Interim Remedial Action Plan Supplement, Ephrata Landfill Corrective Action, Pilot Test of Multi-Phase Extraction (MPE) and Additional Monitoring Wells

Prepared for
Grant County Department of Public Works

and

City of Ephrata

September 2015

Prepared by
Parametrix

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CERTIFICATION

The technical material and data contained in this document, other than the Phase 1 Well Installation, Testing, and Sampling Plan contained in Appendix B, were prepared under the supervision and direction of the undersigned, whose seal, as a professional engineer licensed to practice as such, is affixed below. The materials in Appendices A and B are provided for information.

Prepared by Brian Pippin, P.E.

Reviewed by Dwight Miller, P.E.

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TABLE OF CONTENTS

APPENDICES

ACRONYMS AND ABBREVIATIONS

AO	Agreed Order
COC	contaminant of concern
CQA	construction quality assurance
Ecology	Washington State Department of Ecology
FS	feasibility study
HASP	health and safety plan
IRAP	interim remedial action plan
LNAPL	light non-aqueous phase liquid
MPE	multi-phase extraction
NES	north end soils
O&M	operations and maintenance
PLPs	Potentially Liable Parties
POC	point of compliance
PS&E	plans, specifications, and estimates
SAP	sampling and analysis plan
Supplement	IRAP Supplement
SVE	soil vapor extraction
VOC	volatile organic compound
WAC	Washington Administrative Code

1. INTRODUCTION

This interim remedial action plan supplement (IRAP Supplement; Supplement) was prepared to add interim remedial actions to those described in the original IRAP (Parametrix 2006), which was made part of Agreed Order No. DE 3810 (AO) between Grant County and the City of Ephrata (Potentially Liable Parties; PLPs) and the Washington State Department of Ecology (Ecology). The interim remedial actions described here include 1) a pilot test of multi-phase extraction (MPE) in the P1 zone, which is saturated and must first be dewatered; 2) a pre-treatment facility and evaporation pond to manage the discharges associated with dewatering and MPE; and 3) the installation and testing of new groundwater monitoring wells along the site's northern conditional point of compliance (POC). The MPE pilot test area, proposed monitoring wells, pre-treatment facility, and evaporation pond area are shown in Figure 1.

1.1 PURPOSE AND OBJECTIVES OF INTERIM ACTIONS

The interim remedial actions described in this plan are designed to fill data gaps and lead to a better understanding of P1 zone hydrogeology and likely response to future cleanup actions, and they may result in some reduction of P1 zone contamination. The absence of monitoring wells along a section of the northern POC confounds more complete evaluation of the northerly plume leading from the P1 contaminant area (immediately south of the area where buried drums of industrial waste were removed in 2008), so additional wells are planned. Releases from the buried drums have now been confirmed as a significant source of groundwater contamination, particularly the high contaminant of concern (COC) concentrations in the P1 contaminant area. Although the draft feasibility study (FS) (Parametrix 2012) identified soil vapor extraction (SVE; now planned as MPE) in the P1 contaminant area as an important component of the preferred cleanup action alternative for the site, data supporting that alternative are limited and highly variable, and the feasibility of MPE cannot be predicted with confidence. MPE pilot testing will include direct measurement of vapor flow rates and driving pressure differentials once a vadose zone is created within the P1 contaminant area. The data will support a more reliable calculation of P1 zone air permeability, which is needed to design a vapor extraction system and more accurately estimate contaminant removal rates.

2. DESCRIPTIONS OF PROPOSED INTERIM REMEDIAL ACTIONS

This section describes the proposed interim actions, which include installation of new extraction and observation wells in the P1 contaminant area, new groundwater monitoring wells along the northern POC, construction of a pre-treatment facility and evaporation pond, and an MPE pilot test in the P1 contaminant area. These interim actions are planned in two phases, as described in Appendix A (MPE Pilot Test Plan).

Phase 1 will comprise the following activities:

- Well drilling and data collection, as described in Appendix B (Well Installation and Testing Work Plan)
- Well pump testing, borehole videoing, and P1 zone core analysis
- Phase 2 work plan development, including the final MPE pilot test design, based on data and observations from Phase 1
- Pre-treatment facility and evaporation pond design and construction

Phase 2 will comprise the following activities:

- P1 zone dewatering, starting with pumping only, then vacuum-enhanced drawdown
- MPE pilot testing

The new evaporation pond and pre-treatment facility are included in Phase 1 because they are needed to manage groundwater discharged during P1 zone dewatering and MPE pilot testing. The approach of completing an MPE pilot test to inform the FS is similar to one that is being taken for the Asotin County Landfill site in Clarkston, Washington. Ecology has pointed out that pilot testing at Asotin County Landfill is being conducted as an interim action to provide data to complete that FS, and the agency has recommended that approach for this site. A summary of these interim remedial action activities is included in the discussion below, and further details are included in Appendices A and B.

2.1 NEW EXTRACTION AND OBSERVATION WELLS

New extraction and observation wells will be installed in the P1 contaminant area and tested to provide data for refining the MPE pilot test plans. The new wells will also be used to perform and monitor the MPE pilot test. Wells used for extraction will be equipped with pneumatically operated liquid pumps, as well as vacuum connections, for enhanced groundwater flow into the wells and for vapor extraction. The compressor and vacuum pump will either be co-located with the pre-treatment equipment or installed near the new P1 zone wells. Pneumatic, vacuum, and fluid discharge lines will be sized and routed as part of the pre-treatment facility and evaporation pond engineering design planned for Phase 1 of the interim actions. Details regarding installation of these wells and associated data collection and analysis are provided in Appendix B (Well Installation and Testing Work Plan).

2.2 GROUNDWATER TREATMENT AND DISPOSAL

Pond evaporation was used as the groundwater disposal option for the prior interim action, although the original evaporation pond was removed in 2011. For these interim actions, groundwater extracted from the P1 contaminant area will be pre-treated, then discharged to a new evaporation pond.

2.2.1 Pre-treatment Facility

Dewatering the P1 zone will require deeper drawdown and generally more aggressive pumping than performed previously, and light non-aqueous phase liquid (LNAPL) may be entrained at times. With the increased water volume and proximity of the evaporation pond near Neva Lake Road, a pre-treatment facility will be planned, designed, and constructed during Phase 1 to reduce the potential for exposure to volatile organic compound (VOC) vapors. Further planning for the pre-treatment facility, based on current site information, is provided in Appendix A (MPE Pilot Test Plan). Pre-treatment facility design is one of the first priorities upon approval of this IRAP Supplement, along with evaporation pond design and well installation, testing, and sampling. Construction is planned to be completed by fall 2016, along with the evaporation pond.

2.2.2 Evaporation Pond

Because the evaporation pond constructed for the initial interim action was decommissioned, a new evaporation pond will be constructed to dispose of pre-treated groundwater The evaporation pond is planned in the area of the removed scale and maintenance shop, where north end soils (NES) remain between the Neva Lake Road corridor and the edge of the existing landfill cover (Figure 1). Other locations may need to be considered if the aforementioned location proves impractical.

The evaporation pond will be planned, designed, and constructed during Phase 1 of the interim action. The extent of NES capping, as well as any possible excavation of NES, will be determined as part of evaporation pond design. Details regarding the evaporation pond are provided in Appendix A. Evaporation pond design is one of the first priorities upon approval of this IRAP Supplement, along with pre-treatment facility design and well installation, testing, and sampling. Evaporation pond construction is planned to start by spring 2016 and be completed by fall 2016.

2.3 MULTI-PHASE EXTRACTION PILOT TEST

MPE pilot test plan details are provided in Appendix A. The new extraction and observation wells mentioned above (Section 2.1) and detailed in Appendix B will be used during the P1 dewatering and MPE pilot test. Design of the MPE pilot test will be finalized using Phase 1 data and observations collected from the new P1 zone wells and described in the Phase 2 work plan, which will be developed at the end of Phase 1.

The MPE pilot test will be conducted during Phase 2 of the interim actions and is planned to start in fall 2016 after construction of the pre-treatment facility and evaporation pond is completed. Liquid and vapor extraction will start without well vacuum or venting; however, the observation wells will be useable as vents if venting is needed to increase liquid and vapor extraction. Vacuum will be applied gradually for enhanced groundwater extraction.

The MPE pilot test is planned for 90 days; however, the pilot test duration will be determined based on the time needed to achieve target P1 zone drawdown and evaluate multiple vapor flow and pressure operating points.

3. SUPPLEMENTARY WORK PRODUCTS

Supplementary work products described below will be prepared pursuant to the interim action documentation requirements under Washington Administrative Code (WAC) 173-340-430.

3.1 ENGINEERING DESIGN

The engineering design objective is to develop plans, specifications, and estimates[1] (PS&E), reports, operations and maintenance (O&M) manuals, and permits (substantive requirements of exempted permits) for the interim actions consistent with the applicable requirements of WAC 173-340-400 (4) and (5). The main engineering deliverables prepared for the interim actions include PS&E, O&M manuals, and, for the pond (i.e., liner), a Construction Quality Assurance (CQA) Plan.

PS&E. The specifications will follow the format contained in “Washington State Department of Transportation 2014 Standard Specifications for Road, Bridge, and Municipal Construction” (as amended April 6, 2015) and applicable Grant County standards.

[1] The engineer’s opinion of probable cost will be used for estimates.

Pre-treatment facility and evaporation pond plans are anticipated to include the following sheets:

G0.0	Title Sheet, Vicinity Map, and Index
G1.0	Abbreviations, Legend, Site Map, General Notes
G2.0	Process Flow Diagram
G3.0	Hydraulic Profile
C1.0	Site Plan
C2.0	Pretreatment Grading, Paving, and Drainage Plan
C3.0	Pretreatment Grading, Paving, and Drainage Sections & Details
C4.0	Pipe Routing, Trenching, and Insulation Details
C5.0	Pond Grading Plan and Sections
C6.0	Pond Grading Plan and Sections
C7.0	Pond Liner Plan and Details
C8.0	Pond Liner Plan and Details
C9.0	Miscellaneous Pond Details
C10.0	Miscellaneous Pond Details
M1.0	Pretreatment Plan View
M2.0	Sections – Dissolved Air Flotation
M3.0	Sections - Chemical Feed, Compressor, and Blower
M4.0	Sections - Waste Collection Tank and Waste Pump
M5.0	Sections - Moisture Knock-out, Blower, GAC
M6.0	Well Vault Details
M7.0	General details
S1.0	Building Department Information and Notes
S2.0	Building Plan
S3.0	Building Sections
S4.0	Foundation Details
P1.0	Treatment and Well Process and Instrumentation Diagram
E1.0	Electrical Legend
E2.0	Electrical Site Plan
E3.0	Building Lighting and Power Plan
E4.0	One Line Diagram
E5.0	Electrical Details

The plan sheet list above is provided to convey the magnitude and concept of the pre-treatment facility and evaporation pond design. Plan sheet content, quantity, and arrangement are subject to change during engineering design.

