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LONG-TERM GROUNDWATER MONITORING PLAN

SOUND BATTERY PROPERTY
2310 EAST 11TH STREET
TACOMA, WASHINGTON
WASHINGTON STATE DEPARTMENT OF ECOLOGY
FACILITY SITE NO. 1247
VOLUNTARY CLEANUP PROGRAM NO. SW1208

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May 19, 2016

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1.0 INTRODUCTION

This Long-Term Groundwater Monitoring Plan provides the scope of work for groundwater monitoring at the Sound Battery Company property at 2310 East 11th Street in Tacoma, Washington (herein referred to as the Site) (Figures 1 and 2). Long-term groundwater monitoring is required by the Washington State Department of Ecology (Ecology) as part of the institutional controls required by the Environmental Covenant for regulatory closure for the Site. The Site is known as Facility Site No. 1247 by Ecology and is enrolled in the Ecology Voluntary Cleanup Program (VCP) under Identification No. SW1208.

1.1 BACKGROUND

A cleanup action was completed in February 2015, which included demolition of the Site building and removal of sections of the floor slab, excavation of 277 tons of soil containing lead at concentrations exceeding the Washington State Model Toxics Control Act Cleanup Regulation (MTCA) Method A cleanup level for industrial land use as established in Chapter 173-340 of the Washington Administrative Code (WAC 173-340), off-Site stabilization of lead in the excavated soil, and disposal of stabilized soil at a Subtitle D waste disposal facility in accordance with the Ecology-reviewed and -approved *Cleanup Action Plan, Sound Battery Property, 2310 East 11th Street, Tacoma, Washington* dated July 24, 2014, prepared by Farallon Consulting, L.L.C. (Farallon) (2014). An earlier cleanup action was completed in April 2002, which included excavation of 880 tons of soil containing lead at concentrations exceeding the MTCA Method A cleanup level for unrestricted land use from around the exterior of the Site building and from adjacent areas of the surrounding three parcels. The 2002 cleanup action included on-Site stabilization of lead in the excavated soil and disposal of stabilized soil at a Subtitle D waste disposal facility. The 2002 cleanup action is documented in *Final Cleanup Action Report* dated July 22, 2002, prepared by GeoSystems Analysis, Inc. (2002).

The laboratory analytical results for confirmation soil samples collected from the bottom and sidewalls of the final excavation limits and from prior sample locations confirm that soil with concentrations of lead exceeding the MTCA Method A cleanup level for industrial land use has been excavated and removed from the Site. Lead has not been detected at concentrations exceeding the MTCA Method A cleanup level in groundwater samples collected from monitoring wells MW-1 through MW-4 (Farallon 2013).

The cleanup action completed to date is documented in the *Closure Report, Sound Battery Property, 2310 East 11th Street, Tacoma, Washington* dated July 27, 2015, prepared by Farallon (Closure Report) (2015). The cleanup action includes implementation of an Environmental Covenant with Site-specific restrictions and requirements, including industrial land use, limitations on groundwater use, and a groundwater monitoring program as defined herein.

1.2 PURPOSE

The purpose of this Long-Term Groundwater Monitoring Plan is to provide the specifications and schedule for collection and analysis of groundwater samples from the existing monitoring well network at the Site over the course of the next 5 years. The Long-Term Groundwater Monitoring Plan will be attached to an Environmental Covenant recorded on the property deed. Groundwater analytical results will be used during an Ecology 5-year review to evaluate whether the cleanup implemented at the Site was effective and protective of human health and the environment, and if the groundwater monitoring program can be terminated (Ecology 2015).

1.3 ORGANIZATION

This Long-Term Groundwater Monitoring Plan has been organized into the following sections:

- **Section 2—Groundwater Monitoring Program**: This section provides a description of the Long-Term Groundwater Monitoring Plan, including schedule, personnel health and safety, standard operating procedures (SOPs) for groundwater level gauging and sampling, laboratory analysis, waste management, field documentation, and reporting.
- **Section 3—References:** This section lists documents cited in this Long-Term Groundwater Monitoring Plan.
- **Section 4—Limitations:** This section presents Farallon standard limitations for work products and use by third parties.

2.0 GROUNDWATER MONITORING PROGRAM

This section provides the scope of work for the groundwater monitoring program, including schedule, personnel health and safety, SOPs for groundwater level gauging and sampling, laboratory analysis, waste management, field documentation, and reporting. The groundwater monitoring program consists of measuring the depth to groundwater and collection and analysis of groundwater samples for total and dissolved lead from monitoring wells MW-1 through MW-4 (Figure 2). SOPs for components of the groundwater monitoring program are contained in Appendix A, Standard Operating Procedures. Examples of field forms for use during the groundwater monitoring program are provided in Appendix B, Field Forms.

2.1 SCHEDULE

Groundwater monitoring and sampling will be performed every 18 months for 5 years. The first groundwater monitoring and sampling event is scheduled to occur in the second quarter of 2016.

The cleanup action was completed in February 2015; therefore, 2015 is Year 1. Three groundwater monitoring and sampling events will be conducted according to the following schedule:

- Event 1, Year 2: Second quarter 2016;
- Event 2, Year 3: Fourth quarter 2017, approximately 18 months after Event 1; and
- Event 3, Year 5: Second quarter 2019, approximately 18 months after Event 2.

After groundwater monitoring through Event 3, Year 5, the Site will undergo an Ecology review to determine if the Site cleanup action is protective and the groundwater monitoring program can be terminated.

