PACIFIC groundwater GROUP

NORTH END SUPPLEMENTAL INVESTIGATION
PHASE 1
EPHRATA LANDFILL

June 2019

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EPHRATA LANDFILL

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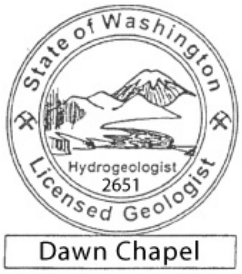
SIGNATURE

This report, and Pacific Groundwater Group's work contributing to this report, were reviewed by the undersigned and approved for release.



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1.0 INTRODUCTION

Pacific Groundwater Group (PGG) has prepared this work plan for supplemental site characterization work to be conducted at the Ephrata Landfill (site) in Grant County, Washington (Figure 1). Additional site characterization related to the nature and extent of groundwater contamination at the north end of the site is being performed.

Volatile organic compounds (VOCs) are the main groundwater contaminant of concern at the site and include chlorinated compounds and benzene, toluene, ethylbenzene, and xylene (BTEX). Non-aqueous phase liquid (NAPL) is present in the P1 shallow water-bearing zone below the former drum cache (herein referred to as the Drum Source Area).

Discussions between Washington Department of Ecology (Ecology), and representatives of Grant County Public Works, and the City of Ephrata determined that additional groundwater characterization and evaluation of remedial technology effectiveness should be conducted prior to completing the FS (Parametrix 2019). Based on those discussions, the objectives of Phase 1 characterization work include:

- Further refine the stratigraphy and lithology of P1 and P2 water-bearing zones, and Roza aquifer at the Drum Source Area, the "Hole", and in down-gradient areas.
- Refine the extent of contamination in the P1 zone at the Drum Source Area including further evaluation of vertical migration of halogenated volatile organic compounds (HVOCs) as high concentration dissolved-phase liquid and/or as dense non-aqueous phase liquid (DNAPL) into the underlying P2 zone and possibly the underlying Roza aquifer.
- Refine the extent of contamination in the P2 zone below and surrounding the Drum Source Area.
- Refine the extent of contamination in the Roza aquifer proximate to the Drum Source Area, the Hole, and in down-gradient areas.
- Improve understanding of hydraulic connection(s) and preferential migration pathways between the P1 and P2 water bearing zones and the underlying Roza aquifer at the Drum Source Area and the Hole.
- Evaluate yields of newly installed wells and nearby aquifer transmissivities.
- Install wells suitable for future pilot testing in the P1 and P2 water bearing zones, and/or Roza aquifer near the Drum Source Area and the Hole.
- Survey all site well locations and monitoring point elevations consistent with Ecology datum standards.

Specific tasks to meet the objectives will include well installation (Section 3), a survey of the well network (Section 4), and groundwater sampling (Section 5).

This work will be conducted consistent with WAC 173-340 (Model Toxics Control Act, MTCA) and Agreed Order DE3810, in coordination with the Washington Department of Ecology (Ecology), Grant County Public Works, and the City of Ephrata. Results of the Supplemental Phase 1 work will be used to inform additional investigation focusing on

pilot testing of feasible remedial technologies at the site. Additional pilot testing will be addressed under a separate work plan.

2.0 BACKGROUND

Please refer to the revised draft FS and reports referenced therein for discussion of the extent of contamination and conceptual site model (Parametrix 2018). This section briefly describes the context for the supplemental study areas and data objectives for each area.

The investigation is broken into three overlapping study areas at the north end of the site based on the general contaminant source areas and the down-gradient dissolved phase plume. These include:

- Drum Source Area
- Groundwater in the "Hole"
- Down-gradient dissolved phase plume

Wells completed within the boundary of the closed landfill will be drilled through existing landfill refuse and the overlying liner and cap. Special considerations for work in these areas are discussed in Section 3.2.

2.1 DRUM SOURCE AREA

The Drum Source Area includes the former drum cache and immediate surrounding area. The base of the drum cache was on hard basalt interpreted as the bottom of the P1 zone. High concentrations of dissolved-phase liquid and LNAPL containing chlorinated and non-chlorinated compounds have been confirmed in the P1 water bearing zone and have been the target of recovery operations. DNAPL is suspected based on high concentrations of chlorinated ethenes detected in some groundwater samples collected in the P1 zone, but has not been confirmed.

The investigation will further assess impacts to the P1 and P2 water bearing zones and the Roza aquifer in this area (Figure 2). The supplemental well locations will further refine the nature and extent of contamination. In addition, the wells installed may be used for additional multi-phase extraction (MPE) pilot testing of impacted water bearing zones. Wells in this area will be completed as 6-inch diameter wells to accommodate future MPE pilot testing.

2.2 GROUNDWATER IN THE "HOLE"

The "Hole" is a topographic depression in the top-of-basalt surface west of the Drum Source Area, and is completely covered by the original landfill (Figure 1). The water table is above the basalt within the "Hole" and landfill refuse is in direct contact with groundwater. The mixture of refuse, groundwater, and landfill gas may create geochemical conditions not found elsewhere. Groundwater at and down-gradient of the Hole is impacted by volatile organic compounds as well as elevated concentrations of landfill leachate indicators such as chloride.

The investigation in the Hole will target the P2 water bearing zone and Roza aquifer (Figure 2). The P2 zone is projected to intercept the sides of the Hole above the elevation of groundwater in the Hole. Based on well logs the P1 appears to pinch out before reaching the Hole. If the P1 water bearing zone is encountered during drilling of new P2 and Roza wells between the Drum Source Area and the Hole, then a new P1 well will be installed. The Roza aquifer is projected to occur beneath the Hole. A new Roza aquifer well will be installed beneath the bottom of the Hole adjacent to existing well EW-1 where access is already available for a drill rig (Figure 2). Access elsewhere would require road building on the landfill cap.

Investigation in the Hole area will improve understanding of potential lateral and vertical groundwater migration pathways between the Hole and the Drum Source Area within the P2 water bearing zone and underlying Roza aquifer. Wells in this area will also be 6-inch diameter to accommodate potential future pilot testing of remedial actions in this area.

2.3 DOWN GRADIENT DISSOLVED PHASE PLUME

RI investigative work identified a dissolved phase groundwater plume down-gradient of the north end sources - referred to as the northerly plume in the RI and revised draft FS (PGG 2010 and 2017 and Parametrix 2018). The lateral extents of contamination in the P1 and P2 water bearing zones are limited and based on existing data appear to be contained within the proposed[1] groundwater conditional point of compliance (POC) for the site. Migration of the down-gradient dissolved phase plume beyond the POC occurs mainly within the Roza aquifer towards the north and to a lesser extent the deeper Interflow aquifer at the northeast corner of the POC (Interflow well MW-58c in Figure 1). Existing wells indicate that the extent of contamination in the Roza aquifer beyond the northern POC is limited to property that is owned by the County.

