APPENDIX H

Landfill Gas System Evaluation Summary Report

King County Department of Natural Resources and Parks

Solid Waste Division

Phase 1 – Vashon Island Closed Landfill

CONTRACT NO. E00102E08

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Landfill Gas System Evaluation Summary Report

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FINAL

LANDFILL GAS SYSTEM EVALUATION SUMMARY REPORT

Vashon Island Closed Landfill

Prepared for: King County Solid Waste Division

Project No. 090057-310.1.7.9 • August 29, 2019 Final

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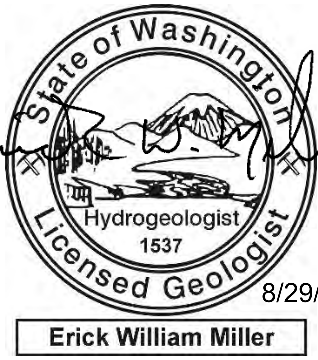

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Contents

Executive Summary... ES-1

1 Introduction 1

2 Background.. 2

2.1 Summary of Landfill History 2

2.2 Summary of Previous Investigation Results 3

2.2.1 Geologic and Hydrogeologic Setting 3

2.2.2 Extent of Solid Waste 3

2.2.3 Primary Contaminant Source 4

2.3 Landfill Gas Monitoring Network 5

2.3.1 Compliance Probes 5

2.3.2 Temporary Probes 6

2.4 Landfill Gas Collection System 6

2.4.1 Recent System Improvements 7

2.4.2 Landfill Gas Collection System Equipment Evaluation 7

2.5 Extent of Refuse Investigation 8

2.6 Landfill Gas Influence Testing 9

2.7 Post-Closure Landfill Gas Requirements 9

2.7.1 Landfill Gas Collection 9

2.7.2 Landfill Gas Treatment 10

3 Extent of Refuse Investigation 11

3.1 Subsurface Exploration Methodology 11

3.1.1 Drilling Methods 11

3.1.2 Investigative Derived Waste 12

3.1.3 Decontamination Procedures 12

3.2 South Slope Area Activities 12

3.2.1 Geophysical Survey 12

3.2.2 Soil Borings 13

3.2.3 Gas Probes 13

3.2.4 Gas Extraction Wells 14

3.3 Northwest Perimeter Road Area Activities 14

3.3.1 Geophysical Survey 14

3.3.2 Soil Borings 15

3.3.3 Gas Probes 15

3.4 Investigation Results and Recommendations 15

3.4.1 Extent of Refuse 15

3.4.2 Cover Characteristics 16

4 Extended Influence Testing Activities ... 17
4.1 Landfill Gas Collection and Monitoring Network ... 17
4.2 Baseline Monitoring ... 17
4.3 Startup Operations ... 17
4.4 Optimization Operations and Monitoring ... 18

5 Landfill Gas System Performance and Optimization Analysis ... 19
5.1 Historical Performance ... 19
5.1.1 Landfill Gas Generation ... 19
5.1.2 Landfill Gas Collection ... 19
5.1.3 Landfill Gas Migration Control ... 20
5.2 Performance During Influence Testing and Monitoring ... 21
5.2.1 Observed Vacuum Influence ... 21
5.2.2 Observed Landfill Gas Collection Rates ... 21
5.2.3 Conclusions and Recommendations ... 22
5.3 Air Quality Analysis ... 22
5.3.1 Landfill Gas Concentrations ... 22
5.3.2 System Flow Rates ... 23
5.3.3 Current Loading Rates ... 23
5.3.4 Conclusions and Recommendations ... 23
5.4 Optimization Analysis ... 24
5.4.1 Landfill Gas Collection System Optimization ... 24
5.4.2 Landfill Gas Treatment Optimization ... 25
5.4.3 Conclusions and Recommendations ... 25

6 Treatment Alternatives Analysis ... 27
6.1 Landfill Gas Treatment System Options ... 27
6.2 Operational Considerations ... 28
6.3 Optimization Schedule ... 29

7 Summary of Recommendations and Next Steps ... 30
7.1 Landfill Gas Collection ... 30
7.2 Landfill Gas Treatment ... 30
7.3 Landfill Gas Migration Monitoring ... 31
7.4 Landfill Gas Sampling and Air Quality Analysis ... 31

8 References ... 32

9 Limitations ... 35

List of In-Text Tables

5-1 Summary of Inferred ROIs During Extended Influence Test 21

5-2 Low-Quality Gas Collectors 25

6-1 Cost Comparison of Treatment Options 28

6-2 LFG Treatment Options Compared to Flow Rates 29

List of Tables

1 Gas Probe and Extraction Well Construction Information

2 Summary of Extended Influence Testing and Monitoring

3 Extended Influence Testing and Monitoring Measurement Summary

4 Pressure and Flow During Extended Influence Testing and Monitoring

5 Water Levels During Extended Influence Testing and Monitoring

6 Summary of Landfill Gas Sample Results at Blower Inlet (2013 and 2019)

7 Calculations and Loading Rates from March 2019 LFG Sample

List of Figures

1 Site Location Map

2 Property Features

3 Extent of Solid Waste

4 Landfill Gas Collection and Monitoring Systems

5 Surface Water Drainage Features

6 Leachate Collection and Monitoring Systems

7 Exploration Locations

8 Geologic Cross Section A-A’

9 Geologic Cross Section B-B’

10 Geologic Cross Section C-C’

11 Geologic Cross Section D-D’

12 Observed LFG Collection and LandGEM Model Results Over Time

13 LFG Collection Rates at Monitoring Points

List of Figures (continued)

14	LFG Concentrations at Compliance Probes Over Time
15	Extent of Observed Methane Over Time
16	Extended Influence Testing – Continuous LFG Monitoring Data
17	Extended Influence Testing – LFG Concentration Trends at Probes
18	Extended Influence Testing – Observed Vacuum and ROIs
19	LFG Collection Rates in South Slope Area
20	Analysis of Observed VOCs in Landfill Gas

List of Appendices

A	Daily Field Reports (Extent of Refuse Investigation and Extended Influence Testing)
B	Investigation Logs
C	Geophysical Investigation Report
D	LFG Equipment Evaluation Report
E	LandGEM Model Report
F	Laboratory Report
G	Report Limitations and Guidelines for Use

Executive Summary

Aspect Consulting, LLC (Aspect) and Herrera Environmental Consultants (Herrera) have prepared this Landfill Gas System Evaluation Summary Report (Report) for the Vashon Island Closed Landfill (VLF). This Report summarizes findings from an extent of refuse investigation and landfill gas (LFG) extended influence testing performed at the VLF, and provides recommendations based on LFG control system and treatment technology performance. The purpose of this work was to confirm the extent of refuse in two specific areas outside of the closed landfill area (the Northwest Perimeter Road and South Slope Areas) and provide a current and holistic understanding of LFG conditions at the VLF, to support the ongoing voluntary Remedial Investigation (RI) and Feasibility Study (FS) and assessment of termination of post-closure care activities.

The VLF property is located on the west side of Vashon Island (Figure 1). Major property features include the closed landfill, South Slope Area, stormwater features, roads, and existing transfer station facility (Figure 2). The extent of refuse in the Northwest Perimeter Road and South Slope Areas was not completely delineated prior to performing the work described in this Report. Refuse extent investigation activities documented in this Report have confirmed the extent of unlined refuse in these areas and aided in refining the boundary of unlined refuse across the VLF, as shown on Figure 3.

Historically, engineering controls have been operated and maintained in compliance with applicable regulations and to minimize environmental impacts. During the RI, groundwater quality impacts near the South Slope Area indicated additional LFG engineering controls were warranted. The LFG control system was expanded to the South Slope Area and extended influence testing was initiated to evaluate the effectiveness of these additional LFG engineering controls on improving groundwater quality conditions. Based on results of the extended influence testing and LFG system evaluation, we recommend the following changes in operations be considered to provide more effective LFG engineering control at the VLF.

LFG Collection

- Continue active LFG collection from the South Slope Area (GW-9, GW-10, GW-11) and from laterals T3 and T4 while the ongoing groundwater quality and LFG-to-groundwater migration pathway evaluations are performed.
- Transition low-quality/low-producing LFG collection wells and trenches from active collection to passive venting. Monitoring of perimeter probes should be performed to document migration control and compliance.
- Consider replacing the existing collection system blower/motor. We also recommend modifying the system to accommodate a manual switch and duplex system.

LFG Migration Monitoring

- Continue compliance LFG monitoring as required by the current monitoring program.
- Evaluate revisions to the monitoring program as the LFG collection system transitions from active collection to passive venting.

LFG Treatment

- Evaluate whether the amount of granular activated carbon (GAC) currently used for LFG treatment can be reduced for current and lower flow rates.
- As the LFG collection system transitions from active collection to passive venting, use bio-berms as an alternative to GAC treatment for polishing LFG prior to venting to the atmosphere.

LFG Sampling and Air Quality Analysis

- Periodically sample LFG at the blower system to assess changes in potential emissions related to changes in LFG collection operations. This will support demonstrating compliance with air quality regulations and goals.

In our opinion, implementing these recommendations will help take a major step toward ending post-closure activities at the VLF.

1 Introduction

Aspect Consulting, LLC (Aspect) and Herrera Environmental Consultants (Herrera) have prepared this Landfill Gas System Evaluation Summary Report (Report) for the Vashon Island Closed Landfill (VLF). Work described in this Report was performed for King County Solid Waste Division (KCSWD) under Tasks 310.1.6.4, 310.1.7.7, and 310.1.7.9, of Contract Number E00102E08 for Environmental Investigations, Monitoring, and Remediation Services for Closed Landfills.

This Report summarizes findings from an extent of refuse investigation and landfill gas (LFG) extended influence testing performed at the VLF, and provides recommendations based on LFG control system and treatment technology performance. The purpose of this work was to confirm the extent of refuse in two specific areas outside of the closed landfill area (the Northwest Perimeter Road and South Slope Areas) and provide a current and holistic understanding of LFG conditions at the VLF, to support the ongoing voluntary Remedial Investigation (RI) and Feasibility Study (FS) and assessment of termination of post-closure care activities. The VLF property is located on the west side of Vashon Island (Figure 1). The site layout and major features are shown on Figure 2.

The extent of refuse in the Northwest Perimeter Road and South Slope Areas was not completely delineated prior to performing the work described in this Report. Data collection in 2018 to support the extent of refuse determination and LFG extended influence testing were completed by Aspect. The evaluation of LFG conditions are based on monitoring data collected by King County and others as referenced.

Based on evaluation of the LFG system, we recommend LFG collection optimization and transitioning from active to passive LFG collection in portions of the landfill. To ensure LFG migration is controlled and that groundwater quality is protected, the existing monitoring program should continue at VLF and be modified appropriately as the collection system is optimized and transitioned to a passive system. Once the system has transitioned to passive collection, LFG conditions can be compared to the criteria presented in the Washington State Department of Ecology (Ecology) guidance document *Preparing for Termination of Post-Closure Activities at Landfills Closed Under 173-304 WAC* (Ecology, 2013) including "little to no LFG generation."

The remaining sections of this Report include summaries of the following:

- Section 2 – Background information
- Section 3 – 2018 extent of refuse investigation activities
- Section 4 – 2018 extended influence testing activities
- Section 5 – LFG System Performance and Optimization Analysis, including an updated air quality analysis
- Section 6 – Treatment Alternatives Analysis
- Section 7 – Recommendations and Next Steps

2 Background

The VLF facility currently includes a transfer and recycling station, a scale house, and post-closure environmental controls. Landfill environmental controls include a permanent geomembrane cover system across Phase 1 and 2 closure areas, LFG extraction and treatment, stormwater management, and leachate collection. Figure 2 depicts the closure areas and existing facility features. Existing environmental controls are depicted on Figures 3 through 6.

This section includes a summary of historical activities, including landfilling, environmental investigations, and corrective actions. The regulatory requirements driving historical and future post-closure activities are also discussed.

2.1 Summary of Landfill History

Solid waste disposal activities occurred at the VLF since the early 1900s. King County assumed operations during the late 1950s (R.W. Beck and Associates, 1983), at which time routine record-keeping practices were initiated. Based on review of historical topographic maps, solid waste was placed in a former valley. The northwest portion of the landfill, approximately 2.3 acres, was closed in 1988 in accordance with WAC 173-304 (Phase 1 Closure Area). During Phase 1 closure, a liner was placed across the central portion of the landfill. Refuse was accepted for placement in the lined portion of the landfill until 1999. Final landfill closure (Phase 2 closure) was completed in 2001 in accordance with WAC 173-351.

Phase 1 closure activities included installation of a cover system, a liner below the “lateral expansion area” (i.e., Phase 2 closure), surface water management features, a leachate collection system, and LFG collection infrastructure. Approximately 10 acres were covered or lined. Refuse placed in the ravine between the south toe of the lined area and the south stormwater facilities (also referred to as the South Slope Area) was stabilized using geotextile and a native soil cover (Berryman & Henigar and UES, 2006a). The gravity leachate collection system installed as part of the Phase 1 closure included leachate conveyance infrastructure within the landfill footprint, a lined leachate lagoon, a discharge pump station, a leachate tank truck loading station, and a perforated toe collector and pump station at the base of the South Slope Area. The surface water management systems installed as part of the Phase 1 closure included ditches, culverts, and siltation and detention ponds. The LFG monitoring network and LFG collection system improvements are described in Sections 2.3 and 2.4, respectively.

Phase 2 closure activities commenced after discontinuing placement of material in the lateral expansion area in August 1999. At that time, a temporary plastic cover was placed over the refuse. Final Phase 2 closure was completed between 1999 and 2001. The closure activities began with expansion of the existing surface water management infrastructure and improvements to accommodate flows following installation of the final cover system. The second stage of Phase 2 closure involved installation of an impermeable cap over the refuse, and upgrades to the other environmental control systems. The combined Phase 1 and Phase 2 closure areas are approximately 10.3 acres. Final closure record drawings were presented by Berryman & Henigar et al. (2001).

Detailed descriptions of the final cover, surface water management, leachate collection, and LFG collection systems at the VLF following Phase 2 closure are provided by Berryman & Henigar and UES (2006a). A summary of these systems is provided in the 2018 Agency Draft Remedial Investigation (RI) Report (Agency Draft RI Report; Aspect, 2018a).

2.2 Summary of Previous Investigation Results

Hydrogeology, water quality, and environmental investigations have been conducted at the VLF since 1983, led by R.W. Beck and Associates and Sweet, Edwards and Associates (1984), Harper-Owes (1986), Harper-Owes, et al. (1988), CH2M HILL (1995, 1996), Berryman & Henigar et al. (2000, 2001), Berryman & Henigar and UES (2004, 2006a), King County (2011a and 2011b), and Aspect (2012). Results from all previous investigation activities at the VLF are described in the 2018 Agency Draft RI Report (Aspect, 2018a). A brief summary of previous investigation results that support the conceptual site model and efforts in this report is provided below. All exploration locations from previous investigations are depicted on Figure 7, including borings, test pits, probes, wells, and surface water sampling locations.

2.2.1 Geologic and Hydrogeologic Setting

VLF geology is composed of glacially derived sediments, with surficial geology in the southern portion of the property being primarily glacial till and advance outwash. Cross section locations are shown on Figure 3. Cross sections illustrating the geologic and hydrogeologic setting at the VLF are included as Figures 8 through 11.

