GeoEngineers
2101 4th Avenue, Suite 900
Seattle, Washington 98121
206.728.2674

December 5, 2019

City of Olympia
601 4th Avenue East
Olympia, Washington 98501

Attention: Donna Buxton

Subject: Remedial Investigation Report Addendum
Former West Olympia Landfill Site
Olympia, Washington
GEI File No. 0415-071-01

This letter transmits the Remedial Investigation (RI) Report Addendum for the Former West Olympia Landfill Site (Site), prepared by GeoEngineers and Landau Associates for the City of Olympia (City). The RI report (dated August 30, 2019) was revised and the Addendum was prepared in response to Washington State Department of Ecology (Ecology) comments regarding the RI report that were received on October 2, 2019 (Attachment 1). The Ecology comments request responses to nine elements of the RI report. The Ecology comments that were addressed by revisions to the August 2019 RI report are included in the revised paper and electronic/PDF versions of the report (Revised RI Report) and the comments that included additional data analysis and/or presentation are addressed in the RI Report Addendum, as discussed below.

Revised RI Report (Submitted Separately)

The August 2019 RI report was revised to address the following Ecology comments:

- **Comments #2, #3, and #4** – Revised Figures 4-6, 4-7, 4-8, 4-9 and 6-1 that include sampling depths for soil gas sampling locations; and
- **Comment #8** – Appendix Table A-7 that was not included in the August 2019 version of the RI report.

Minor text edits that do not affect the substance of the report were also made for consistency with the revised figures.

RI Report Addendum

Two technical memoranda were prepared as an addendum to the RI report to address Ecology Comments#1, #5, #6, #7, and #9 as follows:

- **Comments #1 and #7 – Groundwater Characterization Summary:** This technical memorandum summarizes the results of the September 2019 (dry season) groundwater sampling event (Comment #1). In addition, this document provides a comparison of dry season results with the groundwater data used to characterize the nature and extent of groundwater contamination at the Site, as discussed in the Revised RI Report. A figure summarizing iron and manganese groundwater data for perimeter wells is also included as part of this memorandum (Comment #7). The 2019 groundwater characterization summary technical memorandum is provided as Attachment 2.
- **Comments #5, #6, and #9 – Soil Vapor Intrusion Analysis:** This technical memorandum summarizes the results of the soil vapor intrusion analysis conducted to evaluate the potential for vapor intrusion on neighboring properties from measured soil gas and groundwater concentrations at the Site (Comment #6). Figures summarizing available methane data (Comment #9), and TCE soil gas results for locations that exceeded Site screening levels (Comment #5) were also included as part of this memorandum. The soil vapor intrusion analysis technical memorandum is provided as Attachment 3.

Please contact us if you have questions regarding any of the information presented.

Yours very truly,

GeoEngineers, Inc.

Tim L. Syverson, LHG
Associate

Landau Associates

Sarah Fees, LG
Senior Geologist

Attachments:
Attachment 1. Ecology Comments on August 30, 2019 RI Report
Attachment 2. RI Report Addendum, Technical Memorandum: Groundwater Characterization Summary
Attachment 3. RI Report Addendum, Technical Memorandum: Soil Vapor Intrusion Analysis

SJB:TLS:ch

ATTACHMENT 1

Ecology Comments on August 30, 2019 RI Report

Attachment A
West Olympia Landfill
Comments on Remedial Investigation:
10/02/2019

The following information should be included in a technical memorandum as an addendum to the site's remedial investigation.

1. 2019 dry season groundwater monitoring results.

2. Figure 4-6, should include the depths of soil-gas sampling locations.

3. Figures 4-7, 4-8, and 4-9 should include the depths of soil-gas sampling locations.

4. Figure 6-1, should have the sampling depth for each location.

5. Trichloroethylene (TCE) is a chemical of concern in soil-gas, please make a diagram like Figure 6-1 for TCE results and show the depth and concentration for each sampling location.

6. The TCE short term indoor residential value is 2.0 $\mu g/m^3$ (average during 21 –day period) and long term residential TCE indoor concentration is 0.37 $\mu g/m^3$. Ecology's October 2019

Memorandum 22 (Table 1) is attached to the email to provide background information.

Evaluate whether measured TCE soil-gas and groundwater concentrations at the landfill could cause indoor air issues in the neighboring properties. Conduct the analysis in accordance with Ecology's 2009 Vapor-Intrusion Guidance and October 2019 Ecology's TCE Memorandum 22 (Tables 1 and 2).

7. Iron and Manganese are indicator landfill parameters, submit a figure like Figure 4-4, summarizing Iron and Manganese groundwater data since 2014 in the perimeter wells.
8. Ecology could not find Table A-7 in Appendix A in electronic and the paper copy of RI.
9. Please include all the measured methane data in one figure.

ATTACHMENT 2

RI Report Addendum, Technical Memorandum: Groundwater Characterization Summary

Technical Memorandum

TO: Donna Buxton, LHG, City of Olympia

FROM: Sydney J. Bronson, PE and Tim L. Syverson, LHG

DATE: December 5, 2019

RE: **Remedial Investigation Report – December 2019 Addendum Technical Memorandum : 2019 Groundwater Characterization Summary Former West Olympia Landfill Site**
Olympia, Washington
File No. 0415-071-01

Introduction

This technical memorandum was prepared as part of the December 2019 Addendum to the Remedial Investigation (RI) report for the City of Olympia (City) Former West Olympia Landfill Site (Site) dated August 30, 2019. The addendum was prepared in response to Washington State Department of Ecology (Ecology) comments regarding the RI report that were received on October 2, 2019. The Ecology comments request responses to nine main elements of the RI report. This memorandum responds to Ecology comments #1 and #7 regarding Site groundwater and primarily groundwater analytical data collected after publication of the RI report in August 2019. The other Ecology comments regarding soil gas and the potential for vapor intrusion and edits to RI report figures are addressed separately. Specifically, this technical memorandum includes responses regarding:

- Comment #1 – September 2019 (dry season) groundwater monitoring and sampling results.
- Comment #7 – A figure presenting the available iron and manganese groundwater data for Site perimeter wells from 2014 to 2019.

Also included is a comparison of March and September 2019 (wet and dry season, respectively) groundwater analytical results and conclusions regarding how the 2019 data informs our understanding of the nature and extent of groundwater contamination at the Site (Section 4.0 of the RI report).

Groundwater Characterization: September 2019

As requested by Ecology, supplemental groundwater investigation was conducted in 2019 consisting of two sampling events: a wet season event completed in March and a dry season event completed in September. These events were conducted to document the current extent of groundwater contamination at the Site and seasonal variations in groundwater elevations between winter-spring (i.e., wet season) and summer-fall (i.e., dry season) months. A description of the March 2019 wet season event is provided in RI Section 2.2.1 of the RI report, and the September dry season event is described below.

Field Activities: September 2019

The September dry season groundwater sampling event, which was completed between September 23 and 25, 2019, included measuring groundwater elevations and collecting groundwater samples for laboratory analysis from 13 monitoring wells including:

- Ten wells on the former landfill property (LAI-1, LAI-2, LAI-3, LAI-5d, LAI-MW-1, LAI-MW-2, LAI-MW-3, LAI-MW-4, PGG-1, and PGG-2); and
- Three off-property downgradient wells (OLY-1, OLY-2, and MW-23).
- Note that well PGG-2 was not sampled during the dry season event because the static water level and associated water column in the well was insufficient for sampling using a bladder pump as outlined in the Groundwater Sampling Work Plan, as noted below. In an effort to sample groundwater, the well was bailed dry using a disposable bailer, and the water level was monitored over a 24-hour period to identify and evaluate any recharge. After 24-hours the well had not recharged to its previous static water level, so due to the insufficient water level and recharge, sampling with a bailer was not conducted.

The dry season sampling event was conducted in accordance with the Ecology-approved Groundwater Sampling Work Plan dated March 1, 2019 (GEI 2019) incorporating the minor revisions detailed in the email from the City to Ecology dated August 20, 2019.

Low-flow Groundwater Sampling and Analysis

Groundwater samples were collected from each well (except PGG-2) for water quality field parameters and laboratory analysis using a submersible bladder pump (or a submersible Grundfos pump in the case of deep well LAI-5d, and a dedicated submersible pump at MW-23) and low-flow sampling techniques. Laboratory analysis for the groundwater samples included:

- Volatile organic compounds (VOCs) by United States Environmental Protection Agency (EPA) Method 8260C;
- Dissolved metals including arsenic (EPA 200.8), chromium (EPA 200.8), iron (EPA 6010D), lead (EPA 6010D), mercury (EPA 7470A), manganese (EPA 6010D), and nickel (EPA 200.8); and
- Natural attenuation parameters for the samples from five wells (LAI-1, LAI-2, LAI-MW-2, LAI-MW-4 and OLY-2) for future use during the development of the Site Feasibility Study. Natural attenuation parameters analyzed for included sulfate, nitrate, dissolved gases (acetylene, methane, ethene, and ethane) and total organic carbon.
- Ferrous iron data was also collected via field-kit analysis for the groundwater samples from all of the monitoring wells.

Equipment Decontamination and Investigation-Derived Waste

Dedicated single-use disposable tubing and bladders were used to collect groundwater samples. Equipment that came in direct contact with potentially contaminated media, including the water level indicator probe, the bladder pump and Grundfos pump housings was decontaminated between uses using a phosphate-free detergent (e.g., Alconox®) solution wash followed by a distilled water rinse. Investigation-derived waste (IDW), including refuse and monitoring well purge water, generated during the sampling event was contained, properly labeled, and stored off-site at a secure City of Olympia-approved location for appropriate off-property disposal. The drum was transported for appropriate disposal at Waste Management's Subtitle C Landfill in Arlington, Oregon by DH Environmental Inc. on September 26, 2019.

Findings: September 2019

Groundwater Elevations

Groundwater elevations measured during the September 2019 event were consistent with previous monitoring events indicating groundwater flow generally from the southeast to the northwest in the Qga aquifer with a local groundwater divide beneath the Site that results in groundwater flow to the southwest and northwest. As anticipated, groundwater levels were lower in both the upper Qga and lower Qpg aquifers[1] during the September 2019 (dry season) event compared to the March 2019 (wet season) event. Specifically, groundwater elevations were approximately 10 feet lower with measured elevations from the Qga aquifer ranging between approximately 116 and 105 feet across the Site as shown on Figure 1. These elevations correspond to groundwater depths of approximately 50 to 60 feet below ground surface at the Site.

Chemical Analytical Results

During the September 2019 monitoring event 13 groundwater samples[2] were collected from 12 monitoring wells for laboratory analysis to evaluate dry-season concentrations of the chemicals of concern (COCs) at the Site including metals and volatile organic compounds (VOCs).

VOCs

As discussed in Sections 3.1.2 and 3.2.2 of the RI report, TCE is the only indicator hazardous substance (IHS) identified for groundwater. The analytical results for TCE are summarized in Table 1 and shown on Figure 2. Consistent with previous sampling events, TCE was detected at concentrations greater than the Site screening level (SL) of 1.6 micrograms per liter (µg/L) at only two on-property locations LAI-1 and LAI-MW-2, and one off-property location OLY-2. TCE was also detected at concentrations greater than the laboratory reporting limit but less than the SL at two locations on the northwest portion of the property: PGG-1 and LAI-2. TCE was not detected at concentrations greater than the laboratory reporting limits in any of the remaining eight monitoring wells sampled.

[1] Note that Site data from the Qpg aquifer is available from only one location: monitoring well LAI-5d.
[2] One sample was collected per well and one duplicate sample was collected from monitoring well LAI-MW-1.

In addition to TCE, the following VOCs were detected at concentrations greater than the laboratory reporting limits but less than the SL: cis-1,2-Dichloroethene (DCE; LAI-1 and LAI-MW-2) and dichlorodifluoromethane (CFC-12; LAI-MW-1).

Metals

Metals were not identified as IHSs for groundwater as discussed in Section 3.2.2 of the RI report. However, dissolved metals were analyzed for during the 2019 sampling events for Site characterization purposes, and to evaluate iron and manganese concentrations, which are known indicators of landfill impacts to groundwater.

Dissolved iron was detected at concentrations greater than the laboratory reporting limit but less than the Site SL of 11,200 µg/L at locations LAI-5d, LAI-MW-4, and MW-23. Dissolved manganese was detected at a concentrations greater than the Site SL of 2,240 µg/L in the sample from well LAI-5d from the deeper Qpg aquifer (consistent with previous sampling results), and was detected at concentrations greater than the laboratory reporting limit but less than the SL at locations MW-23 and PGG-1.

The iron and manganese data for groundwater samples from 2014 through September 2019 are presented on Figure 3.

The March and September 2019 (wet and dry season, respectively) chemical analytical results are presented in Table 2.

Summary and Conclusions

Supplemental groundwater investigation was conducted in March and September 2019 to document current groundwater conditions including the concentrations of the COCs (particularly trichloroethene [TCE]) in Site groundwater. The March wet season event is summarized in Section 2.2.1 of the RI report, and the September dry season event are summarized in this memorandum as an addendum to the RI report.

The September 2019 monitoring and sampling results are consistent with the previous results for the Site, and do not change the findings or conclusions presented in the RI report (Section 4.0) regarding the nature and extent of groundwater contamination, or the pathways of concern or potential receptors as identified through the conceptual site model (CSM) (Section 5.0). Relevant conclusions from the RI report for groundwater at the Site include the following:

- The concentrations of dissolved iron and manganese in Site wells suggest these metals are currently not strong indicators of landfill contamination for this Site. Dissolved manganese was detected above the screening level in the deeper well, LAI-5d; that detection likely reflects the older age of the groundwater in the deeper Qpg aquifer, as discussed in Section 2.3 of the RI report.
- The waste and undocumented fill placed at the landfill property as part of the former landfilling operations are the source of the IHS TCE in groundwater.

- The IHS TCE is present in shallow groundwater at and downgradient of the landfill property.
- Ingestion is the primary pathway of concern for the TCE concentrations in shallow groundwater (from the Qga aquifer); there is no evidence that TCE from the Site has affected the deeper Qpg groundwater aquifer, which is a drinking water source for the area.
- Based on the occurrence of the IHS TCE, the current landfill property use, and the availability of publicly supplied drinking water, the TCE in groundwater does not pose an imminent threat to human health or the environment.

References

GeoEngineers, Inc. (GEI). 2019. Groundwater Sampling Work Plan, West Olympia Landfill Site, Olympia, Washington. GeoEngineers. March 1.

Limitations

We have prepared this report for the exclusive use of the City of Olympia. Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted environmental science practices in this area at the time this report was prepared. The conclusions and opinions presented in this report are based on our professional knowledge, judgment and experience. No warranty or other conditions, express or implied, should be understood.

Please feel free to contact Sydney Bronson (425.861.6086) or Tim Syverson (206.448.4197) should you have any questions or require additional information.

Yours very truly,
GeoEngineers, Inc.

