ENVIRONMENTAL PARTNERS INC 1180 NW Maple Street, Suite 310 Issaquah, Washington 98027 ph 425.395.0010

Compliance Monitoring Plan
Post Closure Monitoring Under the Olalla Landfill Cleanup Action Plan

Olalla Landfill
Kitsap County, Washington

Prepared For:

Kitsap County Department of Public Works
Solid Waste Division
614 Division Street, MS-27
Port Orchard, Washington 98366

March 17, 2015

Prepared By:

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Hydrogeologist
280
Licensed Geologist
DOUGLAS C. KUNKEL

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Principal Hydrogeologist

EPI Project Number: 45403.0

QR DK TR DK

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DISTRIBUTION LIST

This Compliance Monitoring Plan (CMP) distribution list identifies all individuals who should receive a copy of the approved CMP, either in hard copy or electronic form. Individuals on this distribution list should also receive any subsequent revisions to this CMP.

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ABBREVIATIONS AND ACRONYMS

Abbreviation/ Acronym	Definition
CMP	Compliance Monitoring Plan
COCs	Constituents of concern
DO	Dissolved oxygen
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
HASP	Health and Safety Plan
KCPW	Kitsap County Public Works
KPHD	Kitsap Public Health District
Landfill	Olalla Landfill
MFS	Minimum Functional Standards for Solid Waste Handling
µg/L	Micrograms per liter
ORP	Oxidation-reduction potential
QAP	Quality Assurance Plan
RI/FS	Remedial Investigation/Feasibility Study
SAP	Sampling and Analysis Plan
SWD	Kitsap County Public Works Solid Waste Division
SWHP	Solid Waste Handling Permit
TOC	Total organic carbon
VOC	Volatile organic compound
WAC	Washington Administrative Code

1.0 INTRODUCTION

This Compliance Monitoring Plan (CMP) was prepared by Environmental Partners, Inc. (EPI) on behalf of Kitsap County Public Works Solid Waste Division (SWD) to document groundwater, surface water and landfill gas monitoring procedures performed under the Olalla Landfill Cleanup Action Plan (CAP) (Parametrix 2014) and the requirements of post closure care Washington Administrative Code (WAC) 173-304-407, Minimum Functional Standards for Solid Waste Handling (MFS). MFS monitoring requirements are further described Post Closure Solid Waste Handling Permit (SWHP) for the Olalla Landfill (the Landfill). The SWHP is issued annually by the Kitsap Public Health District (KPHD).

The CMP is organized as follows:

- **Section 1 Introduction –** Describes the organizational structure of the CMP and the three Attachments to the CMP, which contain the Sampling and Analysis Plan, the Quality Assurance Plan, and the site-specific Health and Safety Plan for the Landfill. Describes the physical setting, layout, and history of the Landfill.

- **Section 2 Project Organization –** Identifies the organizational structure of the project, identifies roles and responsibilities for individuals involved in significant project roles.

- **Section 3 Regulatory Framework –** Defines the regulatory framework for implementation of Landfill monitoring under the SWHP and the CAP and identifies constituents of concern, cleanup levels, and the conditional point of compliance for the Landfill.

- **Section 4 Selected Cleanup Action –** Describes the selected cleanup action, monitored natural attenuation (MNA), indicators of the MNA process, and its applicability to site-specific conditions at the Landfill.

- **Section 5 Implementation of the Cleanup Action Plan –** Describes implementation of the CAP and the groundwater monitoring program designed to demonstrate MNA and progress toward CULs

- **Section 6 References** – References for materials that are cited in the text.

1.1 Compliance Monitoring Plan Organization

The CMP organizes and combines elements that were formerly provided in separate documents including the Sampling and Analysis Plan (SAP), Quality Assurance Plan (QAP), and Health and Safety Plan (HASP) for the Landfill. These elements are presented as attachments to the CMP so that they can be revised and updated individually as needed. In addition, organizing the SAP, QAP, and HASP as separate attachments within the CMP makes them more useful as references for field staff, analytical laboratory staff, and project managers, who have different roles and responsibilities within the project and therefore, will focus on different elements of the CMP.

The attachments to the CMP are:

- **Attachment A – Sampling and Analysis Plan (SAP)** is included as Attachment A and documents groundwater, surface water, and landfill gas monitoring procedures performed at the Landfill. The SAP also includes procedures for documentation, sample management, decontamination, and the inspection, operation, and maintenance procedures for monitoring wells, landfill gas flares, and monitoring equipment at the Landfill.

- **Attachment B – Quality Assurance Plan (QAP)** is included as Attachment B and provides a detailed description of work associated with field activities and specifies the protocols for collecting samples, taking measurements, and performing other field operations that are specific to monitoring under the requirements of the Olalla Landfill CAP (Parametrix 2014) post closure care under WAC 173-304-407, Minimum Functional Standards for Solid Waste Handling at the Olalla Landfill.

- **Attachment C – Health and Safety Plan (HASP)** is included as Attachment C and includes health and safety procedures and equipment requirements for all activities related to implementation of the remedial action performed under the CAP and SWHP at the Landfill. A copy

1.2 Landfill Location and Description

The Landfill is located in southern Kitsap County, Washington, approximately 0.75 miles east of Highway 16 at 2850 SE Burley-Olalla Road, Port Orchard, Washington, in the northeast quarter of Section 1, T22N, R1E as shown in Figure 1-1.

Kitsap County Public Works (KCPW) owns the Landfill property and the current parcel number of the property is 012201-1-029-2003. The original parcel consisted of approximately 75 acres, which was subdivided into two parcels in 1996, a 45-acre parcel to the north, and a 30-acre parcel to the south. The 30-acre parcel to the south was never used as a landfill.

The Landfill consists of an approximately 6.5-acre area capped by a clay-amended soil low-permeability barrier and vegetated protective soil cover (Phase I Area) and an approximate 4.5-acre area covered with vegetated soil (Phase II Area). Both the Phase I and Phase II areas of the Landfill are surrounded by a gravel perimeter access road that encompasses approximately 12 acres.

The perimeter road is accessed through a locked gate at Bandix Road SE to the east side of the property. The Landfill area also contains a groundwater monitoring well network, a passive landfill gas collection system, a surface water conveyance system, a storm water detention pond, public access controls, and a surrounding vegetation buffer. The Phase I and Phase II Areas, monitoring wells, flares, surface water sampling location, and other features of the Landfill, are shown in Figure 1-2.

In addition to the closed Landfill, the north parcel contains a Drop Box, known as a Recycling and Garbage Facility in Kitsap County, which was established as a transfer station at the time the Landfill stopped accepting waste. A fence and locked gate separate the Recycling and Garbage Facility from the Landfill. Two monitoring wells, MW-5 and MW-5A, are located on the Recycling and Garbage Facility side of the fence. The remainder of the groundwater and surface water sampling locations and the landfill gas flares are located on the Landfill (south) side of the fence.

1.3 Landfill History

Records indicate that waste disposal at the Landfill started in the late 1950s or early 1960s; however, the exact timeframe is unknown. During operation, the Landfill accepted solid waste from residential and light commercial self-haulers. The waste types disposed at the Landfill were mixed municipal solid waste, demolition and construction materials, and a small volume of septic sludge (Parametrix 1988). Initial Landfill operations reportedly consisted of burning the refuse and covering the waste with soil on monthly intervals. Open burning was stopped in the early 1970s.

In late 1971, KCPW took over operation of the Landfill and operated the facility in accordance with the solid waste landfill practices at the time, which included compaction of the waste and daily soil cover of the compacted waste (Parametrix 1988). The transfer station began operations in the northern part of the property in the spring of 1985, and the Landfill no longer accepted waste after that time.

After the Landfill stopped accepting waste in 1985, prior to formal closure activities, KCPW installed four groundwater monitoring wells, designated MW-1 through MW-4. Two additional monitoring wells, MW-5 and MW-6, were installed in 1988 as part of the Landfill closure activities. MW-5A was installed in 1989 as a replacement well for MW-5, which is screened in a laterally discontinuous perched groundwater zone above the elevation of the refuse. Well MW-7 was installed in 1993 after closure activities were completed to provide an additional monitoring location at the southwest corner of the Landfill. Two additional downgradient monitoring wells, MW-8 and MW-10, were installed in 2010 as part of the Remedial Investigation/Feasibility Study (RI/FS) conducted for the Landfill. Monitoring well locations at the Landfill are shown in Figure 1-2.

A passive landfill gas collection system was installed within the Phase I Area of the Landfill during closure activities in 1989 in accordance with the final closure plan (Parametrix 1988). The passive gas collection system was installed under the low permeable cover to collect and vent Landfill gas. The gas system consists of three flares connected with 6-inch diameter perforated polyethylene pipes. Flares 1 and 2 are located on the east side of the Landfill and Flare 3 is located on the southwest side of the Landfill as shown in Figure 1-2.

Long-term monitoring activities have been conducted at the Landfill since closure and are ongoing. These activities include quarterly groundwater monitoring from the Landfill monitoring well network, quarterly landfill gas monitoring, and annual surface water monitoring. Monitoring is conducted to meet the requirements of the Landfill Post Closure SWHP issued annually by KPHD.

Remedial Investigation (RI) activities were conducted between May 2010 and May 2014, when the final RI/FS report was submitted to the Washington State Department of Ecology (Ecology) and KPHD. The investigation approach used for the RI/FS was to sample site soil, groundwater, surface water, and landfill gas in order to develop information as to the origin, nature, and extent of the constituents of concern (COCs) at the Landfill.

2.0 PROJECT ORGANIZATION

The SWD has overall responsibility for all activities at the Landfill including operation, maintenance, monitoring, and reporting. Project management, quality assurance, laboratory, and field responsibilities of essential project personnel are defined in the following sections.

2.1 Project Organization Chart

The names and company or agency affiliations for individuals involved in significant project roles and addresses are show in the Distribution List. Project management organization for CAP and MFS monitoring and reporting is depicted in Figure 1-3. More detailed descriptions of project roles on the project organization chart are provided below.

2.2 Project Roles and Responsibilities

- Ms. Alexis McKinnon is the Projects and Operations Manager for SWD and serves as the SWD Project Manager and the main SWD contact for coordinating access to the Landfill and obtaining keys and SWD-owned equipment prior to monitoring events.

- The KPHD serves as the local health jurisdiction and environmental regulatory agency for the Landfill. The KPHD Solid and Hazardous Waste Program Manager is ultimately responsible for issuing and enforcing the Post Closure SWHP issued for the Landfill. Jan Brower is the KPHD Program Manager for the Landfill.

- The Consultant Project Manager is responsible for overseeing project performance to ensure contract compliance and for implementing all necessary actions and adjustments to accomplish the Landfill monitoring and reporting program objectives.

- The Consultant Field Monitoring Site Manager is responsible for overseeing the field monitoring tasks of this project and is responsible for day-to-day coordination with the Consultant Project Manager on technical issues, coordinating and managing field staff, implementing quality control procedures for field measurements, and for monitoring and documenting all fieldwork performed for this project. Field monitoring includes the groundwater, surface water, and landfill gas monitoring tasks.

- The Consultant Health and Safety Officer is responsible for evaluating risks associated with implementation of the SAP and site-specific HASP.

- The Consultant Project Database Manager and is responsible for data entry, statistical evaluations, and data uploads to Ecology's Electronic Information Management (EIM) database.

- TestAmerica Seattle (TestAmerica), located in Tacoma, Washington, is the designated analytical laboratory for analysis of groundwater and surface water samples for this project. Heather Prater is the Laboratory Director and Kristine Allen is the primary contact person for TestAmerica on this project. Terri Torres is the Laboratory Quality Assurance Manager for TestAmerica.

One person may serve in two or more of the roles noted above, and shown on the project organization chart (Figure 1-3), as appropriate for the project. For example, the same individual may serve as the Field Monitoring Manager and as the Health and Safety Officer.

3.0 REGULATORY FRAMEWORK

The Landfill was closed in 1988-1989 in accordance with the Olalla Landfill Final Closure Plan (Parametrix 1988). Post-closure activities consist primarily of quarterly landfill monitoring, maintenance, and reporting performed under WAC 173-304-407 Minimum Functional Standards for Solid Waste Handling (MFS) "General Closure and Post Closure Requirements", Kitsap County Board of Health Ordinance 2010-01 "Solid Waste Regulations", and Post Closure SWHP that are issued annually by KPHD.

3.1 Constituents of Concern

Groundwater COCs identified during the RI, arsenic, iron, manganese, and vinyl chloride, were based on existing long-term monitoring results for the Landfill. The procedure used for selecting the COCs was to compare analytical results from long-term monitoring to regulatory screening levels defined as constituent concentrations above which the levels may pose a threat to human health or the environment. Groundwater samples were analyzed for the COCs identified, as well as the full WAC 173-351-990 Appendix III constituent list, which is the list of hazardous inorganic and organic constituents in the Municipal Solid Waste Landfill regulations.

3.2 Cleanup Levels

Cleanup levels (CULs) were developed for the COCs according to the requirements of the MTCA regulations (Ecology 2007), which stipulate that cleanup levels be "at least as stringent as all applicable state and federal laws" (RCW 70.105D.030 [2][e]). The Final RI/FS Report (Parametrix 2014) described the process for evaluating the indicator hazardous substances and identified the following remaining COCs that must be addressed by the selected cleanup action at the Landfill:

- Arsenic CUL = 1.29 micrograms per liter (μg/L);

- Iron CUL = 300 μg/L;

- Manganese CUL = 50 μg/L; and
- Vinyl chloride CUL = 0.29 μg/L.

Although vinyl chloride was initially identified as a COC for the RI/FS, vinyl chloride was not detected at concentrations that exceeded the CUL within the past three years. Vinyl chloride, however, will continue to be monitored.

3.3 Groundwater Conditional Point of Compliance

The point of compliance (POC) is the point or points where CULs established in accordance with WAC 173-340-720 through 173-340-760 shall be attained. WAC 173-340-720(8) defines the standard groundwater POC for all sites as the groundwater throughout the site from the uppermost level of the saturated zone extending vertically to the lowest most depth, which could potentially be affected by the site. However, WAC 173-340-720(8)(c) allows for a conditional point of compliance (CPOC) where it is not practicable to meet the cleanup level throughout the site within a reasonable restoration timeframe. The regulation requires that the CPOC shall be as close as practicable to the source of hazardous substances and shall not extent beyond the property boundary.

The Landfill meets the conditions for a CPOC because leachate will continue to be released from the Landfill for years thereby creating an ongoing source of contaminants and maintaining reducing geochemical conditions that are anticipated to impact groundwater under the capped or covered refuse. The source material in the landfill waste will not be completely mitigated without complete removal of all refuse at the Landfill; therefore, it will not be practicable to meet the cleanup levels throughout the Landfill within a reasonable restoration timeframe.

As noted in the CAP, the Landfill property boundaries are appropriate as the Landfill CPOC. Based on the west-northwest regional groundwater flow direction established during the RI, the western property boundary is a downgradient boundary, the north and south boundaries are roughly parallel to regional groundwater flow, and the eastern boundary is upgradient. The Landfill property boundary is also within the 1,000-foot minimum distance required for water supply wells located near solid waste landfills (WAC 173-160-171). The downgradient wells located along the western property boundary (MW-3, MW-6, MW-7, MW-8, and MW-10) are close to the refuse limits and will serve as the monitoring points at the CPOC.

4.0 SELECTED CLEANUP ACTION

Monitored Natural Attenuation (MNA) and Land Use Controls is the selected cleanup action alternative. This alternative was selected using the MTCA Feasibility Study process and is described in detail in the RI/FS report (Parametrix 2014).

The cleanup action consists of the following elements:

- Continued quarterly monitoring of five (5) groundwater monitoring wells (MW-1, MW-3, MW-6, MW-8, and MW-10) and annual monitoring of two (2) cross-gradient wells (MW-5A and MW-7) and one (1) surface water location (SW-2) with quarterly reporting. For the purposes of the feasibility study, it was assumed that monitoring would occur for 30 years.

- Continued inspection, maintenance, and repair of Landfill closure systems, including the cap, drainage ditches, and the Landfill gas system.

- Continued quarterly monitoring, maintenance, and operation of the Landfill gas system.

- Preparation of a Restrictive Covenant, Land Use Control Implementation Plan, and Notice of Conveyance or Other Transfer of an Interest in the Property upon property transfer. The Restrictive Covenant will also be put in place when the cleanup action is complete or when the facility no longer operates under a post-closure permit. **(The Restrictive Covenant element of the cleanup action is not included in this Compliance Monitoring Plan)**.

4.1 Monitored Natural Attenuation Description and Applicability

Natural attenuation is the process by which concentrations of chemicals introduced into the environment are reduced over time by a combination of natural physical, biological, and chemical processes. MNA relies on the continuation of site-specific natural attenuation processes to achieve cleanup levels at the CPOC within a reasonable restoration timeframe. Groundwater monitoring of the conditions favorable for those site-specific natural attenuation processes is necessary to demonstrate that natural attenuation is maintained over time at the Landfill.

Characteristics of sites where MNA might be appropriate (WAC 173-340-370(7)) are provided below followed by a description of conditions present at the Landfill that meet each of the characteristics supporting MNA.

Characteristics Supporting MNA	Conditions at Olalla Landfill
Source control, including removal and/or treatment of hazardous substances, has been conducted to the maximum extent practicable.	The Olalla Landfill Phase I Area was closed with a low permeability bentonite-amended soil cap in accordance with Chapter 173-304 WAC. The cap is monitored and maintained in accordance with the Landfill closure plan and the SWHP. The Phase II area is covered by a minimum of 1 foot of vegetated soil, and wastes remain dry and are separated from the uppermost aquifer by 40 to 50 feet, indicating no direct contact between waste and groundwater.
Leaving contaminants on-site during the restoration timeframe does not pose an unacceptable threat to human health or the environment.	Groundwater at the Olalla Landfill exceeds CULs at the CPOC; however, no direct contact exposure route for groundwater ingestion or contact is identified. Continued post-closure operation and land use controls will reduce the potential for future changes to groundwater exposure scenarios.

Characteristics Supporting MNA	Conditions at Olalla Landfill
There is evidence that natural biodegradation or chemical degradation is occurring and will continue to occur at a reasonable rate at the site.	Based on typical trends observed with other similar closed Chapter 173-304 WAC landfills, declining leachate releases and landfill gas production over time lead to long-term declining trends in groundwater contaminant concentrations. Groundwater concentrations of COCs at the Landfill have been steady or declining during the monitoring period and would be expected to continue to decline and ultimately achieve CULs.
Appropriate monitoring requirements are conducted to evaluate if conditions favorable for natural attenuation processes are maintained and that human health and the environment are protected.	Quarterly groundwater monitoring is required at the Landfill as part of the SWHP and will continue in accordance with the current SWHP. Monitored parameters include parameters used to evaluate if natural attenuation processes are taking place including specific conductance, pH, dissolved oxygen, and oxidation-reduction potential. Land use restrictions currently in place and permit limitations on developing adjacent properties within 1,000 feet of the Landfill will continue to protect potential exposure through direct contact or ingestion of groundwater that exceeds CULs.

4.2 Monitored Natural Attenuation Process Indicators

Natural attenuation processes at the Landfill that might reduce the COC concentrations in groundwater during transport downgradient are dispersion, dilution, chemical stabilization, and sorption. Dispersion and dilution appear to be the current dominant attenuation processes at the Landfill; however, as the leachate generation and anaerobic conditions beneath the Landfill dissipate over time, the geochemistry within the subsurface will change and chemical stabilization and sorption will likely become the dominant attenuation processes to attain decreasing metals concentrations in groundwater. Supporting information for this statement includes:

- pH is commonly neutral or slightly acidic in samples collected from all Landfill wells which allows for the mobilization of metals in anaerobic (reducing) geochemical conditions or the precipitation or re-adsorption of metals to the aquifer matrix in aerobic (oxidizing) geochemical conditions;

- Dissolved oxygen (DO) and oxidation-reduction potential (ORP) levels are generally low in samples collected from Landfill wells with historical or current vinyl chloride detections and elevated metals concentrations. This demonstrates that the anaerobic (reducing) geochemical condition that favor biodegradation of chlorinated volatile organic compounds (VOCs) is occurring and that the anaerobic geochemical conditions are also mobilizing common metals that are present in the aquifer matrix; and

- DO and ORP levels are generally high in samples collected from Landfill wells where metals concentrations are low indicating that aerobic (oxidizing) geochemical conditions at the Landfill have the ability to decrease metals concentrations at locations where those oxidizing conditions exist.

4.3 Groundwater Monitoring to Demonstrate MNA and Progress Toward Attaining Cleanup Levels

MNA requires long-term groundwater monitoring to demonstrate that natural attenuation processes continue to occur and that COC concentrations will meet cleanup levels within a reasonable timeframe. These data will be obtained under the quarterly groundwater monitoring program, which will continue in accordance with the requirements specified in the current SWHP and in subsequent SWHPs, which are prepared and submitted annually by the KPHD.

During each sampling event, depth-to-water measurements will be measured at wells MW-1, MW-2, MW-3, MW-4, MW-5, MW-5A, MW-6, MW-7, MW-8, and MW-10. These wells were selected because they provide appropriate upgradient, cross gradient, and downgradient coverage of groundwater elevations at the Landfill. Although not required by the SWHP, SWD has elected to measure depth to water at well MW-5. This will be done to track changes in the water level of the shallow, discontinuous perched saturated zone that is not hydraulically connected to the uppermost aquifer beneath the Landfill. The depth to water measurement schedule and measurement procedures are presented in greater detail in the SAP (Attachment A).

Wells MW-1, MW-3, MW-5A, MW-6, MW-7, MW-8, and MW-10 will be sampled for laboratory analyses. Of the wells sampled, MW-3, MW-6, MW-8, and MW-10 represent downgradient locations, MW-5A and MW-7 represent cross-gradient locations, and MW-1 represents the upgradient location. The constituents to be analyzed include field parameters (i.e., pH, specific conductance, DO, temperature, and ORP), dissolved metals (i.e., arsenic barium, iron, manganese, and zinc), total metals (i.e., calcium, potassium, and sodium), VOCs including vinyl chloride, and conventional constituents (e.g., ammonia, chloride, total organic carbon, bicarbonate, carbonate, nitrate, nitrite, sulfate, and alkalinity), chemical oxygen demand, total coliform, and total organic carbon. The groundwater monitoring schedule and the constituents analyzed for each of the monitoring wells is described in greater detail in the SAP (Attachment A).

Measured field parameters, specifically pH, DO, and ORP, provide an indication of the geochemical characteristics of the aquifer. These parameters will be evaluated over time to determine if, and to what extent, natural attenuation is occurring. Natural attenuation will be indicated by geochemical conditions becoming more neutral and more aerobic as evidenced primarily by increasing pH, increasing DO concentrations and higher ORP values in downgradient wells. As the geochemical conditions become more neutral and more aerobic the dissolved metals concentrations should demonstrate downward trends over time.

5.0 IMPLEMENTATION OF THE CLEANUP ACTION PLAN

Quarterly monitoring is currently ongoing in accordance with the SWHP and will continue under the CAP. Quarterly reports will be used to evaluate the effectiveness of the cleanup action on an ongoing basis. The overall effectiveness of the cleanup action will be evaluated at 5-year intervals as part of the periodic review process. The first quarter of the 5-year interval will correspond with the first quarterly monitoring event following Ecology and KPHD approval of the selected cleanup action in December

2014. The first quarterly monitoring event under the CAP will be the March 2015 event and the first 5-year period review will be performed following the June 2020 quarterly monitoring event.

The 5-year review process will include an evaluation of human exposure to impacted drinking water similar to the off-site water supply well evaluation conducted during the RI. If available, all six off-site water supply wells sampled during the RI will be sampled concurrently with the final quarterly monitoring at the end of the 5-year period. Prior to performing off-site well sampling, a review of the Ecology Well Log database will be conducted to evaluate if new water supply wells have been installed downgradient of the Landfill with a screened interval that could potentially impacted by the Landfill. If SWD determines that new wells exist that could be potentially impacted, the wells will be sampled along with the other six water supply wells. All water supply well samples will be analyzed for dissolved arsenic, iron, and manganese. Sampling of the water supply wells will be conducted by SWD in partnership with KPHD under an inter-agency agreement.

SWD might perform a technical analysis demonstrating the effectiveness of semi-annual sampling after collecting an additional 5 years of quarterly data during the first 5-year review period under the CAP. Proposed adjustments to the monitoring frequency and constituent list will require approval from KPHD.

If significant changes to the current environmental conditions at the Landfill occur during future monitoring, KCPW will evaluate the changes and respond appropriately as required under the SWHP. Examples of changes include increases in COCs concentrations outside of historical trends or detection of new constituents at concentrations potentially harmful to human health or the environment. Investigations as to potential causes will be performed on a case by case basis and appropriate responses developed in coordination with KPHD.

No later than 10 years after commencing the implementation of Alternative 1, SWD will thoroughly re-evaluate all available performance data and reconsider viable alternatives versus Alternative 1, monitored natural attenuation, including Alternative 2 (Geomembrane cap over the Phase I area), for the remedial action of the Landfill.

6.0 REFERENCES

Ecology (Washington State Department of Ecology). 2007. Model toxics control act cleanup regulations. Washington Administrative Code (WAC) 173-340. November 2007.

Parametrix. 1988. Closure Plan for the Olalla Landfill, Kitsap County, Final Report. Parametrix, Inc., Bellevue, Washington. June 1988.

Parametrix. 2014. Olalla Landfill Remedial Investigation/Feasibility Study. Prepared for Kitsap County Public Health District. May 2014.

Figures

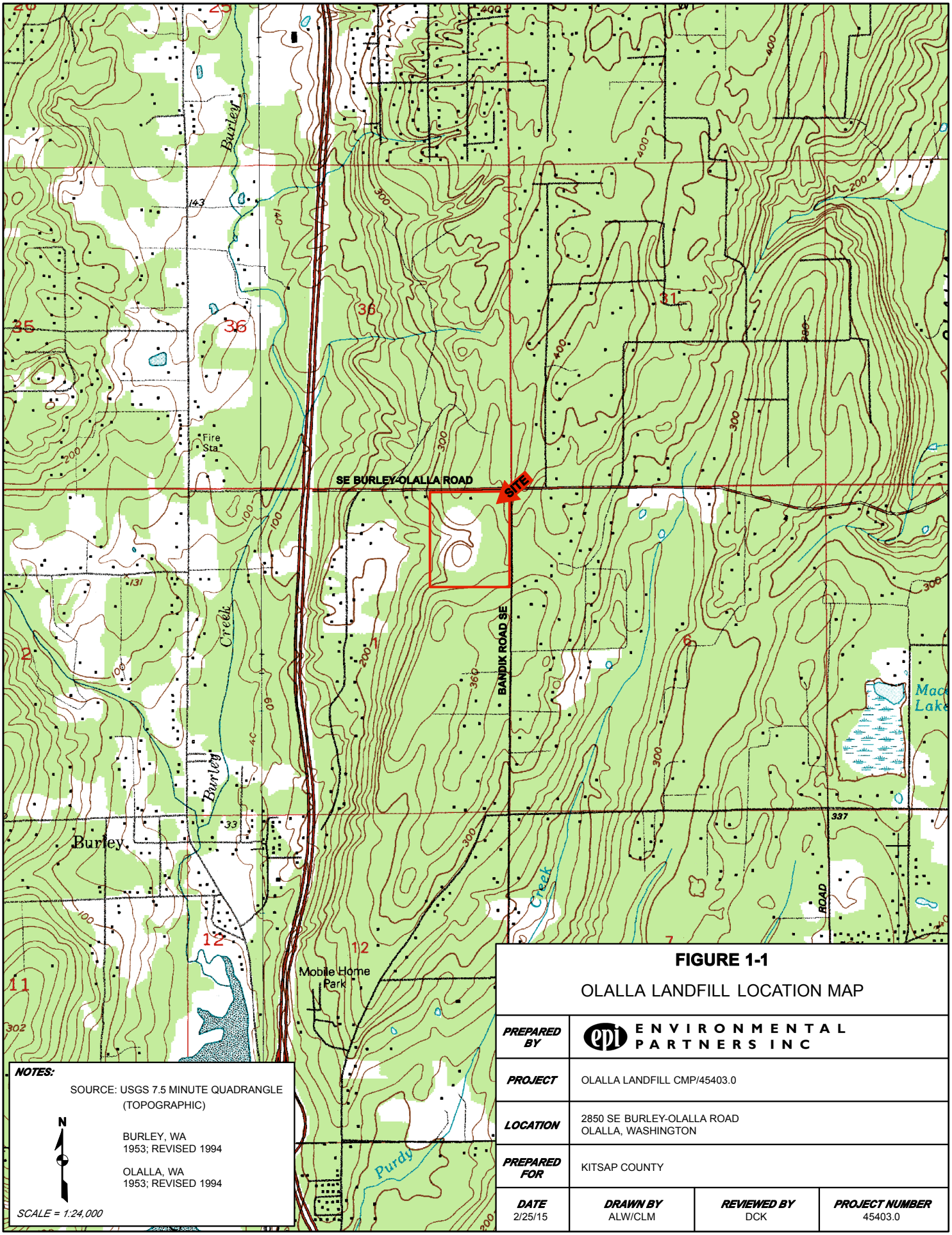
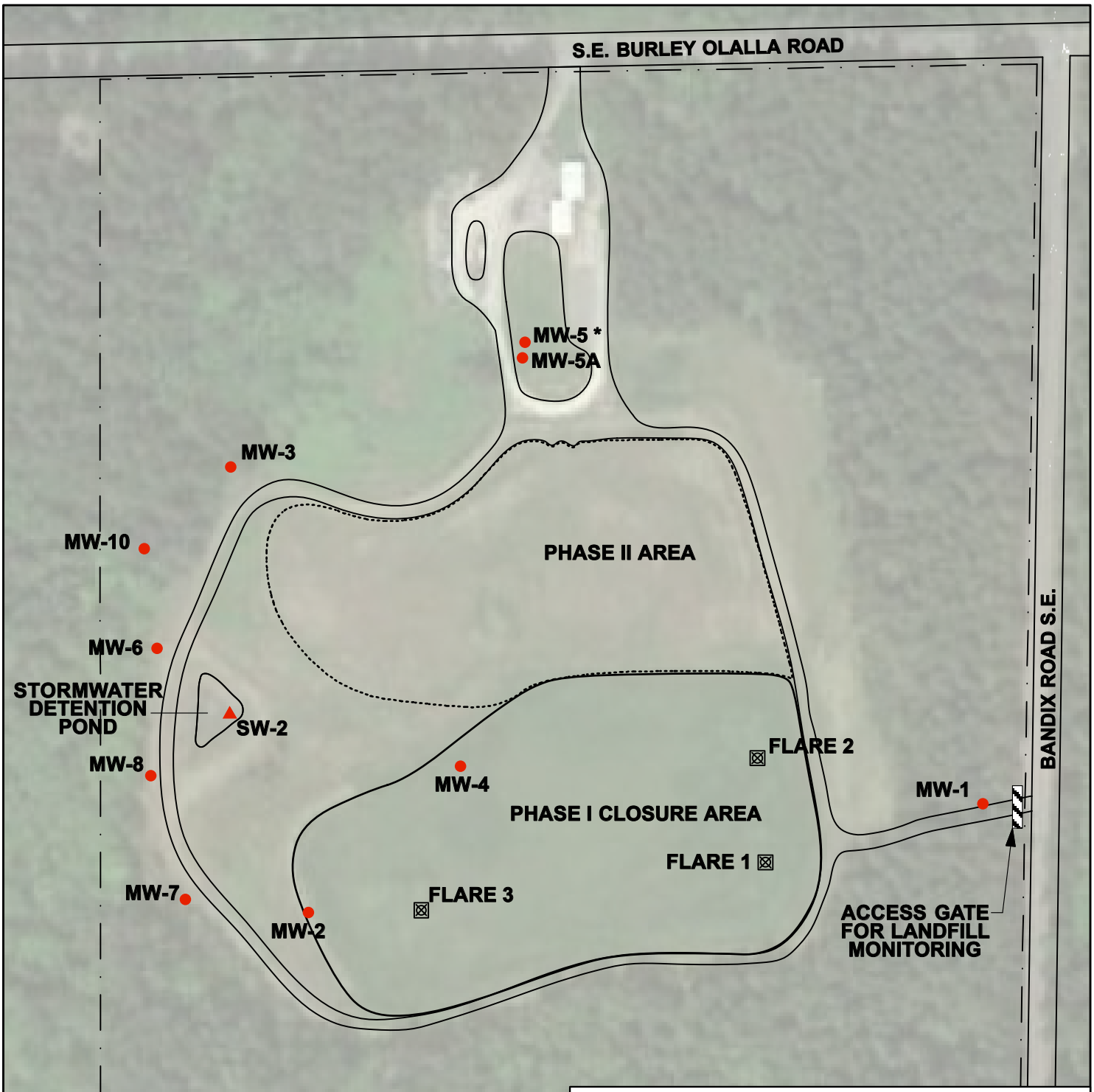


FIGURE 1-1

OLALLA LANDFILL LOCATION MAP

PREPARED BY	ENVIRONMENTAL PARTNERS INC		
PROJECT	OLALLA LANDFILL CMP/45403.0		
LOCATION	2850 SE BURLEY-OLALLA ROAD OLALLA, WASHINGTON		
PREPARED FOR	KITSAP COUNTY		
DATE 2/25/15	**DRAWN BY** ALW/CLM	**REVIEWED BY** DCK	**PROJECT NUMBER** 45403.0



BASE MAP SOURCE:
- Google Earth

TOPOGRAPHIC CONTOUR SOURCE:
- KITSAP COUNTY PARCEL VIEWER

MW-5 is completed in a shallow perched groundwater zone.

