and purge water will be transported to a fenced area at Pier 2-East (adjacent to Florida Street) and transferred to a 1,100-gallon poly tank. Waste water will periodically be picked up via tanker truck and transported to the Phillip Services facility in Kent, Washington for treatment. Waste water disposal will be managed under an existing Phillip Services waste profile developed for waste water during the Phase I GWCMP.

# 4 Laboratory Protocols and Data Management

## 4.1 Analysis of Samples

To achieve the objectives of the Phase II GWCMP, groundwater samples will be analyzed for as noted in Section 2.3. Table 2.1 summarizes planned field parameter and laboratory analytes by well, and identifies the hydrologic position (i.e.: upgradient or within/downgradient) of each well in relation to the individual RAs.

Sample container and preservation requirements are summarized in Table 3.1. Project-specific analytical methods, associated analytes, and reporting limit goals for project groundwater samples are identified Table 4.1. Changes in analytical methods will not be allowed without prior written documentation from the laboratory regarding the desired substitution and its rationale, and prior written acceptance by Aspect.

Project quantitation limits are recognized to be goals, because instances may arise where high sample concentrations or other interferences preclude achieving the desired reporting limits and associated QC criteria. If this occurs, the laboratory will report the reason(s) for deviations from the reporting limits or noncompliance with QC criteria, and the missed goals will be noted during data validation. Routine, poorly substantiated noncompliance with the reporting limit goals will not be acceptable. All sample materials shall be archived by the laboratory(ies) and only disposed of with program sponsor approval.

## 4.2 Laboratory Reporting

The minimum laboratory data reporting requirements are as follows:

- **Sample Receipt.** Copies of the chain-of-custody forms, filled out for all sample shipments and noting any problems in sample packaging, custody, and sample preservation, will be included in each laboratory report of sample results.
- **Sample Results.** For each analytical method run, all analytes for each sample will be reported as a detected concentration or as undetected at the sample's detection or reporting limit. The laboratories will also report dilution factors for each sample as well as dates of extraction (if applicable) and analysis.
- **Case Narratives.** Each lab report should include a signed statement by the laboratory project manager noting the analyses completed and any deviations in analytical protocol or QA requirements for those analyses (and reasons for them).
- **Quality Control Results**. Laboratory quality control samples will be analyzed at the rates specified in the applicable analytical method, and as noted in Section C.1.4 of the Quality Assurance Project Plan (QAPP). These results will be included in the laboratory data reports, along with records that clearly match all blind duplicate QA samples with laboratory sample IDs.

The laboratory reports will include data qualifiers to identify analytical quality control concerns in accordance with the specifications of USEPA published methods. Details on laboratory QA/AC procedures for this project are discussed further in the Phase II QAPP (Appendix C).

## 4.3 Data Management

Raw data generated in the field and/or received from analytical laboratories will be reviewed, entered into an electronic database, and validated for consistency and correctness. Data validation will be completed by Mintga Lin of Pyron Environmental Inc. The data validation process evaluates technical data quality, verifies that adequate documentation was performed, and determines whether the analytical data are usable and meet project DQOs. Project DQOs, and the specifics of the data validation process for the Phase II data are presented in Appendix C. The resulting data validation reports will be appended to the Phase II data report, as noted in Section 5.2.

Following data review and validation, all field and analytical data will be transmitted to the Port of Seattle Data Manager in the format of the POS Field Module and Lab Electronic Data Deliverable (EDD) for loading to the Port's EMIS database. In addition, data will be electronically submitted to Ecology within 120 days following receipt of the validated data completion of each sampling report to Ecology's EIM database utilizing the "Submit Data" web page (https://fortress.wa.gov/ecy/eimimport/submit.htm).

Additional information on data management is provided in the Phase II Data Management Plan (Appendix D).

# 5 Data Evaluation and Reporting

## 5.1 Data Evaluation

The Phase II GWCMP was developed to confirm that the surface water resources of Elliot Bay and the West Waterway are sufficiently protected by the cleanup actions that were completed at the SWHP. Groundwater in the SWHP is not considered potable and therefore is not considered to be a potential source of drinking water to the public. The appropriate concentrations for comparison to the Phase II GWCMP data are those that are protective of the aquatic environment in Elliot Bay and the West Waterway, and those that are protective of the public that may consume aquatic organisms from those surface waters.

The design of the Phase II GWCMP involves monitoring of groundwater downgradient of the RAs that eventually discharges to those surface waters. Monitoring immediately downgradient of the RAs will provide a "worst case" assessment of contaminant concentrations in the groundwater pathway. As the monitoring wells recommended for sampling will not directly monitor groundwater at the actual point of discharge to the West Waterway and Elliott Bay, future evaluation of compliance criteria may need to account for natural processes that affect the contaminant concentrations between the monitoring points and the point of discharge.

The three processes that most directly affect the concentration of contaminants along the flow path from a monitoring well to a discharge point are degradation, retardation, and tidal dilution. All of these processes likely are occurring along flow paths between Phase II GWCMP monitoring wells and the actual points of discharge. These processes are described in more detail below:

- Degradation includes any process that causes a contaminant to break down into a simpler compound. Light hydrocarbons and PAH compounds typically degrade more readily than heavy hydrocarbons and PAHs. Metals are elements and do not degrade, but may change form which can subsequently affect toxicity.
- Retardation is the difference between rate of groundwater movement and the rate of movement of a contaminant in groundwater. Retardation is a result of interactions between contaminants and the aquifer matrix. For organic compounds, this interaction is largely limited to sorption to organic carbon in the aquifer matrix. For metals, retardation may be due to complexing with other constituents in groundwater or sorption to the aquifer matrix. Sorption of metals is not limited to organic carbon, but occurs on clays and other types of material in the aquifer. Retardation slows the travel time of contaminants and gives degradation process more time to work on the contaminants. For many heavy PAHs, for instance, the retardation rate is so high that they degrade faster than they move through the aquifer. Compounds that strongly sorb may also be transported at such a slow rate that they do not reach receptors in a reasonable timeframe.

- Tidal dilution is a direct mixing of surface water and groundwater in the aquifer over tidal cycles. Tidal dilution factors have been computed for a number of sites in Washington State. Tidal dilution factors greater than 10,000 have been computed for water table aquifers. If necessary, a tidal dilution factor can be estimated for the SWHP based on the change in water level over tidal cycles and estimates of inland groundwater inflow using data collected presented in the *Tidal Monitoring Study Report* (Aspect Consulting, 2002).
- As noted in Section 2.4 above, water quality in the monitored Estuarine Aquifer wells will be evaluated after one year of monitoring, If no inorganic or organic constituents are detected in the these wells above background levels during the first year, these wells will be dropped from the program and the assessment of the Estuarine Aquifer will be considered complete.

## 5.2 Reporting

Following the fourth sampling event in the second calendar year, a *Groundwater Quality Monitoring Evaluation Report* will be prepared to document the sampling results. This report will be completed and submitted to Ecology within 60 days following receipt of the validated laboratory results from the fourth sampling event, and will include the following:

- Tabulated Phase II water level measurements and field and analytical groundwater quality data (with appropriate data qualifiers).
- Maps showing the interpreted groundwater elevation contours for each sampling event.
- A comparison of the analytical results to the protective water quality concentrations identified in the Port's memorandum (see below).
- Laboratory and data validation backup reports.
- Any recommended changes to the future Phase II GWCMP monitoring activities.

Prior to, or concurrent with, the submittal of the *Groundwater Quality Monitoring Evaluation Report*, the Port will develop a memorandum identifying the appropriate water quality concentrations, protective of surface water, against which the GWCMP data should be compared. The influences of degradation, retardation, and tidal dilution may be taken into account in estimating concentrations to be compared to the Phase II groundwater data. The memorandum will be submitted to Ecology for review and concurrence.

As noted in the *Groundwater Conceptual Letter*, the remediation activities completed at each of the RAs are believed to be protective of groundwater quality whose highest beneficial use is discharge to surface water. As such, the Phase II GWCMP is not expected to continue indefinitely. Groundwater monitoring will continue for 1 year after submission of the *Groundwater Quality Monitoring Evaluation Report*. Monitoring may be continued after that time in select wells for select analytes, if Ecology and the Port are in mutual agreement that additional monitoring is warranted to meet the program's objectives. Once the goal of demonstrating the surface water protection is met, groundwater monitoring will be discontinued.

# 6 References

Aspect Consulting, LLC, 2002, Tidal monitoring study report, Phase I ground water confirmation monitoring program, Southwest Harbor Project. Bainbridge Island, Washington. Unpublished work.

Aspect Consulting, LLC, 2007, Southwest Harbor Project, Phase I groundwater confirmation monitoring program, hydrologic characterization report, Bainbridge Island, Washington. Unpublished work.

EPA, (October 1999), USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review. EPA 540/R-99-008.

EPA, 2000, In Situ Treatment of Soil and Groundwater Contaminated with Chromium, Technical Resource Guide, EPA 625/R-00/004. October 2000.

EPA, (June 2001), USEPA Contract Laboratory Program National Functional Guidelines for Low Concentration Organic Data Review. EPA 540-R-00-006.

EPA, (February 2004), SW-846 On-Line, Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods, www.epa.gov/epaoswer/hazwaste/test/main.htm.

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Port of Seattle, 1999, Groundwater Conceptual Letter, submitted by the Port of Seattle to the Washington State Department of Ecology, dated March 1999.

Retec, 1994, Current Conditions Report, Pacific Sound Resources Superfund Site, Remediation Area 4, Southwest Harbor Cleanup and Redevelopment Project. Seattle, Washington. Unpublished Work.

# Limitations

Work for this project was performed and this report prepared in accordance with generally accepted professional practices for the nature and conditions of work completed in the same or similar localities, at the time the work was performed. It is intended for the exclusive use of Port of Seattle for specific application to the referenced property. This report does not represent a legal opinion. No other warranty, expressed or implied, is made.

# Table 2.1 – Phase II Groundwater Analytes

SWHP Phase II GWCMP

| | | | Phase II Analytes | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Phase II Groundwater Monitoring Locations (see Figure 2.2) | | Field Parameters[1] | | | | Metals[1] | | | | | | Organic Chemicals[1] | | | | |
| Remediation Area (RA) | Wells Located Upgradient of Corresponding RA | Wells Located within or Downgradient of Corresponding RA | pH | Conductivity | Dissolved Oxygen | Temperature | Antimony | Arsenic | Chromium | Copper | Lead | Nickel | CEEs | CPAHs | TPH as Diesel and Oil with silica gel cleanup | Bis (2-ethyl hexyl) phthalate | PCBs |
| RA-1 (Former Spokane Street Properties) | FM-105 | CMP-17[2] and MW-125 | √ | √ | √ | √ | | √ | | | √ | | √ | √ | √ | √ | √ |
| RA-2 | CMP-1 and CMP-2 | CMP-3 | √ | √ | √ | √ | | √ | | | √ | | | √ | √ | √ | √ |
| RA-3 and RA-1 (Former Buckley Yard) | CMP-5 | CMP-4, CMP-308S and MW-308N (proximal) CMP-15[3], MW-36[3], MW-44[3], and MW-26R[3] (distal) | √ | √ | √ | √ | | √ | | | √ | | | √ | √ | √ | √ |
| RA-5 | | CMP-15[3], MW-36[3], MW-44[3] and MW-26R[3] | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | | √ | √ | √ | √ |

[1] Field parameters and analysis for specific RAs as identified in the Ecology-approved *Groundwater Conceptual Letter*, Port of Seattle, 1999.

[2] Well CMP-17 is also located along flow paths potentially passing through the southeastern portion of RA-2.

[3] Wells CMP-15, MW-26R, MW-36 and MW-44 are also located along flow paths passing through the southern portion of RA-4.

## Table 3.1 – Sample Containers, Preservatives, and Holding Times

SWHP Phase II GWCMP

| Analyte | Analytical Method | Sample Container | Preservation and Storage | Method Holding Time |
|---|---|---|---|---|
| | | | | |
| **Metals** | | | | |
| Antimony | EPA 6010B/ EPA 6020 | 500 mL HDPE | $HNO_3$ to pH<2; 4° C | 6 months |
| Arsenic | | 500 mL HDPE | $HNO_3$ to pH<2; 4° C | 6 months |
| Chromium | | 500 mL HDPE | $HNO_3$ to pH<2; 4° C | 6 months |
| Copper | | 500 mL HDPE | $HNO_3$ to pH<2; 4° C | 6 months |
| Lead | | 500 mL HDPE | $HNO_3$ to pH<2; 4° C | 6 months |
| Nickel | | 500 mL HDPE | $HNO_3$ to pH<2; 4° C | 6 months |
| **Organics** | | | | |
| Chlorinated Ethanes/Ethenes (CEEs) | EPA 8260B | 40 mL glass vial (VOA) | HCl to pH<2; 4° C | 14 days |
| Carcinogenic PAHs | EPA 8270C/SIM | 1 L Amber Glass | 4° C | 7 days |
| Petroleum Hydrocarbons (diesel and oil ranges) | NWTPH-Dx with silica gel cleanup | 500 mL Amber Glass | HCl to pH<2; 4° C | 14 days |
| Bis (2-ethyl hexyl) phthalate | EPA 8270C | 1 L Amber Glass | 4° C | 7 days |
| Polychlorinated Biphenyls (PCBs) | EPA 8082 | 1 L Amber Glass | 4° C | 7 days |

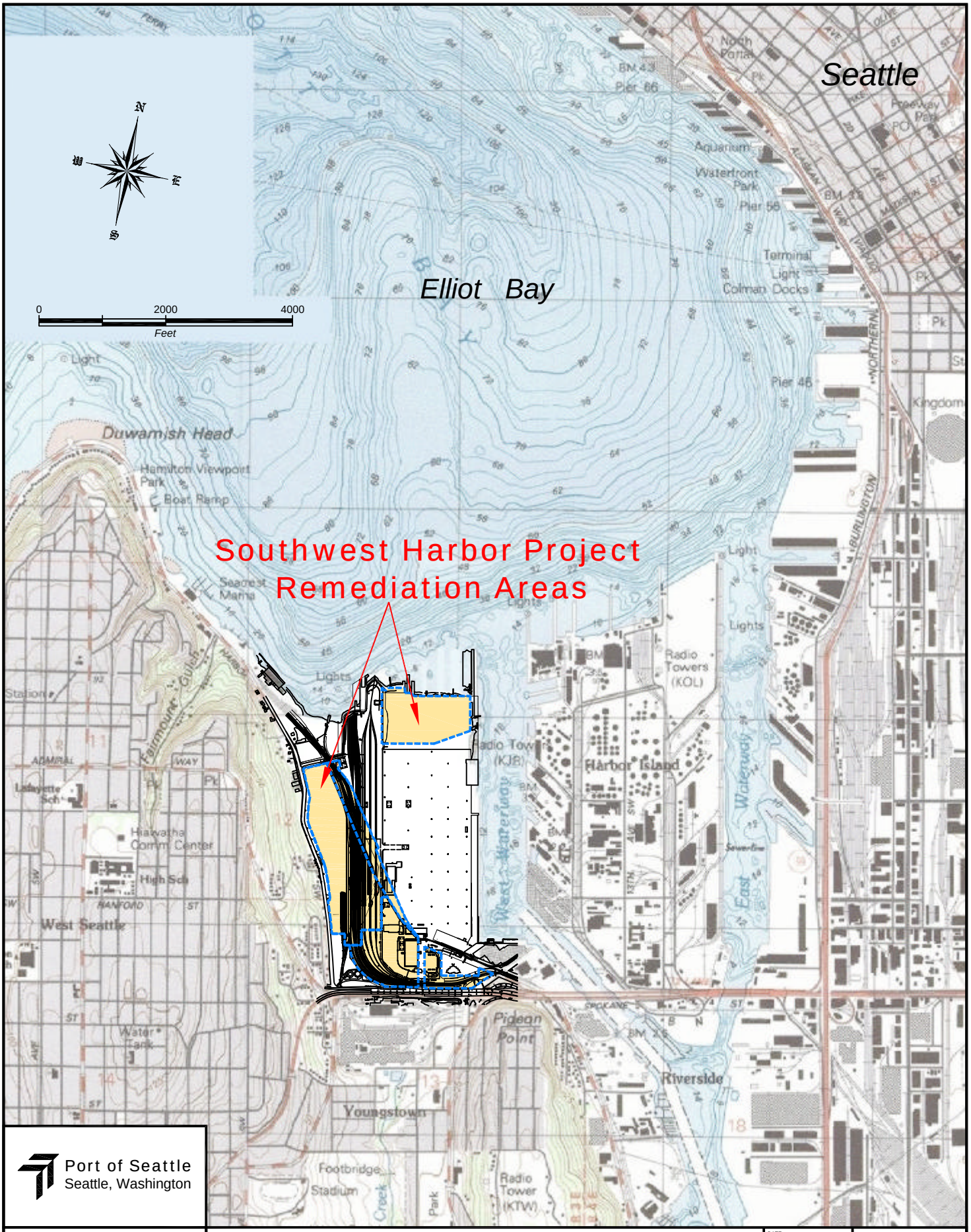
# Table 4.1 - Laboratory Analytical Methods and Reporting Limits

SWHP Phase II GWCMP

| Analyte | Analytical Method | Reporting Limit Goal [1] | Units |
|---|---|---|---|
| | | | |
| **Metals** | | | |
| Antimony | EPA 6010B/ EPA 6020 | 5.0 | µg/L |
| Arsenic | | 0.2 | µg/L |
| Chromium (total[2]) | | 10 | µg/L |
| Copper | | 1.0 | µg/L |
| Lead | | 1.0 | µg/L |
| Nickel | | 0.5 | µg/L |
| **Organics** | | | |
| Chlorinated Ethanes and Ethenes | EPA 8260B | 0.2-1.0 | µg/L |
| Carcinogenic PAHs | EPA 8270C/SIM | 0.01 | µg/L |
| Petroleum Hydrocarbons (diesel and oil ranges) with silica gel cleanup | NWTPH-Dx | 250/500 | µg/L |
| Bis (2-ethyl hexyl) phthalate | EPA 8270C | 1.0 | µg/L |
| Polychlorinated Biphenyls (PCBs) | EPA 8082 (low level) | 0.01 | µg/L |

[1] – Minimum practically achievable reporting limit for each compound. The presence of interference or required dilutions in individual samples may raise actual reporting limits.