Groundwater in two underlying stratigraphic units (Unit C and Unit D) has been characterized for the nature and extent of constituents of concern (COCs) at the VLF. Subunits Cc2 and Cc3 are considered to be the principal water-bearing layers of Unit C and are not continuous across the VLF. The Cc units are separated from one another by fine-grained soils (Cf). Groundwater with concentrations of COCs exceeding preliminary cleanup levels (PCULs) is limited to Unit Cc2. Groundwater flow in Unit Cc2 is westerly and discharges from seeps located on the steep hillslope on the western side of the VLF property. Groundwater COCs have not been detected above PCULs in Unit D, both in on-property wells and in off-property domestic drinking water wells monitored by King County. In all deeper borings completed onsite, a fine-grained portion of Unit C was observed separating the water-bearing portions of Unit C from the Unit D aquifer.

2.2.2 Extent of Solid Waste

Based on review of historical topographic maps, refuse was placed in a former valley running approximately north-south. The horizontal extent of solid waste (Figure 3), is based on multiple lines of evidence:

- Visual observations (Golder Associates, 1987)
- Geophysical investigations (Aspect and Duoos, 2018)
- Subsurface explorations
- LFG occurrence

The vertical extent of solid waste in the central portion of the VLF has not been verified by subsurface explorations; however, review of historical topographic maps indicate that solid waste reaches a maximum thickness of 20 to 40 feet near the center of the former valley and thins towards the outer margins of the landfill (Golder Associates, 1986). Site investigations suggest that refuse extends approximately 300 feet south of the lined Phase 2 Closure Area (South Slope Area) and approximately 70 feet west of the lined Phase 1 Closure Area (the Northwest Perimeter Road Area). The leachate lagoon, located at the south end of the landfill, was constructed with a geomembrane liner; and it is unknown if solid waste underlies this feature. The estimated extent of Phase 1 and 2 final covers, and unlined refuse (solid waste placed prior to 1988) are shown on Figure 3.

Much of the South Slope Area is covered by geotextile fabric that was installed during Phase 1 closure activities at depths of 3.5 to 6.5 feet below ground surface (bgs) and covered with topsoil. Fill soil thickness above unlined refuse in the Northwest Perimeter Road Area ranged from approximately 4.5 to 9 feet. Where refuse was encountered in borings in these areas, the depth interval of refuse is included with the boring ID on Figure 3. Section 3 describes details of the extent of refuse investigation outside the main refuse area.

Within the context of underlying geology, solid waste/refuse is in contact with till or the advance outwash. As a coarser grained unit, the advance outwash would permit greater contaminant transport than the till.

2.2.3 Primary Contaminant Source

The constituents detected at the VLF in groundwater at concentrations exceeding PCULs are metals (arsenic and iron) and VOCs (vinyl chloride, TCE, benzene, and 1,2-dichoropropane). Based on results from the 2005 Berryman & Henigar source evaluation (Berryman & Henigar and UES, 2006b) and the 2015/2016 Anchor QEA geochemical evaluation (Anchor QEA, 2017), LFG generated from the refuse area is the primary source of groundwater quality impacts at the VLF.

The Berryman & Henigar source evaluation (2006b) included an analysis of groundwater, leachate, and LFG data, and provided the following primary findings:

- Groundwater conditions at the VLF changed in response to closure activities.
- Leachate was impacting water quality prior to and just after Phase 2 closure but was minimal after Phase 2 closure.
- LFG was the primary source of water quality impacts to groundwater and springs after Phase 2 closure.

The 2015/2016 Anchor QEA geochemical evaluation (Anchor QEA, 2017) included analysis of specific constituent data from selected groundwater, seep, and leachate sample locations such that lines of evidence for attributing groundwater impacts from leachate or LFG could be identified. An isotopic analysis was also performed to confirm LFG as the primary source of impacts to groundwater quality. Anchor QEA (2017) provided the following primary findings:

- LFG is the primary source of groundwater contamination, which is consistent with the broader VLF dataset.

- Leachate does not appear to be a primary source for groundwater contamination post-closure, except at seep SW-2, where chloride and sodium concentrations were slightly higher than those observed at MW-33 and MW-35. This suggests a minor contribution of leachate at SW-2, in addition to the contribution by LFG.
- Chloride concentrations observed at SW-2 are consistent with a residual leachate impact because chloride concentrations have decreased overtime. Chloride concentrations at SW-2 were near 50 mg/L in 2010, but by 2017 had decreased to approximately 20 mg/L. This decreasing trend in chloride concentrations, paired with consistent elevated alkalinity concentrations, presents strong evidence that leachate is a residual impact and LFG is the current and primary impact.

Additional details on the analysis and findings from the source and geochemical evaluations can be found in the 2018 Agency Draft RI Report (Aspect, 2018a).

Surface water impacts are located along the West Hillslope. Groundwater from Unit C discharges as seeps along the West Hillslope on the west side of the VLF property, flows downhill, and is intercepted by weirs near the western property boundary. The water flows as surface water beyond the western property boundary in an unnamed tributary of Robinwood Creek. Elevation and visual reconnaissance of the soil outcrops at the surface indicate that the seeps are expressions of groundwater discharging from Unit C. An analysis of groundwater chemistry from these seeps and impacted VLF monitoring wells indicates that Unit Cc2 is the primary source of contamination at the seeps. Thus, groundwater discharging from the property is a source to downgradient surface water.

2.3 Landfill Gas Monitoring Network

King County performs routine LFG compliance monitoring in accordance with the VLF permit requirements. LFG is monitored monthly at 26 gas probes, in accordance with the "Environmental Monitoring Sampling and Analysis Plan and Quality Assurance Project Plan for Vashon Island Landfill" (King County, 2016). Probe monitoring is used to demonstrate lateral control of LFG migration and protection of surrounding properties. LFG compliance monitoring results have indicated that lateral LFG migration has been and is being controlled, and performance monitoring results have indicated improvements in control of vertical LFG migration in the South Slope Area (see Section 5.1 for details).

Compliance gas probes to evaluate LFG migration control were installed between 1986 and 1995 in soils around the refuse perimeter, near the property boundary. Temporary gas probes were installed between 2014 and 2018 in or near refuse to assess the performance of the LFG collection system. Gas probe construction details are included in Table 1 and their locations shown on Figure 4.

2.3.1 Compliance Probes

The initial compliance LFG probes for the VLF included P-1, P-2, GP-5, and GP-6, which were installed in 1986. P-1 and P-2 were decommissioned prior to construction of the landfill liner in the lateral expansion area in 1989 (Phase 2). Additional compliance probes GP-1 and GP-2 were installed in 1992 for monitoring further south of the landfill.

In 1995, eight LFG probe sets (NP-1 through NP-8) were installed for monitoring to the east, south, west, and north of the landfill. Each of these probe sets included a shallow, intermediate, and deep probe.

Monitoring wells MW-13 and MW-24, located adjacent to gas probe set NP-3, have been monitored routinely for LFG concentrations since 2010.

2.3.2 Temporary Probes

In 2014, temporary probes VTP-1S, VTP-2S, and VTP-2D were installed to assess LFG conditions inside the property boundary. VTP-1S was installed in native soils west of the Phase 1 Closure Area and the EF-3 horizontal collector to assess potential LFG migration. Due to the screen interval of VTP-1S typically being submerged by perched groundwater, and no LFG was measured; this probe was decommissioned in 2016. VTP-2S and VTP-2D were installed in the South Slope Area. VTP-2S was screened in the gravel gas collection layer above refuse and VTP-2D was screened in refuse.

In August 2016, two temporary probe pairs (VTP-3S/VTP-3D and VTP-4S/VTP-4D) were installed to supplement existing probes VTP-2S and VTP-2D. These temporary probes were used to assess the extent of LFG migration and monitor the performance of LFG extraction well GW-9 at controlling LFG migration during an "influence test" conducted from September 2016 through March 2017. Shallow probes (VTP-3S and VTP-4S) were screened within waste and deep probes (VTP-3D and VTP-4D) were screened in native soils below waste. Installation of extraction well GW-9 is discussed in Section 2.4.

In January 2017, two additional temporary probe pairs (VTP-5S/VTP-5D, and VTP-6S/VTP-6D) were installed during the influence test to further investigate the extent of refuse, assess the potential for methane (CH_4) migration, and evaluate the radius of influence for LFG extraction from GW-9.

In April 2018, four temporary probes (VTP-7, VTP-8, VTP-9, and VTP-10) and one temporary probe pair (VTP-11S/VTP-11D) were installed during an investigation of refuse extent. Temporary probes VTP-7 through VTP-10 were installed in the South Slope Area and VTP-11S and VTP-11D were installed outside the northwest corner of the perimeter road.

All temporary probes, except for VTP-11S and VTP-11D were used for monitoring during the extended influence testing, as described in Section 4.

2.4 Landfill Gas Collection System

The existing LFG collection system includes horizontal trenches and vertical wells that were installed between 1988 and 2018. The existing LFG collection system operated in accordance with the 1997 Operations and Maintenance Manual (CH2M Hill, 1997). The system layout is depicted on Figure 4.

As part of the Phase 1 closure in 1988, King County installed a passive LFG collection system using horizontal perforated piping connected to independent elevated flares (including EF-1, EF-2, EF-3, and EF-4), in addition to the gas collection gravel placed beneath the Phase 1 closure cover system. The system was designed to control LFG along the edges of waste (EF-1, EF-2, and EF-3) and within the covered waste area (EF-4).

In 1996, King County converted the passive LFG collection system to an active system by installing a blower and treatment system, connecting EF-1 through EF-4 to a gas conveyance pipe header, and decommissioning the elevated flares. The collected LFG was not flammable, and LFG was treated using granular activated carbon (GAC). Condensate from LFG conveyance piping was pumped or drained into leachate pipes for conveyance to the lined leachate lagoon. LFG collection infrastructure was expanded in 1996 with the following installations:

- Vertical gas wells GW-1 through GW-8 across the bottom two-thirds of refuse thickness in the Phase 1 Closure Area (CH2M HILL, 1997).
- Horizontal trench collectors T-1 and T-5 along the northern and western edges of unlined waste in the gas collection gravel placed above the refuse and beneath the Phase 1 closure cover system.
- Horizontal trench collector T-2 along the eastern edge of unlined waste in reworked “natural soil material” beneath the Phase 1 bottom liner geomembrane (no waste had yet been placed above the liner in this area).
- Horizontal trench collectors T-3 and T-4 in what was then uncovered refuse above the bottom liner at the south end of the landfill, within the Phase 2 closurearea.

During landfilling activities between 1996 and 1999, horizontal trench collectors FT-1 through FT-4 were installed between refuse lifts and connected to the existing active LFG collection system. In 2001, horizontal trench collectors FT-5 and FT-6 were installed just below the 2001 closure cover system and connected to the existing active LFG collection system.

2.4.1 Recent System Improvements

Since 2015, improvements have been made to the LFG collection system to optimize performance and control LFG migration.

In August 2016, a vertical LFG extraction well (GW-9) was installed to initiate LFG collection in the South Slope Area (Figure 4). GW-9 was screened across refuse, and the aboveground wellhead was connected to the active LFG collection system with an aboveground lateral. A valved monitoring assembly was installed to adjust flow and to measure flow, gas concentrations, and static pressure throughout influence testing and monitoring.

In June 2018, two vertical LFG extraction wells (GW-10 and GW-11) were installed to supplement LFG collection and influence testing in the South Slope Area. In September 2018, GW-10 and GW-11 were connected to the active LFG collection system. Extended influence testing that included extracting LFG from GW-9, GW-10, and GW-11, and monitoring nearby gas probes, was completed on December 5, 2018. Monitoring has continued since completion of the extended influence testing to evaluate the effectiveness of LFG extraction and LFG migration control in the South Slope Area. The South Slope Area LFG influence testing activities and results are described in Section 2.6. Extended influence testing activities are described in Section 4 and the results are discussed in Section 5.1.

2.4.2 Landfill Gas Collection System Equipment Evaluation

A camera survey within laterals EF-1, EF-2, EF-3, and T-2 was conducted in June 2015 (Herrera, 2015). These horizontal collectors were characterized by lower-than-anticipated flow rates and LFG concentrations, indicating potential blockages. Although limited gravel debris was found inside the horizontal collectors, no blockages were identified (Herrera, 2015). Relative to the design drawings, the location of EF-1 appeared to be shifted approximately 10 feet to the south and EF-2 appeared to be shifted approximately 30 feet to the west and not beneath the landfill liner (Herrera, 2015). The functionality of lateral EF-1 was thought to be compromised, as excavation inspection and the camera survey revealed fine-grained material in the pipe bedding, which could limit or impede vacuum influence through the material. EF-1 had standing water less than one-third full for the first 20 feet of the inspection.

In August 2018, an inspection and evaluation of LFG equipment was conducted to determine if the LFG treatment system at the VLF was meeting original design specifications, current function and operating requirements, and equipment interchangeability/standardization criteria. It was concluded that equipment requires either maintenance, repair, or replacement to maintain continued functionality for the environmental controls systems. Surging was also observed at the blower and could have been a result of sagging LFG conveyance lines to the blower. Herrera recommended fixing the sag in the line at the corner of the entrance road, where the road is also sagging, to provide more efficient blower operations (Herrera, 2018; Appendix D).

A summary of the 2018 site inspections and condition assessment results, as well as recommendations for maintenance, repair, or replacement of the existing LFG equipment, are provided in the "Landfill Gas Equipment Evaluation Memorandum" (Herrera, 2018; Appendix D).

2.5 Extent of Refuse Investigation

The extent of refuse investigation activities were performed in the South Slope and Northwest Perimeter Road areas to evaluate three primary conditions:

1. The potential for LFG migration from the main closure area to these areas
2. Cover conditions in these areas
3. LFG control options

The depth and extent of refuse in the main landfill closure area and the South Slope and Northwest Perimeter Road areas is documented in the Agency Draft RI Report (Aspect, 2018a). The investigation and evaluation activities were performed in general accordance with the Geophysical Work Plan (Aspect, 2017a) and Subsurface Work Plan (Aspect, 2018b). The geophysical and subsequent subsurface investigations performed as part of this scope confirmed the extent of refuse in the South Slope Area and Northwest Perimeter Road Area as described below in Section 3.

The investigation results, combined with ongoing LFG monitoring and influence testing in the South Slope Area, provided sufficient data to evaluate LFG conditions and to support recommendations for future LFG control.

2.6 Landfill Gas Influence Testing

LFG influence testing was initiated in the South Slope Area after evaluating monitoring results and the historical performance of LFG collection in the southern portion of the landfill. The initial stage of LFG influence testing in the South Slope Area included monitoring at extraction well GW-9 and several gas monitoring probes.

The GW-9 influence test was conducted from September 14, 2016, through March 1, 2017. The GW-9 influence test demonstrated that the horizontal effective radius of influence for extraction from GW-9 was approximately 100 feet, and that LFG extraction from GW-9 was expected to limit or eliminate the gas-to-groundwater transport pathway within the radius of influence. Methane and CO_2 concentrations decreased substantially in temporary probes during and following the influence test. Extraction of LFG from GW-9 reduced methane concentrations within the radius of influence in both the refuse (shallow zone) and underlying native soils (deep zone) to below 1 percent. Specific data obtained from the GW-9 influence test are provided in the "Vashon Closed Landfill – Influence Testing Summary Report" (Aspect, 2017b).