3.2 CONSTRUCTION

Construction will be conducted with approved plans and specifications and schedule. Construction will be documented consistent with the applicable requirements of WAC 173-340-400(6)(b).

Construction documentation will include field notes, photographs, and submittals. Evaporation pond construction documentation will also include CQA forms and survey data. Construction activities will be recorded in weekly reports and a summary report, including record drawings.

3.3 HEALTH, SAFETY, AND ENVIRONMENTAL PLANS

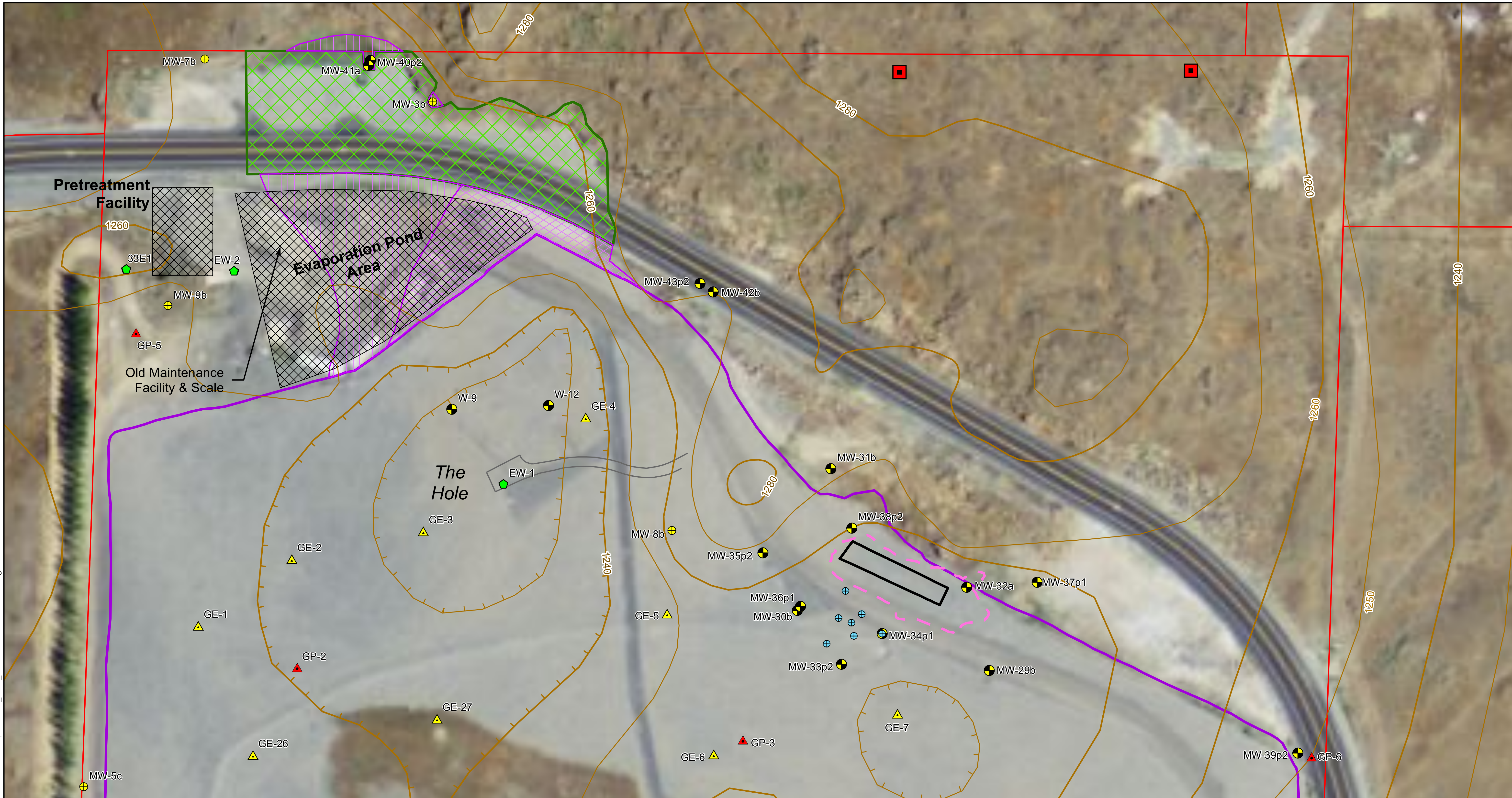
Health, safety, and environmental plans developed for the earlier interim actions will be updated as needed for Phase 1 activities to include new requirements identified for well installation and initial operation, the pre-treatment facility, and the evaporation pond. The sampling and analysis plan (SAP) for well installation and testing activities under Phase 1 of the interim actions is addressed in Appendix B (Well Installation and Testing Work Plan). Contractors will be required to develop project-specific health and safety plans (HASPs) addressing their own activities and protection of the public and environment during construction. Contractors will be required to address spill prevention and response plans and waste management. Any additional requirements for the Phase 2 dewatering and MPE pilot testing will be addressed in the Phase 2 work plan.

4. REFERENCES

Parametrix. 2006. Interim Remedial Action Plan Ephrata Landfill Corrective Action. Prepared by Parametrix, Bellevue, Washington. December 2006.

Parametrix. 2012. Agency Review Draft Ephrata Landfill Feasibility Study. Consultant’s report prepared for Grant County and City of Ephrata.

FIGURES



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Existing Wells
- Quarterly Monitoring Well (MW)
- Remedial Investigation Monitoring Well (MW)
- Gas Extraction (GE)
- Gas Probe (GP)
- Other Well

Top of Basalt Elevation Contour
- 20-ft Contour
- 10-ft Contour

- Capped Unlined Landfill Extent
- North End Soils Excavation
- Approximate Area of Refuse Not Capped
- Approximate Area of Contaminated Soils Not Capped
- Drum Cache Outline
- Extent of Soil Removal to Bedrock
- County Owned Parcels

- Preliminary P1 Pilot Test Well Configuration
- New POC Well Nests

0 Feet 100
N
2013 NAIP Orthophoto

Figure 1

Planned Locations of Interim Actions

Ephrata Landfill
RIFS

PgG

APPENDIX A

MPE Pilot Test Plan

Appendix A
MPE Pilot Test Plan

1. INTRODUCTION

This appendix summarizes a pilot test of multi-phase extraction (MPE) in the P1 zone at the north end of the Ephrata Landfill (site). New wells will be installed into the P1 zone south of the former buried drums (hereafter referred to as the P1 contaminant area), and a pre-treatment facility and new evaporation pond will be constructed and operated.

Well discharge during MPE is expected to include light non-aqueous phase liquid (LNAPL), groundwater, and vapor. However, the feasibility of vapor extraction hinges on the ability to dewater the P1 zone and the air permeability of the P1 zone once it is dewatered. A 90-day test period is planned for this site because a substantial time interval may be required to dewater the P1 zone and test the performance of vapor phase extraction. Extraction of 300,000 to 500,000 gallons of contaminated groundwater from the P1 zone will be required. Installing an evaporation pond is less costly than offsite disposal (see Section 2.2), so an evaporation pond is planned to support the MPE pilot test. Pre-treatment is also planned to separate LNAPL and reduce volatile organic compound (VOC) concentrations before groundwater is discharged to the evaporation pond (see Section 2.1).

Pilot testing is planned in two main phases:

> **Phase 1** will consist of well drilling, borehole videoing, core analyses, pump testing, and data collection to refine the final design of the MPE pilot test. Wells will be installed into the P1 contaminant area (Figure A-1). Engineering, permitting, bidding, and construction of the evaporation pond and pre-treatment facility will also be performed during Phase 1 so that P1 zone dewatering can start as soon as possible. A Phase 2 work plan will be prepared at the end of Phase 1 incorporating the results from Phase 1 to guide decisions about target vapor extraction rates and vacuums, and the selection of equipment for the MPE pilot test.
>
> **Phase 2** will consist of P1 zone dewatering and the MPE pilot test. Although planned for 90 days, the actual test period will be determined by the time needed to draw down P1 zone water levels in the test area and observe steady-state vapor flow versus vacuum characteristics.

2. PHASE 1: WELLS, PRELIMINARY TESTS, AND PRE-TREATMENT AND EVAPORATION FACILITIES

Phase 1 comprises new well installation, borehole videoing, core analyses of the P1 zone, pump testing of P1 zone wells, and planning, design, and construction of a liquid phase pre-treatment facility and new evaporation pond. Well drilling, borehole videoing, core analyses, pump testing, and additional data collection are described in detail in Appendix B (Well Installation and Testing Work Plan). Planning, design, and construction of a pre-treatment facility and a new evaporation pond are described below.

2.1 PRE-TREATMENT FACILITY

Dewatering the P1 zone requires deeper drawdown and generally more aggressive pumping than was performed during earlier interim remedial actions, and LNAPL may thus be entrained at times. Although disposal by evaporation was previously approved, with the increased water volume and proximity of Neva Lake Road to the new evaporation pond, pre-treatment is recommended to reduce potential VOC emissions before groundwater is discharged to the evaporation pond. P1 zone groundwater is also high in iron and manganese, and pump corrosion and metals precipitation were observed during previous groundwater extraction from the P1 zone. Thus a liquid-phase pre-treatment facility will be planned, designed, and constructed along with the new evaporation pond.

Pre-treatment comprising LNAPL and metals separation (i.e., dissolved air flotation [DAF]) should be sufficient to keep VOC emissions from groundwater discharged to the evaporation pond below Small Quantity Emission Rates (Chapter 173-460 Washington Administrative Code [WAC]). Although other alternatives are available for VOC reduction (i.e., oil-water separation, air stripping), air strippers tend to foul when exposed to high metals concentrations. DAF removes metals and provides LNAPL separation and VOC aeration. Air discharged from the DAF unit will need to be filtered through granular activated carbon (GAC) to trap VOCs.

Aggressive fluid pumps for the extraction wells and a vacuum pump will also be installed during Phase 1. Piston pumps are tentatively planned because of the caustic chemical environment in the P1 zone and because the estimated well discharge rates are relatively low. Other types of aggressive fluid pumps might be considered, and pump selection will be optimized during facility design. All pumps being considered are pneumatic, so a compressed air supply system will be needed.