[2] – Potential presence of hexavalent chromium to be evaluated by Eh-pH ratio analysis (EPA, 2000 – *In Situ Treatment of Soil and Groundwater Contaminated with Chromium, Technical Resource Guide*, EPA 625/R-00/004. October 2000).

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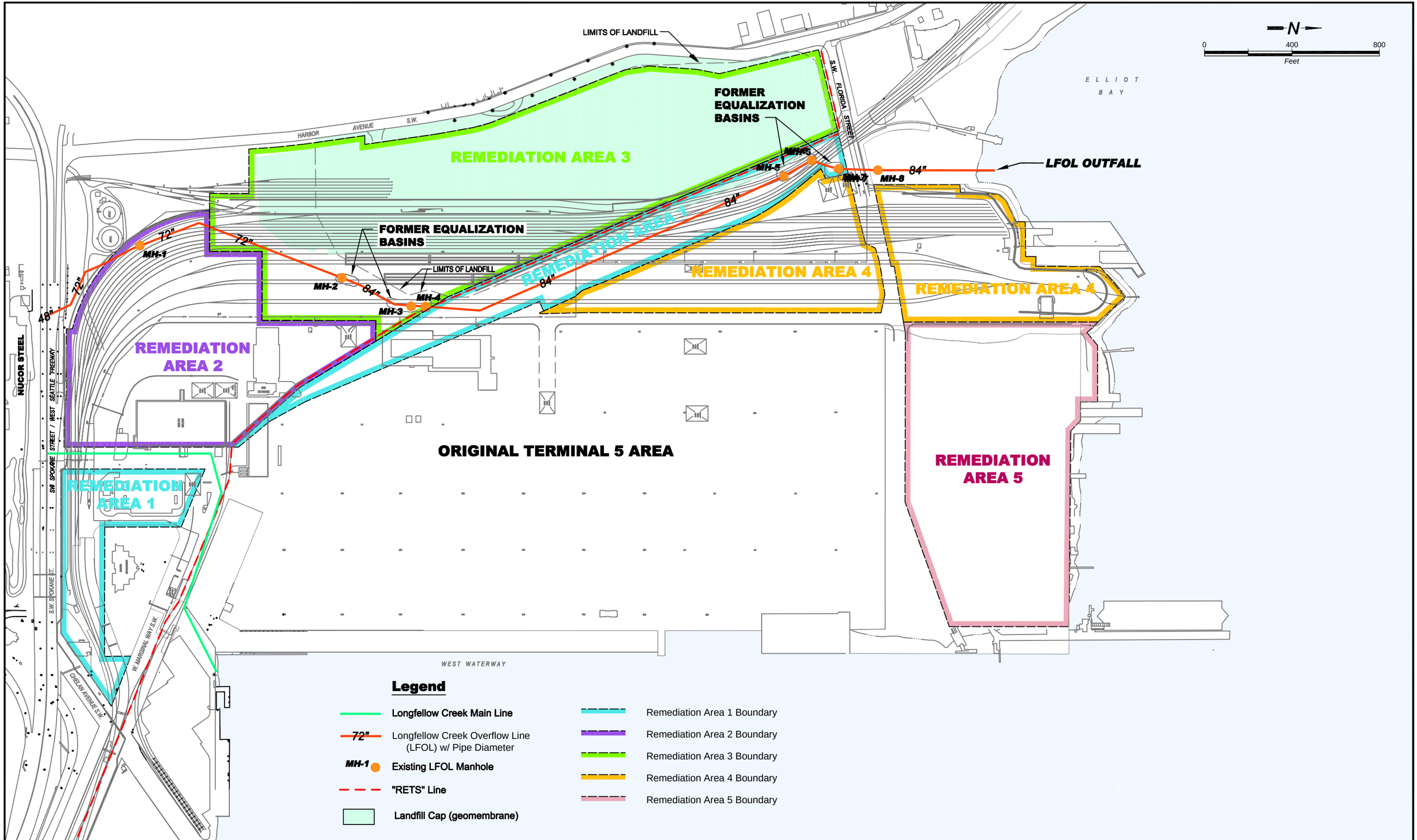
# Site Vicinity Map

SWHP Groundwater Confirmation Monitoring Program
Phase II Monitoring Plan

| | |
|---|---|
| DATE: Jan 2007 | PROJECT NO. 990106 |
| DESIGNED BY: WVG | |
| DRAWN BY: PMB | FIGURE NO. 1.1 |
| REVISED BY: LLC | |

Q:\POS\ 990106 Terminal 52\2007-01 Phase 2 WQ Monitoring Plan\990106-01.dwg




Survey Update 1/8/02

*Groundwater Elevation Datum: MLLW*

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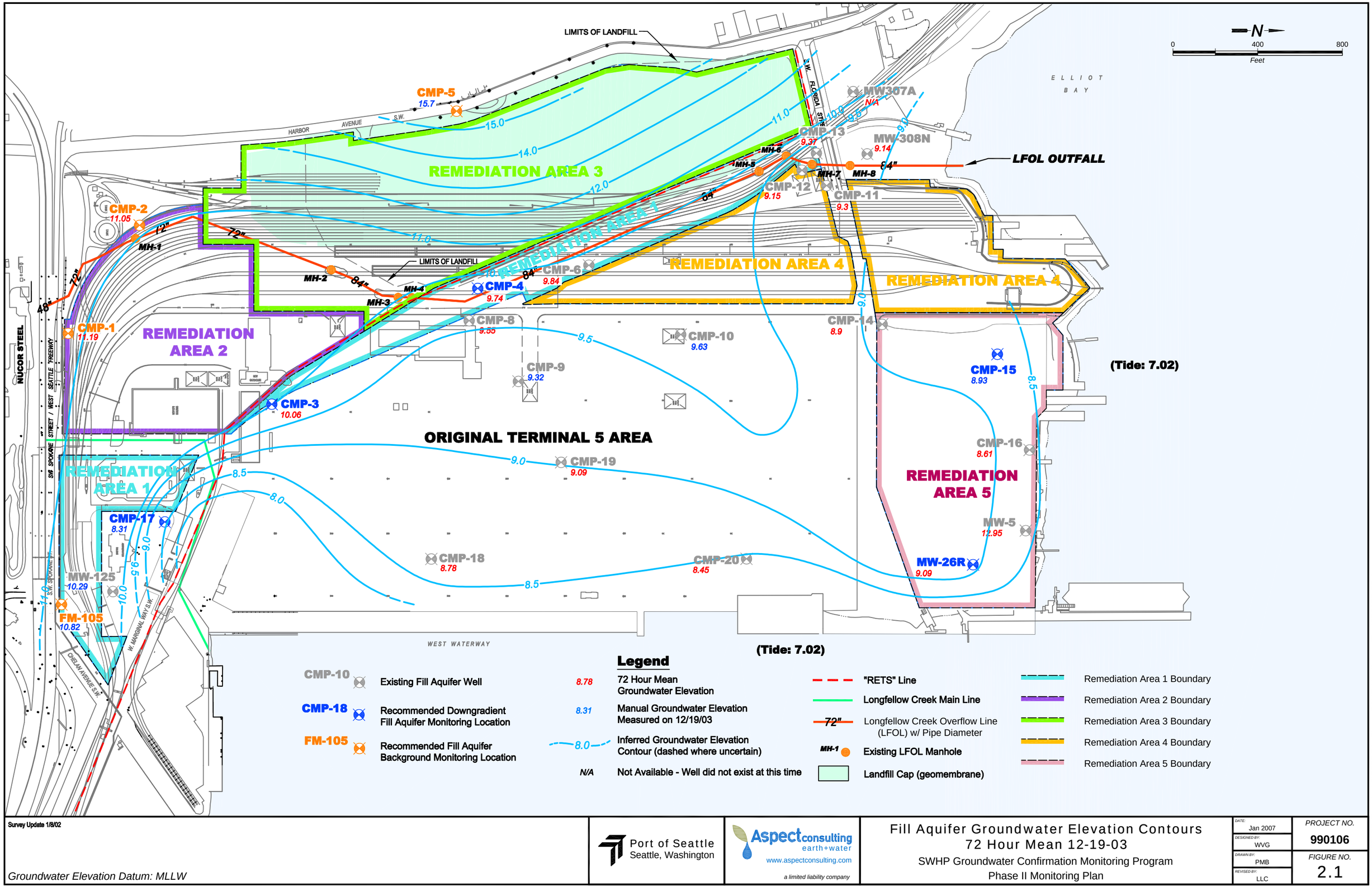
# Southwest Harbor / Terminal 5 Site Plan

SWHP Groundwater Confirmation Monitoring Program
Phase II Monitoring Plan

| | |
|---|---|
| DATE: Jan 2007 | PROJECT NO. 990106 |
| DESIGNED BY: WVG | |
| DRAWN BY: PMB | FIGURE NO. 1.2 |
| REVISED BY: - | |

Q:\POS\990106 Terminal 5\2007-01 Phase 2 WQ Monitoring Plan\990106-04.dwg




Survey Update 1/8/02

Groundwater Elevation Datum: MLLW

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Seattle, Washington

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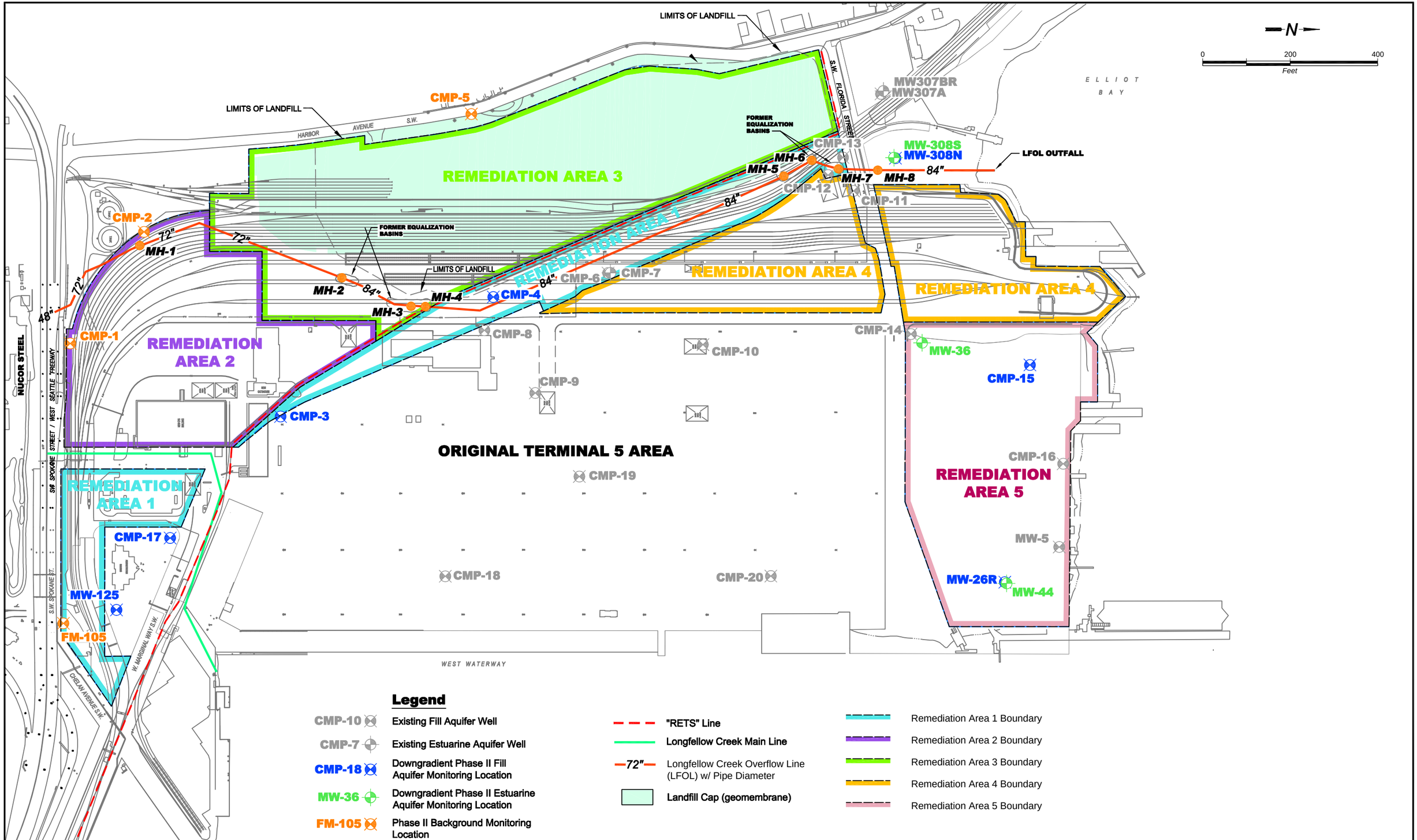
# Fill Aquifer Groundwater Elevation Contours
## 72 Hour Mean 12-19-03
SWHP Groundwater Confirmation Monitoring Program
Phase II Monitoring Plan

| | |
|---|---|
| DATE: | Jan 2007 |
| DESIGNED BY: | WVG |
| DRAWN BY: | PMB |
| REVISED BY: | LLC |
| PROJECT NO. | 990106 |
| FIGURE NO. | 2.1 |

Q:\POS\990106 Terminal 5\2007-01 Phase 2 WQ Monitoring Plan\990106-02.dwg




## Legend

| | |
|---|---|
| CMP-10 | Existing Fill Aquifer Well |
| CMP-7 | Existing Estuarine Aquifer Well |
| CMP-18 | Downgradient Phase II Fill Aquifer Monitoring Location |
| MW-36 | Downgradient Phase II Estuarine Aquifer Monitoring Location |
| FM-105 | Phase II Background Monitoring Location |
| | "RETS" Line |
| | Longfellow Creek Main Line |
| 72" | Longfellow Creek Overflow Line (LFOL) w/ Pipe Diameter |
| | Landfill Cap (geomembrane) |
| | Remediation Area 1 Boundary |
| | Remediation Area 2 Boundary |
| | Remediation Area 3 Boundary |
| | Remediation Area 4 Boundary |
| | Remediation Area 5 Boundary |

Survey Update 1/8/02

Groundwater Elevation Datum: MLLW

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Seattle, Washington

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# Proposed Phase II Monitoring Locations

SWHP Groundwater Confirmation Monitoring Program
Phase II Monitoring Plan

| | |
|---|---|
| DATE: | Sept 2008 |
| DESIGNED BY: | WVG |
| DRAWN BY: | PMB |
| REVISED BY: | |
| PROJECT NO. | 080064 |
| FIGURE NO. | 2.2 |

Q:\POS\080064 Terminal 5\2008-09\080064-03.dwg

# APPENDIX A

# Phase II Equipment Specifications

# SECTION 9001
# ENGINEERING SPECIFICATION: DEDICATED GROUND-WATER SAMPLING PUMP SPECIFICATION

## PART 1 --- GENERAL

### 1.1 SCOPE

1.1.1 The manufacturer shall furnish a dedicated ground water sampling system with one or more bladder pumps and associated tubing and well caps for the collection of ground water quality samples.