Further characterization of the down-gradient dissolved phase plume will target the P2 water bearing zone and Roza aquifer north of the Drum Source Area (Figure 3). Data collected in this portion of the investigation will further refine the nature and extent of contamination in the down-gradient dissolved phase plume both up- and down-gradient from the proposed POC. Wells in this area will be completed as 2-inch diameter resource protection wells.

3.0 MONITORING WELL INSTALLATION

Approximately 81 wells will be drilled and installed during this supplemental investigation (Figures 2 and 3). Table 1 summarizes the estimated depths and completion targets for each of the wells – final depths may vary. Given the discontinuous nature of the P1 and P2 water bearing zones, these zones may not occur at all the locations identified in Figures 2 and 3. Final target zones, screen intervals, and well depths will be determined in the field based on observations during drilling (Section 3.3).

[1] A POC will not be formally established until completion of the Cleanup Action Plan (CAP). 'Conditional' (C) is dropped from the acronym for brevity.

Some special drilling considerations and approaches are required at this site. These are highlighted below and discussed in more detail in the following sections:

- Most of the wells completed near the Hole and Drum Source Area will penetrate the closed landfill including landfill refuse and the overlying liner and cap. Special considerations for work in these areas are discussed in Section 3.2.
- Where wells may penetrate contaminated zones overlying deeper target zones, temporary telescopic drill casing with seals isolating the upper zones from the target zone will be used (Section 3.3).

3.1 WELL ACCESS LOGISTICS

Most well locations are not currently accessible for a full-size drill rig due to either the cobbly landfill cover or uneven basalt surfaces beyond the landfill extent. Grant County will construct roads and level pads to accommodate the drill rigs at the well locations. Figures 2 and 3 show the estimated location for necessary roads – final locations will be determined after consultation with Grant County. These roads will also provide access for later groundwater sampling and/or remediation pilot testing and implementation.

3.2 LANDFILL LINER PENETRATIONS

All borings advanced through the closed and capped landfill will need to penetrate the landfill liner. The liner is installed below the rocky cover material and above a soil fill layer and/or refuse. The liner is a thick high-density polyethylene (HDPE) membrane. The liner controls landfill gas emissions and prevents precipitation recharge from entering the closed landfill cell. Liner penetrations should therefore be made carefully due to asphyxiation and fire hazards associated with landfill gas. The liner repair should be made by a qualified professional to ensure proper function after well installation is complete.

The following steps will be taken at these locations.

1. Grant County will remove cover material to the liner at the investigation location and adjacent to the drilling pad. The County will not cut the liner.

2. The liner will be cut by the driller to allow access immediately before drilling begins. Air space above the liner cut will be monitored for methane concentrations during drilling operations, consistent with the health and safety plan (Section 9).

3. Following completion of the monitoring well, Grant County or the driller will have a contractor seal the liner against the well casing and/or monument. If the liner is to be sealed against the steel stickup monument, the annular space between the well casing and monument will be sealed with hydrated bentonite, neat cement, or other approved seal material.

4. The well monument must be set at an elevation that will allow replacement of the rocky landfill cover material. The cover material is typically 2- to 3-feet thick.

3.3 DRILLING AND LOGGING

Because of laterally variable geology not conducive to consistent geologic unit projections between boreholes, wells will be screened based on observations at the specific boring location. The target basalt intervals at the site are located in the interflows of the Roza member of the Columbia River Basalts (Thordarson and Self, 1998). The Roza member locally consists of overlapping pahoehoe type lava flow lobes that are locally variable in extent and thickness. Mapped vertical sections through the Roza member near the site consist of between two and six flows depending on location, with some outcrops documenting complex lava breakout structures. Consistent with prior drilling observations at the site and regional literature, interflows encountered at the site are expected to vary in elevation and thickness between boreholes.

Drilling will target the P1 and P2 water bearing zones and Roza aquifer as defined in the RI (PGG 2010). All three target units occur within the Roza member of the Columbia River Basalts. Exploration locations are shown in Figures 2 and 3. Targeted depths and intervals are estimated in Table 1; however, given the variability in thickness and vertical position of the target units, final depths and intervals will be based on field observations during drilling.

Both air rotary and sonic drilling methods will be used in this investigation to leverage the information gained from each method, as discussed below.

- A select subset of Roza aquifer wells in each target area (i.e. Drums Source Area and down-gradient dissolved phase plume) will first be drilled using a full-size sonic drill rig with a continuous recovery core barrel (sonic boring locations are identified in Figures 2 and 3). Continuous coring will support more direct observation of subsurface lithology in each target area. However, water added to cool the sonic drill bit is likely to mask observations of ambient subsurface saturation.
- The remaining wells in each target area will be drilled using air rotary. Air rotary drilling has been used successfully at this site in the past, and will be the primary drilling method used for most of the new wells in this investigation. The method allows for relatively easy identification of thin water-bearing zones interbedded within the low permeability layers through observation of drilling action and drill cutting moisture. Where drilling is noticeably easier or retrieved cuttings are wet/moist, soft or visibly weathered and broken, drilling will be temporarily stopped to checked for intrusion of groundwater into the borehore.

A field geologist will be on site during drilling and construction of wells to document the work and log borings. Field observations will include at a minimum drilling action, lithology, visual and olfactory observations including staining and/or odor, photoionization detector (PID) readings, fracture density, weathering, and saturation (see Section 3.5). Field notes will include any additional analysis used to support selection of the final screened interval, or decision not to screen some borings, for each location.

Borings in the source area will be drilled approximately 2 feet below the target aquifer into the underlying hard basalt to create a “sump” in the well for potential future dewatering and MPE pilot testing activities.

Boreholes will be temporarily sealed during drilling to minimize the potential for contaminated groundwater to flow down the borehole into the lower aquifer targeted for screening. See Table 1 for wells requiring temporary seals.

Permanent monitoring wells will be constructed in accordance with Washington State Department of Ecology requirements for construction of monitoring and resource protection wells (WAC 173-160). All drilling and well construction will be conducted by a driller licensed in the State of Washington and consistent with WAC 173-160.

3.4 MONITORING WELL INSTALLATION

Wells installed in the Drum Source Area and Hole will be completed with 6-inch diameter construction to accommodate future pilot testing. Wells completed in the down-gradient dissolved phase plume will be completed with 2-inch diameter construction (Table 1). Wells installed through the landfill will be constructed using schedule 80 PVC, and all other wells will be constructed with schedule 40 PVC. Casing and screens will have flush thread joints and O-ring seals. Final screen lengths will be 5- to 10-feet, depending on the thickness of the target zone. Screen intervals will be surrounded by a Colorado silica sand pack to a minimum of 1 foot above the top of screen. Screens will have a 0.020-inch slot size. Well seal material above the screen will consist of hydrated bentonite and/or neat cement to the ground surface. The well casing will extend approximately 2 feet above ground surface and be protected with a locking steel monument.

All newly constructed wells will be developed to remove suspended fines and to promote hydraulic connection with the aquifer.