A metal building is planned near the new evaporation pond to house and secure the pre-treatment equipment and attendant controls and instrumentation (Figure A-1). Due to area classifications for vapor handling equipment and piping, described below, part of the building will be walled and part will be a roofed, open area (i.e., awning area). An air compressor, needed to supply air for pneumatic well pumps, and a vacuum pump, needed for vacuum enhanced dewatering, will be located either in the pre-treatment building or remotely near the wells. Fluid, compressed air, and vacuum lines will be sized and routed as part of the pre-treatment facility design.

Vapors removed during MPE may have the potential to contain flammable concentrations of methane and VOCs, and this possibility will need to be evaluated during pretreatment system design. If flammable concentrations are a possibility, vapor handling equipment will need to be suitable for Class 1, Division 2, Group D locations. This could include outdoor areas within 15 feet of vapor handling equipment and piping subject to possible leakage of flammable gas. Vapor handling equipment will be located in the awning area to limit any cost impacts to the building, power, and lighting.

2.2 EVAPORATION POND

The evaporation pond will be planned, designed, and constructed to dispose of groundwater extracted from the P1 zone after pre-treatment. An estimated 300,000 to 500,000 gallons of groundwater will be extracted over a 90-day dewatering and pilot testing period. This estimate is based on calculations using standard equations and aquifer properties measured in the P1 zone at location MW-34p1 during the remedial investigation (RI). This estimate also assumes vacuum-enhanced recovery, which will be needed due to the relatively low P1 zone permeability. The evaporation pond will be designed to accommodate total extraction from three extraction wells at a rate of between 2 and 6 gallons per minute (gpm), although rates are expected to equilibrate to a longer-term total extraction rate of about 2 gpm. These estimates may be refined based on Phase 1 data.

An onsite evaporation pond is planned, rather than offsite disposal, because costs for design and construction will be less than costs for offsite disposal of the expected 300,000 to 500,000 gallons of pumped groundwater. Based on contaminated water disposal real costs from the drum removal activity (i.e., $2.48/gallon in 2008), offsite disposal would cost about $744,000 to $1,240,000 for the expected 300,000 to 500,000 gallons of pumped groundwater, plus the costs of temporary onsite storage and offsite transport to the disposal facility. In comparison, design and construction of a new evaporation pond would cost less than $600,000.

The evaporation pond is being planned in the area of the removed scale and maintenance shop (Figure A-1). Other locations may need to be considered if this plan proves impractical.

The area around the removed scale and maintenance shop appears to be physically suitable for an evaporation pond, and it is reasonably close to the P1 contaminant area. The area is located within the permitted boundary of the landfill but is not needed for landfill operations. Although available space is constrained by the Neva Lake Road corridor to the north and the original landfill to the south, an evaporation pond with sufficient capacity for the planned P1 zone dewatering can be designed within the constraints of the available footprint. However, since the area of north end soils (NES) roughly matches the area needed for a 500,000-gallon evaporation pond (i.e., about 0.5 acre), the evaporation pond layout will simply be optimized for the available space.

The evaporation pond will be planned and designed during Phase 1 of the interim action. Pond construction is planned for spring 2016 due to seasonal constraints on geomembrane liner installation. The extent of capping and excavation of NES will be determined as part of evaporation pond design. All remaining NES south of the Neva Lake Road corridor will be capped or removed as part of this interim action.

For excavated NES from the Neva Lake Road interim action, comparison of available site data to regulations at 40 Code of Federal Regulations (CFR) Part 268 – *Land Disposal Restrictions* (LDR), Subpart D – *Treatment Standards*, § 286.48 – *Universal Treatment Standards* (UTS) determined that the material could be disposed of in the active landfill cell as long as it passed the paint filter test (September 12, 2012, technical memorandum from Brian Pippin to Cole Carter). This comparison was updated for NES remaining after the Neva Lake Road interim action, and the same conclusion was reached—the remaining NES that may be excavated during evaporation pond construction is not expected to contain LDR-regulated constituents in concentrations exceeding UTS and can be placed directly in the active landfill cell, with any saturated material spread on liners to dry through evaporation before being placed in the active landfill.

2.3 PHASE 2 WORK PLAN

Phase 1 data will be reported along with limited interpretation when field activities and analyses are completed and used to refine estimates of vapor and liquid extraction rates for final MPE pilot test design. At the end of Phase 1, a Phase 2 work plan will be prepared to provide additional details of the MPE pilot test design that will be finalized based on the data and observations collected in Phase 1. The Phase 2 work plan will address design, operation, and reporting of results of the MPE pilot test. It will include pilot test design and operation and maintenance (O&M) documents; identify any additional health, safety, and environmental plan requirements, including sampling and analysis plan (SAP) or health and safety plan (HASP) requirements; and describe any additional reporting requirements. The Phase 2 work plan is tentatively scheduled to be developed from January through May 2016, before the start of any Phase 2 work.

MPE pilot tests are often performed using temporary, portable systems. P1 zone analyses based on data from the RI and interim actions suggest that P1 zone intrinsic permeability may be marginal for vapor extraction. This will be further evaluated with new data collected during Phase 1. If intrinsic permeability is confirmed to be marginal, and presuming suitable portable equipment for rent is found, the soil vapor extraction pilot test will be planned with temporary equipment.

3. PHASE 2: MULTI-PHASE EXTRACTION PILOT TEST

The following sections describe the P1 zone dewatering and elements of the MPE pilot test. Data collected during Phase 1 will be used to finalize the MPE pilot test design prior to Phase 2 implementation.

3.1 P1 ZONE DEWATERING

The new extraction and observation wells installed during Phase 1 and existing well MW-34p1 (Figure A-1 and Appendix B, Well Installation and Testing Work Plan) will be used during P1 zone dewatering and the MPE pilot test.

The MPE pilot test will be conducted during Phase 2 of this interim action and is planned to start in fall 2016 after construction of the pre-treatment facility and new evaporation pond is completed. Liquid and vapor extraction will start without well vacuum or venting; however, the observation wells will be useable as vents if venting is needed to increase liquid and vapor extraction. Vacuum will be applied gradually for enhanced groundwater extraction.

The planned schedule for P1 zone dewatering and the MPE pilot test is 90 days, but could be adjusted depending on field observations. The test duration will be determined on a performance basis, as needed to achieve target P1 zone drawdown and evaluate multiple vapor flow and pressure operating points.

3.1.1 Extraction Schedule and Monitoring

Extraction from each well will be phased in to evaluate the effectiveness of each individual extraction well. The test will initially be operated without vacuum to begin dewatering the P1 zone. The proposed testing schedule is summarized in Table 1 and described as follows:

Initial Dewatering:

1 Week (pump one well, no vacuum):

- Monitor liquid extraction rates and water levels in all observation wells.

1 to 2 Weeks (continue pumping the first well and pump a second well, no vacuum):

- Monitor liquid extraction rates in each well and water levels in all observation wells.

Continued Dewatering with Applied Vacuum:

Remainder of Test (continue pumping the first and second wells, pump the third well, and apply vacuum):

- Monitor liquid extraction rates in each well and water levels in all observation wells.
- Monitor soil vapor extraction rates in each well.
- Monitor air pressures in all wells and inline.
- Monitor VOCs in vapor and water (photoionization detector [PID] and lab samples).

- Monitor landfill gas in vapor extraction (gas meter).

Monitoring:

- Water levels in all P1 zone wells
- Vacuum pressures in all P1 zone wells
- Vapor contaminant mass removal (meters and lab samples collected periodically)
- Water contaminant mass removal (meters and lab samples collected periodically)
- LNAPL removal (oil-water separator)
- VOC reduction (air stripper)
- Radius of vacuum influence

Table 1. Soil Vapor Extraction Pilot Test Schedule

		Extraction			Monitoring					
Step	Duration	Number of Extraction Wells	Total Liquid Pumped	Vacuum Applied	Water Levels	Well Pressure	System Pressure	Liquid Extraction Rate	Vapor Extraction Rate	Gas (PID and Landfill Gas)
1	1 week	1	Yes	No	X			X		
2	1-2 weeks	2	Yes	No	X			X		
3	Remainder of test (many weeks)	3	Yes	Yes	X	X	X	X	X	X

3.2 SOIL VAPOR EXTRACTION

The performance of soil vapor extraction will be tested consistent with the Phase 2 work plan, which will be developed based on Phase 1 data and observations as described above (see Section 2.3). The following sections reflect preliminary plans and provide the basis for estimates associated with the MPE pilot test.

3.2.1 Blower Selection

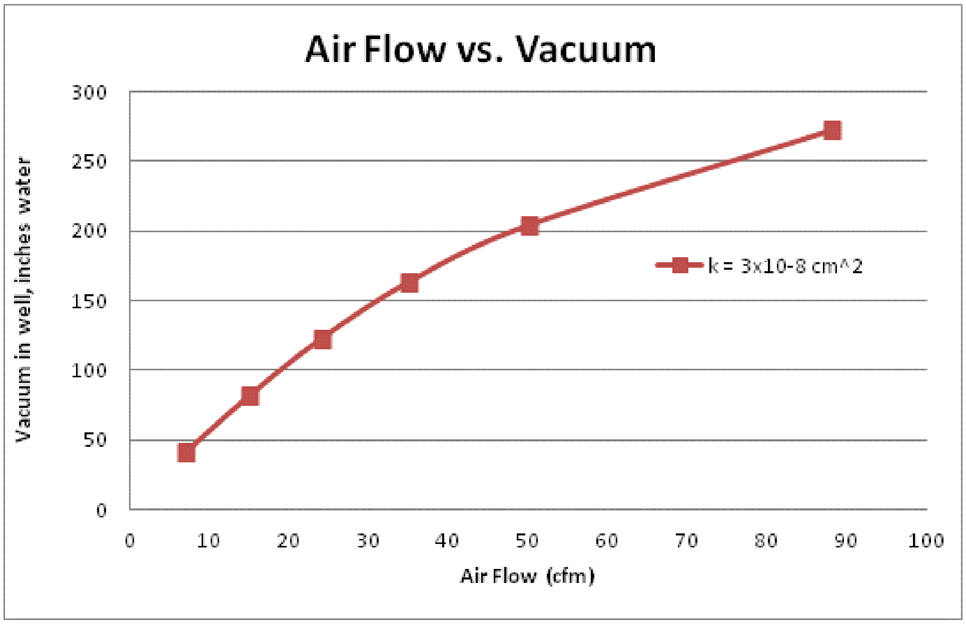
An air flow versus vacuum pressure curve was developed using a steady-state analytical solution for vapor flow in a homogeneous soil system (Johnson et al. 1990). The solution requires an estimate of soil intrinsic permeability (k), which is estimated from the P1 zone hydraulic conductivity (K):

$$k = K(\mu/\gamma)$$

Where

- K = P1 zone hydraulic conductivity (K = 8 to 10 feet/day)
- μ = dynamic viscosity of water (0.001 Ns/m^2)
- γ = specific weight of water (9.789 KN/m^3)

Using the above equation, the average intrinsic permeability for the P1 zone is $3x10^{-8}$ cm^2 and the air flow (cubic feet per minute) versus vacuum pressure (inches of water) curve per well is:



The estimated vacuum and air flow range described above is too broad to use for equipment selection, and will be refined based on Phase 1 results. The low estimate is representative of a low-capacity system in operation for a short time interval (i.e., 1 week). The high estimate is representative for a higher-capacity system in operation for a longer time interval (i.e., several weeks). Phase 1 results are needed to refine the vapor extraction equipment requirements.