### 1.2 PROCESS DESCRIPTION

1.2.1 A bladder pump allows water to flow through an inlet check valve into the interior of the pump bladder due to the pressure gradient exerted by the hydrostatic head of the water it is submerged in. After the interior of the bladder is filled with water, compressed gas is applied to the exterior of the bladder to force the water to flow through an outlet check valve and out of the pump. The compressed gas is delivered to the pump through a gas supply tube connected to a compressed gas source with a control device located at the wellhead, and the pump liquid discharge is delivered to the wellhead through a water discharge tube with both tubes terminating in a wellhead cap. The water pumped and conveyed in a manner to minimize alteration of water quality in any way. When the pump bladder is squeezed sufficiently to empty it of water, the compressed gas control device stops the flow of compressed gas and vents the pump's gas supply tube to the atmosphere. This venting allows the pressure on the outside of the pump bladder to decrease to less than that of the hydrostatic head present at the pump inlet due to the pump's submergence. The pump bladder can thereby refill and repeat the cycle as needed to achieve desired flow for purging and sampling the well. The pump controller at the wellhead controls the sequencing of applying compressed gas to and venting of the pump. A compressed gas source at the wellhead provides the necessary flow of compressed gas to the controller. A water level measurement device allows measurement of water levels in the well before and during pumping, and can be connected to the pump controller to temporarily cease pumping when the water level in the well is drawn down beyond preset limits. A flow cell connected to the water discharge tube measures water quality parameters and provides indication of completion of well purging.

 

1.3 SUBMITTALS

1.3.1 Manufacturer shall submit the following with the bid:

1.3.1.1 Product data for selected models, including dimensions, materials of construction, pressure and depth ratings, flow capacity, weights, measurement accuracy, accessories and warranty coverage. See attached data sheets for full specifications.

## PART 2 --- PRODUCTS

2.1 GENERAL

2.1.1 The sampling pump system shall be a Well Wizard dedicated bladder pump system. See data sheets for model number(s). Equipment shall be manufactured by QED Environmental Systems Inc. and represented by _____ or pre-approved equivalent.

2.1.2 All components and options shall meet requirements specified on the data sheets attached to this specification.

2.2 EQUIPMENT DESIGN REQUIREMENTS

2.2.1 Standard product design shall include complete bladder pump assembly, with all fittings, check valves, bladder and inlet screens with the following specifications:

2.2.1.1 The bladder pumps shall be of squeeze-type design, with water entering the interior of the bladder tube, and air pressure applied to the annular space between the exterior of the bladder and the interior of the pump body.

2.2.1.2 The pump shall be capable of running dry without any damage to the pump, controls or power source.

2.2.1.3 The pump shall also be capable of continuous operation for a minimum of 12 hours at a low rate of 0.1 L/minute or less without damage, malfunction or automatic shutdown.

2.2.1.4 The pump must be capable of lifting water from 300 feet without modification.

 

2.2.1.5 The bladder and all other pump components must be able to withstand 150 PSI differential pressure without damage or malfunction.

2.2.1.6 The pump assembly must be able to withstand a submergence of at least 200 feet and an inlet pressure of at least 85 PSI without damage to the bladder or other components; and without slippage of the bladder from its mounting or leakage around the bladder mounting seal.

2.2.1.7 Bladders shall be Dura-Flex Type-62 Teflon, field replaceable, and capable of a minimum of 200,000 cycles of operation without failure or leakage. Evidence of this performance must be supported by a minimum of ten years of production QC testing data from the manufacturer of the pumps.

2.2.1.8 The pump assembly must be cleaned using a multi-stage washing and rinsing process utilizing phosphate-free laboratory-grade detergent and deionized and filtered water. The cleanliness of the pumps must be certified by soaking the pumps for at least 24 hours in reagent-grade water, with internal recirculation of the water through each pump assembly. Samples of the final soak water shall be analyzed by an independent EPA-certified laboratory for EPA Method 8260 and 625 volatile organic compounds, acid extractable and base-neutral compounds, and results of the analysis correlated to each pump through a numbered and signed certification tag attached to the pump. The efficacy of the cleaning and certification process must be supported by a minimum of ten years of production QC testing data from the manufacturer of the pumps.

2.2.1.9 The pump and tubing when assembled must have a minimum tensile strength of 150 pounds without the use of an auxiliary support cable to prevent pump loss and fitting leakage.

2.2.1.10 The pump and all of its components including the bladder shall be covered by a minimum standard warranty of 10 years provided by the manufacturer of the pump.

**(Choose for PVC Pump)**

2.2.1.11 The bladder pump shall have an overall length of 42 inches, an outside diameter of 1.66 inches, and a bladder capacity of 395 milliliters; or (where the application warrants) an overall length of 19.5 inches, an outside diameter of 1.66 inches, and a bladder capacity of 130 milliliters.

2.2.1.12 The pump must be constructed entirely of PVC and PTFE materials, with lead-free Viton® o-rings. The materials used in construction of the pump, including external fittings and connections, must be virgin-grade first-run quality, with no reprocessed or reground ingredient, additives or fillers used.

2.2.1.13 All PVC components used must be NSF-grade, extruded specifically with no markings or lubricants.

2.2.1.14 Each pump shall be fitted with a PVC inlet screen, 6 inches in length, and having a screen opening size of .010 slot. The screen shall attach directly by threading to the pump inlet housing.

2.2.1.15 To provide steady low-flow pumping rates and to minimize sample aeration in the discharge tube and the introduction of air into in-line flow cells, the pump shall have a check valve design that typically allows less than 0.1 ml/minute drainback during the pump refill cycle, and in no more than 0.5 ml/minute drainback during refill.

**(Choose for Stainless Steel/Teflon Pump)**

2.2.1.16 The bladder pump shall have an overall length of 42 inches, an outside diameter of 1.5 inches, and a bladder capacity of 495 milliliters; or (where the application warrants) an overall length of 15 inches, an outside diameter of 1.5 inches, and a bladder capacity of 100 milliliters.

2.2.1.17 The pump must be constructed entirely of Type 316 stainless steel and PTFE materials, with lead-free Viton® o-rings. The materials used in construction of the pump, including external fittings and connections, must be virgin-grade first-run quality, with no reprocessed or reground ingredient, additives or fillers used.

2.2.1.18 All stainless steel components of the pump, including the body, discharge nipple, center discharge rod, fittings, center rod and body cross pins, and inlet screen assembly must be electropolished to remove all traces of embedded scale, rust, foreign debris, oils and grinding compounds from manufacturing; and to passivate the surface of the metal to protect against corrosion, tarnish or oxidation that could affect sample chemistry.

2.2.1.19 The pump fittings must be type 316 Stainless Steel, compression-type design with a two-part ferrule and outer compression nut, as manufactured by Swagelock®, with special provision made to ensure elimination of the standard metal coatings normally present on the threads.

2.2.1.20 Each pump shall be provided with a fine stainless steel mesh inlet screen

 

assembly to protect the pump from malfunction or damage by large solids. The inlet screen shall be 6 inches in length, and of .010 mesh. The screen shall attach to the pump inlet housing by means of stainless steel set screws.

2.2.1.21 To provide steady low-flow pumping rates and to minimize sample aeration in the discharge tube and the introduction of air into in-line flow cells, the pump shall have a check valve design that typically allows less than 0.1 ml/minute drainback during the pump refill cycle, and in no more than 0.5 ml/minute drainback during refill.

**(Choose for High Pressure Stainless Steel/Teflon Pump)**

2.2.1.22 The bladder pump shall have an overall length of 42 inches, an outside diameter of 1.66 inches, and a bladder capacity of 395 milliliters.

2.2.1.23 The pump must be constructed entirely of Type 316 stainless steel and PTFE materials, with lead-free Viton® o-rings. The materials used in construction of the pump, including external fittings and connections, must be virgin-grade first-run quality, with no reprocessed or reground ingredient, additives or fillers used.

2.2.1.24 All stainless steel components of the pump, including the body, discharge nipple, center discharge rod, fittings, center rod and body cross pins, and inlet screen assembly must be electropolished to remove all traces of embedded scale, rust, foreign debris, oils and grinding compounds from manufacturing; and to passivate the surface of the metal to protect against corrosion, tarnish or oxidation that could affect sample chemistry.

2.2.1.25 The pump fittings must be type 316 Stainless Steel, compression-type design with a two-part ferrule and outer compression nut, as manufactured by Swagelock®, with special provision made to ensure elimination of the standard metal coatings normally present on the threads.

2.2.1.26 Each pump shall be provided with a fine stainless steel mesh inlet screen assembly to protect the pump from malfunction or damage by large solids. The inlet screen shall be 6 inches in length, and of .010 mesh. The screen shall attach to the pump inlet housing by means of stainless steel set screws.

**(Choose for Teflon Pump)**

2.2.1.27 The bladder pump shall have an overall length of 42 inches, an outside diameter of 1.5 inches, and a bladder capacity of 495 milliliters; or (where the application warrants) an overall length of 15 inches, an outside diameter of 1.5 inches, and a bladder capacity of 100 milliliters.

2.2.1.28 The pump must be constructed entirely of PTFE materials, with lead-free Viton® o-rings. The materials used in construction of the pump, including external fittings and connections, must be 100% virgin-grade first-run quality, with no reprocessed or reground ingredient, additives or fillers used.

2.2.1.29 Each pump shall be fitted with a Teflon inlet screen, 6 inches in length, and having a screen opening size of .010 slot. The screen shall attach directly by threading to the pump inlet housing.

2.2.1.30 The bladder pumps shall be of squeeze-type design, with water entering the interior of the bladder tube, and air pressure applied to the annular space between the exterior of the bladder and the interior of the pump body.

2.2.1.31 The pump shall be capable of running dry without any damage to the pump, controls or power source.

2.2.1.32 The pump shall also be capable of continuous operation for a minimum of 12 hours at a low rate of 0.1 L/minute or less without damage, malfunction or automatic shutdown.

2.2.1.33 The pump must be capable of lifting water from 300 feet without modification.

2.2.1.34 The bladder and all other pump components must be able to withstand 150 PSI differential pressure without damage or malfunction.

2.2.1.35 The pump assembly must be able to withstand a submergence of at least 200 feet and an inlet pressure of at least 85 PSI without damage to the bladder or other components; and without slippage of the bladder from its mounting or leakage around the bladder mounting seal.

2.2.1.36 Bladders shall be Dura-Flex Type-62 Teflon, field replaceable, and capable of a minimum of 200,000 cycles of operation without failure or

 

leakage. Evidence of this performance must be supported by a minimum of ten years of production QC testing data from the manufacturer of the pumps.

**(Choose for PVC Pump)**

2.2.1.37 The bladder pump shall have an overall length of 42 inches, an outside diameter of 1.66 inches, and a bladder capacity of 395 milliliters; or (where the application warrants) an overall length of 19.5 inches, an outside diameter of 1.66 inches, and a bladder capacity of 130 milliliters.

2.2.1.38 The pump must be constructed entirely of PVC and PTFE materials, with lead-free Viton® o-rings. The materials used in construction of the pump, including external fittings and connections, must be virgin-grade first-run quality, with no reprocessed or reground ingredient, additives or fillers used.

2.2.1.39 All PVC components used must be NSF-grade, extruded specifically with no markings or lubricants.

2.2.1.40 Each pump shall be fitted with a PVC inlet screen, 6 inches in length, and having a screen opening size of .010 slot. The screen shall attach directly by threading to the pump inlet housing.

2.2.1.41 To provide steady low-flow pumping rates and to minimize sample aeration in the discharge tube and the introduction of air into in-line flow cells, the pump shall have a check valve design that typically allows less than 0.1 ml/minute drainback during the pump refill cycle, and in no more than 0.5 ml/minute drainback during refill.

**(Choose for Stainless Steel/Teflon Pump)**

2.2.1.42 The bladder pump shall have an overall length of 42 inches, an outside diameter of 1.5 inches, and a bladder capacity of 495 milliliters; or (where the application warrants) an overall length of 15 inches, an outside diameter of 1.5 inches, and a bladder capacity of 100 milliliters.

2.2.1.43 The pump must be constructed entirely of Type 316 stainless steel and PTFE materials, with lead-free Viton® o-rings. The materials used in construction of the pump, including external fittings and connections, must be virgin-grade first-run quality, with no reprocessed or reground ingredient, additives or fillers used.

2.2.1.44 All stainless steel components of the pump, including the body, discharge nipple, center discharge rod, fittings, center rod and body cross pins, and inlet screen assembly must be electropolished to remove all traces of embedded scale, rust, foreign debris, oils and grinding compounds from

manufacturing; and to passivate the surface of the metal to protect against corrosion, tarnish or oxidation that could affect sample chemistry.

2.2.1.45 The pump fittings must be type 316 Stainless Steel, compression-type design with a two-part ferrule and outer compression nut, as manufactured by Swagelock®, with special provision made to ensure elimination of the standard metal coatings normally present on the threads.

2.2.1.46 Each pump shall be provided with a fine stainless steel mesh inlet screen assembly to protect the pump from malfunction or damage by large solids. The inlet screen shall be 6 inches in length, and of .010 mesh. The screen shall attach to the pump inlet housing by means of stainless steel set screws.

2.2.1.47 To provide steady low-flow pumping rates and to minimize sample aeration in the discharge tube and the introduction of air into in-line flow cells, the pump shall have a check valve design that typically allows less than 0.1 ml/minute drainback during the pump refill cycle, and in no more than 0.5 ml/minute drainback during refill.

**(Choose for High Pressure Stainless Steel/Teflon Pump)**

2.2.1.48 The bladder pump shall have an overall length of 42 inches, an outside diameter of 1.66 inches, and a bladder capacity of 395 milliliters.

2.2.1.49 The pump must be constructed entirely of Type 316 stainless steel and PTFE materials, with lead-free Viton® o-rings. The materials used in construction of the pump, including external fittings and connections, must be virgin-grade first-run quality, with no reprocessed or reground ingredient, additives or fillers used.

2.2.1.50 All stainless steel components of the pump, including the body, discharge nipple, center discharge rod, fittings, center rod and body cross pins, and inlet screen assembly must be electropolished to remove all traces of embedded scale, rust, foreign debris, oils and grinding compounds from manufacturing; and to passivate the surface of the metal to protect against corrosion, tarnish or oxidation that could affect sample chemistry.

2.2.1.51 The pump fittings must be type 316 Stainless Steel, compression-type design with a two-part ferrule and outer compression nut, as manufactured by Swagelock®, with special provision made to ensure elimination of the standard metal coatings normally present on the threads.

2.2.1.52 Each pump shall be provided with a fine stainless steel mesh inlet screen assembly to protect the pump from malfunction or damage by large solids. The inlet screen shall be 6 inches in length, and of .010 mesh. The screen shall attach to the pump inlet housing by means of stainless steel set screws.

**(Choose for Teflon Pump)**

2.2.1.53 The bladder pump shall have an overall length of 42 inches, an outside diameter of 1.5 inches, and a bladder capacity of 495 milliliters; or (where the application warrants) an overall length of 15 inches, an outside diameter of 1.5 inches, and a bladder capacity of 100 milliliters.

2.2.1.54 The pump must be constructed entirely of PTFE materials, with lead-free Viton® o-rings. The materials used in construction of the pump, including external fittings and connections, must be 100% virgin-grade first-run quality, with no reprocessed or reground ingredient, additives or fillers used.

2.2.1.55 Each pump shall be fitted with a Teflon inlet screen, 6 inches in length, and having a screen opening size of .010 slot. The screen shall attach directly by threading to the pump inlet housing.