2.2 HEALTH AND SAFETY

Field work will be conducted in compliance with health and safety requirements of WAC 296-843, Hazardous Waste Operations, which presents requirements for a Site-specific health and safety plan relevant to the work and anticipated Site conditions in accordance with WAC 296-843-120. A current Site-specific health and safety plan will be prepared for the work, will be updated as needed for each sampling event, and will accompany field personnel during field work.

2.3 STANDARD OPERATING PROCEDURES

SOPs to be employed during the groundwater monitoring program are contained in Appendix A. Examples of field forms for data collected in the field are included in Appendix B. The methodologies for measuring the depth to groundwater and for sampling groundwater are described below.

2.3.1 Depth to Groundwater Measurement

The locking well caps will be removed from monitoring wells MW-1 through MW-4 and groundwater will equilibrate for at least 15 minutes prior to measuring depth to groundwater. The depth to groundwater will be measured in the monitoring wells to the nearest 0.01 foot using an electronic water-level indicator. The depth to the monitoring well bottom will be measured to evaluate siltation of the monitoring well. Specific methods are provided in SOP GW-01, Groundwater Level Measurements in Monitoring Wells provided in Appendix A. Table 1, *Groundwater Elevations*, summarizes the depth to groundwater measurements collected in August 2012.

2.3.2 Groundwater Sampling

The monitoring wells will be sampled in accordance with the U.S. Environmental Protection Agency (EPA) guidance document *Low Flow (Minimal Drawdown) Ground-Water Sampling Procedures* (EPA 1996). Before the monitoring wells are purged, the intake of the dedicated polyethylene tubing will be placed approximately 2 to 3 feet below the measured depth to water. Groundwater will be purged from each well using a peristaltic pump at a flow rate of 100 to 300 milliliters per minute. During the purging of groundwater, field measurements for pH, temperature, specific conductivity, dissolved oxygen, and oxidation-reduction potential will be measured approximately every 3 minutes using a water-quality analyzer equipped with a flow-through cell. Field measurements will include periodic water level measurements and pump flow rates. Field measurements will be recorded on a Low Flow Well Purging and Sampling Data form such as the one contained in Appendix B. Nondisposable equipment will be decontaminated between uses.

Groundwater samples will be collected after the field measurements are completed and the rate of groundwater drawdown has stabilized to within the parameters established by EPA (1996) and in accordance with the sample handling procedures described below. Groundwater samples for total lead analysis will be collected directly from dedicated tubing into laboratory-supplied 250-milliliter sample containers with nitric acid preservative sufficient to lower pH to less than 2. Groundwater samples for dissolved lead analysis will be collected from the discharge of a 0.45-micron field filter fitted onto the dedicated tubing. Care will be taken to minimize exposure of sampled water to air and to not handle the lid of the container when the sample is being collected.

Each container will be filled completely to limit headspace, and the lid will be tightened securely. Each sample container will be labeled with the date and time sampled, well identification and number, project number, and preservative(s). Sample collection information will be documented on a Chain of Custody form and the sample will be placed into a cooler at approximately 4 degrees Celsius. Properly preserved, the holding time for groundwater samples collected for lead analysis is 6 months.

Specific methods are provided in SOP GW-02, Groundwater Sampling Procedures provided in Appendix A. Table 2, *Summary of Groundwater Lead Analytical Results*, contains analytical results for groundwater samples collected in August 2012.

2.4 LABORATORY ANALYSIS

Groundwater samples will be transported to an accredited environmental analytical laboratory such as OnSite Environmental Inc. of Redmond, Washington. Groundwater samples will be analyzed for total and dissolved lead by EPA Method 200.8 with a maximum practical quantitation limit of 1.0 microgram per liter.

2.5 WASTE MANAGEMENT

Investigation-derived wastewater generated by groundwater sampling activities will be placed into labeled Washington State Department of Transportation-approved steel drums. The drums will be temporarily stored on the Site pending receipt of laboratory analytical data for waste profiling. Investigation-derived wastes will be disposed of at an authorized disposal facility within 90 days of generation.

2.6 FIELD DOCUMENTATION

Documentation of field activities will be provided on Field Report forms, Groundwater Level Measurement Summary forms, Low Flow Well Purging and Sampling Data forms, sample labels, Chain-of-Custody forms, waste material container labels, and Waste Inventory Tracking Sheets. Field forms for use during field activities are summarized below.

2.6.1 Field Report Form

Field personnel will be required to keep a daily field log on a Field Report form. Field notes will be as descriptive and inclusive as possible, enabling independent parties to reconstruct the sampling situation from the recorded information. Language will be objective, factual, and free of inappropriate terminology. A summary of each day's events will be provided on the Field Report form. At a minimum, field documentation will include the date, job number, project identification and location, weather conditions, sample collection data, personnel present and responsibilities, field equipment used, and any activities performed in a manner other than as specified. Field personnel will sign the completed Field Report form. An example Field Report form is included in Appendix B.

2.6.2 Groundwater Level Measurement Summary Form

A Groundwater Level Measurement Summary form will be used by the Field Scientist to document the water level measurements for monitoring wells MW-1 through MW-4 for each groundwater monitoring event. Information to be recorded on the Groundwater Level Measurement Summary form includes: date, monitoring well identification number, time of gauging, depth to water, total well depth, and notes pertaining to the gauging information for each monitoring well. An example Groundwater Level Measurement Summary form is included in Appendix B.