NOTES:

- APPROXIMATE PROPERTY BOUNDARY
- PERIMETER ACCESS ROAD
- MW-8 ● MONITORING WELL
- SW-2 ▲ SURFACE WATER SAMPLING LOCATION
- ⊠ LANDFILL GAS FLARE

N

0 50 100 200

SCALE: 1" = 200'

FIGURE 1-2

OLALLA LANDFILL
MONITORING WELL, FLARE, AND SURFACE WATER SAMPLING LOCATIONS
KITSAP COUNTY, WASHINGTON

PREPARED BY	epi ENVIRONMENTAL PARTNERS INC		
PROJECT	OLALLA LANDFILL QAPP/45403.0		
LOCATION	2850 SE BURLEY-OLALLA ROAD OLALLA, WASHINGTON		
PREPARED FOR	KITSAP COUNTY		
DATE 2/25/15	DRAWN BY ALW/CLM	REVIEWED BY ALW/CLM	PROJECT NUMBER 45403.0

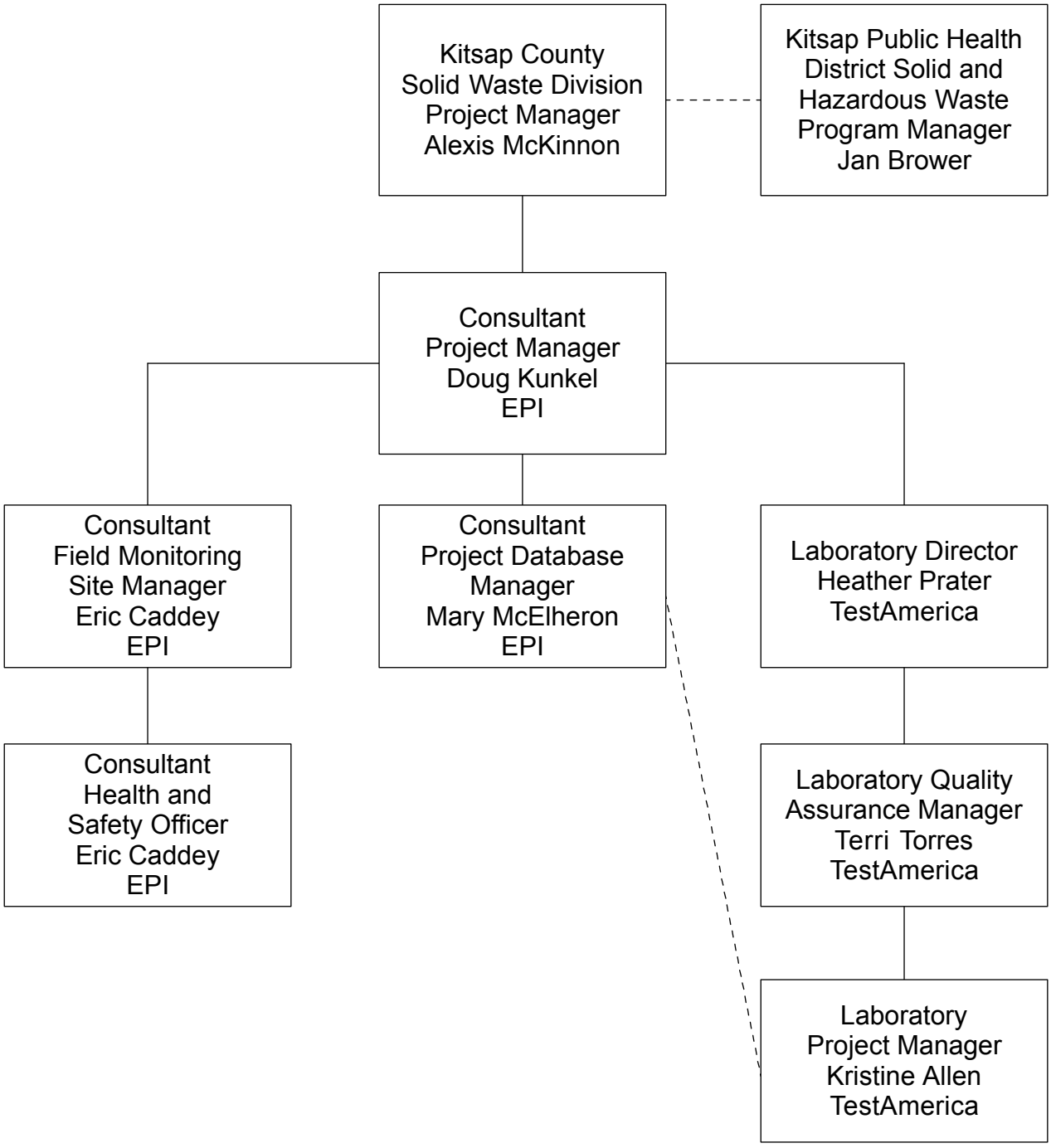


FIGURE 1-3
OLALLA LANDFILL PROJECT ORGANIZATION CHART
KITSAP COUNTY, WASHINGTON

PREPARED BY	ENVIRONMENTAL PARTNERS INC		
REPORT	COMPLIANCE MONITORING PLAN		
LOCATION	OLALLA LANDFILL KITSAP COUNTY, WASHINGTON		
PREPARED FOR	KITSAP COUNTY		
DATE 2/25/15	***DRAWN BY*** CLM	***REVIEWED BY*** DCK	***PROJECT NUMBER*** 45403.0

KEY:
——— DIRECT REPORT
- - - - COMMUNICATION AND COORDINATION

Attachment A
Sampling and Analysis Plan

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Sampling and Analysis Plan
Post Closure Monitoring Under the Olalla Landfill Cleanup Action Plan

Olalla Landfill
Kitsap County, Washington

Prepared For:

Kitsap County Department of Public Works
Solid Waste Division
614 Division Street, MS-27
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March 17, 2015

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State of Washington
Hydrogeologist
260
Licensed Geologist
DOUGLAS C. KUNKEL

Douglas C. Kunkel, L.G., L.H.G.
Principal Hydrogeologist

EPI Project Number: 45403.0

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KCPW	Kitsap County Public Works
Landfill	Olalla Landfill
L/min	Liters per minute
MFS	Minimum Functional Standards for Solid Waste Handling
mL	Milliliter
NTU	Nephelometric turbidity unit
ORP	Oxidation-reduction potential
PVC	Polyvinylchloride
SAP	Sampling and Analysis Plan
SWD	Kitsap County Public Works Solid Waste Division
SWHP	Solid Waste Handling Permit
VOC	Volatile organic compound

1.0 INTRODUCTION

This Sampling and Analysis Plan (SAP) was prepared by Environmental Partners, Inc. (EPI) on behalf of Kitsap County Public Works Solid Waste Division (SWD) to document groundwater, surface water and landfill gas monitoring procedures performed at the Olalla Landfill (the Landfill). The monitoring and reporting work is performed under the Olalla Landfill Cleanup Action Plan (CAP; Parametrix 2014) and the requirements of post closure care Washington Administrative Code (WAC) 173-304-407, Minimum Functional Standards for Solid Waste Handling (MFS). MFS monitoring requirements are further described Post Closure Solid Waste Handling Permit (SWHP) for the Landfill.

Landfill monitoring requirements under the CAP and the SWHP are the same and will be performed concurrently.

The SAP is organized as follows:

- **Section 1 Introduction** – Presents the organization structure of the SAP, briefly describes the physical setting, layout, and history of the Landfill.

- **Section 2 Monitoring Event Preparation** – Describes the preparation steps and procedures required for monitoring events at the Landfill and presents the monitoring schedule for groundwater, surface water and landfill gas.

- **Section 3 Groundwater Sampling Procedures** – Describes groundwater monitoring, schedule, requirements, and procedures under the CAP. Sampling procedures are presented in the order in which they occur during monitoring events. This section includes protocols for environmental sampling, field measurement procedures, and documentation.

- **Section 4 Surface Water Sampling Procedures** – Describes surface water monitoring schedule, requirements, and procedures under the CAP. Sampling procedures are presented in the order in which they ideally occur during a monitoring event. This section includes protocols for surface water sampling, field measurement procedures and documentation,

- **Section 5 Landfill Gas Monitoring Procedures** – Describes landfill gas monitoring procedures and requirements under the CAP. This section includes specific protocols for landfill gas field measurements and documentation.

- **Section 6 Sample Management** – Describes chain of custody, sample packing, and sample transport procedures for groundwater and surface water samples.

- **Section 7 Decontamination Procedures** – Describes decontamination procedures for water level probes, groundwater sampling equipment, personnel, and personal protective equipment (PPE).

- **Section 8 Operation, and Maintenance Procedures** – Describes inspection, operation, and maintenance procedures for monitoring wells, landfill gas flares, and monitoring and sampling equipment used at the Landfill.

1.1 Landfill Location and Description

The Landfill is located in southern Kitsap County, Washington, approximately 0.75 miles east of Highway 16 on SE Burley-Olalla Road in the northeast quarter of Section 1, T22N, R1E, as shown in Figure 1-1.

Kitsap County Public Works (KCPW) owns the Landfill property, which consists of an approximately 6.5-acre area capped by a clay-amended soil low-permeability barrier and vegetated protective soil cover (Phase I Area) and an approximate 4.5-acre area covered with vegetated soil (Phase II Area). Both the Phase I and Phase II areas of the Landfill are surrounded by a gravel perimeter access road that encompasses approximately 12 acres.

The perimeter road is accessed through a locked gate at Bandix Road SE to the east side of the property. The Landfill area also contains a groundwater monitoring well network, a passive landfill gas collection system, a surface water conveyance system, a storm water detention pond, public access controls, and a surrounding vegetation buffer. The Phase I and Phase II Areas, monitoring wells, flares, surface water sampling location, and other features of the Landfill, are shown in Figure 1-2.

In addition to the closed Landfill, the north parcel contains a Drop Box, known as a Recycling and Garbage Facility in Kitsap County, which was established as a transfer station at the time the Landfill stopped accepting waste. A fence and locked gate separate the Recycling and Garbage Facility from the Landfill. Two monitoring wells, MW-5 and MW-5A, are located on the Recycling and Garbage Facility side of the fence. The remainder of the groundwater and surface water sampling locations and the landfill gas flares are located on the Landfill (south) side of the fence.

1.2 Landfill History

Records indicate that waste disposal at the Landfill started in the late 1950s or early 1960s; however, the exact timeframe is unknown. During operation, the Landfill accepted solid waste from residential and light commercial self-haulers. The waste types disposed at the Landfill were mixed municipal solid waste, demolition and construction materials, and a small volume of septic sludge (Parametrix 1988). Initial Landfill operations reportedly consisted of burning the refuse and covering the waste with soil on monthly intervals. Open burning was stopped at the Landfill in the early 1970s.

In late 1971, KCPW took over operation of the Landfill and operated the facility in accordance with the solid waste landfill practices at the time, which included compaction of the waste and daily soil cover of the compacted waste (Parametrix 1988). The transfer station began operations in the northern part of the property in the spring of 1985, and the Landfill no longer accepted waste after that time.

After the Landfill stopped accepting waste in 1985, prior to formal closure activities, KCPW installed four groundwater monitoring wells, designated MW-1 through MW-4. Two additional monitoring wells, MW-5 and MW-6, were installed in 1988 as part of the Landfill closure activities. MW-5A was installed in 1989 as a replacement well for MW-5, which is screened in a laterally discontinuous perched groundwater zone above the elevation of the refuse. Well MW-7 was installed in 1993 after closure activities were completed to provide an additional monitoring location at the southwest corner of the Landfill. Two additional downgradient monitoring wells, MW-8 and MW-10, were installed in 2010 as part of the Remedial Investigation/Feasibility Study (RI/FS) conducted for the Landfill. Monitoring well locations at the Landfill are shown in Figure 1-2.

A passive landfill gas collection system was installed within the Phase I Area of the Landfill during closure activities in 1989 in accordance with the final closure plan (Parametrix 1988). The passive gas collection system was installed under the low permeable cover to collect and vent Landfill gas. The gas system consists of three flares connected with 6-inch diameter perforated polyethylene pipes. Flares 1 and 2 are located on the east side of the Landfill and Flare 3 is located on the southwest side of the Landfill as shown in Figure 1-2.

1.3 Training Requirements and Certifications

Field personnel must be trained as required by the Occupational Safety and Health Administration's (OSHA) Hazardous Waste Operations and Emergency Response (HAZWOPER) regulations. Sampling team members should be briefed regarding potential site hazards and given instructions for proper emergency procedures before sampling begins. Sampling team members must be familiar with and sign the Olalla Landfill Health and Safety Plan (HASP), which is provided in Attachment C of the Compliance Monitoring Plan (CMP).

2.0 MONITORING EVENT PREPARATION

2.1 Data Review

Prior to mobilization field staff should review field notes and sample data sheets from the prior sampling event to identify any potentially unresolved issues that were noted during previous sampling events. Field staff should also review the analytical data from the previous sampling event to evaluate if anticipated contaminant concentrations warrant changes to the HASP (Attachment C).

2.2 Landfill Monitoring Schedule

The Landfill is currently on a quarterly monitoring schedule per the CAP and the Solid Waste Handling Plan (SWHP) issued by Kitsap Public Health District (KPHD). Quarterly monitoring events are typically performed in March, June, September, and December. The monitoring schedule can be modified if weather or other events cause a monitoring event to be postponed but monitoring should return to the normal quarterly schedule noted above to maintain relatively consistent time intervals in the data record. A summary of the monitoring schedules for groundwater, surface water, and landfill gas is presented in Table 2-1.

During the first three quarterly monitoring events of the year groundwater samples are collected from upgradient well MW-1 and downgradient wells MW-3, MW-6, MW-8, and MW-10. During the fourth quarterly monitoring event cross-gradient wells MW-5A and MW-7 are sampled in addition to the five wells sampled during the previous quarters. Groundwater sampling is described in Section 3.

Surface water samples are collected at surface water sampling location SW-2, if surface water is present, during the first or fourth (March or December) sampling event of each calendar year. If a surface water sample is successfully collected during the first (March) sampling event of the year an additional fourth quarter (December) surface water sample is not required. Surface water sampling is described in Section 4.

Landfill gas composition is measured in all three passive landfill gas flares at the Landfill during each quarterly event as described in Section 5.

2.3 Bottle Order

The following procedures will be implemented for ordering bottles from the analytical laboratory prior to each monitoring event:

- Contact the laboratory at least three weeks before the planned sampling event to allow the lab sufficient time to prepare and ship the bottle order and to allow enough time for samplers to confirm that all of the requested bottles, including quality assurance sample bottles, have arrived in good condition.

- Pay particular attention to pre-preserved sample bottle and inspect them to confirm that they contain appropriate preservatives and are sealed properly so that they do not leak and damage or contaminate other sample bottles. If sample bottles are missing or damaged immediately contact the laboratory for replacement bottles to complete the bottle order. An example bottle order form is provided in Attachment A. An Excel file containing the bottle order form template that can be modified to accommodate changes to the MFS sampling is provided on the attached CD ROM in the pocket on the back cover of this SAP.

- Order at least one additional set of sample bottles from the laboratory to provide extra containers in the event of accidental breakage, contamination, or other mishaps. Volatile organic analysis (VOA) vials for volatile organic compound (VOC) analysis are particularly vulnerable to damage, especially the caps, and a full set of extra VOA vials is warranted and recommended per bottle order.

- Confirm that there are sufficient coolers for the filled sample bottles, proper packing material, and sufficient ice to maintain an internal cooler temperature of 4^{o} Celsius (C) or cooler. Contact the analytical laboratory to obtain more or larger coolers if additional coolers are needed to properly pack samples for transport or shipment.

Examples of completed bottle order forms for quarterly monitoring and for annual monitoring are provided in Attachment A of this SAP.

2.4 Coordination with Kitsap County

At least two weeks prior to each sampling event samplers will coordinate the sampling schedule and County-owned equipment pickup with Ms. Alexis McKinnon at SWD (360) 337-5784 or other designated SWD staff. This communication is necessary to confirm that the proposed sampling date is acceptable to the County and to inform them of the upcoming monitoring event.

SWD will provide keys to the padlock for the access gate located on Bandix Road SE as shown in Figure 1-2. SWD will also provide the key for the groundwater monitoring wells, the stormwater detention pond where the surface water monitoring station SW-2 is located, and the landfill gas flare compounds.

Field staff must also contact SWD to obtain the County-owned Grundfos™ pump control unit, or must rent an equivalent pump controller, for the dedicated Grundfos™ submersible pumps that are installed in the monitoring well network for the Landfill. All equipment, including County-owned sampling equipment should be inspected and tested prior to mobilizing to the Landfill to confirm proper operation. The equipment should be repaired or replaced as necessary.

2.5 Equipment Preparation and Inspection

A list of equipment that is necessary or recommended for monitoring at the Landfill is presented in Attachment B of this SAP. The equipment list in Attachment B is not intended to be comprehensive but is intended to be a guide for the minimum equipment needed to complete monitoring at the Landfill.

- All mechanical and electrical equipment needs to be inspected and tested approximately one week prior to mobilization for sampling to allow sufficient time to repair or replace any equipment determined to be unusable as noted in Section 8.3.

- The landfill gas meter is commonly rented and shipped from a third-party equipment rental vendor. If a vendor provides the landfill gas meter, the sampler must confirm that the meter was properly calibrated prior to shipment and the calibration documentation must be retained as part of the field record for the sampling event with a copy provided to the SWD Project Manager.

- If the vendor cannot or does not calibrate the meter, appropriate calibration gases and regulators must be obtained and the meter must be calibrated using the correct gas standards and regulators per the instrument manufacturer's instructions.

3.0 GROUNDWATER SAMPLING PROCEDURES

The following sections provide descriptions of the groundwater monitoring schedule and sampling procedures that are used to fulfill the requirements of CAP and SWHP monitoring for the Landfill.

3.1 Monitoring Well Locations and Sampling Schedule

Ten monitoring wells are installed at the Landfill at the locations shown in Figure 1-2. Well construction information including surveying data for the 10 monitoring wells are summarized on Table 3-1. Geologic and well construction logs for the monitoring wells are provided in Attachment C. Depth to water measurements are obtained from all 10 monitoring wells during all quarterly monitoring events as described in Section 3.3.

Per the CAP and SWHP, the monitoring well network is comprised of seven of the 10 monitoring wells installed at the Landfill: upgradient well MW-1, cross-gradient wells MW-5A and MW-7, and downgradient wells MW-3, MW-6, MW-8, and MW-10. It should be noted that there is no MW-9 because that designation has historically been used to identify field duplicates as discussed in Section 3.6.3. For tracking and identification purposes and to avoid confusion with the duplicate designation, MW-9 was not used to identify a monitoring well. Per the SWHP, MW-2, MW-4, and MW-5 are not sampled; however, depth to water measurements are taken in these wells during each monitoring event.

The groundwater sampling portion of the monitoring program for the Landfill generally consists of the following elements:

- Upgradient well, MW-1, and downgradient wells, MW-3, MW-6, MW-8, and MW-10, are sampled quarterly for the full constituents list in the SWHP.

- Cross-gradient wells MW-5A and MW-7 are sampled annually, during the fourth quarter (December) sampling event for a reduced constituent list.

The current Landfill monitoring schedule for groundwater, surface water, and landfill gas is presented in Table 2-1.

3.2 Field Instrument Calibration

Specific models of field equipment currently used at the Landfill might not be used for future sampling events if they become obsolete, are replaced, or if rental equipment is used. Therefore, instrument-specific calibration instructions are not appropriate for this SAP and the information presented in this section represents general guidelines for instrument calibration using most commercially available instruments that are likely to be used at the Landfill.

Field instruments that are capable of being calibrated will be calibrated prior to sampling by the instrument rental vendor or the field sampler(s). If a rental instrument is calibrated by a vendor field

samplers will retain the calibration documentation as part of the sampling record for that monitoring event and will provide a copy of the calibration sheet to the SWD Project Manager. Instruments calibrated by the field sampler(s) will be calibrated following manufacturer's instructions using appropriate buffers or calibration standards.

Calibration information generated by the field sampler(s) will be documented on Calibration Data Forms, which are provided in Attachment D. There are two types of Calibration Data Forms in Attachment B, one form is designed for multi-parameter meters, and second form can be used for individual instruments. The Calibration Data Forms include blank fields for the following information:

- Manufacturer, model number and serial number of the field instrument(s) used during sampling.
- Manufacturer, lot number, and concentration or pH of calibration standards and buffers.
- Measured values of standards and buffers after calibration is completed.
- Observations if instrument calibration deviates from manufacturer's standards.

Instruments that fail to calibrate per manufacturer's written standards will be removed from service and repaired by a qualified technician or replaced. Samplers will obtain appropriate replacement equipment to complete the sampling event.

Field instruments and water level indicators are powered by batteries, either replaceable or rechargeable, that must be checked routinely for integrity and charge level. Field samplers will maintain extra batteries for instruments with replaceable batteries in case battery replacement is necessary during a sampling event.

3.3 Depth to Water Measurements

Static groundwater level measurements will be obtained before sampling at each of the 10 monitoring wells at the Landfill. Static groundwater level measurement will be performed at MW-5, which is not a requirement in the SWHP but will be measured to track the water level in the shallow perched aquifer in which it is installed.

Depth to water will be measured to the pump wellhead for wells containing dedicated sampling pumps. For wells with no dedicated pumps depth to water measurements will be made to the top of the polyvinyl chloride (PVC) well casing at a marked measuring point or to the north side of the casing if no marked measuring point is present. Water level measurements will be performed using an electronic water level indicator and will be measured to a precision of 0.01 foot. Water level measurement data will be recorded on Depth to Water Measurement Field Data Forms. An example form is included in Attachment D. Information entered on Water Level Measurement Field Data Forms should include the following:

- Manufacturer and model of electronic water level indicator;
- Date and time of measurement to the nearest minute;
- Depth to water to the nearest 0.01 foot; and
- Observations regarding the condition of the well and surrounding area (e.g., protective casing, surface seal, cap, lock, bollards, soil conditions near the well such as depressions, ponded surface water, or other subsidence features, and any installed sampling equipment) as noted in Section 8.1.

The portion of the electronic water level indicator prove and tape that comes into contact with the inside of a well and with groundwater will be decontaminated before use and between measurement locations by spray rinsing with distilled or deionized water. If the water level indicator tape cannot be decontaminated adequately by spray rinsing with distilled or deionized water it will be decontaminated by washing in a solution of Liquinox™ detergent, or equivalent, and potable water followed by spray rinsing with distilled or deionized water as noted in Section 7.

The depth to water measurement and the total depth of the well will be used to calculate the volume of groundwater in the PVC well casing. The wetted casing volume will be calculated using the following equation:

$$\text{Wetted Casing Volume} = (TD-DTW) \times 0.16$$

Where:

TD = Total well depth in feet

DTW = Depth to water in feet

0.16 = gallons of water per foot of 2-inch diameter PVC well casing

Calculated wetted casing volumes of wells that are sampled will be documented on Groundwater Sampling Field Data forms, examples of which are presented in Attachment D. Although there is no minimum casing volume to remove during low-flow purging procedures, the calculated casing volumes are documented for reference to evaluate how much water was purged during low flow purging relative to the volume of water in the well. This information might be useful in evaluating the cause should the field or laboratory data appear anomalous.

3.4 Well Purge Methods and Procedures

Wells that are part of the MFS monitoring well network at the Landfill are equipped with dedicated Grundfos™ submersible pumps that are used for both purging and sampling. Wells will be purged prior to sampling using low-flow (minimal drawdown) purging procedures. Low-flow purging procedures are used to minimize disturbance associated with turbidity and to provide quicker stabilization time for the

measured field parameters pH, dissolved oxygen (DO), temperature, conductivity and oxidation-reduction potential (ORP). Procedures and guidance for low flow purging and sampling can be found in the document titled Low-Stress (Low Flow) Purging and Sampling Procedures for the Collection of Ground Water Samples from Monitoring Wells (EPA 1996).

In general, purging should start at a low flow rate and increase to a rate of approximately 0.5 liters per minute (L/min). The depth to water in the well being purged will be measured periodically, approximately every 3 to 5 minutes. If drawdown is more than 0.3 foot below the original static water level, reduce the pumping rate to stabilize drawdown. Typical low flow pumping rates range between 0.2 L/min and 0.5 L/min. Purging will continue until field parameters are stabilized, as discussed in Section 3.5. To the extent possible, wells will not be purged to dryness.

The control unit for the pumps has a variable frequency control for pumping rate that is displayed as a numeric value on the controller. The frequency used for purging and sampling at each well will be recorded on the Groundwater Sampling Field Data Forms. An example form is presented in Attachment D. The recorded frequencies from the prior event can be used as a guide for attaining an acceptable low-flow pumping rate during the next sampling event.

Purge water will be temporarily retained in 5-gallon buckets, or equivalent. After purging and sampling is completed at each well location the bucket(s) containing purge water will be carried approximately 25 feet or more to a location that is topographically downgradient from the well and the purge water will be poured onto the ground.

3.5 Field Parameter Measurements/Stabilization

Before stabilization parameter measurements are performed, field instruments will be calibrated according to manufacturer's instructions as noted in Section 3.2. Temperature, DO, ORP, pH, specific conductance, and the turbidity of the purged water will be measured during purging and recorded approximately every 3 to 5 minutes. The probes for ORP and DO will be housed in a flow-through cell to avoid entrainment of atmospheric gases during measurement, which can affect results. In addition, the appearance or odor of the water, if notable, will be described on the Groundwater Sampling Field Data Forms. The purge stabilization criteria are based on three successive readings of the field water quality parameters. The following are the stabilization criteria for low-flow purging:

- pH ± 0.1 pH units;
- Specific conductance ± 3 percent;
- Turbidity ± 10 percent if turbidity is >10 Nephelometric Turbidity Units (NTUs);
- Temperature ± 0.1°Celsius (C);
- DO ± 0.3 micrograms per liter (µg/L); and

- ORP ± 10 millivolts.

When the above stabilization criteria have been met, groundwater at the sampling point is stabilized and sample collection can begin. If turbidity is less than 10 NTUs the ± 10 percent stabilization criterion has been met. Because of their sensitivity to atmospheric effects ORP and DO may not always be appropriate stabilization parameters and their optional use as stabilization parameters will depend on site-specific conditions.

The total volume of water purged from each well will be recorded on the Groundwater Sampling Field Data Forms.

3.6 Groundwater Sample Collection

After achieving field parameter stabilization through low flow purging, groundwater samples will be collected following procedures documented in Low-Stress (Low Flow) Purging and Sampling Procedures for the Collection of Ground Water Samples from Monitoring Wells (EPA 1996). For wells that are purged to dryness, sample collection will occur after sufficient recovery to at least 80 percent of the original static water level before purging. The appropriate use of field equipment and decontamination protocols will be followed to minimize or eliminate the potential for cross-contamination. Nitrile gloves, or equivalent, will be changed, at a minimum, between wells and whenever the potential for cross contamination is suspected.

3.6.1 Sequence of Groundwater Sample Collection

Groundwater samples will be collected into laboratory-cleaned, pre-labeled sample bottles and preserved as appropriate for the analytical parameters. Table 3-2 lists recommended analytical methods, requirements for sample containers, preservatives, holding times, and related sample handling instructions. Sample bottles should be filled starting with the most sensitive sample aliquot and ending with the least sensitive aliquot.

For samples from wells MW-1, MW-3, MW-6, MW-8, and MW-10 sample bottles will be filled in the following order:

1. VOCs.
2. Total Coliform.
3. Geochemical Indicator Parameters—Bicarbonate, Carbonate, Chloride, Sulfate, Alkalinity, Ammonia, Nitrate, Nitrite, and pH.
4. Total Organic Carbon (TOC).
5. Chemical Oxygen Demand (COD).
6. Total Metals — Calcium, Potassium, and Sodium.
7. Dissolved Metals (field filtered) — Arsenic, Barium, Iron, Manganese, and Zinc.

Per the CAP and SWHP, wells MW-5A and MW-7 are sampled annually (fourth quarter) for a reduced constituent list during the fourth quarter sampling event. For MW-5A and MW-7 sample bottles will be filled in the following order:

1. Vinyl Chloride;
2. pH; and,
3. Dissolved Metals (field filtered) — Arsenic, Iron, and Manganese.

Groundwater samples for dissolved metals will be field-filtered prior to collection using single-use disposable in-line 0.45-micron filters.