2.2.2 Pump Tubing

2.2.2.1 Each pump shall be supplied with tubing to meet the following specifications;

2.2.2.2 The air supply and discharge tubing shall be thermally bonded together for installation as a single line, without any external sheathing material or cable ties. The air supply and discharge tubing shall be able to be separated without the use of any tools for attachment to fittings. Once separated, the remaining bonding ridge shall not require trimming or removal for installation into a compression-type fitting for leak-tight connection to compression type fittings.

2.2.2.3 Tubing shall be ¼" air supply, with discharge sized to match the bladder pump. The tolerance on the diameter shall not exceed + 0.05 inches, and shall fit into standard-sized compression-type fittings without trimming, reaming or resizing.

2.2.2.4 The tubing shall have a minimum bend radius of 1.25 inches, and must be able to withstand 300 PSI working pressure.

2.2.2.5 All materials must be 100% virgin-grade, extruded in the USA with US-manufactured resins, with no regrind materials, additives, fillers, mold release agents or printing.

2.2.2.6 Each tubing bundle shall be provided with inserts (material to be compatible with the pump construction) needed for secure connection to the pump and wellhead assembly.

**(Choose for Polyethylene Tube)**

2.2.2.7 The tubing shall be manufactured of all polyethylene.

**(Choose for Teflon-Lined Polyethylene Tube)**

2.2.2.8 The tubing shall be manufactured of polyethylene, with the discharge tubing having an inner-wall lining of Teflon.

2.2.2.9 The tubing shall be provided with rigid inserts inside the end of the tube connected to the pump fittings, to prevent discharge flow from being blocked due to the Teflon lining being pushed or peeled back into the liquid flow path.

**(Choose for Teflon Tube)**

2.2.2.10 The tubing shall be manufactured of all Teflon.

2.2.3 Wellhead Cap Assembly

2.2.3.1 Each pump shall be supplied with a well cap assembly to meet the following specifications;

2.2.3.2 The system shall include a well head cap assembly designed to support the weight of the down-well system components and limit the access to the well to prevent accidental contamination or damage.

2.2.3.3 The cap body shall be constructed of anodized aluminum, require less than ¼" vertical clearance between the top of the casing and the underside of any existing protective well closures, and be machined to fit standard well casing diameters without interference to allow easy installation and removal without modification. Manufacturer shall also be able to provide caps for specialized applications requiring water tight, or locking capabilities.

2.2.3.4 The pump air supply fitting shall consist of a compression-type brass fitting for connection to the pump air supply tubing, and a quick-connect

brass fitting for connection to the controlled air supply hose.

2.2.3.5 The pump discharge fitting shall be a bore-through design that allows the discharge tubing to pass continuously through the cap, preventing sample water from contacting the fitting. The cap shall also include a flexible discharge tube, constructed of inert materials, which attaches via a slip fit grip ring to the pump discharge tube end and stores between uses in the water level measurement hole.

2.2.3.6 The cap shall include an access hole for water level measurement and include a polyethylene dust protection cap to cover the entire cap to prevent accidental introduction of contaminants to the fittings or well.

2.2.3.7 The cap shall include as standard equipment a polyethylene tag with special writing surface to allow marking well identification and pump controller setting information.

2.2.4 Freeze Protection

2.2.4.1 Each pump shall be provided with freeze protection that shall meet the following specifications;

2.2.4.2 The cap shall include a means of freeze protection that will allow for the positive discharge of any water in the tubing to prevent blockage of flow due to ice formation or damage to the pump discharge tubing near the well head.

**(Choose for Freeze Protection Kit-MicroPurge Applications)**

2.2.4.3 The freeze protection kit shall consist of a length of flexible polyethylene tubing 0.125" OD with a quick-connect brass fitting allowing connection to the controller compressed gas supply hose end. Water in the discharge tube near the wellhead can be removed by inserting the 0.125" tube into the pump liquid discharge tube end at the wellhead, then applying gentle drive gas pressure to the 0.125" tube. An optional in-line filter shall be available for removal of organic and particulate contaminants from the gas supply if desired.

**(Choose for freeze prevention in standard 3-5 well volume applications)**

2.2.4.4 A special tube coupler of appropriate size and material with a .020 inch diameter drilled hole installed shall be supplied to allow for drain back and prevent in-line freezing once sampling is completed.

2.2.5 General System Specifications and Vendor Requirements

2.2.5.1 The manufacturer shall have a minimum of 15 years experience providing pneumatic bladder pumps in groundwater monitoring applications.

2.2.5.2 The entire system shall be covered by a standard one-year warranty provided by the manufacturer, with the exception of the bladder pumps which shall be covered by a standard ten-year warranty as noted in A.12 above.

2.2.5.3 The manufacturer shall provide full product technical support by telephone during normal business hours, and additional 7 day/24 hour support via a toll-free telephone hotline.

2.2.5.4 The manufacturer shall have a local factory trained agent, and shall have OSHA certified technicians available for installation or start-up assistance.

2.2.5.5 The manufacturer shall have a minimum of eleven (11) years experience with a pump certification program as described in 2.2.1.8.

2.2.5.6 Manufacturer's facility shall include a 300' test well for flow rate verification.

2.2.5.7 Manufacturer must be capable of shipping all standard equipment within ten working days of receipt of order.

2.2.5.8 All bladder pumps, downwell tubing, well caps, and accessories to be supplied by:

QED Environmental Systems, Inc.
P.O. Box 3726
Ann Arbor, MI 48106
(800) 624-2024 (734) 995-1170 FAX
www.qedenv.com

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# APPENDIX B

# Phase II Monitoring Well Completion Reports

**List of Well Completion Reports**

CMP-1

CMP-2

CMP-3

CMP-4

CMP-5

CMP-15

CMP-17

MW-26R

MW-36

MW-44

MW-125

MW-308A(N)

MW-308B(S)

FM-105

| | | | | |
|---|---|---|---|---|
| Coarse-Grained Soils - More than 50%[1] Retained on No. 200 Sieve | Gravels - More than 50%[1] of Coarse Fraction Retained on No. 4 Sieve | ≤5% Fines[5] | GW | Well-graded gravel and gravel with sand, little to no fines |
| | | | GP | Poorly-graded gravel and gravel with sand, little to no fines |
| | | ≥15% Fines[5] | GM | Silty gravel and silty gravel with sand |
| | | | GC | Clayey gravel and clayey gravel with sand |
| | Sands - 50%[1] or More of Coarse Fraction Passes No. 4 Sieve | ≤5% Fines[5] | SW | Well-graded sand and sand with gravel, little to no fines |
| | | | SP | Poorly-graded sand and sand with gravel, little to no fines |
| | | ≥15% Fines[5] | SM | Silty sand and silty sand with gravel |
| | | | SC | Clayey sand and clayey sand with gravel |
| Fine-Grained Soils - 50%[1] or More Passes No. 200 Sieve | Silts and Clays Liquid Limit Less than 50 | | ML | Silt, sandy silt, gravelly silt, silt with sand or gravel |
| | | | CL | Clay of low to medium plasticity; silty, sandy, or gravelly clay, lean clay |
| | | | OL | Organic clay or silt of low plasticity |
| | Silts and Clays Liquid Limit 50 or More | | MH | Elastic silt, clayey silt, silt with micaceous or diato-maceous fine sand or silt |
| | | | CH | Clay of high plasticity, sandy or gravelly clay, fat clay with sand or gravel |
| | | | OH | Organic clay or silt of medium to high plasticity |
| Highly Organic Soils | | | PT | Peat, muck and other highly organic soils |

## Terms Describing Relative Density and Consistency

| | Density | SPT[2] blows/foot |
|---|---|---|
| Coarse-Grained Soils | Very Loose | 0 to 4 |
| | Loose | 4 to 10 |
| | Medium Dense | 10 to 30 |
| | Dense | 30 to 50 |
| | Very Dense | >50 |
| | **Consistency** | **SPT[2] blows/foot** |
| Fine-Grained Soils | Very Soft | 0 to 2 |
| | Soft | 2 to 4 |
| | Medium Stiff | 4 to 8 |
| | Stiff | 8 to 15 |
| | Very Stiff | 15 to 30 |
| | Hard | >30 |

### Test Symbols

G = Grain Size
M = Moisture Content
A = Atterberg Limits
C = Chemical
DD = Dry Density
K = Permeability

## Component Definitions

| Descriptive Term | Size Range and Sieve Number |
|---|---|
| Boulders | Larger than 12" |
| Cobbles | 3" to 12" |
| Gravel | 3" to No. 4 (4.75 mm) |
| Coarse Gravel | 3" to 3/4" |
| Fine Gravel | 3/4" to No. 4 (4.75 mm) |
| Sand | No. 4 (4.75 mm) to No. 200 (0.075 mm) |
| Coarse Sand | No. 4 (4.75 mm) to No. 10 (2.00 mm) |
| Medium Sand | No. 10 (2.00 mm) to No. 40 (0.425 mm) |
| Fine Sand | No. 40 (0.425 mm) to No. 200 (0.075 mm) |
| Silt and Clay | Smaller than No. 200 (0.075 mm) |

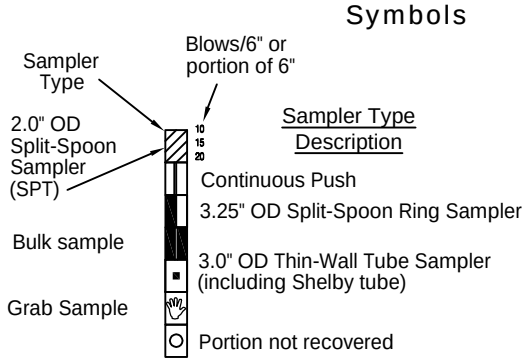
## [3] Estimated Percentage

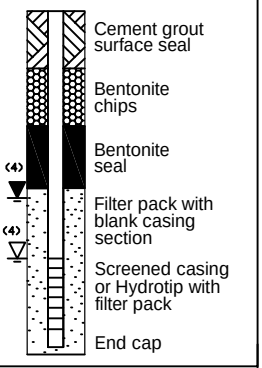
| Percentage by Weight | Modifier |
|---|---|
| <5 | Trace |
| 5 to 15 | Slightly (sandy, silty, clayey, gravelly) |
| 15 to 30 | Sandy, silty, clayey, gravelly) |
| 30 to 49 | Very (sandy, silty, clayey, gravelly) |

## Moisture Content

Dry - Absence of moisture, dusty, dry to the touch
Slightly Moist - Perceptible moisture
Moist - Damp but no visible water
Very Moist - Water visible but not free draining
Wet - Visible free water, usually from below water table

## Symbols




(1) Percentage by dry weight
(2) (SPT) Standard Penetration Test (ASTM D-1586)
(3) In General Accordance with Standard Practice for Description and Identification of Soils (ASTM D-2488)
(4) Depth of groundwater
(5) Combined USCS symbols used for fines between 5% and 15% as estimated in General Accordance with Standard Practice for Description and Identification of Soils (ASTM D-2488)

ATD = At time of drilling
Static water level (date)

Classifications of soils in this report are based on visual field and/or laboratory observations, which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field or laboratory testing unless presented herein. Visual-manual and/or laboratory classification methods of ASTM D-2487 and D-2488 were used as an identification guide for the Unified Soil Classification System.


Aspect consulting
earth+water
www.aspectconsulting.com
a limited liability company


# Exploration Log Key

DATE:
DESIGNED BY:
DRAWN BY:
REVISED BY:
PROJECT NO.
FIGURE NO.
B-1

Q:_ACAD Standards\Standard Details\Exploration Log Key B1.dwg

Aspect consulting
IN-DEPTH PERSPECTIVE

# Geologic & Monitoring Well Construction Log

| Project Number | Well Number | Sheet |
|---|---|---|
| 990106 | CMP-1 | 1 of 1 |

| | | | |
|---|---|---|---|
| Project Name | Southwest Harbor Project | Monument Elev. (ft mllw) | 22.90 |
| Location | Seattle, Washington | Water Elev. (ft mllw) | 11.4 |
| Drilling Method | Hollow Stem Auger 8" OD/4" ID ; Holt Drilling | Start Date | September 19, 2001 |
| Sampling Method | 2" Diameter, Split Spoon Sampler | Finish Date | September 19, 2001 |

| Depth feet | Well Construction | PID (ppm) | H2S (ppm) | S T | Blows/ 6" | Sample ID | Mtl. Graphic | Description |
|---|---|---|---|---|---|---|---|---|
| | 8" Steel Monument Type L-868<br>Concrete seal | | | | | | | **CRUSHED GRAVEL SURFACE**<br>1-1/4" minus crushed gravel |
| | Bentonite chips | 0 | 0 | | 12<br>15<br>17 | S-1 | | **FILL**<br>Dense, damp, dark brown SAND; sand fine to medium |
| 5 | Filter Pack, 10 X 20 & 20 X 40 Colorado Silica Sand | | | | | | | |
| | Well Screen 2" ID SCH 40 PVC, 0.01" slot size | 0 | 0 | | 13<br>8<br>6 | S-2 | | -grades to medium dense |
| 10 | 11.5' ATD | | | | | | | Medium dense, wet, black SAND; sand fine to medium, trace red grains |
| | | 0 | 0 | | 3<br>6<br>10 | S-3 | | |
| 15 | | | | | | | | Medium dense, wet, gray-brown SAND; sand fine to medium |
| | PVC Threaded End Cap<br>Filter Pack, 10 X 20 & 20 X 40 Colorado Silica Sand | 0 | 0 | | 4<br>6<br>10 | S-4 | | |
| 20 | | | | | | | | Bottom of exploration boring at 19 feet. |

Sampler Type (ST):
- 3.25" OD D & M Split-Spoon Ring Sampler
- No Recovery
- 2" OD Split-Spoon Sampler

Lab Tests:
- G - Grain Size
- P - Permeability
- M - Moisture Content

▼ Water Level (ATD) ▽ Static Water Level

Logged by: RRH
Approved by: WVG
Figure No.

SWHARBOR jSWHARBOR.GPJ February 5, 2002

Aspect consulting
IN-DEPTH PERSPECTIVE

# Geologic & Monitoring Well Construction Log

| Project Number | Well Number | Sheet |
|---|---|---|
| 990106 | CMP-2 | 1 of 1 |

| | | | |
|---|---|---|---|
| Project Name | Southwest Harbor Project | Monument Elev. (ft mllw) | 23.04 |
| Location | Seattle, Washington | Water Elev. (ft mllw) | 10.5 |
| Drilling Method | Hollow Stem Auger 8" OD/4" ID ; Holt Drilling | Start Date | September 18, 2001 |
| Sampling Method | 2" Diameter, Split Spoon Sampler | Finish Date | September 18, 2001 |

| Depth feet | Well Construction | PID (ppm) | H2S (ppm) | ST | Blows/ 6" | Sample ID | Mtl. Graphic | Description |
|---|---|---|---|---|---|---|---|---|
| | 8" Steel Monument Type L-868<br>Concrete seal | | | | | | | **RECENT FILL**<br>-road ballast, 1-1/4" minus gravel with sand; trace silt |
| | Bentonite chips | 0 | 0 | | 12<br>50/6" | S-1 | | **OLDER FILL**<br>Very dense, damp to moist, brown SAND; sand fine to medium |
| 5 | | | | | | | | Very dense, damp, brown GRAVELLY SAND with SILT |
| | Filter Pack, 10 X 20 & 20 X 40 Colorado Silica Sand | | | | | | | Dense, damp, dark brown SANDY GRAVEL |
| | Well Screen 2" ID SCH 40 PVC, 0.01" slot size | 0 | 0 | | 18<br>16<br>12 | S-2 | | **SLAG AND KILN BRICK**<br>Slag and kiln brick like material at 8.5' |
| 10 | | | | | | | | |
| | 12.5' ATD | 0 | 0 | | 23<br>15<br>9 | S-3 | | Yellow kiln brick like material in shoe at 12'<br>-drills like gravels |
| 15 | | | | | | | | Medium dense, wet, brown GRAVELLY SAND; some slag and kiln brick |
| | PVC Threaded End Cap<br>Filter Pack, 10 X 20 & 20 X 40 Colorado Silica Sand | 0 | 0 | | 9<br>16<br>8 | S-4 | | |
| 20 | | | | | | | | Bottom of exploration boring at 19 feet. |

Sampler Type (ST):
- 3.25" OD D & M Split-Spoon Ring Sampler
- No Recovery
- 2" OD Split-Spoon Sampler

Lab Tests:
- G - Grain Size
- P - Permeability
- M - Moisture Content

▼ Water Level (ATD) ▽ Static Water Level

Logged by: RRH
Approved by: WVG
Figure No.