2.6.3 Low Flow Well Purging and Sampling Data

A Low Flow Well Purging and Sampling Data form will be used by the Field Scientist during groundwater sampling activities to record information pertaining to the groundwater samples being collected. This form documents field measurements made during purging and groundwater sampling. An example Low Flow Well Purging and Sampling Data form is included in Appendix B.

2.6.4 Sample Label

A sample label will be filled out and affixed to each sample container immediately prior to sample collection. The label will be filled out in indelible ink and include the medium, date, time sampled, sample identification and number, project name, project number, sampler's initials, and analyte preservative(s), if any. An example sample label is included in Appendix B.

2.6.5 Chain of Custody Form

The Chain of Custody form records the procedures followed whenever samples are collected, transferred, stored, analyzed, or destroyed, and is intended to create an accurate written record that can be used to trace the possession and handling of the sample from the moment of its collection through analysis and reporting of analytical values. The Chain of Custody form will be filled out by field sampling personnel at the time a sample is collected.

All samples submitted to the laboratory are accompanied by the Chain of Custody form. This form is checked for accuracy and completeness, signed, and dated by the laboratory sample custodian accepting the sample. At the laboratory, each sample is assigned a unique sequential laboratory identification number that is stamped or written on the Chain of Custody form.

The Chain of Custody form includes the client name, project name and number, date and time sampled, sample identifier, sampler's initials, analysis, and analyte preservative(s). An example Chain of Custody form is included in Appendix B.

2.6.6 Waste Material Container Label

A waste material container label will be filled out and affixed to the waste container immediately upon filling. The label will be filled out in indelible ink and include the job number and name, the address where the waste was generated, container contents, date, consultant's name and telephone number, and sampler's initials. An example waste material container label is included in Appendix B.

2.6.7 Waste Inventory Tracking Sheet

A Waste Inventory Tracking Sheet will be used to document and track the wastes generated during the groundwater monitoring program. The form will include information on the waste container, origin of the waste, type of waste, date generated, date removed from the Site, transporter, and disposal location. An example Waste Inventory Tracking Sheet is included in Appendix B.

2.7 REPORTING

Following completion of each groundwater monitoring and sampling event, a brief Groundwater Monitoring Report will be prepared to summarize the groundwater monitoring activities and present the analytical results. The report will include the following:

- A description of the activities performed, including groundwater monitoring and sampling;
- A summary table of groundwater elevation data;
- Summary tables of the analytical results and water quality data for groundwater samples collected during the monitoring well sampling activities;
- Figures depicting the monitoring well locations, groundwater elevation contours, and analytical results; and
- Farallon's conclusions pertaining to the groundwater monitoring results.

Groundwater monitoring and sampling data will be submitted to the Ecology Electronic Information Management database as data are generated.

3.0 REFERENCES

Farallon Consulting, L.L.C. (Farallon). 2013. *Remedial Investigation and Focused Feasibility Study Report, Sound Battery, 2310 East 11th Street, Tacoma, Washington.* Prepared for Clark Davis, Davis Law Office, PLLC, Gig Harbor, Washington. November 19.

———. 2014. *Cleanup Action Plan, Sound Battery Property, 2310 East 11th Street, Tacoma, Washington.* Prepared for Marvin Dykman c/o Clark Davis, Davis Law Office, PLLC, Gig Harbor, Washington. July 24.

_____. 2015. *Closure Report, Sound Battery Property, 2310 East 11th Street, Tacoma, Washington.* Prepared for Marvin Dykman c/o Clark Davis, Davis Law Office, PLLC, Gig Harbor, Washington. July 27.

GeoSystems Analysis, Inc. 2002. *Final Cleanup Action Report*. Prepared for Sound Battery. July 22.

U.S. Environmental Protection Agency (EPA). 1996. *Low-Flow, (Minimal Drawdown) Ground-Water Sampling Procedures.* Prepared by Robert W. Puls and Michael J. Barcelona. Publication No. EPA/540/S-95/504. April.

Washington State Department of Ecology (Ecology). 2015. E-mail Communication Regarding Sound Battery Property Closure Report. From Thomas Middleton. To Tad Cline, Farallon. December 22.

4.0 LIMITATIONS

4.1 GENERAL LIMITATIONS

The conclusions contained in this report/assessment are based on professional opinions with regard to the subject matter. These opinions have been arrived at in accordance with currently accepted hydrogeologic and engineering standards and practices applicable to this location. The conclusions contained herein are subject to the following inherent limitations:

- **Accuracy of Information.** Farallon obtained, reviewed, and evaluated certain information used in this report/assessment from sources that were believed to be reliable. Farallon's conclusions, opinions, and recommendations are based in part on such information. Farallon's services did not include verification of its accuracy or authenticity. Should the information upon which Farallon relied prove to be inaccurate or unreliable, Farallon reserves the right to amend or revise its conclusions, opinions, and/or recommendations.
- **Reconnaissance and/or Characterization.** Farallon performed a reconnaissance and/or characterization of the Site that is the subject of this report/assessment to document current conditions. Farallon focused on areas deemed more likely to exhibit hazardous materials conditions. Contamination may exist in other areas of the Site that were not investigated or were inaccessible. Site activities beyond Farallon's control could change at any time after the completion of this report/assessment.

For the foregoing reasons, Farallon cannot and does not warrant or guarantee that the Site is free of hazardous or potentially hazardous substances or conditions, or that latent or undiscovered conditions will not become evident in the future. Farallon's observations, findings, and opinions can be considered valid only as of the date of the report hereof.