Tim L. Syverson, LHG
Associate

Sydney J. Bronson, PE
Environmental Engineer

SJB:TLS:ch

Attachments:

Table 1. IHS Concentrations in Groundwater

Table 2. Comprehensive Groundwater Data (March and September 2019)

Figure 1. Groundwater Elevation Contours Upper Aquifer (Qga) – September 2019

Figure 2. Groundwater Samples – TCE Analytical Results

Figure 3. Groundwater Samples – Iron and Manganese Analytical Results

Disclaimer: Any electronic form, facsimile or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by GeoEngineers, Inc. and will serve as the official document of record.

Table 1

IHS Concentrations in Groundwater

Former West Olympia Landfill Site
Olympia, Washington

Exploration Location[1]	Sample ID	Sample Date	VOCs[2] (µg/L) TCE
LAI-1	JGLX0	1/15/2014	**17**
	JGWE0DL	3/25/2015	**27**
	JG5R0	6/24/2015	**20**
	JHAY0	9/23/2015	**19**
	JHEH0	12/16/2015	**21**
	LAI-1-20190320	3/20/2019	**23**
	LAI-1-20190924	9/24/2019	**13**
LAI-2	JGLX2	1/14/2014	**1.1**
	LAI-2-20190321	3/21/2019	**2.6**
	LAI-2-20190924	9/24/2019	**0.58**
LAI-3	JGLX4	1/13/2014	0.5 U
	LAI-3-20190322	3/22/2019	0.20 U
	LAI-3-201900923	9/23/2019	0.20 U
LAI-5d	JGLX6	1/15/2014	0.5 U
	LAI-5D-032819	03/28/19	0.20 U
	LAI-5D-20190925	9/25/2019	0.20 U
LAI-MW-1	JGLX8	1/13/2014	0.5 U
	LAI-MW-1-20190322	03/22/19	0.20 U
	LAI-MW-1-20190924	9/24/2019	0.20 U
LAI-MW-2	JGLY0DL	1/15/2014	**41**
	JGWE1DL	3/26/2015	**22**
	JG5R1	6/24/2015	**50**
	JHAY1	9/23/2015	**19**
	JHEH1	12/16/2015	**43**
	LAI-MW-2-20190321	03/21/19	**22**
	LAI-MW-2-20190924	9/24/2019	**15**
LAI-MW-3	JGLY2	1/14/2014	0.5 U
	LAI-MW-3-20190322	03/22/19	0.20 U
	LAI-MW-3-20190923	9/23/2019	0.20 U
LAI-MW-4	JGLY4	1/13/2014	0.5 U
	LAI-MW-4-20190321	03/21/19	**0.27**
	LAI-MW-4-20190924	9/24/2019	0.20 U
MW-23	JGLZ0	1/23/2014	0.5 U
	MW-23-031919	03/19/19	0.20 U
	MW-23-20190923	9/23/2019	0.20 U
OLY-01	JGWE2	3/25/2015	0.5 U
	JG5R2	6/24/2015	0.5 U
	JHAY2	9/23/2015	0.5 U
	JHEH2	12/16/2015	**0.11 J**
	OLY-1-20190321	03/21/19	0.20 U
	OLY-1-20190923	9/23/2019	0.20 U

Exploration Location[1]	Sample ID	Sample Date	VOCs[2] (µg/L) TCE
OLY-02	JGWE3	3/25/2015	**2.6**
	JG5R3	6/24/2015	**2.8**
	JHAY3	9/23/2015	**4.5**
	JHEH3	12/17/2015	**6.1**
	OLY-2-20190321	03/21/19	**2.8**
	OLY-2-20190925	9/25/2019	**4**
PGG-1	JGLY6	1/14/2014	**0.27 J**
	PGG-1-20190320	3/20/2019	**0.29**
	PGG-1-20190925	9/25/2019	**0.42**
PGG-2	JGLY8	1/14/2014	0.5 U
	PGG-2-20190321	03/21/19	0.20 U
	Not Applicable[3]	9/25/2019	--
		Site-specific Screening Level	1.6

Notes:

[1] Approximate exploration locations shown on Figure 2.

[2] Volatile organic compounds (VOCs) analyzed by EPA 8260.

[3] Monitoring well PGG-2 was not sampled during the September 2019 event because there was insufficient water in the well for sampling. Well was bailed until dry and water did not recharge after 24 hours.

J = analyte was positively identified and the value is an estimated quantity because the concentration was below the Contract-Required Quantitation Limits (CRQLs).

TCE = trichloroethene

U = analyte not detected, laboratory reporting limit shown

µg/L = micrograms per liter

Detected analyte value is bolded. Detected value greater than screening level is shaded.

Table 2

Comprehensive Groundwater Data (March and September 2019)

Former West Olympia Landfill Site

Olympia, Washington

			Location Sampling Event Sample ID Date	LAI-1 2019_GEO-WET LAI-1-20190320 03/20/19	LAI-1 2019_GEO-WET DUP-1-20190320 03/20/19	LAI-1 2019_GEO-DRY LAI-1-20190924 09/24/19	LAI-2 2019_GEO-WET LAI-2-20190321 03/21/19	LAI-2 2019_GEO-DRY LAI-2-20190924 09/24/19	LAI-3 2019_GEO-WET LAI-3-20190322 03/22/19	LAI-3 2019_GEO-DRY LAI-3-20190923 09/23/19	LAI-5d 2019_GEO-WET LAI-5D-032819 03/28/19	LAI-5d 2019_GEO-DRY LAI-5D-20190925 09/25/19	LAI-MW-1 2019_GEO-WET LAI-MW-1-20190322 03/22/19	LAI-MW-1 2019_GEO-DRY LAI-MW-1-20190924 09/24/19
Analytes	Unit(s)	Total or Dissolved	GW Screening (1/22/18)											
Metals														
Arsenic	µg/L	T	5	--	--	--	--	--	--	--	--	--	3.3 U	--
Arsenic	µg/L	D	5	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U
Calcium	µg/L	T	--	--	--	--	--	--	--	--	120,000	--	19,000	--
Chromium	µg/L	T	100	--	--	--	--	--	--	--	--	--	11 U	--
Chromium	µg/L	D	100	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Iron	µg/L	T	11,200	--	--	--	--	--	--	--	--	--	160	--
Iron	µg/L	D	11,200	56 U	56 U	56 U	56 U	56 U	56 U	56 U	2,100	2,100	56 U	56 U
Ferrous Iron	mg/L	T	--	--	--	0.02 U	--	0.02 U	--	0.02 U	--	2.24	--	0.02 U
Lead	µg/L	T	15	--	--	--	--	--	--	--	--	--	1.1 U	--
Lead	µg/L	D	15	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Magnesium	µg/L	T	--	--	--	--	--	--	--	--	64,000	--	4,100	--
Manganese	µg/L	T	2,240	--	--	--	--	--	--	--	--	--	10 U	--
Manganese	µg/L	D	2,240	11 U	11 U	11 U	11 U	11 U	11 U	11 U	2,600	2,500	11 U	11 U
Mercury	µg/L	T	0.89	--	--	--	--	--	--	--	--	--	0.50 U	--
Mercury	µg/L	D	0.89	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Nickel	µg/L	T	100	--	--	--	--	--	--	--	--	--	22 U	--
Nickel	µg/L	D	100	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
Potassium	µg/L	T	--	--	--	--	--	--	--	--	10,000	--	1,700	--
Sodium	µg/L	T	--	--	--	--	--	--	--	--	20,000	--	7,000	--
Volatile organic compounds (VOCs)														
Benzene	µg/L	T	2.4	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Toluene	µg/L	T	640	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Ethylbenzene	µg/L	T	700	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Xylene, m-,p-	µg/L	T	290	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U
Xylene, o-	µg/L	T	440	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,1,1,2-Tetrachloroethane	µg/L	T	1.68	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,1,1-Trichloroethane	µg/L	T	200	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,1,2,2-Tetrachloroethane	µg/L	T	0.219	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,1,2-Trichloroethane	µg/L	T	4.51	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,1-Dichloroethane	µg/L	T	7.68	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,1-Dichloroethene	µg/L	T	7	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,1-Dichloropropene	µg/L	T	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,2,3-Trichlorobenzene	µg/L	T	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,2,3-Trichloropropane	µg/L	T	0.5	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,2,4-Trichlorobenzene	µg/L	T	15.1	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,2,4-Trimethylbenzene	µg/L	T	28.4	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,2-Dibromo-3-Chloropropane	µg/L	T	0.5	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dibromoethane	µg/L	T	0.2	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,2-Dichlorobenzene (o-Dichlorobenzene)	µg/L	T	600	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,2-Dichloroethane	µg/L	T	4.2	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U

			Location	LAI-1	LAI-1	LAI-1	LAI-2	LAI-2	LAI-3	LAI-3	LAI-5d	LAI-5d	LAI-MW-1	LAI-MW-1
			Sampling Event	2019_GEO-WET	2019_GEO-WET	2019_GEO-DRY	2019_GEO-WET	2019_GEO-DRY	2019_GEO-WET	2019_GEO-DRY	2019_GEO-WET	2019_GEO-DRY	2019_GEO-WET	2019_GEO-DRY
			Sample ID	LAI-1-20190320	DUP-1-20190320	LAI-1-20190924	LAI-2-20190321	LAI-2-20190924	LAI-3-20190322	LAI-3-20190923	LAI-5D-032819	LAI-5D-20190925	LAI-MW-1-20190322	LAI-MW-1-20190924
			Date	03/20/19	03/20/19	09/24/19	03/21/19	09/24/19	03/22/19	09/23/19	03/28/19	09/25/19	03/22/19	09/24/19
Analytes	Unit(s)	Total or Dissolved	GW Screening (1/22/18)											
1,2-Dichloropropane	µg/L	T	3.89	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,3,5-Trimethylbenzene	µg/L	T	80	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,3-Dichlorobenzene (m-Dichlorobenzene)	µg/L	T	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,3-Dichloropropane	µg/L	T	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,4-Dichlorobenzene (p-Dichlorobenzene)	µg/L	T	4.85	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
2,2-Dichloropropane	µg/L	T	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
2-Butanone (MEK)	µg/L	T	4800	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	6.4 U	6.6 U	5.0 U	5.0 U	6.4 U	5.0 U
2-Chloroethyl vinyl ether	µg/L	T	--	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.3 U	1.8 U	1.5 U	1.0 U	1.3 U	1.0 U
2-Chlorotoluene	µg/L	T	160	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
2-Hexanone	µg/L	T	--	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.5 U	2.6 U	2.0 U	2.0 U	2.0 U
4-Chlorotoluene	µg/L	T	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
4-Methyl-2-Pentanone (Methyl isobutyl ketone)	µg/L	T	640	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Acetone	µg/L	T	7200	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	6.9 U	6.6 U	6.9 U	5.0 U	6.9 U	5.0 U
Bromobenzene	µg/L	T	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Bromochloromethane	µg/L	T	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Bromodichloromethane	µg/L	T	1.84	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Bromoform (Tribromomethane)	µg/L	T	55.4	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Bromomethane	µg/L	T	11.2	0.29 U	0.29 U	0.20 U	0.29 U	0.20 U	0.20 U	0.20 U	0.47 U	0.20 U	0.20 U	0.20 U
Carbon Disulfide	µg/L	T	400	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.25 U	0.20 U	0.20 U	0.20 U	0.20 U
Carbon Tetrachloride	µg/L	T	0.539	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Chlorobenzene	µg/L	T	100	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Chloroethane	µg/L	T	18290	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.3 U	1.0 U	1.0 U	1.0 U	1.3 U	1.0 U
Chloroform	µg/L	T	1.2	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Chloromethane	µg/L	T	153	1.3 U	1.3 U	1.0 U	1.4 U	1.0 U	1.0 U	1.3 U	1.3 U	1.0 U	1.0 U	1.0 U
cis-1,2-Dichloroethene	µg/L	T	16	**1.6**	**1.5**	**1.1**	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
cis-1,3-Dichloropropene	µg/L	T	0.44	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Dibromochloromethane	µg/L	T	4.53	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Dibromomethane	µg/L	T	80	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Dichlorodifluoromethane (CFC-12)	µg/L	T	5.66	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	**0.23**
Hexachlorobutadiene	µg/L	T	0.561	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Isopropylbenzene (Cumene)	µg/L	T	720	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Methyl Iodide (Iodomethane)	µg/L	T	--	1.4 U	1.4 U	1.5 U	1.6 U	1.5 U	1.4 U	1.0 U	2.5 U	1.4 U	1.4 U	1.5 U
Methyl t-butyl ether	µg/L	T	24.3	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Methylene Chloride	µg/L	T	5	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.3 U	1.0 U	1.0 U	1.0 U	1.0 U
Naphthalene	µg/L	T	8.93	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
n-Butylbenzene	µg/L	T	400	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
n-Propylbenzene	µg/L	T	800	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
p-Isopropyltoluene	µg/L	T	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Sec-Butylbenzene	µg/L	T	800	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Styrene	µg/L	T	100	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Tert-Butylbenzene	µg/L	T	800	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Tetrachloroethene	µg/L	T	5	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
trans-1,2-Dichloroethene	µg/L	T	100	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
trans-1,3-Dichloropropene	µg/L	T	0.44	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Trichloroethene	µg/L	T	1.55	**23**	**23**	**13**	**2.6**	**0.58**	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U

			Location	LAI-1	LAI-1	LAI-1	LAI-2	LAI-2	LAI-3	LAI-3	LAI-5d	LAI-5d	LAI-MW-1	LAI-MW-1
			Sampling Event	2019_GEO-WET	2019_GEO-WET	2019_GEO-DRY	2019_GEO-WET	2019_GEO-DRY	2019_GEO-WET	2019_GEO-DRY	2019_GEO-WET	2019_GEO-DRY	2019_GEO-WET	2019_GEO-DRY
			Sample ID	LAI-1-20190320	DUP-1-20190320	LAI-1-20190924	LAI-2-20190321	LAI-2-20190924	LAI-3-20190322	LAI-3-20190923	LAI-5D-032819	LAI-5D-20190925	LAI-MW-1-20190322	LAI-MW-1-20190924
			Date	03/20/19	03/20/19	09/24/19	03/21/19	09/24/19	03/22/19	09/23/19	03/28/19	09/25/19	03/22/19	09/24/19
Analytes	Unit(s)	Total or Dissolved	GW Screening (1/22/18)											
Trichlorofluoromethane (CFC-11)	µg/L	T	120	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Vinyl Acetate	µg/L	T	7800	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.4 U	1.0 U	1.0 U	1.0 U	1.0 U
Vinyl Chloride	µg/L	T	0.29	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Conventionals														
Acetylene	µg/L	--	NE	--	--	1.06 U	--	1.06 U	--	--	--	--	--	--
Bicarbonate Ion (HCO3)	µg/L	--	NE	--	--	--	--	--	--	--	--	**380**	--	--
Chloride	µg/L	--	NE	--	--	--	--	--	--	--	--	**34**	--	--
Ethane	µg/L	--	NE	--	--	--	1.23 U	--	1.23 U	--	--	--	--	--
Ethylene	µg/L	--	NE	--	--	--	1.14 U	--	1.14 U	--	--	--	--	--
Methane	µg/L	--	NE	--	--	--	0.65 U	--	0.65 U	--	--	--	--	--
Nitrate	µg/L	--	NE	--	--	**2.3**	--	**0.81**	--	--	--	--	--	--
Silicon dioxide	µg/L	--	NE	--	--	--	--	--	--	--	--	**53,000**	--	--
Sulfate	mg/L	--	NE	--	--	--	**71**	--	**19**	--	--	**170**	--	--
Total Dissolved Solids	mg/L	--	NE	--	--	--	--	--	--	--	--	**680**	--	--
Total Organic Carbon	mg/L	--	NE	--	--	--	**1.6**	--	1.0 U	--	--	--	--	--

Notes:

J = analyte was positively identified and the associated numerical value is an estimated quantity.
Bolding indicates analyte was detected.
Analyte was not detected in the sample; reporting limit exceeded the screening level.
Analyte concentration exceeded the screening level.

mg/L = milligrams per liter
µg/L = micrograms per liter

NE = not established
U = analyte not detected, laboratory reporting limit shown.