Protective bollards will be installed around completed monitoring wells where feasible. Heavy concrete blocks (i.e. “Ecology Blocks”) will be used where standard protective bollards are not practicable (i.e. through the landfill cap and on hard basalt). Blocks will be furnished and installed by Grant County after the wells have been constructed. A variance from Ecology will be required for use of blocks in lieu of bollards.

3.4.1 Telescopic Construction

Wells that are completed through potentially contaminated intervals will use telescopic construction methods to temporarily seal upper contaminated intervals from deeper intervals and prevent cross-contamination. Sealing will follow standard practices and will generally be conducted by keying the drill casing into the unit immediately below the contaminated interval (e.g., dense basalt below P2 zone) placing seal material at the base of the outer drill casing and then advancing a smaller diameter drill casing through and below the placed seal. Wells requiring telescopic construction and seals are shown in Table 1 and Figure 4 shows an example of a telescopic construction through landfill refuse.

3.4.2 Well Nomenclature

Completed wells will be named using unique sequential numbers with a suffix indicating the target interval (i.e. -p1, -p2, -b). For example, MW-79p1, MW-80p2, and MW-81b for the P1, P2, and Roza respectively.

3.5 FIELD OBSERVATIONS

A field geologist will observe drilling and prepare a boring log and well construction documenting field observations and well construction details. Field observations will include:

- Drill penetration rate and quality.
- Lithology, fracture density, and weathering characteristics
- Observation of saturation as allowed by the drilling conditions and methods
- Observable oil sheens or odors in drill cuttings or water
- PID readings from bagged grab samples.
- Boring and well construction details including boring exploration number, final site well number, description of materials encountered at depth, target aquifer, final well screen construction, and Ecology unique well tag number.

3.6 SHORT TERM PUMPING TESTING

Brief single-well pumping tests up to one hour will be conducted at all newly installed wells to assess local transmissivities and well yields. Tests will be performed using a temporary electric submersible pump during the first round of groundwater sampling (see Section 5.0). Water-level measurements will be taken often during the pumping test to the nearest 0.01 foot using a hand-held water level probe. Pumping rates will be monitored with either an in-line flow meter or a graduated vessel. Recovery will be monitored to 90 percent recovery. Drawdown and recovery data will be analyzed in AQTESOV[2] to estimate local transmissivity and well yield.

4.0 WELL SURVEY

Following completion of well drilling, all site monitoring wells will be surveyed consistent with Ecology geospatial data standard[3]. The survey will meet the following criteria:

- Measurement at the north side of the top of PVC well casing (well cap/plug removed) and the top of the north side of the steel monument at each well.
- Vertical accuracy to 0.01 foot or better in North American Vertical Datum 1988 (NAVD 88).
- Horizontal accuracy to 0.1 foot or better in North American Datum 1983 High Accuracy Reference Network (NAD 83 HARN) in Washington State Plane coordinates.
- All survey elevations and locations will be reported in feet.

[2] AQTESOLV is the industry standard software for interpreting aquifer tests (http://www.aqtesolv.com/)
[3] Ecology geospatial data standards are documented at: https://ecology.wa.gov/Research-Data/Data-resources/Geographic-Information-Systems-GIS/Standards

- Survey to be conducted by a licensed surveyor.
- Survey will include measurement of at least one local benchmark to the project datum to support future survey efforts.
- Survey will include documentation of survey quality assurance including repeat measurements (closed loop) to demonstrate internal consistency, and documentation of the name, location, accuracy, and precision of the benchmark(s) used in the survey.

The survey will be conducted by either Grant County public works surveyors or a qualified subcontractor.

5.0 GROUNDWATER SAMPLING AND MONITORING

Groundwater sampling in this work plan will include two events:

1. The regularly scheduled 2019 Q2 sampling event (June 2019) of select RI wells plus additional existing RI wells.

2. Sampling of all newly installed wells in this work plan.

3. Expanded groundwater level monitoring

Analytical and field parameters to be sampled are shown in Table 2. Sampling and monitoring during each event are described below (Sections 5.1 and 5.2). Future sampling events and locations within the expanded RI well network will be decided following review of the first round of sampling data generated from these two events.

One year of expanded quarterly groundwater level monitoring will also be conducted during this supplemental investigation (see Section 5.3).

5.1 JUNE 2019 SAMPLING

Current routine groundwater sampling at the site includes required quarterly monitoring of 16 select wells in accordance with solid waste performance monitoring under WAC 173-351 (PGG 2013) and voluntary bi-annual monitoring of 7 select RI monitoring wells (PGG 2010)[4]. All routine monitoring data is submitted to Ecology's Environmental Information Management System (EIM).

The upcoming June 2019 RI monitoring event for the site will include sampling the 7 bi-annually monitored wells plus 17 additional RI wells listed in Table 3. Synoptic depth to water measurements will be collected for the complete set of wells in the P1 and P2 water bearing zones and the Roza aquifer prior to sampling (see Section 5.3).

[4] The original bi-annual RI monitoring wells were: MW-48b, MW-46p2, MW-44b, MW-45c, Whitson well, MW-33p2, MW-35p2, and MW-38p2 (PGG 2010). The current bi-annual RI monitoring wells are: MW-42b, MW-44b, MW-33p2, MW-35p2, MW-38p2, MW-63b, and MW-58c (Table 3).

Sampling of the additional wells will provide data from the P1 and Roza wells in the Drum Source Area, the Hole, and down-gradient P2 well MW-39p2. The P1 wells have not been sampled since groundwater in the P1 water bearing zone rebounded after completion of the 2017 P1 MPE pilot test (Parametrix and PGG 2018) and the other wells have not been sampled since completion of the RI in 2010 (PGG 2010).

5.2 SAMPLING OF NEWLY INSTALLED WELLS

Following completion of the installation of new monitoring wells, synoptic depth to water measurements will be collected for the complete set of wells in each water bearing zone prior to sampling. Synoptic water levels and sampling will occur at least 48 hours after well development to allow ambient water levels to equilibrate in the newly installed wells. New wells will be sampled for the parameters listed in Table 2. In addition to the standard RI monitoring parameters, samples from the newly installed P2 and Roza down-gradient wells will also be analyzed for select natural attenuation parameters in support of evaluating monitored natural attenuation (MNA) in the final FS.

Depending on the drilling schedule, sampling of the new wells may occur during the regularly scheduled September 2019 event.

5.3 EXPANDED GROUNDWATER LEVEL MONITORING

Groundwater levels are currently collected from a subset of site monitoring wells during each quarterly sampling event. Beginning with the June 2019 event, routine water level monitoring will be expanded to include all site monitoring wells with the exception of wells MW-54c and MW-55c – these two wells are located about ½ mile northeast of the landfill and will not offer substantive information on groundwater flow directions and gradients at the site[5].

Newly installed wells under this supplemental investigation will be included in the expanded groundwater level monitoring. Expanded groundwater level monitoring at the site will occur for a minimum of four quarters (one year) to assess seasonal variability in groundwater flow directions and gradients. After one year, a subset of wells will be selected for long term monitoring of groundwater levels. All sampled wells well be gauged for water levels before purging the well.