This report/assessment has been prepared in accordance with the contract for services between Farallon and Client, and currently accepted industry standards. No other warranties, representations, or certifications are made.

4.2 LIMITATION ON RELIANCE BY THIRD PARTIES

Reliance by third parties is prohibited. This report/assessment has been prepared for the exclusive use of Client to address the unique needs of Client at the Site at a specific point in time. Services have been provided to Client in accordance with a contract for services between Farallon and Client, and generally accepted environmental practices for the subject matter at the time this report was prepared.

No other party may rely on this report unless Farallon agrees in advance to such reliance in writing. Any use, interpretation, or reliance upon this report/assessment by anyone other than Client is at the sole risk of that party, and Farallon will have no liability for such unauthorized use, interpretation, or reliance.

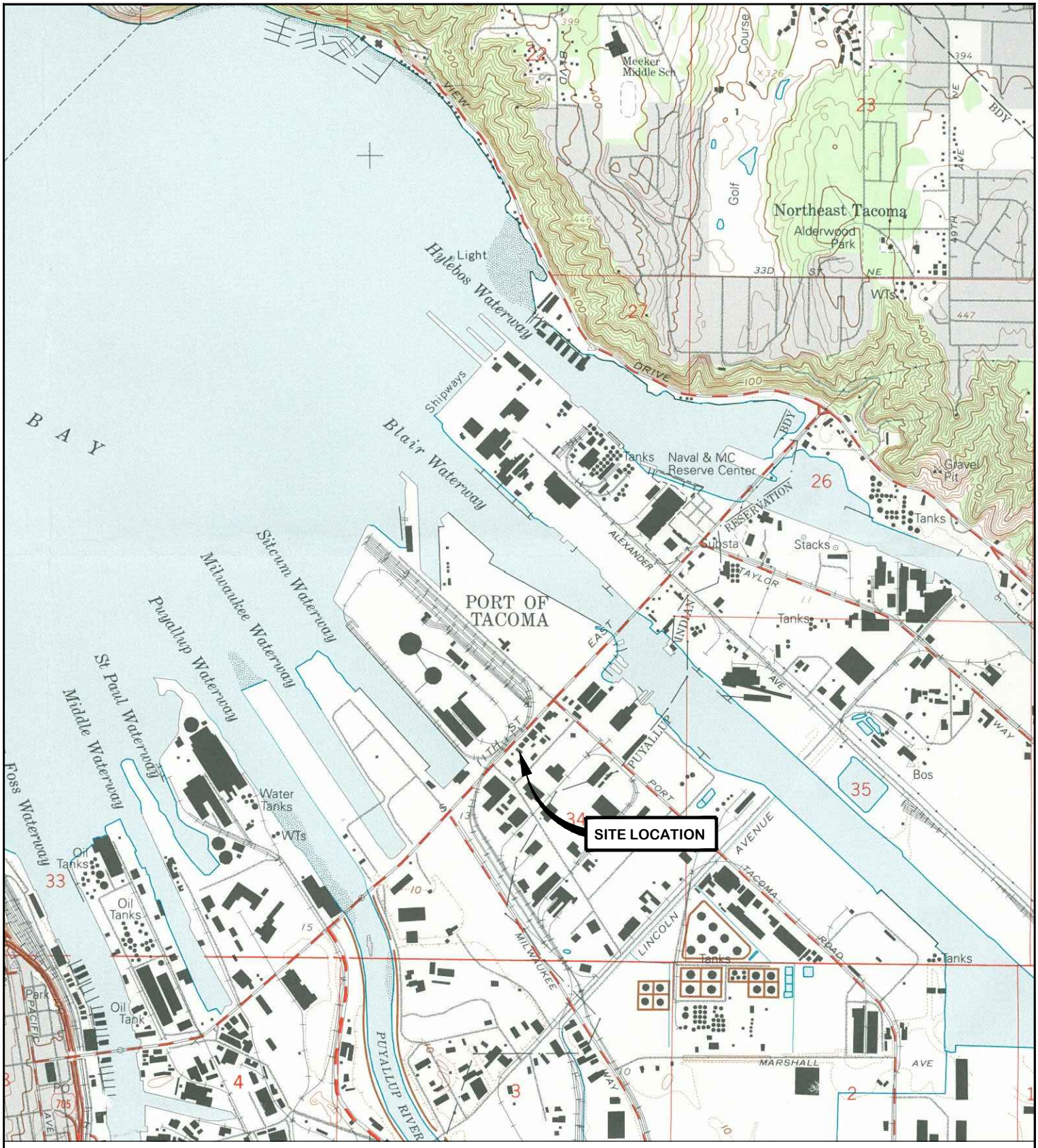
Do not rely on this report/assessment if:

- It was not prepared for you;
- It was not prepared for your project;
- It was not prepared for your specific Site; or
- It was not prepared under an approved scope of work for which you are under contract with Farallon.