SWHARBOR SWHARBOR.GPJ February 5, 2002

Aspect consulting
IN-DEPTH PERSPECTIVE

# Geologic & Monitoring Well Construction Log

| Project Number | Well Number | Sheet |
|---|---|---|
| 990106 | CMP-3 | 1 of 1 |

| | | | |
|---|---|---|---|
| Project Name | Southwest Harbor Project | Monument Elev. (ft mllw) | 17.75 |
| Location | Seattle, Washington | Water Elev. (ft mllw) | 8.2 |
| Drilling Method | Hollow Stem Auger 8" OD/4" ID ; Holt Drilling | Start Date | September 19, 2001 |
| Sampling Method | 2" Diameter, Split Spoon Sampler | Finish Date | September 19, 2001 |

| Depth feet | Well Construction | PID (ppm) | H2S (ppm) | ST | Blows/ 6" | Sample ID | Mtl. Graphic | Description |
|---|---|---|---|---|---|---|---|---|
| | 8" Steel Monument Type L-868<br>Concrete seal | | | | | | | **ASPHALT SURFACE** |
| | | | | | | | | **FILL**<br>-road ballast, 1-1/4" minus crushed gravel; trace sand and silt; cobbles in cutting |
| | Bentonite chips | 0 | 0 | | 6<br>9<br>26 | S-1 | | Dense, damp, brown GRAVELLY SAND; trace silt, sand fine to coarse |
| 5 | Filter Pack, 10 X 20 & 20 X 40 Colorado Silica Sand | | | | | | | |
| | | 0 | 0 | | 13<br>31<br>42 | S-2 | | Very dense, moist, brown SANDY GRAVEL; sand fine to coarse<br>-very gravelly to 11 feet |
| | 9.5' ATD | | | | | | | |
| 10 | Well Screen 2" ID SCH 40 PVC, 0.01" slot size | | | | | | | Loose, wet, dark brown GRAVELLY SAND with SILT; sand fine to coarse |
| | | 0 | 0 | | 3<br>5<br>3 | S-3 | | |
| 15 | | | | | | | | Medium dense, wet, brown SANDY GRAVEL with SILT |
| | PVC Threaded End Cap | 0 | 0 | | 4<br>9<br>11 | S-4 | | |
| | Filter Pack, 10 X 20 & 20 X 40 Colorado Silica Sand | | | | | | | **TIDAL MARSH DEPOSITS**<br>Very stiff, moist, light brown SANDY SILT; sand fine |
| | | | | | | | | Bottom of exploration boring at 17.5 feet. |
| 20 | | | | | | | | |

Sampler Type (ST):
- 3.25" OD D & M Split-Spoon Ring Sampler
- No Recovery
- 2" OD Split-Spoon Sampler

Lab Tests:
- G - Grain Size
- P - Permeability
- M - Moisture Content

▼ Water Level (ATD) ▽ Static Water Level

Logged by: RRH
Approved by: WVG
Figure No.

SWHARBOR SWHARBOR.GPJ February 5, 2002

Aspect consulting
IN-DEPTH PERSPECTIVE

# Geologic & Monitoring Well Construction Log

| Project Number | Well Number | Sheet |
|---|---|---|
| 990106 | CMP-4 | 1 of 1 |

| | | | |
|---|---|---|---|
| Project Name | Southwest Harbor Project | Monument Elev. (ft mllw) | 20.25 |
| Location | Seattle, Washington | Water Elev. (ft mllw) | 7.93 |
| Drilling Method | Hollow Stem Auger 8" OD/4" ID ; Holt Drilling | Start Date | September 18, 2001 |
| Sampling Method | 2" Diameter, Split Spoon Sampler | Finish Date | September 18, 2001 |

| Depth feet | Well Construction | PID (ppm) | H2S (ppm) | ST | Blows/ 6" | Sample ID | Description |
|---|---|---|---|---|---|---|---|
| | 8" Steel Monument Type L-868 | | | | | | **ASPHALT SURFACE** |
| | Concrete seal | | | | | | **FILL** -railroad bedding, 1-1/4" crushed gravel; trace sand |
| | | 0 | 0 | | 10 20 28 | S-1 | Dense, damp, brown SAND; sand fine to medium; no visible structure (fill) |
| | Bentonite chips | | | | | | |
| 5 | Filter Pack, 10 X 20 & 20 X 40 Colorado Silica Sand | | | | | | |
| | Well Screen 2" ID SCH 40 PVC, 0.01" slot size | 0 | 0 | | 10 19 22 | S-2 | |
| 10 | | | | | | | |
| | 12.32' ATD | 0 | 0 | | 2 3 4 | S-3 | -grades to loose -becomes wet |
| 15 | | | | | | | Loose, wet, gray SAND; few silt, trace gravels, sand fine to medium |
| | | 0 | 0 | | 0 2 3 | S-4 | |
| | PVC Threaded End Cap | | | | | | |
| | Filter Pack, 10 X 20 & 20 X 40 Colorado Silica Sand | | | | | | Bottom of exploration boring at 17.5 feet. |
| 20 | | | | | | | |

Sampler Type (ST):
- 3.25" OD D & M Split-Spoon Ring Sampler
- No Recovery
- 2" OD Split-Spoon Sampler

Lab Tests:
- G - Grain Size
- P - Permeability
- M - Moisture Content

▼ Water Level (ATD) ▽ Static Water Level

Logged by: RRH
Approved by: WVG
Figure No.

SWHARBOR SWHARBOR.GPJ February 5, 2002

Aspect consulting
IN-DEPTH PERSPECTIVE

# Geologic & Monitoring Well Construction Log

| Project Number | Well Number | Sheet |
|---|---|---|
| 990106 | CMP-5 | 1 of 1 |

| | | | |
|---|---|---|---|
| Project Name | Southwest Harbor Project | Monument Elev. (ft mllw) | 24.07 |
| Location | Seattle, Washington | Water Elev. (ft mllw) | 13.1 |
| Drilling Method | Hollow Stem Auger 8" OD/4" ID ; Holt Drilling | Start Date | October 29, 2001 |
| Sampling Method | 2" Diameter, Split Spoon Sampler, 140 lb hammer | Finish Date | October 29, 2001 |

| Depth feet | Well Construction | PID (ppm) | H2S (ppm) | ST | Blows/ 6" | Sample ID | Mtl. Graphic | Description |
|---|---|---|---|---|---|---|---|---|
| | 8" Steel Monument<br>Morris Flush Mount | | | | | | | **CONCRETE ROAD BED** |
| | Concrete seal | | | | | | | **FILL**<br>Dense, damp, brown SANDY GRAVEL; trace silt, trace wood, trace glass; sand fine to medium |
| | Bentonite chips | 0 | 0 | | 16<br>12<br>15 | S-1 | | Medium dense, damp, brown SAND; sand fine to medium |
| | Filter Pack, 10 X 20 & 20 X 40 Colorado Silica Sand | | | | | | | |
| 5 | V-Wrap Well Screen<br>2" ID SCH 40 PVC,<br>0.01" slot size | | | | | | | **NATIVE DEPOSITS**<br>Medium dense, moist, brown SAND with gray SILTY SAND interbeds to 2" |
| | | 0 | 0 | | 5<br>6<br>5 | S-2 | | |
| 10 | ▼ 11.0' ATD | | | | | | | Loose, wet, gray SLIGHTLY SILTY to SILTY SAND; sand fine to medium |
| | | 0 | 0 | | 2<br>3<br>6 | S-3 | | |
| 15 | PVC Threaded End Cap | 0 | 0 | | 4<br>7<br>8 | S-4 | | -grades to medium dense with trace gravel |
| | | 0 | 0 | | 1<br>1<br>3 | S-5 | | **LAWTON CLAY**<br>Soft, wet, gray CLAYEY SILT |
| | | | | | | | | Bottom of exploration boring at 19 feet. |

Sampler Type (ST):
- 3.25" OD D & M Split-Spoon Ring Sampler
- No Recovery
- 2" OD Split-Spoon Sampler

Lab Tests:
- G - Grain Size
- P - Permeability
- M - Moisture Content

▼ Water Level (ATD) ▽ Static Water Level

Logged by: RRH
Approved by: WVG
Figure No.

SWHARBOR SWHARBOR.GPJ February 5, 2002

Aspect consulting
IN-DEPTH PERSPECTIVE

# Geologic & Monitoring Well Construction Log

| Project Number | Well Number | Sheet |
|---|---|---|
| 990106 | CMP-15 | 1 of 1 |

| | | | |
|---|---|---|---|
| Project Name | Southwest Harbor Project | Monument Elev. (ft mllw) | 18.74 |
| Location | Seattle, Washington | Water Elev. (ft mllw) | 6.7 |
| Drilling Method | Hollow Stem Auger 8" OD/4" ID ; Holt Drilling | Start Date | November 5, 2001 |
| Sampling Method | 2" Diameter, Split Spoon Sampler, 140 lb hammer | Finish Date | November 5, 2001 |

| Depth feet | Well Construction | PID (ppm) | H2S (ppm) | ST | Blows/ 6" | Sample ID | Mtl. Graphic | Description |
|---|---|---|---|---|---|---|---|---|
| | 8" Steel Monument Type C-868 | | | | | | | **ASPHALT** |
| | Concrete seal | | | | | | | **FILL** Very dense, damp, brown SANDY GRAVEL |
| | Bentonite chips | 0 | 0 | | 29 35 20 | S-1 | | |
| 5 | | | | | | | | Dense, moist, dark brown to black SANDY GRAVEL with SILT; trace wood and slag-like material |
| | Filter Pack, 10 X 20 & 20 X 40 Colorado Silica Sand | | | | | | | Medium dense, moist, black SAND; sand fine to medium |
| | | 0 | 0 | | 3 8 11 | S-2 | | |
| | V-Wrap Well Screen 2" ID SCH 40 PVC, 0.01" slot size | | | | | | | |
| 10 | | | | | | | | |
| | 12.0' ATD | | | | | | | |
| | | 0 | 0 | | 4 7 9 | S-3 | | -wet at 12.5' |
| 15 | | | | | | | | **TIDAL MARSH DEPOSITS** |
| | | 0 | 0 | | 4 6 16 | S-4 | | Medium dense, wet, brown SAND; trace silt, trace organics, trace shell fragments; sand fine to medium; slight creosote-like odor |
| | PVC Threaded End Cap | | | | | | | |
| | | | | | | | | Bottom of exploration boring at 17.4 feet. |

Sampler Type (ST):
- 3.25" OD D & M Split-Spoon Ring Sampler
- No Recovery
- 2" OD Split-Spoon Sampler

Lab Tests:
- G - Grain Size
- P - Permeability
- M - Moisture Content

▼ Water Level (ATD) ▽ Static Water Level

Logged by: RRH
Approved by: WVG
Figure No.

SWHARBOR SWHARBOR.GPJ February 5, 2002

Aspect consulting
IN-DEPTH PERSPECTIVE

# Geologic & Monitoring Well Construction Log

| Project Number | Well Number | Sheet |
|---|---|---|
| 990106 | CMP-17 | 1 of 1 |

| | | | |
|---|---|---|---|
| Project Name | Southwest Harbor Project | Monument Elev. (ft mllw) | 18.61 |
| Location | Seattle, Washington | Water Elev. (ft mllw) | 7.3 |
| Drilling Method | Hollow Stem Auger 8" OD/4" ID ; Holt Drilling | Start Date | November 6, 2001 |
| Sampling Method | 2" Diameter, Split Spoon Sampler, 140 lb hammer | Finish Date | November 6, 2001 |

| Depth feet | Well Construction | PID (ppm) | H2S (ppm) | ST | Blows/ 6" | Sample ID | Mtl. Graphic | Description |
|---|---|---|---|---|---|---|---|---|
| | 8" Steel Monument Type C-868<br>Concrete seal<br>Bentonite chips | 0 | 0 | | 15<br>26<br>28 | S-1 | | **FILL**<br>Very dense, moist, dark brown GRAVELLY SAND; trace silt |
| 5 | Filter Pack, 10 X 20 & 20 X 40 Colorado Silica Sand | | | | | | | Dense, moist, dark brown SAND; sand fine to medium; red sand grains visible |
| | V-Wrap Well Screen 2" ID SCH 40 PVC, 0.01" slot size | 0 | 0 | | 10<br>15<br>19 | S-2 | | - 1" silt lense at 8.5' |
| 10 | 11.3' ATD | | | | | | | Medium dense, wet, dark gray SAND with silt interbeds; sand fine to medium |
| | | 0 | 0 | | 5<br>6<br>8 | S-3 | | |
| 15 | | 0 | 0 | | 5<br>6<br>6 | S-4 | | |
| | PVC Threaded End Cap | | | | | | | Bottom of exploration boring at 16.5 feet. |

Sampler Type (ST):
- 3.25" OD D & M Split-Spoon Ring Sampler
- No Recovery
- 2" OD Split-Spoon Sampler

Lab Tests:
- G - Grain Size
- P - Permeability
- M - Moisture Content

▼ Water Level (ATD) ▽ Static Water Level

Logged by: RRH
Approved by: WVG
Figure No.

SWHARBOR SWHARBOR.GPJ February 5, 2002

Aspect consulting
IN-DEPTH PERSPECTIVE

# Geologic & Monitoring Well Construction Log

| Project Number | Well Number | Sheet |
|---|---|---|
| 990106 | MW-26(R) | 1 of 1 |

| | | | |
|---|---|---|---|
| Project Name | Southwest Harbor Project | Monument Elev. (ft mllw) | 18.59 |
| Location | Seattle, Washington | Water Elev. (ft mllw) | 7.59 |
| Drilling Method | Hollow Stem Auger 8" OD/4" ID ; Holt Drilling | Start Date | November 6, 2001 |
| Sampling Method | 2" Diameter, Split Spoon Sampler, 140 lb hammer | Finish Date | November 6, 2001 |

| Depth feet | Well Construction | PID (ppm) | H2S (ppm) | ST | Blows/ 6" | Sample ID | Mtl. Graphic | Description |
|---|---|---|---|---|---|---|---|---|
| | 8" Steel Monument Type C-868 | | | | | | | **ASPHALT SURFACE** |
| | Concrete seal | | | | | | | **FILL**<br>Medium dense, damp, brown SANDY GRAVEL; sand fine to medium, gravel medium to coarse |
| | Bentonite chips | 0 | 0 | | 5<br>10<br>6 | S-1 | | Medium dense, damp, brown SAND; sand fine to medium |
| 5 | Filter Pack, 10 X 20 & 20 X 40 Colorado Silica Sand | | | | | | | -trace shell fragments in cuttings |
| | V-Wrap Well Screen 2" ID SCH 40 PVC, 0.01" slot size | 0 | 0 | | 3<br>6<br>5 | S-2 | | -grades to wet at 9' |
| 10 | 11.0' ATD | | | | | | | |
| | | 0 | 0 | | 4<br>7<br>17 | S-3 | | **TIDAL MARSH DEPOSITS**<br>Medium dense, wet, dark gray to brown SILTY SAND with SILT interbeds; trace organics, trace shells |
| 15 | | 0 | 0 | | 5<br>6<br>5 | S-4 | | -grades to loose at 16' |
| | PVC Threaded End Cap | | | | | | | Bottom of exploration boring at 17 feet. |

Sampler Type (ST):
- 3.25" OD D & M Split-Spoon Ring Sampler
- No Recovery
- 2" OD Split-Spoon Sampler