Table 2

Comprehensive Groundwater Data (March and September 2019)

Former West Olympia Landfill Site

Olympia, Washington

			Location	LAI-MW-1	LAI-MW-2	LAI-MW-2	LAI-MW-2	LAI-MW-3	LAI-MW-3	LAI-MW-4	LAI-MW-4	MW-23
			Sampling Event	2019_GEO-DRY	2019_GEO-WET	2019_GEO-WET	2019_GEO-DRY	2019_GEO-WET	2019_GEO-DRY	2019_GEO-WET	2019_GEO-DRY	2019_GEO-WET
			Sample ID	DUP-20190924	LAI-MW-2-20190321	LAI-MW-2-PDB-20190321	LAI-MW-2-20190924	LAI-MW-3-20190322	LAI-MW-3-20190923	LAI-MW-4-20190321	LAI-MW-4-20190924	MW-23-031919
			Date	09/24/19	03/21/19	03/21/19	09/24/19	03/22/19	09/23/19	03/21/19	09/24/19	03/19/19
Analytes	Unit(s)	Total or Dissolved	GW Screening (1/22/18)									
Metals												
Arsenic	µg/L	T	5	--	3.3 U	--	--	--	--	--	--	--
Arsenic	µg/L	D	5	3.0 U	3.0 U	--	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U
Calcium	µg/L	T	--	--	61,000	--	--	--	--	--	--	--
Chromium	µg/L	T	100	--	11 U	--	--	--	--	--	--	--
Chromium	µg/L	D	100	10 U	10 U	--	10 U	10 U	10 U	10 U	10 U	10 U
Iron	µg/L	T	11,200	--	50 U	--	--	--	--	--	--	--
Iron	µg/L	D	11,200	56 U	56 U	--	56 U	56 U	56 U	56 U	100	1,900
Ferrous Iron	mg/L	T	--	--	--	--	0.02 U	--	0.4	--	0.02 U	--
Lead	µg/L	T	15	--	1.1 U	--	--	--	--	--	--	--
Lead	µg/L	D	15	1.0 U	1.0 U	--	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Magnesium	µg/L	T	--	--	13000	--	--	--	--	--	--	--
Manganese	µg/L	T	2,240	--	10 U	--	--	--	--	--	--	--
Manganese	µg/L	D	2,240	11 U	11 U	--	11 U	11 U	11 U	11 U	11 U	37
Mercury	µg/L	T	0.89	--	0.50 U	--	--	--	--	--	--	--
Mercury	µg/L	D	0.89	0.50 U	0.50 U	--	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Nickel	µg/L	T	100	--	22 U	--	--	--	--	--	--	--
Nickel	µg/L	D	100	20 U	20 U	--	20 U	20 U	20 U	20 U	20 U	20 U
Potassium	µg/L	T	--	--	2,400	--	--	--	--	--	--	--
Sodium	µg/L	T	--	--	15,000	--	--	--	--	--	--	--
Volatile organic compounds (VOCs)												
Benzene	µg/L	T	2.4	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Toluene	µg/L	T	640	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Ethylbenzene	µg/L	T	700	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Xylene, m-,p-	µg/L	T	290	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U
Xylene, o-	µg/L	T	440	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,1,1,2-Tetrachloroethane	µg/L	T	1.68	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,1,1-Trichloroethane	µg/L	T	200	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,1,2,2-Tetrachloroethane	µg/L	T	0.219	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,1,2-Trichloroethane	µg/L	T	4.51	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,1-Dichloroethane	µg/L	T	7.68	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,1-Dichloroethene	µg/L	T	7	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,1-Dichloropropene	µg/L	T	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,2,3-Trichlorobenzene	µg/L	T	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,2,3-Trichloropropane	µg/L	T	0.5	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,2,4-Trichlorobenzene	µg/L	T	15.1	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,2,4-Trimethylbenzene	µg/L	T	28.4	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,2-Dibromo-3-Chloropropane	µg/L	T	0.5	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dibromoethane	µg/L	T	0.2	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,2-Dichlorobenzene (o-Dichlorobenzene)	µg/L	T	600	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,2-Dichloroethane	µg/L	T	4.2	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U

			Location	LAI-MW-1	LAI-MW-2	LAI-MW-2	LAI-MW-2	LAI-MW-3	LAI-MW-3	LAI-MW-4	LAI-MW-4	MW-23
			Sampling Event	2019_GEO-DRY	2019_GEO-WET	2019_GEO-WET	2019_GEO-DRY	2019_GEO-WET	2019_GEO-DRY	2019_GEO-WET	2019_GEO-DRY	2019_GEO-WET
			Sample ID	DUP-20190924	LAI-MW-2-20190321	LAI-MW-2-PDB-20190321	LAI-MW-2-20190924	LAI-MW-3-20190322	LAI-MW-3-20190923	LAI-MW-4-20190321	LAI-MW-4-20190924	MW-23-031919
			Date	09/24/19	03/21/19	03/21/19	09/24/19	03/22/19	09/23/19	03/21/19	09/24/19	03/19/19
Analytes	Unit(s)	Total or Dissolved	GW Screening (1/22/18)									
1,2-Dichloropropane	µg/L	T	3.89	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,3,5-Trimethylbenzene	µg/L	T	80	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,3-Dichlorobenzene (m-Dichlorobenzene)	µg/L	T	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,3-Dichloropropane	µg/L	T	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,4-Dichlorobenzene (p-Dichlorobenzene)	µg/L	T	4.85	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
2,2-Dichloropropane	µg/L	T	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
2-Butanone (MEK)	µg/L	T	4800	5.0 U	5.0 U	5.0 U	5.0 U	6.4 U	6.6 U	5.0 U	5.0 U	5.0 U
2-Chloroethyl vinyl ether	µg/L	T	--	1.0 U	1.0 U	1.0 U	1.0 U	1.3 U	1.8 U	1.0 U	1.0 U	1.0 U
2-Chlorotoluene	µg/L	T	160	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
2-Hexanone	µg/L	T	--	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.5 U	2.0 U	2.0 U	2.0 U
4-Chlorotoluene	µg/L	T	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
4-Methyl-2-Pentanone (Methyl isobutyl ketone)	µg/L	T	640	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Acetone	µg/L	T	7200	5.0 U	5.0 U	5.0 U	5.0 U	6.9 U	6.6 U	5.0 U	5.0 U	6.6 U
Bromobenzene	µg/L	T	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Bromochloromethane	µg/L	T	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Bromodichloromethane	µg/L	T	1.84	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Bromoform (Tribromomethane)	µg/L	T	55.4	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Bromomethane	µg/L	T	11.2	0.20 U	0.29 U	0.29 U	0.20 U	0.20 U	0.20 U	0.29 U	0.20 U	0.37 U
Carbon Disulfide	µg/L	T	400	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.25 U	0.20 U	0.20 U	0.20 U
Carbon Tetrachloride	µg/L	T	0.539	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Chlorobenzene	µg/L	T	100	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Chloroethane	µg/L	T	18290	1.0 U	1.0 U	1.0 U	1.0 U	1.3 U	1.0 U	1.0 U	1.0 U	1.0 U
Chloroform	µg/L	T	1.2	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Chloromethane	µg/L	T	153	1.0 U	1.4 U	1.4 U	1.0 U	1.0 U	1.3 U	1.4 U	1.0 U	1.3 U
cis-1,2-Dichloroethene	µg/L	T	16	0.20 U	0.85	0.80	0.26	0.20 U	0.20 U	0.21	0.20 U	0.20 U
cis-1,3-Dichloropropene	µg/L	T	0.44	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Dibromochloromethane	µg/L	T	4.53	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Dibromomethane	µg/L	T	80	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Dichlorodifluoromethane (CFC-12)	µg/L	T	5.66	0.27	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Hexachlorobutadiene	µg/L	T	0.561	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Isopropylbenzene (Cumene)	µg/L	T	720	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Methyl Iodide (Iodomethane)	µg/L	T	--	1.5 U	1.6 U	1.6 U	1.5 U	1.4 U	1.0 U	1.6 U	1.5 U	1.8 U
Methyl t-butyl ether	µg/L	T	24.3	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Methylene Chloride	µg/L	T	5	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.3 U	1.0 U	1.0 U	1.0 U
Naphthalene	µg/L	T	8.93	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
n-Butylbenzene	µg/L	T	400	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
n-Propylbenzene	µg/L	T	800	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
p-Isopropyltoluene	µg/L	T	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Sec-Butylbenzene	µg/L	T	800	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Styrene	µg/L	T	100	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Tert-Butylbenzene	µg/L	T	800	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Tetrachloroethene	µg/L	T	5	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	1.5	0.20 U	0.20 U
trans-1,2-Dichloroethene	µg/L	T	100	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
trans-1,3-Dichloropropene	µg/L	T	0.44	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Trichloroethene	µg/L	T	1.55	0.20 U	22	22	15	0.20 U	0.20 U	0.27	0.20 U	0.20 U

			Location	LAI-MW-1	LAI-MW-2	LAI-MW-2	LAI-MW-2	LAI-MW-3	LAI-MW-3	LAI-MW-4	LAI-MW-4	MW-23
			Sampling Event	2019_GEO-DRY	2019_GEO-WET	2019_GEO-WET	2019_GEO-DRY	2019_GEO-WET	2019_GEO-DRY	2019_GEO-WET	2019_GEO-DRY	2019_GEO-WET
			Sample ID	DUP-20190924	LAI-MW-2-20190321	LAI-MW-2-PDB-20190321	LAI-MW-2-20190924	LAI-MW-3-20190322	LAI-MW-3-20190923	LAI-MW-4-20190321	LAI-MW-4-20190924	MW-23-031919
			Date	09/24/19	03/21/19	03/21/19	09/24/19	03/22/19	09/23/19	03/21/19	09/24/19	03/19/19
Analytes	Unit(s)	Total or Dissolved	GW Screening (1/22/18)									
Trichlorofluoromethane (CFC-11)	µg/L	T	120	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Vinyl Acetate	µg/L	T	7800	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.4 U	1.0 U	1.0 U	1.0 U
Vinyl Chloride	µg/L	T	0.29	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Conventionals												
Acetylene	µg/L	--	NE	--	--	--	1.06 U	--	--	--	1.06 U	--
Bicarbonate Ion (HCO3)	µg/L	--	NE	**58**	**150**	--	--	--	--	--	--	--
Chloride	µg/L	--	NE	**2.8**	**3.8**	--	--	--	--	--	--	--
Ethane	µg/L	--	NE	--	0.50 U	--	1.23 U	--	--	--	1.23 U	--
Ethylene	µg/L	--	NE	--	0.50 U	--	1.14 U	--	--	--	1.14 U	--
Methane	µg/L	--	NE	--	1.0 U	--	0.65 U	--	--	--	0.65 U	--
Nitrate	µg/L	--	NE	--	--	--	**2.5**	--	--	--	**2**	--
Silicon dioxide	µg/L	--	NE	**18,000**	**25,000**	--	--	--	--	--	--	--
Sulfate	mg/L	--	NE	**14**	**55**	--	**32**	--	--	--	**66**	--
Total Dissolved Solids	mg/L	--	NE	**72**	**250**	--	--	--	--	--	--	--
Total Organic Carbon	mg/L	--	NE	--	1.0 U	--	1.0 U	--	--	--	**1.8**	--

Notes:

J = analyte was positively identified and the associated numerical value is an estimated quantity.

Bolding indicates analyte was detected.

Analyte was not detected in the sample; reporting limit exceeded the screening level.

Analyte concentration exceeded the screening level.

mg/L = milligrams per liter

µg/L = micrograms per liter

NE = not established

U = analyte not detected, laboratory reporting limit shown.

Table 2

Comprehensive Groundwater Data (March and September 2019)

Former West Olympia Landfill Site

Olympia, Washington

			Location	MW-23	OLY-01	OLY-01	OLY-02	OLY-02	OLY-02	PGG-1	PGG-1	PGG-2
			Sampling Event	2019_GEO-DRY	2019_GEO-WET	2019_GEO-DRY	2019_GEO-WET	2019_GEO-WET	2019_GEO-DRY	2019_GEO-WET	2019_GEO-DRY	2019_GEO-WET
			Sample ID	MW-23-20190923	OLY-1-20190321	OLY-1-20190923	OLY-2-20190321	OLY-2-PDB-20190321	OLY-2-20190925	PGG-1-20190320	PGG-1-20190925	PGG-2-20190321
			Date	09/23/19	03/21/19	09/23/19	03/21/19	03/21/19	09/25/19	03/20/19	09/25/19	03/21/19
Analytes	Unit(s)	Total or Dissolved	GW Screening (1/22/18)									
Metals												
Arsenic	µg/L	T	5	--	--	--	--	--	--	--	--	--
Arsenic	µg/L	D	5	3.0 U	3.0 U	3.0 U	3.0 U	--	3.0 U	3.0 U	3.0 U	3.0 U
Calcium	µg/L	T	--	--	--	--	23,000	--	--	--	--	--
Chromium	µg/L	T	100	--	--	--	--	--	--	--	--	--
Chromium	µg/L	D	100	10 U	10 U	10 U	10 U	--	10 U	10 U	10 U	10 U
Iron	µg/L	T	11,200	--	--	--	--	--	--	--	--	--
Iron	µg/L	D	11,200	940	56 U	56 U	56 U	--	56 U	56 U	56 U	56 U
Ferrous Iron	mg/L	T	--	0.5	--	0.89	--	--	0.02 U	--	0.02 U	--
Lead	µg/L	T	15	--	--	--	--	--	--	--	--	--
Lead	µg/L	D	15	1.0 U	1.0 U	1.0 U	1.0 U	--	1.0 U	1.0 U	1.0 U	1.0 U
Magnesium	µg/L	T	--	--	--	--	7,200	--	--	--	--	--
Manganese	µg/L	T	2,240	--	--	--	--	--	--	--	--	--
Manganese	µg/L	D	2,240	33	11 U	11 U	11 U	--	11 U	11 U	1,100	11 U
Mercury	µg/L	T	0.89	--	--	--	--	--	--	--	--	--
Mercury	µg/L	D	0.89	0.50 U	0.50 U	0.50 U	0.50 U	--	0.50 U	0.50 U	0.50 U	0.50 U
Nickel	µg/L	T	100	--	--	--	--	--	--	--	--	--
Nickel	µg/L	D	100	20 U	20 U	20 U	20 U	--	20 U	20 U	20 U	20 U
Potassium	µg/L	T	--	--	--	--	1,200	--	--	--	--	--
Sodium	µg/L	T	--	--	--	--	11,000	--	--	--	--	--
Volatile organic compounds (VOCs)												
Benzene	µg/L	T	2.4	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Toluene	µg/L	T	640	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Ethylbenzene	µg/L	T	700	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Xylene, m-,p-	µg/L	T	290	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U
Xylene, o-	µg/L	T	440	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,1,1,2-Tetrachloroethane	µg/L	T	1.68	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,1,1-Trichloroethane	µg/L	T	200	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,1,2,2-Tetrachloroethane	µg/L	T	0.219	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,1,2-Trichloroethane	µg/L	T	4.51	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,1-Dichloroethane	µg/L	T	7.68	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,1-Dichloroethene	µg/L	T	7	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,1-Dichloropropene	µg/L	T	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,2,3-Trichlorobenzene	µg/L	T	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,2,3-Trichloropropane	µg/L	T	0.5	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,2,4-Trichlorobenzene	µg/L	T	15.1	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,2,4-Trimethylbenzene	µg/L	T	28.4	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,2-Dibromo-3-Chloropropane	µg/L	T	0.5	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dibromoethane	µg/L	T	0.2	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,2-Dichlorobenzene (o-Dichlorobenzene)	µg/L	T	600	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,2-Dichloroethane	µg/L	T	4.2	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U