3.2.2 Vapor Treatment

Vapor phase treatment will comprise either routing to the existing landfill flare or filtration with GAC. Since the P1 zone conditions are methanogenic and connectivity with the original landfill is presumed, it is possible that extracted vapor could have relatively high methane concentrations. Extracted vapor with approximately 20 percent or higher volumetric methane concentrations, and oxygen concentrations under about 5 percent, will be routed to the existing landfill flare. The flare is designed to ensure 98 percent or higher destruction of methane and VOCs. Extracted vapors with less than 20 percent methane or more than 5 percent oxygen will be directed to GAC filters.

Vapor phase management will also be part of the Phase 2 planning described above. Equipment for both disposal methods (i.e., flare and GAC) will likely be installed, although a final decision will be guided by Phase 1 data and observations.

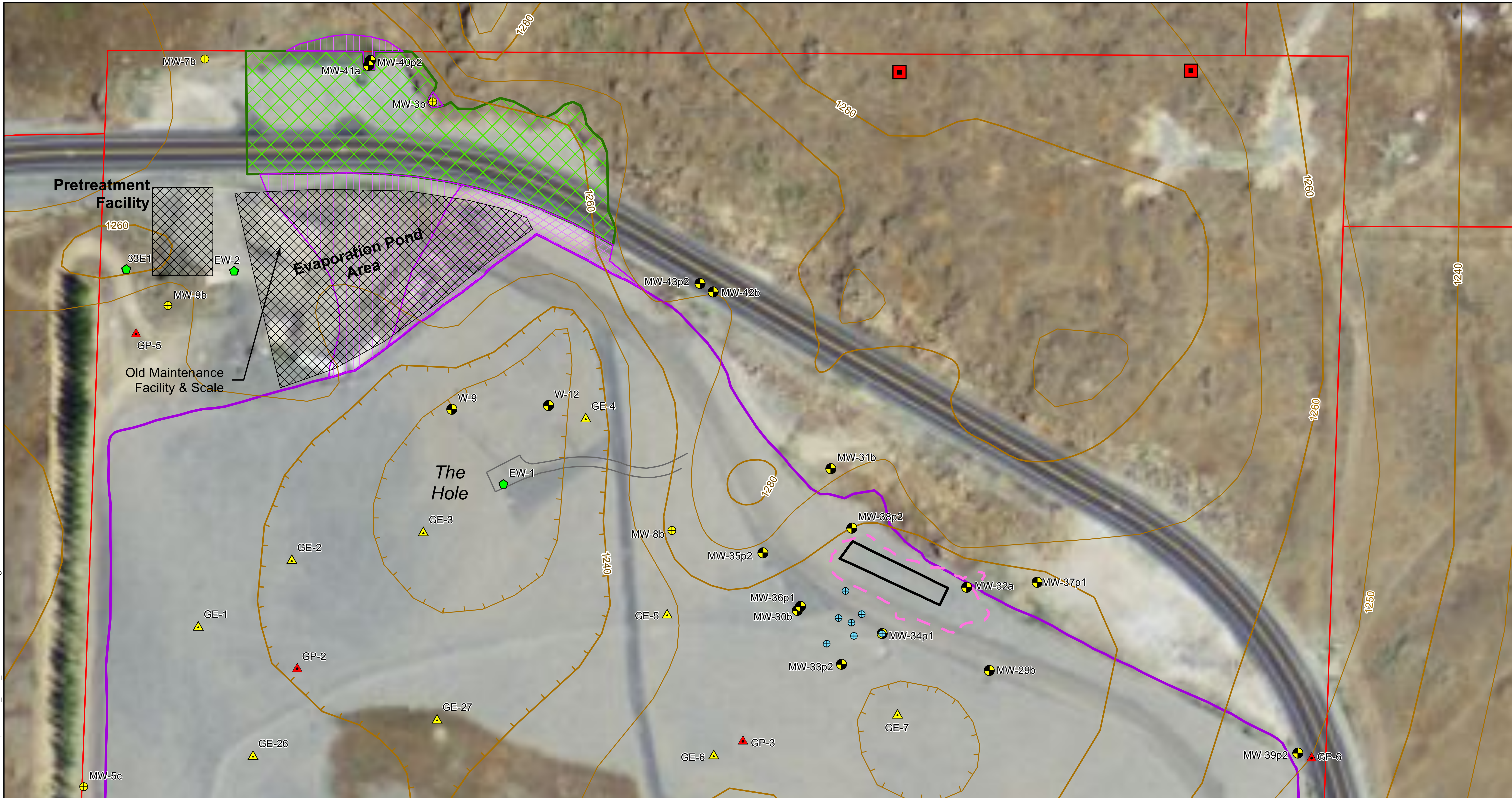
3.3 POST-PILOT TESTING ANALYSIS

Data collected during pilot testing will be analyzed to evaluate long-term feasibility of MPE. Findings will be summarized in a second RI addendum and an interim action report and reflected in the revised FS.

4. REFERENCES

Johnson, P. C., M. W. Kemblowski, and J. D. Colthart. 1990. Quantitative Analysis for the Cleanup of Hydrocarbon-Contaminated Soils by In-Situ Soil Venting. Vol. 28, No. 3 – Ground Water – May-June 1990.

FIGURES



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Existing Wells

- Quarterly Monitoring Well (MW)
- Remedial Investigation Monitoring Well (MW)
- Gas Extraction (GE)
- Gas Probe (GP)
- Other Well

Top of Basalt Elevation Contour

- 20-ft Contour
- 10-ft Contour

- Capped Unlined Landfill Extent
- North End Soils Excavation
- Approximate Area of Refuse Not Capped
- Approximate Area of Contaminated Soils Not Capped
- Drum Cache Outline
- Extent of Soil Removal to Bedrock
- County Owned Parcels

- Preliminary P1 Pilot Test Well Configuration
- New POC Well Nests

0 Feet 100

N

2013 NAIP Orthophoto

Figure A-1

Planned Locations of Interim Actions

Ephrata Landfill
RIFS

PgG

APPENDIX B

Well Installation and Testing Work Plan

PACIFIC groundwater GROUP

APPENDIX B

WELL INSTALLATION, TESTING, AND SAMPLING
NORTH END POINT OF COMPLIANCE AND
P1 CONTAMINANT AREA
WORK PLAN
EPHRATA LANDFILL

JUNE 5, 2015

APPENDIX B

DRAFT WELL INSTALLATION, TESTING, AND SAMPLING NORTH END POINT OF COMPLIANCE AND P1 CONTAMINANT AREA WORK PLAN EPHRATA LANDFILL

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June 5, 2015

TABLE OF CONTENTS

TABLES

FIGURES

ATTACHMENTS

SIGNATURE

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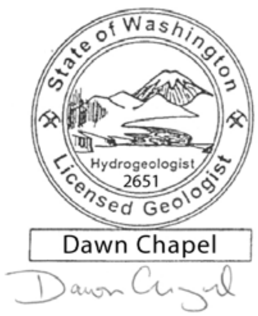

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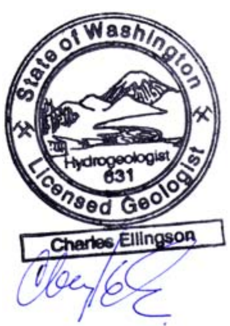

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1.0 INTRODUCTION

Pacific Groundwater Group (PGG) has prepared this work plan for well installation, testing, and sampling to be conducted at the Ephrata Landfill (site) in Grant County, Washington (Figure B-1). This work plan is a part of the interim remedial action plan (IRAP) supplement for the site (Parametrix, 2015). Specifically this work plan covers installation, testing, and sampling of new groundwater wells to refine the site conceptual model and to assist with final remedy selection for the site. The new well locations are:

- Two monitoring well nests (referred to as Western and Eastern) at the site's northern conditional point of compliance (POC) to investigate the extent of groundwater contamination migrating off-site in the Northerly Plume (PGG, 2010) and to evaluate aquifer properties at these locations (Figure B-2).
- Six (possibly eight) groundwater wells in the P1 zone south of the area where buried industrial waste drums were removed (hereafter referred to as the P1 contaminant area) (Figure B-2) to investigate P1 zone properties and to conduct a pilot test of multi-phase extraction (MPE).

The results of this work will be documented in the final Remedial Investigation and Feasibility Study (RI/FS) for the site. A draft RI/FS was recently completed (PGG, 2010 and 2012 and Parametrix, 2012).

2.0 BACKGROUND

The following section provides a brief overview of the site hydrogeology and groundwater contaminant plumes as characterized in the draft RI (PGG, 2010 and 2012), followed by data gaps identified for further investigation under this work plan.

2.1 HYDROGEOLOGY AND GROUNDWATER CONTAMINANT PLUMES

Site hydrogeologic units identified in the draft RI consist of two water-bearing zones and four aquifers within permeable interflow zones of the Columbia River Basalt Group (CRBG) and one aquifer within the saturated portions of the Outwash sand-and-gravel (PGG, 2010). The CRBG units from shallowest to deepest are:

- Wanapum Basalt:
    - P1 saturated zone
    - P2 saturated zone
    - Roza aquifer
    - Interflow aquifer
    - Frenchman Springs aquifer
- Vantage Interbed
- Grand Ronde Basalt:

- Undifferentiated aquifers

Individual water bearing zones and aquifers within the basalt are generally separated from each other by dense (hard) low permeable columnar basalt aquitards of variable thickness that restrict water movement between individual basalt aquifers.