Lab Tests:
- G - Grain Size
- P - Permeability
- M - Moisture Content

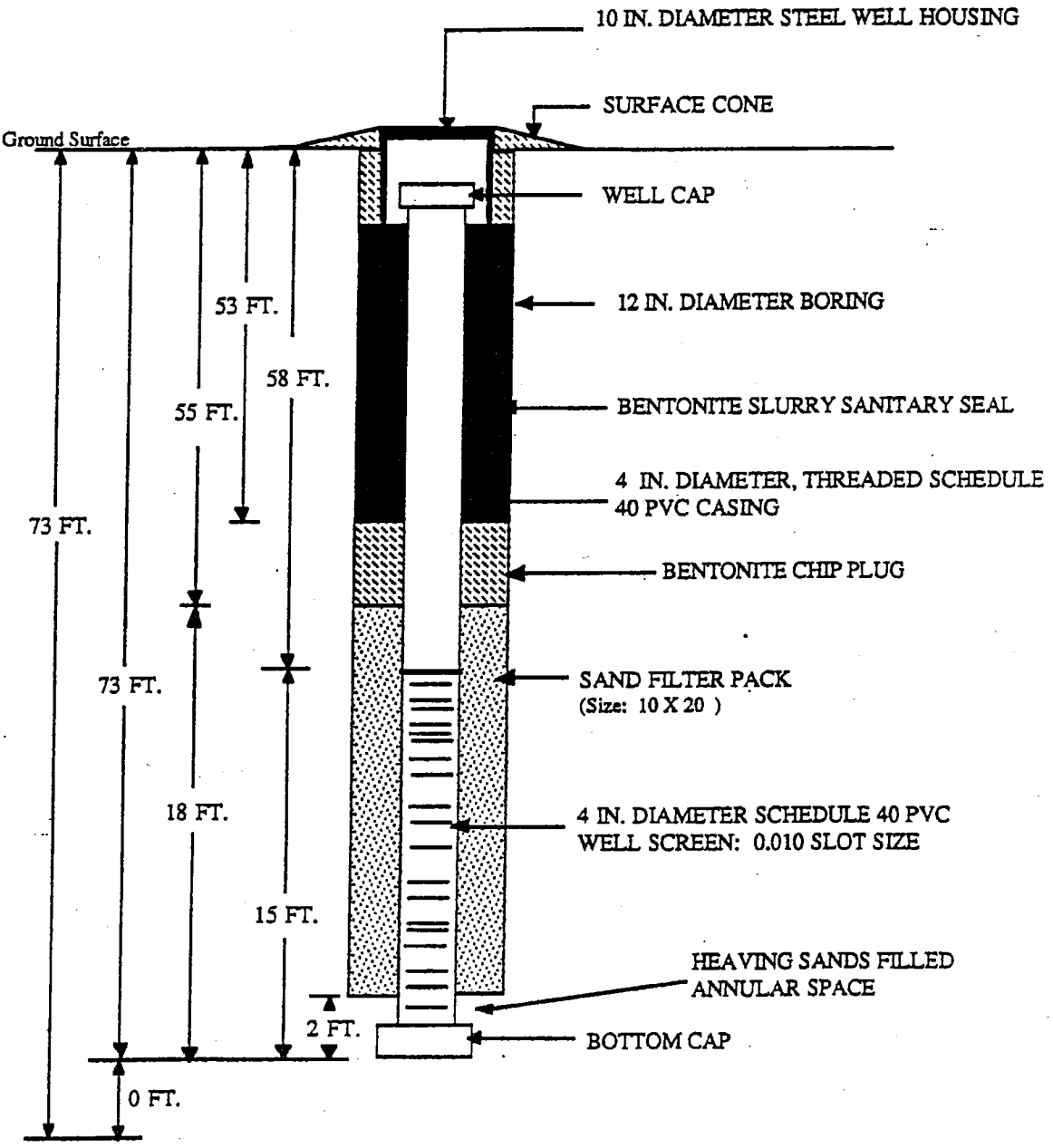
▼ Water Level (ATD) ▽ Static Water Level

Logged by: RRH
Approved by: WVG
Figure No.

SWHARBOR SWHARBOR.GPJ February 5, 2002

NOT TO SCALE

Top of Casing Elevation:




| | | |
|---|---|---|
| enviro | Well MW36 Completion Diagram<br>Date Well Completed: 7/8/90<br>Geologist/ Engineer: M. S. SUROWIEC<br>Job Name: POS/ Lockheed Yard 2 | Figure<br>C-39A |
| Job No. 900625 Appr MES Date: 1/8/90 | | |

# Log of Boring MW44

DRAFT

| Analytical Results | Blow Count | Sample Recovery (%) | Depth (ft) | Soil Profile | USCS Symbol | Soil Description | PID/ Remarks |
|---|---|---|---|---|---|---|---|
| MW44-0.5 ft. WTPH-418.1 | 4,6, 12 | 90 | 0 | | | ASPHALT, 6 inches. | 4.2 ppm |
| | | 90 | | | SP | Loose to medium dense, brown, fine SAND: laminated in places; trace silt; dry; no sign of contamination. (Hydraulic Fill) | no odors |
| | 2,4,6 | 90 | 5 | | | - occasional shell fragments and charcoal. | |
| MW44-5 ft. WTPH-418.1 | 5,6,6 | 90 | | | | - 2 inch bed of shell fragments and stony debris (slag?); moist. | 3.4 ppm |
| | 5,4,4 | 90 | | | | | |
| | 3,3,3 | 90 | | | | - dark gray, wet, slightly brackish odor. | slight odor |
| MW44-10 ft. WTPH-418.1 | 2,4,5 | 90 | 10 | | SP/ ML | Loose, dark gray, silty, fine SAND and SILT: laminated and bedded; minor shell fragments; plant fibers along laminae, 6" reedy bed at 10.5; wet. (Tidal Marsh soil) | 1.8 ppm slight sulfur odor |
| | 7,6,7 | 90 | | | | | |
| | 2,2,3 | 90 | | | | | |
| MW44-15 ft. WTPH-418.1 | 1,1,1 | 15 | 15 | | SP | Very loose, dark gray, fine SAND. (Fluvial Deltaic soil) | no odor |
| | 2,4,4 | 90 | | | ML | Soft, dark gray SILT: laminated; occasional reeds; wet. | no odor |
| | 2,2,2 | 90 | | | CL | Soft to medium stiff, dark gray, Clayey SILT: laminated; wet; peaty debris on laminae; occasional shell fragments; sandy beds toward base. | 2.7 ppm slight sulfur odor |
| | 2,2,5 | 90 | 20 | | | | |
| | 2,3,3 | 60 | | | SP | Very loose to medium dense, dark gray, fine SAND: laminated with occasional thin clayey silt interbeds;shell fragments and/or plant debris in places. (Fluvial Deltaic soils) | |
| | 3,4,5 | 90 | | | | | 2.4 mm Background: 0.0 ppm below 25'. |
| | 3,5 | 90 | 25 | | | - 4" clayey silt interbed at 24 feet. | no odor |
| MW44-25 ft. WTPH-418.1 | 4,4,4 | 90 | | | | | 0.0 ppm |
| | 2,3,2 | 80 | | | | - 4" clayey silt interbed. | slight sulfur odor |
| | 1,1,1 | 90 | | | | | |
| | 2,1,1 | 60 | 30 | | | | 0.0 ppm |
| | 3,6,1 | 90 | | | CL | Soft, green gray, Clayey SILT: laminated, with soft sediment deformation. | slight sulfur odor |
| | 3,8,11 | 90 | | | SP | Loose to medium dense, dark gray, fine SAND: laminated; occasional silt laminae, shells, plant debris; wet; no sign of contamination. (Fluvial Deltaic beds) | |
| | 11,17, 22 | 90 | 35 | | | | |
| | 13,15, 16 | 90 | | | | - silt laminae with soft sediment deformation. | |
| | 8,11, 14 | 90 | | | | - peaty layer | no odor |
| | 8,11,9 | 90 | | | | - shell fragments | 0.0 ppm |
| | | | 40 | | | (continues on page 2) | |

*enviros*

Job No.900819 Task 15.3 Appr.: Date:

Date Drilled: 6-23-92
Geologist/Engineer: S.H. Evans
Equipment: 6" i.d. Hollowstem Auger
Ground Water Level When Drilling: 9.5 feet
Project Name: Southwest Harbor Project

A-

# Log of Boring MW44 (cont.)

15' screen 58' – 73'

DRAFT

| Analytical Results | Blow Count | Sample Recovery (%) | Depth (ft) | Soil Profile | USCS Symbol | Soil Description | PID/ Remarks |
|---|---|---|---|---|---|---|---|
| | | | 40 | | | (continued from page 1) | |
| | 4,4,4 | 90 | | | CL | Soft, green gray to dark gray, Clayey SILT: laminated; occasional sand beds, shell fragments, soft sediment deformation; no evidence of contamination. (Fluvial Deltaic soil) | 0.0 ppm no odor transitional sequence |
| | 2,3,5 | 70 | | | | | |
| | 3,3,3 | 90 | | | | | |
| MW44-45 ft. WTPH-418.1 | 2,2,2 | 100 | 45 | | | - very dark gray bands. Interval sampled. | 0.0 ppm |
| | 1,2,3 | 90 | | | | - increasing sand interbeds. | |
| | 3,2,5 | 90 | | | SP/ CL | Loose and soft, interbedded, dark gray and dark green gray, fine SAND and Clayey SILT: shell fragments, peaty debris; wet; no sign of contamination. (Fluvial Deltaic soil) | slight sulfur odor |
| | 5,6 | 90 | 50 | | | | no odor |
| MW44-50 ft. WTPH-418.1 | 3,2,5 | 90 | | | | | 0.0 ppm slight sulfur odor |
| | 1,2,4 | 90 | | | | | |
| | 4,7,7 | 90 | | | | - clam shells and peaty laminae. | |
| | 3,4,6 | 90 | 55 | | | | |
| | 3,5,9 | 80 | | | SP | Loose to medium dense, dark gray, fine SAND: occasional clayey silt laminae; peaty plant debris; no sign of contamination. (Fluvial Deltaic soil) | no odor |
| | 5,9,9 | 90 | | | | | |
| | 3,5,5 | 90 | 60 | | | - 2" peaty silt bed at 59.5'. | |
| | 3,4,4 | 70 | | | SM | Loose, dark gray, Silty fine SAND and SILT: wood debris at top; clayey laminae; occasional peaty material; no sign of contamination. (Fluvial Deltaic soil) | no odor slight sulfur odor |
| | 3,4,4 | 90 | | | | | |
| | 3,3,3 | 90 | 65 | | | | |
| MW44-65 ft. Acid/Base/Nutral | 4,5,8 | 90 | | | SP | Medium dense to loose, dark gray, fine SAND: clean; laminated; wet; no sign of contamination. (Fluvial Deltaic beds) | no odor |
| | 7,6,8 | 90 | | | | - thin silt beds. | |
| | 3,3,3 | 0 | 70 | | | | |
| | 1,2,3 | 0 | | | | | |
| | 2,2,3 | 5 | | | | | no odor |
| | 4,4 | 60 | 75 | | | - occasional shell fragments | |
| MW44-75 ft. WTPH-418.1 | 3,2,4 | 5 | | | | | |
| | | | 80 | | | Total Depth: 78.5 feet Note: sample interval at approximately 68 feet overdrilled. Sand pack on well squeezed by native soil after removal of auger, pushing sand up to 58 feet. | Background: 0.0 ppm |

screen 58' – 73'

**enviros**

Job No. 900819 Task 15.3 Appr.: Date:

Date Drilled: 6-23-92
Geologist/Engineer: S.H. Evans
Equipment: 6" i.d. Hollowstem Auger
Ground Water Level When Drilling: 9.5 feet
Project Name: Southwest Harbor Project

A-

# Well Installation
(Above Grade)

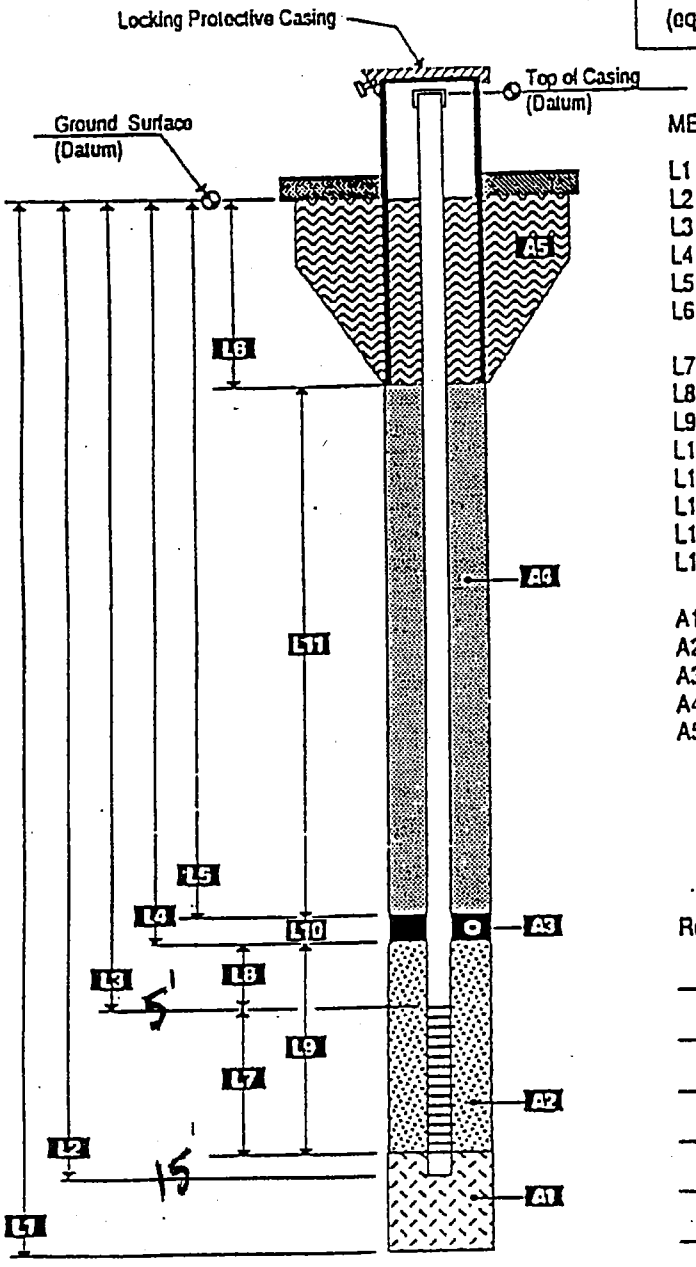
Well No. MW-125

Page 1 of 1

URS Consultants, Inc.

| Client | Project SWH RA-1 | Site | Zone |
|---|---|---|---|
| Location MW-125 | Well Owner Port | Supervised by (company) Terra | Installed by (company) Ramlo |
| Date Started 5-13-94 | Date Completed 5-13-94 | Formation at Completion | Screen Zone |

Ground Surface Elevation _____ feet MSL
(minus) Top of Casing Elevation _____ feet MSL
(equals) Well Stickup _____ feet




MEASUREMENTS IN FEET

| | | | |
|---|---|---|---|
| L1 | Total Borehole depth | 16.5 | feet (BGS) |
| L2 | Casing depth | 15 | feet (BGS) |
| L3 | Depth to top of screen | 5 | feet (BGS) |
| L4 | Depth to filter material | 3 | feet (BGS) |
| L5 | Depth to seal material | 3 | feet (BGS) |
| L6 | Depth to backfill material | 2 | feet (BGS) |
| L7 | Screen length | 10 | feet |
| L8 | Height of filter above screen | 2 | feet |
| L9 | Thickness of filter material | 12 | feet |
| L10 | Thickness of seal material | 2 | feet |
| L11 | Thickness of backfill material | | feet |
| L12 | Casing Stickup | 0 | feet |
| L13 | Borehole Diameter | 10 | inches |
| L14 | Casing Diameter | 2 | inches |

| | | |
|---|---|---|
| A1 | Backfill material | Native |
| A2 | Filter material | 10-20 Silica Sand |
| A3 | Seal material | Bentonite Chips |
| A4 | Annular Seal material | — |
| A5 | Surface seal material | Concrete |