Based on results of the GW-9 influence test, LFG extraction from the South Slope Area was found to provide benefit to the protection of groundwater and GW-9 has remained connected to the LFG collection system and operational. As recommended in Aspect (2017b), additional temporary gas probes were installed in April 2018 to further investigate the extent of refuse and methane, and effectively identify where two new vertical LFG extraction wells (GW-10 and GW-11) should be located. To prepare for extended influence testing, the "Vashon Island Closed Landfill – Draft Landfill Gas Extended Influence Testing Work Plan Addendum" (Work Plan Addendum; Aspect, 2018c) was developed.

The extended influence testing activities performed in 2018 are described in Section 4, and performance and observations from the testing are described in Section 5.2 as part of the overall LFG collection, treatment, and optimization analysis.

2.7 Post-Closure Landfill Gas Requirements

Protection of human health and the environmental is the utmost priority for KCSWD and the landfill post-closure care period. As it specifically relates to LFG, WAC 173-351-200(4)(a) indicates that owners or operators of a municipal solid waste (MSW) landfill must ensure that:

1. The concentration of methane gas generated by the facility does not exceed 25 percent of the lower explosive limit for methane in facility structures (excluding gas control or recovery system components).

2. The concentration of methane gas does not exceed the lower explosive limit for methane at the facility property boundary or beyond.

3. The concentration of methane gas does not exceed 100 parts per million by volume of methane in offsite structures.

2.7.1 Landfill Gas Collection

The existing LFG control and collection system was designed and has been operated to ensure that the standards listed above are met. Routine monitoring performed by

KCSWD indicate compliance with regulatory thresholds. Historical LFG system and performance details are summarized above in Section 2.4. Details of the LFG system performance evaluation are included in Section 5.

2.7.2 Landfill Gas Treatment

Landfill gas treatment at the VLF is regulated by the Puget Sound Clean Air Agency (PSCAA). Since 1997, LFG treatment has included passing LFG through GAC before discharge to the atmosphere, as described in the Notice of Construction No. 6513 approved by the Puget Sound Air Pollution Control Agency (CH2M Hill, 1997). Emission sources that include treatment capacity of greater than 200 standard cubic feet per minute (scfm) must be registered under Section 5.03 of PSCAA's Regulation I. Toxic air pollutants (TAPs) emitted from an MSW landfill are required to be monitored, managed, and treated as described in PSCAA Regulation III.

An air quality analysis is included in Section 5, which indicates a dispersion analysis is not required based on current data. LFG treatment alternatives evaluated in Section 6 account for whether or not active or passive LFG treatment are acceptable based on the quality of LFG being collected from the VLF.

3 Extent of Refuse Investigation

Between December 2017 and April 2018, subsurface extent of refuse investigation activities in the South Slope Area and Northwest Perimeter Road Area included a geophysical survey, soil borings, and installation of gas probes. Based on findings from these investigations and previous influence test results, two gas extraction wells (GW-10 and GW-11) were installed in the South Slope Area in June 2018 and utilized for extended influence testing as described later in this report.

The geophysical survey consisted of magnetometer, EM-31, and electrical resistivity in the South Slope Area and Dual-EM in the Northwest Perimeter Road Area. The survey types were selected to provide the best possible results considering known conditions in each area. Following evaluation of the geophysical survey results, soil borings were sited and advanced in April 2018 to delineate the extent of refuse in the South Slope Area (B-6 through B-10) and the Northwest Perimeter Road Area (B-11 and B-12). Soil gas probes were installed in April 2018 to evaluate LFG conditions in the South Slope Area (VTP-7 through VTP-10) and the Northwest Perimeter Road Area (VTP-11S and VTP-11D).

The temporary LFG probes will be decommissioned following the current LFG investigation. A description of subsurface exploration methodology and additional details for the activities performed in each area are described below. Figure 3 shows the installed location of each soil boring and gas probe.

3.1 Subsurface Exploration Methodology

Subsurface investigations were conducted in accordance with approved work plans. Drilling methods, handling and disposal of investigation derived waste, and decontamination procedures are summarized below.

3.1.1 Drilling Methods

The borings were advanced using a dual-casing rotosonic drilling system that allowed the collection of continuous-core soil samples. During drilling, samples for soil classification and field screening were collected continuously in up to10-foot lengths using a 4.75-inch-diameter inner core barrel and an 8-inch-diameter outer casing. Soil samples and cuttings were field-screened for the presence of volatile organic compound (VOC) vapors using a MiniRae 3000 photoionization detector (PID). The PID is designed to detect and measure VOC vapors in air, but it does not detect methane. VOC concentrations were monitored to protect worker health and safety during drilling and screen for VOCs present in soil or refuse encountered during drilling.

A LandTec GEM 5000 LFG meter was used to monitor methane, carbon dioxide (CO_2), oxygen (O_2), and hydrogen sulfide (H_2S) concentrations. LFG and hydrogen sulfide measurements were taken from the top of the drill casing after each sample run, and periodic ambient air measurements were recorded as part of Health and Safety monitoring. PID and methane levels in the breathing zone were below concentrations that would trigger mitigation or work stoppage, as specified in the project-specific Health and Safety Plan. Soil sample descriptions were made in general accordance with ASTM International (ASTM) Method D2488, Standard Practice for Description and

Identification of Soils (Visual/Manual Procedure). All information pertaining to the borings was recorded on field boring logs, including PID field screening results.

Daily field reports are provided in Appendix A. Final logs for each soil boring, which include exploration notes, field screening measurements, and soil/material descriptions are provided in Appendix B.

3.1.2 Investigative Derived Waste

Drill cuttings were contained in roll-off containers designed for hauling to an approved facility following designation sampling. The containers were appropriately labeled as IDW. Soil cuttings within each container were segregated by borehole using plastic sheathing and were disposed of at the Cedar Hills Regional Landfill according to King County waste clearance requirements.

All water generated during the drilling and decommissioning activities was temporarily contained in WSDOT-approved 55-gallon drums. The water generated during drilling was removed by a King County vactor truck for disposal.

3.1.3 Decontamination Procedures

Equipment used for drilling or making measurements in boreholes was decontaminated prior to use on-Site and decontaminated again between drilling locations. Drilling equipment was decontaminated by the drilling contractor, Holt Services (Holt), using appropriate decontamination procedures, including a mobile, hot-water high-pressure washer, buckets, and brushes.

Sampling equipment, such as the water level indicator, was decontaminated after use at each borehole location by spraying Alconox or other non-phosphate detergent on the equipment, scrubbing the equipment with a brush, rinsing it thoroughly with potable water, and then rinsing it thoroughly with distilled water.

3.2 South Slope Area Activities

3.2.1 Geophysical Survey

A magnetometer survey, electromagnetic (EM) survey, and electrical resistivity imaging (ERI) were performed on the South Slope Area to assess the horizontal and vertical extent of refuse. These methods were selected based on the depth of refuse.

The magnetometer/gradiometer measures anomalies related to buried ferrous material. The detailed magnetic data (total field and vertical gradient data) were obtained at approximate 0.5-foot intervals along accessible survey lines that were generally spaced about 50 feet or less apart throughout the area of interest. Figure 2 from the "Geophysical Investigation Report" (Aspect and Duoos, 2018) shows the magnetometer survey lines (Appendix C).

The EM survey was performed over the eastern portion of the South Slope Area using an EM-34 Conductivity Meter with a 10-meter coil spacing to record horizontal and vertical dipole data at effective depths of 25 and 45 feet, respectively. The EM-34 survey lines are shown on Figure 3 in Aspect and Duoos (2018). Due to the greater depth of refuse in the area, the Dual-EM instrument, which has an effective depth of 18 feet, was not used.

In an attempt to better assess the depth of refuse, one ERI profile was run approximately east-west across the South Slope Area.

The geophysical surveys were referenced to a grid system established using 300-foot tape measure and pink spray paint and/or PVC pin flags. The locations of most of the grid points were obtained with a sub-meter GPS system.

3.2.2 Soil Borings

Five soil borings (B-6 through B-10) were completed in the South Slope Area. Soil samples were collected using the drilling equipment and methods described below. Prior to the commencement of drilling, soil boring locations were field-staked by project representatives from King County, Aspect, and Holt. Public and private utility locates were conducted prior to drilling.

3.2.3 Gas Probes

Gas probes in the South Slope Area (VTP-7 through VTP-10) were installed and soil samples were collected using the same drilling equipment and methods described above for soil borings. The purpose of the additional gas probes in the South Slope Area were to evaluate the extent of refuse and monitor the zone of influence from extraction wells. Soil samples were screened using the same field-screening methods described above for the soil borings. Worker health and safety was also monitored during installation of the gas probes using the methods described above.

VTP-7 and VTP-8 (South Slope Area)

Gas probes VTP-7 and VTP-8 were installed on the South Slope about 230 feet west and 170 feet southwest of GW-9, respectively, to help define the lateral and vertical extent of LFG. VTP-7 and VTP-8 were constructed with 5-foot sections of screen situated within refuse. The portion of each borehole below refuse was backfilled with bentonite chips and hydrated to seal the boring and prevent potential vertical migration of LFG.

Refuse was identified from approximately 7 feet bgs to 15 feet bgs in the VTP-7 boring. VTP-7 was subsequently screened between 9 and 14 feet bgs. At VTP-8, refuse was identified from approximately 15 to 21 feet bgs, and the gas probe was screened from 15 to 20 feet bgs. Gravel filter pack was placed in the borehole annulus to surround the probe screen and extend from 1 foot below the bottom of the probe to 1 foot above the top of screen. Bentonite chips were placed in the boreholes above the gravel filter pack up to approximately 2 feet bgs where concrete was then installed to create a surface seal and secure the flush-mounted 12-inch-diameter steel monument.

VTP-9 and VTP-10 (South Perimeter Road/EF-1 Area)

Gas probes VTP-9 and VTP-10 were installed in the South Perimeter Road about 150 feet northwest and 50 feet north-northwest of GW-9, respectively, to monitor LFG within the "gas collection gravel" layer identified in design documents (Harper-Owes, 1998). The gas collection gravel layer was installed below the Phase 2 closure liner and above the refuse in the South Slope Area to collect and convey LFG toward EF-1. The soil materials observed during drilling VTP-9 and VTP-10 were described as gravelly, silty sand; this was consistent with soils encountered during investigation of backfill around EF-1. Refuse was not identified in either 10-foot deep boring.

VTP-9 and VTP-10 were both screened from 7.5 to 10 feet bgs across what was inferred as the gas collection gravel layer. Gravel filter pack was placed in each borehole annulus to surround the probe screen and extended from the bottom of boring to 7 feet bgs (VTP-9) and 6.75 feet bgs (VTP-10). Bentonite chips were placed in the boreholes above the gravel filter pack up to approximately 2 feet bgs where concrete was then installed to create a surface seal and secure the flush-mounted 12-inch-diameter steel monument.

3.2.4 Gas Extraction Wells

Gas extraction wells GW-10 and GW-11 were installed along the access road for the leachate lagoon west of GW-9. The well locations were determined based on the positive results of the GW-9 influence test, the inferred thickness of refuse, drilling access, and ease of connection with the existing LFG collection system. Refuse was encountered in the boring for GW-10 from approximately 12.5 to 32.5 feet bgs, and in the boring for GW-11 from approximately 7.5 to 20 feet bgs.

Borings were advanced several feet into native material below the refuse, then backfilled with bentonite chips to provide a bottom seal. Perforated 4-inch HDPE screens were set within a layer of gravel filter pack, and extended from 15.5 to 28.5 feet bgs and 10.5 to 17.5 feet bgs for GW-10 and GW-11, respectively. The filter pack extended approximately 1 foot above the perforations, and the remaining annulus was filled with bentonite chips. See GW-10 and GW-11 boring/well logs in Appendix B for additional detail.

The wellheads for GW-10 and GW-11 were connected to the LFG lateral extending from EF-1 to GW-9. A monitoring assembly was installed to allow for measurements of pressure, flow, and LFG concentrations.

3.3 Northwest Perimeter Road Area Activities

3.3.1 Geophysical Survey

Ground Penetrating Radar (GPR) and Dual-EM methods were employed in the Northwest Perimeter Road Area, with the Dual-EM method providing the best indications of buried refuse. A preliminary test of the GPR method indicated that it did not provide a distinct difference between native materials and buried refuse. The presence of the underground utilities also complicated the GPR data. Therefore, the GPR method was not pursued further.

Preliminary evaluation of the shallow EM method (Dual-EM instrument; effective to a depth of 18 feet) indicated that a reasonable change in EM conductivity could be observed between the native materials and the refuse, based on the boring and test pit information.

The Dual-EM data were recorded along lines that run approximately perpendicular to the Northwest Perimeter Road. The lines were spaced at 50- to 70-foot intervals using a surveyor's wheel and heading north along the road. Line 0 N is located along the north edge of the entrance to the site. Each survey line was marked at 10-foot intervals using a 300-foot tape measure and pink paint and/or PVC pin flags. The beginning (Station 0') of most of the lines was located at the chain link fence along the west edge of the grassy area about 30 to 50 feet west of the Northwest Perimeter Road. GPS coordinates were recorded at Station 30E and 90E along each line.

One Dual-EM line was proposed to run north-south, 20 feet west of the chain link fence, if access conditions allowed. This area had very heavy brush and large trees and was not accessible; therefore, that line was not included.

3.3.2 Soil Borings

Two soil borings (B-11 and B-12) were advanced in the Northwest Perimeter Road Area and soil samples were collected using the same drilling equipment and methods described above for soil borings B-6 through B-10 in the South Slope Area. The purpose of soil borings B-11 and B-12 in the Northwest Perimeter Road Area were to evaluate the extent of refuse and cover characteristics if encountered. Soil samples were screened using the same field-screening methods described above, and worker health and safety was also monitored using the methods described above. Refuse was not encountered in soil borings B-11 and B-12.

3.3.3 Gas Probes

Gas probes in the Northwest Perimeter Road Area (VTP-11S and VTP-11D) were installed and soil samples were collected using the same drilling equipment and methods described above for soil borings and gas probes in the South Slope Area. The purpose of the additional gas probes in the Northwest Perimeter Road Area was to evaluate the extent of refuse and monitor LFG. Soil samples were screened using the same field-screening methods described above, and worker health and safety was also monitored using the methods described above. Refuse was not encountered in soil borings for VTP-11S and VTP-11D.

3.4 Investigation Results and Recommendations

3.4.1 Extent of Refuse

The subsurface investigation described above provided confirmatory evidence to define the horizontal and vertical extent of refuse at the VLF. The horizontal extent of refuse is depicted on Figure 3. Cross sections included as Figures 8 through 11 indicate the vertical extent of refuse along the transects shown on Figure 3. All logs that support the defined extent of refuse are included in Appendix B. Results from the 2018 subsurface investigation in each area are described below.

South Slope Area

The geophysical results generally correlate with the depth and extent of refuse determined from boring information in the South Slope Area. The various geophysical methods used (magnetometer, EM-34, and ERI) correlate well with each other. In addition, the ERI profile correlated well with the depth of the base of the refuse observed in several borings and wells, although it was not able to delineate the depth to the top of refuse. The areas with moderate to high anomalous zones indicate a high confidence for the presence of buried refuse. Questionable and/or low anomalous zones are less distinct and may indicate smaller amounts of refuse and/or natural changes in subsurface conditions.