FIGURES

LONG-TERM GROUNDWATER MONITORING PLAN
Sound Battery Property
2310 East 11th Street
Tacoma, Washington

Farallon PN: 1117-001



REFERENCE: 7.5 MINUTE USGS QUADRANGLE TACOMA NORTH, WASHINGTON. DATED 1953 AND PHOTOREVISED 1981

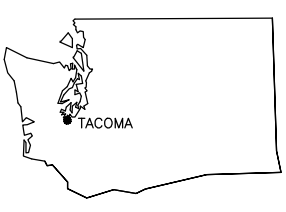


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FIGURE 1

VICINITY MAP
SOUND BATTERY PROPERTY
2310 EAST 11TH STREET
TACOMA, WASHINGTON

FARALLON PN: 1117-001

Drawn By: DJR | Checked By: DEW | Date: 5/5/2016 | Disk Reference: 1117-001_00

EAST 11TH STREET

MW-4

GROUNDWATER ug/L		
DATE	DISSOLVED LEAD	TOTAL LEAD
08/07/2012	<1.0	<1.1

FORMER TACOMA FIRE STATION NUMBER 12 PROPERTY

OFFICE

OFFICE

ASPHALT

LOADING DOCK

FORMER LEAD MELTING POTS AREA

CONCRETE FLOORING

MW-1

GROUNDWATER ug/L		
DATE	DISSOLVED LEAD	TOTAL LEAD
08/07/2012	<1.0	<1.1

PROPERTY BUILDING DEMOLISHED DURING THE CLEANUP

ORIGINAL BUILDING (~1947)

BRICK CHIMNEY

BATTERY ASSEMBLY LINE

FORMER LEAD MELTING POTS AREA

ASPHALT

OUTLET

CONCRETE FLOORING

BATTERY HOIST

INLET

ASPHALT

FIRST ADDITION (~1960)

BATTERY CHARGE AREA

FORMER ACID TANK AREA

SECOND ADDITION (YEAR UNKNOWN)

ASPHALT

APPROXIMATE GROUNDWATER FLOW DIRECTION

APEX FORGE AND TOOL COMPANY PROPERTY

MW-3

GROUNDWATER ug/L		
DATE	DISSOLVED LEAD	TOTAL LEAD
08/07/2012	<1.0	1.3

GRAVEL

PROPANE ABOVE GROUND STORAGE TANK

FASTCO BUILDING PROPERTY

MW-2

GROUNDWATER ug/L		
DATE	DISSOLVED LEAD	TOTAL LEAD
08/07/2012	<1.0	<1.1

PREMIER TRANSPORT PARKING AREA

LEGEND

- PROPERTY LINE
- FENCE
- FORMER ABANDONED CONCRETE-FILLED FLOOR DRAIN
- MW-3 SHALLOW MONITORING WELL
- APPROXIMATE EXTENT OF 2002 SHALLOW SOIL EXCAVATION
- APPROXIMATE EXTENT OF 2015 SHALLOW SOIL EXCAVATION
- GROUNDWATER ANALYTICAL RESULTS IN MICROGRAMS PER LITER (ug/L)
- < = INDICATES CONCENTRATION NOT DETECTED AT OR ABOV STATED LABORATORY PRACTICAL QUANTITATION LIMIT
- ALL LOCATIONS ARE APPROXIMATE

NOTE:
SITE BUILDING DEMOLISHED AND REMOVED FROM SITE IN FEBRUARY 2015

N

0 20
Scale in feet

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FIGURE 2

SITE MAP
SOUND BATTERY PROPERTY
2310 EAST 11TH STREET
TACOMA, WASHINGTON

FARALLON PN: 1117-001

Drawn By: DJR Checked By: TC Date: 5/5/2016 Disk Reference: 1117-001_00

TABLES

LONG-TERM GROUNDWATER MONITORING PLAN
Sound Battery Property
2310 East 11th Street
Tacoma, Washington

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Table 1
Groundwater Elevations
Sound Battery Property
2310 East 11th Street
Tacoma, Washington
Farallon PN: 1117-001

Monitoring Well	Date Measured	Well Head Elevation (feet)[1]	Depth to Water (feet)[2]	Groundwater Elevation (feet)[1]
MW-1	8/7/2012	10.48	6.34	4.14
MW-2	8/7/2012	15.25	10.66	4.59
MW-3	8/7/2012	13.83	9.50	4.33
MW-4	8/7/2012	10.34	6.21	4.13

NOTES:

[1] Elevations based on an arbitrary 100-foot datum established at the Site.

[2] In feet below measuring point on top of well casing.

Table 2
Summary of Groundwater Lead Analytical Results
Sound Battery Property
2310 East 11th Street
Tacoma, Washington
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Sample Location	Sample Identification	Sample Date	Analytical Results (micrograms per liter)[2]	
			Dissolved[3] Lead	Total Lead
MW-1	MW-1-080712	08/07/2012	< 1.0	1.3
MW-2	MW-2-080712	08/07/2012	< 1.0	< 1.1
MW-3	MW-3-080712	08/07/2012	< 1.0	< 1.1
MW-4	MW-4-080712	08/07/2012	< 1.0	< 1.1
MTCA Method A Cleanup Levels for Groundwater[1]			**15**	**15**

NOTES:

Results in **bold** denote that sample results exceed applicable screening level.

< denotes analyte not detected at or exceeding the laboratory practical quantitation limit listed.

[1] Washington State Model Toxics Control Act Cleanup Regulation (MTCA) Method A Groundwater Cleanup Levels, Table 720-1 of Section 900 of Chapter 173-340 of the Washington Administrative Code, as revised 2013.

[2] Analyzed by U.S. Environmental Protection Agency Method 200.8/7470A

[3] Dissolved denotes field- or lab-filtered with 0.45-micron filter.