Screen Slot Size 0.010
Depth to Water 7.6

Remarks
Sand - 6 bags
Bentonite - 1 bags
Concret - 2 bags

s/s centralizer on screen

| Recorded By | Checked By | Date |
|---|---|---|
| CRL | | 7-10-94 |

10/21/93

| Project: PORT OF SEATTLE<br>Project Location: - SEATTLE, WA<br>Project Number: 93C0423 | Log of Boring MW308A(N)<br>Sheet 1 of 1 Fill Aq. |
|---|---|

| | | | | | |
|---|---|---|---|---|---|
| Date(s) Drilled | 4/5/94 | Logged By | K. GOFFMAN | Checked By | G. DAVIS |
| Drilling Method | 8"OD 4"ID HOLLOW STEM AUGER | Top of PVC Elevation (feet) | 14.7 | Total Depth Drilled (feet) | 21.5 |
| Drill Rig Type | MOBILE B-61 | Drilled By | TACOMA PUMP AND DRILLING | Hammer Weight/ Drop (lbs/in.) | 140#/30" |
| Groundwater Level (ft bgs) | 8 | Sampler Type | SPLIT SPOON | Approx. Surface Elevation (feet) | 15.4 |
| Diameter of Hole (inches) | 8 | Diameter of Well (inches) | 2 | Type of Well Casing | SCH 40 PVC | Screen Perforation | .02" (12.5'-17.5') |
| Type of Sand Pack | 10/20 SILICA SAND | Type/Thickness of Seal(s) | CONCRETE / 0-2' BENTONITE / 2-10' | | |
| Comments | | | | | |

| Depth, feet | Elevation, feet | SAMPLES Type | SAMPLES Number | SAMPLES Blow Count | Graphic Log | MATERIAL DESCRIPTION | Well Completion Log | SAMPLES Recovery % | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 15 | | | | | Asphalt | | | |
| | | | | | | Loose medium to fine SAND (SP), little silt, black, damp, sand has white, red grains | | | |
| 5 | 10 | X | 1 | 19 | | | | 100 | |
| | | | | | | | | | Initial GW contact |
| 10 | 5 | X | 2 | 13 | | Few silt layers, little organic material, wet | | 90 | |
| | | X | 3 | 50/3" | | | | 90 | |
| 15 | 0 | X | 4 | 47 | | Stiff fine sandy SILT (SM), black, wet, some organic material; thin interbeds ("2") of above sand | | 100 | |
| | | | | | | Loose medium to fine SAND (SP), little silt, black, wet, some organic material (wood) | | | |
| | | | | | | Stiff clayey to fine sandy SILT (SM), dark grey, wet | | | |
| | | X | 5 | 14 | | Loose, medium to fine SAND (SP), little silt, black, wet, with some organic debris (wood) | | | |
| 20 | -5 | X | 6 | 51 | | Stiff fine sandy SILT (SM), dark gray to black, wet, | | | |
| | | | | | | Loose medium to fine SAND (SP), little silt, black, wet, with some organic debris (wood) | | | |
| | | | | | | Stiff fine sandy SILT (SM), dark grey to black, wet | | | |
| | | | | | | Loose medium fine SAND (SP), little silt, black, wet | | | |
| 25 | | | | | | Boring terminated at 21.5 ft bgs. | | | |

**Project:** PORT OF SEATTLE
**Project Location:-** SEATTLE, WA
**Project Number:** 93C0423

# Log of Boring MW308B(5)

Sheet 1 of 2 EST. AQ.

| | | | | | |
|---|---|---|---|---|---|
| Date(s) Drilled | 4/4/94 | Logged By | K. GOFFMAN | Checked By | G. DAVIS |
| Drilling Method | 8"OD 4"ID HOLLOW STEM AUGER | Top of PVC Elevation (feet) | 14.5 | Total Depth Drilled (feet) | 40.0 |
| Drill Rig Type | MOBILE B-61 | Drilled By | TACOMA PUMP AND DRILLING | Hammer Weight/ Drop (lbs/in.) | 140#/30" |
| Groundwater Level (ft bgs) | 7.5 | Sampler Type | SPLIT SPOON | Approx. Surface Elevation (feet) | 15.5 |
| Diameter of Hole (inches) | 8 | Diameter of Well (inches) | 2 | Type of Well Casing | SCH 40 PVC | Screen Perforation | .02" (35'-40') |
| Type of Sand Pack | 10/20 SILICA SAND | Type/Thickness of Seal(s) | CONCRETE / 0-2' BENTONITE / 2-31' | | |
| Comments | | | | | |

| Depth, feet | Elevation, feet | SAMPLES Type | SAMPLES Number | SAMPLES Blow Count | Graphic Log | MATERIAL DESCRIPTION | Well Completion Log | SAMPLES Recovery % | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 15 | | | | | Asphalt | | | |
| | | | 1 | 70 | | Very dense, medium to fine SAND (SP), little coarse sand, some silt, black to dark gray, damp | | 100 | Silt decreasing downward, trace at base of sampler |
| 5 | 10 | | | | | Silt decreasing | | | |
| | | | 2 | 5 | | Fine to medium SAND (SP), trace silt, black, wet, some wood fragments | ▽ | 90 | Initial GW contact |
| 10 | 5 | | | | | Sand has white and red grains | | 100 | |
| | | | 3 | 28 | | Medium dense fine sandy SILT (SM), some shell fragments, black, wet | | | |
| 15 | 0 | | | | | Medium dense, fine to medium SAND (SP), trace silt, black, wet; sand has white and red grains | | 50 | |
| | | | 4 | 15 | | Very stiff SILT (SM), little fine sand, black, wet, with shell fragments, (interbeds of sand and silt) | | | |
| 20 | | | | | | | | | |

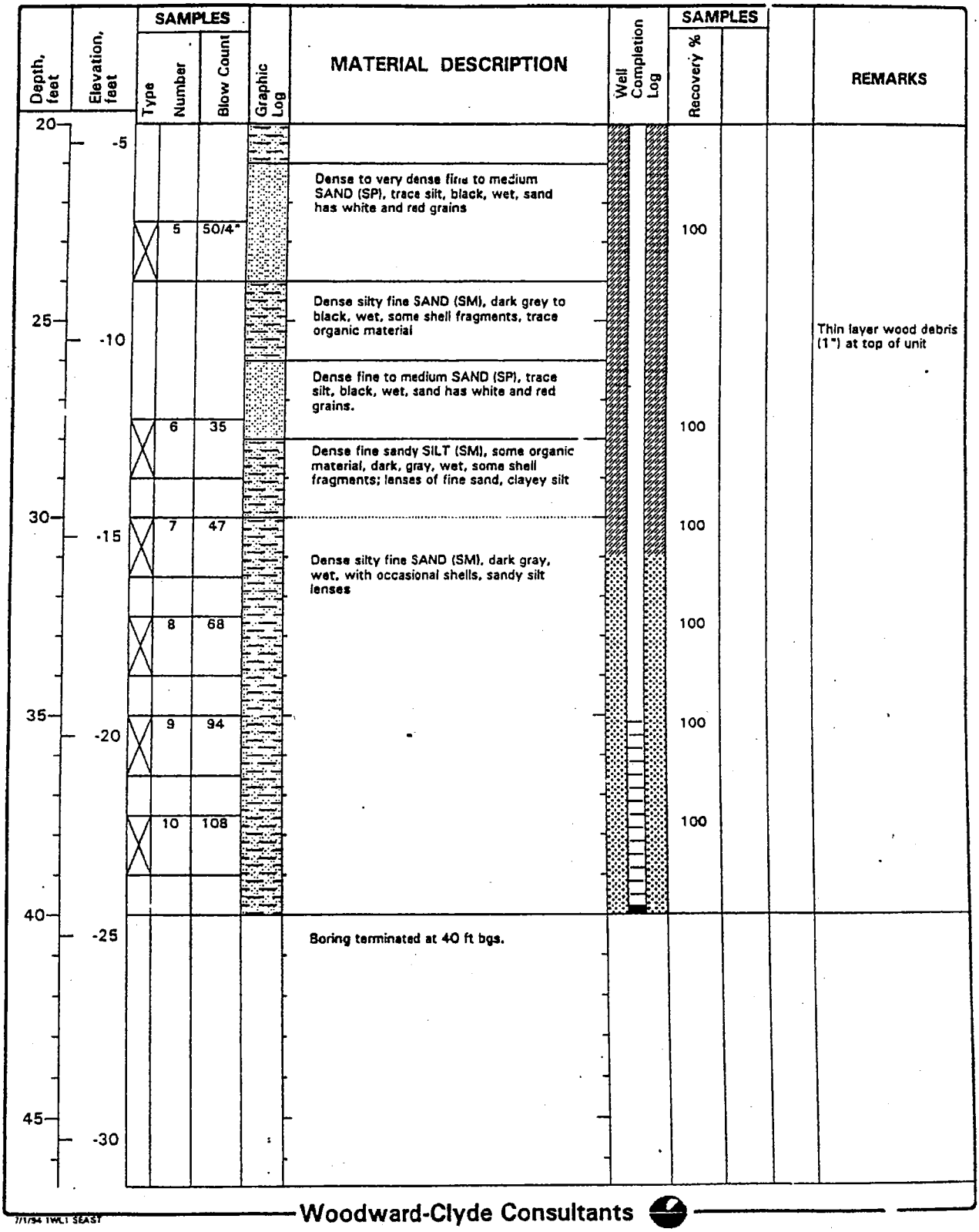
Woodward-Clyde Consultants

7/1/94 1WL1 SEA.ST

Project: PORT OF SEATTLE
Project Location: SEATTLE, WA
Project Number: 93C0423

# Log of Boring MW308B(S)

Sheet 2 of 2




Woodward-Clyde Consultants

7/1/94 1WL1 SEAST

# Converse NW

## Geologic & Monitoring Well Construction Log

| Project Number | Well Number | Sheet |
|---|---|---|
| 92-35175 | FM-105 | 1 of 1 |

Project: ALKI CSO
Location: SW Spokane St
Elevation (Top of Well Casing):
Surface Elevation: 115
Water Level Elev.: 106
Start Date: September 28, 1992
Drilling Method: Hollow Stem Auger
Finish Date: September 29, 1992
Sampler/Driving Weight: SPT 140lb /R 300lb

| Depth feet | Well Construction | Other Tests | ST | Blows/12" | Moisture/Density | Description |
|---|---|---|---|---|---|---|
| | flush mount steel monument | | | | | FILL |
| | concrete surface seal | | | 22 | | SAND; mottled gray-brown, fine to medium, little gravel, clayey silt lumps with few gravel clasts; medium dense, slightly moist |
| | bentonite chip seal | | | | | |
| | 2" ID schedule 40 PVC riser | | | 9 | | GRAVEL; olive-brown, with fine sand matrix, scattered clay lumps; loose, slightly moist |
| 5 | | | | 9 | | SILT; olive-gray, few fine sand, few gravel, wood fragments; stiff, slightly moist |
| | 10/20 silica sand | | | | | SAND; dark brown, fine to medium, few coarse; very loose, wet |
| | | | | 3 | | |
| | 12/23/92 | | | | | |
| 10 | | G | | 2 | 21 / 95 | wood fragments, gray mottled clay lumps |
| | | | | | | gray, few fine to coarse gravel clasts |
| | 2" ID 0.010" slot, schedule 40 PVC | | | 2 | | dark gray to black, little silt, few wood fragments |
| 15 | | | | | | |
| | | | | | | SILT; dark gray to black, little fine sand, wood fragments; very loose, wet |
| | PVC bottom cap | FM-105 | | 2 | | drive shoe has pitch black silt with medium strong petroleum/tar odor (0ppm) with charcoal lump |
| | native backfill | | | | | |
| 20 | | | | | | Bottom of boring at depth 19 feet. Piezometer installed to depth 17 feet.<br>Composite soil sample (FM-105-C) collected from 0-10 feet.<br>Less than 1 ppm total organic vapors detected by OVM field screening of each soil sample. |

ST - Sampler Type:
- 2" OD Split Spoon Sampler (SPT)
- Grab Sample

Lab Tests:
- Ch - Chemical Properties

(Sample I.D. Number)

Logged by: CJP
Approved by: VJP

## Table B.1 - Summary of GWCMP Monitoring Network

SWHP Phase II GWCMP

| Well Identification | Aquifer Unit | Installation Date | Total Boring Depth (feet bgs) | Screen Interval Depth (feet bgs) | General Site Location and Monitoring Purpose |
|---|---|---|---|---|---|
| CMP-1 | Fill | 9/19/2001 | 19 | 7 to 17 | Upgradient of RA-2. |
| CMP-2 | Fill | 9/18/2001 | 19 | 7 to 17 | Upgradient of RA-2. |
| CMP-3 | Fill | 9/19/2001 | 17.5 | 6 to 16 | Downgradient of RA-2. |
| CMP-4 | Fill | 9/18/2001 | 17.5 | 7 to 17 | Upgradient of RA-1, downgradient of RA-3. |
| CMP-5 | Fill | 10/29/2001 | 19 | 5 to 15 | Upgradient of RA-3. |
| CMP-6 | Fill | 9/18/2001 | 17.5 | 7 to 17 | Downgradient of RA-1 and RA-3, paired with Estuarine Aquifer well CMP-7. |
| CMP-8 | Fill | 9/18/2001 | 19 | 7 to 17 | Downgradient of RA-1 and RA-3. |
| CMP-9 | Fill | 9/18/2001 | 19 | 7 to 17 | Downgradient of RA-1 and RA-3. |
| CMP-10 | Fill | 9/19/2001 | 16.5 | 5 to 15 | Downgradient of RA-1, RA-3, and RA-4. |
| CMP-11 | Fill | 9/17/2001 | 19 | 6 to 16 | Downgradient of RA-1 and RA-3, LFOL north-south transect well. |
| CMP-12 | Fill | 9/17/2001 | 19 | 6 to 16 | Downgradient of RA-1 and RA-3, LFOL north-south transect well. |
| CMP-13 | Fill | 9/17/2001 | 19 | 6 to 16 | Downgradient of RA-1 and RA-3, LFOL north-south transect well. |
| CMP-14 | Fill | 11/5/2001 | 17 | 6.5 to 16.5 | Downgradient of RA's 1, 3, and 4, paired with Estuarine Aquifer well MW-36. |
| CMP-15 | Fill | 11/5/2001 | 17.4 | 7 to 17 | Downgradient portion of RA-5. |
| CMP-16 | Fill | 11/5/2001 | 17 | 6.2 to 16.2 | Downgradient portion of RA-5. |
| CMP-17 | Fill | 11/6/2001 | 16.5 | 6 to 16 | Downgradient of RA-1. |
| CMP-18 | Fill | 4/2/2003 | 19 | 7 to 17 | In old Terminal 5 Area, downgradient of RA's 1, 2, and 3. |
| CMP-19 | Fill | 4/2/2003 | 19 | 7 to 17 | In old Terminal 5 Area, downgradient of RA's 1, 3, and 4. |
| CMP-20 | Fill | 4/2/2003 | 19 | 7 to 17 | In old Terminal 5 Area, downgradient of RA's 1, 3, and 4. |
| MW-26R | Fill | 11/6/2001 | 17 | 6.5 to 16.5 | Downgradient of RA-5, paired with Estuarine Aquifer well MW-44. |
| MW-5 | Fill | 8/3/1989 | 25 | 5 to 25 | Downgradient of RA-5. |
| MW-125 | Fill | 5/13/1994 | 16.5 | 5 to 15 | Downgradient of RA-1. |
| MW-307A | Fill | 4/7/1994 | 26.5 | 15 to 20 | Cross/downgradient of RA-3, paired with MW-307-B, LFOL north-south transect well. |
| MW-308N | Fill | 4/5/1994 | 21.5 | 12.5 to 17.5 | Downgradient of RA-1 and RA-3, paired with Fill Aquifer well MW-308-S. |
| FM-105 | Fill | 9/29/1992 | 19 | 7 to 17 | |
| CMP-7 | Estuarine | 11/7/2001 | 49 | 37 to 47 | Downgradient of RA-1 and RA-3, paired with Fill Aquifer well CMP-6. |
| MW-307BR | Estuarine | 11/9/2001 | 40 | 29 to 39 | Downgradient of RA-3, paired with Estuarine Aquifer well MW-307A. |
| MW-36 | Estuarine | 7/8/1990 | 73 | 58 to 73 | Downgradient of RA-1 and RA-3, cross/downgradient of RA-4, upgradient of RA-5, paired with MW-8. |
| MW-44 | Estuarine | 6/23/1992 | 78.5 | 59 to 74 | Downgradient in RA-5, paired with Fill Aquifer well MW-26. |
| MW-308S | Estuarine | 4/6/1994 | 40 | 35 to 40 | Downgradient of RA-1 and RA-3, paired with Estuarine Aquifer well MW-308-N. |

Upgradient Phase II Monitoring Well

Downgradient Phase II Monitoring Well

# APPENDIX C

# Phase II Quality Assurance Project Plan (QAPP)

# C.1 QAPP

This QAPP establishes quality assurance objectives for the Phase II GWCMP to be conducted at the Port of Seattle's Southwest Harbor Project site at Terminal 5, in Seattle. This plan also presents the QA organization and quality control (QC) procedures developed to meet the project objectives. The project QA objectives are presented as data quality objectives (DQOs), and are measured by data quality indicators (DQIs) described and quantified herein.