In the South Slope Area, observed refuse depths and thicknesses supported and refined the geophysical investigation findings. In soil borings for probes VTP-7 and VTP-8, refuse thicknesses of 8 feet and 6 feet, respectively, were identified approximately 7 and 15 feet below ground surface. In borehole B-7, approximately 3 feet of refuse was observed to be overlain by 12 feet of soil cover material, and underlain by about 5 feet of scattered debris in soil. Other soil borings were drilled beyond the extent of refuse. Borings for gas extraction wells GW-10 and GW-11 encountered approximately 20 and 12 feet of refuse, respectively, at approximately 13 and 8 feet below ground surface. No water was encountered in the subsurface explorations during drilling.

Northwest Perimeter Road Area

Refuse was not encountered in soil borings B-11 and B-12 or in borings for probes VTP-11S and VTP-11D. The geophysical survey in the Northwest Perimeter Road Area provides insight on the northern and southern extent of refuse below the road; however, interpretation of results west of the road were complicated by sources of interference, which prevented delineation of the west edge of refuse.

3.4.2 Cover Characteristics

The extent of the cover system at the VLF are shown on Figure 3. For the South Slope Area, the surface cover observed was generally consistent with the designed cover systems. Explorations in the Northwest Perimeter Road Area did not encounter cover over refuse, but did encounter fill soils. Descriptions of soils encountered at each location are provided on the boring logs included in Appendix B.

Main Refuse – South Perimeter Road Area

Cover soils near the south perimeter road were characterized by observations made during installation of probes VTP-9 and VTP-10. The cover system in this area was generally consistent with the designed cover systems (Harper Owes, 1988); however, the backfill beneath the geotextile was a silty sand, while the cover system plans indicate a gas collection gravel layer beneath the geotextile.

South Slope Area

For the explorations VTP-7, VTP-8, GW-10, and GW-11, where significant refuse was identified, approximately 6 to 12 inches of topsoil was identified overlying 7 to 15 feet of silty sand. Much of the South Slope Area is covered by geotextile fabric that was installed during Phase 1 closure activities at depths of 3.5 to 6.5 feet bgs and covered with topsoil. The approximate extent of geotextile fabric is shown on Figure 3. Descriptions of cover material encountered at each location are provided on the boring logs included in Appendix B.

4 Extended Influence Testing Activities

The LFG extended influence testing and monitoring was performed in general accordance with the Work Plan Addendum (Aspect, 2018c) over the course of approximately three months. For the extended influence testing, vacuum was applied at the South Slope Area LFG collection wells starting on September 12, 2018. Monitoring consisted of baseline, startup and optimization phases, as described below. Table 2 provides a summary of the monitoring performed throughout the extended influence testing period. Daily field reports summarizing each influence test visit are included in Appendix A.

4.1 Landfill Gas Collection and Monitoring Network

The LFG collection wells utilized during the extended influence testing included GW-9, GW-10, and GW-11. The LFG monitoring network included all temporary gas probes in the South Slope Area (VTP-2S, VTP-2D, VTP-3S, VTP-3D, VTP-4S, VTP-4D, VTP-5S, VTP-5D, VTP-6S, VTP-6D, VTP-7, VTP-8, VTP-9, and VTP-10) to inform the LFG migration conceptual model. A summary of extraction well and gas probe construction details used during the testing and monitoring period is provided in Table 1. Figure 4 shows the locations of the extraction wells and gas probes.

4.2 Baseline Monitoring

Baseline monitoring was performed for 2 weeks prior to initiating vacuum and monitoring (i.e., startup) at GW-10 and GW-11. LFG measurements were monitored continuously using GasClam units at each extraction well throughout the baseline monitoring period. Manual measurements were recorded at the start of baseline monitoring using a GEM5000 field instrument at each extraction well and monitoring probe. A summary of baseline monitoring, including dates and activities performed, is included in Table 2.

4.3 Startup Operations

At startup, vacuum was applied to the subsurface in the South Slope Area by opening the flow control valves at each extraction well (GW-9, GW-10, and GW-11) to induce vacuum up to 10 inches water column (IWC) and flows of up to 60 scfm combined. The flow control valves are located on the 2-inch Flow-Wing assemblies installed at each well head. Flow rates were estimated by measuring the differential pressure[1] across the 2-inch Flo-Wing monitoring assembly. Following stabilization of LFG concentrations and pressure readings, flow control valves at each extraction well were adjusted such that flow could gradually be increased during future monitoring events per the Work Plan Addendum extraction well monitoring procedures. The initial combined flow rate on the day of startup was approximately 36 scfm and pressure readings were less than 10 IWC at each extraction well. Monitoring was performed at the time of startup consistent with monitoring activities performed throughout the optimization period, as described below.

[1] Differential pressure is the difference between the pressures measured across the Flo-Wing monitoring assembly, and is used to calculate flow.

4.4 Optimization Operations and Monitoring

Optimization operations and monitoring were conducted for 3 months following startup, from September 12, 2018 through December 5, 2018. Adjustments to vacuum and flow rate from each extraction well were made based on monitoring observations and procedures from the Work Plan Addendum. In general, optimization monitoring included the following:

- Four weekly, followed by two monthly, manual measurements of vacuum, flow, and LFG concentrations at gas extraction wells.
- Four weekly, followed by two monthly, manual measurements of vacuum, LFG concentrations, and depth to water at LFG monitoring probes.
- Monitoring equipment (GasClam units and GEM5000 field instrument) were calibrated and/or bump tested as necessary during each monitoring event.
- Continuous data recorded by the GasClam units at the extraction wells were downloaded during each monitoring event. Batteries and moisture filters were also replaced in the GasClams as needed.

Throughout the optimization monitoring period, malfunctions occurred with the GasClam units that were set in extraction wells GW-9 and GW-10 such that continuous data for specific dates throughout the monitoring period may not be reliable. Per the Work Plan Addendum, manual measurements were recorded during each monitoring event throughout the influence testing and monitoring period. Manual measurements were relied upon in place of continuous monitoring data where appropriate for the performance analysis results described in Section 5.2.

5 Landfill Gas System Performance and Optimization Analysis

As described in detail below, historical LFG system performance reflects high collection rates that exceeded generation rates and resulted in excellent lateral LFG migration control. The LFG system was expanded to include the South Slope Area and observed conditions during influence testing have demonstrated improvements in vertical LFG migration control.

5.1 Historical Performance

5.1.1 Landfill Gas Generation

Over the long-term, calculated LFG generation and observed LFG collection have trended downward. The Environmental Protection Agency's (EPA) Landfill Gas Emissions Model (LandGEM) model was used to estimate the LFG generation rate from the VLF.

Results from EPA's LFG generation model (LandGEM) indicate that over the long-term, calculated LFG generation and observed LFG collection have trended downward. Figure 12 compares the LFG generation calculated using LandGEM (stacked line chart for methane and CO_2) with the actual LFG collection observed (stacked area chart for methane and CO_2). Since 2015, the LandGEM calculated results have been within 10 percent of the observed LFG collected from the landfill.

Input to the LandGEM model included total waste mass (581,000 tons based on 968,000 cubic yards with a density of 1,200 pounds per cubic yard), the age of waste (uniformly placed from 1950 through 1999), and the methane-generating capacity of the waste. The methane-generating capacity was adjusted from a default value of 170 cubic meters per megagram to 50 cubic meters per megagram so that LandGEM results would more closely match actual observed gas collection rates. LFG generation model parameters defining the type of waste were consistent with MSW landfills and included a decay in methane generation rate of 5 percent per year. With this adjustment, LFG generation rates (methane and CO_2) were estimated at approximately 33 scfm in 2018, a close match with the 31 scfm of LFG actually collected. Therefore, the LandGEM model results are useful for projecting long-term LFG generation rates. The LandGEM model report is provided in Appendix C and includes details on the model input and output.

5.1.2 Landfill Gas Collection

The LFG collection system has been operated at high flow rates to maximize LFG migration control. The LFG collection system's blower is a Hauck model TBGB-090-250B-11, with a belt-drive 7.5 horsepower (HP) motor. The blower manufacturer's operations manual and equipment data sheet indicates the blower is rated for a maximum flow rate of 360 scfm (Hauck, 1997).

The annual operating average system flow rate has ranged between 164 and 307 scfm since 2006. The system flow rate was increased in 2013 in an attempt to improve LFG collection efficiency. This increase in flow rate resulted in greater collection of atmospheric air (i.e., oxygen and balance gas), not LFG (i.e., methane and CO_2). These results indicated that the zone of influence for the LFG collection system was maximized. As the decomposition process has become more aerobic, methane has accounted for a smaller fraction of the LFG being collected, decreasing from approximately 37 percent in 2006 to approximately 22 percent in 2018.

To maximize LFG collection at the landfill, flows have generally been focused on individual LFG collection points with greater concentrations of methane and CO_2. Historical operations have been assessed to identify locations that warrant flow optimization. LFG collection rates observed at collection monitoring points are shown on stacked column graphs for selected years on Figure 13. The height of the stacked column charts on Figure 13 represent the average total flow from the individual locations, with different colors representing the methane, CO_2, oxygen, and balance gas content. LFG collection at each monitoring point is presented for the following years:

- 2006 – Baseline conditions following final landfill closure
- 2016 – GW-9 was installed in mid-September
- 2017 – After GW-9 was installed and before installation of GW-10 and GW-11
- 2018 – GW-10 and GW-11 were installed in mid-September

Some locations have been operated minimally due to low LFG concentrations, including the following: EF-4, FT-1, FT-2, FT-3, FT-4, FT-6, GW-1, GW-3, GW-5, GW-6, GW-8, and T-2. During monthly monitoring, these locations have been repeatedly tested and found to provide little potential for LFG collection. Leak detection assessment may be warranted at those LFG collection locations within the Phase 2 Closure Area (FT-1 through FT-5), where atmospheric air should not be observed.

A few locations have been operated with below-average LFG concentrations, including the following: EF-1, EF-2, EF-3, and T-1. These locations show disproportionately high oxygen concentrations (14 to 20 percent by volume) compared to other active points, which reflects atmospheric air intrusion.

Selected locations have been operated to collect LFG at sustained rates, including the following: FT-05, GW-2, GW-4, GW-7, T-3, T-4, and T-5.

5.1.3 Landfill Gas Migration Control

Methane concentrations at the VLF compliance probes have been below 1 percent by volume since 1998, indicating that lateral LFG migration has been controlled at the landfill. The regulatory threshold for methane at compliance/perimeter monitoring points is 5 percent by volume. Decreasing CO_2 concentrations at compliance probes also demonstrate control of LFG migration. Figure 14 shows observed compliance probe LFG concentrations over time with maximum methane concentrations illustrated on the left graph, and maximum CO_2 concentrations illustrated on the right graph. Figure 15 shows color-coded indicators of maximum observed methane concentrations at compliance probes, temporary probes, and LFG collection points in 2016, 2017, and 2018.

5.2 Performance During Influence Testing and Monitoring

During influence testing, the concentrations of methane and CO_2 decreased across the South Slope Area, while oxygen concentrations increased. When GW-10 and GW-11 were first operated, temporary increases in methane and CO_2 concentrations were observed potentially reflecting inter-well competition. By the end of the extended influence test, methane was not detected below the refuse, and CO_2 concentrations were decreasing.

LFG concentrations observed during each extended influence test monitoring event are included in Table 3. LFG concentrations observed at each extraction well are presented in charts on Figure 16. LFG concentrations dating back to 2016 are included for the GW-9 chart. LFG concentrations observed at each monitoring probe utilized during the testing are presented in charts on Figure 17.

5.2.1 Observed Vacuum Influence

During the extended influence test, vacuum was observed at each temporary probe in the South Slope Area. Monitoring measurements are included in Table 3. Table 5-1 provides a summary of the inferred radius of influence (ROI), screen length, and average flow rate for each LFG extraction well during the extended influence test.

Table 5-1. Summary of Inferred ROIs During Extended Influence Test

Well	ROI	Screen Length	Average Flow Rate
GW-9	190 ft	18 ft	20 scfm
GW-10	135 ft	13 ft	22 scfm
GW-11	40 ft	6.5 ft	7 scfm

In addition to the ROI for each extraction well, the vacuum/pressures observed at each monitoring point at the end of the extended influence testing period are included on Figure 18. The ROI (also commonly referred to as the zone of influence) for the three vertical LFG extraction wells covers the South Slope Area and was larger than the ROI for GW-9 observed in March 2017.

5.2.2 Observed Landfill Gas Collection Rates

Since wells GW-9, GW-10, and GW-11 were installed in the South Slope Area, they have collected LFG (including methane and CO_2) at rates between 2.8 and 6.5 scfm on average. Between September 2016 and September 2018, GW-9 alone collected 3.2 scfm LFG on average. In late 2018, GW-9, GW-10, and GW-11 collected 6.5 scfm of methane and CO_2 combined. LFG collection rates from each extraction well dating back to the start of operation are depicted on Figure 19.

LFG collection from EF-1 and EF-2, also located at the south end of the VLF, was relatively stable at 2.5 scfm in 2016 and 2.3 scfm in 2017—comparable to historical rates. During 2018, LFG collection at EF-1 and EF-2 dropped to 1.5 scfm. Wells GW-9, GW-10, and GW-11 appeared to collect most of the LFG previously collected at EF-1, and some of the LFG previously collected at EF-2.

The combined flow rate from GW-9, GW-10, and GW-11 during the extended influence testing was more than double the flow rate when operating GW-9 only during the 2016/2017 influence test, resulting in more LFG collection. Differential pressure readings and calculated flow rates from each monitoring event, including monthly monitoring through March 6, 2019, are provided in Table 4. Simultaneously, oxygen approached atmospheric concentrations at most monitoring points, indicating robust LFG migration control.

Reduced flow from GW-11 over time was associated with increasing water levels, which completely saturated the screen following the extended influence test. Increasing water levels were not observed at GW-9 or GW-10. Water levels in the extraction wells during and after the extended influence test are included in Table 5. Temporary probe VTP-7 is located closest to extraction well GW-11, and exhibited the effects of reduced LFG collection efficiency at GW-11. Starting in January 2019 when the screen was fully submerged, liquid management was implemented at GW-11 to improve LFG collection. Additional measures will be needed to address water observed in GW-11.

5.2.3 Conclusions and Recommendations

Based on the extended influence test results and monitoring through March 2019, the addition of extraction wells GW-10 and GW-11 has increased LFG collection efficiency in the South Slope Area when wells are under vacuum, compared to operating GW-9 only during the initial influence test. The zone of influence for these three vertical wells appeared to cover the South Slope Area, including in native soil below the refuse.

Vertical LFG migration control was improved. Methane was not present or slightly present (<0.5 percent using manual measurements) at all monitoring points in the South Slope Area, except for a subset of probes completed in waste (VTP-4S, VTP-5S, and VTP-7). CO_2 was not present or slightly present at most monitoring points. oxygen has approached atmospheric concentrations at most monitoring points since GW-10 and GW-11 began operating.

5.3 Air Quality Analysis

An air quality analysis was performed based on changes in LFG concentrations, current and expected system flow rate, and loading rates based on recent sampling results and the existing treatment system.

5.3.1 Landfill Gas Concentrations

To assess current conditions and understand if LFG treatment is required, the quality of LFG being collected from the VLF was evaluated by collecting an LFG sample from the collection system. Aspect collected the LFG sample on March 14, 2019, from a sample port on the LFG header line at the inlet to the blower system. The sample was analyzed for VOCs and sulfur compounds by EPA Method TO-15, acrylonitrile by Method 8260, and major gases by Method 3C. Sample results are summarized in Table 6 and the laboratory report is provided in Appendix F.