The Vantage Interbed is an ash-rich siltstone about 25 feet thick that forms a laterally extensive regional aquitard between the overlying Frenchman Springs aquifer and deeper aquifers within the Grande Ronde Basalt.

The Outwash sand-and-gravel aquifer occurs above the CRBG within erosional depressions of the basalt surface. An off-site aquifer was also identified within permeable sandstone of the Ringold Formation east of the landfill (PGG, 2010).

The P1, P2, Roza, and Interflow of the Wanapum Basalt are the focus of this investigation. While these units are generally water-bearing, the hydraulic conductivity can vary by several orders of magnitude. Generally the hydraulic conductivity increases in order as follows: P2<P1<Roza<Interflow.

As summarized in the draft RI (PGG, 2010 and 2012), the P1 zone is the shallowest saturated basalt interflow identified near the former buried drum area. The zone is discontinuous and of limited lateral extent with an observed thickness up to about 5 feet. A second shallow saturated basalt interflow, identified as the P2 zone, occurs about 10 feet below the P1 zone. Both the P1 and P2 zones have low permeabilities and would not ordinarily be considered aquifers, although they could hypothetically supply small volumes of groundwater to wells (typically less than 1 gallon per minute) and implicitly transports contaminants to deeper aquifers.

During the RI, the highest concentrations of total volatile organic compounds (VOCs) in groundwater at the site were measured in the P1 contaminant area (MW-34p1 and MW-36p1 in Figure B-2). Residual light non-aqueous phase liquid (LNAPL) was also observed in the P1 contaminant area. Although significant attenuation is observed within relatively short distances (a few hundred feet or less, both vertically and horizontally) from the highly contaminated area, low levels of some P1 zone contaminants have been detected in downgradient aquifers both on and off site.

Site sources of groundwater contamination identified in the draft RI include residual contamination in the P1 contaminant area, the original unlined landfill and "Hole"[1], and contaminated north end soils (NES) (Figure B-2; PGG, 2010 and 2012).

The draft RI characterized two groundwater contaminant plumes originating from site sources:

- A northerly plume originating from the P1 contaminant area and other secondary sources at the north end of the landfill. Contaminant migration is generally downward through P1 and P2 then into the Roza, with off-site migration towards the north in the Roza aquifer, then to saturated alluvium and downward to the Interflow aquifer to-

[1] The Hole is a 20-foot-deep depression in the basalt surface beneath the original unlined landfill. Well logs indicate 50 to 55 feet of refuse mixed with gravel, cobble, and sand occurs within and piled above the Hole, and the lower 5 to 7 feet of soil/refuse is saturated with groundwater.

wards the north and the northeast. There is limited lateral migration in either the P1 or P2, due to discontinuity of those two zones and low permeability.

- A landfill plume originating beneath the original landfill and extending radially in the Interflow aquifer towards the west, south, and east where the Interflow aquifer discharges to the Outwash aquifer. Some vertical migration to the deeper Frenchman Springs aquifer may also occur.

Organic contaminants of concern (COC) in one or both plumes generally include one or more of the following groups of VOCs:

- Chlorinated ethenes
- Chlorinated ethanes
- Chlorinated methanes
- Benzene
- Dichlorobenzenes
- 1,2 Dichloropropane (1,2-DCP)

The hydrogeology and nature and extent of contamination are discussed in detail in the draft RI (PGG, 2010 and 2012).

2.2 IDENTIFIED DATA GAPS

The following sections describe data gaps identified for further investigation with this work plan.

2.2.1 Feasibility of Multi-Phase Extraction of the P1 Zone

The draft FS identified continuous groundwater extraction, evaporation, and soil vapor extraction (SVE) from the P1 contaminant area as the preferred cleanup action for the site (Parametrix, 2012). Because this action is expected to comprise LNAPL, groundwater, and vapor extraction, this is now being referred to as multi-phase extraction (MPE). MPE has the potential to remove significant contaminant mass from the P1 zone; however, the effectiveness of the vapor phase extraction depends on the ability to dewater the P1 zone and to create unsaturated conditions with sufficient air permeability to transmit contaminant vapors to extraction wells. MPE pilot test results are needed to evaluate P1 zone responses to dewatering and applied vapor pressure gradients. In support of MPE pilot testing, six to eight new P1 zone wells will be installed, tested, and sampled as part of this work plan (Section 3).

2.2.2 Concentrations and Aquifer Characteristics: North End Point of Compliance

The northern POC is approximately 1400 feet long and site-specific investigations to date include just the western 400 feet (MW-3b and MW-7b in the Roza Aquifer). To address this data gap, additional monitoring wells will be installed, tested, and sampled along the eastern half of the northern POC (see Section 3). As described in the draft FS, these additional wells are also needed for compliance monitoring (Parametrix, 2012).

3.0 WELL INSTALLATION, TESTING, AND SAMPLING

PGG will subcontract drilling services to drill and install new groundwater wells in target aquifers at the northern POC and in the P1 contaminant area. All wells will be drilled in accordance with WAC 173-160, Minimum Standards for Construction and Maintenance of Wells. Work at the northern POC and P1 contaminant area is discussed separately below.

3.1 NORTHERN POINT OF COMPLIANCE WELLS

New northern POC wells will comprise two well nests farther east along the property line than existing wells (Figure B-2). At each nest, wells will be completed in the following hydrogeologic units where present: P1 zone, P2 zone, Roza aquifer, and Interflow aquifer. Up to four wells will be completed at each location, depending on the presence of the P1 zone. The P1 zone is discontinuous and may not exist at either or both new well nests.

The County will construct road access for the drill rig. Final well locations may vary somewhat from those shown in Figure 2, depending on accessibility.

3.1.1 Drilling and Logging

Drilling will be accomplished with an air rotary drill rig. A PGG geologist will be on site during drilling and construction to document the work and log borings. Depths to target intervals will be determined during drilling by observations of the geologist and driller as further described below.

Boreholes will be temporarily sealed during drilling so that contaminated groundwater does not flow down the borehole into the lower aquifer targeted for screening. Zones not targeted for screening will not necessarily be isolated from one another during drilling. However, in all cases permanent well seals will be continuous from the top of the sand pack to ground surface.

During drilling, identification of saturated zones will be based on target depths summarized in Table B-1 and drilling action, examination of drill cuttings, and moisture. If drilling action becomes noticeably easy and/or cuttings have weathered appearance (soft, moist, broken, weathered faces, clay and or silt), then drilling will temporarily stop to check for groundwater.

Any boring not completed as a monitoring well will be backfilled with hydrated bentonite chips. Details on monitoring well installation are described in Section 3.1.2.

3.1.2 Monitoring Well Installation

Each monitoring well will comprise a 2-inch diameter schedule 40 PVC casing and screen with flush threaded joints and O-ring seals. Screen lengths will be 5 or 10 feet, and screened intervals will be packed with Colorado silica sand. Well seal material above the screen will consist of hydrated bentonite to the ground surface. The well casing will extend approximately 2 feet above ground surface and be protected with a 8-inch locking steel monument. Protective bollards will be installed around completed monitoring wells.

Newly installed wells will be developed to remove suspended fines and to ensure hydraulic connection with the aquifer. Development wastewater will be collected into drums or a water tank and disposed of in the County's lined leachate pond at the south end of the new landfill (Figure B-1).

3.1.3 Drilling Equipment Decontamination Procedures and Waste Disposal

Drilling equipment will be pressure washed between boreholes. The driller will provide a pressure washer, water tank, and decontamination station to collect wash water runoff. Decontamination waste water will be disposed of in the County's lined leachate pond.

Drill cuttings will be placed into 55-gallon drums or onto heavy plastic lined basins for disposal in the active landfill cell.

3.1.4 Aquifer Testing

Brief aquifer pumping tests will be conducted at all newly installed wells to assess aquifer properties. Tests will be performed using a temporary electric submersible pump. The County will supply a generator to power the pump. The aquifer tests will be performed before groundwater samples are collected, with pumping during the test serving as the purging of the well (see Section 5). Water-level measurements will be taken often during the pumping test to the nearest 0.01 foot using a hand-held water level probe.

A short step-rate pumping test will be used to evaluate a sustainable pumping rate for a constant rate test. A constant rate test not exceeding one hour duration will be performed on each new well. Flow rates will be measured by routing discharge through a flow meter or graduated container. Field water quality parameters will be measured periodically during the test. After the test, the pumping rate will be reduced to less than 1 gallon per minute (gpm) for sampling. Total volume of water removed from the well will be recorded. Although depth to water will be noted shortly after the step-rate test, complete recovery data will not be collected or used for aquifer calculations. Purge water will be collected and disposed of in the County's lined leachate pond.

3.1.5 Groundwater Sampling

Groundwater samples will be collected from each new well following aquifer pumping tests and analyzed for site COCs (Table 2). Details on groundwater sampling procedures are provided in Section 5.

3.2 P1 CONTAMINANT AREA WELLS

Six new wells will be installed in the P1 contaminant area near MW-34p1 (Figure B-2) for MPE pilot testing (Parametrix, 2015). Washington State Department of Ecology has granted permission to drill resource protection wells through the refuse in this area for site remedial investigative purposes (PGG, 2008). The County will construct access roads prior to drilling, construct liner repairs and seals around each newly installed well, and restore the disturbed cover layers.

The preliminary P1 well configuration consists of an inner and outer grouping of wells designed to provide a range of well spacings (from about 15 to 60 feet) to assess the radius of influence during the pilot test (Figure B-2). Final well placement may vary depending on field observations during drilling. Table B-1 shows proposed wells and estimated target depths.

Additional P1 wells (up to two are planned) may be installed, tested, and sampled depending on field observations during installation of the six wells described above and for additional observation locations to support pilot testing. For example, if the thickness of the P1 zone is observed to increase significantly in a particular direction, additional wells may be installed in that direction.

3.2.1 Drilling and Logging

Records from installation of wells MW-34p1 and MW-36p1 suggest the following materials and depths as planning estimates for the new wells:

- Landfill refuse ~ 0 to 25 feet
- Hard, dry, unweathered basalt ~ 25 to 30 feet
- P1 zone (wet, soft, weathered, fractured basalt) ~ 2 to 5 feet thick

Drilling of the P1 borings will be accomplished using a sonic drill rig. The boring will be cased through refuse (8-inch diameter), then drilled open hole through hard basalt to the top of the P1 zone. A 5-foot long 4-inch diameter core barrel enclosed in a 6-inch sonic barrel will then be advanced through the P1 zone to attempt a continuous core of the P1 zone at each boring location (Section 3.2.2). If undisturbed cores cannot be obtained using the sonic core barrel, then an air rotary rig may be used with a triple tube core barrel and inner split tube to attempt core recovery. Four-inch sonic cores are planned based on the driller's prior experience at the site. Irrespective of plans, it is unknown whether recovery of intact cores from the P1 zone will be feasible.