			Location	MW-23	OLY-01	OLY-01	OLY-02	OLY-02	OLY-02	PGG-1	PGG-1	PGG-2
			Sampling Event	2019_GEO-DRY	2019_GEO-WET	2019_GEO-DRY	2019_GEO-WET	2019_GEO-WET	2019_GEO-DRY	2019_GEO-WET	2019_GEO-DRY	2019_GEO-WET
			Sample ID	MW-23-20190923	OLY-1-20190321	OLY-1-20190923	OLY-2-20190321	OLY-2-PDB-20190321	OLY-2-20190925	PGG-1-20190320	PGG-1-20190925	PGG-2-20190321
			Date	09/23/19	03/21/19	09/23/19	03/21/19	03/21/19	09/25/19	03/20/19	09/25/19	03/21/19
Analytes	Unit(s)	Total or Dissolved	GW Screening (1/22/18)									
1,2-Dichloropropane	µg/L	T	3.89	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,3,5-Trimethylbenzene	µg/L	T	80	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,3-Dichlorobenzene (m-Dichlorobenzene)	µg/L	T	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,3-Dichloropropane	µg/L	T	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
1,4-Dichlorobenzene (p-Dichlorobenzene)	µg/L	T	4.85	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
2,2-Dichloropropane	µg/L	T	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
2-Butanone (MEK)	µg/L	T	4800	6.6 U	5.0 U	6.6 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
2-Chloroethyl vinyl ether	µg/L	T	--	1.8 U	1.0 U	1.8 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
2-Chlorotoluene	µg/L	T	160	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
2-Hexanone	µg/L	T	--	2.5 U	2.0 U	2.5 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
4-Chlorotoluene	µg/L	T	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
4-Methyl-2-Pentanone (Methyl isobutyl ketone)	µg/L	T	640	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Acetone	µg/L	T	7200	6.6 U	5.0 U	6.6 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Bromobenzene	µg/L	T	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Bromochloromethane	µg/L	T	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Bromodichloromethane	µg/L	T	1.84	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Bromoform (Tribromomethane)	µg/L	T	55.4	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Bromomethane	µg/L	T	11.2	0.20 U	0.29 U	0.20 U	0.29 U	0.29 U	0.20 U	0.29 U	0.20 U	0.29 U
Carbon Disulfide	µg/L	T	400	0.25 U	0.20 U	0.25 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Carbon Tetrachloride	µg/L	T	0.539	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Chlorobenzene	µg/L	T	100	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Chloroethane	µg/L	T	18290	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Chloroform	µg/L	T	1.2	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Chloromethane	µg/L	T	153	1.3 U	1.4 U	1.3 U	1.4 U	1.4 U	1.0 U	1.3 U	1.0 U	1.4 U
cis-1,2-Dichloroethene	µg/L	T	16	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
cis-1,3-Dichloropropene	µg/L	T	0.44	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Dibromochloromethane	µg/L	T	4.53	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Dibromomethane	µg/L	T	80	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Dichlorodifluoromethane (CFC-12)	µg/L	T	5.66	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Hexachlorobutadiene	µg/L	T	0.561	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Isopropylbenzene (Cumene)	µg/L	T	720	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Methyl Iodide (Iodomethane)	µg/L	T	--	1.0 U	1.6 U	1.0 U	1.6 U	1.6 U	1.4 U	1.4 U	1.4 U	1.6 U
Methyl t-butyl ether	µg/L	T	24.3	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Methylene Chloride	µg/L	T	5	1.3 U	1.0 U	1.3 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Naphthalene	µg/L	T	8.93	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
n-Butylbenzene	µg/L	T	400	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
n-Propylbenzene	µg/L	T	800	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
p-Isopropyltoluene	µg/L	T	--	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Sec-Butylbenzene	µg/L	T	800	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Styrene	µg/L	T	100	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Tert-Butylbenzene	µg/L	T	800	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Tetrachloroethene	µg/L	T	5	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
trans-1,2-Dichloroethene	µg/L	T	100	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
trans-1,3-Dichloropropene	µg/L	T	0.44	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Trichloroethene	µg/L	T	1.55	0.20 U	0.20 U	0.20 U	2.8	1.5	4	0.29	0.42	0.20 U

			Location	MW-23	OLY-01	OLY-01	OLY-02	OLY-02	OLY-02	PGG-1	PGG-1	PGG-2
			Sampling Event	2019_GEO-DRY	2019_GEO-WET	2019_GEO-DRY	2019_GEO-WET	2019_GEO-WET	2019_GEO-DRY	2019_GEO-WET	2019_GEO-DRY	2019_GEO-WET
			Sample ID	MW-23-20190923	OLY-1-20190321	OLY-1-20190923	OLY-2-20190321	OLY-2-PDB-20190321	OLY-2-20190925	PGG-1-20190320	PGG-1-20190925	PGG-2-20190321
			Date	09/23/19	03/21/19	09/23/19	03/21/19	03/21/19	09/25/19	03/20/19	09/25/19	03/21/19
Analytes	Unit(s)	Total or Dissolved	GW Screening (1/22/18)									
Trichlorofluoromethane (CFC-11)	µg/L	T	120	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Vinyl Acetate	µg/L	T	7800	1.4 U	1.0 U	1.4 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Vinyl Chloride	µg/L	T	0.29	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Conventionals												
Acetylene	µg/L	--	NE	--	--	--	--	--	--	--	--	--
Bicarbonate Ion (HCO3)	µg/L	--	NE	--	--	--	**80**	--	--	--	--	--
Chloride	µg/L	--	NE	--	--	--	**4.8**	--	--	--	--	--
Ethane	µg/L	--	NE	--	--	--	0.50 U	--	--	--	--	--
Ethylene	µg/L	--	NE	--	--	--	0.50 U	--	--	--	--	--
Methane	µg/L	--	NE	--	--	--	1.0 U	--	--	--	--	--
Nitrate	µg/L	--	NE	--	--	--	--	--	**1.5**	--	--	--
Silicon dioxide	µg/L	--	NE	--	--	--	**29000**	--	--	--	--	--
Sulfate	mg/L	--	NE	--	--	--	**12**	--	**25**	--	--	--
Total Dissolved Solids	mg/L	--	NE	--	--	--	**120**	--	--	--	--	--
Total Organic Carbon	mg/L	--	NE	--	--	--	1.0 U	--	1.0 U	--	--	--

Notes:

J = analyte was positively identified and the associated numerical value is an estimated quantity.

Bolding indicates analyte was detected.

Analyte was not detected in the sample; reporting limit exceeded the screening level.

Analyte concentration exceeded the screening level.

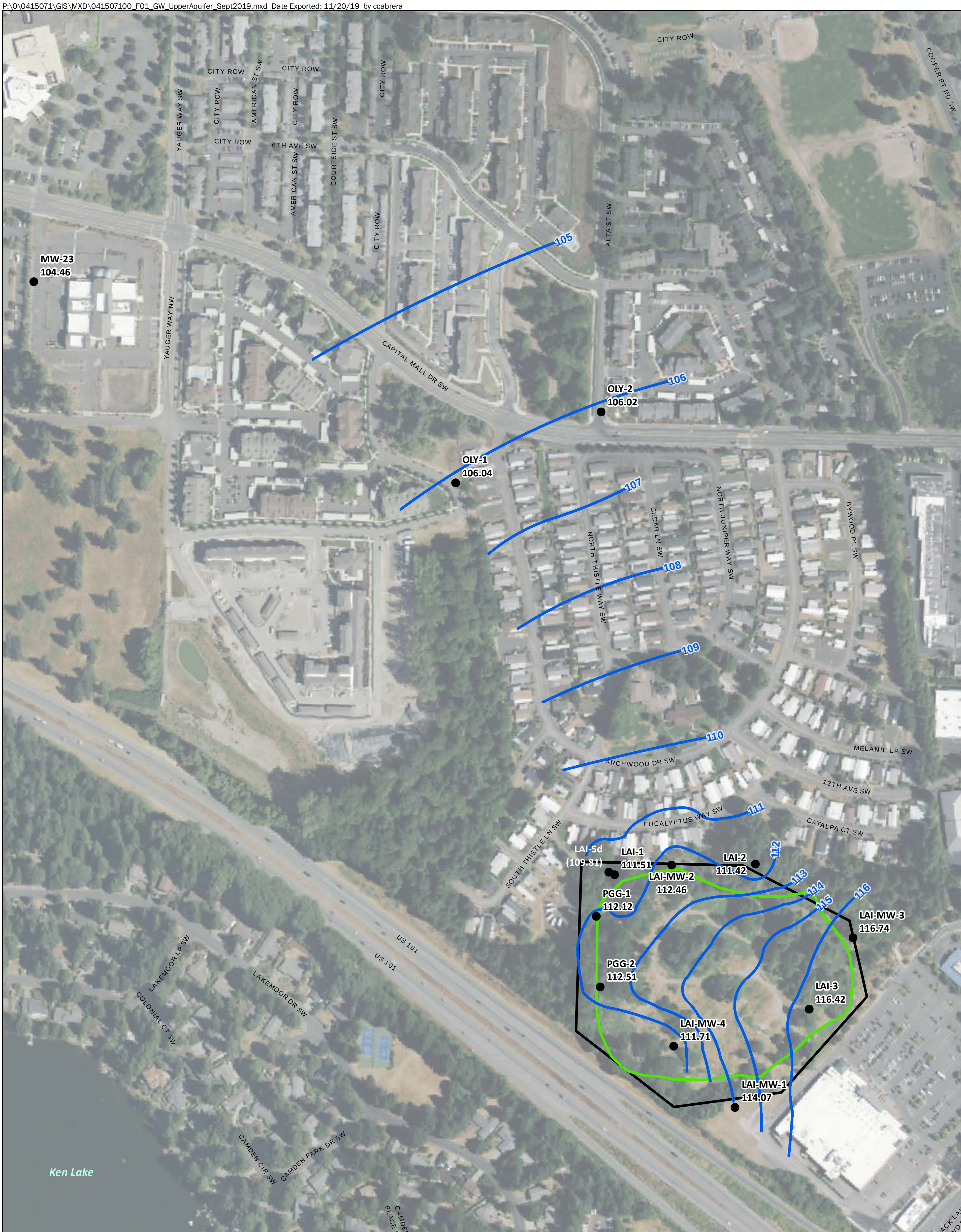
mg/L = milligrams per liter

µg/L = micrograms per liter

NE = not established

U = analyte not detected, laboratory reporting limit shown.

P:\0\0415071\GIS\MXD\041507100_F01_GW_UpperAquifer_Sept2019.mxd Date Exported: 11/20/19 by ccabrera



- Monitoring Well Location and Groundwater Elevation (Feet)
- Groundwater Elevation Contour (1 Foot)
- Approximate Extent of Waste
- Approximate Parcel Boundary

N W E S

300 0 300
Feet

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers and will serve as the official record of this communication.
3. LAI-5d is screened in the lower aquifer (Qpg) and was not used for contours, but is shown for reference.

Data Sources: Thurston County GIS; Esri World Imagery. Groundwater elevations from WOLF - September 2019 monitoring event.
Projection: NAD 1983 StatePlane Washington South FIPS 4602 Feet

Groundwater Elevation Contours
Upper Aquifer (Qga) - September 2019

West Olympia Landfill Site
Olympia, Washington

GeoEngineers

Figure 1

P:\0\0415071\GIS\MXD\041507100_F02_GW_TCE_Sept2019.mxd Date Exported: 11/06/19 by ccabrera

OLY-2

Sample Date	TCE (ug/L)
3/2015	2.6
6/2015	2.8
9/2015	4.5
12/2015	6.1
3/2019	2.8
9/2019	4

OLY-1

Sample Date	TCE (ug/L)
3/2015	0.5 U
6/2015	0.5 U
9/2015	0.5 U
12/2015	0.11 J
3/2019	0.20 U
9/2019	0.20 U

LAI-1

Sample Date	TCE (ug/L)
1/2014	17
3/2015	27
6/2015	20
9/2015	19
12/2015	21
3/2019	23
9/2019	13

LAI-MW-2

Sample Date	TCE (ug/L)
1/2014	41
3/2015	22
6/2015	50
9/2015	19
12/2015	43
3/2019	22
9/2019	15

LAI-2

Sample Date	TCE (ug/L)
1/2014	1.1
3/2019	2.6
9/2019	0.58

PGG-1

Sample Date	TCE (ug/L)
1/2014	0.27 J
3/2019	0.29
9/2019	0.42

LAI-MW-4

Sample Date	TCE (ug/L)
3/2015	1 U
6/2015	1 U
9/2015	1 U
12/2015	1 U
3/2019	0.27
9/2019	0.20 U

Legend

- Approximate Extent of Waste
- Approximate Parcel Boundary
- ● TCE not detected in groundwater >RL.
- ● TCE RLs detected in groundwater >RLs, but <SL during one or more sampling events.
- ● TCE detected in groundwater >SL (1.6 µg/L) during one or more sampling events.

N W E S

300 0 300

Feet

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers and will serve as the official record of this communication.
3. µg/L = micrograms per Liter
4. U = analyte not detected above the listed reporting limit.
5. TCE = trichloroethene
6. SL = screening level
7. RL = reporting limit
8. JQ = analyte positively identified and value is an estimated quantity because the concentration was below the contract-required quantitation limits.