APPENDIX A
STANDARD OPERATING PROCEDURES

LONG-TERM GROUNDWATER MONITORING PLAN
Sound Battery Property
2310 East 11th Street
Tacoma, Washington

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STANDARD OPERATING PROCEDURE GW-01
GROUNDWATER LEVEL MEASUREMENTS IN MONITORING WELLS

PURPOSE AND APPLICATION

The purpose of this standard operating procedure is to provide field personnel with an outline of the specific information needed to measure and document the depth to groundwater in monitoring wells.

The step-by-step guidelines provided in this standard operating procedure are to be followed by the field crew to ensure consistent and representative measurements of depth to groundwater in monitoring wells.

EQUIPMENT AND SUPPLIES

The following equipment is necessary to properly measure the depth to groundwater in monitoring wells:

- A well key, hand drill, socket set, allen wrench, speed wrench, padlock key, or other well-access equipment specific to the well monument cover plate;
- An electric water meter with down-hole equipment narrow enough to fit within the monitoring well, calibrated to 0.01 foot, with sufficient line to reach the bottom of the monitoring well;
- Materials necessary to provide required documentation, including field books and field forms;
- Personal protective equipment (PPE) as described in the site Health and Safety Plan;
- Decontamination equipment; and
- Field forms for recording data.

DECONTAMINATION

Equipment that will come into contact with well water is to be decontaminated before arrival at the site, upon relocation at the site, and upon exit from the site.

PROCEDURES

The instructions below are to be followed for measuring water levels at each monitoring well:

- Don appropriate PPE as described in the site Health and Safety Plan.
- Remove soil or vegetation from the well site.
- Open the wellhead enclosure and remove standing water inside the well monument using a bilge pump or cup prior to opening the well cap. Standing water can be disposed of to the ground surface.

- Open the well cap.
- Allow the water level to equilibrate for approximately 15 minutes before measuring depth to groundwater. Measure and record the depth to groundwater using a pre-decontaminated water-level meter. With the water-level meter turned on to a medium level of sensitivity, slowly lower the meter into the well casing until it reaches the water table. When the probe reaches the interface of the water table, it will beep. If the monitoring well does not have a dedicated pump, lower the water-level indicator probe to the bottom of the well to measure the total depth of the well. Gently bounce the probe on the well bottom and pull the slack in the cord to read the total depth.
- Read the measurements from a surveyed notch or marking in the polyvinyl chloride well riser or, in the event there is no notch, record the measurement from the north side of the well casing. Conduct all measurements three times to ensure that the readings are accurate and represent true depths. Take the measurements to the nearest 0.01 foot, and record on the Low Flow Well Purging and Sampling Data form and the Groundwater Level Measurement Summary form. The additional 2 to 3 inches from the zero point of the sonde to the tip of the sonde will be discounted for all total depth measurements.
- Decontaminate the water-level meter before re-use.
- Close the well appropriately and record any well-integrity concerns on the Field Report form.

DOCUMENTATION

Document monitoring well water-level measurements on the Groundwater Level Measurement Summary form.

REFERENCES

U.S. Environmental Protection Agency. 1992. *RCRA Ground-Water Monitoring: Draft Technical Guidance.* Office of Solid Waste. November.

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STANDARD OPERATING PROCEDURE GW-02
GROUNDWATER SAMPLING PROCEDURES

PURPOSE AND APPLICATION

The purpose of this standard operating procedure is to provide groundwater sampling personnel with the information needed to collect and document groundwater samples from monitoring wells using U.S. Environmental Protection Agency (EPA) (1996) low-flow groundwater sampling procedures for chemical analysis to ensure consistent and representative sampling.

The step-by-step guidelines provided in this standard operating procedure are to be followed by the field crew conducting low-flow groundwater sampling.

EQUIPMENT AND SUPPLIES

The following equipment is necessary to properly purge and sample a groundwater monitoring well:

- A well key, hand drill, socket set, padlock key, or other well-access equipment;
- An electric water-meter sufficiently long to reach the bottom of the well, calibrated to 0.01 foot;
- Well-purging equipment (e.g., pump, tubing, power supply, extension cord);
- A sufficient number of waste containers, including lids, gaskets, and fasteners, to contain all purge water unless other water-handling arrangements have been made;
- A flow-through water-quality meter to measure temperature, pH, specific conductivity, dissolved oxygen, oxidation/reduction potential, and turbidity;
- Materials necessary to provide required documentation, (e.g., sample labels, Field Report forms, Low Flow Well Purging and Sampling Data form, and Chain of Custody forms);
- Sample containers with the chemical preservatives appropriate for the samples, as required by the analytical laboratory;
- Personal protective equipment (PPE) as described in the site-specific Health and Safety Plan; and
- Sampling support equipment (e.g., sample coolers, ice and/or blue ice, bubble wrap, clear tape, duct tape, re-sealable plastic bags, razor knives, garbage bags, paper towels, distilled water, and nitrile gloves).

DECONTAMINATION

Reusable equipment that will come into contact with the well and/or be used to acquire samples is to be decontaminated before arrival at the site, upon relocation at the site, and upon exit from the site.

PROCEDURES FOR LOW-FLOW SAMPLING

Well sampling procedures have been developed for monitoring wells without a dedicated pump (non-dedicated wells). The sections below present the procedures for setup, purging, sample collection, and post-sampling activities for non-dedicated wells.