The goal of this QAPP is to provide a quantified degree of confidence in the project data by establishing a system of quality and performance checks on data collection, analysis, and reporting activities, and a mechanism of appropriate and timely corrective action to achieve compliance with established performance and quality criteria.

## C.1.1 Data Quality Objectives

The overall DQO for the Phase II GWCMP is to establish confidence that monitoring data are of known, appropriate, and sufficient quality to support their intended use, which is to verify the expected protectiveness of the SWHP remedial actions with respect to surface water quality at the points of groundwater discharge to Elliot Bay and the West Waterway. To accomplish this goal, project data should be technically sound, statistically valid, and properly documented, having been evaluated against established criteria for the principal DQIs of precision, accuracy, representativeness, completeness, and comparability.

Definitions of the DQIs and the limits and/or goals assigned to each are provided in the next section of this QA Plan. Sections C.1.3 and C.1.4 describe field and laboratory procedures, respectively, that will provide for, and allow assessment of, the DQIs, and therefore the project DQOs. Section C.1.5 discusses routine Data Validation for this project, and Section C.1.6 identifies Corrective Actions to be undertaken to restore data quality should the results of data validation indicate such a need.

## C.1.2 Data Quality Indicators

Quality control procedures provide the means of controlling the precision and bias of the results. Adherence to established procedures for sample collection, preservation, and storage will reduce errors due to sampling and sample instability. Analytical and measurement systems must be in control, which means that errors have been reduced to acceptable levels and then documented.

The following DQIs will be used to verify that the Phase II data are of acceptable quality. Table C.1 provides a tabulation of these DQIs and their associated quality assurance/control limits.

### C.1.2.1 Precision

Precision measures the scatter in the data resulting from random error, and is a quantitative measure of the variability of a group of measurements compared to their average values. Analytical precision is measured through matrix spike/matrix spike duplicate (MS/MSD) samples, laboratory duplicates, and field duplicate samples.

The results from the matrix spikes and matrix spike duplicate, laboratory duplicate, and field duplicate analyses will be used to determine the relative percent difference (RPD) between the pair of analyses. This is a measure of analytical precision and can be calculated as:

$$RPD = 100 \times \frac{(C_1 - C_2)}{(C_2 - C_2)/2}$$

where

| | | |
|---|---|---|
| $RPD$ | = | relative percent difference |
| $C_1$ | = | larger of the two observed values |
| $C_2$ | = | smaller of the two observed values |

Laboratory precision will be evaluated against the RPD performance criteria presented in Table C.1.

Currently, few performance criteria have been established for field duplicates. Field duplicate precision will be screened against a RPD of 30 percent for water samples, as recommended by USEPA Region I. If the field-duplicate results indicate a RPD of greater than 30 percent, potential sources of error in the sampling and analysis program will be evaluated and corrected.

### C.1.2.2 Accuracy (Bias)

Accuracy measures the closeness of the measured value to the true value. Accuracy depends in part on the correct choice of monitoring tools and procedures to minimize sample disturbance from collection to analysis. Analytical accuracy is assessed by "spiking" samples with known standards (surrogates or matrix spikes) and establishing the percent recovery. Surrogate recoveries will be determined for every sample analyzed for organics. For spiked samples, the percent recovery (%R) can be used as the measure of accuracy as

$$\%R = 100 \times (S - U)/C_{sa}$$

where

| | | |
|---|---|---|
| $\%R$ | = | percent recovery |
| $S$ | = | measured concentration in the spiked aliquot |
| $U$ | = | measured concentration in the unspiked aliquot |
| $C_{sa}$ | = | actual concentration of spike added |

Laboratory accuracy will be evaluated against quantitative matrix spike and surrogate spike recovery performance criteria presented in Table B-1.

### C.1.2.3 Representativeness, Completeness, and Comparability

Representativeness measures how closely the measured results reflect the actual concentration or distribution of the chemical compounds in the matrix sampled. The sampling plan design, sampling techniques, and sample handling procedures (e.g., storage, preservation, and transportation) have been developed to assure representative samples.

Measurement of completeness (C) can be defined as the ratio of acceptable (non-rejected) measurements obtained to the total number of measurements for an activity. Completeness can be defined as

$$C = 100 \times \frac{N_a}{N_t}$$

where

| | | |
|---|---|---|
| *Na* | = | number of acceptable data points |
| *Nt* | = | total number of data points |

The Q/A objectives for representativeness, completeness, and comparability will be achieved by:

- Collecting representative samples.
- Implementing standardized and uniform field and laboratory procedures.
- Collecting field equipment blanks for non-dedicated/disposable equipment and analyzing laboratory blanks to verify that the analytical results are representative of the sampled medium and not influenced by cross-contamination.
- Reporting data in conventional and standard units.

## C.1.3 Field Quality Control Samples

### C.1.3.1 Field Documentation

Accurate documentation of field activities will be maintained using field log-books, field forms, correspondence forms, and photographs. Entries will be made in sufficient detail to provide an accurate record of field activities without reliance on memory.

Field log entries will be dated and include a chronological description of task activities, names of individuals present, names of visitors, weather conditions, etc. When photographs are taken, the project number, date, picture number, and description of the photograph will be entered on a photograph log.

### C.1.3.2 Field QC Samples

Field duplicates will be collected from approximately 10 percent of the sample population, with a minimum of one field duplicate per sampling event, for each analyte in the whole of the sampling event. The field duplicate will be submitted as a blind duplicate with a unique sample identifier.

If non-dedicated sampling equipment is used, one equipment rinsate blank sample will be collected during each day of sampling. Rinsate blanks are samples of deionized water collected from the sampling equipment after the equipment has been decontaminated.

Trip blanks are samples of contaminant-free water prepared by the laboratory that are shipped with the sample bottles from the lab and remain with the samples during sampling and transport to the lab. One trip blank will be submitted for each set of samples shipped to the laboratory for volatile organic chemical analyses.

### *C.1.3.3 Field Preventative Maintenance*

The equipment used for measuring each parameter during well purging and sampling will be calibrated according to the manufacturer's instructions prior to use each day and every 4 hours afterward. Periodic schedules for preventative maintenance of instruments, including meter testing, parts replacement, and general cleaning will be followed according to the manufacturer's recommendations.

## C.1.4 Laboratory Quality Control Procedures

The laboratories' quality control officer is responsible for assuring that all routine internal quality assurance and quality control procedures are implemented by the laboratory. The laboratory quality control procedures used for this project will consist of the following, at a minimum:

- Instrument calibration and standards as defined in EPA SW-846;
- Laboratory blank measurements;
- Accuracy and precision measurements as defined above; and
- Reporting limits that are adequate to identify target analytes and to compare groundwater sample data to applicable surface water screening levels.

Table 4.1 of the main document provides a tabulation of laboratory reporting limit goals.

Table C.1 summarizes the quality assurance control limits to which the laboratory will conform.

Initial data reduction, evaluation, and reporting at the laboratory will be carried out as described in the appropriate analytical protocols and the laboratory's QA Manual.

### *C.1.4.1 Laboratory QC Samples*

Internal laboratory quality control samples will be analyzed at the rates specified in the applicable analytical methods; these control samples are expected to consist of the following:

- Laboratory Blanks. Laboratory blanks shall be run and reported at a frequency of one per 20 samples (one per batch if less than 20 samples are submitted). All project sample results shall be cross-referenced to the corresponding laboratory blank sample in the laboratory reports.
- Matrix Spike Samples. Matrix spike samples, and duplicates, will be processed by the lab for all organic and inorganic analyses, at a frequency of one per 20

samples (one per batch if less than 20 samples are submitted). All project sample results shall be cross-referenced to the corresponding matrix spike sample(s). The report will indicate what samples were spiked, the spike concentration, the spiked sample result, the associated percent recovery(ies), and how this compares to project's control limits (Table C.1) for matrix spike results for each method and matrix.

- Laboratory Duplicates and/or Matrix Spike Duplicates. Relative percent differences will be reported for all duplicate pairs and will be reported relative to the project control limits noted in Table C.1.
- Laboratory Control Samples (LCS). When run for internal quality control, LCS results will be reported with and cross-referenced to the corresponding sample data. Control limits for LCS will be reported as specified in the analytical method.

The laboratory will notify the Aspect project manager if any of the samples require re-analysis due to: 1) poor precision, 2) calibration range exceedance, 3) sample matrix interference, or 4) instrument error. Qualifications of data based on "matrix interferences" will not be acceptable without thorough backup documentation.

### *C.1.4.2 Laboratory Preventative Maintenance*

Preventative maintenance in the laboratory will be the responsibility of the laboratory personnel and analysts. This maintenance includes routine care and cleaning of instruments, and inspection and monitoring of carrier gases, solvents, and glassware used in analyses. Details of the maintenance procedures are addressed in the respective laboratory's Standard Operating Procedures and Methods manuals.

Precision and accuracy data are examined for trends and excursions beyond control limits to determine evidence of instrument malfunction. Maintenance will be performed when an instrument begins to change as indicated by the degradation of peak resolution, shift in calibration curves, decrease in sensitivity, or failure to meet one or another of the method-specific quality control criteria.

## C.1.5 Data Validation

After receipt of the laboratory reports, the data will be validated in general accordance with EPA's National Functional Guidelines for inorganic and organic analytes (EPA 1999, 2001, and 2004). Each validation will include evaluations of the following, as appropriate to the particular analysis:

- Completeness of sample custody records;
- Verification that holding times were met;
- Assessment of any reported method blank contamination;
- Verification that reporting limits were met;
- Assessment of field and laboratory duplicate precision;
- Assessment of matrix spike and surrogate accuracy; and
- Verification of the completeness of the data set.

The data validator will report all laboratory results together with any data qualifier flags assigned after data validation in a format suitable for uploading into the data management database as described in Appendix D. A narrative report shall accompany each data validation deliverable. That narrative report shall identify all data validation review steps that were performed and discuss all assigned data qualifier flags, the basis for their assignment, and implications for data usability.

## C.1.6 Corrective Action

If routine data validations result in detection of unacceptable conditions or data, the Aspect project manager will be responsible for implementing procedures to correct these conditions. Potential corrective actions are outlined in each respective EPA method used and include but are not limited to the following:

- Identifying the source of the violation;
- Re-analyzing samples if holding time criteria permit;
- Resampling and analyzing;
- Evaluating and amending sampling and analytical procedures; and/or
- Accepting data and flagging to indicate the level of uncertainty.

## Table C.1 Phase II GWCMP Data Quality Indicators

SWHP Phase II GWCMP

| Data Quality Indicator | Measurement | Frequency | Limits |
|---|---|---|---|
| Precision | Matrix Spike Duplicate | 1 per batch (or 1 per 20 samples) | RPD ≤ 5 |
| | Laboratory Duplicate | 1 per batch (or 1 per 20 samples) | RPD ≤ 5 |
| | Field Duplicate | 1 per batch (or 1 per 20 samples) | RPD ≤ 5 |
| Accuracy | Matrix Spike Samples | 1 per batch (or 1 per 20 samples) | %R ≥ 75% |
| Representativeness | Laboratory Blank Samples | 1 per batch (or 1 per 20 samples) | No excessive contamination (in terms of concentration, frequency, or number of analytes). |
| | Conformance to Field and Laboratory Procedures | Assessed once per sampling event as part of Data Validation | No excessive errors or omissions. |
| Completeness | Number of Data Points | Assessed once per sampling event as part of Data Validation | %C ≥ 90% |
| Comparability | Standardized Units | Assessed once per sampling event as part of Data Validation | No non-standard units. |

# APPENDIX D

# Phase II Data Management Plan

# D.1 Data Management Plan

The objective of this plan is to provide a system of data management that results in complete and representative data in a consistent and readily accessible format to facilitate decision-making throughout the term of the Phase II GWCMP. To this end, the data will be stored in a relational database or spreadsheet, and data processing routines will be accomplished through programmed functions, to the extent possible and practicable, to reduce the chance for errors caused by re-entry or electronic cutting and pasting techniques. The data processing routines will also allow data to be processed efficiently and consistently. The database and related files will be backed up daily to tapes and stored off-site, for emergency data recovery, if necessary.

## D.1.1 Data Processing

At the beginning of the Phase II GWCMP, anticipated sampling event and analysis requirements will be loaded into the database to be used after each sampling event to verify that all expected data have been collected. All data collected in the field via handwritten field logs, electronic equipment, and Chain-of-Custody transmittals to laboratories will be processed upon completion of the field work, cross-checked for completeness and accuracy, and loaded into the database, as appropriate. Timely processing of the field data will provide an opportunity to identify omissions or errors in field procedures, preparation of Chain of Custody forms, and instructions to the laboratory, and therefore for timely corrective action.

Analytical laboratory data will be processed via a standard EDD (electronic data deliverable) format that will allow efficient Aspect processing, as well as upload to the project database. The lab EDDs will be verified electronically before loading into the database. This will include checks for data conformity to defined valid values, completeness, and application of correct analytical methods and detection limits. EDDs not meeting the verification checks will be returned to the laboratory for correction and resubmittal. When the lab EDDs have passed verification, the data will be loaded into the database and flagged as pending validation and the EDD will be forwarded to the data validator for validation. The validator will update the EDD with qualifiers, notes, and corrected values where appropriate, after which the data manager will process the validation EDD, electronically updating qualifiers and changes in the database and flagging data as validated.

Once validated the data in the database will be available for reporting in tables and graphics. Tabulation and graphics development will be completed through direct data exchange between the database and presentation and evaluation tools whenever possible. Figure D.1 illustrates data management for the Phase II GWCMP.

## D.1.2 Data Validation

All Phase II GWCMP data will be subject to data validation reviews. The data validation process quantifies technical data quality, verifies that adequate documentation was performed, and determines whether the analytical data are usable and meet project Data Quality Objectives (DQOs). Data validation will be completed by Mintga Lin of Pyron Environmental Inc.

The analytical laboratory (or laboratories) will be directed to submit all data packages with sufficient detail to support the required data validation process. Specific formats for data delivery (electronic and hard copy) and required data reporting elements shall be developed through consultation between Aspect's data manager and the analytical lab(s) at the start of the program. Aspect's data and project managers will coordinate throughout the project to track laboratory reporting, data validation, and data management schedules and verify that appropriate data management protocols are occurring.

## Aspect Consulting FIELD DATA COLLECTION

groundwater sample collection

samples to external laboratory / ies

external laboratory analysis

Lab Electronic Data Deliverable (EDD)

Lab Data loaded to Aspect Standard database and verified for consistency and completeness

Field Data QC'd and Entered into Aspect Standard database
Groundwater measurements, water quality, coordinates, etc.

Tidal Measurements

Lab data sent to validator

laboratory data validation

Validated lab data returned to Aspect – validation qualifiers updated in database

**Aspect Standard database used for analysis**

Aspect Electronic Data Deliverable (EDD)
POS Field Module
Validated Lab EDD
Transmitted to POS
to be loaded to EMIS

linked read only tables

**EMIS T5 Project database – Read Only Copy**

POS sends periodic or requested update to Aspect Consulting

**PORT OF SEATTLE- EMIS database**

POSDEV

Validated Data Loded to EMIS

**EMIS T5 Project database**

Port of Seattle

## Aspect Consulting DATA MANIPULATON AND ANALYSIS

**CAD System**

manual & dynamic link/s

'Base' & generated spatial data, etc

manual link/s

manual & dynamic link/s

dynamic & manual link/s

**GIS System**

manual link/s

dynamic & manual link/s

manual link/s

Surfer Gridding of SWLs, temp, pH, conductivity, etc

dynamic link/s

**Excel Spreadsheets & Graphs**

| Client | Page 1 of 1 | Prepared by | GBT | 1/11/07 |
|---|---|---|---|---|
| Port of Seattle<br>T5 Project<br>Data Management / Data Flow | | Approved by | WVG | 1/11/07 |

**Legend**:
blue = Port of Seattle EMIS Database
black = Aspect Data Collection
brown = Aspect Data Analysis
green = Laboratory Chemical Analysis
magenta = Data Validation
orange = Read Only EMIS data

Aspect

W:\POS Terminal 5 GW Monitoring BV990106\Phase II\Monitoring Plan\
T5DataManagement_2007.vsd

**Figure D-1**