5.4 SAMPLING PROCEDURES AND QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

Groundwater sampling and QA/QC procedures will be conducted consistent with procedures documented in the RI Sampling Analysis and Quality Assurance Project Plan (PGG 2007). To the extent practicable, sampling will progress from the least contaminated wells (i.e. down-gradient wells) to the more contaminated wells (i.e. shallower wells

[5] MW-54c and MW-55c are monitoring wells installed during the RI targeting the Interflow aquifer about ½ mile northeast of the landfill and are difficult to access by vehicle. Monitoring of these wells during the RI indicates very low transmissivity at MW-54c and MW-55 was completed as a dry well.

located closer to the Drum Source Area). Additional equipment blanks not specified in the 2007 SAP/QAPP may be collected periodically through the sampling events.

6.0 INVESTIGATION DERIVED WASTE

Investigation derived waste (IDW) will include drill cuttings (soils), purge water, decontamination water, and field equipment such as tubing and gloves.

- Soils will be drummed and stored in a central staging area. Drums will be transferred into the active lined landfill by Grant County. All drums will be clearly labeled with collection date, drum contents (cuttings, water, etc), and boring identifier.
- Water will be separated from soils to the extent possible and stored in drums or totes for transfer to the evaporation pond. Empty water drums and totes may be disposed of in the active lined landfill along with soil drums. All drums or totes that are not immediately discharged to the evaporation pond will be clearly labeled with collection date, drum contents (cuttings, water, etc), and boring identifier.
- Disposable field equipment such as gloves will be bagged and disposed of as non-hazardous waste to the active lined landfill.

7.0 REPORTING

Initial results from Supplemental Phase 1 work and other 2019 Q2 sampling will be summarized in a concise data report with summary tables, borings, and brief narrative. Final data analysis and interpretation will be included in an updated conceptual site model report in support of the final FS.

8.0 SCHEDULE

Phase 1 work is to begin as soon as this work plan is approved, with drilling to take place during the summer of 2019 if possible. The scheduling of Supplemental Phase 1 tasks will be contingent on driller availability, time to construct well access roads, drilling and well completion, and groundwater sampling. Approximate sequence and duration for each task item is presented below.

Item	Duration	Task Start Point
Solicit Drillers and Award	3 weeks	Work Plan Approval
Construct Road Access	4 weeks	Schedule dependent on County.
Well Drilling and Installation	8 weeks	Mobilization; driller lead time may increase later in spring and summer.
Survey Wells	1 week	Drilling Completion
Groundwater Water Levels, Sampling and Testing	4 weeks	Drilling Completion
Sample Analysis and Validation	3 weeks	Sampling Completion
Data Report	2 weeks	Receipt of Validated Analytical Data

Results of the Supplemental Phase 1 work will be used to develop the Supplemental Phase 2 work elements. A second phase of investigation focusing on pilot testing of feasible remedial technologies will be planned based on the additional data obtained during the Supplemental Phase 1 work described in this plan.

9.0 HEALTH AND SAFETY PLAN

PGG's project Health and Safety Plan (PGG 2016) will apply to PGG personnel during implementation of Supplemental Phase 1 investigation work. Drillers, contractors, and other consultant's on site will adhere to their own health and safety plans.

10.0 REFERENCES

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Table 1. Exploration and Well Summary Table
Ephrata Landfill, Grant County, Washington