For comparison, historical LFG sample results from the same sample location and typical concentrations for LFG constituents in MSW landfills are included in Table 6. The historical LFG sample was collected on May 1, 2013, for analysis of VOCs by EPA

Method TO-15, nonmethane organic compounds (NMOCs) by EPA Method 25C, and sulfur compounds by EPA Method TO-15/ASTM D5504. Under the Clean Air Act, EPA provides average constituent concentrations for gas collected from municipal solid waste landfills in *Compilation of Air Pollutant Emission Factors* (AP-42) (EPA, 1995).

VOC concentrations observed at the blower inlet in 2019 and 2013 were less than typical concentrations observed at MSW landfills.

The concentration of hydrogen sulfide at the blower inlet in 2019 and 2013 (see Table 6) were 3,870 $\mu g/m^3$ and 50,400 $\mu g/m^3$, respectively. The decrease in hydrogen sulfide concentrations between 2013 and 2019 can be attributed to one or more factors, including:

- The landfill refuse decomposition process has become more aerobic since 2013.
- There is currently a greater proportion of atmospheric air present in LFG at the blower inlet compared to 2013.
- The LFG collection system included extraction from GW-9, GW-10, and GW-11 in 2019, where there was little to no hydrogen sulfide observed during extended influence testing.

5.3.2 System Flow Rates

The system flow rate in 2019 was estimated at 200 scfm, based on the summed flows from individual locations. By comparison, the flow rate in 2013 was estimated at 350 scfm. The decrease in system flow rates between 2013 and 2019 can be attributed to the increasing age of the blower, decreasing LFG conveyance efficiency, and LFG collection from GW-9, GW-10, and GW-11.

5.3.3 Current Loading Rates

The loading rates for TAPs were calculated based on the March 14, 2019 LFG sample results, a system flow rate of 200 scfm, and the regulatory averaging period. The loading rates were then compared to the Small Quantity Emissions Rates (SQERs), which are included in Table 7 and illustrated on Figure 20. If the TAP concentration is less than the SQER, then screening-level air dispersion analysis is not necessary to ensure emissions meet the ambient source impact level. For example, hydrogen sulfide is a TAP with a SQER of 0.263 lbs/day. The calculated hydrogen sulfide loading rate for the March 14, 2019 data was 0.0696 lbs/day, which is below the SQER.

The calculated loading rates for all TAPs sampled on March 14, 2019, were below their respective SQERs, and air dispersion analysis is not necessary to ensure that emissions meet the ambient source impact level.

5.3.4 Conclusions and Recommendations

Based on our understanding of the air quality regulations, replacement of the existing blower system with a new blower rated for no more than 200 scfm would potentially allow PSCAA to exempt the LFG collection system from registration. Based on the current loading rates, all TAPs were below the SQER. GAC vessels are currently being used for treatment and may be more efficient if flow can be reduced at the blower. Alternative treatment methods (i.e., biofilter technology) could be incorporated to replace GAC treatment.

5.4 Optimization Analysis

Optimization of the LFG collection and treatment system was evaluated by focusing on the following elements:

- Landfill gas quality and collection at extraction locations
- Atmospheric air intrusion
- Loading rates and whether GAC treatment is needed

5.4.1 Landfill Gas Collection System Optimization

Atmospheric air intrusion into the LFG collection system is occurring as shown by oxygen levels reaching atmospheric conditions while methane and CO_2 concentrations are not increasing. In the near-term (within the next 2 years), taking low-quality wells off-line and passively venting them while monitoring compliance probes would allow for a systematic approach to transitioning to a passive system for portions of the landfill. Low-quality wells and laterals could be taken off-line sequentially over time, allowing perimeter probe monitoring to demonstrate compliance. In the long-term, active LFG collection from selected locations, such as the new wells in the South Slope Area, will likely need to be provided for an estimated 5 to 10 years until groundwater protection is demonstrated. Once groundwater protection is demonstrated, LFG collection could be transitioned from active to passive.

In addition, the existing blower and motor are aging and should be replaced by a more efficient system. Downsizing may be possible if active collection is not deemed necessary for portions of the landfill, and if low-quality wells and laterals are taken off-line over time. Downsizing to a blower rated for less than 200 scfm may qualify the LFG collection system to be exempt from PSCAA registration requirements.

Figure 15 shows maximum methane percentages observed in extraction wells, trench risers, and probes from 2016, 2017, and 2018. As shown on the figure, methane concentrations have generally decreased over time near the VLF and remained below the regulatory threshold of 5 percent methane by volume at compliance probes.

Table 5-2 provides a list of wells and trench risers with averaged methane, CO_2, and oxygen percentages shown, since 2016 (when MW-9 was installed), that are considered low-quality gas collectors that could potentially be transitioned to passive:

Table 5-2. Low-Quality Gas Collectors

ID	Methane %	Carbon Dioxide %	Oxygen %	Valve Position
GW-1	0.5	2.3	18	Closed
GW-2	6.5	14	4.9	Closed
GW-3	1.6	5.5	15	Closed
GW-4	8.6	20	0.4	Open
GW-5	0.9	2.1	19	Closed
GW-6	0.3	5.0	16	Closed
GW-7	3.4	16	3.0	Open
GW-8	0.5	6.3	14	Closed
FT-5	5.0	18	1.8	Open
FT-6	1.0	10	10	Closed
EF-1	0.1	0.8	20	Open
EF-2	0.6	6.4	14	Open
EF-3	0.2	5.7	14	Open
EF-4	0.03	0.9	20	Closed
T1	0.3	6.3	14	Open
T2	0.02	3.6	17	Closed

Notes:
Average percentages from 2016 through March 2019 for methane, carbon dioxide, and oxygen.

As low-quality wells are taken off-line and the system transitions to passive venting, migration control should be evaluated and confirmed.

5.4.2 Landfill Gas Treatment Optimization

Currently, treatment of LFG is required at the VLF and is performed by a fixed fan conveying the LFG to a series of GAC containers before being vented to the atmosphere. There are eight total GAC containers, with two working at a time, rotated monthly.

Based on the March 14, 2019, gas sampling results, there were no TAP loading rate exceedances of emission factors, indicating no need for treatment of collected LFG. Since treatment is currently required, reducing the hydrogen sulfide loading by optimizing the collection system and reducing the overall flow rate and loading could reduce the amount of GAC needed for treatment, thereby reducing GAC costs.

As the LFG treatment system transitions from GAC, and collection transitions to passive, compost bio-berms could provide polishing of the actively-collected and passively-vented LFG.

5.4.3 Conclusions and Recommendations

With the exception of the South Slope Area, the system is currently overpulling, as evidenced by increased atmospheric air and a decrease in methane and CO_2. Monitoring of perimeter probes should be performed while taking low-quality/low-producing wells offline and transitioning to passive venting to ensure the LFG system is in compliance.

Treatment of LFG is currently required, but loading rates calculated using March 2019 sampling results indicate that biofiltration could replace GAC. Although there were no loading rate exceedances, one noteworthy TAP is hydrogen sulfide. The calculated loading rate for hydrogen sulfide did not exceed its emission factor, but it is relatively close. Compost bio-berms would provide effective polishing of the collected LFG before venting to the atmosphere, especially as the system transitions to passive venting.

Active LFG collection from the South Slope Area (GW-9, GW-10, GW-11) and from laterals T3 and T4 should continue while the ongoing groundwater evaluation is performed.

6 Treatment Alternatives Analysis

This section identifies three alternatives for LFG treatment, presents preliminary, feasibility-level cost estimates for the three options, addresses operational considerations, and outlines a schedule for optimizing LFG collection and treatment.

6.1 Landfill Gas Treatment System Options

Landfill gas is treated to maintain methane levels below the regulatory LEL of 5 percent by volume and for odor from hydrogen sulfide.

Currently, treatment of LFG at the VLF is performed by a fixed fan conveying the LFG to a series of GAC containers before being vented to the atmosphere. There are eight total GAC containers, with two working at a time, rotated monthly. Each container includes 2,000 pounds of GAC. Operational costs of GAC are provided below in Table 6-1 with an annual maintenance cost over a 10-year period.

An evaluation of treatment technologies was performed for KCSWD as part of the "Conceptual Design Report—Landfill Gas Collection and Treatment, Enumclaw Landfill" (Herrera, 2014). Due to the low concentrations of LFG, many replacement technologies such as a portable vent spark flare or thermal oxidizer are technically unfeasible or too costly.

A viable alternative to GAC canisters may be converting to bio-berms or compost pad/facilities as a cost savings measure. Bio-berms oxidize methane by methanotrophic bacteria that transforms methane and oxygen into water, CO_2, and biomass. Methanotrophs (sometimes called methanophiles) can metabolize methane as their only source of carbon and energy. Bio-berms generally uptake 200 grams/m^3 of methane per day. Bio-berms can also uptake hydrogen sulfide at a rate of 10 times the amount of methane, so they are effective at polishing LFG.

The cost of installing bio-berms are provided in Table 6-1. Media inside the bio-berms (generally compost or hog fuel), degrades over time and generally needs to be replaced every 7 to 10 years. Maintenance costs would be for a replacement of 70 percent of the compost volume, to keep 30 percent of the existing compost as a starter/stock of bacteria for degradation. Individual bio-berms could be installed for each well riser taken off-line, or a single (long) bio-berm could be installed on top of the VLF, which may be easier for operations personnel to maintain. Cost for both options are provided, with longer lateral pipe runs required for the single berm.

The cost comparison of treatment options provided is shown over a 10-year period, with maintenance of the bio-berms occurring in year 11.

Table 6-1. Cost Comparison of Treatment Options

Alternatives	Multiple Bio-Berms	Single Bio-Berm	GAC
Installation Costs	$65,000	$125,000	$0
Maintenance Costs Over 10-year Period	$10,000	$5,000	$380,000
Total	**$75,000**	**$130,000**	**$380,000**

Notes:
GAC = granular activated carbon

A final alternative would be to take low methane- and carbon-dioxide-producing locations off-line by disconnecting them from the lateral and passively venting the wells to atmosphere without treatment. There would be minimal costs associated with the alternative, as most of the low-producing wells are already shut off at the valve. A concern with this alternative would be odor control associated with hydrogen sulfide that may not make this option feasible.

6.2 Operational Considerations

The operational considerations for future LFG treatment focus on bridging the transition from active to passive LFG collection. Bio-berms can be utilized either on active blower systems or passive collection systems. For the passive LFG collection system, landfill gases move from within the landfill through the biofilter during decreasing barometric pressure. During increasing barometric pressure, ambient air moves through the biofilter into the landfill. This reversal of gas movement can supply methanotrophic bacteria with the methane and oxygen needed.

Slowly transitioning low methane- and carbon-dioxide-producing wells and trenches to passive system could be utilized with bio-berms. The transition period would be scheduled over a 5 to 10-year time frame. Continued monitoring of probes would be performed to evaluate effectiveness of transition to a partial passive system.

Table 6-2 provides a comparison of potential simultaneous treatment options for selected LFG collection points during the transition period. Collective averages for total flow (scfm) and methane flow rates (scfm) during the extended influence testing in 2018 are compared for each treatment option. Table 6-2 assumes that the wells on the South Slope area (GW-9, GW-10, and GW-11), as well as T3 and T4, continue to be actively collected and treated with the current GAC system. Wells listed for potential passive bio-berm treatment or left closed include GW-1 through GW-8 as well as FT-5 and FT-6. Of these collection points, only GW-4, GW-7, and FT-5 are open as of March 2019. Closed wells could remain closed to optimize LFG collection based on LFG concentrations.

Collection points T1, T2, and EF-1 through EF-4 are locations that potentially could be passively vented, closed or left closed. Of these collection points, T1, EF-01, EF-02, and EF-03 are open as of March 2019. EF-04 and T2 could remain closed, and flows at T1, EF-02, and EF-03 could be adjusted to optimize LFG collection.

Table 6-2. LFG Treatment Options Compared to Flow Rates

LFG Treatment Option	Total Flow Rate for Active Wells (scfm)	Methane Flow Rate for Active Wells (scfm)	Number of Active Wells	Number of Closed Wells
Active GAC	57	3.8	5	0
Passive Bio-berm	53	3.5	4	6
Passive Direct	68	0.1	4	2

Notes:
Flow rates for selected LFG collection points during 2018 extended influence testing

Taking wells offline could enable reducing flow rates at the blower and optimizing the treatment process. The transition to a partial passive system could reduce the active flow rate from the current 200 scfm to 60 scfm. The GAC canisters should be monitored; if breakthrough is occurring over a longer period of time, the GAC cannisters could be used either one at time or over a longer time period.

Relative to other wells, condensate is forming at a higher rate in extraction wells GW-9, GW-10, and GW-11. The laterals connecting these wells to the LFG header were installed aboveground, increasing the potential to generate condensate. Temporary condensate management has included installing sumps and directing collected condensate to the leachate lagoon. GW-11 has shown reduced flow since January 2, 2019, as the screened portion of the well is underwater. Future improvements in condensate management, such as burying the laterals and/or installing a downwell pump in GW-11, will be explored in the pending Feasibility Study. Eventually, after demonstrating groundwater protection in the South Slope Area, lowering flow rates at these wells may help reduce the volume of condensate.

6.3 Optimization Schedule

LFG migration has been, and continues to be, controlled. Compliance probe monitoring will continue during the transition to a partially passive system. If LFG migration is detected at compliance probes, the closest passive wells will be brought back online to the active system.

Current operations should continue during the groundwater evaluation through the third quarter of 2019. The blower system could then be replaced with a downscaled system capable of no more than 200 scfm, assuming that air quality registration is not required. To optimize the LFG system, the LFG collection piping could be modified to allow passive collection from low-quality gas collectors. Wells in the South Slope Area would remain on the active system along with other higher-quality gas collectors, and would continue to be treated for odor by the GAC cannisters or biofilter technology. Once groundwater protection is demonstrated over the next 5 to 10 years, flows could be decreased on the blower to reduce the concentration of atmospheric air introduced into the LFG system.

7 Summary of Recommendations and Next Steps

Investigation activities in 2018 provided confirmation for the extent of refuse in the Northwest Perimeter Road and South Slope areas of the VLF (Figure 3). Based on the extended influence testing in late 2018 and the LFG system evaluation discussed above, we recommend the following to provide efficient LFG system operations and effective LFG collection that is protective of groundwater.

An evaluation of groundwater quality will be provided as an element of the ongoing RI/FS.

7.1 Landfill Gas Collection

- Active LFG collection from the South Slope Area (GW-9, GW-10, and GW-11) and from laterals T3 and T4 will continue while the ongoing groundwater quality and LFG-to-groundwater migration pathway evaluation are performed (through the Third Quarter of 2019).
- Transition low-quality/low-producing LFG collection wells and trenches (listed in Table 5-2) from active collection to passive venting with polishing treatment, using bio-berms. The wells should be taken off-line to allow a reduction in the total collection flow rate and loading at the blower over a 1-year period. While transitioning from active to passive, a rebound test and monitoring of perimeter probes should be performed to document migration control and compliance.
- While the existing collection system blower/motor is functional, the service life is nearing expiration; replacement should be considered if deemed necessary following completion of the ongoing RI/FS and transition of low-quality wells to passive venting, preferably with a blower that is limited by a maximum flow of 200 scfm. We also recommend modifying the system to accommodate a manual switch and duplex system to allow for easier maintenance options and to extend the service life of the new blower. Additional upgrades and maintenance to the LFG system piping, valving, and fittings can be completed at the same time, which would benefit the system as a whole.