After core collection (or attempted coring), the borehole will be videoed with focus on the P1 zone if feasible depending on conditions as described further below (Section 3.2.3), the P1 zone will then be reamed to 8-inches, and 4-inch wells will be constructed (Section 3.2.4).

3.2.2 P1 Core Collection and Analysis

P1 cores will be logged, photographed, labelled, and secured in coolers for shipment to a soils lab for analysis if field examination indicates that reliable laboratory analyses can likely be achieved. Reliable laboratory analysis will require intact cores that have not been disturbed or deformed. Collection of suitable intact P1 zone cores is planned, although success is uncertain in weathered/fractured basalt. Intact, undisturbed cores are needed for the planned laboratory analyses, which include:

- LNAPL fluorescence
- Soil moisture retention curve
- Air permeability
- Density
- Porosity
- Vapor extraction lab simulation (i.e., air leach test)

Analytical results will support more accurate estimates of P1 zone dewatering rates and air permeability for final MPE pilot test design.

Once cores are collected or attempted, a downhole video survey will be performed if conditions permit, as described below.

3.2.3 Borehole Video Survey

A borehole video survey of each well is planned if conditions allow. Videoing requires that a borehole remain open. Video can be taken below the water level; however, high turbidity would compromise video quality. To optimize video quality, the borehole will be cleared of water and drill cuttings by airlift before videoing. For each well location where videoing is feasible, the survey will produce 360 degree color footage of the bore walls in the P1 zone.

Borehole videos of the P1 formation will document observable features of the P1 zone, such as fracture patterns and orientation, soil color, texture, and moisture, and residual LNAPL.

3.2.4 Well Installation

Each P1 well will comprise a 4-inch diameter schedule 80 PVC casing and screen with flush threaded joints and O-ring seals (schedule 80 PVC will be used for all wells through refuse). Screen lengths will be 5 feet, and screened intervals will be packed with Colorado silica sand. Well seal material above the screen (but within the basalt) will consist of hydrated bentonite to the ground surface. The well casing will extend approximately 2 feet above ground surface and be protected with an 8-inch locking steel monument.

Newly installed wells will be developed to remove suspended fines and to ensure hydraulic connection with the water-bearing zone. Development waste water will be collected in double-wall plastic drums or tanks and held pending evaluation for disposal. Disposal options may include the County’s lined leachate pond (i.e., if concentrations are below land disposal regulation [LDR] thresholds), off-site disposal, or disposal to the new evaporation pond (Parametrix, 2015).

3.2.5 Drilling Equipment Decontamination Procedures and Waste Disposal

Drilling equipment will be pressure washed between boreholes. The driller will provide a pressure washer and decontamination station for wash-water run-off collection and temporary storage in drums or a tank. Decontamination waste water will be disposed of in the County's lined leachate pond.

Drill cuttings will be collected in heavy plastic lined basins or 55-gallon drums at each site. The County will dispose of drill cuttings in the active landfill. In the RI, head-space screening results for cuttings from P1 contaminant area wells using a photoionization detector (PID) were well below established site background concentrations (PGG, 2008). Field screening will therefore not be repeated for this investigation.

3.2.6 Aquifer Testing

Short-term aquifer pumping tests (up to 1 hour) will be conducted on each new P1 well to evaluate short-term well yields. A longer-term pumping test (up to 12 hours) will also be conducted on at least one well while monitoring water level responses in other nearby wells to evaluate transmissivity and lateral hydraulic continuity in the P1 zone. Results of the longer-term aquifer test will be used to provide estimates of long-term extraction rates and groundwater volumes required to dewater the P1 zone for MPE pilot testing (Parametrix, 2015).

Tests will be performed using a temporary electric submersible pump. The consultants will evaluate appropriate pumps to use in the challenging chemical conditions expected in the P1 zone. The County will supply a generator to power the pump. The aquifer tests will be performed before groundwater samples are collected, with the pumping test also serving to purge each well before sample collection (Section 5). Water levels will be measured frequently with a manual probe (i.e., to the nearest 0.01 foot) during the pump test. Pressure transducers will also be deployed in the well(s) to collect digital water level measurements throughout the test. Pressure transducers will be left in the wells for at least the duration of the MPE pilot test to monitor changes in water levels.

A short step-rate pumping test will be used to evaluate a sustainable pumping rate for a constant rate test. Flow rates will be measured by routing discharge through a flow meter or graduated container. Field water quality parameters will be measured periodically during the test, and an interface probe will be used to monitor potential LNAPL accumulation in the pumping well. If sufficient LNAPL is observed in the new P1 wells during testing (at least 1-inch thickness of LNAPL in a well), a sample will be collected for laboratory analysis of VOCs and diesel/gasoline range total petroleum hydrocarbons (low LNAPL volume may limit the number of possible analyses). LNAPL sampling procedures are discussed in Section 5.

Liquids extracted from the P1 zone will be contained on-site in clearly marked double-walled drums or tanks to be evaluated for disposal. Options include off-site disposal or disposal to the new evaporation pond (Parametrix, 2015).

3.2.7 Groundwater Sampling

Groundwater samples will be collected from each new P1 well following aquifer pumping tests and analyzed for site COCs (Table 2). Analytical data collected from the P1 zone will be used to assess spatial variability of contaminant mass in the P1 zone and to support the pre-treatment facility design for the pilot test. Because groundwater in the P1 contaminant area may contain LNAPL, analytical results are not expected to be representative of true groundwater concentrations. Analytical data collected from groundwater thought to be in contact with residual LNAPL will therefore not be used to characterize migration of groundwater contamination (PGG, 2013 and DOE, 2014).

Details on groundwater sampling procedures are provided in Section 5.

4.0 WELL SURVEYING

All newly installed wells will be surveyed at the top of casing for location and elevation as soon as feasible after drilling. Precision for the elevation survey will be 0.01 foot.

5.0 SAMPLING PROCEDURES

The following sections describe procedures for collecting samples of LNAPL and groundwater for laboratory analysis.

5.1 LNAPL SAMPLING PROCEDURES

LNAPL samples will be collected for laboratory analysis of VOCs (EPA Method 8260) and diesel/gasoline range total petroleum hydrocarbons (Methods NWTPH-Dx and NWTPH-Gx) where a 1-inch or thicker LNAPL layer is observed in a well.

Two PGG personnel will work together to collect LNAPL samples using a disposable bottom-fill hand bailer on a polyethylene line as follows:

1. Personnel will wear clean, disposable, latex gloves, safety glasses, Tyvek suit, and half mask respirators with cartridges to remove VOC gases.

2. Measure the depth and thickness of the LNAPL using an interface probe.

3. Measure and mark the depth and thickness on the polyethylene line starting from the bottom of the bailer.

4. Cover ground area around well with heavy plastic and place an empty 5-gallon bucket next to the well.

5. Slowly lower the bailer into the well to the top of the LNAPL. Use the marked bailer line as a guide, and listen for sound of bailer hitting top of LNAPL. Bail the top of the LNAPL by gently lowering and lifting the bailer less than 1 inch.

6. Slowly raise bailer to surface.

7. Slowly tilt bailer and pour collected LNAPL into laboratory provided sample containers over the 5-gallon bucket to contain any LNAPL that may spill during sampling. Take care to ensure sample containers for VOC analysis contain no air bubbles (head space).

8. Repeat steps 5-7 until sample containers are full or LNAPL volume in the well is depleted. Priority will be to collect samples for VOC analysis followed by samples for hydrocarbon analysis.

9. Record sample identification data on sample container, field sampling form (Appendix A), and chain-of-custody record. Sample identification will include at least the following information:

    - Project name and number
    - Name of collector
    - Date and time of collection
    - Place of collection
    - The sample I.D., which will be the well number
    - Presence of any preservative

10. Immediately after collection, place samples in a cooler at approximately 4 degrees C with sufficient chemical ice to retain a cold temperature until received by the laboratory.

11. *Hand deliver* samples to the laboratory in sealed coolers accompanied by chain-of-custody forms (Attachment B) and any other pertinent documentation.

If bottom-fill disposable bailers prove inadequate for collection of LNAPL, then weighted top-fill bailers or adsorbent socks may be used.

Any LNAPL that may spill onto heavy plastic or into the 5-gallon bucket will be contained using chemical absorbent pads. The used pads will be placed into double-lined heavy plastic garbage bags and disposed of in the clearly marked on-site 55-gallon drum currently being used for managing spent LNAPL socks in well MW-34p1. Disposable bailers, heavy plastic, and sampling gloves used during sampling will also be contained in double-lined heavy plastic garbage bags and disposed of in the on-site 55-gallon drum.

Laboratory analyses will be completed by a Washington State accredited laboratory in accordance with WAC 173-50.

5.2 GROUNDWATER SAMPLING PROCEDURES

Groundwater samples will be collected from all newly installed wells and analyzed for site COCs (Table B-2). Samples will be collected with temporary electric submersible pumps capable of discharge from near 0 to 3 gpm. The pumps will be located within the screened section of the well. Since sampling of the new wells will occur towards the end of aquifer testing, stabilization of field parameters commonly used during well purging will not be necessary; although field parameters will be collected and recorded during aquifer testing (Section 3).

Field meters and field testing kits will be calibrated and used in accordance with manufacturer guidelines. Purge volume will be measured with a graduated container or flow meter. All field measurements will be recorded on field sampling forms (Attachment A).

The following section describes groundwater sample collection procedures.

5.2.1 Sample Collection Procedure

The following steps will be followed for collection of groundwater samples:

1. Collect samples in laboratory provided containers in a manner that minimizes contact with air. Collect samples for VOC analysis first, followed by those for inorganic constituents. Take care to ensure sample containers for VOC analysis contain no air bubbles (head space). All field personnel will wear clean, disposable, latex gloves when collecting samples.

2. Filter samples for dissolved metals analysis in the field using a 0.45-micron in-line filter. Record filtration on the field sampling form (Appendix A), the sample container, and the chain-of-custody form (Attachment B).

3. Record sample identification data on sample container, field sampling form, and chain-of-custody form. Sample identification will include at least the following information:

    - Project name and number
    - Name of collector
    - Date and time of collection
    - Place of collection
    - The sample I.D., which will be the well number
    - Presence of any preservative or filtration

4. Immediately after collection, place samples in a cooler at approximately 4 degrees C with sufficient chemical ice to retain a cold temperature during hand delivery or overnight shipment to the laboratory.