Boring ID	Target Zone	Investigation Area	Total Depth (feet bgs)	Well Diameter (inches)	Well Screen Length (ft)	Screen Slot Size (in)	Well Construction Material	Landfill Liner Present?	Surface Elevation	Top of Basalt Elevation	Estimated Depth To (bgs):						Easting	Northing
											P1 Top	P1 Bottom	P2 Top	P2 Bottom	Roza Top	Roza Bottom		
B-71	Roza	Downgradient	42	2	5 to 10	0.02	sch. 40 PVC	--	1,245	1,240	--	--	5	10	25	40	1,869,577	710,282
B-72	Roza	Hole	85	6	5 to 10	0.02	sch. 80 PVC	Yes	1,288	1,228	33	38	48	53	68	83	1,870,149	709,889
B-73	P2	b/t Drum Area and Hole	58	6	5 to 10	0.02	sch. 80 PVC	Yes	1,291	1,254	36	41	51	56	71	86	1,870,327	709,764
B-74	Roza	b/t Drum Area and Hole	88	6	5 to 10	0.02	sch. 80 PVC	Yes	1,291	1,255	36	41	51	56	71	86	1,870,332	709,761
B-75	P1	b/t Drum Area and Hole	43	6	5 to 10	0.02	sch. 80 PVC	Yes	1,291	1,254	36	41	51	56	71	86	1,870,332	709,767
B-76	P2	Source Area	57	6	5 to 10	0.02	sch. 80 PVC	Yes	1,290	1,254	35	40	50	55	70	85	1,870,463	709,671
B-77	P1	Source Area	42	6	5 to 10	0.02	sch. 80 PVC	Yes	1,290	1,254	35	40	50	55	70	85	1,870,468	709,669
B-78	Roza	Source Area	87	6	5 to 10	0.02	sch. 80 PVC	Yes	1,290	1,253	35	40	50	55	70	85	1,870,468	709,674
B-79	P1	b/t Drum Area and Hole	40	6	5 to 10	0.02	sch. 80 PVC	Yes	1,288	1,262	33	38	48	53	68	83	1,870,314	709,871
B-80	P2	b/t Drum Area and Hole	55	6	5 to 10	0.02	sch. 80 PVC	Yes	1,288	1,262	33	38	48	53	68	83	1,870,313	709,877
B-81	Roza	b/t Drum Area and Hole	85	6	5 to 10	0.02	sch. 80 PVC	Yes	1,288	1,262	33	38	48	53	68	83	1,870,318	709,875
B-82	Roza	Downgradient	53	2	5 to 10	0.02	sch. 40 PVC	--	1,256	1,259	1	6	16	21	36	51	1,869,769	710,470
B-83	P1	Source Area	34	6	5 to 10	0.02	sch. 80 PVC	Yes	1,282	1,256	27	32	42	47	62	77	1,870,473	709,766
B-84	P1	Source Area	34	6	5 to 10	0.02	sch. 80 PVC	Yes	1,282	1,259	27	32	42	47	62	77	1,870,433	709,808
B-85	P1	Source Area	34	6	5 to 10	0.02	sch. 80 PVC	Yes	1,282	1,259	27	32	42	47	62	77	1,870,455	709,791
B-86	Roza	Source Area	79	6	5 to 10	0.02	sch. 80 PVC	Yes	1,282	1,270	27	32	42	47	62	77	1,870,433	709,814
B-87	P2	Source Area	49	6	5 to 10	0.02	sch. 80 PVC	Yes	1,282	1,260	27	32	42	47	62	77	1,870,438	709,811
B-88	P2	Source Area	51	6	5 to 10	0.02	sch. 80 PVC	Yes	1,284	1,249	29	34	44	49	64	79	1,870,591	709,664
B-89	Roza	Source Area	81	6	5 to 10	0.02	sch. 80 PVC	Yes	1,284	1,249	29	34	44	49	64	79	1,870,592	709,670
B-90	P1	Source Area	36	6	5 to 10	0.02	sch. 80 PVC	Yes	1,284	1,249	29	34	44	49	64	79	1,870,596	709,666
B-91	P1	Source Area	34	6	5 to 10	0.02	sch. 80 PVC	Yes	1,282	1,256	27	32	42	47	62	77	1,870,483	709,787
B-92	P2	Source Area	49	6	5 to 10	0.02	sch. 80 PVC	Yes	1,282	1,256	27	32	42	47	62	77	1,870,488	709,784
B-93	Roza	Source Area	79	6	5 to 10	0.02	sch. 80 PVC	Yes	1,282	1,256	27	32	42	47	62	77	1,870,488	709,790
B-94	P2	Source Area	49	6	5 to 10	0.02	sch. 80 PVC	Yes	1,282	1,254	27	32	42	47	62	77	1,870,550	709,759
B-95	P1	Source Area	34	6	5 to 10	0.02	sch. 80 PVC	Yes	1,282	1,255	27	32	42	47	62	77	1,870,555	709,760
B-96	Roza	Source Area	79	6	5 to 10	0.02	sch. 80 PVC	Yes	1,282	1,254	27	32	42	47	62	77	1,870,473	709,844
B-97	Roza	Source Area	79	6	5 to 10	0.02	sch. 80 PVC	Yes	1,282	1,254	27	32	42	47	62	77	1,870,552	709,765
B-98	P1	Source Area	34	6	5 to 10	0.02	sch. 80 PVC	Yes	1,282	1,254	27	32	42	47	62	77	1,870,478	709,841
B-99	P2	Source Area	49	6	5 to 10	0.02	sch. 80 PVC	Yes	1,282	1,260	27	32	42	47	62	77	1,870,478	709,847
B-100	P1	Source Area	30	6	5 to 10	0.02	sch. 80 PVC	Yes	1,278	1,254	23	28	38	43	58	73	1,870,507	709,828
B-101	P2	Source Area	45	6	5 to 10	0.02	sch. 80 PVC	Yes	1,278	1,253	23	28	38	43	58	73	1,870,507	709,834
B-102	Roza	Source Area	75	6	5 to 10	0.02	sch. 80 PVC	Yes	1,278	1,253	23	28	38	43	58	73	1,870,512	709,832
B-103	Roza	Downgradient	59	2	5 to 10	0.02	schd. 40 PVC	--	1,262	1,258	7	12	22	27	42	57	1,870,040	710,304
B-104	P1	Source Area	31	6	5 to 10	0.02	sch. 80 PVC	Yes	1,279	1,254	24	29	39	44	59	74	1,870,647	709,719
B-105	Roza	Source Area	70	6	5 to 10	0.02	sch. 80 PVC	Yes	1,273	1,263	18	23	33	38	53	68	1,870,502	709,864
B-106	Roza	Source Area	75	6	5 to 10	0.02	sch. 80 PVC	Yes	1,278	1,254	23	28	38	43	58	73	1,870,552	709,817
B-107	P2	Source Area	45	6	5 to 10	0.02	sch. 80 PVC	Yes	1,278	1,255	23	28	38	43	58	73	1,870,556	709,815
B-108	P2	Source Area	46	6	5 to 10	0.02	sch. 80 PVC	Yes	1,279	1,253	24	29	39	44	59	74	1,870,652	709,721
B-109	P1	Source Area	30	6	5 to 10	0.02	sch. 80 PVC	Yes	1,278	1,255	23	28	38	43	58	73	1,870,557	709,821
B-110	P1	Source Area	30	6	5 to 10	0.02	sch. 80 PVC	Yes	1,278	1,254	23	28	38	43	58	73	1,870,588	709,795
B-111	Roza	Source Area	75	6	5 to 10	0.02	sch. 80 PVC	Yes	1,278	1,254	23	28	38	43	58	73	1,870,588	709,801
B-112	P2	Source Area	45	6	5 to 10	0.02	sch. 80 PVC	Yes	1,278	1,254	23	28	38	43	58	73	1,870,593	709,798
B-113	P2	Source Area	42	6	5 to 10	0.02	schd. 40 PVC	--	1,275	1,275	20	25	35	40	55	70	1,870,452	709,944
B-114	P2	Source Area	37	6	5 to 10	0.02	sch. 80 PVC	Yes	1,270	1,267	15	20	30	35	50	65	1,870,503	709,897
B-115	P2	Source Area	35	6	5 to 10	0.02	sch. 80 PVC	Yes	1,268	1,261	13	18	28	33	48	63	1,870,551	709,861
B-116	Roza	Source Area	65	6	5 to 10	0.02	sch. 80 PVC	Yes	1,268	1,260	13	18	28	33	48	63	1,870,556	709,858
B-117	P1	Source Area	20	6	5 to 10	0.02	sch. 80 PVC	Yes	1,268	1,261	13	18	28	33	48	63	1,870,556	709,864
B-118	P2	Source Area	46	6	5 to 10	0.02	sch. 80 PVC	Yes	1,279	1,258	24	29	39	44	59	74	1,870,744	709,677
B-119	Roza	Source Area	65	6	5 to 10	0.02	sch. 80 PVC	Yes	1,268	1,255	13	18	28	33	48	63	1,870,593	709,834
B-120	P1	Source Area	31	6	5 to 10	0.02	sch. 80 PVC	Yes	1,279	1,258	24	29	39	44	59	74	1,870,744	709,683
B-121	Roza	Source Area	76	6	5 to 10	0.02	sch. 80 PVC	Yes	1,279	1,258	24	29	39	44	59	74	1,870,748	709,679
B-122	P2	Source Area	35	6	5 to 10	0.02	sch. 80 PVC	Yes	1,268	1,261	13	18	28	33	48	63	1,870,593	709,840
B-123	P1	Source Area	20	6	5 to 10	0.02	sch. 80 PVC	Yes	1,268	1,260	13	18	28	33	48	63	1,870,597	709,837
B-124	P2	Downgradient	45	2	5 to 10	0.02	schd. 40 PVC	--	1,278	1,270	23	28	38	43	58	73	1,870,355	710,091
B-125	P2	Downgradient	33	2	5 to 10	0.02	schd. 40 PVC	--	1,266	1,262	11	16	26	31	46	61	1,870,215	710,250
B-126	P2	Source Area	40	6	5 to 10	0.02	schd. 40 PVC	--	1,273	1,272	18	23	33	38	53	68	1,870,567	709,920
B-127	P1	Source Area	25	6	5 to 10	0.02	schd. 40 PVC	--	1,273	1,272	18	23	33	38	53	68	1,870,572	709,916
B-128	Roza	Source Area	70	6	5 to 10	0.02	schd. 40 PVC	--	1,273	1,272	18	23	33	38	53	68	1,870,573	709,923
B-129	P1	Source Area	26	6	5 to 10	0.02	schd. 40 PVC	--	1,274	1,273	19	24	34	39	54	69	1,870,635	709,885
B-130	Roza	Source Area	71	6	5 to 10	0.02	schd. 40 PVC	--	1,274	1,273	19	24	34	39	54	69	1,870,640	709,882
B-131	P2	Source Area	41	6	5 to 10	0.02	schd. 40 PVC	--	1,274	1,260	19	24	34	39	54	69	1,870,701	709,836
B-132	Roza	Source Area	71	6	5 to 10	0.02	schd. 40 PVC	--	1,274	1,261	19	24	34	39	54	69	1,870,706	709,840
B-133	Roza	Downgradient	74	2	5 to 10	0.02	schd. 40 PVC	--	1,277	1,276	22	27	37	42	57	72	1,870,294	710,314
B-134	P2	Downgradient	44	2	5 to 10	0.02	schd. 40 PVC	--	1,277	1,277	22	27	37	42	57	72	1,870,305	710,311
B-135	P2	Source Area	43	6	5 to 10	0.02	schd. 40 PVC	--	1,276	1,263	21	26	36	41	56	71	1,870,829	709,804