Data Sources: Thurston County GIS; Esri World Imagery.
Projection: NAD 1983 StatePlane Washington South FIPS 4602 Feet

Groundwater Samples - TCE Analytical Results

West Olympia Landfill Site
Olympia, Washington

GeoEngineers

Figure 2

P:\0\0415071\GIS\MXD\041507100_F03_GW_IronMn_Sept2019.mxd Date Exported: 11/07/19 by ccabrera

LAI-MW-2

Sample Date	Fe (ug/L)	Mn (ug/L)
1/2014	100 U	1.4
3/2019	56 U	11 U
9/2019	56 U	11 U

LAI-2

Sample Date	Fe (ug/L)	Mn (ug/L)
1/2014	100 U	2.3
3/2019	56 U	11 U
9/2019	56 U	11 U

LAI-1

Sample Date	Fe (ug/L)	Mn (ug/L)
1/2014	100 U	0.52
3/2019	56 U	11 U
9/2019	56 U	11 U

LAI-5d

Sample Date	Fe (ug/L)	Mn (ug/L)
1/2014	2,250	2,370
3/2019	2,100	2,100
9/2019	2,600	2,500

LAI-MW-3

Sample Date	Fe (ug/L)	Mn (ug/L)
1/2014	100 U	1.8
3/2019	56 U	11 U
9/2019	56 U	11 U

PGG-1

Sample Date	Fe (ug/L)	Mn (ug/L)
1/2014	100 U	1.5
3/2019	56 U	11 U
9/2019	56 U	1,100

PGG-2

Sample Date	Fe (ug/L)	Mn (ug/L)
1/2014	100 U	1.5
3/2019	56 U	11 U
9/2019	--	--

LAI-3

Sample Date	Fe (ug/L)	Mn (ug/L)
1/2014	100 U	1.1
3/2019	56 U	11 U
9/2019	56 U	11 U

LAI-MW-4

Sample Date	Fe (ug/L)	Mn (ug/L)
1/2014	100 U	2.4
3/2019	56 U	11 U
9/2019	100	11 U

LAI-MW-1

Sample Date	Fe (ug/L)	Mn (ug/L)
1/2014	100 U	0.99
3/2019	56 U	11 U
9/2019	56 U	11 U

Legend

- Approximate Extent of Waste
- Approximate Parcel Boundary

Iron (Fe) SL = 11,200 µg/L
Manganese (Mn) SL = 2, 240 µg/L

N W E S

300 0 300
Feet

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers and will serve as the official record of this communication.
3. '- -' sample not collected
4. Reported metals concentrations are dissolved
5. µg/L = micrograms per Liter
6. U = analyte not detected above the listed reporting limit.
8. SL = screening level

Data Sources: Thurston County GIS; Esri World Imagery.
Projection: NAD 1983 StatePlane Washington South FIPS 4602 Feet

Groundwater Samples - Iron and Manganese Analytical Results

West Olympia Landfill Site
Olympia, Washington

GEOENGINEERS

Figure 3

ATTACHMENT 3

RI Report Addendum, Technical Memorandum: Soil Vapor Intrusion Analysis

Technical Memorandum

TO: Donna Buxton, LHG, City of Olympia

FROM: Sarah Fees, LG

DATE: December 5, 2019

RE: **Soil Vapor Intrusion Analysis**
West Olympia Landfill
Olympia, Washington
258052.030.032

Introduction

This technical memorandum prepared for the City of Olympia, summarizes the results of a soil vapor intrusion (VI) analysis, which was conducted at the former West Olympia Landfill Site (Site) to evaluate the potential for VI to occur at neighboring properties. The VI analysis specifically addresses Washington State Department of Ecology (Ecology) comment #6 provided in the October 2, 2019 comments on the Remedial Investigation (RI) report dated August 30, 2019. This memorandum addresses VI analysis for adjacent properties only; it does not address VI potential on the landfill property itself because there are no existing structures and future VI potential will be addressed through the cleanup action.

In addition to the VI analysis, Ecology requested two new figures associated with soil gas at the Site (comments #5 and #9). Ecology requested a figure documenting trichloroethene (TCE) concentrations, similar to the figure presenting tetrachloroethene (PCE) concentrations in soil gas (Figure 6-1 of the RI report). The measured TCE soil gas concentrations at the Site are presented on Figure 1. Ecology also requested a figure documenting methane concentrations in soil gas at the Site. Methane data collected since 2006 are presented on Figure 2.

Soil Gas and Groundwater Data

Soil gas and groundwater data are presented in the RI report (GEI and LAI 2019) and are briefly summarized below. Active and passive soil gas sampling locations and groundwater monitoring wells at the Site are shown on Figure 3. Soil gas and groundwater data do not indicate a concern for vapor intrusion to occur at properties neighboring the Site, as discussed below.

Soil Gas

Volatile organic compounds (VOCs) were analyzed in soil gas at the Site in October 2014, July 2016, and May and June 2018. Soil gas samples have been collected from 24 temporary and permanent active soil gas sampling locations and 64 temporary passive soil gas sampling locations (See Figure 3). Five locations (GP-1 through GP-5) were sampled twice (in October 2014 and in May/June 2018). TCE concentrations in soil gas above the screening level (SL; 12 micrograms per cubic meter [$\mu g/m^3$]) are presented on Figure 1. PCE concentrations in soil gas above the SL (320 µg/m^3) are presented on Figure 4.

PCE and TCE were not detected in soil gas at the boundaries of the landfill property, with the exception of TCE at GP-21 (May 2018) toward the southern edge of the Site, indicating that it is unlikely VOCs are migrating off the property. PCE and TCE were detected on the interior of the property within the approximate extent of landfill waste. PCE concentrations in soil gas range from 2.9 µg/m^3 to 2,860 µg/m^3. PCE has been detected in soil gas at concentrations above the SL (320 µg/m^3) only in samples collected at 26 locations within the interior of the landfill. TCE concentrations in soil gas range from 8.3 µg/m^3 to 871 µg/m^3. TCE has been detected in soil gas at concentrations above the SL (12 µg/m^3) at nine locations in the interior of the landfill and at one location in the southern part of the property outside of the landfill waste. Locations with exceedances of the SLs are confined to the interior of the property, and are bounded by locations with either no VOC detections or concentrations below the SLs at the landfill property boundary, except at the previously-mentioned GP-21 to the south and distant from the residential properties to the north of the landfill property.

Groundwater

The nature and extent of groundwater contamination at the Site was evaluated based on groundwater samples collected in 2014, 2015, and 2019 at 10 monitoring wells on the landfill property and three monitoring wells located downgradient of the landfill property. Detections of TCE above the SL (1.6 µg/liter [L]) are documented at four of the 13 Site groundwater monitoring wells. The highest TCE concentration detected at the Site during 2019 was 23 µg/L at LAI-1 during the March sampling event. The monitoring wells with detections of TCE are screened in the Vashon Advance Outwash (Qga) aquifer at depths ranging from 45 to 77 feet below ground surface (ft bgs). The depth to groundwater in the Qga aquifer is approximately 50 ft bgs. The Qga aquifer is underlain by the pre-Vashon glaciolacustrine deposits (Qpf) aquitard and the deeper Pre-Vashon Gravel (Qpg) aquifer. Samples from the single well screened in this deeper aquifer, well LAI-5d, have not had detections of VOCs indicating that groundwater contamination is limited to the upper Qga aquifer. Well locations, along with 2019 TCE SL exceedances, are presented on Figure 5. The source of TCE in the Qga aquifer is likely from historical landfill waste material which leached into groundwater in the Qga aquifer, driven primarily by precipitation recharge (see conceptual site model in the RI report [GEI and LAI 2019], Figure 5-1).

VOCs in groundwater can partition from the dissolved phase to vapor phase, and can contribute to VOC soil vapor concentrations and to VI. However, Site data indicate that groundwater at the Site is not a source of VOCs in soil vapor. Groundwater under the Site in the Qga aquifer is located at a depth of approximately 50 ft bgs and is below the Vashon Till (Qgt) aquitard, a low-permeability soil unit that impedes movement of both groundwater and vapor. While the Site groundwater in the Qga has detections of TCE, the locations of the detected TCE concentrations in groundwater do not correlate with elevated soil gas concentrations. For example, near the northwestern edge of the landfill property where recent groundwater TCE concentrations are highest (23 µg/L at LAI-1 in March 2019; Figure 5), TCE has not been detected at the adjacent and nearby soil gas sample locations (GP-11, GP-1, and GP-23; Figure 1). Given this lack of co-occurrence of TCE, these data do not indicate that the groundwater is the source for the VOCs detected in soil gas. The presence of VOCs in shallow soil gas is attributed to residual VOC contamination in the waste material and associated soil. VOCs likely volatilize from the limited, disseminated residual waste product that is left at the Site directly into soil gas.

Vapor Intrusion Assessment

No structures are currently present on the landfill property. However, Ecology requested that the potential for vapor intrusion be evaluated for the neighboring residential property (Friendly Village manufactured housing community). The evaluation was conducted in accordance with Ecology's draft guidance for evaluating soil vapor intrusion (Ecology 2009) and Ecology's Implementation Memoranda No. 21 (Ecology 2018) and 22 (Ecology 2019).

Ecology guidance lays out a multiple line of evidence and phased approach to VI assessment, where groundwater data may be used as an initial screening tool to determine if further VI investigation and assessment is warranted. Groundwater VI SLs are used only to determine if additional VI assessment is needed; exceedances of groundwater VI SLs are not an indication that the VI exposure pathway is potentially complete. If groundwater concentrations warrant additional VI assessment, soil gas concentrations are measured and evaluated to determine whether VOCs are present in sufficient concentrations near the ground surface and close enough to existing structures to migrate beneath, and enter into, indoor air at concentrations exceeding the indoor air SLs. Residential structures within 100 ft of shallow soil gas concentrations exceeding SLs are considered to have the potential to be impacted by vapor migration[1] and evaluation of indoor air may be warranted if such conditions exist (Ecology 2018). However, if soil gas concentrations within 100 ft of structures are determined to be non-detect or below SLs, the vapor intrusion pathway can generally be screened out, particularly if there are multiple lines of evidence demonstrating that vapor intrusion is unlikely (Ecology 2018).

Multiple lines of evidence were compiled to demonstrate that the VI pathway can be screened out for locations beyond the landfill property boundary. Importantly, there are no soil gas concentrations exceeding SLs within 100 ft of neighboring residences. All soil gas exceedances are on the interior of the landfill property and are bounded along the exterior of the property nearest to the residential area by soil gas concentrations that are non-detect or below SLs for VOCs. As described above, groundwater in the Qga aquifer is not a source of VOCs in shallow soil gas due to a thick, low-

[1] Preferential pathways, such as utilities, may cause vapors to migrate more than 100 ft in the subsurface; however, no preferential pathways are known to be present on the landfill property.

permeability aquitard that is present throughout the Site; therefore, shallow soil gas outside of the landfill property is not expected to be impacted by VOCs from the Site.

Johnson-Ettinger Model

Although the Site empirical data demonstrate that VI from the landfill is unlikely to occur on neighboring properties, the Johnson-Ettinger model (JEM) was run as an additional line of evidence to further demonstrate that PCE and TCE in shallow soil gas do not pose a VI risk at the neighboring properties. As described above, soil gas sample locations with exceedances of the SLs are located on the interior of the landfill property and are bounded by locations within the landfill property boundaries that have concentrations either non-detect or below the SLs. Also, the concentrations exceeding the SLs were detected at locations more than 100 ft from residential structures. However, to be conservative in our use of the JEM, the highest detected concentrations of TCE (210 µg/m3 at GP-5; Figure 1) and PCE (1200 µg/m3 at GP-16; Figure 4) from the most recent soil gas sampling event (May-June of 2018) were used to calculate predicted indoor air concentrations in overlying structures. The JEM accounts for the depth of the soil gas samples below the surface, but does not account for lateral separation distance; that is, the model assumes a structure directly overlies the inputted soil gas concentrations, which is not the case at the Site.

Depths for the soil gas samples were assumed to be the center of the screened interval. For example, for a screened interval between 3 and 13 ft, the depth modeled was 8 ft. Additional conservative or default values were used in the model for vadose zone characteristics, including a subsurface matrix of sand[2]. Conservative or default building characteristics for residential structures were used in the model including: slab-on-grade foundation, 0.66-ft foundation thickness, approximately 1,600 square-foot enclosed space floor area, and an indoor air exchange rate of 0.45 per hour. The resulting output from the JEM consist of low, best estimate, and high theoretical (predicted) indoor air concentrations for an overlying structure. These indoor air concentrations from the JEM were compared to the Ecology Model Toxics Control Act (MTCA) Method B (unrestricted) indoor air screening level for long-term exposure and the US Environmental Protection Agency (EPA) screening level for short-term exposure.

The soil gas concentration of 210 µg/m^3 TCE, when inputted to the JEM, resulted in low, best estimate, and high theoretical indoor air concentrations less than the MTCA Method B indoor air SL for long-term exposure (0.37 µg/m^3) and the EPA SL for short-term exposure (2.0 µg/m^3). The soil gas concentration of 1200 µg/m^3 PCE also resulted in low, best estimate and high theoretical indoor air

[2] The assumption of a sand matrix is consistent with the boring logs at GP-5 and GP-16. Both monitoring locations are screened in the waste material and are described as silty sand and gravel or gravelly sand with evidence of refuse and/or charred wood pieces.

concentrations less than the MTCA Method B indoor air SL. Results of the JEM evaluation are provided in Table 1. Inputs and outputs of the JEM are provided in Attachment 1.

Conclusions

In summary, multiple lines of evidence demonstrate that the vapor intrusion pathway can be screened out as a mechanism for TCE migration beyond the landfill property boundary. TCE and PCE concentrations in soil gas closest to the neighboring residential structures are non-detect demonstrating that VOCs in soil gas are not migrating to the landfill property boundary. Exceedances of the TCE and PCE SLs in soil gas are limited to the interior of the landfill property, are more than 100 ft from neighboring buildings, and are not expected to result in vapor intrusion on adjacent properties. There are no known preferential pathways that would potentially result in off-site migration of VOCs in soil gas. Additionally, the JEM was used to model theoretical indoor air concentrations in overlying structures. Using the highest VOC soil gas concentrations detected at the Site during the most recent investigation, indoor air concentrations would not be expected to exceed indoor air SLs even in a structure directly overlying the elevated soil gas concentrations. Empirical data from the Site also demonstrate that groundwater in the Qga aquifer is not a source for the VOCs detected in shallow soil gas; therefore, there is no evidence that the groundwater contamination will result in VOCs in shallow soil gas outside of the landfill property.