If groundwater sampling locations yield groundwater at such a low rate that sample bottles cannot be filled by the end of the day groundwater sampling will resume within the same monitoring well the following day. No additional purging or parameter stabilization is necessary if the sampling event is performed within 24-hours of initial parameter stabilization or if the location was purged to dryness.

3.6.2 Groundwater Sample Identification

Sample labels will be affixed to sample containers and will be completed with their appropriate sample information prior to sample collection. Sample labels will use the following system for sample identification:

OL-MW-XX

Where:

OL—Identifies samples from Olalla Landfill

MW—Identifies samples from monitoring wells

XX—Monitoring well location number (e.g., MW-3, MW-10)

In addition to sample identification, sample labels contain fields to record other sample specific information including the following:

- Initials of the person(s) collecting the sample;
- Sample collection data (mm/dd/yy);
- Sample collection time to the nearest minute using military (24-hour) time. Record the initial sample start time if all aliquots are collected consecutively;
- Requested laboratory analysis; and
- Preservative used, if any.

3.6.3 Field Duplicate Sample Identification

A field duplicate sample is collected from one of the four downgradient monitoring wells, (MW-3, MW-6, MW-8, or MW-10) during the quarterly monitoring events as described in Section 3.7.1. Duplicate sample locations will be rotated throughout the year such that each of the four downgradient monitoring wells will have one duplicate sample collected every year. Duplicate samples will be assigned fictitious sample identifiers using the following duplicate sample identification system:

- First quarter: MW-9 is the field duplicate of MW-3
- Second quarter: MW-17 is the field duplicate of MW-6
- Third quarter: MW-12 is the field duplicate of MW-8
- Fourth quarter: MW-13 is the field duplicate of MW-10

3.6.4 Sample Documentation

Additional pertinent information and observations will be recorded in the field notebook and on field data forms by the field sampler(s). Example Groundwater Sampling Field Data Forms in Attachment D provides an appropriate format for recording the water level, field parameter, and sample identification information presented in the preceding sections. In addition, the field sampler(s) will document the following information:

- Sampling team members (first and last name and company affiliation and their designated responsibility (e.g., field team leader, assistant).
- Weather conditions at the time of sampling.
- Frequency settings of pump controller used for purging and sampling.
- Well purging data, (e.g., start time, end time, purge rate, total volume purged).
- Field parameter measurements (i.e., water level, pH, conductivity, temperature, turbidity, DO, and ORP).
- Sample data including sample date and time (military or 24-hour time), sample identification, number and types of bottles filled, preservatives, filtration, and analyses requested.

3.7 Field Quality Control Samples

Field and analytical quality control (QC) checks are used to evaluate whether the measurement system is performing adequately and whether data quality objectives (DQOs) and measurement quality objectives (MQOs) are being met. This is accomplished, in part, through the analysis of controlled samples that are introduced to the laboratory from the field. Field duplicates, trip blanks, and if necessary, equipment blanks are collected and submitted to the project laboratory, where applicable, to provide a means of assessing the quality of data resulting from the field sampling program as shown in Table 3-3.

3.7.1 Field Duplicate Samples

Field duplicate samples are used to check for sampling and analysis reproducibility. Field duplicates are submitted to the project laboratory at a frequency of 10 percent of the field samples for every analytical method.

Field duplicates will be submitted blind to the laboratory, with sample numbers that are indistinguishable from primary samples (see Section 3.6.3). Analytical parameter, methods, and frequency for field duplicates are described in Table 3-3. Quality control criteria for field duplicate relative percent difference (RPD) are discussed further in the Quality Assurance Plan (QAP), which is Attachment B to the CMP.

3.7.2 Trip Blank Samples

A trip blank is a distilled, deionized, or equivalent water sample, which originated at the project laboratory. This sample travels with the empty water sample containers to the field and is present in the cooler during sampling. At the conclusion of sampling the trip blank is added to the chain-of-custody and is shipped back to the laboratory with the field samples. Trip blanks monitor potential cross-contamination during sample handling and shipping. Trip blanks will be analyzed for VOCs only. One trip blank sample will be included with each sampling event. Ideally, the results for the trip blank samples will be "not detected". Trip blank analytical parameters, method of analysis, and frequency are shown in Table 3-3.

3.7.3 Equipment Blank Samples

Currently all CAP and SWHP monitoring wells at the Landfill are equipped with dedicated sampling pumps that do not require decontamination unless they are removed from the wells for service or modifications. This eliminates potential cross contamination between sampling locations and eliminates the need to evaluate decontamination procedures through the use of equipment blank samples.

In the unlikely event of dedicated sampling equipment failure, the use of non-dedicated sampling equipment might be necessary. If multiple use, non-dedicated sampling equipment is used the equipment decontamination procedures that are included in Section 7 will be performed prior to

sampling and between sampling locations. In addition, an equipment blank sample will be collected to assess the effectiveness of decontamination procedures for the multiple use field sampling equipment.

The equipment blank sample will be collected from the final rinse of sampling equipment after the decontamination process has been performed. The final rinse for the equipment blank sample will use laboratory-supplied reagent water, or equivalent, poured over the decontaminated equipment. A less desirable alternative is to use store-purchased distilled water for the equipment blank. Equipment blank samples will be analyzed for the same parameters as the associated field samples. Ideally, the results for the equipment blank samples will be "not detected" indicating that the potential for cross-contamination is acceptably limited by the decontamination procedures.

4.0 SURFACE WATER SAMPLING PROCEDURES

4.1 Surface Water Sample Locations and Schedule

The CAP and SWHP require collection of a minimum of one annual surface water sample from the surface water sampling location designated SW-2. The SW-2 location is at the storm water detention pond as show on Figure 1-2. Per the SWHP, the surface water sample is collected at SW-2 if surface water is present, either between January and March (first quarter) or between November and December (fourth quarter) for each calendar year.

The preferred sampling point at SW-2 is from the storm water pipe that discharges into the detention pond. If there is no flow from the discharge pipe a sample may be collected from water in the storm water pond itself, if water is present.

4.2 Surface Water Field Parameter Measurements

The SWHP requires measurements for a subset of the groundwater field parameters at the SW-2 surface water location. The field parameters measured at SW-2 are:

- pH;
- Specific Conductance; and
- Temperature.

Purging is not required prior to sample collection at SW-2 and therefore, one set of field parameter measurements is collected from SW-2 per sampling event. The use of a flow-through cell is not warranted at SW-2 because measurements of the oxygen sensitive parameters DO and ORP are not required at this location.

4.3 Surface Water Sample Collection

Per the SWHP, surface water samples are collected for the following laboratory analyses:

- Fecal Coliform;
- Nitrate-Nitrogen; and
- pH.

4.3.1 Surface Water Sample Containers, Preservatives, and Holding Times

All sample containers will be new, certified clean, and provided by the analytical laboratory. The analytical laboratory will retain clean container certification documentation. Surface water sample containers, handling requirements, and holding times are summarized in Table 4-1.

4.3.2 Surface Water Sample Identification

Sample labels will be affixed to sample containers and will be completed with their appropriate sample information prior to sample collection. Sample labels will use the following system for sample identification:

OL-SW-2

Where:

OL—Identifies samples from Olalla Landfill

SW-2—Identifies samples from the surface water sampling location SW-2

In addition to sample identification, sample labels contain fields to record other sample specific information including the following:

- Initials of the person(s) collecting the sample;
- Sample collection data (mm/dd/yy);
- Sample collection time to the nearest minute using military (24-hour) time. Record the initial sample start time if all aliquots are collected consecutively;
- Requested laboratory analysis; and
- Preservative used, if any.

4.3.3 Surface Water Sample Field Data Form

Field parameter data and sampling information for surface water samples will be documented on Surface Water Sample Field Data Form. An example Surface Water Sample Field Data Form is provided in Attachment D. The Surface Water Sample Field Data Form should contain areas for field parameter data entry as well as descriptions of the appearance and flow rate of surface water at SW-2. Field staff can calculate the approximate flow rate using the bucket and stop watch method if flow rates are high or by noting the time required to fill the 500-mL sample bottle and converting that rate into a liter per minute value.

5.0 LANDFILL GAS MONITORING PROCEDURES

Per the CAP and SWHP landfill gas monitoring is performed during all four quarterly MFS monitoring events. Each of the three flares is monitored for the following parameters:

- Methane (% by volume and % Lower Explosive Limit);
- Oxygen (% by volume);
- Carbon dioxide (% by volume); and
- Gas pressure (inches of water).

All of the landfill gas parameters are field measured and no laboratory samples are required for landfill gas monitoring.

5.1 Landfill Gas Flare Locations

The three passive landfill gas flares, designated Flare 1 through Flare 3, are located in the Phase I Area of the Landfill as shown on Figure 1-2. Each of the three flares is enclosed in separate gated and locked chain link fence enclosures. The key that opens the padlocks on the groundwater monitoring well protective casings also opens the padlocks on the flare enclosures.

5.2 Landfill Gas Measurement Procedures

Landfill gas monitoring will be conducted using the following procedures.

- Unlock the fenced enclosures to access each flare.
- The landfill gas flares are equipped with sampling ports containing hose barb fittings that are operated by a ball valve. Inspect the opening of the hose barb to make sure that no debris is embedded in the opening that could be drawn into the landfill gas meter, potentially damaging the instrument.

- Connect the calibrated landfill gas meter to the hose barb using appropriate flexible plastic tubing and open the valve on the hose barb.

- Turn the landfill gas meter pump on and begin monitoring the required measurement parameters. Landfill gas measurements could fluctuate initially but should stabilize over time.

- When the landfill gas parameter readings stabilize, based on professional judgment of consistent stable readings, record the results as described in the following section.

- Close and lock the fenced enclosures.

5.3 Landfill Gas Monitoring Field Data Form

Field samplers will document the stabilized landfill gas measurements in the appropriate field of the Landfill Gas Monitoring Field Data Forms. An example Landfill Gas Monitoring Field Data Form is presented in Attachment D.

The landfill gas flares and enclosures should be inspected for maintenance issues as described in Section 8.2. Maintenance items will be documented on the "Comments / Inspection Results" portion of the Landfill Gas Monitoring Field Data Form.

6.0 SAMPLE MANAGEMENT

6.1 Chain-of-Custody

Samples collected during this environmental monitoring effort represent physical evidence collected from the field. Because of the potential use of these samples as evidence, their possession must be traceable from collection until the data are ultimately used. Chain-of-Custody procedures are used to maintain and document sample possession. The principal documents used are:

- Sample labels;

- Sample custody seals (if samples are shipped by courier);

- Field sampling records; and

- Chain-of-Custody forms.

Strict Chain-of-Custody procedures will be followed to insure sample integrity and accountability during the Landfill sampling activities. The Chain-of-Custody will begin when the sample is collected and will be maintained until final disposal of the sample.

Verifiable sample custody is an integral part of all field and laboratory operations associated with the monitoring activities at the Landfill. The primary purpose of the Chain-of-Custody procedures is to document the possession of the samples from collection through storage and analysis to reporting. Chain-of-Custody forms will become the permanent record of sample handling and shipment. The consultant's Field Monitoring Site Manager or his/her designee will be responsible to the consultant's Project Manager for monitoring compliance with Chain-of-Custody procedures.

Field sampling personnel are responsible for the care and security of samples from the time the samples are collected until they have been turned over to the shipping agent or laboratory. A sample is considered to be in one's custody if it is in plain view at all times, in the physical possession of the sampler, or stored in a locked place where tampering is prevented.

Empty coolers containing ice or ice-substitute will be available at the site for use each day in the field. Samples collected during the day will be stored in shipping coolers beginning at the time of collection. Filled sample coolers will be locked inside the field vehicle when sampling personnel are not present.

A Chain-of-Custody form will be filled out for each cooler. Only samples in that cooler will be listed on the Chain-of-Custody form. An example of the Chain-of-Custody record is shown in Attachment D. Each Chain-of-Custody form will contain the following information at a minimum:

- Site name/location and project name;
- Sample identification numbers;
- Date and time of sampling;
- Inclusive dates and times of sample possession;
- Type of sample and number of sample containers associated with each sampling point;
- Consecutive number of coolers in a shipment (e.g., cooler #1 of 3);
- List of analyses requested;
- Name and signature of sampling personnel;
- Shipping airbill number, when applicable;
- Comments regarding filtered samples, or any other information that is necessary for the lab; and,
- Spaces for transfer of custody acknowledgment.

When the Chain-of-Custody forms are complete, the field team member(s) will cross-check the forms for possible errors. Any corrections will be made to each record with a single strike mark that is dated and initialed. The person who initials corrections will be the same person who relinquishes custody of the samples.

6.2 Sample Packaging

Before packing samples the tightness of the bottle cap will be checked and tightened as necessary. The exterior of the samples bottles will be inspected to ensure they are clean and dry and that they are labeled correctly.

If samples are shipped, the shipping containers, waterproof ice chests or coolers, which are commonly supplied by the analytical laboratory, will be constructed and packed to meet the following requirements:

- There will be no releases of materials to the environment.
- Inner containers that are breakable (e.g., glass bottles) will be packaged to prevent breakage and leakage.
- The cushioning and absorbent material used for sample packing will not be reactive with sample contents and will not have the potential to contaminate the samples.

As noted above, the analytical laboratory commonly supplies appropriate coolers for sample storage and shipping. However, if additional coolers are needed only sturdy watertight plastic or metal-clad coolers are acceptable.

After sample collection and documentation samples that will be shipped to the analytical laboratory will be packed as follows:

1. Seal the drain plug (if present) on the cooler by taping over the drain hole from inside and outside the cooler.
2. Place a layer of bubble wrap or other non-reactive cushioning on the bottom of the cooler.
3. Wrap glass sample bottles with bubble wrap and seal the wrapped glass bottles in Ziploc™-type plastic bags.
4. All glass bottles will be placed in the cooler standing vertically and will not be placed on their sides.
5. Fill the spaces between the glass bottles with plastic sample bottles, bubble wrap, or other waterproof non-reactive cushioning material.

6. Add double bagged ice (in sealed Ziploc™-type plastic bags) or ice substitute as necessary to maintain an internal cooler temperature of 4°C or lower.

7. Place the completed Chain-of-Custody form(s) in a sealed Ziploc™-type plastic bag and attach this bag to the inside of the cooler lid.

8. Attach signed custody seals at both the front and back of the cooler so that the seals must be broken if the cooler is opened. The custody seals will contain a sample team member's signature (signature must match signature on Chain-of-Custody forms OR signature in field notes) and the date.

9. Tape over the custody seals with fiber packing tape and wrap the tape completely around the cooler so the custody seals will be cut if the fiber tape is cut.

10. Place the name and address of the receiving laboratory in a position clearly visible on the outside of the cooler lid.

If the samples are hand delivered to the laboratory the following sampling packing procedures will be followed:

1. Place all glass bottles in the cooler standing vertically so they are not be placed on their sides.

2. Fill the spaces between the glass bottles with plastic sample bottles, bubble wrap, or other waterproof non-reactive cushioning material.

3. Add double bagged ice (in sealed Ziploc™-type plastic bags) as necessary to maintain an internal cooler temperature of 4°C or lower.

6.3 Sample Shipment/Transport

Samples will be hand delivered to the lab for analysis each day of sampling following standard Chain-of-Custody procedures. In the event that samples are shipped to the lab by courier sample custody procedures for packaging and shipping as noted in Section 6.2 will be followed. Optimally samples should be delivered to the laboratory the same day as sampling to satisfy short holding time requirements (total and fecal coliform). Hand delivered sample coolers do not need to be sealed with fiber tape or custody seals as long as custody of the samples is maintained at all times.

If the sample cooler is not in custody of the sampler signed and dated custody seals will be placed on the cooler lid and body and taped with fiber strapping tape in a manner that requires the custody seals and tape to be cut to gain access to the contents of the cooler. Sample coolers are considered to be in the custody of the sampler if they are in a locked vehicle.

Samples will be shipped or hand delivered to TestAmerica for analysis after each day of sampling at the address below.

TestAmerica Seattle
5755 8th Street East
Tacoma, WA 98424
Contact: Kristine Allen (425) 420-9200
Kristine.Allen@testamericainc.com

If samples are shipped the field sampler(s) will call the laboratory on the following day to confirm the number and condition of the samples received at the laboratory.

6.4 Laboratory Receipt Records

When the samples are received, a designated laboratory sample custodian accepts custody of the samples and verifies that the Chain-of-Custody form matches the samples received. Samples are logged in and assigned a unique laboratory sample identification number. Samples and sample aliquots, including sample extracts, are tracked through laboratory analysis using laboratory sampling routing forms. Details of the analytical laboratory's sample control, record keeping, and document control are presented in the analytical laboratory's quality assurance manual.

Upon sample receipt the overall condition of the samples along with any discrepancies will be noted in the Chain-of-Custody and on the case narrative. The internal temperature of the cooler will be determined by measuring the temperature near the samples. Upon receipt by the laboratory the Chain-of-Custody form will be signed and dated by laboratory personnel. Laboratory personnel will verify sample identifications and sample bottle number using the Chain-of-Custody. Shipping manifests and chain-of-custody forms signed and dated by laboratory personnel will be considered sufficient documentation of sample custody transfer from the sampler, through the shipping agent, to the analyst in the contracted analytical laboratory.

The sample team will retain a copy of each Chain-of-Custody form for the project file and the original copy will be sent with the samples. Bills of lading (if samples are shipped) will also be retained as part of the documentation for the Chain-of-Custody records. In conjunction with data reporting, the analytical laboratory will return electronic files of the original Chain-of-Custody forms to the SWD Project Manager for inclusion into the central project file.

7.0 DECONTAMINATION PROCEDURES

Well purging and sampling equipment that comes into direct contact with sample media, sample containers, or the inside of a monitoring well will ideally be dedicated equipment, assigned to and used at only one well location or will be single-use, disposable equipment that is used at a single location then replaced. If the sampling equipment is not dedicated or single-use disposable equipment, it will be decontaminated between each sampling location using the procedures described in the following sections.

7.1 Water Level Probe Decontamination

The portion of the water level indicator that becomes submerged in groundwater during water level measurements will be decontaminated by spray rinsing with distilled or deionized water. If the water level indicator requires additional decontamination, field sampler(s) will use the following decontamination process:

1. Spray rinse the portion of the water level indicator tape that enters the well casing with a solution of Liquinox™ (or equivalent) and potable tap water.

2. Spray rinse with distilled or deionized water.

3. Wipe the water level indicator tape dry with a new clean paper towel.

7.2 Groundwater Sampling Equipment Decontamination

Although dedicated pumps are used in each well currently sampled, if non-dedicated, multiple-use sampling equipment is used for groundwater sampling due to equipment failure it will be decontaminated prior to use and between each sample location according to the steps noted below. Examples of non-dedicated, multiple-use groundwater sampling equipment includes: submersible pumps and bladder pumps. The steps for aqueous sampling equipment decontamination are as follows:

1. Wash in a solution of Liquinox™ (or equivalent) and potable tap water.

2. Rinse with distilled or deionized water.

3. Spray wash with technical-grade or higher isopropyl alcohol.

4. Spray-rinse with distilled or deionized water.

7.3 Decontamination of Workers and Personal Protective Equipment

It is anticipated that all work associated with groundwater sampling, surface water sampling, and flare monitoring at the Landfill will be conducted in modified Level D protection. Requirements for upgrading to Level C protection are outlined in the Health and Safety Plan, which is provided in Attachment C of the CMP.

Modified Level D protection includes the following components:

- Cotton or Tyvek™ coveralls or equivalent;

- Safety glasses or equivalent;

- Nitrile inner and outer gloves;
- Steel-toed, steel-shank rubber boots, or waterproof leather steel toe, steel shank boots (when working around drilling rigs, probe rigs, or other heavy equipment);
- Hearing protection when appropriate (i.e., while drilling, probing, or working around blowers, generators, or other loud equipment);
- Hard hat (when working around drilling rigs, probe rigs, or other heavy equipment); and
- Department of Transportation (DOT)-approved safety vest (when working around drilling rigs, probe rigs, or other heavy equipment).

Prior to lunch breaks and following the completion of each day's activities on site sampling personnel will remove their outer gloves, remove their boots (if rubber boots are used), remove their coveralls, and then remove their inner gloves. Personnel will then wash their hands and faces with soap and water prior to eating or leaving the site. Inner and outer gloves and Tyvek™ coveralls will be discarded as solid waste. Cotton coveralls will be laundered as needed or replaced if excessive contamination is suspected. Hard hats will be washed when visibly dirty or as necessary

8.0 OPERATION AND MAINTENANCE PROCEDURES

8.1 Monitoring Well Operation and Maintenance

Monitoring wells will be inspected for maintenance issues during every quarterly sampling event performed at the Landfill. Wells will be inspected for the following potential maintenance issues:

- Condition of the lock and protective steel casing;
- Condition of the well cap and PVC well casing;
- Condition of the surface seal and protective bollards;
- Observations regarding soil depressions, ponded surface water, or other subsidence features; and
- Condition of any installed sampling equipment.

Any repair or maintenance issues will be documented on the Depth to Water Measurement Form, or equivalent, and will be reported to the consultant's Project Manager and to the SWD Project Manager.

Sampling staff will perform minor maintenance and repair issues at the time of discovery if possible. Examples of minor issues that sampling staff should be prepared to address include: PVC well cap replacement, lock lubrication (using graphite), re-marking measuring points, and limited brush removal to access the wells.

8.2 Landfill Gas Flare Operation and Maintenance

The passive landfill gas flares will be inspected during each monitoring event for the following items:

- Proper lock and gate operation;
- Proper tightness of bolts and clamps on the flare enclosure;
- Differential settlement;
- Proper monitoring valve operation; and
- Debris or cracks in the hose barb.

Any problems that are identified by the flare inspections will be documented in the field notes and will be reported to the consultant's Project Manager and the SWD Project Manager.

8.3 Sampling Equipment Operation and Maintenance

Sampling equipment and field instruments will be checked prior to each sampling event to assure proper function, battery charge, and inclusion of all parts and ancillary equipment such as calibration kits and flow-through cells. Potential problems to look for during the field equipment checks include:

- Low charge or missing batteries, or low charge on rechargeable batteries;
- Missing or damaged probes;
- Damaged or worn parts, cables, hoses, etc.;
- Missing calibration kits or insufficient volume of calibration fluids or gases; and
- Missing ancillary equipment such as flow-through cells, Tedlar bags, regulators, and probe fill solutions.

The condition of the dedicated sampling pumps and other SWD-owned equipment will be evaluated after each sampling event so that there is sufficient time to repair or replace equipment that is not suitable for monitoring. The SWD Project Manager will be notified of the equipment condition that requires service. Equipment that cannot be repaired by the sampling team will be sent to a qualified repair technician or the manufacturer for service.

9.0 REFERENCES

EPA. 1999. USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review. Office of Emergency and Remedial Response. October 1999.

Parametrix. 1988. Closure Plan for the Olalla Landfill, Kitsap County, Final Report. Parametrix, Inc., Bellevue, Washington. June 1988.

Parametrix. 2014. Olalla Landfill Remedial Investigation/Feasibility Study. Prepared for Kitsap County Public Health District. May 2014.

Tables

Table 2-1: CAP and SWHP Monitoring Schedule

Olalla Landfill, Kitsap County, WA

Sample Location	First Quarter									Second and Third Quarters								Fourth Quarter											
	Water Level	Field Parameters	VOCs	T & D Metals	Total Coliform	Fecal Coliform	Geochemical	TOC / COD	Landfill Gas Parameters	Water Level	Field Parameters	VOCs	T & D Metals	Total Coliform	Geochemical	TOC / COD	Landfill Gas Parameters	Water Level	Field Parameters	VOCs	T & D Metals	Total Coliform	Fecal Coliform	Geochemical	TOC / COD	D. Metals - COC list	pH (field and lab)	Vinyl Chloride	Landfill Gas Parameters
MW-1	■	■	■	■	■		■	■		■	■	■	■	■	■	■		■	■	■	■	■		■	■				
MW-2	■									■								■											
MW-3	■	■	■	■	■		■	■		■	■	■	■	■	■	■		■	■	■	■	■		■	■				
MW-4	■									■								■											
MW-5	■									■								■											
MW-5A	■									■								■	■							■	■	■	
MW-6	■	■	■	■	■		■	■		■	■	■	■	■	■	■		■	■	■	■	■		■	■				
MW-7	■									■								■	■							■	■	■	
MW-8	■	■	■	■	■		■	■		■	■	■	■	■	■	■		■	■	■	■	■		■	■				
MW-10	■	■	■	■	■		■	■		■	■	■	■	■	■	■		■	■	■	■	■		■	■				
SW-2[1]		■				■	■												■				■	■					
Flares 1, 2, 3									■								■												■

Notes:

[1] Surface water sample from SW-2 collected during first quarter or fourth quarter, not both quarters.

Field Parameters = pH, specific conductance, temperature, ORP, and DO

VOCs = Volatile organic compounds by EPA Method 8260C standard list, vinyl chloride by selective ion monitoring (SIM)

T (total) Metals = calcium, potassium, sodium

D (dissolved) Metals = arsenic, barium, iron, manganese, zinc

Geochemical = alkalinity, ammonia, bicarbonate, carbonate, chloride, sulfate, nitrate, nitrite, pH

TOC / COD = total organic carbon / chemical oxygen demand

Dissolved Metals - COC list = arsenic, iron, manganese

Landfill gas parameters = methane (%LEL), oxygen(% vol), carbon dioxide (% vol), and gas pressure

Table 3-1: Monitoring Well Construction Data Summary

Olalla Landfill, Kitsap County, WA

Well	Total Well Depth (ft bgs)	Measuring Point Elevation (ft NGVD 29)	Surface Elevation (ft NGVD 29)	Screened Interval (ft bgs)	Northing	Easting	Measuring Point Description
MW-1	87	343.79	342.53	82-87	161858.133	560525.840	Pump wellhead
MW-2	73	323.25	318.95	68-73	161704.534	559572.839	Top of PVC casing
MW-3	55.5	296.95	294.95	50.5-55.5	162333.903	559463.060	Pump wellhead
MW-4	68	320.93	317.35	63-68	161911.192	559787.735	Top of PVC casing
MW-5	35.5	334.17	332.78	25-35	162510.115	559878.901	Top of PVC casing
MW-5A	98	332.53	331.43	86-96	162487.878	559875.742	Pump wellhead
MW-6	35	271.17	269.14	28-33	162077.699	559358.970	Pump wellhead
MW-7	33	280.43	278.21	21-31	161723.016	559398.979	Pump wellhead
MW-8	38	272.85	270.73	25-35	161897.813	559350.147	Pump wellhead
MW-10	47	279.21	276.84	37-47	162218.490	559340.899	Pump wellhead

Notes:
NGVD 29 = National Geodetic Vertical Datum (1929)
bgs = below ground surface

Table 3-2: Recommended Laboratory Methods and Sample Requirements for Groundwater Samples

Olalla Landfill, Kitsap County, WA

Constituent Group	Analytical Method	Container Type	Handling and Preservation	Holding Time
VOCs	EPA 8260C Vinyl chloride by SIM or Low Level 8260C	(3) 40 mL VOA vials	No headspace, HCl, cool to <4°C	14 days if preserved, 7 days if unpreserved
Total Coliform	SM18 9222B	300 mL sterile AG	Cool to <4°C	24 hours
Alkalinity	SM 2320B	500-mL HDPE	Cool to <4°C	14 days
Ammonia	EPA 350.1			28 days
Bicarbonate	SM 2320B			14 days
Carbonate	SM 2320B			14 days
Chloride	EPA 300.0			28 days
Sulfate	EPA 300.0			28 days
Nitrate	EPA 300.0	500-mL HDPE		48 hours
Nitrite	EPA 300.0			
pH	SM 4500 H+B	250-mL AG or from any unpreserved sample container	Cool to <4°C	24 hours
Total Organic Carbon	SM 5310B	125-mL AG	H_2SO_4 to pH <2, cool to <4°C	28 days
Chemical Oxygen Demand	SM 5220C	125-mL AG	H_2SO_4 to pH <2, cool to <4°C	28 days
Total Metals (calcium, potassium, sodium)	EPA 6010/7000 series	250 mL HDPE	HNO_3 to pH <2, cool to <4°C	6 months
Dissolved Metals (arsenic, barium, iron, manganese, zinc)	EPA 6010/6020/7000 series	250 mL HDPE	Field filter, HNO_3 to pH <2, cool to <4°C	6 months

Notes:
AG = amber glass
HCl = hydrochloric acid
HNO_3 = nitric acid
H_3PO_4 = phosphoric acid
HDPE = high density polyethylene
mL = milliliter
VOA = volatile organic analysis
VOC - volatile organic compound

Table 3-3: Groundwater Monitoring Field Quality Control Sample Summary
Olalla Landfill, Kitsap County, WA

Parameter	Number of Samples Per Quarter				
	Method	Primary Samples	Field Duplicate Samples (10%)	Trip Blank (one per event)	Total
VOCs	EPA 8260C GC/MS	5	1	1	7
VOCs (Vinyl Chloride)	EPA 8260C GC/MS Low level or SIM	5 (Q) 7 (A)	1	1	7 (Q) 9 (A)
Dissolved Metals (As, Fe, Mn)	EPA 6010/6020/7000 series	5 (Q) 7 (A)	1	NA	6 (Q) 8 (A)
Dissolved Metals (Ba, Zn)	EPA 6010/6020/7000 series	5	1	NA	6
Total Metals (Ca, K, Na)	EPA 6010/7000 series	5	1	NA	6
pH (laboratory)	SM 4500 H+B	5	1	NA	6
Alkalinity (mg $CaCO_3$/L)	SM 2320B	5	1	NA	6
Bicarbonate (mg $CaCO_3$/L)	SM 2320B	5	1	NA	6
Carbonate (mg $CaCO_3$/L)	SM 2320B	5	1	NA	6
Chloride	EPA 300.0	5	1	NA	6
Sulfate	EPA 300.0	5	1	NA	6
Ammonia - Nitrogen	EPA 350.1	5	1	NA	6
Nitrate Nitrogen	EPA 300.0	5	1	NA	6
Nitrite Nitrogen	EPA 300.0	5	1	NA	6
Total Organic Carbon	SM 5310B	5	1	NA	6
Chemical Oxygen Demand	SM 5220C	5	1	NA	6
Total Coliform	SM 9222 B	5	1	NA	6

Notes:

(Q) = Quarterly event

(A) = Annual event

Monitoring wells MW-1, MW-3, MW-6, MW-8, and MW-10 are sampled quarterly. Monitoring wells MW-5A and MW-7 are sampled annually.