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Table 1. Exploration and Well Summary Table

Ephrata Landfill, Grant County, Washington

Boring ID	Target Zone	Investigation Area	Total Depth (feet bgs)	Well Diameter (inches)	Well Screen Length (ft)	Screen Slot Size (in)	Well Construction Material	Landfill Liner Present?	Surface Elevation	Top of Basalt Elevation	Estimated Depth To (bgs):						Easting	Northing
											P1 Top	P1 Bottom	P2 Top	P2 Bottom	Roza Top	Roza Bottom		
B-136	Roza	Source Area	73	6	5 to 10	0.02	schd. 40 PVC	--	1,276	1,263	21	26	36	41	56	71	1,870,834	709,801
B-137	P1	Source Area	28	6	5 to 10	0.02	schd. 40 PVC	--	1,276	1,264	21	26	36	41	56	71	1,870,833	709,807
B-138	P2	Downgradient	52	2	5 to 10	0.02	schd. 40 PVC	--	1,285	1,282	30	35	45	50	65	80	1,870,515	710,199
B-139	Roza	Downgradient	83	2	5 to 10	0.02	schd. 40 PVC	--	1,286	1,283	31	36	46	51	66	81	1,870,525	710,193
B-140	Roza	Downgradient	75	2	5 to 10	0.02	schd. 40 PVC	--	1,278	1,278	23	28	38	43	58	73	1,870,076	710,666
B-141	P2	Downgradient	52	2	5 to 10	0.02	schd. 40 PVC	--	1,285	1,285	30	35	45	50	65	80	1,870,714	710,151
B-142	Roza	Downgradient	82	2	5 to 10	0.02	schd. 40 PVC	--	1,285	1,285	30	35	45	50	65	80	1,870,725	710,154
B-143	P2	Downgradient	14	2	5 to 10	0.02	schd. 40 PVC	--	1,247	1,240	--	--	7	12	27	42	1,871,178	709,750
B-144	Roza	Downgradient	67	2	5 to 10	0.02	schd. 40 PVC	--	1,270	1,270	15	20	30	35	50	65	1,870,518	710,576
B-145	Roza	Downgradient	52	2	5 to 10	0.02	schd. 40 PVC	--	1,255	1,255	--	--	15	20	35	50	1,871,017	710,123
B-146	Roza	Downgradient	65	2	5 to 10	0.02	schd. 40 PVC	--	1,268	1,268	13	18	28	33	48	63	1,870,353	710,788
B-147	P2	Downgradient	22	2	5 to 10	0.02	schd. 40 PVC	--	1,255	1,255	--	--	15	20	35	50	1,871,017	710,137
B-148	Roza	Downgradient	55	2	5 to 10	0.02	schd. 40 PVC	--	1,258	1,258	3	8	18	23	38	53	1,870,873	710,615
B-149	Roza	Downgradient	32	2	5 to 10	0.02	schd. 40 PVC	--	1,235	1,235	--	--	--	--	15	30	1,871,134	710,702
B-150	Roza	Downgradient	49	2	5 to 10	0.02	schd. 40 PVC	--	1,252	1,252	--	--	12	17	32	47	1,870,725	711,135
B-151	Roza	Downgradient	42	2	5 to 10	0.02	schd. 40 PVC	--	1,245	1,245	--	--	5	10	25	40	1,871,044	711,071
		Total Estimated Footage	*4,173*															
		Number of Wells	*81*															

Notes:

b/t: between

Borings will be assigned well names in the field. Well names and Boring IDs will be recorded in field logs.

ft bgs: feel below ground surface

Easting and Northing in Washington State Plane NAD83 (feet)

Elevations are reported in a local datum.

All depths and elevations reported in feet and approximate

-- indicates no, not likely present, or not present.

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Table 2. Analytical and Field Parameters

Ephrata Landfill, Grant County, Washington

Parameters	All Wells	Phase 1 Downgradient Wells
Standard RI Monitoring Parameters		
8260 VOC	X	
SIM-8260 VOC (vinyl chloride)	X	
Metals 200.9 (Arsenic, Iron, and Manganese)	X	
Chloride (method 325.2)	X	
Nitrate/Nitrite (method 353.2)	X	
TDS (method 160.1)	X	
Natural Attenuation Parameters		
Ethene, Ethane, and Methane (method RSK 175)		X
Sulfate (method 375.2)		X
Alkalinity (method 2320)		X
Field Parameters		
pH	X	
Temperature	X	
Specific Conductance	X	
Dissolved Oxygen	X	
Oxidation-Reduction Potential	X	
Turbidity	X	