Limitations

This Technical Memorandum has been prepared for the exclusive use of the City of Olympia for specific application to the West Olympia Landfill. No other party is entitled to rely on the information, conclusions, and recommendations included in this document without the express written consent of Landau Associates. Further, the reuse of information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and authorization by Landau Associates, shall be at the user's sole risk. Landau Associates warrants that within the limitations of scope, schedule, and budget, our services have been provided in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions as this project. We make no other warranty, either express or implied.

This document has been prepared under the supervision and direction of the following key staff.

LANDAU ASSOCIATES, INC.

Sarah Fees, LG
Senior Geologist

JEC/SEF/JWW/KFH/kjg
[\\TACOMA3\PROJECT\258\052\R\RI REPORT\RI REPORT ADDENDUM\VAPOR INTRUSION TM_LAI\VAPORINTRUSTION_TM_DRAFT.DOCX]

Attachments: Figure 1. TCE Soil Gas Results Exceedances of Screening Levels (2014, 2016, and 2018)
Figure 2. Methane Soil Gas Results 2006 to 2018
Figure 3. Soil Gas and Groundwater Sample Locations
Figure 4. PCE Soil Gas Results Exceedances of Screening Levels (2014, 2016, and 2018)
Figure 5. Groundwater Results – Exceedances of Screening Levels – TCE
Table 1. Johnson Ettinger Model Results Summary
Attachment 1. JEM Input and Output

References

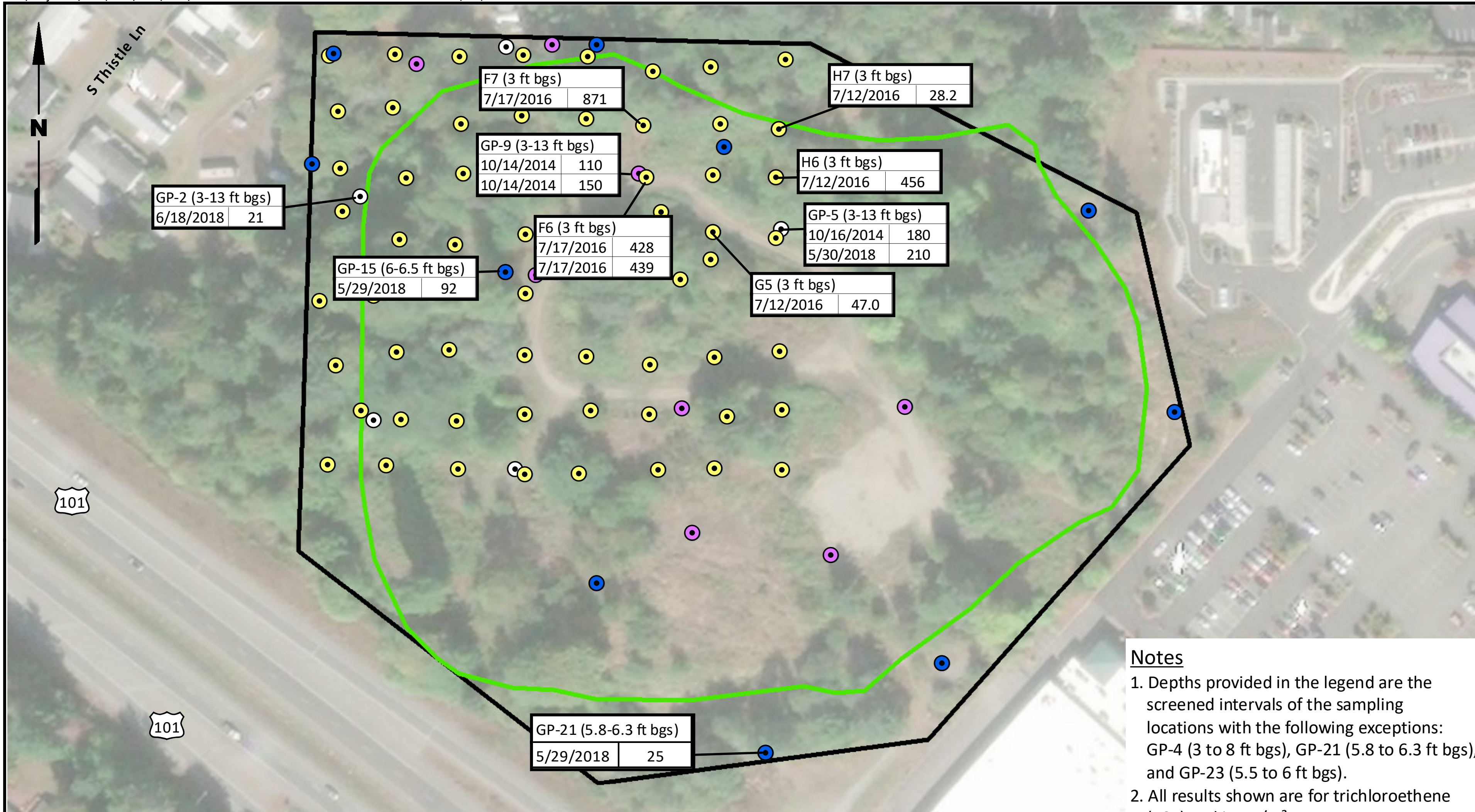
Ecology. 2009. *Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action*. Washington State Department of Ecology. Olympia, Washington.

Ecology. 2018. Implementation Memorandum No. 21, Frequently Asked Questions (FAQs) Regarding Vapor Intrusion (VI) and Ecology's 2009 Draft VI Guidance. Washington State Department of Ecology. Olympia, Washington. November 15.

Ecology. 2019. Implementation Memorandum No. 22, Vapor Intrusion (VI) Investigations and Short-term Trichloroethene (TCE) Toxicity. Washington State Department of Ecology. Olympia, Washington. October 1.

GEI and LAI. 2019. Final Report: *Remedial Investigation Report, Former West Olympia Landfill Site, Olympia, Washington.* GeoEngineers and Landau Associates, Inc. Prepared for City of Olympia, Washington. August 30.

G:\Projects\258\052\020\021\F01SoilGasTCEExceedances2014-2018.mxd 11/14/2019



Notes

1. Depths provided in the legend are the screened intervals of the sampling locations with the following exceptions: GP-4 (3 to 8 ft bgs), GP-21 (5.8 to 6.3 ft bgs), and GP-23 (5.5 to 6 ft bgs).
2. All results shown are for trichloroethene (TCE) and in µg/m³.
3. Soil gas exceedance = concentration greater than the MTCA Method B sub-slab soil gas screening level; 12 µg/m³ for TCE.
4. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Legend

- Permanent Soil Gas Sample Location (3 to 13 ft bgs, Installed 2006)
- Temporary Active Soil Gas Sample Location (3 to 13 ft bgs, October 2014)
- Temporary Passive Soil Gas Sample Location (3 ft bgs, July 2016)
- Permanent Soil Gas Sample Location (6 to 6.5 ft bgs, Installed 2018)
- Approximate Extent of Waste
- Subject Property
- F7 (3 ft bgs) 7/17/16 871 — Exceedance of Soil Gas Screening Level

Data Sources: Thurston County GIS; Esri World Imagery.

0 150 300

Scale in Feet

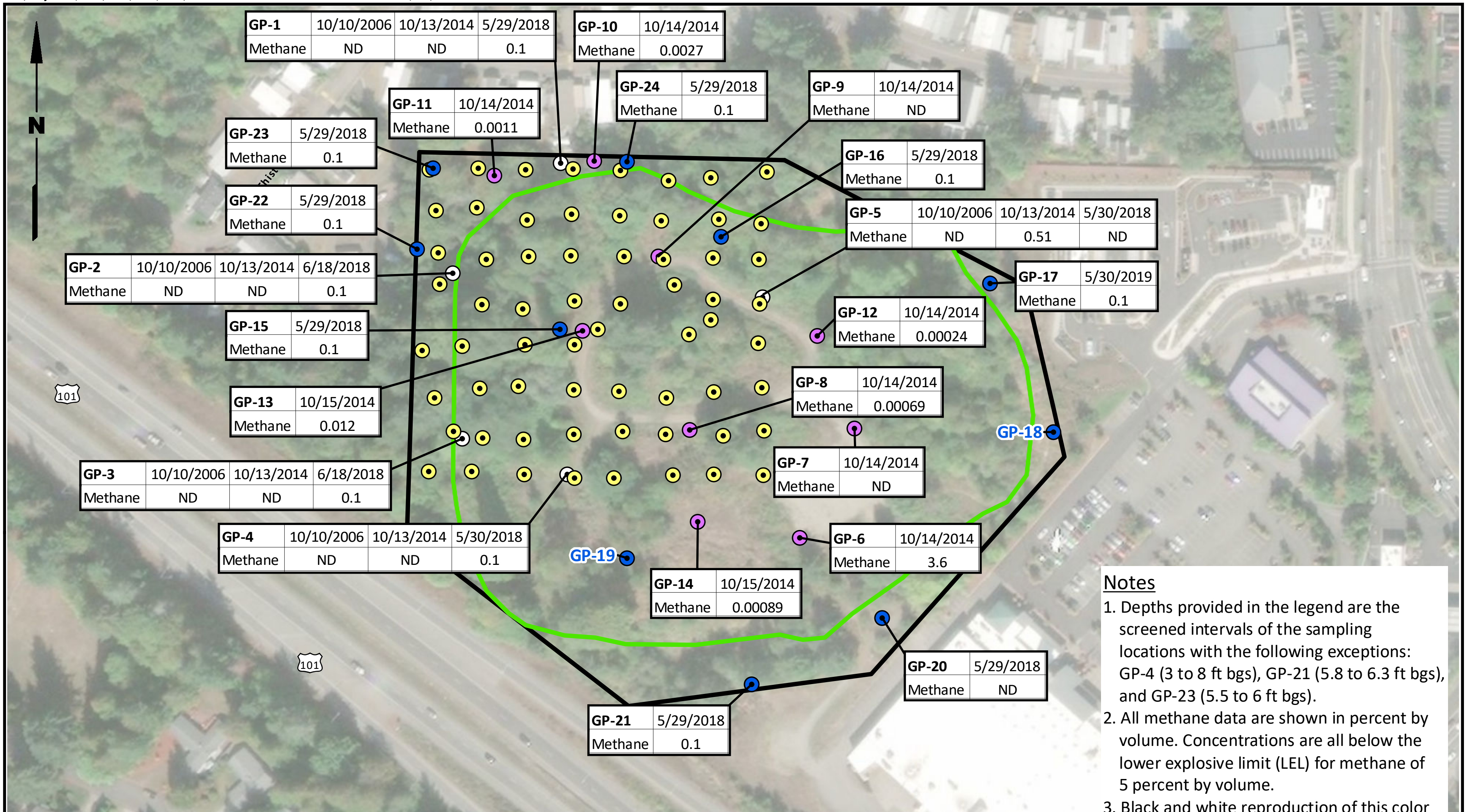
Landau Associates

West Olympia Landfill Site
Olympia, Washington

TCE Soil Gas Results Exceedances of Screening Levels (2014, 2016, and 2018)

Figure 1

G:\Projects\258\052\020\021\F02SoilGasMethane2006-2018.mxd 11/18/2019



Notes

1. Depths provided in the legend are the screened intervals of the sampling locations with the following exceptions: GP-4 (3 to 8 ft bgs), GP-21 (5.8 to 6.3 ft bgs), and GP-23 (5.5 to 6 ft bgs).
2. All methane data are shown in percent by volume. Concentrations are all below the lower explosive limit (LEL) for methane of 5 percent by volume.
3. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Legend

- Permanent Soil Gas Sample Location (3 to 13 ft bgs, Installed 2006)
- Temporary Active Soil Gas Sample Location (3 to 13 ft bgs, October 2014)
- Temporary Passive Soil Gas Sample Location (3 ft bgs, July 2016)
- Permanent Soil Gas Sample Location (6 to 6.5 ft bgs, Installed 2018)
- Approximate Extent of Waste
- Subject Property

0 200 400

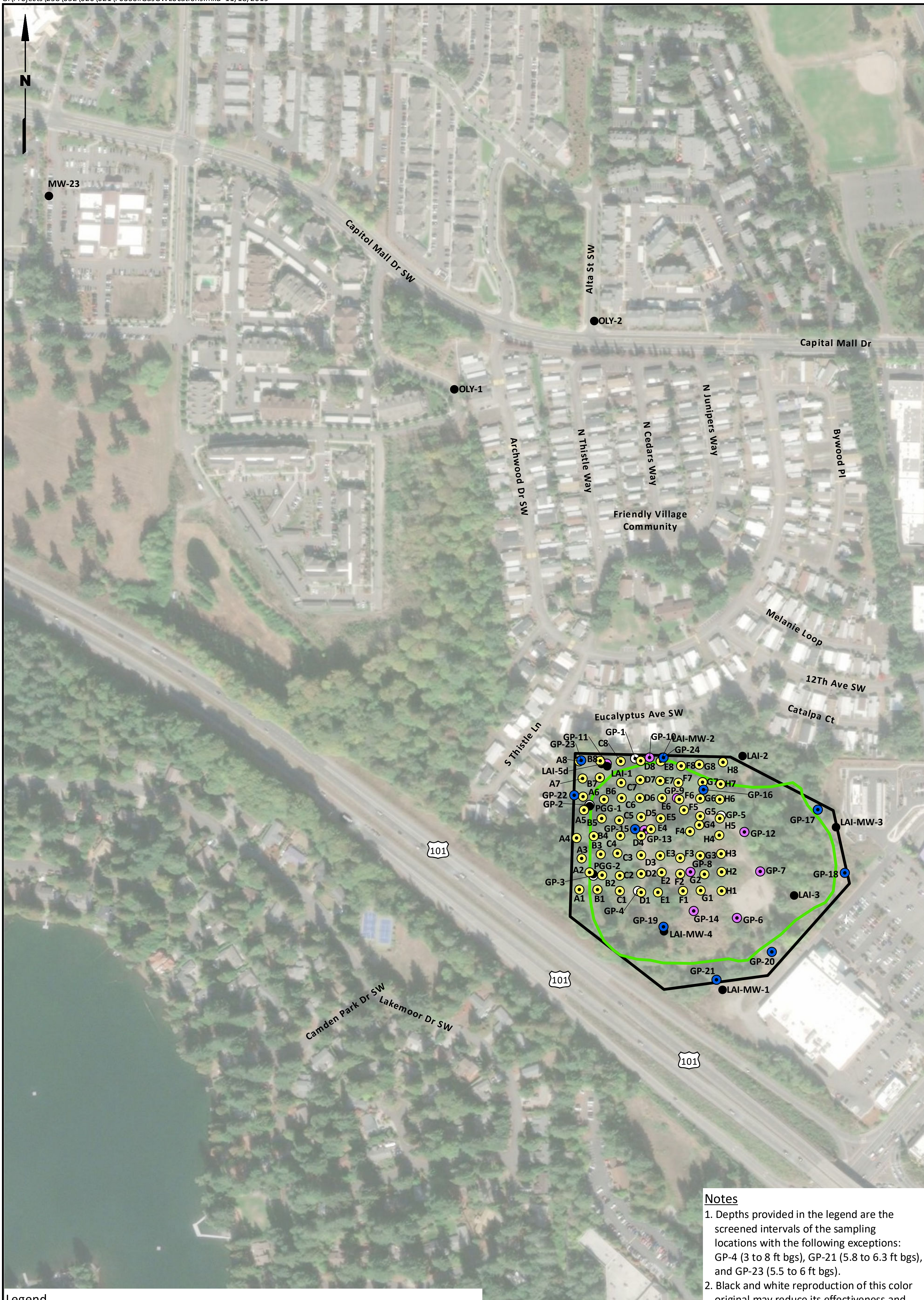
Scale in Feet

Data Sources: Thurston County GIS; Esri World Imagery.