Considering cost and interchangeability with equipment at other King County landfill sites, we recommend the replacement blower/motor be a New York Blower 2206A10 Pressure Blower with aluminum radial-bladed wheel with arrangement 8 direct-drive configuration and Baldor model EM7174T I 10 HP motor.

7.2 Landfill Gas Treatment

- Since treatment of LFG is currently required, we recommend assessing if the amount of GAC used for treatment can be replaced with biotreatment for current and lower flow rates. Biotreatment provides effective LFG treatment, and material and maintenance cost savings.
- As the LFG collection system transitions from active collection to passive venting, we recommend using bio-berms as an alternative to GAC treatment for polishing LFG prior to venting to the atmosphere. It is expected that bioberms

will provide sufficient treatment and cost savings compared to the existing GAC treatment.

7.3 Landfill Gas Migration Monitoring

- Routine compliance LFG monitoring shall continue as required by the current monitoring program, and until the transition from active to passive LFG collection is complete.
- As the LFG collection system transitions from active collection to passive venting, the LFG migration monitoring program will likely need to be revised to include performance-based monitoring throughout the transition period with a rebound test.

7.4 Landfill Gas Sampling and Air Quality Analysis

- We recommend periodic sampling of LFG at the blower system to assess changes in TAP concentrations, which may be sensitive to changes in LFG collection flow rates. The air quality regulatory agency may request a specific sampling frequency when approving the transition from GAC treatment to passive venting with bio-berms.

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9 Limitations

Work for this project was performed for the King County Solid Waste Division (Client), and this report was prepared in accordance with generally accepted professional practices for the nature and conditions of work completed in the same or similar localities, at the time the work was performed. This report does not represent a legal opinion. No other warranty, expressed or implied, is made.

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Please refer to Appendix G titled "Report Limitations and Guidelines for Use" for additional information governing the use of this report.

TABLES

Table 1. Gas Probe and Extraction Well Construction Information

Project No. 090057 Task 310.1.7.9, Vashon Island Closed Landfill, Vashon Island, King County, Washington

Well ID	Well Diameter (in)	Stick-up (ft)	TOC Elevation (ft, NAVD88)	Ground Surface Elevation [a] (ft, NAVD88)	Boring Depth (ft bgs)	Screened Interval (ft bgs)	Filter Pack Interval (ft bgs)	Screened Geologic Unit [b]	Notes
Gas Probes									
GP-1	2	2.48	NA	361.28	36	20 - 30	20 - 36	Upper Unit B	
GP-2	2	2.48	NA	363.68	36	25 - 30	25 - 35	Upper Unit B	
GP-5	0.75	NA	NA	359.46	151	3 - 5	3 - 84.5	NA	In MW-5 boring, decommissioned
GP-6	0.75	NA	NA	396.02	166.5	2.5 - 5	3 - 116	NA	In MW-6 boring, decommissioned
NP-1D	0.75	NA	NA	406.72	104.5	90 - 104	58 - 104.5	Unit B	Three probes in singular borehole
NP-1M	0.75	NA	NA	406.72	104.5	38 - 48	36 - 52	Lower Unit A and Upper Unit B	
NP-1S	0.75	NA	NA	406.72	104.5	12 - 22	10 - 25	Unit A	
NP-2 D	0.75	NA	NA	394.81	104.7	79.5 - 94.5	63 - 95	Lower Unit B	
NP-2 M	0.75	NA	NA	394.81	104.7	47 - 57	44 - 58	Upper Unit B	Three probes in singular borehole
NP-2 S	0.75	NA	NA	394.81	104.7	12 - 22	10 - 24	Unit A	
NP-3D	0.75	NA	NA	376.49	100	77 - 92	50 - 97	Unit B and Upper C Unit	Three probes in singular borehole
NP-3M	0.75	NA	NA	376.49	100	33 - 44	31 - 45	Unit A and Upper Unit B	
NP-3S	0.75	NA	NA	376.49	100	12 - 22	10 - 23	Unit A	
NP-4D	0.75	NA	NA	360.48	120	75 - 90	73 - 91	Lower Unit B and Upper Cc1 Unit	
NP-4M	0.75	NA	NA	360.48	120	32 - 42	30 - 43	Upper Unit B	Three probes in singular borehole
NP-4S	0.75	NA	NA	360.48	120	12 - 22	10 - 23	Unit A	
NP-5D	0.75	NA	NA	358.09	90	65 - 80	63 - 85	Unit Cc1	
NP-5M	0.75	NA	NA	358.09	90	30 - 40	28 - 42	Lower Unit B	Three probes in singular borehole
NP-5S	0.75	NA	NA	358.09	90	10 - 20	8 - 21	Lower Unit A and Upper Unit B	
NP-6D	0.75	NA	NA	384.52	115	90 - 105	88 - 108	Unit Cc1	Three probes in singular borehole
P-6M	0.75	NA	NA	384.52	115	35 - 45	33 - 46	Unit B	
NP-6S	0.75	NA	NA	384.52	115	12 - 22	10 - 23	Unit A	
NP-7D	0.75	NA	NA	376.49	110	86 - 99	84 - 104	Lower Unit B and Upper Cc1 Unit	Three probes in singular borehole
NP-7M	0.75	NA	NA	376.49	110	39 - 49	37 - 50	Upper Unit B	
NP-7S	0.75	NA	NA	376.49	110	12 - 22	10 - 24	Unit A	
NP-8D	0.75	NA	NA	403.24	125	95 - 110	93 - 112	Lower Unit B and Unit Cf	
NP-8M	0.75	NA	NA	403.24	125	49 - 59	47 - 60	Mid Unit B	Three probes in singular borehole
NP-8S	0.75	NA	NA	403.24	125	12 - 22	10 - 24	Unit A	
P-1	0.75	NA	NA	396.6	5	3 - 5	NA	NA	Decommissioned
P-1	1	NA	NA	396.6	99.5	89.5 - 90.5	NA	NA	Decommissioned
P-1	1	NA	NA	396.6	140	114 - 124	NA	Unit Cc1 and Unit Cf	Decommissioned
P-1A	1	NA	NA	394.02	128.5	114 - 124	NA	NA	Decommissioned
P-1B	1	NA	NA	396.68	106	94 - 104	NA	Lower Unit B	Decommissioned.
P-1D	NA	NA	NA	398.6	140 est	NA	NA	Unit Cc1 and Unit Cf	Decommissioned.
P-2	1.25	NA	NA	377.35	126	100 - 115	NA	Unit Cf	Decommissioned.

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Project No. 090057 Task 310.1.7.9, Vashon Island Closed Landfill, Vashon Island, King County, Washington

Well ID	Well Diameter (in)	Stick-up (ft)	TOC Elevation (ft, NAVD88)	Ground Surface Elevation [a] (ft, NAVD88)	Boring Depth (ft bgs)	Screened Interval (ft bgs)	Filter Pack Interval (ft bgs)	Screened Geologic Unit [b]	Notes
P-2A	2	NA	NA	377.2	94	80 - 92	NA	Unit Cc1	Decommissioned.
P-3	2	NA	377.37	377.67	115.5	108 - 113	106 - 113	Unit Cc1	Renamed MW-13
P-4	2	NA	377.93	377.53	90.5	80 - 90	77 - 90	Unit B	Renamed MW-24
Temporary Gas Probes									
VTP-1D	0.75	3	NA	NA	34	31 - 33.5	30 - 34	Unit B (SP)	Boring log notes overdrilling VTP-1S to 10 ft bgs and installing VTP-1D in the same location.
VTP-1S	NA	NA	NA	NA	NA	NA	NA	NA	Decommissioned.
VTP-2D	0.75	3.5	NA	NA	25	21.5 - 24	15 - 25	Refuse	
VTP-2S	0.75	3	NA	NA	7	4.5 - 7	4 - 7	Soil cover (GW/ML)	
VTP-3D	0.75	3	365.08	361.58	43.5	36 - 38.5	34 - 40	Unit B (SP)	
VTP-3S	0.75	3	365.90	362.15	40	25 - 27.5	23 - 29	Refuse	Nested with VTP-3D.
VTP-4D	0.75	3	361.86	358.08	60	51.5 - 54	50 - 56	Unit B (SP)	
VTP-4S	0.75	3	362.58	358.58	45	22.5 - 25	21 - 27	Refuse	Not nested with VTP-4D.
VTP-5D	0.75	3.4	363.09	359.69	30	24 - 26.5	22 - 28	Unit B (SP)	
VTP-5S	0.75	3.37	363.38	360.01	30	15 - 17.5	13 - 19	Refuse	Nested with VTP-5D.
VTP-6D	0.75	3.47	328.31	324.84	40	18.5 - 21	17 - 23	Unit B (SP)	Alternating layers of poorly graded sand and silty sands (SP-SM) below 25 ft bgs.
VTP-6S	0.75	3.74	328.25	324.51	20	6.5 - 9	4 - 10	Refuse	
VTP-7	2	0.58	359.2	359.78	20	9 - 14	4 - 15	Refuse	
VTP-8	2	0.43	358.89	359.32	25	15 - 20	14 - 21	Refuse	
VTP-9	2	0.43	373.22	373.65	10	7.5 - 10	7 - 10	Unit A (SM)	
VTP-10	2	0.83	375.31	376.14	10	7.5 - 10	6.75 - 10	Unit A (SM)	
VTP-11S	2	0.65	400.83	401.48	15	6 - 11	5 - 12	Unit A (SM)	
VTP-11D	2	0.67	401.48	402.15	45	31 - 41	30 - 42	Unit B (SP)	
Landfill Gas Extraction Wells									
GW-1 to -8	NA	NA	NA	NA	NA	NA	NA	NA	
GW-9	4	4.09	362.28	358.19	40	17 - 35	17 - 35	Refuse	
GW-10	4	3.85	363.80	359.95	35	15.5 - 28.5	14.5 - 29.5	Refuse	
GW-11	4	3.52	363.68	360.16	25	10.5 - 17	9.5 - 18	Refuse	

Notes:

ft = feet

ft, NAVD88 = feet, North America Vertical Datum of 1988.

ft bgs = feet below ground surface

ft btoc = feet below top of casing

in = inches

NA = data not available

a - Ground elevation for probes listed as "Gas Probes" have been adjusted to NAVD88 by adding 3.6 feet. Original elevationswere provided on borings logs in NGVD29.

b - Unified Soil Classification System (USCS) two-letter soil texture classification provided in parentheses. Refer to the Figure B-1 Exploration Log in Appendix B for details.

Table 2. Summary of Extended Influence Testing and Monitoring

Project No. 090057 Task 310.1.7.9, Vashon Island Landfill, King County, WA

<table>
<tr><th>Monitoring Location</th><th>Baseline Monitoring
8/29/2018 to 9/12/2018</th><th>Startup Operations
9/12/2018</th><th>Optimization Operations and Monitoring
9/12/2018 to 12/5/2018</th></tr>
<tr><td colspan="4">Extraction Wells</td></tr>
<tr><td>GW-9</td><td>Not instrumented</td><td colspan="2">Gas Clam installed 9/12/2018 for continuous monitoring through test period.
No monitoring data recorded 10/4-10/10 and 10/28-11/15.</td></tr>
<tr><td>GW-10</td><td colspan="3">Gas Clam installed on 8/29/2018 for continuous monitoring through test period.
No monitoring data recorded 9/27-10/5.
Unreliable methane concentrations recorded 10/25-11/15 and 11/18-12/5.</td></tr>
<tr><td>GW-11</td><td colspan="3">Gas Clam installed on 8/29/2018 for continuous monitoring through test period.</td></tr>
<tr><td colspan="4">Gas Probes</td></tr>
<tr><td>VTP-2S</td><td rowspan="14">Not instrumented</td><td rowspan="12">Manual measurements recorded</td><td rowspan="12">Manual measurements recorded
Weekly from 9/12/2018 through 10/10/2018
and Monthly on 11/7/2018 and 12/5/2018</td></tr>
<tr><td>VTP-2D</td></tr>
<tr><td>VTP-3S</td></tr>
<tr><td>VTP-3D</td></tr>
<tr><td>VTP-4S</td></tr>
<tr><td>VTP-4D</td></tr>
<tr><td>VTP-5S</td></tr>
<tr><td>VTP-5D</td></tr>
<tr><td>VTP-6S</td></tr>
<tr><td>VTP-6D</td></tr>
<tr><td>VTP-7</td></tr>
<tr><td>VTP-8</td></tr>
<tr><td>VTP-9</td><td rowspan="2">Measurements not recorded</td><td>Manual measurements recorded
Weekly on 10/3/2018 and 10/10/2018 and
Monthly on 11/7/2018 and 12/5/2018</td></tr>
<tr><td>VTP-10</td><td>Manual measurements recorded
Weekly from 9/26/2018 through 10/10/2018
and Monthly on 11/7/2018 and 12/5/2018</td></tr>
</table>

Table 3. Extended Influence Testing and Monitoring Measurement Summary

Project No. 090057 Task 310.1.7.9, Vashon Island Closed Landfill, King County, WA

Location	Date	CH_4 (%vol)	CO_2 (%vol)	O_2 (%vol)	Static Pressure (inwc)	Barometric Pressure (inHg)
GW-9	9/12/2018	4.0	18.0	0.4	-5.1	29.55
	9/19/2018	3.5	16.9	1.3	-3.04	29.66
	9/26/2018	4.0	16.9	1.2	-2.92	29.87
	10/3/2018	4.4	17.5	1.5	-9.32	29.66
	10/5/2018	4.0	18.1	1.3	-12.1	29.48
	10/10/2018	2.8	16.5	1.4	-9.73	29.67
	11/7/2018	2.5	16.3	1.7	-12.55	29.97
	12/5/2018	2.8	17.7	2.2	-8.92	29.73
	1/2/2019	2.1	16.8	4.2	-11.16	29.78
	1/30/2019	2.1	16.7	3.1	-10.23	29.56
	3/6/2019	2.6	17.0	2.4	-9.13	29.22
GW-10	8/29/2018	0.5	14.4	3.8	-0.75	29.38
	9/12/2018	3.1	15.6	4.0	-2.7	29.55
	9/19/2018	0.7	13.3	5.2	-3.07	29.66
	9/26/2018	2.0	13.6	4.6	-2.98	29.87
	10/3/2018	2.2	12.8	5.6	-8.18	29.66
	10/5/2018	1.7	13.1	5.9	-9.79	29.48
	10/10/2018	1.5	12.4	5.7	-9.36	29.67
	11/7/2018	0.8	11.7	6.6	-9.28	29.97
	12/5/2018	0.8	12.6	6.8	-8.2	29.73
	1/2/2019	0.6	12.6	7.5	-8.2	29.78
	1/30/2019	0.7	11.9	7.8	-10.37	29.56
	3/6/2019	0.8	12.6	6.6	-11.04	29.22
GW-11	8/29/2018	25.6	18.8	0.7	-10.75	29.38
	9/12/2018	5.4	7.3	12.5	-7.28	29.55
	9/19/2018	2.1	5.6	14.5	-3.82	29.66
	9/26/2018	1.9	5.6	14.6	-3.03	29.87
	10/3/2018	0.5	1.3	20.2	-11.48	29.66
	10/5/2018	0.9	3.5	17.4	-13.13	29.48
	10/10/2018	0.5	3.3	17.0	-9.37	29.67
	11/7/2018	0.5	5.3	14.8	-12.68	29.97
	12/5/2018	0.3	6.6	14.0	-10.26	29.73
	1/2/2019	0.0	3.0	18.9	-12.85	29.78
	1/30/2019	1.5	1.7	19.7	-10.56	29.56
	3/6/2019	0.0	0.3	20.7	-9.98	29.22