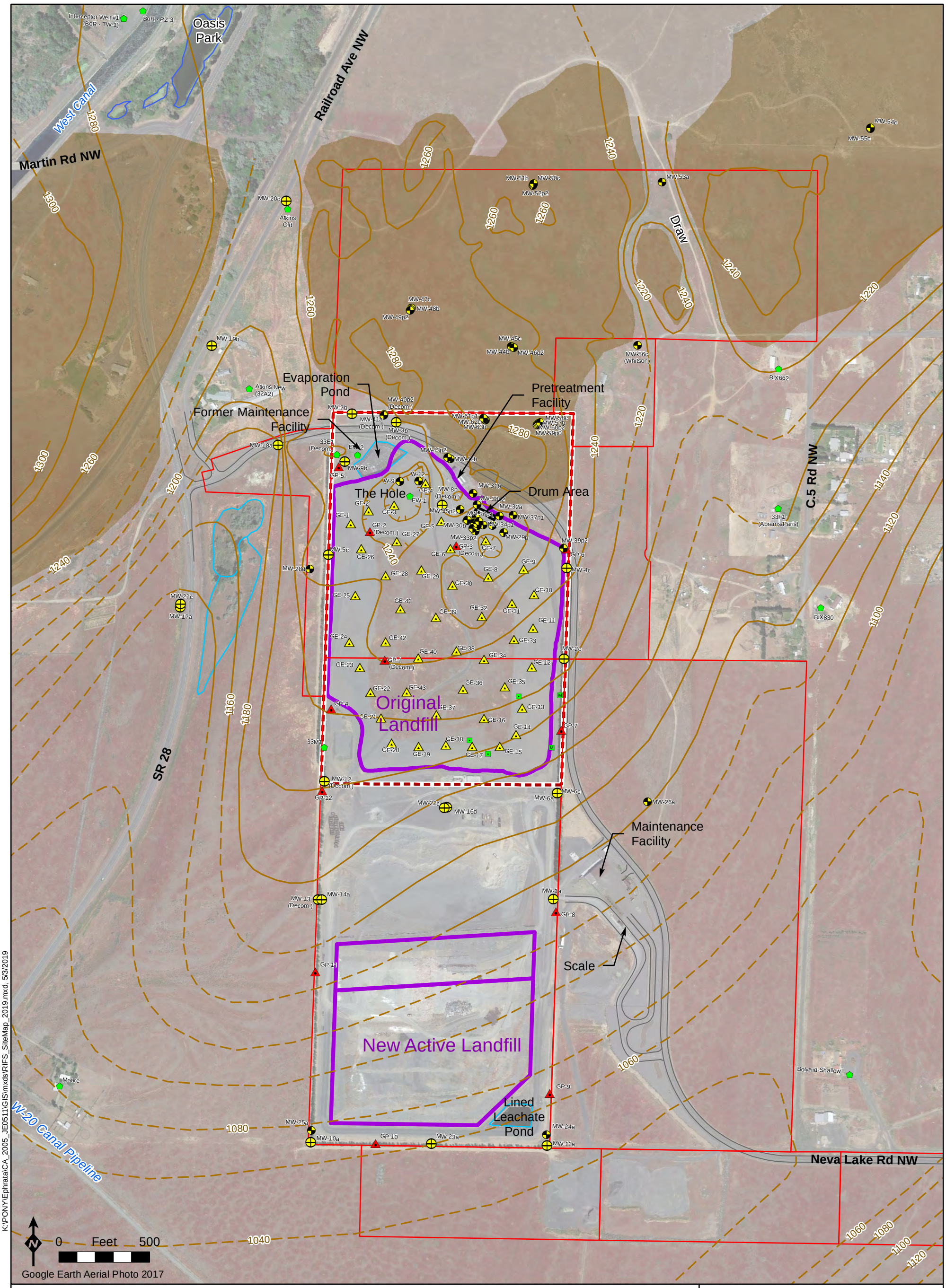
Table 3. June 2019 Sampling Event Wells

Ephrata Landfill, Grant County, Washington

Well	Target Interval
Routine Q2 RI-Area Monitoring Wells*	
MW-33p2	P2
MW-35-p2	P2
MW-38p2	P2
MW-42b	Roza
MW-44b	Roza
MW-63b	Roza
MW-58c	Interflow
Additional Wells	
MW-29b	Roza
MW-30b	Roza
MW-31b	Roza
MW-34p1	P1
MW-36p1	P1
MW-37p1	P1
MW-64p1	P1
MW-65p1	P1
MW-66p1	P1
MW-67p1	P1
MW-68p1	P1
MW-69p1	P1
MW-70p1	P1
MW-39p2	P2
EW-1	The Hole
W-9	The Hole
W-12	The Hole

Notes:

* MTCA-driven groundwater sampling is conducted concurrent with landfill sampling required under WAC 173-351; landfill-specific sampling is not described here.



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

Top of Basalt Elevation Contours
(dashed where inferred)
- 20-ft Contour Interval
- Depression (10-ft Contour Interval)

- Basalt Outcrops
- County Owned Parcels
- Landfill Extents
- Groundwater Conditional Point of Compliance

Figure 1

Ephrata Landfill
Site Map

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Ephrata Landfill

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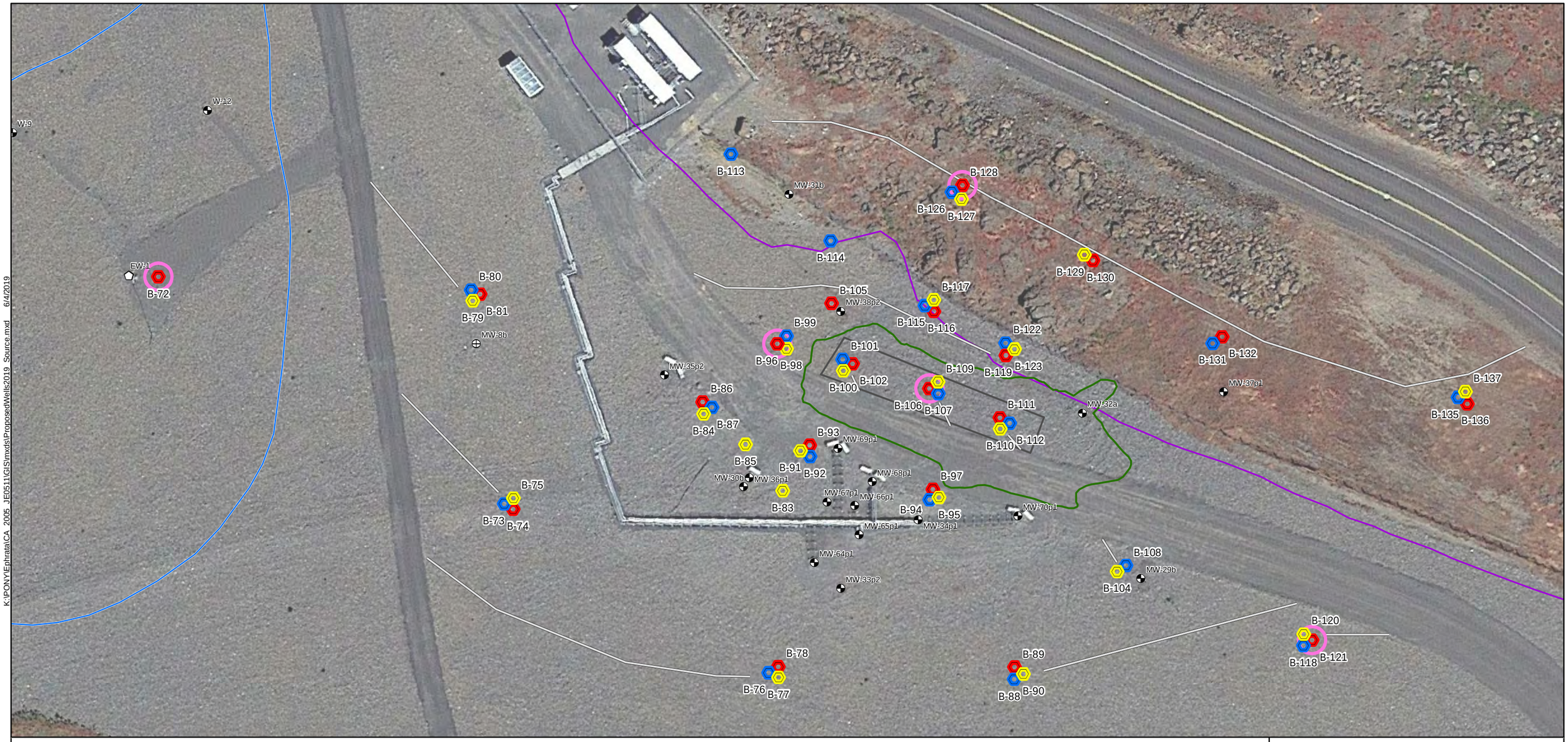