GC/MS = Gas chromatography / mass spectrometry

GC/MS - SIM = Gas chromatography / mass spectrometry - selective ion monitoring

mg $CaCO_3$/L = milligrams of calcium carbonate per liter

Table 4-1: Recommended Laboratory Methods and Sample Requirements for Surface Water Sample

Olalla Landfill, Kitsap County, WA

Constituent Group	Analytical Method	Container Type	Handling and Preservation	Holding Time
Fecal Coliform	SM 9222D	300-mL sterile AG	Cool to <4°C	24 hours
Nitrate-Nitrogen	EPA 353.2	500-mL HDPE		48 hours
pH	SM 4500 H+B	250-mL AG		24 hours

Notes:

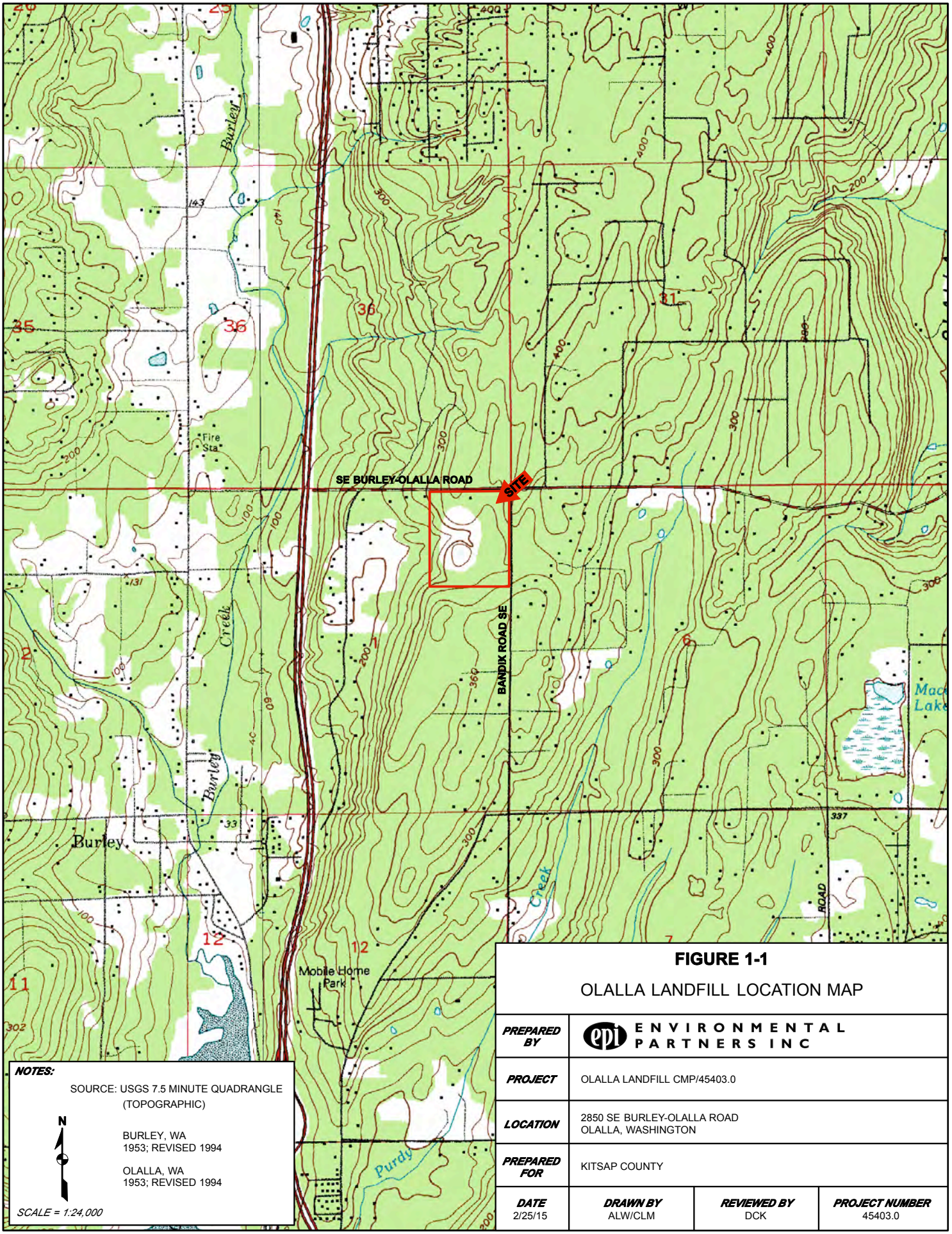
Surface water sample from SW-2 collected during first quarter or fourth quarter, not both quarters.

AG = amber glass

HDPE = high density polyethylene

mL = milliliter

Figures



NOTES:

SOURCE: USGS 7.5 MINUTE QUADRANGLE (TOPOGRAPHIC)

BURLEY, WA
1953; REVISED 1994

OLALLA, WA
1953; REVISED 1994

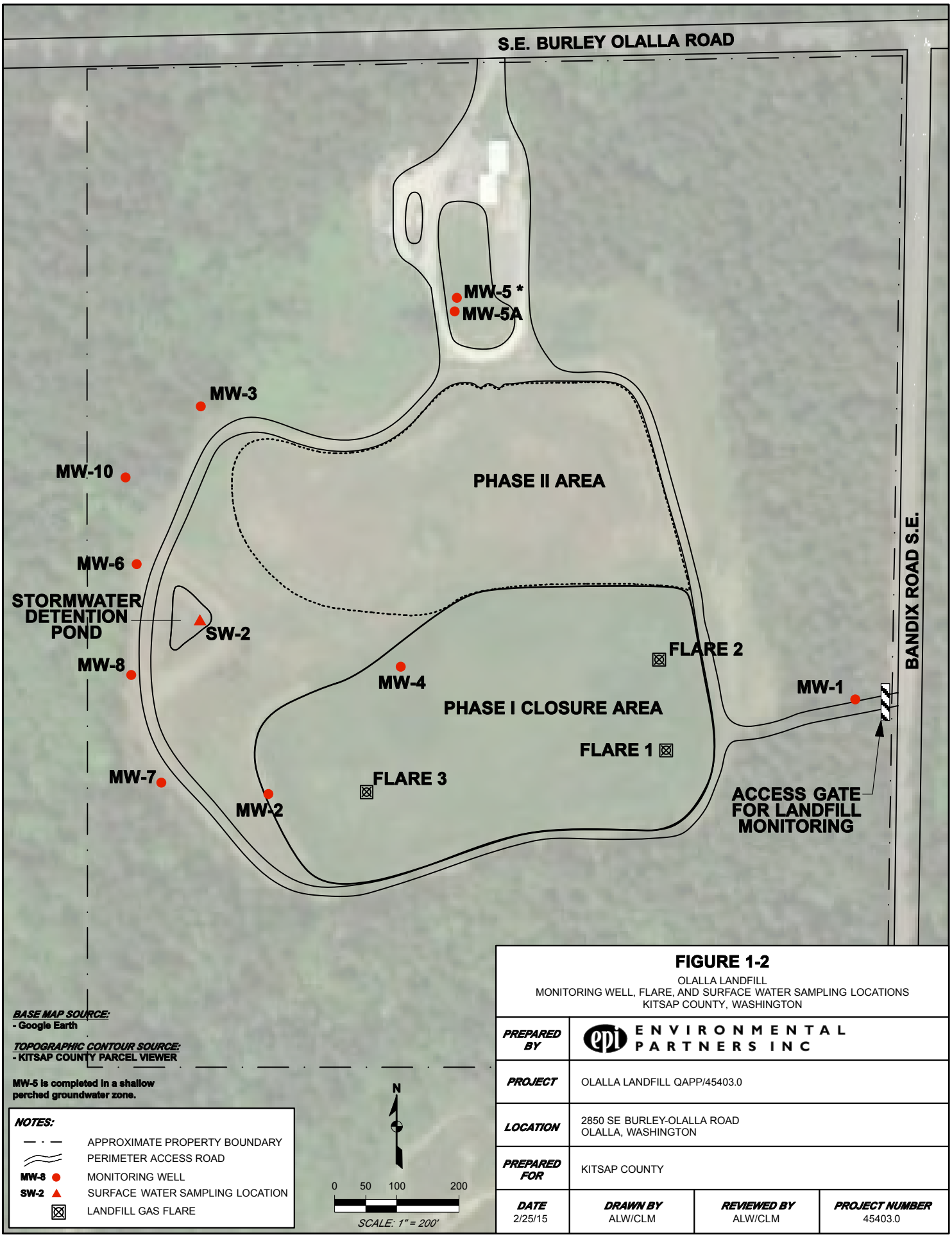
N

SCALE = 1:24,000

FIGURE 1-1

OLALLA LANDFILL LOCATION MAP

PREPARED BY	ENVIRONMENTAL PARTNERS INC		
PROJECT	OLALLA LANDFILL CMP/45403.0		
LOCATION	2850 SE BURLEY-OLALLA ROAD OLALLA, WASHINGTON		
PREPARED FOR	KITSAP COUNTY		
DATE 2/25/15	***DRAWN BY*** ALW/CLM	***REVIEWED BY*** DCK	***PROJECT NUMBER*** 45403.0



BASE MAP SOURCE:
- Google Earth

TOPOGRAPHIC CONTOUR SOURCE:
- KITSAP COUNTY PARCEL VIEWER

MW-5 is completed in a shallow perched groundwater zone.

NOTES:

- APPROXIMATE PROPERTY BOUNDARY
- PERIMETER ACCESS ROAD
- MW-8 ● MONITORING WELL
- SW-2 ▲ SURFACE WATER SAMPLING LOCATION
- ⊠ LANDFILL GAS FLARE

FIGURE 1-2

OLALLA LANDFILL
MONITORING WELL, FLARE, AND SURFACE WATER SAMPLING LOCATIONS
KITSAP COUNTY, WASHINGTON

PREPARED BY	epi ENVIRONMENTAL PARTNERS INC		
PROJECT	OLALLA LANDFILL QAPP/45403.0		
LOCATION	2850 SE BURLEY-OLALLA ROAD OLALLA, WASHINGTON		
PREPARED FOR	KITSAP COUNTY		
DATE 2/25/15	DRAWN BY ALW/CLM	REVIEWED BY ALW/CLM	PROJECT NUMBER 45403.0

Attachment A
Bottle Order Forms

Example Quarterly Event Bottle Order Form

Project Name	Olalla Landfill Monitoring	**Date of Bottle Request**	
Project Number		**Date Bottle are Needed**	
Client:	Environmental Partners, Inc. 1180 NW Maple St. Suite 310 Issaquah, WA 98027	**Estimated Date Samples will Return:**	
Client Contact:	Eric Caddey (425) 395-0010		
Lab PM:		**Order completed by:**	
# of Coolers:	as needed		Include LOOSE Labels
Trip Blanks	1 set (2 VOAs)		Include COC's

Number of Samples	Analysis Requested	Bottles Per Sample	Bottle Size and Type	Preservation	Total Bottles
Groundwater Samples					
6	Volatiles	2	40mL VOA	HCL	12
6	Vinyl chloride by SIM or Low Level	1	40mL VOA	HCL	6
6	Dissolved metals (As, Fe, Zn, Ba, Mn)	1	250 mL HDPE	Field Filtered/HNO_3	6
6	Total metals (K, Na, Ca)	1	250 mL HDPE	HNO_3	6
6	Nitrate, nitrite, chloride, sulfate, alkalinity, carbonate, bicarbonate pH, and ammonia	1	500 mL poly	-	6
6	COD	1	250 mL HDPE	H_2SO_4	6
6	TOC	1	250 mL amber glass	H_2SO_4	6
6	Total coliform	1	300 mL sterile amber glass or poly	-	6
Surface Water Sample (Sampled in March or December)					
1	pH	1	500 mL poly		1
1	Nitrate-Nitrogen	1			1
1	Fecal coliform	1	300 mL sterile amber glass or poly	-	1
				Total Bottles:	**57**

Example Annual (Fourth Quarter) Event Bottle Order Form

Project Name	Olalla Landfill Monitoring	**Date of Bottle Request**	
Project Number		**Date Bottle are Needed**	
Client:	Environmental Partners, Inc. 1180 NW Maple St. Suite 310 Issaquah, WA 98027	**Estimated Date Samples will Return:**	
Client Contact:	Eric Caddey (425) 395-0010		

Lab PM:		**Order completed by:**	
# of Coolers:	as needed		Include LOOSE Labels
Trip Blanks	1 set (2 VOAs)		Include COC's

Number of Samples	Analysis Requested	Bottles Per Sample	Bottle Size and Type	Preservation	Total Bottles
Groundwater Samples					
6	Volatiles	2	40mL VOA	HCL	12
8	Vinyl chloride by SIM or Low Level	1	40mL VOA	HCL	8
6	Dissolved metals (As, Fe, Zn, Ba, Mn)	1	250 mL HDPE	Field Filtered/HNO_3	6
2	Dissolved metals (As, Fe, Mn)	1	250 mL HDPE	Field Filtered/HNO_3	2
2	pH	1	500 mL poly	-	2
6	Total metals (K, Na, Ca)	1	250 mL HDPE	HNO_3	6
6	Nitrate, nitrite, chloride, sulfate, alkalinity, carbonate, bicarbonate pH, and ammonia	1	500 mL poly	-	6
6	COD	1	250 mL HDPE	H_2SO_4	6
6	TOC	1	250 mL amber glass	H_2SO_4	6
6	Total coliform	1	300 mL sterile amber glass or poly	-	6
Surface Water Sample (Sampled in March or December)					
1	pH	1	500 mL poly	-	1
1	Nitrate-Nitrogen	1		-	1
1	Fecal coliform	1	300 mL sterile amber glass or poly	-	1
				Total Bottles:	**63**

Attachment B
Recommended Equipment List

Attachment B: Olalla Landfill MFS Monitoring Recommended Equipment List

Field Instruments Provided by Consultant:	Example
Multi-parameter meter or individual meters as noted:	YSI 556 or Horiba U-22
pH meter	Orion 250A
Specific conductance meter	YSI Pro 30
Dissolved oxygen meter	YSI Model 50B
ORP meter	YSI ORP15
Turbidity meter	LaMott 2020
Flow-through cell for field parameter instruments	
Landfill gas meter (commonly rented)	Landtech GEM 5000, or equivalent
Water Level Indicator	Solinst, Heron, Slope Indicator

Equipment to Obtain from the County:
Keys to Bandix Road Gate, wells, and gates to flares
Grundfos Rediflow II pump controller and electrical cables

Equipment Provided by Consultant:
Appropriate gas powered generator (Honda eu2000i or equvalent)
Power cord for generator
Extra fuel for generator in DOT-approved container(s)
Field logbook with appropriate field data forms
Pens
Sample bottles and coolers
Spray bottles
Appropriate PPE (see HASP)
5-gallon purge water buckets
Watch or phone for sample times
Utility knife or equivalent
Cell Phone

Expendible Supplies:
Nitrile gloves
Garbage bags
Ziploc-type bags
Paper towels
Ice
Distilled or deionized water
Liquinox™ or equivalent non-phosphate detergent
Chain of custody forms
Strapping tape (if shipping sample coolers)
Clear packing tape (if shipping sample coolers)
Calibration fluids for pH, specific conductance, DO, and ORP
Calibration gases (methane, oxygen, CO_2) and appropriate regulators and hoses
Extra batteries or charging cords for meters and water level indicator

Notes:
DOT = Department of Transportation
CO_2 = Carbon dioxide
HASP = Health and safety plan
ORP = Oxidation reduction potential
PPE = Personal protective equipment
YSI = Yellow Springs Instruments

Attachment C
Monitoring Well Geologic Logs and As-Built Diagrams

Boring Log and Construction Data for Well MW-1

Geologic Log

Depth in Feet

Ground Surface Elevation in Feet 340

0 — Medium dense to very dense, moist, tan, slightly silty to silty, fine to medium SAND.

20 — Very dense, moist, gray-tan, sandy GRAVEL.

35 — Very dense, moist to saturated, gray-tan, slightly silty, medium to fine SAND.

50

Well Design 3

Top Casing Elevation in Feet 341.41

Casing Stickup in Feet 1

Lab	Sample	N	pH	EC
	S-1	23	6.5	<5
	S-2	31	5.5	<5
	S-3	50/4"	5.2	5
	S-4	50/6"	5.3	6
	S-5	50/6"	4.9	6
	S-6	50/4"	5.0	19
	S-7	50/4"	5.2	5
	S-8	50/6"	5.3	<5
	S-9	84/9"	5.1	<5
	S-10	50/5"	5.1	<5

J-1513 April 1985

HART-CROWSER & associates, inc.

Sheet 1 of 2 Figure A-2

Boring Log and Construction Data for Well MW-1

Geologic Log

Depth in Feet

Ground Surface Elevation in Feet

50 — Very dense, moist to saturated, gray-tan, slightly silty, medium to fine SAND.

55

60

65

70

75 — Grading wet below 73 feet.

80

85 — Grading fine below 85 feet.

90 — Bottom of Boring at 88.4 Feet. Completed 4/11/85.

95

100

Lab	Sample	N
	S-11	50/6"
	S-12	50/6"
	S-13	50/6"
	S-14	50/6"
	S-15	50/5"
GS	S-16	84/10"
	S-17	50/4"
	S-18	50/5"

Well Design 3

Top Casing Elevation in Feet 341.41

Casing Stickup in Feet 1

pH	EC
5.3	<5
5.1	5
5.1	5
5.5	<5
5.5	<5
5.5	<5
5.5	<5
5.6	<5

4/16/85 ▽

ATD ▽

Surface Seal Concrete

2.0-inch ϕ PVC Riser Pipe

Bentonite

Natural Material

Water Level

Aqua 6 Sand

2.0-inch ϕ PVC Screen (.020 Slot Size)

2-inch O.D. Split Spoon Sample

* No Sample Recovery

N Standard Penetration Resistance, Blows per foot

GS Grain Size Analysis

K Permeability Test

NOTES:

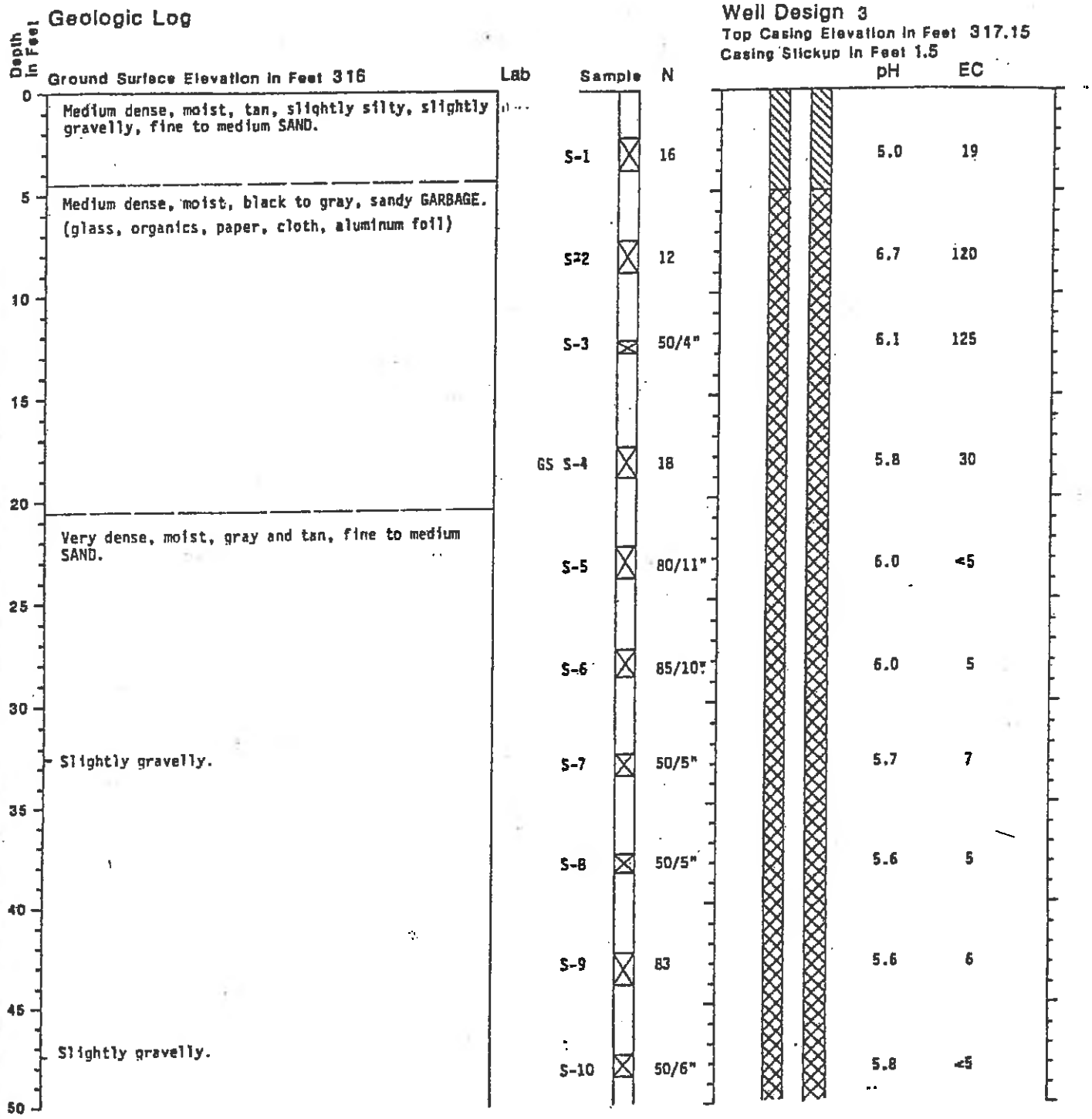
1. Soil descriptions are interpretive and actual changes may be gradual.
2. Water Level is for date indicated and may vary with time of year. ATD: At Time of Drilling
3. Top of PVC casing surveyed by Parametrix to estimate mean sea level datum.

J-1513 April 1985

HART-CROWSER & associates, inc.

Sheet 2 of 2 Figure A-2

Boring Log and Construction Data for Well MW-2

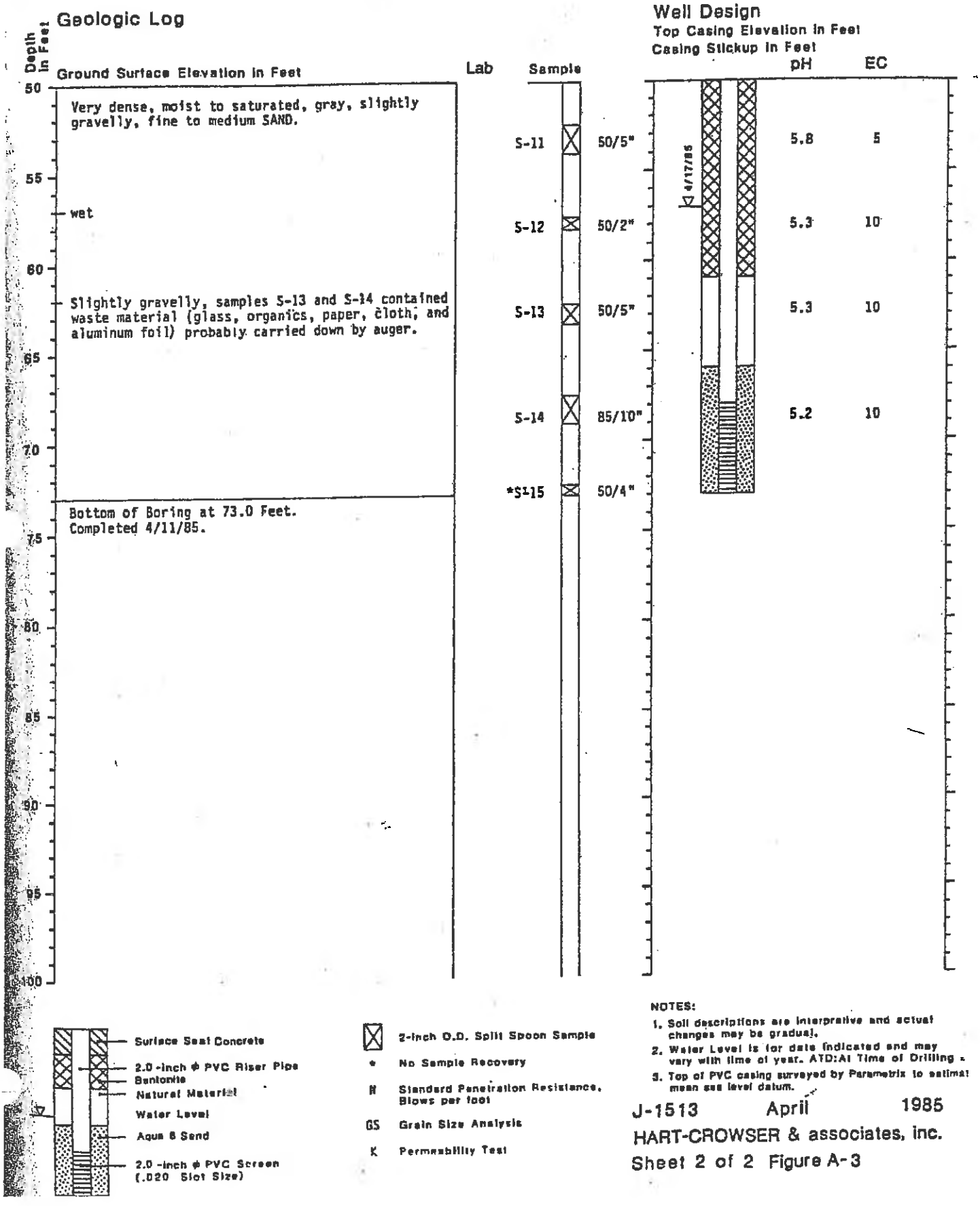


J-1513 April 1985

HART-CROWSER & associates, inc.

Sheet 1 of 2 Figure A-3

Boring Log and Construction Data for Well MW-2



NOTES:

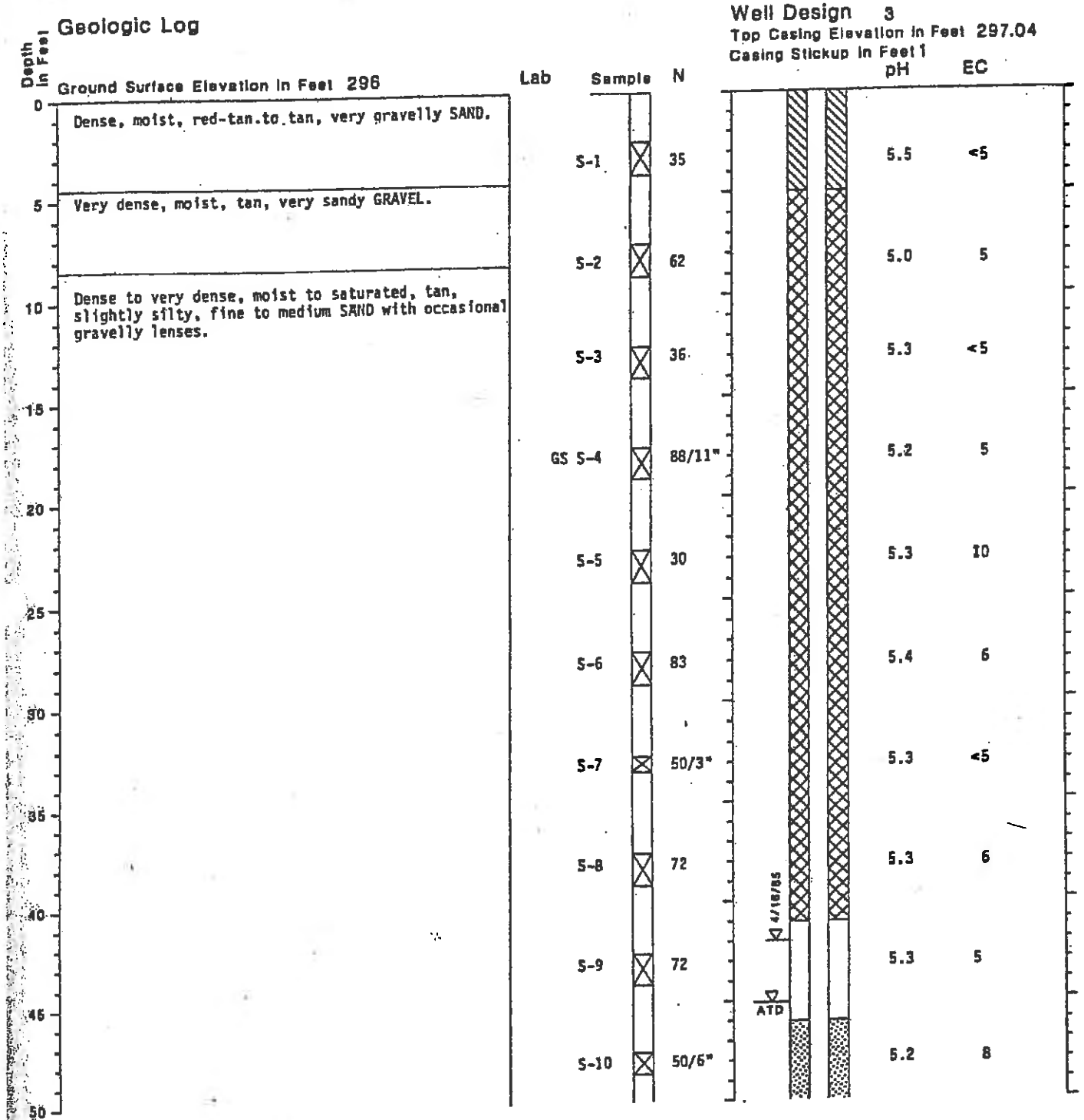
1. Soil descriptions are interpretive and actual changes may be gradual.
2. Water Level is for date indicated and may vary with time of year. ATD:At Time of Drilling.
3. Top of PVC casing surveyed by Parametrix to estimated mean sea level datum.

J-1513 April 1985

HART-CROWSER & associates, inc.

Sheet 2 of 2 Figure A-3

Boring Log and Construction Data for Well MW-3



J-1513 April 1985

HART-CROWSER & associates, inc.

Sheet 1 of 2 Figure A-4

Boring Log and Construction Data for Well MW-3

Geologic Log

Depth In Feet

Ground Surface Elevation In Feet

50 — Very dense, saturated, tan, fine to medium SAND.

55 — Grading to very dense, saturated, tan, very sandy GRAVEL.

60 — Bottom of Boring at 58.3 Feet.
Completed 4/12/85.

65

70

75

80

85

90

95

100

Lab Sample N

◇ S-11 25

S-12 50/4"

Well Design

Top Casing Elevation in Feet

Casing Stickup in Feet

	pH	EC
	5.2	5
	5.2	<5

Surface Seal Concrete

2.0-inch ϕ PVC Riser Pipe

Bentonite

Natural Material

Water Level

Aqua 8 Sand

2.0-inch ϕ PVC Screen (.020 Slot Size)

2-inch O.D. Split Spoon Sample

* No Sample Recovery

N Standard Penetration Resistance, Blows per foot

GS Grain Size Analysis

K Permeability Test

◇ Low blow count due to disturbed material.