5. Hand deliver or overnight ship samples to the laboratory in sealed coolers accompanied by chain-of-custody forms and any other pertinent shipping/sampling documentation. Use one chain-of-custody form per laboratory shipment (Attachment B).

5.2.2 Parameters and Analytical Methods

Groundwater samples will be analyzed for site COCs (Table B-2). Laboratory methods acceptable for analysis of groundwater samples are those described in EPA publications SW-846, Test Methods for Evaluating Solid Waste Physical Chemical Methods; EPA-600/4-91-010, Test Methods for Determination of Metals in Environmental Samples; or EPA-600/4-79-010, Test Methods for Chemical Analysis of Water and Wastes.

Laboratory analyses will be completed by a Washington state accredited laboratory in accordance with WAC 173-50. Target practical quantification limits, or reporting limits, for relatively simple groundwater matrices will be sufficiently low to allow data to be compared to regulatory screening levels. However, samples collected from the P1 contaminant area will likely require dilution, which may elevate laboratory reporting limits above regulatory screening levels.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

Standard field and laboratory QA/QC will be performed as described in Section 7.0 of the Final Sampling Analysis and Quality Assurance Project Plan Remedial Investigation (Task 3 and Task 4) - Investigation of Source and Extent of Groundwater Contamination Ephrata Landfill Corrective Action (PGG, 2007).

7.0 REPORTING

Results of the investigation covered under this work plan will be summarized in a second and final RI addendum. Bi-annual groundwater monitoring of select RI wells that has continued since completion of the draft RI will also be summarized in an RI addendum. All groundwater analytical data will be tabulated and compared to regulatory screening levels.

Because groundwater in the P1 contaminant area may contain LNAPL, analytical results may not be representative of true groundwater concentrations. Analytical data collected from the P1 zone in contact with residual LNAPL will not be used to characterize migration of groundwater contamination (PGG, 2013 and DOE, 2014) and will therefore not be compared to regulatory screening levels.

8.0 REFERENCES

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Parametrix, 2015. *Interim Remedial Action Plan Supplement, Ephrata Landfill Corrective Action, Pilot Test of Multi-Phase Extraction (MPE) and Additional Monitoring Wells*. Consultant's report prepared for Grant County Public Works and City of Ephrata. June 2015.

Parametrix, 2012. *Agency Review Draft Ephrata Landfill Feasibility Study*. Consultant's report prepared for Grant County Public Works and City of Ephrata. August 2012.

Table B-1. New Groundwater Wells

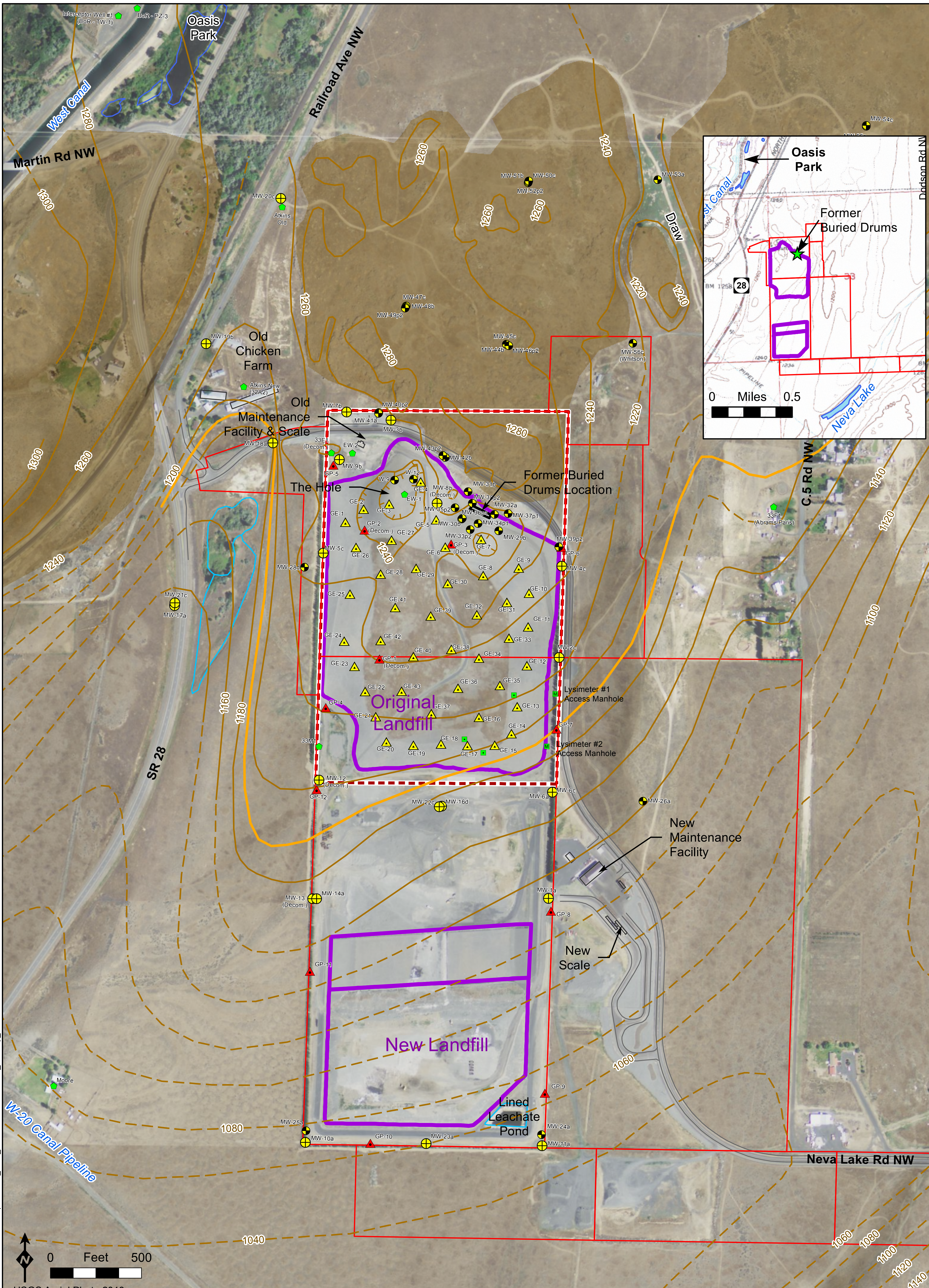
Ephrata Landfill, Grant County, Washington
June 2015

Wells	Boring No.	Location	Target Aquifer	Approximate Target Depth
Northern Point of Compliance				
	B-45	Eastern Nest	P1	25
	B-46	Eastern Nest	P2	35
	B-47	Eastern Nest	Roza	50
	B-48	Eastern Nest	Interflow	150
	B-49	Western Nest	P1	25
	B-50	Western Nest	P2	35
	B-51	Western Nest	Roza	50
	B-52	Western Nest	Interflow	150
P1 Contaminant Area				
	B-53	Former Drum Area	P1	30
	B-54	Former Drum Area	P1	30
	B-55	Former Drum Area	P1	30
	B-56	Former Drum Area	P1	30
	B-57	Former Drum Area	P1	30
	B-58	Former Drum Area	P1	30

Table B-2. Contaminants of Concern (COCs) - Ephrata Landfill
Ephrata Landfill, Grant County, Washington
June 2015

Parameters	Units	Group	Analytical Method	RI Screening Level	Screening Level Source[1]
Organic Parameters					
1,2-Dichloropropane	ug/L	12-DCP	EPA 8260C	1.22	MethB carc
Benzene	ug/L	BTEX	EPA 8260C	0.8	MethB carc
Ethylbenzene	ug/L	BTEX	EPA 8260C	700	Federal MCL
o-Xylene	ug/L	BTEX	EPA 8260C	1600	MethB non-carc
Toluene	ug/L	BTEX	EPA 8260C	640	MethB non-carc
Xylene Isomers, M+P	ug/L	BTEX	EPA 8260C	1600	MethB non-carc
1,1,1-Trichloroethane	ug/L	Ethanes	EPA 8260C	200	Federal MCL
1,1,2-Trichloroethane	ug/L	Ethanes	EPA 8260C	0.77	MethB carc
1,1-Dichloroethane	ug/L	Ethanes	EPA 8260C	7.68	MethB carc
1,2-Dichloroethane (EDC)	ug/L	Ethanes	EPA 8260C	0.48	MethB carc
Chloroethane	ug/L	Ethanes	EPA 8260C		
1,1-Dichloroethene	ug/L	Ethenes	EPA 8260C	7	Federal MCL
cis-1,2-Dichloroethene	ug/L	Ethenes	EPA 8260C	16	MethB non-carc
Tetrachloroethene (PCE)	ug/L	Ethenes	EPA 8260C	5	Federal MCL
Trichloroethene (TCE)	ug/L	Ethenes	EPA 8260C	0.54	MethB carc
Vinyl Chloride	ug/L	Ethenes	EPA 8260C	0.029	MethB carc
2-Butanone	ug/L	Ketones	EPA 8260C	4800	MethB non-carc
2-Hexanone	ug/L	Ketones	EPA 8260C		
4-Methyl-2-Pentanone (MIBK)	ug/L	Ketones	EPA 8260C	640	MethB non-carc.
Acetone	ug/L	Ketones	EPA 8260C	7200	MethB non-carc.
Methylene Chloride	ug/L	MC	EPA 8260C	5	Federal MCL
1,2,4-Trimethylbenzene	ug/L	TMB	EPA 8260C		
1,3,5-Trimethylbenzene	ug/L	TMB	EPA 8260C	80	MethB non-carc
1,3-Dichlorobenzene	ug/L	Other	EPA 8260C		
1,4-Dichlorobenzene	ug/L	Other	EPA 8260C	8.1	MethB carc
4-Isopropyltoluene	ug/L	Other	EPA 8260C		
Bromobenzene	ug/L	Other	EPA 8260C		
Chloroform	ug/L	Other	EPA 8260C	1.41	MethB carc
Chloromethane	ug/L	Other	EPA 8260C		
Naphthalene	ug/L	Other	EPA 8260C	160	MethB non-carc
n-Butylbenzene	ug/L	Other	EPA 8260C	400	MethB non-carc
sec-Butylbenzene	ug/L	Other	EPA 8260C	800	MethB non-carc
Bis(2-ethylhexyl) Phthalate	ug/L	SVOC	EPA 8270D	6	FED
2-Methylphenol (o-cresol)	ug/L	SVOC	EPA 8270D	400	MethB non-carc
Inorganic Parameters					
Chloride	mg/L	Inorganic	Inorganic	250	WAC 173-200
Nitrate as Nitrogen	mg/L	Inorganic	Inorganic	10	Federal MCL
Sulfate	mg/L	Inorganic	Inorganic	250	WAC 173-200
Total Dissolved Solids	mg/L	Inorganic	Inorganic	500	WAC 173-200
Arsenic, Dissolved	ug/L	Metals	Metals	0.058	MethB carc
Iron, Dissolved	ug/L	Metals	Metals	11200	MethB non-carc
Iron, Total	ug/L	Metals	Metals	11200	MethB non-carc
Manganese, Dissolved	ug/L	Metals	Metals	2240	MethB non-carc
Manganese, Total	ug/L	Metals	Metals	2240	MethB non-carc

Notes
MTCA Method B Values from Ecoloyg's CLARC Master Spreadsheet May 2014
Blank screening level indicates there is no established criteria, but organic was detected in one or more wells during the RI.