Proposed Source Area Wells

- P1 Aquifer
- P2 Aquifer
- Roza Aquifer

Existing Wells

- Quarterly Monitoring Well (MW)
- Remedial Investigation Monitoring Well (MW)
- Other Well
- Estimated location of new access roads

- Location of Roza Sonic Core
- Extent of Saturation Above Bedrock (The Hole)
- Groundwater Conditional Point of Compliance
- Extent of Soil Removal to Bedrock
- Former Drum Cache Outline
- Landfill Extent

0 Feet 50

1:600

N

Figure 2

Exploration Locations - Source Area

Ephrata Landfill
RIFS

PgG

Figure 3

Exploration Locations - Downgradient Areas

Ephrata Landfill
RIFS

PgG

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B-150
B-151
131745110
B-146
160901007
B-140
B-149
B-148
B-144
160905008
160905004
B-82
B-103
B-133
B-134
160901002
B-71
B-125
B-139
B-142
B-141
B-147
B-145
B-124
160905021
160903000
160901001
160905048
B-143
160898000

Proposed Downgradient Wells

- P2 Aquifer
- Roza Aquifer

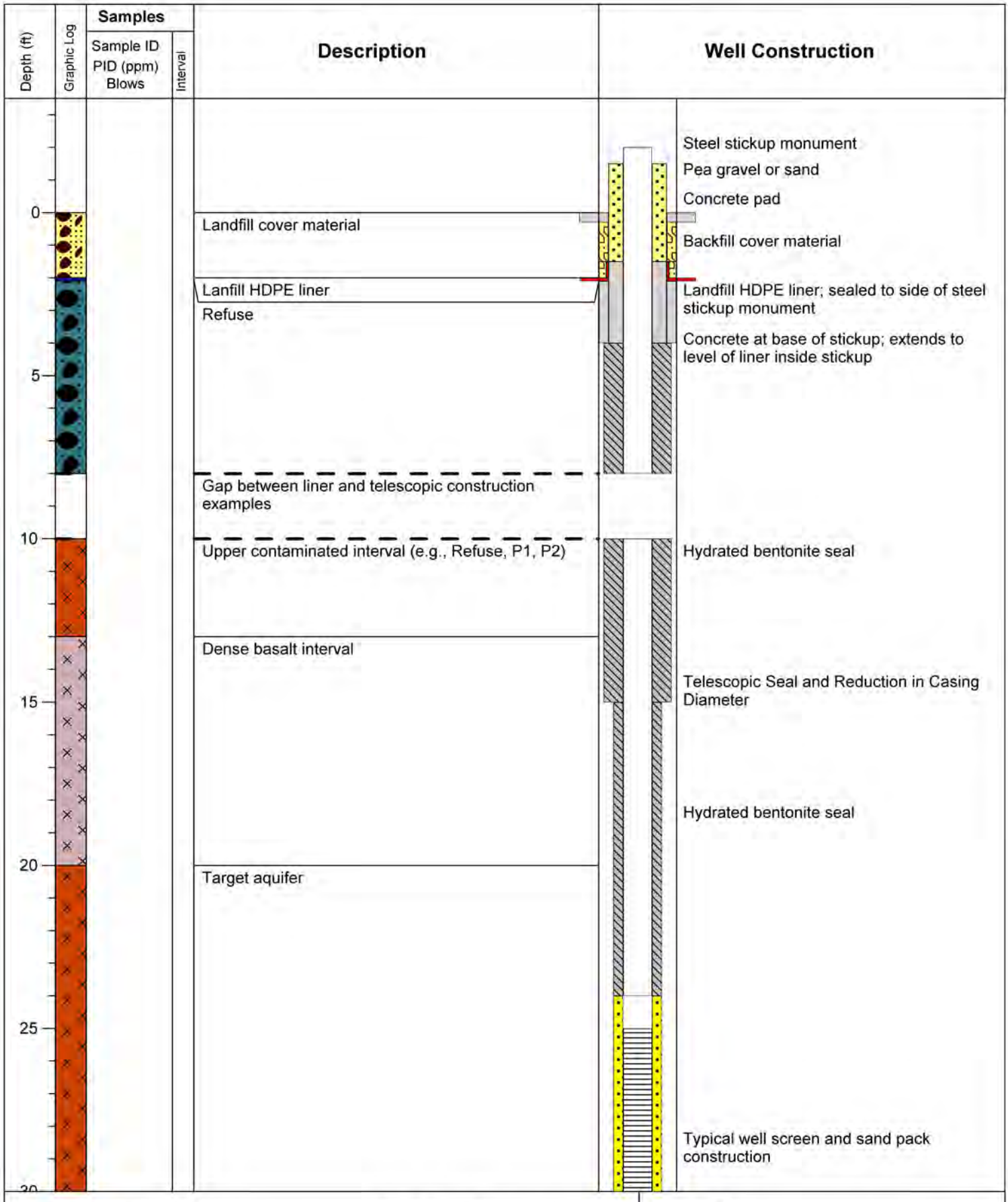
Proposed Source Area Wells

- P1 Aquifer
- P2 Aquifer
- Roza Aquifer
- Location of Roza Sonic Core
- Estimated location of new access roads

- Extent of Saturation Above Bedrock (The Hole)
- Groundwater Conditional Point of Compliance
- Extent of Soil Removal to Bedrock
- Former Drum Cache Outline
- Landfill Extent

0 Feet 250

1:2,000



Address: 3803 Neva Lake Rd
Ephrata, WA
Location (TRS): T00N R0W S00; NW1/4 of NW1/4
Lat/Long: N 200000.0 ft, E 1000000 ft
Logged by: PGG
Completion Date: MM/DD/YYYY

Drilling Firm: Drill Company
Drilling Method: Air Rotary
Ecology ID: AAA-000
DTW: 00.00 ft bmp
MP Elevation: 00.00 ft
V. Datum: NAVD 88

Figure 4
Example Liner Penetration and Telescopic Seal Construction

Ephrata Landfill
Remedial Investigation
JE19XX

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