NOTES:

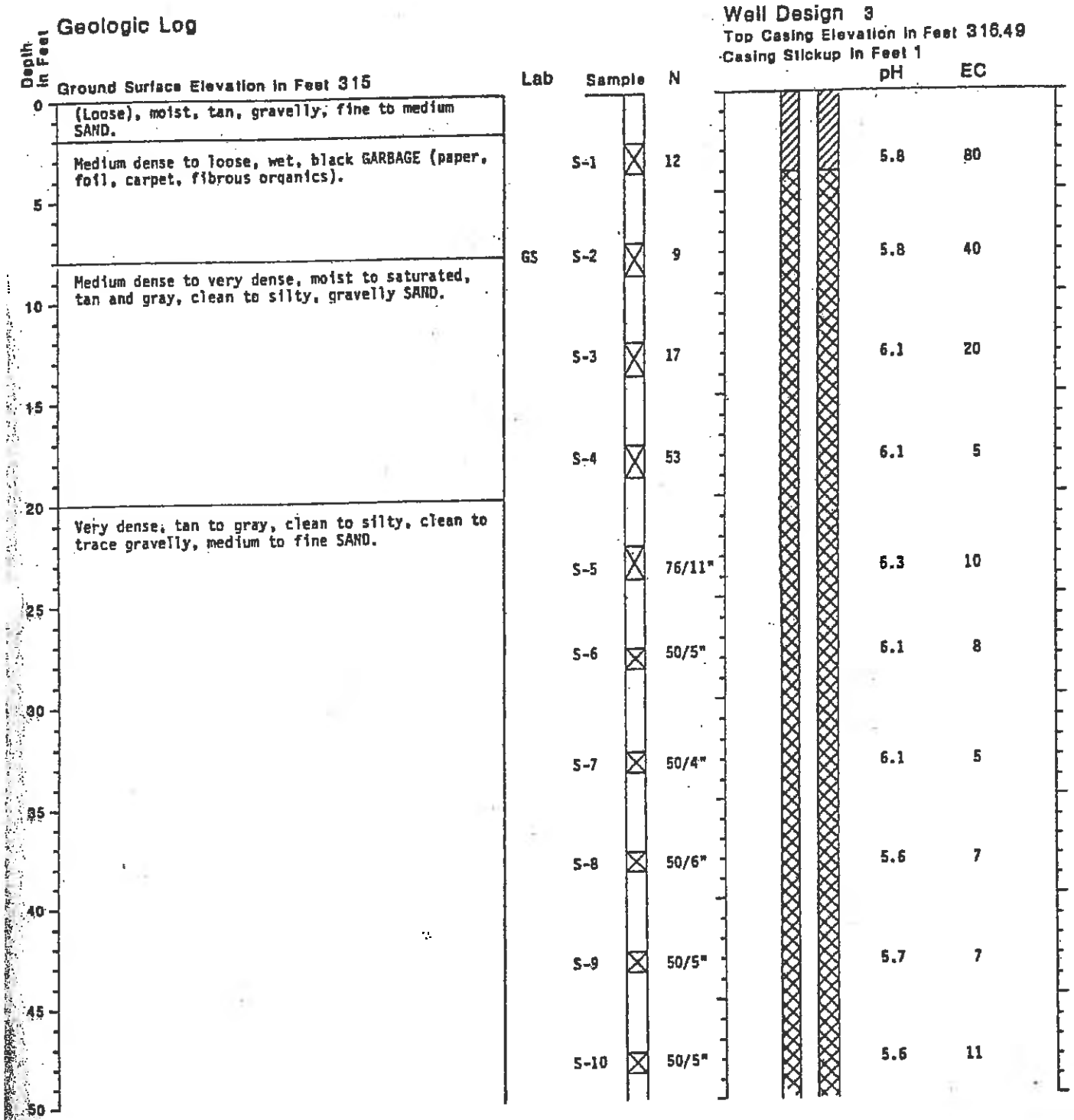
1. Soil descriptions are interpretive and actual changes may be gradual.
2. Water Level is for date indicated and may vary with time of year. ATD:At Time of Drilling
3. Top of PVC casing surveyed by Parametrix to estimated mean sea level datum.

J-1513 April 1985

HART-CROWSER & associates, inc.

Sheet 2 of 2 Figure A-4

Boring Log and Construction Data for Well MW-4

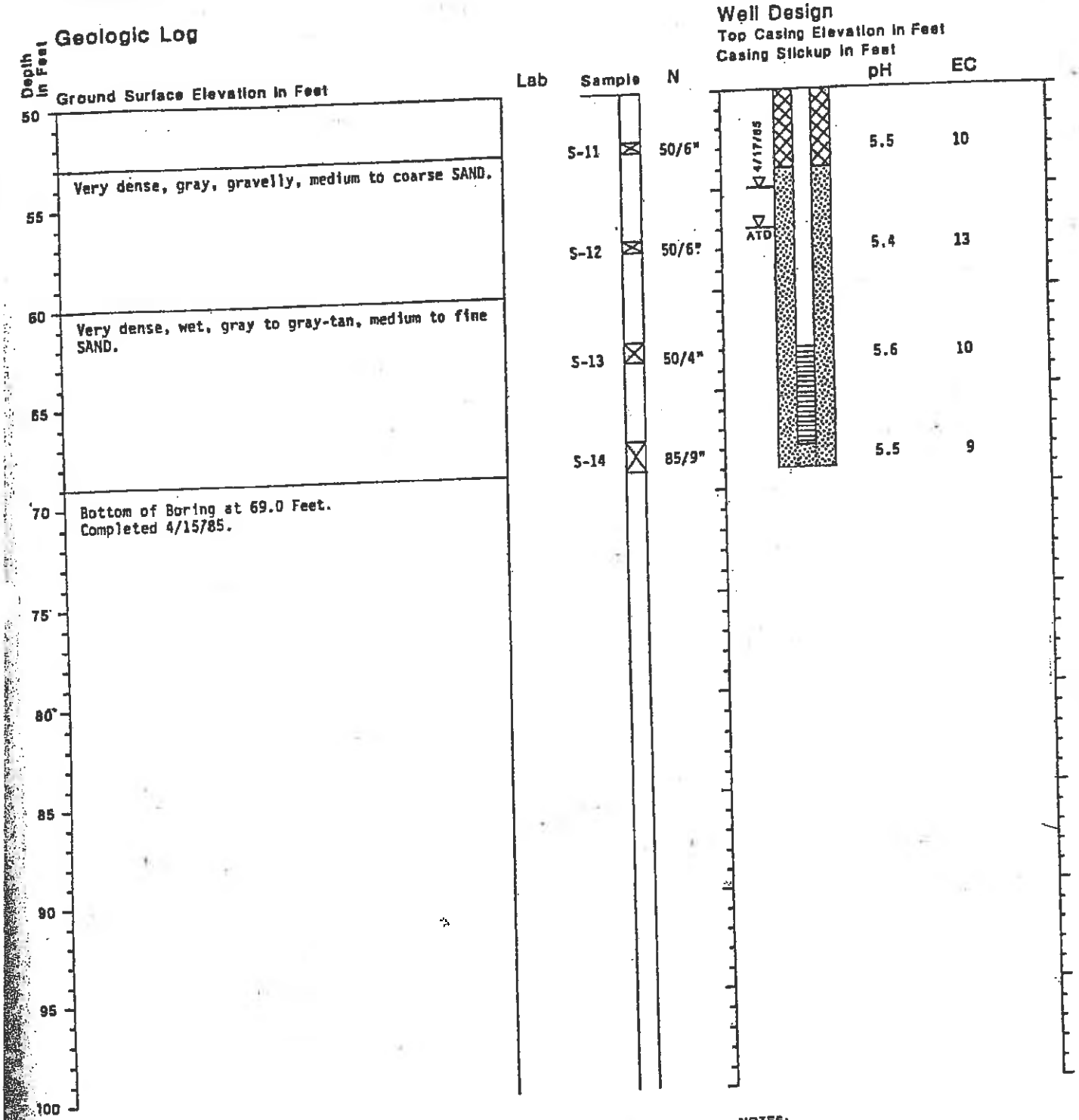


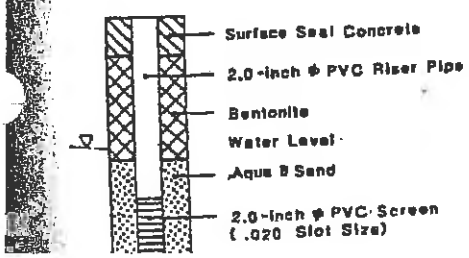
J-1513 April 1985

HART-CROWSER & associates, inc.

Sheet 1 of 2 Figure A-5

Boring Log and Construction Data for Well MW-4





- 2-inch O.D. Split Spoon Sample
- No Sample Recovery
- N — Standard Penetration Resistance, Blows per foot
- GS — Grain Size Analysis
- K — Permeability Test

NOTES:

1. Soil descriptions are interpretive and actual changes may be gradual.
2. Water Level is for date indicated and may vary with time of year. ATD:At Time of Drilling
3. Top of PVC casing surveyed by Parametrix to estimate mean sea level datum.

J-1513 April 1985

HART-CROWSER & associates, inc.

Sheet 2 of 2 Figure A-5

Well Installation Log

Job No. 31-1578-25 Client Kitsap County Location Ollala Landfill

CASING TYPE	2-inch schedule 80 PVC	10 ft lengths	
LENGTH	Casing 0-87 ft	Screen 87-97 ft	Sump 97-99½
JOINT TYPE	flush thread		
SCREEN TYPE	PVC continuous wind		
SLOT SIZE	0.020 inch		
SEAL TYPE	bentonite slurry and pellets		
INSTALL. METHOD	tremie pipe		
FILTER	washed silica sand #10/20		
INSTALL	tremie pipe		
GROUT	bentonit slurry (and pellets above sand)		

DRILLING METHOD	Air rotary			
SAMPLING METHOD	sediment catch basin			
HAMMER WT.	—	DROP	—	
DATE	March 1, 1989			
BY	James Braddock			
DRILLING CONTR.	Soil Samplins Service			
WATER LEVEL	89.7	89.2		
TIME	0940	1010		
DATE	Feb/28/89	Feb/28/89		
	not static			

WELL NO. MW-E 54

SHEET 1 OF 2

START	FINISH
Feb 22 1989	Feb/28/89 drilling
	Mar/1/89 completed

WELL DETAILS		DEPTH	USCS/ GRAPHIC LOG	LOG DESCRIPTION	NOTES
Fill	Casing			GROUND ELEVATION:	
0-79'2" bentonite slurry	Above ground to 86'2" 2" schedule 80 PVC casing	0		0≥2 Organic material	
				2-6½ GRAVEL with sand & silt	Gravel - Sray, reddish brown, white, brown. Sand - same. Silt-bro
				6½-7½ BOULDER or COBBLES	Granitic material
				7½-16 GRAVEL with sand & silt	Similar to that between 2-6½
		10			
				16-28 GRAVELLY SAND	Moist, light brown or tan. Wate
					In hole (~2-3 ft) at 16 ft
					in mornings, before drillins.
		20			
				28-36½ SILTY GRAVEL	Gravel - dark to medium grey
					Silt - Sreyish brown. Some clay
		30			
				36½-48½ CLAY with gravel	Clay - brown. Gravel - blue-sry
		40			
					gradual transition.
				48½-61 CLAY or SILT with some gravel.	Clay or silt - brown, Gravel - blue Srey, less (amount) than above.
		50			
					60½-61 - silt layer
		60		61-108+ SAND	Sand - mostly medium-grained, Clea white, lt & dk brown, dark grey - overall brown color. Occasional zones of up to 10-15% gravel - may be bedded
		70			

2-inch schedule 80 PVC casing

bentonite slurry

Parametrix, Inc.

6/87

Well Installation Log

Job No. 31-1578-25 Client Kitsap County Location Ollala Landfill

CASING TYPE		DRILLING METHOD		WELL NO.	
LENGTH		SAMPLING METHOD			
JOINT TYPE		HAMMER WT.	DROP	SHEET 2	
SCREEN TYPE		DATE		OF 2	
SLOT SIZE		BY		START	FINISH
SEAL TYPE		DRILLING CONTR.			
INSTALL. METHOD		WATER LEVEL			
FILTER		TIME			
INSTALL		DATE			
GROUT					

WELL DETAILS		DEPTH	USCS/ GRAPHIC LOG	LOG DESCRIPTION	NOTES
fill	casing			GROUND ELEVATION:	
	Above ground to 86'2" 2" Schedule 80 PVC casing		Bent. pellets; Bentonite slurry; 2" sched. 80 PVC casing		SAND – continued
79'2" to 82'10" bentonite pellets		80			
82'10" to 98'7" sand filter pack, #10/20	86'2" to 96'2" PVC Screen 2" OD, 0.020" continuous wound screen	90	Sand pack; 2" sch. 80 PVC 0.020" slot screen		Sand becomes a bit coarser, but very gradually (recessional outwash indicated)
98'7" to 108' caved-in sediments	96'2" to 98'2" 2" sch. 80 PVC Sump 98'2" to 98'7" - endcap	100	Caved-in sediments; endcap		(Sand heaves while constructing well, up to 95 foot mark)
		110		108' bottom of ~~well~~ boring	

SOIL SAMPLING SERVICE, INC.

DATE 11-15-18

LOG OF BORING NO. 6 WELL ID # 6 START CARD # 01L2C

CLIENT Scuccolo Const CLIENT JOB # S.S.S. JOB # 11-5521

LOCATION 1/4 NE 1/4 SEC. 1 TOWNSHIP 22 N RANGE 1 E

CITY OLALLA STATE WASH COUNTY KITSAP

DRILLING METHOD AUGER DATUM WATER ELEVATION

RIG # 21 TRUCK # 16 OTHER STEAM CLEANER DATE INSTALLED 11-15-18

TIME & CHARGE DISTRIBUTION	TOTAL TIME
DRILLING	2.5
CREWED STANDBY	
NON-CREWED STANDBY	
MOVING	
INSTALLATION	4.5
WATER	1.5
CLEAN + PATCH	
REDRILL	
TRAVEL	
DEMOB	
SAMPLE METHOD	ATTEMPTS
DRIVE SAMPLES	8
OSTERBURG	

DRILLER TERRY "SKEPPY" HOURS 8.5

HELPER JOE Bishop

HELPER

DRILLER'S SIGNATURE Terry Lohrum

The figures hereon agree with my records.

BY Terry Pentney Scuccolo Const

Inspector or Client's Representative

TOTAL FOOTAGE: 35'

SCALE 1"= 5 FEET

PAGE OF

PVC BLANK 3 X 2 inch X 10 FT

PVC SCREEN 1 X 2 inch X 10 FT

MONUMENT TYPE 1 stand up

2 gal @ 8 #

6 Portland Cement

1/2 BKT 3/8 Pellets

1/2 bg WYO Bentonite

1 bg enviro gel.

1 X 2 inch TE Cap

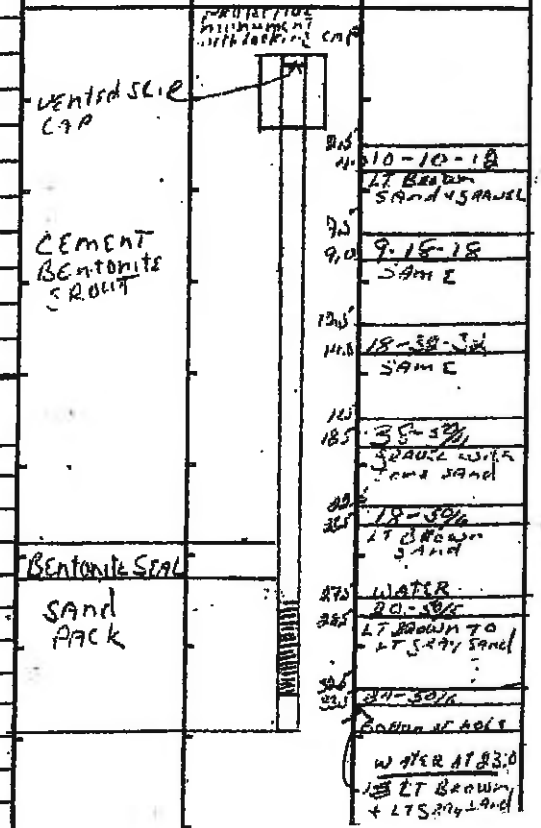
1 X 2 inch SLIP CAP, VENTED

4, Monument Protectors

ANNULUS MATERIAL

AS BUILT

FORMATION DESCRIPTION



COMMENTS

10 FT hard drilling

7:30 - 9:30, installing #5

9:30 - 11:00, WATER

11:00 - 1:30, drilling #6 From 0' to 35'

1:30 - 4:00, installing #6

MONITORING WELL GEOLOGIC & CONSTRUCTION LOG

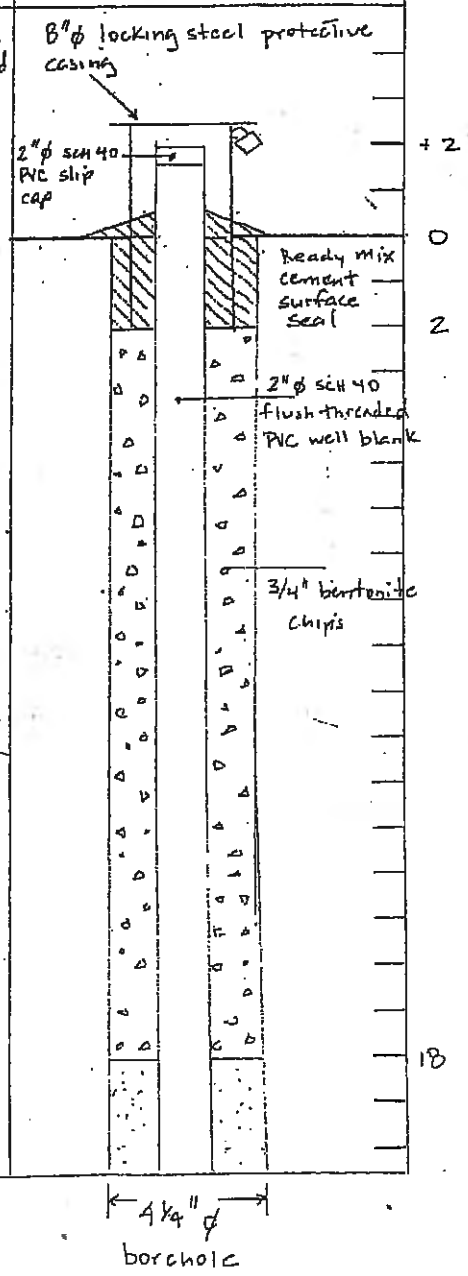
PROJECT NUMBER	WELL NUMBER	SHEET 1 OF 2
SEA35781.B2	MW-7	

PROJECT Olalla Landfill
ELEVATION (TOP OF WELL CASING)
WATER LEVEL ELEVATION 26.09 ft. from top of PVC casing
DRILLING CONTRACTOR Tacoma Pump and Drill
DRILLING METHOD Hollow stem auger

LOCATION Olalla - Burley Road
SURFACE ELEVATION
START DATE 12-21-93
FINISH DATE 12-21-93
HYDROGEOLOGIST K. Gehweiler

DEPTH (FT)	INTERVAL	BLOWCOUNT AND RECOVERY	GEOLOGIC LOG & FIELD OBSERVATIONS	HNu READING
+2				Back-ground 0.1 ppm
0			surface: coarse gravel to large cobble road fill overlaying Brown sand (SP), loose, moist, fine to medium-grained, trace silt.	
5		30 50/4"	Brown gravelly sand (SP-SM), dense, moist, fine to medium-grained sand with some medium to large, sub-rounded to subangular gravel.	
10		40 50/3"	Brown gravelly sand (SP-SM), dense, moist, medium to coarse-grained sand with some medium-sized, sub-rounded to subangular gravel and some silt.	0.1 ppm
15		70/6"	Brown sand (SP-SM), very dense, moist, fine to medium-grained with some silt. Note: a few dried chips of something. Paint?	
20		75/5"	Brown sand (SP-SM), very dense, wet,	0.1 ppm

WELL CONSTRUCTION



MONITORING WELL GEOLOGIC & CONSTRUCTION LOG

PROJECT NUMBER	WELL NUMBER	SHEET 2 OF 2
SEA 35781.82	MW-7	

PROJECT Olalla Landfill
LOCATION Olalla - Burley Road
ELEVATION (TOP OF WELL CASING)
SURFACE ELEVATION
WATER LEVEL ELEVATION 26.09 ft. from top of PVC casing
START DATE 12-21-93
DRILLING CONTRACTOR Tacoma Pump and Drill
FINISH DATE 12-21-93
DRILLING METHOD Hollow stem auger
HYDROGEOLOGIST K. Gehweiler

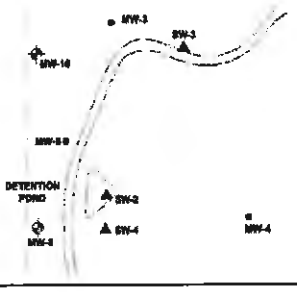
DEPTH (Ft)	INTERVAL	BLOWCOUNT AND RECOVERY	GEOLOGIC LOG & FIELD OBSERVATIONS	HNu READING	WELL CONSTRUCTION
			fine to medium-grained with some silt. No gravel. Sand becomes saturated at approx. 22 ft. bgs.		21
25		75/5"	Brown sand (SP-SM), very dense, saturated, fine to medium-grained with some silt. No gravel.		10-20 sand pack
30		75/4.5"	Brown sand (SP-SM), very dense, saturated, fine to medium-grained with some silt. No gravel.	0.2 ppm	2" ϕ sch 40 flush threaded PVC well screen (0.020" slot) 31 2" ϕ sch 40 flush threaded PVC sump 33
35			stopped drilling at 33.1 ft. bgs. Water level measured at 30.3 ft bgs at 1100, at 26.09 ft bgs at 1345.		

ENVIRONMENTAL PARTNERS INC

Boring/Well Designation: MW-8

Client: Kitsap County Public Works
Logged By: E. Caddey, L.G.
Date of Drilling: 10/7/10
Location: Olalla Landfill
Drilling Contractor: Cascade Drilling
Drill Rig: CME-75
Method: Hollow-Stem Auger
Borehole: 8" diameter

Site Representation:



Depth	Log	USCS Code	Description	Interval	Recovery	Blows per 6"	Sample	PID (ppm)	Well Data	Comments
			Ground Surface							
0			***Gravel***							Above-ground monument with bollards
		SW	***Well-Graded Sand with Gravel*** Tan; moist; mostly fine to coarse sand with little gravel			5-6-6		0.0		
5						9-12-15		0.0		
						50-5"				
10		SP-SM	***Poorly-Graded Sand with Silt and Gravel*** Brown; slightly moist; mostly medium sand with little silt and little gravel			16-50-4"		0.0		
						50-4"				
15		SP	***Poorly-Graded Sand with Gravel*** Gray-Brown; moist to wet; mostly medium sand with little gravel at 21'			50-6"		0.0		2" Sch 40 PVC blank
						10-17-23		0.0		Hydrated bentonite chips
20		SP	***Poorly-Graded Sand*** Gray-brown; moist to wet; medium sand with trace gravel and trace silt			6-8-25		0.0		Water at 22' bgs ATD
25			Becomes gray at 27'			12-50-6"		0.0		Stainless steel centralizer
			Becomes brown at 29'							#2/12 silica sand pack
30						8-21-23		0.0		0.010" slot sch 40 PVC
			Grades to well-rounded medium sand, black, gray and white grains							Stainless steel centralizer
35						12-16-20		0.0		
						2-4-4		0.0		
40			End of Borehole							
45										

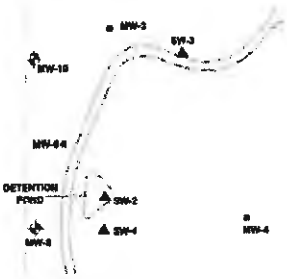
Project No. 60101.0

ENVIRONMENTAL PARTNERS INC

Boring/Well Designation: MW-10

Client: Kitsap County Public Works
Logged By: E. Caddey, L.G.
Date of Drilling: 10/7/10
Location: Olalla Landfill
Drilling Contractor: Cascade Drilling
Drill Rig: CME-75
Method: Hollow-Stem Auger
Borehole: 8" diameter

Site Representation:



Depth	Log	USCS Code	Description	Interval	Recovery	Blows per 6"	Sample	PID (ppm)	Well Data	Comments
			Ground Surface							
0			***Organic Soil***							Above-ground monument with bollards
		SW	***Well-Graded Sand with Gravel*** Tan; moist; mostly fine to coarse sand with little gravel			8-18-27		1.2		
5						12-14-16		4.4		
						9-16-19		5.5		2" Sch 40 PVC blank
10		GP	***Poorly-Graded Gravel*** Gray; moist; mostly fine gravel with little medium sand			9-16-18		0.0		
						50-6"		0.0		
		SW	***Well-Graded Sand with Gravel*** Tan; moist; mostly fine to coarse sand with little gravel			50-6"		0.0		Hydrated bentonite chips
15		SP	***Poorly-Graded Sand with Gravel*** Tan; moist; mostly medium sand with little gravel			50-6"		0.0		
20		SP	***Poorly-Graded Sand*** Gray-Brown; moist to wet; mostly medium sand with trace gravel and trace silt			50-5"		0.0		
25						50-6"		0.0		
30						50-6"		0.0		Water at 32' bgs
			Becomes saturated at 32.4'							
35						8-19-20		0.0		Stainless steel centralizer
40						22-50-5"		0.0		#2/12 silica sand pack
										0.010" slot Sch 40 PVC
45						50-6"		0.0		Stainless steel centralizer
						12-20-22		0.0		

Project No. 60101.0

Attachment D
Field Data Forms

Multiparameter Probe Calibration Log - Olalla Landfill Groundwater Monitoring

Meter Type	Manufacturer	Model Number	Mfg. Serial#	Rental Co. Serial #	Date	Time

Calibrated to Autocal Solution

Calibration Solution Manufacturer _____ Lot Number _____ Exp. Date _____

pH = _____ Turbidity = _____ Temperature = _____

Conductivity = _____ Dissolved Oxygen = _____ ORP = _____

Comments:

Meter Type	Manufacturer	Model Number	Mfg. Serial#	Rental Co. Serial #	Date	Time

Calibrated to Autocal Solution

Calibration Solution Manufacturer _____ Lot Number _____ Exp. Date _____

pH = _____ Turbidity = _____ Temperature = _____

Conductivity = _____ Dissolved Oxygen = _____ ORP = _____

Comments:

Instrument Calibration Log - Olalla Landfill Monitoring

Calibrated By: _____ **Date: _____**

Meter Type	Manufacturer	Model Number	Manufacturer Serial #	Rental Co. Serial #	Time
pH					
pH Electrode					

Calibrated: _____ to 4.00 buffer _____ to 7.00 buffer _____ to 10.00 buffer at _____ °C

Slope =_____ Comments:

Meter Type	Manufacturer	Model Number	Manufacturer Serial #	Rental Co. Serial #	Time
Specific Cond.					

Specific Conductance: Calibrated _____µS/cm to _____µS/cm calibration standard

Electrical Conductivity: Calibrated _____µS/cm to _____µS/cm calibration standard at _____ °C

Comments:

Meter Type	Manufacturer	Model Number	Manufacturer Serial #	Rental Co. Serial #	Time
ORP Meter					
ORP Electrode					

Electrode measured _____millivolts at _____ °C using Zobell prepared on / /

Table value for Zobell solution at this temperature is _____mV.

Meter Type	Manufacturer	Model Number	Manufacturer Serial #	Rental Co. Serial #	Time
Turbidity					

Meter reads _____NTUs using_____ NTUs standard Comments:

Meter reads _____NTUs using_____ NTUs standard

Meter Type	Manufacturer	Model Number	Manufacturer Serial #	Rental Co. Serial #	Time
DO Meter					

Air-Calibration: Measured temperature _____ °C corresponds to _____ mg/L DO (from Table I)

Atmospheric pressure / elevation correction factor _____ (from Table II)

Corrected calibration value _____ mg/L DO (Table I value multiplied by Table II value)

Comments:

Depth to Water Measurement Field Data - Olalla Landfill Monitoring

Well	Time	Measuring Point Elevation (ft. NGVD[1])	Depth to Water (ft.)	Comments and Well Inspection[2] Notes
MW-1		343.79		
MW-2		323.25		
MW-3		296.95		
MW-4		320.93		
MW-5		334.17		
MW-5A		332.53		
MW-6		271.17		
MW-7		280.43		
MW-8		272.85		
MW-10		279.21		

Notes:

[1]NGVD = National Geodetic Vertical Datum (1929)

[2]Observations regarding the condition of the well and surrounding area (e.g., protective casing, surface seal, cap, lock, bollards, soil conditions near the well such as depressions, ponded surface water, or other subsidence features, and any installed sampling equipment).

Groundwater Sampling Field Data - Olalla Landfill Monitoring

Station		Date	
Sample: ID		Field Team: (Initials)	
Field Conditions			

Low-Flow Purge Information

Well Diameter (in.)	
Well Depth (ft.)	
Initial Depth to Water (ft.)	
Depth of Water Column	
1 Casing Volume (gal.)	
Controller setting (Hz)	

Purge Method : Submersible pump

Other: : _____

Start Time	
End Time	
Total Gallons Purged	

Time	Gallons	pH	Conductivity	NTU	DO	Temp.	ORP	Appearance

Sample Information

Sample Method(s) : Submersible pump / Peristaltic pump / Bladder Pump / Other

Analysis	Time	Bottle Type	Preservative/Filtration	Comments
Volatiles and VC		(3) 40-mL VOA	HCl, cool to <4°C	
Total Coliform		300-mL sterile AG or poly	Cool to <4°C	
Geochemical Parameters		500-mL HDPE	Cool to <4°C	
Nitrate/Nitrite		500-mL HDPE	Cool to <4°C	
TOC		250-mL AG	H_2SO_4 to pH <2, cool to <4°C	
COD		250-mL HDPE	H_2SO_4 to pH <2, cool to <4°C	
Total Metals		250-mL HDPE	HNO_3 to pH <2, cool to <4°C	
Dissolved Metals		250-mL HDPE	Field filter, HNO_3 to pH <2, cool to <4°C	

Sample End Time	

Comments / Exceptions:

Notes: Where multiple visits are required to complete sampling, parameters are to be checked prior to sampling for each visit. Enter data under field comments.

Surface Water Sampling Field Data - Olalla Landfill Monitoring

Station		Date	
Sample: ID		Field Team: (Initials)	
Field Conditions			

Field Parameter Data

Time	pH	Specific Conductance	Temperature (°C)	Appearance and Flow Rate

Sample Information

Analysis	Time	Bottle Type	Preservative/Filtration	Comments
Fecal Coliform		300-mL sterile AG or poly	Cool to <4°C	
Nitrate-Nitrogen		500-mL HDPE	Cool to <4°C	
pH		125-mL AG	Cool to <4°C	

Sample End Time

Comments / Exceptions:

Notes: Where multiple visits are required to complete sampling, parameters are to be checked prior to sampling for each visit. Enter data under field comments.