LANDAU ASSOCIATES

West Olympia Landfill Site Olympia, Washington	**Methane Soil Gas Results 2006 to 2018**	Figure 2

G:\Projects\258\052\020\021\F03SoilGasGWLocations.mxd 11/18/2019



Notes

1. Depths provided in the legend are the screened intervals of the sampling locations with the following exceptions: GP-4 (3 to 8 ft bgs), GP-21 (5.8 to 6.3 ft bgs), and GP-23 (5.5 to 6 ft bgs).
2. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Legend

- Existing Groundwater Monitoring Well Location
- Permanent Soil Gas Sample Location (3 to 13 ft bgs, Installed 2006)
- Temporary Active Soil Gas Sample Location (3 to 13 ft bgs, October 2014)
- Temporary Passive Soil Gas Sample Location (3 ft bgs, July 2016)
- Permanent Soil Gas Monitoring Location (6 to 6.5 ft bgs, Installed 2018)
- Approximate Extent of Waste
- Subject Property

0 300 600

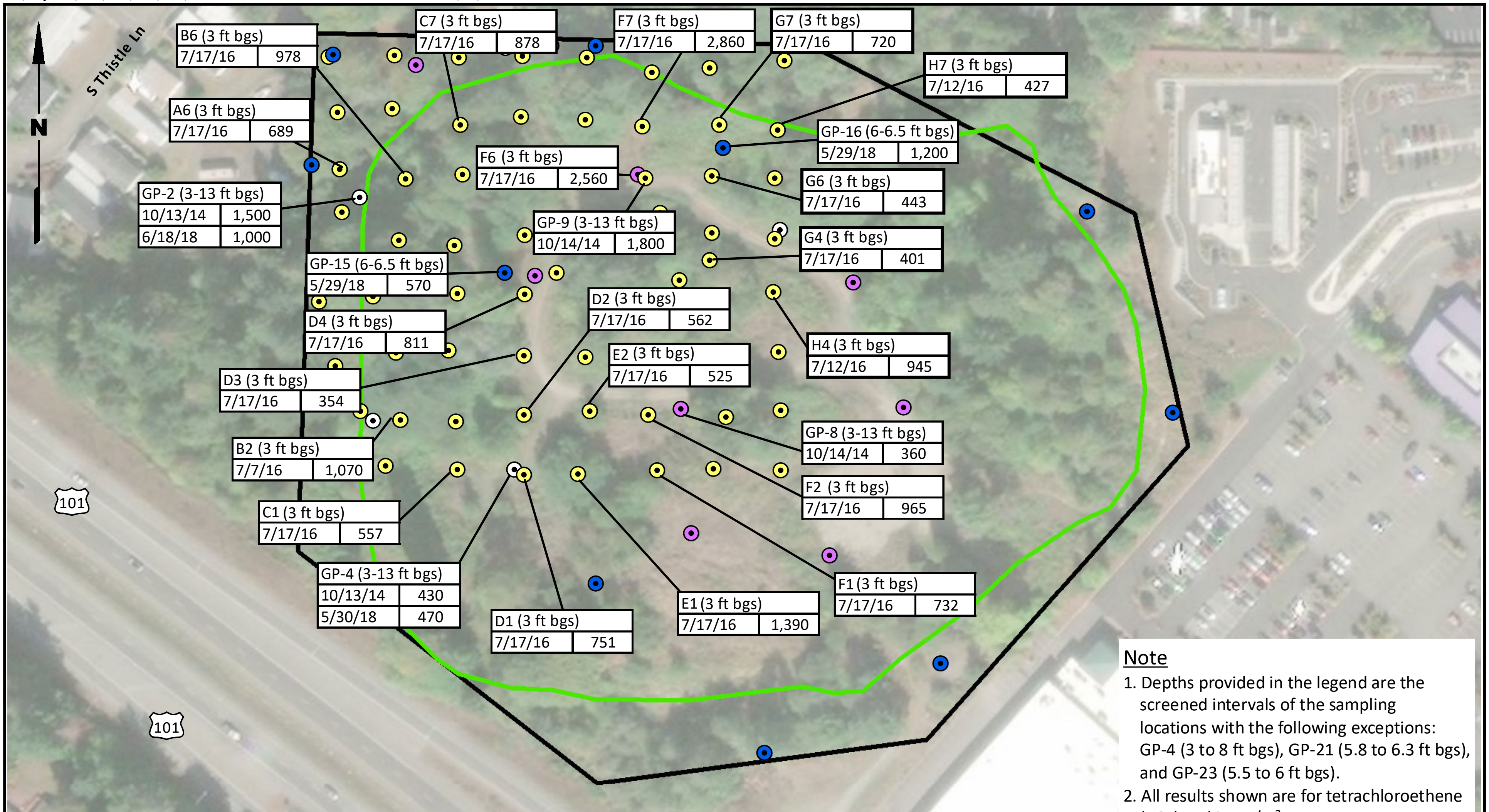
Scale in Feet

Data Sources: Thurston County GIS; Esri World Imagery.

LANDAU ASSOCIATES

West Olympia Landfill Site Olympia, Washington	**Soil Gas and Groundwater Sample Locations**	Figure 3

G:\Projects\258\052\020\021\F04SoilGasPCEExceedances2014-2018.mxd 11/14/2019



Note

1. Depths provided in the legend are the screened intervals of the sampling locations with the following exceptions: GP-4 (3 to 8 ft bgs), GP-21 (5.8 to 6.3 ft bgs), and GP-23 (5.5 to 6 ft bgs).
2. All results shown are for tetrachloroethene (PCE) and in µg/m³.
3. Soil gas exceedance = concentration greater than the MTCA Method B sub-slab soil gas screening level; 320 µg/m³ for PCE.
4. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Legend

- Permanent Soil Gas Sample Location (3 to 13 ft bgs, Installed 2006)
- Temporary Active Soil Gas Sample Location (3 to 13 ft bgs, October 2014)
- Temporary Passive Soil Gas Sample Location (3 ft bgs, July 2016)
- Permanent Soil Gas Sample Location (6 to 6.5 ft bgs, Installed 2018)
- Approximate Extent of Waste
- Subject Property
- D1 (3 ft bgs) 7/17/16 751 — Exceedance of Soil Gas Screening Level

0 150 300

Scale in Feet

Data Sources: Thurston County GIS; Esri World Imagery.

LANDAU ASSOCIATES

West Olympia Landfill Site
Olympia, Washington

PCE Soil Gas Results Exceedances of Screening Levels (2014, 2016, and 2018)

Figure 4

G:\Projects\258\052\020\021\F05GWExceedances.mxd 11/18/2019

Notes

1. Depths provided in the legend are the screened intervals of the sampling locations with the following exceptions: GP-4 (3 to 8 ft bgs), GP-21 (5.8 to 6.3 ft bgs), and GP-23 (5.5 to 6 ft bgs).
2. All groundwater results are shown in µg/L.
3. Groundwater exceedance = concentration greater than the groundwater screening level; 1.6 ug/L for TCE.
4. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Legend

- Existing Monitoring Well Location
- Permanent Soil Gas Sample Location (3 to 13 ft bgs, Installed 2006)
- Temporary Active Soil Gas Sample Location (3 to 13 ft bgs, October 2014)
- Temporary Passive Soil Gas Sample Location (3 ft bgs, July 2016)
- Permanent Soil Gas Monitoring Location (6 to 6.5 ft bgs, Installed 2018)
- Approximate Extent of Waste
- Subject Property

0 300 600

Scale in Feet

Data Sources: Thurston County GIS; Esri World Imagery.

Landau Associates

West Olympia Landfill Site Olympia, Washington	**TCE Groundwater Results Exceedances of Screening Level (2019)**	Figure 5

Table 1
Johnson Ettinger Model Results Summary
West Olympia Landfill
Olympia, Washington

Source Medium	Compound	Exploration Location	Highest Detected Concentrations Used in Modeling Indoor Air Concentrations (µg/m³)	Predicted Indoor Air Concentrations (µg/m³)			Indoor Air Screening Method B Unrestricted Use Levels (µg/m³)
				Low Prediction	Best Estimate Prediction	High Prediction	
Exterior Soil Gas	TCE	GP-5	210	0.021	0.22	0.33	0.37
	PCE	GP-16	1200	0.12	1.2	1.8	9.6

Abbreviations and Acronyms
PCE = tetrachloroethene
TCE = trichloroethene
µg/m³ = micrograms per cubic meter

ATTACHMENT 1

Johnson and Ettinger Model Inputs and Outputs

Model Input **Site Name/Run Number:** GP-5

Note:
-Yellow highlighted cells indicate parameters that typically are changed or must be inputted by the user.
-Dotted outline cells indicate default values that may be changed with justification.
-Toxicity values are taken from Regional Screening Level tables. These tables are updated semi-annually and may not reflect the most current toxicity information.

Use English / Metric Converter

Source Characteristics:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Source medium		Source	Exterior Soil Gas					
Soil gas concentration	(ug/m3)	Cmedium	210		NA			
Depth below grade to soil gas sample	(m)	Ls	2.44		Vary - 50	NA		
Average vadose zone temperature	(^oC)	Ts	25	25	3-30			
Calc: Source vapor concentration	(ug/m3)	Cs	210					
Calc: % of pure component saturated vapor concentration	(%)	%Sat	0.000%					

Chemical:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Chemical Name		Chem	Trichloroethylene					
CAS No.		CAS	79-01-6					
Toxicity Factors								
Unit risk factor	$(ug/m^3)^{-1}$	IUR	see note	see note	NA	NA		Note: TCE Inhalation Unit Risk (IUR)
Mutagenic compound		Mut	Yes	NA	NA	NA		Chronic IUR (Residential) = 1.00 x 10-6
Reference concentration	(mg/m^3)	RfC	2.00E-03	2.00E-03	NA	NA		Mutagenic IUR (Residential) = 3.1 x 10-6

Chemical Properties:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Pure component water solubility	(mg/L)	S	1.28E+03	1.28E+03	NA	NA		
Henry's Law Constant @ 25^oC	$(atm\text{-}m^3/mol)$	Hc	9.85E-03	9.85E-03	NA	NA		
Calc: Henry's Law Constant @ 25^oC	(dimensionless)	Hr	4.03E-01	4.03E-01				
Calc: Henry's Law Constant @ system temperature	(dimensionless)	Hs	4.03E-01	4.03E-01				
Diffusivity in air	(cm2/s)	Dair	6.87E-02	6.87E-02	NA	NA		
Diffusivity in water	(cm2/s)	Dwater	1.02E-05	1.02E-05	NA	NA		

Building Characteristics:

Select Building Assumptions
- (●) Use ratio for Qsoil/Qbuilding (recommended if no site specific data available)
- ( ) Specify Qsoil and Qbuilding separately; calculate ratio

	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Building setting		Bldg_Setting	Residential	Residential				
Foundation type		Found_Type	Slab-on-grade	Slab-on-grade				
Depth below grade to base of foundation	(m)	Lb	0.10	0.10	0.1 - 2.44	NA		
Foundation thickness	(m)	Lf	0.10	0.10	0.1 - 0.25	NA		
Fraction of foundation area with cracks	(-)	eta	0.001	0.001	0.00019-0.0019	1.00		
Enclosed space floor area	(m2)	Abf	150.00	150.00	80 - 200	NA		
Enclosed space mixing height	(m)	Hb	2.44	2.44	2.13 - 3.05	NA		
Indoor air exchange rate	(1 / hr)	ach	0.45	0.45	.15-1.26	NA		
Qsoil/Qbuilding	(-)	Qsoil_Qb	0.0030	0.0030	0.0001 - 0.05	1.24		
Calc: Building ventilation rate	(m3/hr)	Qb	164.70	164.70	NA	0.30		
Calc: Average vapor flow rate into building	(m3/hr)	Qsoil	0.49	0.49	NA	NA		

Model Input **Site Name/Run Number:** GP-5

Chemical Name: Trichloroethylene **CAS No. 79-01-6**

Depth below grade to soil gas sample: 2.44 meters

Vadose zone characteristics:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Stratum A (Top of soil profile):								
Stratum A SCS soil type		SCS_A	Sand					
Stratum A thickness (from surface)	(m)	hSA	2.44					
Stratum A total porosity	(-)	nSA	0.375	0.375	NA	0.20		
Stratum A water-filled porosity	(-)	nwSA	0.054	0.054	0.053 - 0.055	0.25		
Stratum A bulk density	(g/cm^3)	rhoSA	1.660	1.660	NA	0.05		
Stratum B (Soil layer below Stratum A):								
Stratum B SCS soil type		SCS_B	Not Present					
Stratum B thickness	(m)	hSB	0.00					
Stratum B total porosity	(-)	nSB			NA	NA		
Stratum B water-filled porosity	(-)	nwSB			NA	NA		
Stratum B bulk density	(g/cm^3)	rhoSB			NA	NA		
Stratum C (Soil layer below Stratum B):								
Stratum C SCS soil type		SCS_C	Not Present					
Stratum C thickness	(m)	hSC	0.00					
Stratum C total porosity	(-)	nSC			NA	NA		
Stratum C water-filled porosity	(-)	nwSC			NA	NA		
Stratum C bulk density	(g/cm^3)	rhoSC			NA	NA		
Stratum containing soil gas sample								
Stratum A, B, or C		src_soil	Stratum A					
					NA	NA		
					NA			
					NA			

Exposure Parameters:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Target risk for carcinogens	(-)	Target_CR	1.00E-06	1.00E-06	NA	NA		
Target hazard quotient for non-carcinogens	(-)	Target_HQ	1	1	NA	NA		
Exposure Scenario		Scenario	Residential	Residential				
Averaging time for carcinogens	(yrs)	ATc	70	70	NA	NA		
Averaging time for non-carcinogens	(yrs)	ATnc	26	26	NA	NA		
Exposure duration	(yrs)	ED	26	26	NA	NA		
Exposure frequency	(days/yr)	EF	350	350	NA	NA		
Exposure time	(hrs/24 hrs)	ET	24	24	NA	NA		
Mutagenic mode-of-action factor	(yrs)	MMOAF	72	72	NA	NA		MMOAF used in place of ED in risk calculations

Range is based on the reasonable range of Qsoil/Qbuilding values, as reported in the literature.