Set-Up

- Don appropriate PPE as described in the site-specific Health and Safety Plan.
- Brush away soil and/or vegetation, and pump standing water away from the well opening.
- Open the well cap.
- Measure and record the depth to water using a decontaminated water-level meter in accordance with Standard Operating Procedure No. GW-01. Take all measurements from the north point on or at the hatch mark on the well riser. Measure to the nearest 0.01 foot and record the measurements on the Groundwater Level Measurement Summary Form and the Low Flow Sampling and Purging Data form.
- Connect the silicon tubing to the peristaltic pump. Place tubing intake at the midpoint of the screen or set the pump intake to the pre-determined depth according to the Project Manager. If using a bladder pump, insert the bladder pump and attach the dedicated polyethylene tubing so that the pump intake is approximately at the midpoint of the screened interval, or set the pump intake to the pre-determined depth according to the Project Manager.
- Set up the pump and the flow-through cell in preparation for purging. Turn the pump to its lowest setting, set the memory in the flow-through cell to record readings every 3 minutes, and turn on the pump. Begin purging slowly to prevent drawing down the water table.

Purging

- Begin purging, and initiate water-quality testing for temperature, pH, specific conductivity, dissolved oxygen, oxidation/reduction potential, and turbidity. Purge all monitoring wells using a peristaltic or bladder pump and dedicated polyethylene and silicon tubing. Record water-quality parameters every 3 minutes.
- Record water levels every 3 minutes, as possible. It is imperative that the water level not drop by more than 0.33 foot during the low-flow purging process. If the water level continues to drop during purging, reduce the flow rate on the pump.
- Record flow rates every 3 minutes. Ensure that the flow rate does not exceed 500 milliliters per minute (ml/min) during the low-flow purging process.

Purging Requirements

Purging should continue until water-quality parameters have stabilized according to the stability criteria specified below:

Water-Quality Parameter	Stability Criterion
Turbidity	{X} <5 NTU **or** RPD <10% for values {X}>5 NTU
Dissolved oxygen	Δ ≤ 10%
Specific conductivity	RPD ≤ 3%
Oxidation/Reduction potential	Δ <10 mV
pH	Δ ≤ 0.1 unit

NOTES:
Δ = maximum reading minus minimum
mg/l = milligrams per liter
mV = millivolt
NTU=nephelometric turbidity unit
RPD – relative percent difference

Where: {X}= the last three water-quality readings
RPD = $\frac{\Delta}{}$ x 100%
Δ = Maximum {X} – Minimum {X}

Although a well may not stabilize according to the above criteria under some circumstances, the well can still be sampled if one of the following conditions exists:

- If the well does not meet stability criteria due to an instrument accuracy issue. Instrument accuracy sometimes limits the ability to achieve stabilization on a percentage basis. For example, if redox potential consistently fluctuates between 1 and 15 mV, a change in concentrations of greater than 10 mV does not meet the stability criterion. However, because the accuracy of the instrument is ±20 mV, the stability criterion would be considered satisfied within the range of accuracy for the instrument. This consideration is particularly important when water-quality parameter values are low. Field personnel must consult the instrument's manual to determine its accuracy range.
- If the water level drops below the minimum value using low-flow sampling procedures during purging. If a minimum of two tubing volumes have been removed from the well, the well should be sampled as soon as the water level has recovered sufficiently to allow collection of the volume of groundwater necessary for all samples. Use the following equation to determine the minimum volume of groundwater to remove before sampling:
  - Minimum purge volume = 2[500 milliliters + M(length of tubing in feet)]
    Where: M is the volume (in milliliters) contained in a 1-foot length of tubing

    The value of M is provided below for the inner diameters of tubing listed:

Inner Diameter (Inches)	M (Milliliters)
0.125	2.4
0.25	9.7
0.5	39

Record on the Field Report form and the Low Flow Well Purging and Sampling Data form if any well did not meet the stabilization and drawdown criteria, and explain the rationale for sampling the well at the time it was sampled.

Sample Collection

During low-flow sampling, do not stop pumping once the purging requirements have been met. Disconnect the sampling tube from the flow-through cell. It is imperative not to lower the water table or disturb the water column. Fill pre-cleaned sample containers using flexible silicon hose or polyethylene tubing on the discharge side of pump.

Post-Sampling

Record the depth to water to determine whether the water level changed from the original reading, as possible.

Close the well appropriately and record any well integrity concerns on the Field Report form and the Low Flow Well Purging and Sampling Data form.

DOCUMENTATION

Document the well purging and sampling activities on the Low Flow Well Purging and Sampling Data form.

REFERENCES

U.S. Environmental Protection Agency (EPA). 1996. *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures*. EPA/540/5-95/504. April.

APPENDIX B
FIELD FORMS

LONG-TERM GROUNDWATER MONITORING PLAN
Sound Battery Property
2310 East 11th Street
Tacoma, Washington

Farallon PN: 1117-001

FARALLON CONSULTING

Washington
Issaquah | Bellingham | Seattle

Oregon
Portland | Bend | Baker City

California
Oakland | Sacramento | Irvine

FIELD REPORT

Page ___ of ___

Date: _____ **Project #:** _____ **Task #:**_____

Project: _____ **Site Address:** _____

Client: _____ **Contractor:** _____

Weather: _____ **Temp:** _____

Equipment Used: _____

Hours: _____ _____ **Mileage:** _____ **Project Manager:** _____

Contractor *Staff*

Prepared By: _____ **Reviewed By:** _____

Comments:

FIELD REPORT (continued)