Table 3. Extended Influence Testing and Monitoring Measurement Summary

Project No. 090057 Task 310.1.7.9, Vashon Island Closed Landfill, King County, WA

Location	Date	CH_4 (%vol)	CO_2 (%vol)	O_2 (%vol)	Static Pressure (inwc)	Barometric Pressure (inHg)
VTP-2S	9/12/2018	0.0	1.2	19.4	0.05	29.6
	9/19/2018	0.0	0.1	20.7	-0.42	29.66
	9/26/2018	0.0	0.2	20.8	0.35	29.87
	10/3/2018	0.0	0.2	21.0	-1.54	29.64
	10/10/2018	0.0	0.1	21.0	-0.08	29.64
	11/7/2018	0.0	0.1	21.1	0.53	30.05
	12/5/2018	0.0	0.1	21.6	0.12	29.71
	1/2/2019	0.0	0.3	21.7	0.36	29.78
	1/30/2019	NM	NM	NM	-0.05	29.56
	3/6/2019	0.0	0.2	20.9	-0.06	29.27
VTP-2D	9/12/2018	1.6	5.3	14.4	0.03	29.6
	9/19/2018	1.5	3.4	16.3	-0.23	29.66
	9/26/2018	6.6	15.4	4.3	-3.6	29.87
	10/3/2018	3.0	8.0	18.4	-1.53	29.64
	10/10/2018	1.9	7.5	12.1	-0.04	29.67
	11/7/2018	0.0	0.1	21.1	-2.09	30.05
	12/5/2018	0.0	0.1	21.6	-0.87	29.71
	1/2/2019	0.0	0.2	21.7	-0.07	29.76
	1/30/2019	0.3	0.2	21.6	0.06	29.56
	3/6/2019	0.0	0.2	20.9	-0.04	29.24
VTP-3S	9/11/2018	0.0	1.1	19.5	-0.62	29.78
	9/12/2018	0.3	17.0	0.9	-0.77	29.6
	9/19/2018	0.2	18.1	0.5	-0.52	29.66
	9/26/2018	0.4	15.1	2.8	-0.01	29.87
	10/3/2018	0.7	17.2	1.2	-1.62	29.64
	10/10/2018	0.1	16.8	0.1	-1.38	29.63
	11/7/2018	0.2	17.0	0.0	-2.56	30.07
	12/5/2018	0.2	17.9	1.2	-1.27	29.71
	1/2/2019	0.0	0.2	21.8	-0.82	29.78
	1/30/2019	0.0	0.1	21.0	-1.05	29.56
	3/6/2019	0.3	18.5	0.3	0.03	29.29

Table 3. Extended Influence Testing and Monitoring Measurement Summary

Project No. 090057 Task 310.1.7.9, Vashon Island Closed Landfill, King County, WA

Location	Date	CH_4 (%vol)	CO_2 (%vol)	O_2 (%vol)	Static Pressure (inwc)	Barometric Pressure (inHg)
VTP-3D	9/11/2018	0.0	0.7	19.5	-0.5	29.78
	9/12/2018	0.0	0.6	20.4	-0.72	29.6
	9/19/2018	0.0	10.6	7.1	-0.62	29.66
	9/26/2018	0.0	6.0	12.0	-0.52	29.87
	10/3/2018	0.1	15.9	1.2	-1.19	29.64
	10/10/2018	0.0	7.1	12.1	-1.36	29.69
	11/7/2018	0.0	3.4	17.1	-0.01	30.07
	12/5/2018	0.0	9.5	9.8	-1.29	29.71
	1/2/2019	0.0	0.2	21.7	-0.66	29.87
	1/30/2019	0.0	9.1	11.3	-0.91	29.57
	3/6/2019	0.0	12.4	6.1	0.01	29.28
VTP-4S	9/11/2018	0.0	0.1	21.0	-0.99	29.78
	9/12/2018	28.0	25.8	6.5	-0.24	29.6
	9/19/2018	18.9	22.5	4.2	-0.65	29.66
	9/26/2018	0.5	0.8	20.1	-0.03	29.87
	10/3/2018	0	3.6	14.7	-1.78	29.64
	10/10/2018	9.6	12.5	8.9	-1.58	29.67
	11/7/2018	0.2	4.7	17.4	-2.07	27.79
	12/5/2018	0	0.1	21.7	-1.43	29.71
	1/2/2019	0.1	0.2	21.7	-1.69	29.78
	1/30/2019	40.2	36.1	0	-1.64	29.56
	3/6/2019	7.3	14.3	6.9	-0.45	29.21
VTP-4D	9/11/2018	0	0.1	21	-0.21	29.78
	9/12/2018	0	0.9	19.7	-0.54	29.6
	9/19/2018	0	3.2	16	-0.54	29.66
	9/26/2018	0	5.4	12.8	-0.5	29.87
	10/3/2018	6.1	15.7	4.6	-1.33	29.64
	10/10/2018	0	5.7	11.6	-1.3	29.67
	11/7/2018	0	5.8	12	-2.45	30.07
	12/5/2018	0	0.1	21.7	-1.3	29.71
	1/2/2019	0	0.1	21.7	-0.82	29.78
	1/30/2019	0	7.1	9.3	-0.96	29.56
	3/6/2019	0	6.8	10.1	-0.45	29.24

Table 3. Extended Influence Testing and Monitoring Measurement Summary

Project No. 090057 Task 310.1.7.9, Vashon Island Closed Landfill, King County, WA

Location	Date	CH_4 (%vol)	CO_2 (%vol)	O_2 (%vol)	Static Pressure (inwc)	Barometric Pressure (inHg)
VTP-5S	9/11/2018	0	0.1	21	-0.3	29.78
	9/12/2018	34.6	27.5	1.2	-0.69	29.6
	9/19/2018	25.8	28.1	1.1	-0.71	29.66
	9/26/2018	0.1	0.3	20.4	-0.03	29.87
	10/3/2018	12.4	23.6	5.7	-1.53	29.64
	10/10/2018	16.7	22.2	1.8	-1.58	29.64
	11/7/2018	0	0.1	21	-2.71	30.04
	12/5/2018	0	0.1	21.7	-1.62	29.71
	1/2/2019	0	0.1	21.7	-1.18	29.78
	1/30/2019	16.1	21.2	0.3	-1.5	29.55
	3/6/2019	0	0.1	22.1	-1.05	29.28
VTP-5D	9/11/2018	0	0.1	21	0.03	29.78
	9/12/2018	0	6.3	13	-0.66	29.6
	9/19/2018	0	7.9	12.1	-0.62	29.66
	9/26/2018	0	7.2	13.4	-0.78	29.86
	10/3/2018	0	5.4	16.2	-1.55	29.64
	10/10/2018	0	6	15.2	-1.54	29.64
	11/7/2018	0	5.4	15.8	-2.81	30.05
	12/5/2018	0	0.1	21.7	-1.54	29.71
	1/2/2019	0	0.1	21.7	-1.44	29.78
	1/30/2019	0	4.9	17.6	-1.26	29.56
	3/6/2019	0	5.4	17.5	-0.98	29.28
VTP-6S	9/11/2018	0	0.2	20.9	0.01	29.78
	9/12/2018	0	4.3	15.6	0	29.6
	9/19/2018	0	0.1	20.9	0.01	29.66
	9/26/2018	0	0.1	21.1	0.04	29.87
	10/3/2018	0	0.2	20.9	0.09	29.64
	10/10/2018	0	0.2	20.7	-0.07	29.73
	11/7/2018	0	0.1	20.8	-0.06	30.13
	12/5/2018	0	0.2	21.5	-0.1	29.71
	1/2/2019	0	0.2	21.8	0.01	29.78
	1/30/2019	NM	NM	NM	NM	NM
	3/6/2019	0	0.2	20.8	NM	29.25

Table 3. Extended Influence Testing and Monitoring Measurement Summary

Project No. 090057 Task 310.1.7.9, Vashon Island Closed Landfill, King County, WA

Location	Date	CH_4 (%vol)	CO_2 (%vol)	O_2 (%vol)	Static Pressure (inwc)	Barometric Pressure (inHg)
VTP-6D	9/11/2018	0	0.2	20.7	0	29.78
	9/12/2018	0	6.5	11.9	0.01	29.6
	9/19/2018	0	4.5	16.6	-0.02	29.66
	9/26/2018	0	3.7	17.4	0.02	29.87
	10/3/2018	0	4.8	16.4	0.02	29.64
	10/10/2018	0	3.3	17	-0.17	29.73
	11/7/2018	0	1.7	19.7	-0.32	30.1
	12/5/2018	0	0.1	21.6	-0.12	29.71
	1/2/2019	0	0.2	21.8	0.1	29.78
	1/30/2019	0	2	18.1	0.04	29.54
	3/6/2019	0	0.9	20.1	-0.03	29.32
VTP-7	9/12/2018	15.5	15.7	0.3	-0.2	29.6
	9/19/2018	11.8	16.4	0.3	0.04	29.66
	9/26/2018	8.5	15.4	0.6	-0.01	29.86
	10/3/2018	8.2	16.6	0.2	-0.26	29.64
	10/10/2018	5.2	15	0.7	0.06	29.71
	11/7/2018	1.9	15.7	0.8	-0.55	30.04
	12/5/2018	2.9	17.1	0.4	-0.29	29.71
	1/2/2019	7.6	17.5	0.1	-0.01	29.78
	1/30/2019	4.8	15.6	0.6	-0.15	29.55
	3/6/2019	5.3	15.2	0	0.03	29.21
VTP-8	10/3/2018	0.2	14.6	3.9	0.02	29.64
	10/10/2018	0.1	14.6	3.6	-1.66	29.68
	11/7/2018	0.2	17.1	1	-1.01	30.05
	12/5/2018	0	0.1	21.7	-0.52	29.71
	1/2/2019	0	0.2	21.7	-0.11	29.78
	1/30/2019	0	0.1	21.8	-0.31	29.55
	3/6/2019	0	15.2	1.4	-0.5	29.21
VTP-9	10/3/2018	0	0.8	20.5	0.09	29.64
	10/10/2018	0	0.6	20.3	-0.03	29.61
	11/7/2018	0	0.7	20.3	-0.39	30.02
	12/5/2018	0	0.4	21.8	-0.09	29.71
	1/2/2019	0	0.7	21.5	-0.03	29.78
	1/30/2019	0.1	0.2	21.4	-0.04	29.53
	3/6/2019	0	0.6	20.3	-0.05	29.2

Table 3. Extended Influence Testing and Monitoring Measurement Summary

Project No. 090057 Task 310.1.7.9, Vashon Island Closed Landfill, King County, WA

Location	Date	CH_4 (%vol)	CO_2 (%vol)	O_2 (%vol)	Static Pressure (inwc)	Barometric Pressure (inHg)
VTP-10	9/26/2018	0	1.5	19	-1.06	29.87
	10/3/2018	0	0.8	20.6	-0.53	29.64
	10/10/2018	0	1	20	-0.02	29.62
	11/7/2018	0	0.7	20.1	-0.45	30.02
	12/5/2018	0	2.5	19.3	0.08	29.71
	1/2/2019	0	3	18.4	-0.1	29.78
	1/30/2019	0	2.3	18.8	-0.12	29.52
	3/6/2019	0	0.2	20.9	-0.03	29.22

Note:

NM indicates "not measured"

Table 4 - Pressure and Flow During Extended Influence Testing and Monitoring

Project No. 090057 Task 310.1.7.9, Vashon Island Closed Landfill, King County, WA

Location	Date	Differential Pressure Reading (inwc)	Calculated Flow (scfm)
GW-9	9/12/2018	0.17	11.7
	9/19/2018	0.172	11.7
	9/26/2018	0.073	7.6
	10/3/2018	0.31	15.8
	10/5/2018	0.601	21.9
	10/10/2018	0.62	22.3
	11/7/2018	0.297	15.4
	12/5/2018	0.632	22.5
	1/2/2019	0.489	19.8
	1/30/2019	0.42	18.3
	3/6/2019	0.768	24.8
GW-10	8/29/2018	NM	NM
	9/12/2018	0.35	16.7
	9/19/2018	0.326	16.2
	9/26/2018	0.346	16.6
	10/3/2018	0.58	21.6
	10/5/2018	0.42	18.3
	10/10/2018	0.506	20.1
	11/7/2018	0.765	24.8
	12/5/2018	0.981	28.1
	1/2/2019	0.203	12.7
	1/30/2019	1.33	32.7
	3/6/2019	1.23	31.4
GW-11	8/29/2018	NM	NM
	9/12/2018	0.075	7.7
	9/19/2018	0.071	7.5
	9/26/2018	0.009	2.7
	10/3/2018	0.021	4.1
	10/5/2018	0.09	8.5
	10/10/2018	0.048	6.2
	11/7/2018	0.101	9.0
	12/5/2018	0.048	6.2
	1/2/2019	NA	NA
	1/30/2019	NA	NA
	3/6/2019	NA	NA

Notes:

NM indicates "not measured"

NA indicates "not applicable" due to well screen being saturated at time of pressure reading.