Existing Wells
- Quarterly Monitoring Well (MW)
- Remedial Investigation Monitoring Well (MW)
- Gas Extraction (GE)
- Gas Probe (GP)
- Other Well
- Lechate Lysimeter
- Access Manhole

Top of Basalt Elevation Contours (dashed where inferred)
- 20-ft Contour Interval
- Depression (10-ft Contour Interval)
- Outwash Water Table / Top of Basalt Contact
- Basalt Outcrops
- County Owned Parcels
- Landfill Extents
- Groundwater Point of Compliance

Figure B-1
Ephrata Landfill
Site Map

Ephrata Landfill
RIFS

PGG

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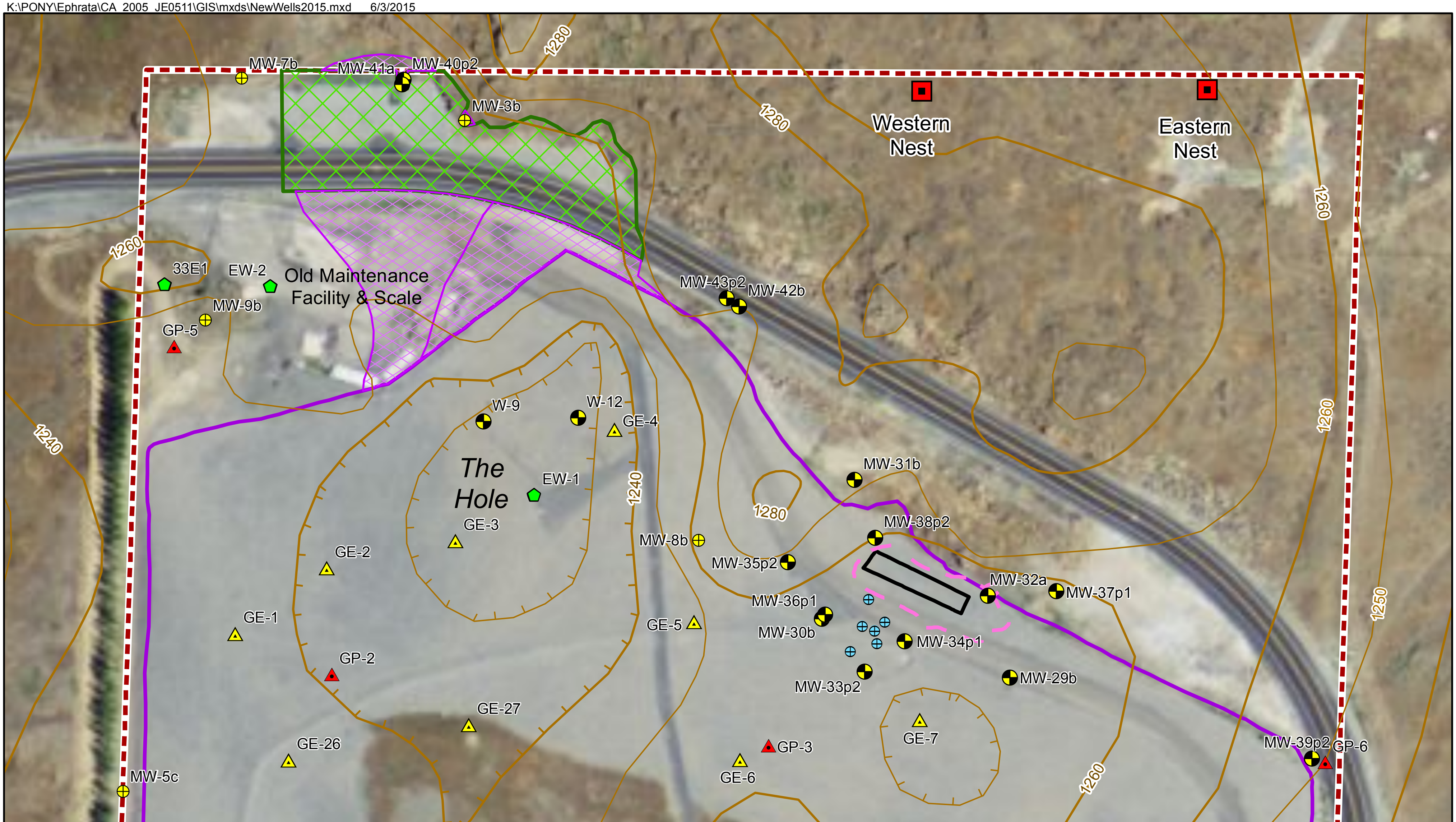

Existing Wells

- Quarterly Monitoring Well (MW)
- Remedial Investigation Monitoring Well (MW)
- Gas Extraction (GE)
- Gas Probe (GP)
- Other Well

Proposed Wells

- P1 Pilot Test Wells
- New POC Well Nests

Top of Basalt Elevation Contour

- 20-ft Contour
- 10-ft Contour

- Capped Unlined Landfill Extent
- Uncapped North End Soils
- Excavated North End Soils
- Former Drum Area
- Extent of Soil Removal to Bedrock
- Groundwater Point of Compliance

0 Feet 150

2013 NAIP Orthophoto

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Figure B-2

Proposed New Groundwater Wells

Ephrata Landfill
RIFS

PgG

ATTACHMENT A
FIELD SAMPLING FORMS

GROUNDWATER SAMPLING FIELD DATA FORM

Well #: ______________

Sampling Event:________________________

Sample #:____________

Project Number: ________________________ Date:________________________
Project Name: ________________________ Location:________________________
Project Address: ________________________ Sampled By:________________________
Client Name: ________________________ Purged By:________________________
Laboratory: ________________________ Date Sent to Lab:________________________
Chain-of-Custody (yes/no):________________________ Field CC Sample Number:________________________
Shipment Method:________________________ Sample Split:________________________

Depth to Water (feet):________________________ Purge Volume Measurement Method:________________
Depth of Well (feet):________________________ Purge Date/Time:________________________
Reference Point (surveyors notch, etc.):____________________ Purging Equipment:________________________
Sampling Equipment:______________________________ Water Level Probe Used:________________________

Casing Volume Constants (CVC): 2-inch = **0.16** gpf ; 4-inch = **0.656** gpf ; 6-inch = **1.47** gpf PV=($\pi r^2 h$) (7.48 gal/ft³)

Purge Volume = ft of water _________ x CVC _________ x Casing Volumes ________ = ____________ gallons

TIME (2400 hr)	CUMULATIVE VOLUME (gal)	pH (units)	EC (umhos/cm 25 c)	Temp. (C)	TURBIDITY (visual)	________	________

Well Integrity:

Bottle Inventory

Day/Time Sampled:________________________

Quantity:	Container:	Preservatives:	Filtered (type):	Remarks:

Signature:________________________________

Page_______ of_______

LNAPL SAMPLING FIELD DATA FORM

Well #: ______________

Sampling Event:________________________

Sample #:____________

Project Number: ______________________________________ Date:____

Project Name: ____ Location:______________________________________

Project Address: ______________________________________ Sampled By:____________________________________

Client Name: ____ Date Sent to Lab:_______________________________

Laboratory: ____

Chain-of-Custody (yes/no):_______________________________

Delivery Method:______________________________________

Depth to Water (feet):___________________________________ LNAPL Thickness in well (feet):_____________________

Depth to Product (feet):_________________________________ Sample Date/Time:________________________________

Depth of Well (feet):____________________________________ Sample Equipment:________________________________

Reference Point (surveyors notch, etc.):____________________ Interface Probe Used:_____________________________

Sampling Equipment:___________________________________

Bottle Inventory Day/Time Sampled: ______________________________

Quantity:	Container:	Preservatives:	Filtered (type):	Remarks:

Signature:_________________________________

Page_______ of_______

ATTACHMENT B
CHAIN OF CUSTODY FORM

Chain of Custody Record & Laboratory Analysis Request

Analytical Resources, Incorporated
Analytical Chemists and Consultants
4611 South 134th Place, Suite 100
Tukwila, WA 98168
206-695-6200 206-695-6201 (fax)

ARI Assigned Number:	Turn-around Requested:	Date:
ARI Client Company:	Phone:	Page: of
Client Contact:		No. of Coolers: Cooler Temps:
Client Project Name:		
Client Project #:	Samplers:	

Sample ID	Date	Time	Matrix	No. Containers	Analysis Requested								Notes/Comments

Comments/Special Instructions	Relinqushed by: (Signature)	Received by: (Signature)	Relinquished by: (Signature)	Received by: (Signature)
	Printed Name:	Printed Name:	Printed Name:	Printed Name:
	Company:	Company:	Company:	Company:
	Date & Time:	Date & Time:	Date & Time:	Date & Time:

Limits of Liability: *ARI will perform all requested services in accordance with appropriate methodology following ARI Standard Operating Procedures and the ARI Quality Assurance Program. This program meets standards for the industry. The total liability of ARI, its officers, agents, employees, or successors, arising out of or in connection with the requested services, shall not exceed the Invoiced amount for said services. The acceptance by the client of a proposal for services by ARI release ARI from any liability in excess thereof, not withstanding any provision to the contrary in any contract, purchase order or co-signed agreement between ARI and the Client.*

Sample Retention Policy: Unless specified by workorder or contract, all water/soil samples submitted to ARI will be discarded or returned, no sooner than 90 days after receipt or 60 days after submission of hardcopy data, whichever is longer. Sediment samples submitted under PSDDA/PSEP/SMS protocol will be stored frozen for up to one year and then discarded.