Model Output

Site Name/Run Number: GP-5

Chemical Name: Trichloroethylene CAS No. 79-01-6

Source to Indoor Air Attenuation Factor	Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Soil gas to indoor air attenuation coefficient	**(-)**	**alpha**	**1.0E-03**	1.0E-04 - 1.6E-03	**1.0E-03**	1.0E-04 - 1.6E-03		

Predicted Indoor Air Concentration	Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Indoor air concentration due to vapor intrusion	(ug/m3)	**Cia**	**2.2E-01**	2.1E-02 - 3.3E-01	**2.2E-01**	2.1E-02 - 3.3E-01		
	(ppbv)		**4.1E-02**	3.9E-03 - 6.1E-02	**4.1E-02**	3.9E-03 - 6.1E-02		

Predicted Vapor Conc. Beneath Foundation	Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Subslab vapor concentration	(ug/m3)	**Css**	**7.3E+01**	6.5E+00 - 2.1E+02	**7.3E+01**	2.1E+02 - 3.3E+03		
	(ppbv)		**1.4E+01**	1.2E+00 - 3.9E+01	**1.4E+01**	3.9E+01 - 6.1E+02		

Diffusive Transport Upward Through Vadose Zone	Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Effective diffusion coefficient through Stratum A	(cm2/sec)	DeffA	1.1E-02	-	1.1E-02	-		
Effective diffusion coefficient through Stratum B	(cm2/sec)	DeffB		-		-		
Effective diffusion coefficient through Stratum C	(cm2/sec)	DeffC		-		-		
				-		-		
Effective diffusion coefficient through unsaturated zone	(cm2/sec)	DeffT	1.1E-02	-	1.1E-02	-		

Critical Parameters		Symbol	Value	Range	Default	Default Range	Flag
α for diffusive transport from source to building with dirt floor foundation	(-)	A_Param	1.6E-03	-	1.6E-03		
Pe (Peclet Number) for transport through the foundation (advection / diffusion)	(-)	B_Param	8.0E+01	2.7E+00 - 1.3E+03	8.0E+01	2.7E+00 - 1.3E+03	
α for convective transport from subslab to building	(-)	C_Param	3.0E-03	1.0E-04 - 5.0E-02	3.0E-03	1.0E-04 - 5.0E-02	

Interpretation

Advection is the dominant mechanism across the foundation.
Diffusion through soil and advection through foundation both control intrusio

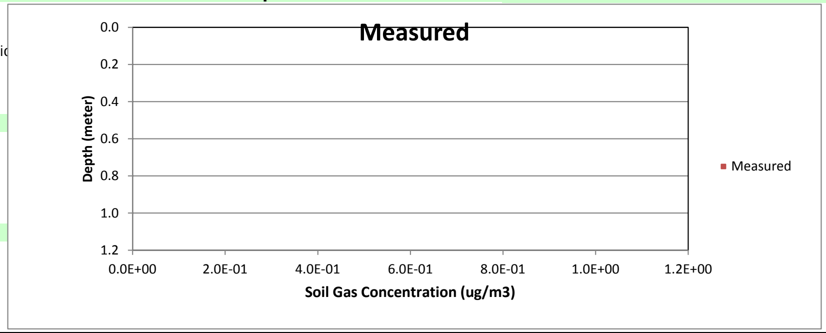
Critical Parameters

Hb, Ls, DeffT, ach, Qsoil_Qb

Non-Critical Parameters

Lf, DeffA, eta

Concentration versus Depth Profile



Model Output Site Name/Run Number: GP-5

Chemical Name: Trichloroethylene CAS No. 79-01-6

Risk Calculations	Units	Symbol	Value	Range	Default	Range	Flag	Comment
Risk-Based Target Screening Levels Scenario: Residential								
Target risk for carcinogens	(-)	Target_CR	1E-06	-	1E-06	-		
Target hazard quotient for noncarcinogens	(-)	Target_HQ	1	-	1	-		
Target indoor air concentration	**(ug/m3)**	**Target_IA**	**4.78E-01**	-	**4.78E-01**	-	Target indoor air concentration based on both cancer risk and non-cancer toxicity	
	(ppbv)		**8.91E-02**	-	**8.91E-02**	-		
Target soil gas concentration	**(ug/m3)**	**Target_SV**	**4.57E+02**	**3.1E+02 - 4.7E+03**	**4.57E+02**	**3.1E+02 - 4.7E+03**		
Incremental Risk Estimates								
Incremental cancer risk from vapor intrusion	**(-)**	**Cancer_Risk**	**4.59E-07**	**4.4E-08 - 6.8E-07**	**4.59E-07**	**4.4E-08 - 6.8E-07**		
Hazard quotient from vapor intrusion	**(-)**	**HQ**	**1.05E-01**	**1.0E-02 - 1.6E-01**	**1.05E-01**	**1.0E-02 - 1.6E-01**		

Model Input

Site Name/Run Number: GP-16

Note:
-Yellow highlighted cells indicate parameters that typically are changed or must be inputted by the user.
-Dotted outline cells indicate default values that may be changed with justification.
-Toxicity values are taken from Regional Screening Level tables. These tables are updated semi-annually and may not reflect the most current toxicity information.

Use English / Metric Converter

Source Characteristics:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Source medium		Source	Exterior Soil Gas					
Soil gas concentration	(ug/m3)	Cmedium	1200		NA			
Depth below grade to soil gas sample	(m)	Ls	1.91		Vary - 50	NA		
Average vadose zone temperature	(^oC)	Ts	25	25	3-30			
Calc: Source vapor concentration	(ug/m3)	Cs	1200					
Calc: % of pure component saturated vapor concentration	(%)	%Sat	0.001%					

Chemical:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Chemical Name		Chem	Tetrachloroethylene					
CAS No.		CAS	127-18-4					
Toxicity Factors								
Unit risk factor	$(ug/m^3)^{-1}$	IUR	2.60E-07	2.60E-07	NA	NA		
Mutagenic compound		Mut	No	NA	NA	NA		
Reference concentration	(mg/m^3)	RfC	4.00E-02	4.00E-02	NA	NA		

Chemical Properties:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Pure component water solubility	(mg/L)	S	2.06E+02	2.06E+02	NA	NA		
Henry's Law Constant @ 25^oC	$(atm\text{-}m^3/mol)$	Hc	1.77E-02	1.77E-02	NA	NA		
Calc: Henry's Law Constant @ 25^oC	(dimensionless)	Hr	7.24E-01	7.24E-01				
Calc: Henry's Law Constant @ system temperature	(dimensionless)	Hs	7.24E-01	7.24E-01				
Diffusivity in air	(cm2/s)	Dair	5.05E-02	5.05E-02	NA	NA		
Diffusivity in water	(cm2/s)	Dwater	9.46E-06	9.46E-06	NA	NA		

Building Characteristics:

Select Building Assumptions
- (●) Use ratio for Qsoil/Qbuilding (recommended if no site specific data available)
- ( ) Specify Qsoil and Qbuilding separately; calculate ratio

	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Building setting		Bldg_Setting	Residential	Residential				
Foundation type		Found_Type	Slab-on-grade	Slab-on-grade				
Depth below grade to base of foundation	(m)	Lb	0.10	0.10	0.1 - 2.44	NA		
Foundation thickness	(m)	Lf	0.10	0.10	0.1 - 0.25	NA		
Fraction of foundation area with cracks	(-)	eta	0.001	0.001	0.00019-0.0019	1.00		
Enclosed space floor area	(m2)	Abf	150.00	150.00	80 - 200	NA		
Enclosed space mixing height	(m)	Hb	2.44	2.44	2.13 - 3.05	NA		
Indoor air exchange rate	(1 / hr)	ach	0.45	0.45	.15-1.26	NA		
Qsoil/Qbuilding	(-)	Qsoil_Qb	0.0030	0.0030	0.0001 - 0.05	1.24		
Calc: Building ventilation rate	(m3/hr)	Qb	164.70	164.70	NA	0.30		
Calc: Average vapor flow rate into building	(m3/hr)	Qsoil	0.49	0.49	NA	NA		

Model Input **Site Name/Run Number:** GP-16

Chemical Name: Tetrachloroethylene CAS No. 127-18-4

Depth below grade to soil gas sample: 1.91 meters

Vadose zone characteristics:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Stratum A (Top of soil profile):								
Stratum A SCS soil type		SCS_A	Sand					
Stratum A thickness (from surface)	(m)	hSA	1.91					
Stratum A total porosity	(-)	nSA	0.375	0.375	NA	0.20		
Stratum A water-filled porosity	(-)	nwSA	0.054	0.054	0.053 - 0.055	0.25		
Stratum A bulk density	(g/cm^3)	rhoSA	1.660	1.660	NA	0.05		
Stratum B (Soil layer below Stratum A):								
Stratum B SCS soil type		SCS_B	Not Present					
Stratum B thickness	(m)	hSB	0.00					
Stratum B total porosity	(-)	nSB			NA	NA		
Stratum B water-filled porosity	(-)	nwSB			NA	NA		
Stratum B bulk density	(g/cm^3)	rhoSB			NA	NA		
Stratum C (Soil layer below Stratum B):								
Stratum C SCS soil type		SCS_C	Not Present					
Stratum C thickness	(m)	hSC	0.00					
Stratum C total porosity	(-)	nSC			NA	NA		
Stratum C water-filled porosity	(-)	nwSC			NA	NA		
Stratum C bulk density	(g/cm^3)	rhoSC			NA	NA		
Stratum containing soil gas sample								
Stratum A, B, or C		src_soil	Stratum A					
					NA	NA		
					NA			
					NA			

Exposure Parameters:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Target risk for carcinogens	(-)	Target_CR	1.00E-06	1.00E-06	NA	NA		
Target hazard quotient for non-carcinogens	(-)	Target_HQ	1	1	NA	NA		
Exposure Scenario		Scenario	Residential	Residential				
Averaging time for carcinogens	(yrs)	ATc	70	70	NA	NA		
Averaging time for non-carcinogens	(yrs)	ATnc	26	26	NA	NA		
Exposure duration	(yrs)	ED	26	26	NA	NA		
Exposure frequency	(days/yr)	EF	350	350	NA	NA		
Exposure time	(hrs/24 hrs)	ET	24	24	NA	NA		
Mutagenic mode-of-action factor	(yrs)	MMOAF	72	72	NA	NA	NOTE	MMOAF not relevant for non-mutagenic compounds

Range is based on the reasonable range of Qsoil/Qbuilding values, as reported in the literature.

Model Output

Site Name/Run Number: GP-16

Chemical Name: Tetrachloroethylene CAS No. 127-18-4

Source to Indoor Air Attenuation Factor	Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Soil gas to indoor air attenuation coefficient	**(-)**	**alpha**	**1.0E-03**	9.6E-05 - 1.5E-03	**1.0E-03**	9.6E-05 - 1.5E-03		

Predicted Indoor Air Concentration	Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Indoor air concentration due to vapor intrusion	(ug/m3)	**Cia**	**1.2E+00**	1.2E-01 - 1.8E+00	**1.2E+00**	1.2E-01 - 1.8E+00		
	(ppbv)		**1.8E-01**	1.7E-02 - 2.6E-01	**1.8E-01**	1.7E-02 - 2.6E-01		

Predicted Vapor Conc. Beneath Foundation	Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Subslab vapor concentration	(ug/m3)	**Css**	**4.1E+02**	3.6E+01 - 1.2E+03	**4.1E+02**	1.2E+03 - 1.8E+04		
	(ppbv)		**6.0E+01**	5.3E+00 - 1.7E+02	**6.0E+01**	1.7E+02 - 2.6E+03		

Diffusive Transport Upward Through Vadose Zone	Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Effective diffusion coefficient through Stratum A	(cm2/sec)	DeffA	8.2E-03	-	8.2E-03	-		
Effective diffusion coefficient through Stratum B	(cm2/sec)	DeffB		-		-		
Effective diffusion coefficient through Stratum C	(cm2/sec)	DeffC		-		-		
				-		-		
Effective diffusion coefficient through unsaturated zone	(cm2/sec)	DeffT	8.2E-03	-	8.2E-03	-		

Critical Parameters		Symbol	Value	Range	Default	Default Range	Flag
α for diffusive transport from source to building with dirt floor foundation	(-)	A_Param	1.5E-03	-	1.5E-03		
Pe (Peclet Number) for transport through the foundation (advection / diffusion)	(-)	B_Param	1.1E+02	3.6E+00 - 1.8E+03	1.1E+02	3.6E+00 - 1.8E+03	
α for convective transport from subslab to building	(-)	C_Param	3.0E-03	1.0E-04 - 5.0E-02	3.0E-03	1.0E-04 - 5.0E-02	

Interpretation

Advection is the dominant mechanism across the foundation.
Diffusion through soil and advection through foundation both control intrusi

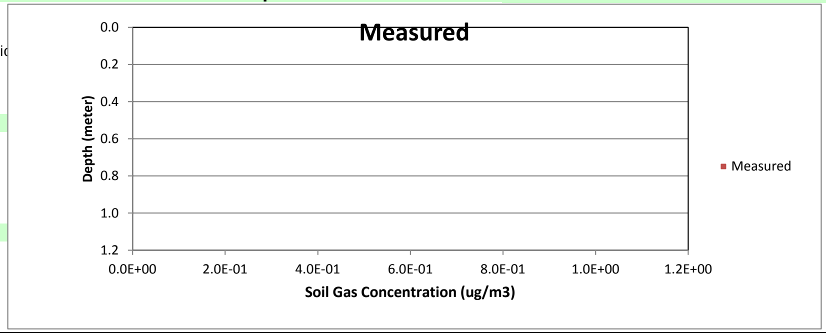
Critical Parameters

Hb, Ls, DeffT, ach, Qsoil_Qb

Non-Critical Parameters

Lf, DeffA, eta

Concentration versus Depth Profile



Model Output Site Name/Run Number: GP-16

Chemical Name: Tetrachloroethylene CAS No. 127-18-4

Risk Calculations	Units	Symbol	Value	Range	Default	Range	Flag	Comment
Risk-Based Target Screening Levels	**Scenario: Residential**							
Target risk for carcinogens	(-)	Target CR	1E-06	-	1E-06	-		
Target hazard quotient for noncarcinogens	(-)	Target HQ	1	-	1	-		
Target indoor air concentration	**(ug/m3)**	**Target_IA**	**1.08E+01**	-	**1.08E+01**	-	Target indoor air concentration based on cancer risk (unit risk factor)	
	(ppbv)		**1.59E+00**	-	**1.59E+00**	-		
Target soil gas concentration	**(ug/m3)**	**Target_SV**	**1.07E+04**	**7.3E+03 - 1.1E+05**	**1.07E+04**	**7.3E+03 - 1.1E+05**		
Incremental Risk Estimates								
Incremental cancer risk from vapor intrusion	**(-)**	**Cancer_Risk**	**1.13E-07**	**1.1E-08 - 1.7E-07**	**1.13E-07**	**1.1E-08 - 1.7E-07**		
Hazard quotient from vapor intrusion	**(-)**	**HQ**	**2.92E-02**	**2.8E-03 - 4.3E-02**	**2.92E-02**	**2.8E-03 - 4.3E-02**		