Landfill Gas Monitoring Field Data - Olalla Landfill Monitoring

Instrument Used:		Date and Time:	
Ambient Temperature:		Field Team:	
Field Conditions:			

Landfill Gas Data

Flare #	Time	Methane (% vol.)	% LEL	Oxygen (% vol.)	Carbon Dioxide (% vol.)	Temperature (°C)	Gas Pressure ("H_2O)

Comments / Inspection Results[1]

[1]Inspect the following: lock and gate operation, tightness of bolts and clamps, differential settlement, valve operation, debris or breaks in hose barb.

Attachment B
Quality Assurance Plan

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Quality Assurance Plan
Post Closure Monitoring Under the Olalla Landfill Cleanup Action Plan

Olalla Landfill
Kitsap County, Washington

Prepared For:

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March 17, 2015

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EPI Project Number: 45403.0

QR DK TR DK

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ABBREVIATIONS AND ACRONYMS

Abbreviation/ Acronym	Definition
CAP	Cleanup Action Plan
COCs	Constituents of concern
DQOs	Data Quality Objectives
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ICP	Inductively Coupled Plasma Mass Spectrometry
Landfill	Olalla Landfill
LCS	Laboratory control samples
MDL	Method Detection Limit
MFS	Minimum Functional Standards for Solid Waste Handling
MQO	Measurement Quality Objectives
MRL	Method Reporting Limit
MS/MSD	Matrix Spike/Matrix Spike Duplicate
QA	Quality assurance
QAP	Quality Assurance Plan
QC	Quality control
RPD	Relative percent difference
SAP	Sampling and Analysis Plan
SM	Standard Methods for Examination of Water and Wastewater
SOP	Standard Operating Procedure
SWD	Kitsap County Public Works Solid Waste Division
SWHP	Solid Waste Handling Permit
VOC	Volatile organic compound

1.0 INTRODUCTION

This Quality Assurance Plan (QAP) was prepared by Environmental Partners, Inc. (EPI) on behalf of Kitsap County Public Works Solid Waste Division (SWD). The QAP provides a detailed description of work associated with quality assurance (QA) and quality control (QC) procedures for field and laboratory activities that are specific to monitoring under the Olalla Landfill Cleanup Action Plan (CAP) (Parametrix 2014) and the requirements of post closure care Washington Administrative Code (WAC) 173-304-407, Minimum Functional Standards for Solid Waste Handling (MFS) for the Olalla Landfill (the Landfill). MFS monitoring requirements are further described in the Post Closure Solid Waste Handling Permit (SWHP) for the Landfill.

1.1 Quality Assurance Plan Organization

The QAP is Attachment B of the Compliance Monitoring Plan (CMP) for post closure monitoring at the Landfill. The QAP is organized as follows:

- **Section 1 Introduction –** Presents the organizational structure of the QAP, the project organizational chart indicating the roles and responsibilities for individuals involved in significant project roles.

- **Section 2 Data Quality Objectives -** Identifies the data quality objectives for the project and defines screening level data and definitive data within the context of this project.

- **Section 3 Field Quality Control Samples -** Discusses the rationale for and the specific protocols for the three types of field quality control samples used for this project: field duplicates, trip blanks, and equipment blanks.

- **Section 4 Laboratory Quality Assurance and Quality Control Methods -** Describes the analytical methods, calibration, data quality objectives (DQOs), analytical quality control procedures, and corrective actions for field and laboratory when data deficiencies or errors are identified.

- **Section 5 Data Handling –** Presents DQOs for screening level data and for definitive data, the Level I data review process, data review reporting, data flags, and overall data assessment procedures.

- **Section 6 Performance and System Audits –** Describes data quality audits for the laboratory and for field procedures.

- **Section 7.0 References** – Provides the references for materials cited within the text.

1.2 Project Organization Chart

SWD has overall responsibility for all activities at the Landfill including operation, maintenance, monitoring, and reporting. Project management, quality assurance, laboratory, and field responsibilities of essential project personnel necessary to fulfill requirements of the CAP and the Solid Waste Handling Permit (SWHP) is depicted in Figure 1-1.

The names and company or agency affiliations for individuals involved in significant project roles and addresses are show in the Distribution List in the Compliance Monitoring Plan (CMP). More detailed descriptions of project roles presented on the project organization chart are provided in Section 2.2 of the CMP.

2.0 DATA QUALITY OBJECTIVES

Data Quality Objectives (DQOs) are used to determine if the data are useable, of known and acceptable quality, and meet project-specific objectives. The usability of the data is determined quantitatively and qualitatively using measurement quality objectives (MQOs), which use specific indicators of data quality such as precision, accuracy (or bias), representativeness, comparability, completeness, and sensitivity.

Specific DQOs for CAP and SWHP monitoring at the Landfill are to:

- Perform ongoing assessment of groundwater, surface water, and landfill gas at the Landfill to ensure that environmental monitoring meets the requirements of the CAP and SWHP.

- Perform ongoing evaluation of the effectiveness that contaminant source control measures have had in achieving site-specific cleanup levels and Washington State groundwater and drinking water regulatory standards. Recommend additional remedial measures to achieve protection standards, if appropriate.

- Evaluate groundwater and surface water sampling results and landfill gas measurements relative to regulatory standards for compounds listed in the CAP and SWHP.

- Statistically evaluate analytical results for groundwater samples relative to historical data to identify statistically significant data trends and to evaluate statistical compliance with the regulatory standards listed in the CAP and SWHP.

2.1 Screening Level Data

Field measurements are performed using portable instruments, which provide data considered to be screening level data. Field measurement results are generally used to evaluate general groundwater and surface water conditions, landfill gas composition, and to determine if well purging stabilization goals have been met. Field measurement methods for groundwater, surface water, and landfill gas are

summarized in Sections 3, 4, and 5, respectively, of the Sampling and Analysis Plan (SAP), which is included as Attachment A of the CMP.

2.2 Definitive Data

Fixed laboratory data meet a higher level of stringency and are used to monitor groundwater and surface water performance and confirmation samples. Analytical methods are discussed in Section 4 of this QAP. To generate data of sufficient quality, the following approach for generating analytical laboratory data for groundwater samples will be followed:

- The laboratory is accredited by Washington State Department of Ecology (Ecology).
- Applicable analytical test methods (e.g., Washington State and U.S. Environmental Protection Agency (EPA) SW-846 methods) will be used.
- The laboratory will use appropriate QC samples and procedures for sample analyses.
- Data Summary packages generated and the documentation provided will be sufficient to perform a Level I data quality review.
- If requested by the SWD project manager, data quality review will be performed on the analytical data according to the procedures specified in Section 5.

3.0 FIELD QUALITY CONTROL SAMPLES

Field and analytical QC checks are used to evaluate whether the measurement system is performing adequately and whether DQOs and MQOs are being met. This is accomplished, in part, through the analysis of controlled samples that are introduced to the laboratory from the field. Field duplicates, trip blanks, and if necessary, equipment blanks are collected and submitted to the project laboratory, where applicable, to provide a means of assessing the quality of data resulting from the field sampling program. Field QA sample types are summarized in Table 3-1.

3.1 Field Duplicate Samples

Field duplicate samples are used to check for sampling and analysis reproducibility. Field duplicates are submitted to the project laboratory at a frequency of at least 10 percent of the field samples for every analytical method.

Field duplicates will be submitted blind to the laboratory, with sample numbers that are indistinguishable from primary samples. Analytical parameter, methods, and frequency for field duplicates are described in Table 3-1. Quality control criteria for field duplicate relative percent difference (RPD) are discussed in Section 4.

3.2 Trip Blank Samples

A trip blank is a distilled, deionized, or equivalent water sample, which originated at the project laboratory. This sample travels with the empty sample containers to the field and is present in the field in the cooler during sampling. At the conclusion of sampling the trip blank is added to the chain-of-custody and is shipped back to the laboratory with the field samples. Trip blanks monitor potential cross-contamination during sample handling and shipping. Trip blanks will be analyzed for volatile organic compounds (VOCs) only. One trip blank sample will be included with each sampling event. Ideally, the results for the trip blank samples will be "not detected". Trip blank analytical parameters, method of analysis, and frequency are shown in Table 3-1.

3.3 Equipment Blank Samples

Currently all CAP/SWHP monitoring wells at the Landfill are equipped with dedicated sampling pumps that do not require decontamination unless they are removed from the wells for service. This eliminates potential cross contamination between sampling locations and eliminates the need to evaluate decontamination procedures through the use of equipment blank samples.

In the unlikely event of equipment failure non-dedicated sampling equipment procedures are in place for decontamination of multiple use sampling equipment. Decontamination procedures are detailed in the SAP, which is included as Attachment A of the CMP.

An equipment blank will be collected to assess the effectiveness of the decontamination procedures used for multiple-use, non-dedicated field sampling equipment. Ideally the equipment blank sample will consist of laboratory supplied reagent water. A less desirable alternative is to use store-purchased distilled water for the equipment blank. The equipment blank will be collected from the final rinse of sampling equipment after the decontamination process has been performed. Equipment blank samples will be analyzed for the same parameters as the associated field samples. Ideally, the results for the equipment blank samples will be "not detected" indicating that the potential for cross-contamination is acceptably limited.

4.0 LABORATORY QUALITY ASSURANCE AND QUALITY CONTROL

The analytical methods and associated QA/QC procedures were selected based on consideration of the DQOs for the Landfill. The analytical methods, calibration procedures, and QC measurements and criteria are based on current analytical protocols in the following:

- EPA SW-846 (SW-846) Test Methods for Evaluation of Solid Waste (Third Edition and Updates)
- Methods for the Chemical Analysis of Water and Wastes (EPA 1983)
- Standard Methods (SM) for Examination of Water and Wastewater (22nd Edition) (American Public Health Association 2012)

- Laboratory-specific Standard Operating Procedures (SOPs)

Groundwater samples will be analyzed using the following, or equivalent, analytical methods:

- Volatile Organic Compounds (including vinyl chloride) by SW-846 8260C GC-MS (low level)
- Metals by SW-846 6010/6020/7000 Series (Dissolved fraction: arsenic, barium, iron, manganese, and zinc) and (Total fraction: calcium, potassium, and sodium)
- Alkalinity, Bicarbonate, and Carbonate by SM 2320B
- Ammonia-Nitrogen by EPA 350.1
- Nitrate—NO_3 by EPA 300.0
- Nitrite—NO_2 by EPA 300.0
- pH by SM 4500 H+B
- Sulfate by EPA 300.0
- Chemical Oxygen Demand (COD) by SM 5220C
- Chloride by EPA 300.0
- Total Coliform by SM 9222B
- Total Organic Carbon (TOC) by EPA 415.1

Surface water samples will be analyzed for the following/or equivalent methods:

- Fecal Coliform by SM 9222D
- Nitrate—Nitrogen (NO_3-N) by EPA 353.2
- pH by SM 4500 H+B

Laboratory QA will be implemented and maintained as described in this plan and according to the project laboratory's QA plans and SOPs to meet the quantitative MQOs, which are established in the sections below. Specific field and laboratory QC criteria are used to evaluate if MQOs have been met. For field QC refer to the SAP, which is Attachment A of the CMP.

4.1 Calibration to Standards

Analytical instrument calibration and maintenance is conducted in accordance with the QC requirements identified in each laboratory SOP and QA Plan, and the manufacturer's instructions. General instrument calibration requirements are presented in the following sections.

4.1.1 Field Instrument Calibration Procedures

Field instruments will be calibrated prior to use and as needed during sampling following manufacturer's instructions. Refer to the SAP in Attachment A of the CMP for discussion on field instrument calibration procedures. Copies of field instrument calibration forms are presented in Attachment A to this QAP.

4.1.2 Laboratory Instrument Calibration

As stated in SW-846 and applicable laboratory SOPs, calibration of all analytical instrumentation is required to ensure that the analytical system is operating correctly and functioning at the sensitivity required to meet project-specific DQOs. Each instrument will be calibrated with standard solutions appropriate to the instrument and analytical method, in accordance with the methodology specified and at the QC frequency specified in the project laboratory's SOPs.

The calibration and maintenance history of the fixed project laboratory instrumentation is an important aspect of the project's overall QA/QC program. As such, all initial and continuing calibration procedures will be implemented by trained personnel following the manufacturer's instructions and in accordance with applicable EPA (or other appropriate method) protocols to ensure the equipment is functioning within the tolerances established by the manufacturer and the method-specific analytical requirements. All laboratory instruments will be calibrated according to manufacturers' instructions as specified in the analytical laboratory's QA plan.

4.2 Data Quality Objectives

The DQOs for the QAP are designed to ensure that the accuracy and precision of the data are sufficient and that the data are useful for performance monitoring of the constituents of concern (COCs) at the Landfill. QA and QC are important elements in all facets of a project. They are mechanisms whereby the proponent can monitor the performance and results of staff or contractors, and they permit the regulatory agency to evaluate the quality of data submitted as part of a project review. The complexity of environmental data and the need for comparability has led to requirements for QA/QC in the analytical laboratory without necessarily recognizing that QA/QC must also be applied throughout the program. For example, poor sampling or sample handling practices can negate the most careful laboratory analyses.

The data quality indicators that are presented in this section are precision, accuracy (bias), representativeness, comparability, completeness, and sensitivity. Data quality indicators and laboratory QA sample types are summarized in Table 4-1. Table 4-2 summarizes laboratory QC frequency. Table 4-3 summarizes project-specific control limits and goals for accuracy, precision and completeness.

Table 4-4 summarizes method detection limits and reporting limits for metals and general chemistry constituents and Table 4-5 summarizes method detection limits and reporting limits for VOCs.

4.2.1 Precision

Precision is a measure of the reproducibility of an analytical result (i.e., to obtain the same or similar results on replicate measurements of the same sample or of duplicate samples). Reproducibility is affected by matrix variations, the extraction procedure, and the analytical method used. For duplicate samples, precision is expressed as the RPD. Precision will be evaluated for two components:

- Analytical method precision will be evaluated using matrix spike duplicates or laboratory duplicates, depending on the analytical method requirements.

- Analytical and field sampling precision will be evaluated using field duplicates.

The RPD (field or laboratory duplicates) will be reviewed during data quality review, and deviations from the specified limits will be noted and the effect on reported data commented upon by the data reviewer. Precision goals are presented in Table 4-3.

4.2.2 Accuracy

Accuracy (or bias) is assessed by determining how close a measured value lies to its true value. Field accuracy is obtained through evaluation of trip blanks, proper sample handling, preservation, and compliance with holding times. Primary indicators of laboratory accuracy are with blank, surrogate or matrix spike, or laboratory control samples. A sample is spiked with an analyte of known concentration and the result is used to calculate the average percent recovery (%R). This can be either a surrogate compound in organic methods, a blank or matrix spike. Accuracy goals are presented in Table 4-3.

Percent recoveries will be reviewed during data quality review, and deviations from the specified limits will be noted and the effect on reported data commented upon by the data reviewer.

4.2.3 Representativeness

Representativeness is a measure of how closely analytical results reflect the actual concentration or distribution of chemical compounds in a sampled media. Site locations for sampling are placed to evaluate effectiveness of environmental monitoring requirements. The number, location, and frequency of samples influence representativeness; these factors are addressed in the SAP, which is included as Attachment A of the CMP. Standard procedures for sample collection and handling have been developed to provide representative data for each sampling event. Field sampling and measurement procedures are discussed in detail in the SAP.

4.2.4 Comparability

Data comparability expresses the confidence with which each sampling event can be compared to another. Comparability will be maintained by use of consistent sampling procedures, approved analytical methods, consistent detection limits, and consistent units.

4.2.5 Completeness

Completeness for usable data is defined as the percentage of usable data out of the total amount of data generated. Specifically, the basis is the total number of scoped samples collected relative to the total number of valid results generated. When feasible, the amount of sample collected will be sufficient to reanalyze the sample, should the initial results not meet QC requirements. Less than 100 percent completeness could result if sufficient chemical contamination exists to require sample dilutions, resulting in an increase in the project-required detection/quantitation limits for some parameters. Highly contaminated environments can also be sufficiently heterogeneous to prevent the achievement of specified precision and accuracy criteria. The target goal for completeness will be 90 percent for laboratory analytical methods as shown in Table 4-3.

4.2.6 Sensitivity

The sensitivity of the analytical methods (i.e., method reporting limits) identified for this project is sufficient to allow comparison of project results to regulatory criteria. Project regulatory criteria and analytical method reporting limits (MRLs) for the project metals and general chemistry COCs are listed in Table 4-6. Regulatory criteria and analytical MRLs for VOC analytes are listed in Table 4-7. Regulatory criteria and analytical MRLs for surface water analytes are listed in Table 4-8. The analytical laboratory periodically updates the method limits. Although updated limits are not expected to impact project DQOs, updated limits will be reviewed to ensure that project DQOs are being met. Method detection limits (MDLs) and MRLs are defined below.

4.2.6.1 Method Detection Limit

The MDL is the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte (Appendix B of 40 CFR 136). MDL goals are listed in Table 4-4 for metals and general chemistry, and Table 4-5 for VOCs.

4.2.6.2 Method Reporting Limit

The MRL is a lowest quantitative value, routinely reported below which the laboratory reports a result of not detected. It may be based on project-specific constituents of concern, regulatory action levels, or sensitivity capability of methods and instrument. The MRLs are adjusted based on the sample matrix and any necessary sample dilutions. Dilutions will only be performed after method-required cleanup procedures and where target analyte concentrations exceed the highest calibration standard. Routine

laboratories MRLs for target analytes noted in the SWHP are listed in Table 4-4 for metals and general chemistry, and Table 4-5 for VOCs.

4.3 Analytical Quality Control

Analytical QC is performed to evaluate the performance of the analytical system and is limited to four types of QC checks, which are:

- Method blanks;
- Surrogate spikes;
- Laboratory control samples (LCS) or other check standards; and
- Laboratory duplicates and matrix spike samples.

Method-specific QC samples are described in the laboratory SOPs. Laboratory control limits for QC samples, method blanks, surrogate spikes, LCS, or other check standards, laboratory duplicates and matrix spike samples are included in Table 4-3.

4.3.1 Method Blanks

Method blanks are used to check for laboratory contamination and instrument bias. Laboratory method blanks will be analyzed at a minimum frequency of five percent or one per analytical batch for all chemical parameter groups.

QC criteria require that no contaminants be detected in the blank(s). If a chemical is detected in a method blank sample, the action taken will follow the laboratory SOPs as modified. Method blank samples will be analyzed for the same parameters as the associated field samples.

4.3.2 Laboratory Control Samples

LCSs are used to monitor the laboratory's day-to-day performance of routine analytical methods, independent of matrix effects. The LCS are prepared by spiking reagent water with standard solutions prepared independently of those used in establishing instrument calibration. The LCS are extracted and analyzed with each batch of samples. Results are compared on a per-batch basis to established control limits and are used to evaluate laboratory performance for accuracy (or bias) and precision (if an LCS duplicate is analyzed). Laboratory control samples may also be used to identify any background contamination of the analytical system that may lead to the reporting of elevated concentration levels or false-positive measurements. LCS control limit criteria are listed in Table 4-3.

4.3.3 Laboratory Duplicates

Precision of the analytical system is evaluated by using laboratory duplicates. Laboratory duplicates are two portions of a single homogeneous sample analyzed for the same parameter. Laboratory duplicates will be prepared and analyzed with project samples as listed in Table 4-2.

4.3.4 Reporting Percent Recovery of Matrix Spikes, Surrogate Spikes and Internal Standards

Accuracy of an analytical measurement can also be evaluated by using surrogate (for organics only) or matrix spikes (organics and inorganics). Surrogate compounds are compounds that are not expected to be detected in the environmental samples being analyzed; however, they are chemically similar to several compounds analyzed in the methods and behave similarly in extracting solvents. Samples for organics analysis will be spiked with surrogate compounds consistent with the requirements described in the laboratory SOPs. Selected samples for organics and inorganic analysis are spiked with target compound(s) and recovery of the matrix spike is evaluated. Because sample characteristics will affect the spike percent recovery, the percent recovery is a measure of accuracy of the overall analytical method on each individual sample. Some laboratories elect to perform both matrix spike and matrix spike duplicates (MS/MSD) on various samples. For this project there is an adequate measure of precision data with field duplicates, laboratory duplicates, and laboratory MS samples therefore, MSD analysis does not need to be performed. MS and surrogate spike acceptance criteria are listed on Table 4-3.

Internal standards are compounds that are very similar but not quite the same as the target compound(s). They are commonly used to assess instrument performance and to determine the concentration of the analyte. The laboratory will reanalyze samples that do not meet internal standard criteria. If the instrument is performing adequately but the reanalyzed samples do not meet internal standard criteria the failure to meet the criteria is typically due to matrix interference. Deliverables for a typical data package associated with this project do not include internal standard summary results. If data anomalies or discrepancies are identified corrective action as described in Section 4.4 will be used to evaluate potential causes of data anomalies and whether additional reporting from the laboratory is required. Current measures of accuracy (LCS, surrogates spikes, matrix spikes, trip blanks, and method blanks) are satisfactory indicators of laboratory performance and meet MQOs for this project.

4.3.5 Data Deficiencies

Laboratory QA will be implemented and maintained as described in this plan and according to the project laboratory's QA plans and SOPs. The analytical methods selected are sufficient to meet the project DQOs. While a best effort will be made to achieve the project DQOs, there may be cases in which it is not possible to meet the specified goals. Any limitation in data quality due to analytical problems will be identified and brought to the attention of the SWD Project Manager. The laboratory will demonstrate that they tried corrective action procedures, as recommended in the applicable methods and their QA Plan. This information will be discussed in the data evaluation report and data will be qualified as necessary.

4.4 Corrective Actions

The ultimate responsibility for maintaining quality throughout the groundwater, surface water, and landfill gas monitoring and compliance rests with the Field Monitoring Manager. The day-to-day responsibility for assuring the quality of field and laboratory data rests with the Site Manager, Laboratory Manager, Laboratory QA Officer, and the Project QA Officer.

Any non-conformances with the established QC procedures will be expeditiously identified and controlled. Where procedures are not in compliance with the established protocol, corrective actions will be taken immediately. Subsequent work that depends on the non-conforming activity will not be performed until the identified non-conformance is corrected.

4.4.1 Field Corrective Action

The Field Monitoring Manager will review the procedures being implemented in the field for consistency with the established protocols. Where procedures are not strictly in compliance with the established protocols, the deviations will be field documented and reported to the Project QA Officer. Corrective actions will be defined by the Project QA Officer and will be documented as appropriate. Upon implementation of the corrective action the Field Monitoring Manager will provide the Project QA Officer with a written memo documenting field implementation for review and will provide a copy to the SWD Project Manager. The memo will become part of the project file.

4.4.2 Laboratory Corrective Action

The Laboratory QA Officer will review the data generated to ensure that all QC samples have been run as specified in the protocol. Recoveries of LCS, surrogates, and MS samples will be evaluated against the control limits listed in Table 4-3 for consistency with method accuracy. Evaluations of RPD will be performed for laboratory duplicates and, if performed, the MSD. Reporting limits will be reviewed to ensure that project specific MQOs are met. Corrective actions are detailed in laboratory SOPs.

Laboratory personnel will be alerted that corrective actions are necessary if any of the following occur:

- QC data are outside the warning or acceptance windows for precision and accuracy.
- Blanks contain contaminants at concentrations above the reporting limit.
- Unusual changes in detection limits are observed.
- Deficiencies are detected during internal or external audits, or poor results of performance evaluation samples.

In addition, if dilutions are necessary to bring individual target analytes within the calibration range, these analytes will be reported from the dilution while the remaining analyte results will be reported from the non-diluted analytical run.

If the analyst identifies any non-conformances in analytical methodologies or quality control sample results, corrective actions will be implemented according to the Aquatic Research QA Plan. Corrective action may include, but will not be limited to the following:

- Reanalyze suspect samples (if adequate volume is available) if holding time criteria permit.
- Recalibrate analytical instruments.
- Resample and analyze new samples.
- Evaluate and amend sampling and/or analytical procedures.
- Accept the data with an acknowledged level of uncertainty.
- Evaluate and attempt to identify the limitations of the data.

The Project QA Officer will not accept data that are still unacceptable after implementation of the required corrective action measures and follow-up corrective actions will be explored.

4.4.2 Corrective Actions Following Data Evaluation

The Project QA Officer will review the field and laboratory data generated for this project to ensure that all project quality assurance objectives are met. If any non-conformances are found in the field procedures, sample collection procedures, field documentation procedures, laboratory analytical and documentation procedures, and data evaluation and quality review procedures, the impact of those non-conformances on the overall project QA objectives will be assessed. Appropriate actions, including resampling and reanalysis, may be recommended to the SWD Project Manager so that the project MQOs can be accomplished.

5.0 DATA HANDLING

5.1 Data Quality Objectives

Data must be of sufficient quality to meet the DQOs noted above. Two levels of data quality and analysis are applicable for this project:

- Screening Level Data; and
- Definitive Data.

5.1.1 Screening Level Data

Field measurements are performed using portable instruments. Field measurement results are used to evaluate landfill gas, groundwater and surface water conditions. Field measurement methods are summarized in the SAP, which is Attachment A of the CMP.

5.1.2 Definitive Data

Fixed laboratory data meets a higher level of stringency and is used to monitor groundwater and surface water samples. To generate data of sufficient quality, the following approach for analytical laboratory data for groundwater samples is followed:

- The laboratory is accredited by Ecology.
- Applicable analytical test methods (e.g., Washington State, and EPA SW-846 methods) will be used.
- Quality control samples and procedures are used by the laboratory for analysis.
- Data Summary packages will be generated and documentation provided is sufficient to perform a Level I data quality review.
- Data quality review will be performed on the analytical data according to the procedures specified in Section 9.2.

5.2 Data Review

The process of data reduction, review, and reporting is applicable to all aspects of the project (field activities, laboratory analyses, analytical data review) and is required for both technical and managerial data. All data generated through field activities, or by the laboratory operation shall be reduced and validated prior to reporting. The following sections describe the process of handling data in terms of data generation, checking, and formatted reports for both field sampling and laboratory analysis data.

5.2.1 Data Reduction

Data, both field and laboratory generated, are reduced either manually on calculation sheets or by computer on formatted printouts. Responsibilities for the data reduction process are delegated as follows:

- Technical personnel will document and review their own work and are responsible for the correctness of the work.
- Major calculations will receive a method and calculation check by a secondary reviewer prior to reporting (peer review).

The Project QA Officer will be responsible for ensuring that data reduction is performed according to protocols discussed in this QAP.

5.2.1.1 Field Data Reduction and Verification

Field data reduction procedures consist of recording measurements made in the field. Measurements for temperature, pH, dissolved oxygen (DO), oxidation-reduction potential (ORP), specific conductance, and turbidity will be recorded by directly reading field instrument meters. Data will be recorded onto appropriate field data forms (see Attachment A) immediately after measurements are taken. If errors are made, results are to be legibly crossed out, initialed, and dated by the field member and corrected in a space adjacent to the original (incorrect) entry.

5.2.1.2 Laboratory Data Reduction and Verification

All data generated by the laboratory will be reviewed prior to data release. The Aquatic Research Laboratory Quality Assurance Program indicates that 100% of the data generated by Aquatic Research will undergo several levels of internal review prior to data release. The levels of review consist of analyst, peer, and Project QA Officer review. Additionally, the Laboratory Manager and/or the Laboratory QA Officer review the completed package(s) for accuracy, overall compliance, and completeness.

5.2.1.1 Laboratory Data Reporting

Data deliverables will be submitted to SWD's consultant for verification and validation as appropriate. An electronic copy will be submitted to the SWD Project Manager. A summary laboratory data package will be submitted to SWD's consultant for each analytical batch. Level I data deliverables will include:

- Cover letter, which identifies the laboratory analytical batch number;
- Matrix and number of samples included; and
- Analyses performed and analytical methods used.

Cover Letters for Level I Data Summary Packages also summarize any issues with sample receipt, anomalies, or discrepancies with the analytical data. The following information is provided:

- Chain-of-Custody;
- Holding time (dates sampled, received, extracted, and analyzed) clearly specified;
- Tabulated sample analytical results with units, data qualifiers, sample volume, dilution factor, laboratory batch and sample number, and sample identification;
- Compound quantitation and reported detection limits;

- Blank summary results;
- Laboratory matrix spike/matrix spike duplicate result summarizing with calculated percent recovery and relative percent differences;
- Laboratory control sample results when performed, with calculated percent recovery;
- Surrogate recoveries for organic analyses;
- Laboratory duplicate analyses; and
- Data qualifiers assigned by the laboratory.

If warranted, a Level II or Level III package may be requested from the laboratory due to questionable data or unusable data. Details of the types of deliverables a Level II data package should have are as follows:

- Organic data deliverables for Level II will include Level I deliverables along with summary data for the following: initial and continuing calibrations, instrument tuning results, internal standard results, analytical run sequences, and prep logs.
- Inorganic (metals) data deliverables for Level II will include Level I deliverables along with summary data for initial and continuing calibration, low level check standards, initial and continuing calibration blanks, interference checks, serial dilution results, instrument or method detection limits, inductively coupled plasma mass spectrometry (ICP) inter-element correction factors, linear ranges, ICP-MS tune data, ICP-MS internal standards relative intensities, analytical run sequences, and prep logs.
- General chemistry data deliverables for a Level II will include Level I deliverables along with summary data for initial and continuing calibration, low level check standards (where applicable), initial and continuing calibration blanks, analytical run sequences, and prep logs.

A Level III package would consist of all of the above plus raw data for samples and QC.

5.2.2 Level I Data Review

If requested by SWD, the Laboratory Manager or Laboratory QA Officer will perform a Level I data review on specific analytical data reports. The data review process quantifies the data quality, both technical and evidentiary, verifies that adequate documentation was performed, and determines whether the analytical data are usable and meet analytical DQOs stated in this QAP.

Technical review requires comparison of QC to the required control limits. If a Level I data review is requested the following QC elements will be reviewed (as appropriate):

- Compliance with the QAP;
- Proper sample collection and handling procedures;
- Holding times and sample receipt conditions;
- Reviewing the laboratory data package for transcription errors, misidentifications, or miscalculations;
- Cover letter;
- Compound quantitation and reported detection limits. Note: Aquatic Research periodically updates MDLs and MRLs. Sample data will be evaluated against associated MDL and MRL data. All MRLs are below current regulatory criteria;
- Method and trip blank summary results;
- Surrogate percent recoveries;
- Laboratory duplicate analyses;
- Matrix spike and matrix spike duplicates;
- Field QC results;
- Assessing the reliability of data based on quality control sample results. Note: Aquatic Research control limits are periodically updated. Updated control limits will be used to assess associated data;
- Data qualifiers assigned by the laboratory;
- Data completeness and format; and
- Overall assessment of data for the project.

5.2.3 Data Review Reporting

Results of the QA review and/or validation will be included in a data quality review report, which will provide a basis for meaningful interpretation of the data quality and evaluate the need for corrective actions and/or comprehensive data validation. This report will be used to generate the quality control summary report.