Page ___ of ___

Project: _____ Date: _____ Project #: _____ Task #:_____

FARALLON CONSULTING

Groundwater Level Measurement Summary Form

Date:		**Project Name:**
Project Number:	**Task:**	**Project Location:**
Equipment Used:		**Project Manager:**

Well Number	Time	Depth to NAPL (feet)	Depth to Water (feet)	NAPL Thickness (feet)	Total Well Depth (feet)	Comments

Prepared By:

LOW FLOW WELL PURGING AND SAMPLING DATA

		WELL NO:
DATE:	PROJECT NAME:	PROJECT NO:
WEATHER CONDITIONS:		
WELL DIAMETER (IN.) ☐ 1 ☐ 2 ☐ 4 ☐ 6 ☐ OTHER _____		
SAMPLE TYPE: ☐ GROUNDWATER ☐ WASTEWATER ☐ SURFACE WATER ☐ OTHER		
WELL DEPTH (TOC) FT.	DEPTH TO WATER BEFORE PURGING (TOC) FT.	
LENGTH OF WATER FT.	CALCULATED ONE WELL VOLUME[1]: _ GAL.	
DEPTH OF SAMPLE POINT FT.	ESTIMATED VOLUME PURGED GAL.	
EQUIP. DECON. ☐ ALCONOX WASH ☐ LIQUINOX WASH ☐ DIST/DEION 1 RINSE ☐ DIST/DEION 2 RINSE ☐ OTHER		
CONTAINER PRESERVATION: ☐ LAB PRESERVED ☐ FIELD PRESERVED		
WATER ANALYZER:	PUMP TYPE:	TUBING:

ACTUAL TIME (min)	FLOW RATE (ml/min)	DEPTH TO WATER (feet)	TEMP ☐ °F ☐ °C	SPECIFIC CONDUCT.	pH	DISS. OXYGEN (mg/l)	TURBIDITY (NTU)	ORP (mV)	REMARKS
			(+/- 0.1°)	(+/- 3%)	(+/- 0.1)	(+/- 10%)	(NA)	(+/- 10 mV)	(EVIDENT ODOR, COLOR, PID)
	INITIAL		--	--	--	--	--	--	

DEPTH TO WATER AFTER PURGING (TOC) FT.	SAMPLE FILTERED ☐ YES ☐ NO SIZE _____
NOTES:	SAMPLE TIME: ID# _ _
	DUPLICATE ☐ TIME: ID#:
	EQUIP. BLANK: ☐ TIME: ID#:
	PREPARED BY:

[1] A 1 FOOT LENGTH OF WATER = 0.05 GAL IN 1" DIA. PIPE 0.17 GAL IN 2" DIA PIPE 0.65 GAL IN 4" DIA PIPE 1.5 GAL IN 6" DIA PIPE

OnSite Environmental Inc.
14648 NE 95th Street
Redmond, WA 98052
(425) 883-3881

Client _____

Project _____

Sample ID _____

Date _____ Time _____

Analysis _____ Preservative _____

Chain of Custody

OnSite Environmental Inc.
14648 NE 95th Street • Redmond, WA 98052
Phone: (425) 883-3881 • Fax: (425) 885-4603

Page _____ of _____

Company:

Project Number:

Project Name:

Project Manager:

Sampled by:

Turnaround Request (in working days)

(Check One)

☐ Same Day ☐ 1 Day

☐ 2 Day ☐ 3 Day

☐ Standard (7 working days)

☐ _____ (other)

Laboratory Number:

Requested Analysis

Lab ID	Sample Identification	Date Sampled	Time Sampled	Matrix	# of Cont.	NWTPH-HCID	NWTPH-Gx/BTEX	NWTPH-Dx	Volatiles by 8260B	Halogenated Volatiles by 8260B	Semivolatiles by 8270C	PAHs by 8270C / SIM	PCBs by 8082	Pesticides by 8081A	Herbicides by 8151A	Total RCRA Metals (8)	TCLP Metals	HEM by 1664	VPH	EPH					% Moisture

	Signature	Company	Date	Time	Comments/Special Instructions
Relinquished by					
Received by					
Relinquished by					
Received by					
Relinquished by					
Received by					

Reviewed by/Date

Reviewed by/Date

Chromatograms with final report ☐

DISTRIBUTION LEGEND: White - OnSite Copy Yellow - Report Copy Pink - Client Copy

NON-HAZARDOUS WASTE

OPTIONAL INFORMATION

Shipper _____

Address _____

City, State, Zip _____

Contents _____

NON-HAZARDOUS WASTE

WASTE INVENTORY TRACKING SHEET

Project Number: _____ **Page:** _____ **of**

Project Name: _____ **Generation Date:** _____

Project Address: _____ **Prepared By:** _____

Field Work Description: _____ **Date Waste Removed:** _____

Project Manager: _____ **Waste Transporter:** _____

Waste Disposal Location:

Unique Container ID	Container Size	% Capacity Used	Contents (Soil/GW/Decon Water)/ Origin (Boring or Well ID)	Date(s) Accumulated	Labeling (Contents Under Test/ Haz/Non-Haz/Other-Specify)	Sampled (Y/N)	Comments

NOTES: Contents should be specified and include identification of well/boring, media, source, depth of soil (if applicable), and any other helpful information.

Container ID should be unique when compared against other nearby containers. Special waste labels may include flammable, corrosive, dangerous when wet, and/or oxidizer.

Location of Drums (sketch or describe):

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