5.2.4 Data Flags

The data quality review process for this project will follow the procedures in EPA's Functional Guidelines (EPA 1999), as appropriate, but applicable to SW-846, this QAP, method SOPs, and professional judgment. Qualifiers applied to the data as a result of the independent review will be limited to:

- E — The analyte was detected at a concentration that exceeds the response of the highest standard in the initial calibration range of the analytical instrument. E-flagged results are replaced by analytical results for the diluted and reanalyzed runs for that sample.
- U — The analyte was analyzed for but was not detected above the sample-specific reporting limit.
- J — The analyte was positively identified; the associated numerical value is an estimate of the concentration of the analyte in the sample.
- UJ — The analyte was not detected above the sample reporting limit. However, the reporting limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
- R — The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.

5.2.5 Overall Assessment of Data

After data have been verified and validated an overall assessment of data quality (referred to as Data Quality Assessment) is performed. This consists of the following steps:

- Review of project objectives and sampling design;
- Data review and reconciling results with DQOs;
- Select the statistical method;
- Verify the assumptions of the statistical method; and
- Draw conclusions from the data.

If MQOs are met, the quality of the data should be useable for meeting project objectives. If questionable data are identified then some determination needs to be done on whether data are useable. If MQOs are not met and DQO process indicates that objectives of the project have not been met the following steps should be taken:

- Identify a corrective action situation;
- Identify corrective actions;
- Approve the implementation of corrective action;
- Document corrective action; and
- Communicate corrective action to the SWD Project Manager.

Any change to the parameter list or frequency of sampling must be approved in writing by the permitting agency and according to regulatory requirements (WAC 173-304-700 and the current SWHP).

6.0 PERFORMANCE AND SYSTEM AUDITS

Performance and systems audits may be conducted to determine the following:

- QA program has been documented in accordance with specified requirements.
- The documented program has been implemented.
- Any non-conformances were identified and corrective action was implemented.

The Project QA Officer is responsible for initiating audits, with the SWD Project Manager's approval, and overseeing audit implementation and if necessary corrective actions.

6.1 Data Quality Audits (Independent Data Validation)

Data generated by the laboratory might undergo a Level I verification by the Laboratory QA Officer, designated staff, or SWD's consultant. Laboratory data that are verified will be evaluated for compliance with DQOs, and with procedural requirements contained in this QAP. The detailed scope of this validation is presented in Section 5.0, Data Handling.

6.2 Laboratory Audits

The analytical laboratory must be certified by Ecology and the State of Washington Department of Health to perform the methods listed in this QAP. No laboratory audit is currently planned; however, if a problem is identified, a systems or performance audit of the laboratory may be conducted in order to identify and correct specific problems.

6.3 Field Audits

Field audits will be conducted if the SWD Project Manager, the Field Monitoring Manager, or the Data Evaluation and Reporting Manager identify the need for field audits based on reviews of analytical data, field notes, and field data forms.

7.0 REFERENCES

American Public Health Association. 2012. Standard Methods for the Examination of Water & Wastewater 22nd Edition.

Environmental Protection Agency (EPA). 1983. Methods for Chemical Analysis of Water and Wastes. March 1983.

EPA. 1999. USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review. Office of Emergency and Remedial Response. October 1999.

Parametrix. 2014. Olalla Landfill Remedial Investigation/Feasibility Study. Prepared for Kitsap County Public Health District. May 2014.

Tables

Table 3-1: Groundwater Monitoring Field Quality Control Sample Summary
Olalla Landfill, Kitsap County, WA

Parameter	Number of Samples Per Quarter				
	Method	Primary Samples	Field Duplicate Samples (10%)	Trip Blank (one per event)	Total
VOCs	EPA 8260C GC/MS	5	1	1	7
VOCs (Vinyl Chloride)	EPA 8260C GC/MS Low level or SIM	5 (Q) 7 (A)	1	1	7 (Q) 9 (A)
Dissolved Metals (As, Fe, Mn)	EPA 6010/6020/7000 series	5 (Q) 7 (A)	1	NA	6 (Q) 8 (A)
Dissolved Metals (Ba, Zn)	EPA 6010/6020/7000 series	5	1	NA	6
Total Metals (Ca, K, Na)	EPA 6010/7000 series	5	1	NA	6
pH (laboratory)	SM 4500 H+B	5	1	NA	6
Alkalinity (mg $CaCO_3$/L)	SM 2320B	5	1	NA	6
Bicarbonate (mg $CaCO_3$/L)	SM 2320B	5	1	NA	6
Carbonate (mg $CaCO_3$/L)	SM 2320B	5	1	NA	6
Chloride	EPA 300.0	5	1	NA	6
Sulfate	EPA 300.0	5	1	NA	6
Ammonia - Nitrogen	EPA 350.1	5	1	NA	6
Nitrate Nitrogen	EPA 300.0	5	1	NA	6
Nitrite Nitrogen	EPA 300.0	5	1	NA	6
Total Organic Carbon	SM 5310B	5	1	NA	6
Chemical Oxygen Demand	SM 5220C	5	1	NA	6
Total Coliform	SM 9222 B	5	1	NA	6

Notes:

(Q) = Quarterly event

(A) = Annual event

Monitoring wells MW-1, MW-3, MW-6, MW-8, and MW-10 are sampled quarterly. Monitoring wells MW-5A and MW-7 are sampled annually.

GC/MS = Gas chromatography / mass spectrometry

GC/MS - SIM = Gas chromatography / mass spectrometry - selective ion monitoring

mg $CaCO_3$/L = milligrams of calcium carbonate per liter

Table 4-1: Data Quality Indicators
Olalla Landfill, Kitsap County, WA

Data Quality Indicator	Field and Laboratory QA/QC Sample Type
Precision	Field Duplicate Laboratory Duplicate Laboratory Matrix Spike Duplicate
Accuracy	Laboratory Matrix Spike Surrogate Spike Laboratory Control Sample Trip Blank Method Blank
Representativeness	Trip Blank Method Blank Chain of Custody Holding Times
Comparability	Method Detection Limits Method Reporting Limits Sample Collection Methods Laboratory Analytical Methods
Completeness	Data Qualifiers Laboratory Deliverables Requested / Reported Results

Notes:
QA/QC = Quality assurance / quality control

Table 4-2: Laboratory Quality Control Frequency
Olalla Landfill, Kitsap County, WA

Parameter	Method	Method Blanks	Lab Duplicates or MSD	MS	LCS	Surrogate
VOCs	EPA 8260C GC/MS	1/batch	1/batch	5%	1/batch	All Samples
VOCs (Vinyl Chloride)	EPA 8260C GC/MS-Low level or SIM	1/batch	1/batch	5%	1/batch	All Samples
Dissolved Metals (As, Ba, Fe, Mn, Zn)	EPA 6010/6020/700 series	1/batch	1/batch	5%	1/batch	NA
Total Metals (Ca, K, Na)	EPA 6010/7000 series	1/batch	1/batch	5%	1/batch	NA
pH (laboratory)	SM 4500 H+B	NA	1/batch	NA	NA	NA
Alkalinity (mg $CaCO_3$/L)	SM 2320B	1/batch	1/batch	NA	5%	NA
Bicarbonate (mg $CaCO_3$/L)	SM 2320B	1/batch	1/batch	NA	5%	NA
Carbonate (mg $CaCO_3$/L)	SM 2320B	1/batch	1/batch	NA	5%	NA
Chloride	EPA 300.0	1/batch	1/batch	5% MS	1/batch[1]	NA
Sulfate	EPA 300.0	1/batch	1/batch	5% MS	1/batch[1]	NA
Ammonia - Nitrogen	EPA 350.1	1/batch	1/batch	5% MS	1/batch[1]	NA
Nitrate Nitrogen	EPA 300.0	1/batch	1/batch	5% MS	1/batch[1]	NA
Nitrite Nitrogen	EPA 300.0	1/batch	1/batch	5% MS	1/batch[1]	NA
Total Organic Carbon	SM 5310B	1/batch	1/batch	5% MS	1/batch[1]	NA
Chemical Oxygen Demand	SM 5220C	1/batch	1/batch	5% MS	1/batch[1]	NA
Total Coliform	SM 9222 B	1/batch	1/batch	5% MS	NA	NA
Fecal Coliform	SM 9222 D	1/batch	1/batch	5% MS	NA	NA

Notes:

GC/MS = Gas chromatography / mass spectrometry

GC/MS - SIM = Gas chromatography / mass spectrometry - selective ion monitoring

mg $CaCO_3$/L = milligrams of calcium carbonate per liter

LCS = Laboratory Control Sample

MS = Matrix Spike

MSD = Matrix Spike Duplicate

NA = Not applicable

[1]Blank spike or standard reference material may substitute for matrix spike data.

Table 4-3: Measurement Quality Objectives: Accuracy, Precision, and Completeness Goals
Olalla Landfill, Kitsap County, WA

Parameters	Analytical Method	Laboratory Control Sample Accuracy[1] (% Recovery)	Matrix Spike Sample Accuracy[2] (% Recovery)	Surrogate Spike[3] (% Recovery)	Precision (RPD) (Dup or MS/MSD)	Completeness
Volatile Organic Compounds (VOCs)						
Volatile Organic Compounds	EPA 8260C	70-130	70-130	51-143	20%	90%
Vinyl Chloride	EPA 8260C Low level or SIM	70-130	70-130	90-110	20%	90%
Metals (Dissolved)						
Arsenic	EPA 6010/6020/7000 series	70-130	75-125	NA	20%	90%
Barium		70-130	75-125	NA	20%	90%
Iron		80-120	75-125	NA	20%	90%
Manganese		80-120	75-125	NA	20%	90%
Zinc		80-120	75-125	NA	20%	90%
Metals (Total)						
Calcium	EPA 6010/7000 series	80-120	75-125	NA	20%	90%
Potassium		80-120	75-125	NA	20%	90%
Sodium		80-120	75-125	NA	20%	90%
General Chemistry						
pH (laboratory)	SM 4500 H+B	80-120	NA	NA	20%	90%
Alkalinity (mg $CaCO_3$/L)	SM 2320B	80-120	80-120	NA	20%	90%
Bicarbonate (mg $CaCO_3$/L)		80-120	80-120	NA	20%	90%
Carbonate (mg $CaCO_3$/L)		80-120	80-120	NA	20%	90%
Chloride	EPA 300.0	80-120	80-120	NA	20%	90%
Sulfate		80-120	80-120	NA	20%	90%
Ammonia - Nitrogen	EPA 350.1	80-120	80-120	NA	20%	90%
Nitrate Nitrogen	EPA 300.0	80-120	80-120	NA	20%	90%
Nitrite Nitrogen		80-120	80-120	NA	20%	90%
Total Organic Carbon	SM 5310B	80-120	80-120	NA	20%	90%
Chemical Oxygen Demand	SM 5220C	80-120	80-120	NA	20%	90%
Total Coliform	SM 9222 B	NA	NA	NA	20%	90%
Fecal Coliform	SM 9222 D	NA	NA	NA	20%	90%

Notes:

Dup = Duplicate

mg $CaCO_3$/L = milligrams of calcium carbonate per liter

MS/MSD = Matrix spike / matrix spike duplicate

NA = Not applicable

RPD = Relative percent difference

pH is also measured in the field.

SIM = Selective ion monitoring

1 - Accuracy data for VOCs. Used default limits of 30-160% recovery and 30% RPD for all organic non-CLP analyses.

2 - Used default value for matrix spike recovery. Default limits for all inorganic analyses are 75-125% recovery and 20% RPD.

3 - Surrogate data are compound specific. This represents a range (minimum and maximum) of current surrogate control limits and subject to periodic updates.

Table 4-4: Metals and General Chemistry Analytes Method Detection Limits and Method Reporting Limits

Olalla Landfill, Kitsap County, WA

Analyte	Method	Method Detection Limit[(1)]	Method Reporting Limit[(1)]	Units
Metals (Dissolved)				
Arsenic	EPA 6010/6020/7000 series	0.010	0.050	µg/L
Barium		0.002	0.005	mg/L
Iron		0.008	0.020	mg/L
Manganese		0.003	0.005	mg/L
Zinc		0.003	0.005	mg/L
Metals (Total)				
Calcium	EPA 6010/7000 series	0.050	0.100	mg/L
Potassium		0.300	0.500	mg/L
Sodium		0.300	0.500	mg/L
General Chemistry				
pH (laboratory)	SM 4500 H+B	0.1	0.1	-log H+
Alkalinity (mg $CaCO_3$/L)	SM 2320B	1	1	mg/L
Bicarbonate (mg $CaCO_3$/L)		1	1	mg/L
Carbonate (mg $CaCO_3$/L)		1	1	mg/L
Chloride	EPA 300.0	0.16	0.5	mg/L
Sulfate		0.76	1	mg/L
Ammonia - Nitrogen	EPA 350.1	0.006	0.01	mg/L
Nitrate Nitrogen	EPA 300.0	0.005		mg/L
Nitrite Nitrogen		0.001	0.002	mg/L
Total Organic Carbon	SM 5310B	0.1	0.25	mg/L
Chemical Oxygen Demand	SM 5220C	6	10	mg/L
Total Coliform	SM 9222 B	1	1	CFU/100 mL
Fecal Coliform	SM 9222 D	1	1	CFU/100 mL

Notes:

1- MDL studies are performed in accordance with 40 CFR Part 136, Appendix B.

CFU /mL = Colony Forming Units per 100 mL

MDL = Method detection limit

MRL = Method reporting limit

µg/L = microgram per liter.

mg/L = milligram per liter

mg $CaCO_3$/L = milligrams of calcium carbonate per liter

Table 4-5: VOC Analytes and Method Detection and Method Reporting Limits
Olalla Landfill, Kitsap County, WA

Chemical	CAS Number	Method	Method Detection Limit	Method Reporting Limit	Units
Volatile Organic Compounds					
Bromobenzene	108-86-1	8260C	0.162	0.4	µg/L
Bromochloromethane	74-97-5	8260C	0.127	0.4	µg/L
Bromomethane	74-83-9	8260C	0.366	0.4	µg/L
n-Butylbenzene	104-51-8	8260C	0.060	0.4	µg/L
sec-Butylbenzene	135-98-8	8260C	0.042	0.4	µg/L
tert-Butylbenzene	98-06-6	8260C	0.087	0.4	µg/L
Carbon tetrachloride	56-23-5	8260C	0.180	0.4	µg/L
Chlorobenzene	108-90-7	8260C	0.096	0.4	µg/L
Chloroethane	75-00-3	8260C	0.238	0.4	µg/L
Chloromethane	74-87-3	8260C	0.176	0.4	µg/L
2-Chlorotoluene	95-49-8	8260C	0.145	0.4	µg/L
4-Chlorotoluene	106-43-4	8260C	0.104	0.4	µg/L
1,2-Dibromo-3-Chloropropane	96-12-8	8260C	0.153	0.4	µg/L
1,2-Dibromoethane	106-93-4	8260C	0.125	0.4	µg/L
Dibromomethane	74-95-3	8260C	0.078	0.4	µg/L
1,2-Dichlorobenzene	95-50-1	8260C	0.123	0.4	µg/L
1,3-Dichlorobenzene	541-73-1	8260C	0.051	0.4	µg/L
1,4-Dichlorobenzene	106-46-7	8260C	0.074	0.4	µg/L
Dichlorodifluoromethane	75-71-8	8260C	0.254	0.4	µg/L
1,1-Dichloroethane	75-34-3	8260C	0.116	0.4	µg/L
1,2-Dichloroethane	107-06-2	8260C	0.103	0.4	µg/L
1,1-Dichloroethene	75-35-4	8260C	0.105	0.4	µg/L
cis-1,2-Dichloroethene	156-59-4	8260C	0.108	0.4	µg/L
trans-1,2-Dichloroethene	156-60-5	8260C	0.175	0.4	µg/L
1,2-Dichloropropane	78-87-5	8260C	0.134	0.4	µg/L
1,3-Dichloropropane	142-28-9	8260C	0.112	0.4	µg/L
2,2-Dichloropropane	590-20-7	8260C	0.333	0.4	µg/L
1,1-Dichloropropene	563-58-6	8260C	0.099	0.4	µg/L
cis-1,3-Dichloropropene	10061-01-5	8260C	0.084	0.4	µg/L
trans-1,3-Dichloropropene	10061-02-6	8260C	0.055	0.4	µg/L
Hexachlorobutadiene	87-68-3	8260C	0.259	0.4	µg/L
Isopropylbenzene	98-82-8	8260C	0.053	0.4	µg/L
4-Isopropyltoluene	99-87-6	8260C	0.078	0.4	µg/L
Methylene chloride	75-09-2	8260C	0.268	0.4	µg/L
Naphthalene	91-20-3	8260C	0.088	0.4	µg/L
n-Propylbenzene	103-65-1	8260C	0.158	0.4	µg/L
Styrene	100-42-5	8260C	0.065	0.4	µg/L
1,1,1,2-Tetrachloroethane	630-20-6	8260C	0.153	0.4	µg/L
1,1,2,2-Tetrachloroethane	79-34-5	8260C	0.083	0.4	µg/L
Tetrachloroethene	127-18-4	8260C	0.192	0.4	µg/L
1,2,3-Trichlorobenzene	87-61-6	8260C	0.080	0.4	µg/L
1,2,4-Trichlorobenzene	120-82-1	8260C	0.111	0.4	µg/L
1,1,1-Trichloroethane	71-55-6	8260C	0.100	0.4	µg/L
1,1,2-Trichloroethane	79-00-5	8260C	0.177	0.4	µg/L
Trichloroethene	79-01-6	8260C	0.188	0.4	µg/L
Trichlorofluoromethane	75-69-4	8260C	0.313	0.4	µg/L

Table 4-5: VOC Analytes and Method Detection and Method Reporting Limits
Olalla Landfill, Kitsap County, WA

Chemical	CAS Number	Method	Method Detection Limit	Method Reporting Limit	Units
1,2,3-Trichloropropane	96-18-4	8260C	0.306	0.4	µg/L
1,2,4-Trimethylbenzene	95-63-6	8260C	0.094	0.4	µg/L
1,3,5-Trimethylbenzene	108-67-8	8260C	0.084	0.4	µg/L
Vinyl chloride by GC/MS	75-01-4	8260C	0.095	0.4	µg/L
Vinyl chloride by SIM	75-01-4	8260	0.020	0.02	µg/L
BTEX					
Benzene	71-43-2	8260C	0.085	0.4	µg/L
Toluene	108-88-3	8260C	0.109	0.4	µg/L
Ethylbenzene	100-41-4	8260C	0.096	0.4	µg/L
m,p-Xylene		8260C	0.205	0.4	µg/L
o-Xylene	95-47-6	8260C	0.159	0.4	µg/L
TRIHALOMETHANES					
Chloroform	67-66-3	8260C	0.161	0.4	µg/L
Bromodichloromethane	75-27-4	8260C	0.097	0.4	µg/L
Dibromochloromethane	124-48-1	8260C	0.159	0.4	µg/L
Bromoform	75-25-2	8260C	0.112	0.4	µg/L
KETONES					
Acetone	67-64-1	8260C	0.383	0.4	µg/L
2-Butanone	78-93-3	8260C	0.057	0.4	µg/L
2-Hexanone	591-78-6	8260C	0.144	0.4	µg/L
4-Methyl-2-Pentanone	108-10-1	8260C	0.191	0.4	µg/L
Other					
Carbon Disulfide	75-15-0	8260C	0.085	0.4	µg/L
2-Chloroethylvinylether	110-75-8	8260C	0.134	0.4	µg/L
Acrylonitrile	107-13-1	8260C	0.37647125	0.4	µg/L
Allyl Chloride	107-05-1	8260C	0.193	0.4	µg/L
1-Chlorobutane	109-69-3	8260C	0.11	0.4	µg/L
trans-1,4-Dichloro-2-Butene	110-57-6	8260C	0.236	0.4	µg/L
Diethyl Ether	60-29-7	8260C	0.384	0.4	µg/L
Ethyl Methacrylate	97-63-2	8260C	0.275	0.4	µg/L
Hexachloroethane	67-72-1	8260C	0.099	0.4	µg/L
Iodomethane	74-88-4	8260C	0.116	0.4	µg/L
Methacrylonitrile	126-98-7	8260C	0.143	0.4	µg/L
Methyl Acrylate	96-33-3	8260C	0.167	0.4	µg/L
Methyl-t-Butyl Ether	1634-04-4	8260C	0.171	0.4	µg/L
Methyl methacrylate	80-62-6	8260C	0.158	0.4	µg/L
Nitrobenzene	98-95-3	8260C	0.252	0.4	µg/L
2-Nitropropane	79-46-9	8260C	0.391	0.4	µg/L
Pentachloroethane	76-01-7	8260C	0.239	0.4	µg/L

Notes:
CAS = Chemical abstract service
µg/L= microgram per liter

Table 4-6: Groundwater Regulatory Levels and Reporting Limits for Metals and General Chemistry

Olalla Landfill, Kitsap County, WA

Chemical	Method	State Drinking Water Standards (a)	State Groundwater Standards (b)	Method Reporting Limit	Units
Metals (Dissolved)					
Arsenic	EPA 6010/6020/7000 series	10*	0.05*	0.050	µg/L
Barium		2,000*	1,000*	5	µg/L
Iron		300**	300**	20	µg/L
Manganese		50**	50**	5	µg/L
Zinc		5,000**	5,000**	5	µg/L
Metals (Total)					
Calcium	EPA 6010/7000 series	-----	-----	100	µg/L
Potassium		-----	-----	500	µg/L
Sodium		20,000***	-----	500	µg/L
General Chemistry					
pH (laboratory)	SM 4500 H+B	-----	6.5-8.5**	0.1	-log H+
Alkalinity (mg $CaCO_3$/L)	SM 2320B	-----	-----	1	mg/L
Bicarbonate (mg $CaCO_3$/L)		-----	-----	1	mg/L
Carbonate (mg $CaCO_3$/L)		-----	-----	1	µg/L
Chloride	EPA 300.0	250**	250**	0.5	mg/L
Sulfate		250**	250**	1.00	mg/L
Ammonia - Nitrogen	EPA 350.1	-----	-----	0.01	mg/L
Nitrate Nitrogen	EPA 300.0	10*	10*	0.01	mg/L
Nitrite Nitrogen		1*	-----	0.002	mg/L
Total Organic Carbon	SM 5310B	-----	-----	0.25	mg/L
Chemical Oxygen Demand	SM 5220C	-----	-----	10	mg/L
Total Coliform	SM 9222 B	1/100 mL*	1/100 mL*	1	CFU/100 mL
Fecal Coliform	SM 9222 D	-----	-----	1	CFU/100 mL

Regulatory Standards:

(a) WAC 246-290-310

(b) WAC 173-200-040

* Primary Standard

** Secondary Standard

*** Recommended level of concern for consumers with restricted daily sodium intake.

Notes:

CFU /mL = Colony Forming Units per 100 mL

µg/L = microgram per liter.

mg/L = milligram per liter

mg $CaCO_3$/L = milligrams of calcium carbonate per liter

Table 4-7: Groundwater Regulatory Levels and Reporting Limits for VOCs
Olalla Landfill, Kitsap County, WA

Chemical	CAS Number	Method	State Drinking Water Standards (a)	State Groundwater Standards (b)	Method Reporting Limit	Units
Volatile Organic Compounds						
Bromobenzene	108-86-1	8260C	-----	-----	0.4	µg/L
Bromochloromethane	74-97-5	8260C	-----	-----	0.4	µg/L
Bromomethane	74-83-9	8260C	-----	-----	0.4	µg/L
n-Butylbenzene	104-51-8	8260C	-----	-----	0.4	µg/L
sec-Butylbenzene	135-98-8	8260C	-----	-----	0.4	µg/L
tert-Butylbenzene	98-06-6	8260C	-----	-----	0.4	µg/L
Carbon tetrachloride	56-23-5	8260C	5	0.3	0.4	µg/L
Chlorobenzene	108-90-7	8260C	100	-----	0.4	µg/L
Chloroethane	75-00-3	8260C	-----	-----	0.4	µg/L
Chloromethane	74-87-3	8260C	-----	-----	0.4	µg/L
2-Chlorotoluene	95-49-8	8260C	-----	-----	0.4	µg/L
4-Chlorotoluene	106-43-4	8260C	-----	-----	0.4	µg/L
1,2-Dibromo-3-Chloropropane	96-12-8	8260C	-----	-----	0.4	µg/L
1,2-Dibromoethane	106-93-4	8260C	-----	0.001	0.4	µg/L
Dibromomethane	74-95-3	8260C	-----	-----	0.4	µg/L
1,2-Dichlorobenzene	95-50-1	8260C	600	-----	0.4	µg/L
1,3-Dichlorobenzene	541-73-1	8260C	-----	-----	0.4	µg/L
1,4-Dichlorobenzene	106-46-7	8260C	75	4	0.4	µg/L
Dichlorodifluoromethane	75-71-8	8260C	-----	-----	0.4	µg/L
1,1-Dichloroethane	75-34-3	8260C	-----	1	0.4	µg/L
1,2-Dichloroethane	107-06-2	8260C	5	0.5	0.4	µg/L
1,1-Dichloroethene	75-35-4	8260C	7	-----	0.4	µg/L
cis-1,2-Dichloroethene	156-59-4	8260C	70	-----	0.4	µg/L
trans-1,2-Dichloroethene	156-60-5	8260C	100	-----	0.4	µg/L
1,2-Dichloropropane	78-87-5	8260C	5	0.6	0.4	µg/L
1,3-Dichloropropane	142-28-9	8260C	-----	-----	0.4	µg/L
2,2-Dichloropropane	590-20-7	8260C	-----	-----	0.4	µg/L
1,1-Dichloropropene	563-58-6	8260C	-----	-----	0.4	µg/L
cis-1,3-Dichloropropene	10061-01-5	8260C	-----	0.2	0.4	µg/L
trans-1,3-Dichloropropene	10061-02-6	8260C	-----	0.2	0.4	µg/L
Hexachlorobutadiene	87-68-3	8260C	-----	-----	0.4	µg/L
Isopropylbenzene	98-82-8	8260C	-----	-----	0.4	µg/L
4-Isopropyltoluene	99-87-6	8260C	-----	-----	0.4	µg/L
Methylene chloride	75-09-2	8260C	5	5	0.4	µg/L
Naphthalene	91-20-3	8260C	-----	-----	0.4	µg/L
n-Propylbenzene	103-65-1	8260C	-----	-----	0.4	µg/L
Styrene	100-42-5	8260C	100	-----	0.4	µg/L
1,1,1,2-Tetrachloroethane	630-20-6	8260C	-----	-----	0.4	µg/L
1,1,2,2-Tetrachloroethane	79-34-5	8260C	-----	-----	0.4	µg/L
Tetrachloroethene	127-18-4	8260C	5	0.8	0.4	µg/L
1,2,3-Trichlorobenzene	87-61-6	8260C	-----	-----	0.4	µg/L
1,2,4-Trichlorobenzene	120-82-1	8260C	70	-----	0.4	µg/L
1,1,1-Trichloroethane	71-55-6	8260C	200	200	0.4	µg/L
1,1,2-Trichloroethane	79-00-5	8260C	5	-----	0.4	µg/L

Table 4-7: Groundwater Regulatory Levels and Reporting Limits for VOCs

Olalla Landfill, Kitsap County, WA

Chemical	CAS Number	Method	State Drinking Water Standards (a)	State Groundwater Standards (b)	Method Reporting Limit	Units
Trichloroethene	79-01-6	8260C	5	3	0.4	µg/L
Trichlorofluoromethane	75-69-4	8260C	-----	-----	0.4	µg/L
1,2,3-Trichloropropane	96-18-4	8260C	-----	-----	0.4	µg/L
1,2,4-Trimethylbenzene	95-63-6	8260C	-----	-----	0.4	µg/L
1,3,5-Trimethylbenzene	108-67-8	8260C	-----	-----	0.4	µg/L
Vinyl chloride by GC/MS	75-01-4	8260C	2	0.02	0.4	µg/L
Vinyl chloride by SIM	75-01-4	8260	2	0.02	0.02	µg/L
BTEX						
Benzene	71-43-2	8260C	5	1	0.4	µg/L
Toluene	108-88-3	8260C	1000	-----	0.4	µg/L
Ethylbenzene	100-41-4	8260C	700	-----	0.4	µg/L
m,p-Xylene		8260C	10	-----	0.4	µg/L
o-Xylene	95-47-6	8260C	10	-----	0.4	µg/L
TRIHALOMETHANES						
Chloroform	67-66-3	8260C	-----	7	0.4	µg/L
Bromodichloromethane	75-27-4	8260C	-----	0.5	0.4	µg/L
Dibromochloromethane	124-48-1	8260C	-----	-----	0.4	µg/L
Bromoform	75-25-2	8260C	-----	5	0.4	µg/L
KETONES						
Acetone	67-64-1	8260C	-----	-----	0.4	µg/L
2-Butanone	78-93-3	8260C	-----	-----	0.4	µg/L
2-Hexanone	591-78-6	8260C	-----	-----	0.4	µg/L
4-Methyl-2-Pentanone	108-10-1	8260C	-----	-----	0.4	µg/L
Other						
Carbon Disulfide	75-15-0	8260C	-----	-----	0.4	µg/L
2-Chloroethylvinylether	110-75-8	8260C	-----	-----	0.4	µg/L
Acrylonitrile	107-13-1	8260C	-----	0.07	0.4	µg/L
Allyl Chloride	107-05-1	8260C	-----	-----	0.4	µg/L
1-Chlorobutane	109-69-3	8260C	-----	-----	0.4	µg/L
trans-1,4-Dichloro-2-Butene	110-57-6	8260C	-----	-----	0.4	µg/L
Diethyl Ether	60-29-7	8260C	-----	-----	0.4	µg/L
Ethyl Methacrylate	97-63-2	8260C	-----	-----	0.4	µg/L
Hexachloroethane	67-72-1	8260C	-----	-----	0.4	µg/L
Iodomethane	74-88-4	8260C	-----	-----	0.4	µg/L
Methacrylonitrile	126-98-7	8260C	-----	-----	0.4	µg/L
Methyl Acrylate	96-33-3	8260C	-----	-----	0.4	µg/L
Methyl-t-Butyl Ether	1634-04-4	8260C	-----	-----	0.4	µg/L
Methyl methacrylate	80-62-6	8260C	-----	-----	0.4	µg/L
Nitrobenzene	98-95-3	8260C	-----	-----	0.4	µg/L
2-Nitropropane	79-46-9	8260C	-----	-----	0.4	µg/L
Pentachloroethane	76-01-7	8260C	-----	-----	0.4	µg/L

Regulatory Standards:

(a) WAC 246-290-310

(b) WAC 173-200-040

Notes:

ug/L = microgram per liter

CAS = Chemical abstract service

Table 4-8: Surface Water Regulatory Levels and Reporting Limits for General Chemistry

Olalla Landfill, Kitsap County, WA

Chemical	Method	State Surface Water Standards (a)	Units	Method Reporting Limit
General Chemistry				
pH (laboratory)	SM 4500 H+B	6.5-8.56	-log H+	0.1
Nitrate Nitrogen	EPA 353.2	<10	mg/L	0.01
Fecal Coliform	SM 9222 D	100	CFU/100 mL	1

Regulatory Standards:

(a) WAC 173-201A-200 - Nitrate Standards is for Class AA water. Fecal coliform standard is 100/100mL for Primary Contact Recreation.

The appropriate class of water for the detention pond has not been established.

Notes:

CFU /100 mL = Colony Forming Units per 100 milliliters

mg/L = milligram per liter

Figure

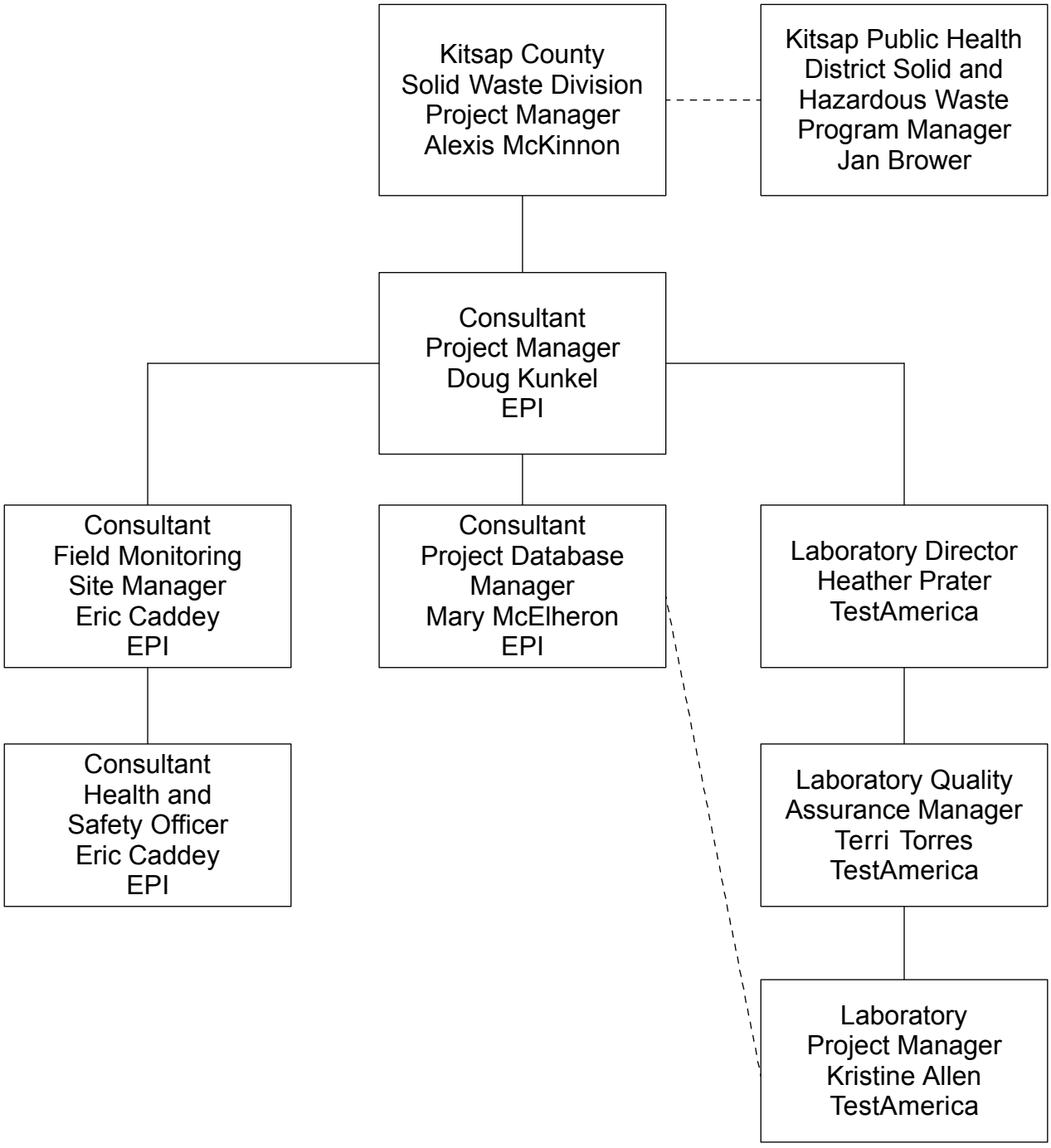


FIGURE 1-1
OLALLA LANDFILL PROJECT ORGANIZATION CHART
KITSAP COUNTY, WASHINGTON

PREPARED BY	epi ENVIRONMENTAL PARTNERS INC		
REPORT	QUALITY ASSURANCE PLAN		
LOCATION	OLALLA LANDFILL KITSAP COUNTY, WASHINGTON		
PREPARED FOR	KITSAP COUNTY		
DATE 2/24/15	***DRAWN BY*** CLM	***REVIEWED BY*** DCK	***PROJECT NUMBER*** 45403.0

KEY:

——— DIRECT REPORT

- - - - COMMUNICATION AND COORDINATION

Attachment A
Example Calibration and Field Data Forms

Multiparameter Probe Calibration Log - Olalla Landfill Groundwater Monitoring

Meter Type	Manufacturer	Model Number	Mfg. Serial#	Rental Co. Serial #	Date	Time

Calibrated to Autocal Solution

Calibration Solution Manufacturer _____ Lot Number _____ Exp. Date _____

pH = _____ Turbidity = _____ Temperature = _____

Conductivity = _____ Dissolved Oxygen = _____ ORP = _____

Comments:

Meter Type	Manufacturer	Model Number	Mfg. Serial#	Rental Co. Serial #	Date	Time

Calibrated to Autocal Solution

Calibration Solution Manufacturer _____ Lot Number _____ Exp. Date _____

pH = _____ Turbidity = _____ Temperature = _____

Conductivity = _____ Dissolved Oxygen = _____ ORP = _____

Comments:

Instrument Calibration Log - Olalla Landfill Monitoring

Calibrated By: _____ **Date: _____**

Meter Type	Manufacturer	Model Number	Manufacturer Serial #	Rental Co. Serial #	Time
pH					
pH Electrode					

Calibrated: _____ to 4.00 buffer _____ to 7.00 buffer _____ to 10.00 buffer at _____ °C

Slope =_____ Comments:

Meter Type	Manufacturer	Model Number	Manufacturer Serial #	Rental Co. Serial #	Time
Specific Cond.					

Specific Conductance: Calibrated _____µS/cm to _____µS/cm calibration standard

Electrical Conductivity: Calibrated _____µS/cm to _____µS/cm calibration standard at _____ °C

Comments:

Meter Type	Manufacturer	Model Number	Manufacturer Serial #	Rental Co. Serial #	Time
ORP Meter					
ORP Electrode					

Electrode measured _____millivolts at _____ °C using Zobell prepared on / /

Table value for Zobell solution at this temperature is _____mV.

Meter Type	Manufacturer	Model Number	Manufacturer Serial #	Rental Co. Serial #	Time
Turbidity					

Meter reads _____NTUs using_____ NTUs standard Comments:

Meter reads _____NTUs using_____ NTUs standard

Meter Type	Manufacturer	Model Number	Manufacturer Serial #	Rental Co. Serial #	Time
DO Meter					

Air-Calibration: Measured temperature _____ °C corresponds to _____ mg/L DO (from Table I)

Atmospheric pressure / elevation correction factor _____ (from Table II)

Corrected calibration value _____ mg/L DO (Table I value multiplied by Table II value)

Comments:

Depth to Water Measurement Field Data - Olalla Landfill Monitoring

Well	Time	Measuring Point Elevation (ft. NGVD[1])	Depth to Water (ft.)	Comments and Well Inspection[2] Notes
MW-1		343.79		
MW-2		323.25		
MW-3		296.95		
MW-4		320.93		
MW-5		334.17		
MW-5A		332.53		
MW-6		271.17		
MW-7		280.43		
MW-8		272.85		
MW-10		279.21		

Notes:

[1]NGVD = National Geodetic Vertical Datum (1929)

[2]Observations regarding the condition of the well and surrounding area (e.g., protective casing, surface seal, cap, lock, bollards, soil conditions near the well such as depressions, ponded surface water, or other subsidence features, and any installed sampling equipment).

Groundwater Sampling Field Data - Olalla Landfill Monitoring

Station		Date	
Sample: ID		Field Team: (Initials)	
Field Conditions			

Low-Flow Purge Information

Well Diameter (in.)	
Well Depth (ft.)	
Initial Depth to Water (ft.)	
Depth of Water Column	
1 Casing Volume (gal.)	
Controller setting (Hz)	

Purge Method : Submersible pump

Other: : _____

Start Time	
End Time	
Total Gallons Purged	

Time	Gallons	pH	Conductivity	NTU	DO	Temp.	ORP	Appearance

Sample Information

Sample Method(s) : Submersible pump / Peristaltic pump / Bladder Pump / Other

Analysis	Time	Bottle Type	Preservative/Filtration	Comments
Volatiles and VC		(3) 40-mL VOA	HCl, cool to <4°C	
Total Coliform		300-mL sterile AG or poly	Cool to <4°C	
Geochemical Parameters		500-mL HDPE	Cool to <4°C	
Nitrate/Nitrite		500-mL HDPE	Cool to <4°C	
TOC		250-mL AG	H_2SO_4 to pH <2, cool to <4°C	
COD		250-mL HDPE	H_2SO_4 to pH <2, cool to <4°C	
Total Metals		250-mL HDPE	HNO_3 to pH <2, cool to <4°C	
Dissolved Metals		250-mL HDPE	Field filter, HNO_3 to pH <2, cool to <4°C	

Sample End Time	

Comments / Exceptions:

Notes: Where multiple visits are required to complete sampling, parameters are to be checked prior to sampling for each visit. Enter data under field comments.

Surface Water Sampling Field Data - Olalla Landfill Monitoring

Station		Date	
Sample: ID		Field Team: (Initials)	
Field Conditions			

Field Parameter Data

Time	pH	Specific Conductance	Temperature (°C)	Appearance and Flow Rate

Sample Information

Analysis	Time	Bottle Type	Preservative/Filtration	Comments
Fecal Coliform		300-mL sterile AG or poly	Cool to <4°C	
Nitrate-Nitrogen		500-mL HDPE	Cool to <4°C	
pH		125-mL AG	Cool to <4°C	

Sample End Time

Comments / Exceptions:

Notes: Where multiple visits are required to complete sampling, parameters are to be checked prior to sampling for each visit. Enter data under field comments.

Landfill Gas Monitoring Field Data - Olalla Landfill Monitoring

Instrument Used:		Date and Time:	
Ambient Temperature:		Field Team:	
Field Conditions:			

Landfill Gas Data

Flare #	Time	Methane (% vol.)	% LEL	Oxygen (% vol.)	Carbon Dioxide (% vol.)	Temperature (°C)	Gas Pressure ("H_2O)

Comments / Inspection Results[1]

[1]Inspect the following: lock and gate operation, tightness of bolts and clamps, differential settlement, valve operation, debris or breaks in hose barb.

Attachment C
Health and Safety Plan

ENVIRONMENTAL PARTNERS INC
1180 NW Maple Street, Suite 310 Issaquah, Washington 98027 ph 425.395.0010

Health and Safety Plan

Site Name:	Olalla Landfill
EPI Project Number:	45403.0
Site Address:	2850 SE Burley-Olalla Road, Port Orchard, Washington 98367
Client:	Kitsap County Public Works Department, Solid Waste Division
Site Contact:	Ms. Alexis McKinnon / Kitsap County
Client Health and Safety Representative:	Ms. Alexis McKinnon / Kitsap County Office Phone: (360) 337-5748 email: amckinno@co.kitsap.wa.us

Planned Activities:	**Location Within Site:**	**Dates:**
Groundwater sampling, surface water sampling, landfill gas flare monitoring	Site-wide	Quarterly sampling: March, June, September, and December

Estimation of Hazards to EPI Personnel:

Low concentrations of vinyl chloride, mechanical equipment, electrical power, slip, trip, fall hazards

Physical Description of the Facility:

Kitsap County Public Works (KCPW) owns the Landfill property, which consists of an approximately 6.5-acre area capped by a clay-amended soil low-permeability barrier and vegetated protective soil cover (Phase I Area) and an approximate 4.5-acre area covered with vegetated soil (Phase II Area). Both the Phase I and Phase II areas of the Landfill are surrounded by a gravel perimeter access road that encompasses approximately 12 acres.

The perimeter road is accessed through a locked gate at Bandix Road SE to the east side of the property. The Landfill area also contains a groundwater monitoring well network, a passive landfill gas collection system, a surface water conveyance system, a storm water detention pond, public access controls, and a surrounding vegetation buffer. The Phase I and Phase II Areas, monitoring wells, flares, surface water sampling location, and other features of the Landfill, are shown in the attached site map (Figure 1).

In addition to the closed Landfill, the north parcel contains a Drop Box, known as a Recycling and Garbage Facility in Kitsap County, which was established as a transfer station at the time the Landfill stopped accepting waste. A fence and locked gate separate the Recycling and Garbage Facility from the Landfill. Two monitoring wells, MW-5 and MW-5A, are located on the Recycling and Garbage Facility side of the fence. The remainder of the groundwater and surface water sampling locations and the landfill gas flares are located on the Landfill (south) side of the fence.

Operation Description of the Facility:

The Olalla Landfill is a closed and capped small municipal landfill. The adjacent Recycling and Garbage Facility is active during normal business hours and has truck and car traffic when open.

Facility Status:

The Olalla Landfill itself is closed and capped. The Recycling and Garbage Facility is operational.

Hazard Assessment			
Chemical State:	☒ Liquid	☐ Solid	☒ Gas
	☒ Vapor	☐ Unknown	
Chemical Characteristics:	☐ Corrosive	☒ Flammable	☒ Toxic
	☒ Volatile	☐ Inert	☐ Other:

Describe Potential Chemical Hazards and Modes of Exposure	
Chemical Hazards:	Vinyl chloride, arsenic, manganese, iron
Potential Modes of Exposure:	Ingestion, inhalation, absorption (dermal)

Potential Chemical Hazards

Chemical Name	Action Levels			Exposure Route	Target Organs	Symptoms
	PEL	STEL	IDLH			
Chlorinated Volatile Organics						
Vinyl chloride	1 ppm		5 ppm	Inhalation, skin/eye contact	Liver, CNS, blood, respiratory system, lymphatic system	Weakness, exhaustion, abdominal pain, gastrointestinal bleeding, enlarged liver, pallor or cyanosis of extremities, liquid: frostbite [potential occupational carcinogen]
Inorganics (as airborne solids)						
Arsenic	0.002 mg/m^3	0.010 mg/m^3	5 mg/m^3	Inhalation, skin absorption, skin/eye contact, ingestion	Liver, kidneys, skin, lungs, lymphatic system	Ulceration of nasal septum, dermatitis, gastrointestinal disturbances, peripheral neuropathy, respiratory irritation, hyperpigmentation of skin [potential occupational carcinogen]
Iron	None Determined		None Determined	Inhalation, ingestion, skin and/or eye contact	Eyes, skin, respiratory system, liver, gastrointestinal tract	Irritation eyes, skin, mucous membrane; abdominal pain, diarrhea, vomiting; possible liver damage

Potential Chemical Hazards

Chemical Name	Action Levels			Exposure Route	Target Organs	Symptoms
	PEL	STEL	IDLH			
Manganese	5 mg/m^3		500 mg/m^3	Inhalation, ingestion	Respiratory system, central nervous system, blood, kidneys	Manganism; asthenia, insomnia, mental confusion; metal fume fever: dry throat, cough, chest tightness, dyspnea (breathing difficulty), rales, flu-like fever; low-back pain; vomiting; malaise (vague feeling of discomfort); lassitude (weakness, exhaustion); kidney damage

Describe Potential Physical Worker Hazards:

Working with electrical motors and equipment, working with gas powered generators, cold stress, heat stress, slip, trip, fall.

Potential Physical Hazards

☒ Heat Stress	☒ Cold Stress	☒ Explosion/Flammability
☒ Noise	☐ Confined-Space Entry	☐ Oxygen-Deficient Atmosphere
☐ Traffic or heavy equipment	☐ Heights	☒ Slip, trip, fall

Prevention of Physical Hazards

Category	Cause	Preventive Measures
Head Hazards	Falling and/or sharp objects, bumping hazards.	Hard hats will be worn by all personnel at all times when working around overhead hazards and heavy equipment.
Foot/Ankle Hazards	Sharp objects, dropped objects, uneven and/or slippery surfaces, and chemical exposure.	Chemical resistant, steel-toed boots must be worn at all times on-site.
Eye Hazards	Sharp objects, poor lighting, bright lights (welding equipment), exposure due to splashes.	Safety glasses/face shields will be worn when appropriate. Shaded welding protection will be worn when appropriate.
Electrical Hazards	Underground utilities, overhead utilities, motors, electrical panels equip. and breakers.	Locator service mark-outs, visual inspection of work area prior to starting work.
Explosion/flammability Hazards	Methane sometimes present in landfill flares at concentrations greater than the lower explosive limit.	No open flames, sparks, or motors allowed inside of the landfill flare enclosures.
Mechanical Hazards	Heavy equipment such as drill rigs, service trucks, excavation equipment, saws, drills, etc.	Competent operators, backup alarms, regular maintenance, daily mechanical checks, proper guards.

Noise Hazards	Machinery creating >85 decibels TWA, >115 decibels continuous noise, or peak at >140 decibels.	Wear earplugs or protective earmuffs when working near gas-powered generators.
Fall Hazards	Elevated and/or slippery or uneven surfaces. Trips caused by poor "house keeping" practices.	Care should be used to avoid such accidents and to maintain good "house keeping". Fall protection devices must be used when work proceeds on elevated surfaces.
Lifting Hazards	Injury due to improper lifting techniques, overreaching/overextending, heavy objects.	Use proper lifting techniques, mechanical devices where appropriate.
Lighting Hazards	Improper illumination.	Limit work to daylight hours or rent additional construction lighting.

Site Activity Considerations			
Will Client Site Representative be Present?	☐ Yes	☒ No	☐ Sometimes
Exact Locations of Chemicals:	☒ Known	☐ Assumed	☐ Unknown
Identify Nearest Off-Site Population:	☒ Rural ☐ Urban	☐ Industrial ☐ Commercial	☐ Residential

Monitoring Equipment

☐ PID ☐ FID ☐ Combustible gas indicator

☐ H_2S/O_2 Meter ☒ Other (describe): Landfill gas meter, which includes an O_2 meter and combustible gas indicator

Monitoring Action Guidelines		
Instrument	**Reading**	**Action Required**
Landfill gas meter (combustible gas indicator, Lower Explosive Limit [LEL], CO_2, O_2) LEL ranges are for ambient air near flares, not monitoring data.	0–10% LEL	No hazard.
	10%–20% LEL	Potential hazard, notify Project Manager.
	>20% LEL	Explosive hazard, evacuate area.

Special Safety Considerations				
If there is more than one level of hazard, or if there are multiple "sites" within a site, the hazards associated with each should be considered. A separate "Special Safety Considerations" section should be completed for each "site."				
Work Location:	Olalla Landfill monitoring wells, surface water sampling location(s) and landfill gas flares.			
Objective of work at this Location:	Water level measurements, groundwater and surface water sampling, landfill gas flare monitoring.			
Level of Protection Planned:	☐ Level C	☐ Level D	☒ Level D-Modified (explain below)	
Modifications to Level of Protection:				
Eye protection to be worn at all times. Hearing protection to be worn when working near operating generator.				

Types of PPE to be Used	
Foot	Steel-toed, steel shank boots.
Hand	Double layer of nitrile gloves when handling groundwater or soil, temperature-appropriate gloves for protection during cold weather.
Eye/Face	Safety glasses
Clothing	Temperature appropriate, long pants are required.
Respiratory	None required
Additional Gear	

Work Party		
Name	**Responsibility**	**Level of Protection**

Site Entry Procedure

The Landfill is accessed through a gavel road with a locked gate off of Bandix Road SE at the southeast corner of the Landfill. Monitoring events should be scheduled well in advance of the event and the Solid Waste Division (SWD) Project Manager should be notified at least two weeks in advance. Keys to the access gates, groundwater monitoring wells, landfill gas flare enclosures, and the stormwater detention pond, must be obtained from the SWD Project Manager a minimum of one day but not more than one week in advance of each event. The keys will be returned to the SWD Project Manager within two days following each event.

Criteria for Changing Personal Protection

Addition of coveralls or Tyvek™ if there is a significant increase in the potential for dermal contact by contaminated groundwater.

Decontamination Procedures

Wash hands and face with soap and water prior to eating or leaving the site. Field staff to have an eye wash kit available if needed.

Work Limitations (i.e., time of day, conditions, etc.)

Work during daylight hours only.

Placement of Disposable Materials

Used PPE (gloves) and expendable sampling equipment will be placed into plastic trash bags and taken offsite for proper disposal.

Placement of Investigation-Derived Residuals (i.e., drilling spoils, decontamination water, purge/development water)

After purging and sampling is completed at each well location the bucket(s) containing purge water will be carried approximately 25 feet or more to a location that is topographically downgradient from the well and the purge water will be poured onto the ground.

Location of Nearest:

Cellular Phone:	With EPI field representative
Running Water:	In the scale building at the adjacent Recycling and Garbage Facility
Public Road:	Bandix Road SE
Lavatory:	At the adjacent Recycling and Garbage Facility

Emergency Planning

Service	Name	Number
Local Police:	Port Orchard Police Department	911
Local EMS:	South Kitsap Fire and Rescue	911
Local Fire Department:	South Kitsap Fire and Rescue	911
Local Hospital:	St. Anthony Hospital - 11567 Canterwood Blvd. NW Gig Harbor, WA	253-530-2000
Client Contact:	Alexis McKinnon	360-337-5784
Site Phone Number:	EPI personnel	425-281-3629

EPI Office (425-395-0010)	Douglas Kunkel	425-395-0016 office 425-241-8170 cell

Directions to Nearest Medical Facility (Map Attached):

The recommended route to St. Anthony's Hospital is highlighted on attached map. The hospital is located approximately 6.6 miles from the site.

Approvals

Title	Signature	Date
EPI Site Safety Officer, Eric Caddey		
EPI Project Manager, Doug Kunkel		
Company H&S Officer, EPI Safety Officer, Doug Kunkel		

Additional Site Personnel

Printed Name and Company	Approvals Signature	Date

Attach Daily Safety Meeting Form to HASP

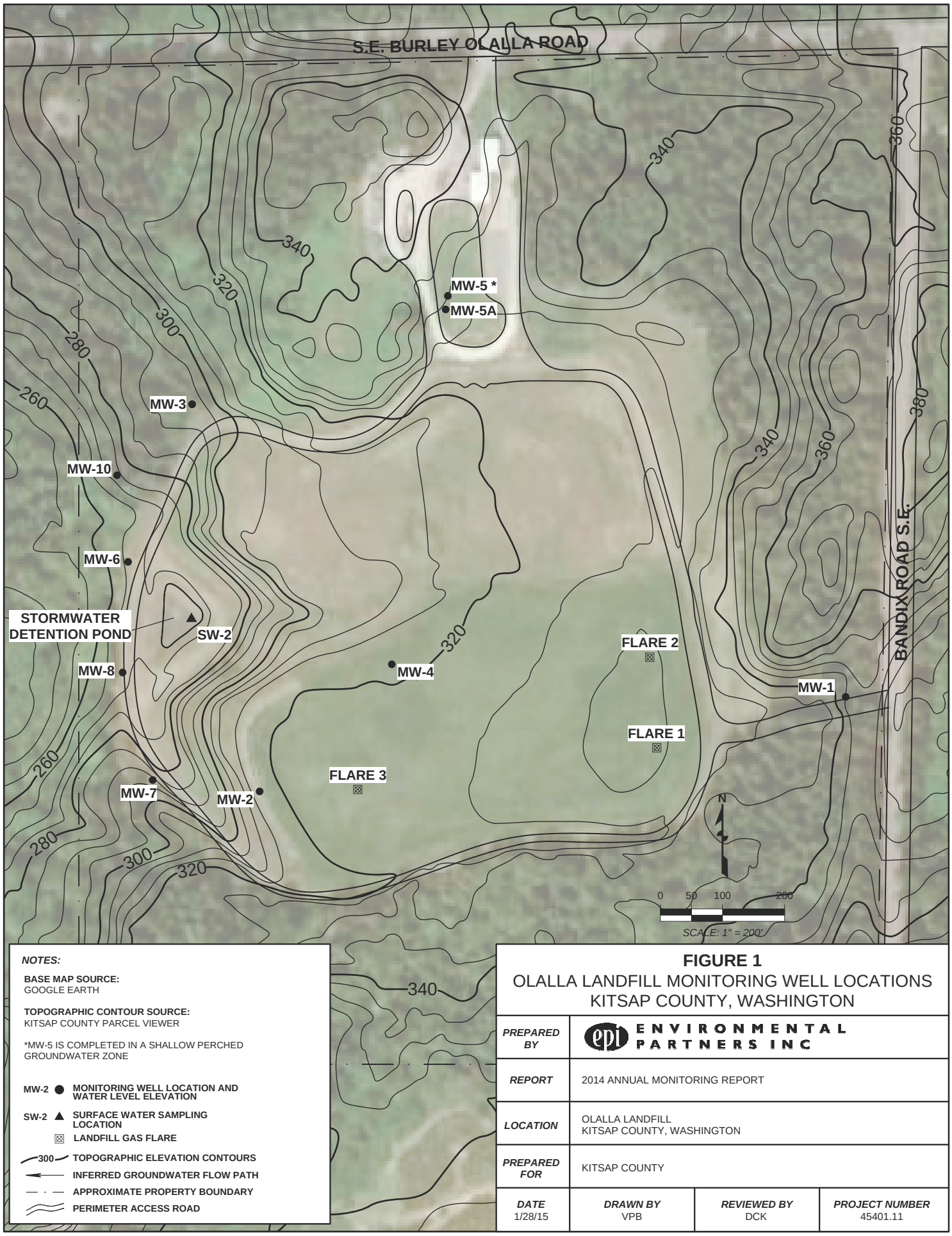
DAILY SAFETY MEETING
ENVIRONMENTAL PARTNERS, INC.

Date:
EPI Project No . / Address:
EPI Personnel Conducting Meeting:

Known or Suspected Potential Hazards	**Personal Protective Equipment**
_____ Chemicals of potential concern	_____ Hard Hat
_____ Traffic (Vehicle and Pedestrian)	_____ Eye Protection
_____ Trips	_____ High-Visibility Clothing
_____ Falls	_____ Flame-Resistant Clothing
_____ Drilling Equipment	_____ Protective Footwear
_____ Excavation Equipment	_____ Coveralls
_____ Noise	_____ Hearing Protection
_____ Hot / Cold	_____ Respirator
_____ Utilities, Subsurface and Overhead	_____ Exclusion Zone (Cones, Signs, Etc.)
_____ Other, Describe:	_____ Other, Describe:
Locations of Emergency Equipment	**Decon, Emergency Signals, Rally Point, Etc.**
_____ Fire Extinguishers	_____ Decon Procedures
_____ Eye Wash	_____ Waste Management
_____ First Aid Kit	_____ Hand Signals for Shutdown
_____ Nearest Medical Facility	_____ Audible Signals for Shutdown
_____ Potable Water	_____ Primary Rally Point
_____ Restroom	_____ Secondary Rally Point
_____ Equipment Shutdown Procedures	_____ Other Emergency Info, Describe:
_____ Other, Describe:	

Persons Attending Safety Meeting

Name / Affiliation (Print)	**Time**
_____ / _____	_____
_____ / _____	_____
_____ / _____	_____
_____ / _____	_____
_____ / _____	_____
_____ / _____	_____
_____ / _____	_____
_____ / _____	_____
_____ / _____	_____
_____ / _____	_____



NOTES:

BASE MAP SOURCE:
GOOGLE EARTH

TOPOGRAPHIC CONTOUR SOURCE:
KITSAP COUNTY PARCEL VIEWER

*MW-5 IS COMPLETED IN A SHALLOW PERCHED GROUNDWATER ZONE

MW-2 ● **MONITORING WELL LOCATION AND WATER LEVEL ELEVATION**

SW-2 ▲ **SURFACE WATER SAMPLING LOCATION**

☒ **LANDFILL GAS FLARE**

300 **TOPOGRAPHIC ELEVATION CONTOURS**

INFERRED GROUNDWATER FLOW PATH

APPROXIMATE PROPERTY BOUNDARY

PERIMETER ACCESS ROAD

FIGURE 1
OLALLA LANDFILL MONITORING WELL LOCATIONS
KITSAP COUNTY, WASHINGTON

PREPARED BY	epi ENVIRONMENTAL PARTNERS INC		
REPORT	2014 ANNUAL MONITORING REPORT		
LOCATION	OLALLA LANDFILL KITSAP COUNTY, WASHINGTON		
PREPARED FOR	KITSAP COUNTY		
DATE 1/28/15	***DRAWN BY*** VPB	***REVIEWED BY*** DCK	***PROJECT NUMBER*** 45401.11

mapquest

Notes

Trip to:

St. Anthony Hospital
11567 Canterwood Blvd NW

Gig Harbor, WA 98332
(253) 530-2000
6.64 miles / 8 minutes
Estimated Fuel Cost: **$.82**

A	**13275 Bandix Rd SE**, Olalla, WA 98359-947247.430678, -122.609812 (Address is approximate)	**Download Free App**
	1. Start out going **north** on **Bandix Rd SE** toward **SE Burley Olalla Rd**. Map	**0.1 Mi** *0.1 Mi Total*
	2. Turn **left** onto **SE Burley Olalla Rd**. Map	**0.6 Mi** *0.8 Mi Total*
EAST 16	3. Merge onto **WA-16 E** via the ramp on the **left**. Map *If you reach Bethel Burley Rd SE you've gone about 0.3 miles too far*	**4.9 Mi** *5.7 Mi Total*
EXIT	4. Take the **Burnham Dr NW** exit. Map	**0.3 Mi** *6.0 Mi Total*
	5. Enter next roundabout and take the 3rd exit onto **Sehmal Dr NW**. Map	**0.2 Mi** *6.2 Mi Total*
	6. Enter next roundabout and take the 3rd exit onto **Canterwood Blvd NW**. Map	**0.5 Mi** *6.6 Mi Total*
	7. **11567 CANTERWOOD BLVD NW**. Map *Your destination is 0.3 miles past Canterwood Blvd NW* *If you reach 122nd St NW you've gone about 0.3 miles too far*	
B	**St. Anthony Hospital** Dennis M Ford MD 11567 Canterwood Blvd NW, Gig Harbor, WA 98332 (253) 530-2000	

Total Travel Estimate: **6.64 miles - about 8 minutes**
Estimated Fuel Cost: **$.82**