Table 5. Water Levels During Extended Influence Testing and Monitoring

Project No. 090057 Task 310.1.7.9, Vashon Island Closed Landfill, King County, WA

Location	Date	Bottom of Well Screen (ft bgs)	Top of Well Screen (ft bgs)	Depth to Water (ft bgs)	Depth to Water (ft btoc)	Was Well Screen Saturated?
GW-9	9/12/2018	35	17	33.85	37.94	no
	9/19/2018			NM	NM	no
	9/26/2018			NM	NM	no
	10/3/2018			NM	NM	no
	10/5/2018			NM	NM	no
	10/10/2018			33.61	37.7	no
	11/7/2018			33.42	37.51	no
	12/5/2018			33.43	37.52	no
	1/2/2019			33.41	37.5	no
	1/30/2019			33.71	37.8	no
	3/6/2019			32.96	37.05	no
GW-10	8/29/2018	28.5	15.5	NM	NM	no
	9/12/2018			27.75	31.6	no
	9/19/2018			NM	NM	no
	9/26/2018			NM	NM	no
	10/3/2018			NM	NM	no
	10/5/2018			NM	NM	no
	10/10/2018			27.69	31.54	no
	11/7/2018			27.19	31.04	no
	12/5/2018			27.2	31.05	no
	1/2/2019			27.2	31.05	no
	1/30/2019			27.65	31.5	no
	3/6/2019			27.2	31.05	no
GW-11	8/29/2018	17	10.5	NM	NM	no
	9/12/2018			15.32	18.84	no
	9/19/2018			NM	NM	no
	9/26/2018			NM	NM	no
	10/3/2018			NM	NM	no
	10/5/2018			NM	NM	no
	10/10/2018			14.13	17.65	no
	11/7/2018			12.61	16.13	no
	12/5/2018			12.39	15.91	no
	1/2/2019			10.47	13.99	yes
	1/30/2019			10.03	13.55	yes
	3/6/2019			9.58	13.1	yes

Note:

NM indicates "not measured"

Table 6. Summary of Landfill Gas Sample Results at Blower Inlet (2013 and 2019)

Project No. 090057 Task 310.1.7.9, Vashon Island Closed Landfill, King County, WA

Sample Location:		Blower Inlet			AP-42 Default Concentration
Date:		May 1, 2013		March 14, 2019	
Chemical	Units	TB	Summa	Summa and TB	
Major Gases (EPA Method 3C)					
Carbon dioxide	%			13.4	
Carbon monoxide	%			< 0.05	0.0141
Methane	%			3.44	
Nitrogen	%			70.0	
Oxygen	%			13.1	
Hydrogen	%			< 0.05	
Sulfur Compounds (EPA Method TO-15)					
Carbon disulfide	µg/m³	< 6.23	< 4.05	5.74	
Carbonyl sulfide	µg/m³			< 24.6	1204
Dimethyl sulfide (methyl sulfide)	µg/m³			< 25.4	19872
Ethyl mercaptan	µg/m³			< 25.4	5794
Hydrogen sulfide	µg/m³			3870 E	49482
Methyl mercaptan	µg/m³			< 19.6	4900
Volatile Organic Compounds (EPA Method 8260C)					
Acrylonitrile	µg/L			< 0.1	13.74
Ethylene dibromide	µg/L			< 0.025	
Volatile Organic Compounds (EPA Method TO-15)					
1,1,1-Trichloroethane	µg/m³	27.1	8.95	21.3	2619
1,1,2,2-Tetrachloroethane	µg/m³	< 2.06	< 2.06	< 2.06	
1,1-Dichloroethane	µg/m³	10	5.67	22.7	9513
1,1-Dichloroethene	µg/m³	10	5.67	4.67	793
1,2-Dibromoethane	µg/m³	< 0.793	< 0.793	2.36	
1,2-Dichlorobenzene	µg/m³	< 1.8	< 1.8	19.6	
1,2-Dichloroethane	µg/m³	6.48	0.909	5.03	1659
1,2-Dichloropropane	µg/m³	< 2.31	< 2.31	63.5	832
1,2,4-Trichlorobenzene	µg/m³	< 2.23	< 2.23	2.70	
1,2,4-Trimethylbenzene	µg/m³	14.2	5.21	468	
1,3,5-Trimethylbenzene	µg/m³	9.05	1.47	209	
1,3-Dichlorobenzene	µg/m³	< 1.8	< 1.8	6.35	
1,4-Dichlorobenzene	µg/m³	< 1.8	< 1.8	57.2	10822
2-Hexanone	µg/m³	< 4.1	< 4.1	5.86	
4-Ethyltoluene	µg/m³	< 1.47	< 3.15	124	
Acetone	µg/m³	34	46	28.9	
Benzene	µg/m³	56	21.4	93.4	
Benzyl chloride	µg/m³	< 2.59	< 2.59	36.0	
Butane	µg/m³				11957
Carbon tetrachloride	µg/m³	< 1.26	< 1.26	< 0.413	25
Chlorobenzene	µg/m³	< 0.921	< 0.921	127	1151
Chlorodifluoromethane	µg/m³				69671
Chloroethane	µg/m³	< 1.32	< 49.8	36.6	
Chloroform	µg/m³	< 0.977	< 0.977	4.36	146
Chloromethane	µg/m³	< 1.03	< 7.52	< 10.3	2499
cis-1,2-dichloroethene	µg/m³	23.8	12.8	266	
Cyclohexane	µg/m³	255 B	68.2 B	311	
Dichlorobenzene	µg/m³				1263
Dichlorobromomethane (bromodichloromethan	µg/m³	< 2.01	< 2.01	< 2.01	20973
Dichlorofluoromethane	µg/m³				11029
Ethane	µg/m³				1093348
Ethanol	µg/m³				51263
Ethylbenzene	µg/m³	951	5.21	2760 E	
Freon 11 (fluorotrichloromethane; CFC-11)	µg/m³	< 1.69	< 1.69	1360 E	4270
Freon 12 (dichlorodifluoromethane; CFC-12)	µg/m³	174	135	198	
Freon 113 (CFC-113)	µg/m³	25.8	20.4	13.4	
Freon 114 (dichlorotetrafluoroethane; CFC-114	µg/m³	67.1	62.4	96.1	
Heptane	µg/m³	407	36.6	294	
n-Hexane	µg/m³	282 B	114 B	365	
Isopropyl alcohol (2-propanol)	µg/m³	7.86	9.73	4.00	
Mercury	µg/m³				2
Methyl ethyl ketone (2-Butanone)	µg/m³	15.8	72.8	55.0	
Methyl isobutyl ketone	µg/m³			62.7	
Methylene chloride (dichloromethane)	µg/m³	< 1.74	< 28.8	119	
MTBE	µg/m³	< 0.721	< 0.721	3.13	
Naphthalene	µg/m³	< 1.57	< 1.57	75.9	
Pentane	µg/m³				9709
Propane	µg/m³				20016
Propylene	µg/m³	676	621	625 E	1184
Styrene	µg/m³	< 1.28	< 1.28	108	7242
Tetrachloroethene (PCE)	µg/m³	15.7	2.03	116	
Tetrahydrofuran	µg/m³	132	31.2	111	
Toluene	µg/m³	147	42.6	1380 E	
trans-1,2-Dichloroethene	µg/m³	< 0.793	< 0.793	17.5	11260
Trichloroethene (TCE)	µg/m³	9.03	1.07	56.5	15155
Vinyl acetate	µg/m³	< 3.52	< 3.52	5.61	
Vinyl chloride	µg/m³	64.8	69.9	151	18763
m,p-Xylenes	µg/m³	1010	9.47	6310 E	
o-Xylene	µg/m³	299	6.17	1530 E	
Total Volatile Organics	µg/m³			151000	

Notes:

Analytes included are those listed on the AP-42 analyte list for landfills with waste in place prior to 1992 (which is the same as the LandGem Model Analyte List) and all analytes detected by the laboratory.

E indicates the laboratory results was reported as an estimated value.

B - Analyte dected in associated Method Blank

Bold - Detected compound above laboratory reporting limit.

TB = Tedlar Bag sample

Summa = Summa cannister sample

Source of 2013 Sample Results: Herrera Environmental Consultants, 2013

µg/m³ = micrograms per cubic meter

Highlighting indicates analyte was detected but not included on the AP-42 Analyte list or LandGem Analyte list for Landfills with waste in place prior to 1992.

Highlighting indicates analyte was included on the AP-42 Analyte list for Landfills with waste in place prior to 1992, but is not included on the WAC-173-460-150 Table for ASIL, SQER and de minimis emission values.

Table 7. Calculations and Loading Rates from March 2019 LFG Sample

Project No. 090057 Task 310.1.7.9, Vashon Island Closed Landfill, King County, WA

Analyte	CAS Number	Molecular Weight	Reported Concentration (March 14, 2019) (ug/m3)	Default Concentration (AP-42) (ppmv)	Default Concentration (AP-42) (ug/m3)	Averaging Period	Flow Volume per Averaging Period (scf)	De Minimis Rate (lbs/avg.per.)	Small Quantity Emission Rate (SQER) (lbs/avg.per.)	Loading Rates (lbs/ave.per.)
Major Gases										
Carbon dioxide		44.01	13.4%							
Carbon monoxide	630-08-0	28.01	< 0.05%	141	161531	1-hr	12000	1.14	50.4	0.1210
Methane		16.04	3.44%							
Nitrogen			70.0%							
Oxygen			13.1%							
Hydrogen			< 0.05%							
TAPs										
1,1,1-Trichloroethane	71-55-6	133.41	21.3	0.48	2619	24-hr	288000	6.57	131	0.0004
1,1,2,2-Tetrachloroethane	79-34-5	167.85	< 2.06			year	105120000	0.165	3.3	0.0135
1,1-Dichloroethane	75-34-3	98.97	22.7	2.35	9513	year	105120000	6	120	0.1490
1,1-Dichloroethene	75-35-4	96.94	4.67	0.2	793	24-hr	288000	1.31	26.3	8.396E-05
1,2-Dibromoethane	106-93-4	187.86	2.36			year	105120000	0.135	2.71	0.0155
1,2-Dichlorobenzene	95-50-1	147	19.6			year*	105120000			0.1286
1,2-Dichloroethane	107-06-2	98.96	5.03	0.41	1659	year	105120000	0.369	7.39	0.0330
1,2-Dichloropropane	78-87-5	112.99	63.5	0.18	832	year	105120000	0.959	19.2	0.4167
1,2,4-Trichlorobenzene	120-82-1	181.46	2.70			year*	105120000			0.0177
1,2,4-Trimethylbenzene	95-63-6	120.19	468			year*	105120000			3.0712
1,3,5-Trimethylbenzene	108-67-8	120.2	209			year*	105120000			1.3715
1,3-Dichlorobenzene	541-73-1	147.01	6.35			year*	105120000			0.0417
1,4-Dichlorobenzene	106-46-7	147	57.2	1.8	10822	year	105120000	0.872	17.4	0.3754
2-Hexanone	591-78-6	100.16	5.86			year*	105120000			0.0385
4-Ethyltoluene	622-96-8	120.2	124			year*	105120000			0.8137
Acetone	67-64-1	58.08	28.9			year*	105120000			0.1897
Acrylonitrile	107-13-1	53.06	< 0.1	6.33	13737	year	105120000	0.0331	0.662	0.0007
Benzene	71-43-2	78.11	93.4			year	105120000	0.331	6.62	0.6129
Benzyl chloride	100-44-7	126.58	36.0			year	105120000	0.196	3.91	0.2362
Butane		58.12		5.03	11957	year*	105120000			78.46
Carbon disulfide	75-15-0	76.13	5.74			24-hr	288000	5.26	105	0.0001
Carbon tetrachloride	56-23-5	153.84	< 0.413	0.004	25	year	105120000	0.228	4.57	0.0027
Carbonyl sulfide		60.07	< 24.6	0.49	1204	year*	105120000			0.1614
Chlorobenzene	108-90-7	112.56	127	0.25	1151	24-hr	288000	6.57	131	0.0023
Chlorodifluoromethane	75-45-6	86.47		19.7	69671	24-hr	288000	328	6570	1.253
Chloroethane	75-00-3	64.52	36.6			24-hr	288000	197	3940	0.0007
Chloroform	67-66-3	119.39	4.36	0.03	146	year	105120000	0.417	8.35	0.0286
Chloromethane	74-87-3	50.49	< 10.3	1.21	2499	24-hr	288000	0.591	11.8	0.0002
cis-1,2-dichloroethene	156-59-2	96.94	266			year	105120000			1.7456
Cyclohexane	110-82-7	84.08	311			24-hr	288000	39.4	789	0.0056
Dichlorobenzene		147		0.21	1263	year*	105120000			8.285
Dichlorobromomethane (bromodichloromethane)	75-27-4	163.83	< 2.01	3.13	20973	year	105120000	0.259	5.18	0.0132
Dichlorofluoromethane		102.92		2.62	11029	year*	105120000			72.37
Dimethyl sulfide (methyl sulfide)		62.13	< 25.4	7.82	19872	year*	105120000			0.1667
Ethane		30.07		889	1093348	year*	105120000			7175
Ethanol		46.08		27.2	51263	year*	105120000			336.4
Ethyl mercaptan		62.13	< 25.4	2.28	5794	year*	105120000			0.1667
Ethylbenzene	100-41-4	106.16	2760 E			year	105120000	3.84	76.8	18.11
Ethylene dibromide		187.88	< 0.025	0.001	8	year*	105120000			0.0002
Freon 11 (fluorotrichloromethane; CFC-11)	75-69-4	137.38	1360 E	0.76	4270	year*	105120000			8.9247
Freon 12 (dichlorodifluoromethane; CFC-12)	75-71-8	120.91	198			year*	105120000			1.2993
Freon 113 (CFC-113)	76-13-1	187.39	13.4			year*	105120000			0.0879
Freon 114 (dichlorotetrafluoroethane; CFC-114)	76-14-2	170.93	96.1			year*	105120000			0.6306
Heptane	142-82-5	100.2	294			year	105120000			1.9293
n-Hexane	110-54-3	86.18	365			24-hr	288000	4.6	92	0.0066
Hydrogen sulfide	7783-06-4	34.08	3870 E	35.5	49482	24-hr	288000	0.0131	0.263	0.0696
Isopropyl alcohol (2-propanol)	67-63-0	60.11	4.00			1-hr	12000	0.35	7.01	2.996E-06
Mercury	7439-97-6	200.61		0.00029	2	24-hr	288000	0.000591	0.0118	0.00004
Methyl ethyl ketone (2-Butanone)	78-93-3	72.11	55.0			24-hr	288000	32.9	657	0.0010
Methyl isobutyl ketone	108-10-1	100.16	62.7			24-hr	288000	19.7	394	0.0011
Methyl mercaptan		48.11	< 19.6	2.49	4900	year*	105120000			0.1286
Methylene chloride (dichloromethane)	75-09-2	84.94	119			year	105120000	9.59	192	0.7809
MTBE	1634-04-4	88.15	3.13			year	105120000	36.9	739	0.0205
Naphthalene	91-20-3	128.17	75.9			year	105120000	0.282	5.64	0.4981
Pentane		72.15		3.29	9709	year*	105120000			63.71
Propane		44.09		11.1	20016	year*	105120000			131.4
Propylene	115-07-1	42.08	625 E	0.688	1184	24-hr	288000	19.7	394	0.0112
Styrene	100-42-5	104.15	108	1.70	7242	24-hr	288000	5.91	118	0.0019
Tetrachloroethene (PCE)	127-18-4	165.83	116			year	105120000	1.62	32.4	0.7612
Tetrahydrofuran	109-99-9	72.1	111			year*	105120000			0.7284
Toluene	108-88-3	92.13	1380 E			24-hr	288000	32.9	657	0.0248
trans-1,2-Dichloroethene	156-60-5	96.94	17.5	2.84	11260	24-hr	288000	5.3	106	0.0003
Trichloroethene (TCE)	79-01-6	131.40	56.5	2.82	15155	year	105120000	4.8	95.9	0.3708
Vinyl acetate	108-05-4	86.09	5.61			24-hr	288000	1.31	26.3	0.0001
Vinyl chloride	75-01-4	62.50	151	7.34	18763	year	105120000	0.123	2.46	0.9909
m,p-Xylenes	106-42-3	106.16	6310 E			24-hr	288000	1.45	29	0.1134
o-Xylene	95-47-6	106.16	1530 E			24-hr	288000	1.45	29	0.0275
Total Volatile Organics			151000							

Notes:

Analytes included are those listed on the AP-42 analyte list for landfills with waste in place prior to 1992 (which is the same as the LandGem Model Analyte List) and all analytes detected by the laboratory.

De minimis rate and small quanitity emission rate (SQER) are from WAC-173-460-150 Table for ASIL, SQER, and de minimis values.

* averaging period assumed to be 1 year.

Flow rate of 200 scfm used to calculate flow volume per averaging period and the corresponding loading rates.

Major gases were analyzed using EPA Method 3C.

TAPs were analyzed using EPA Method TO-15 and EPA Method 8260C.

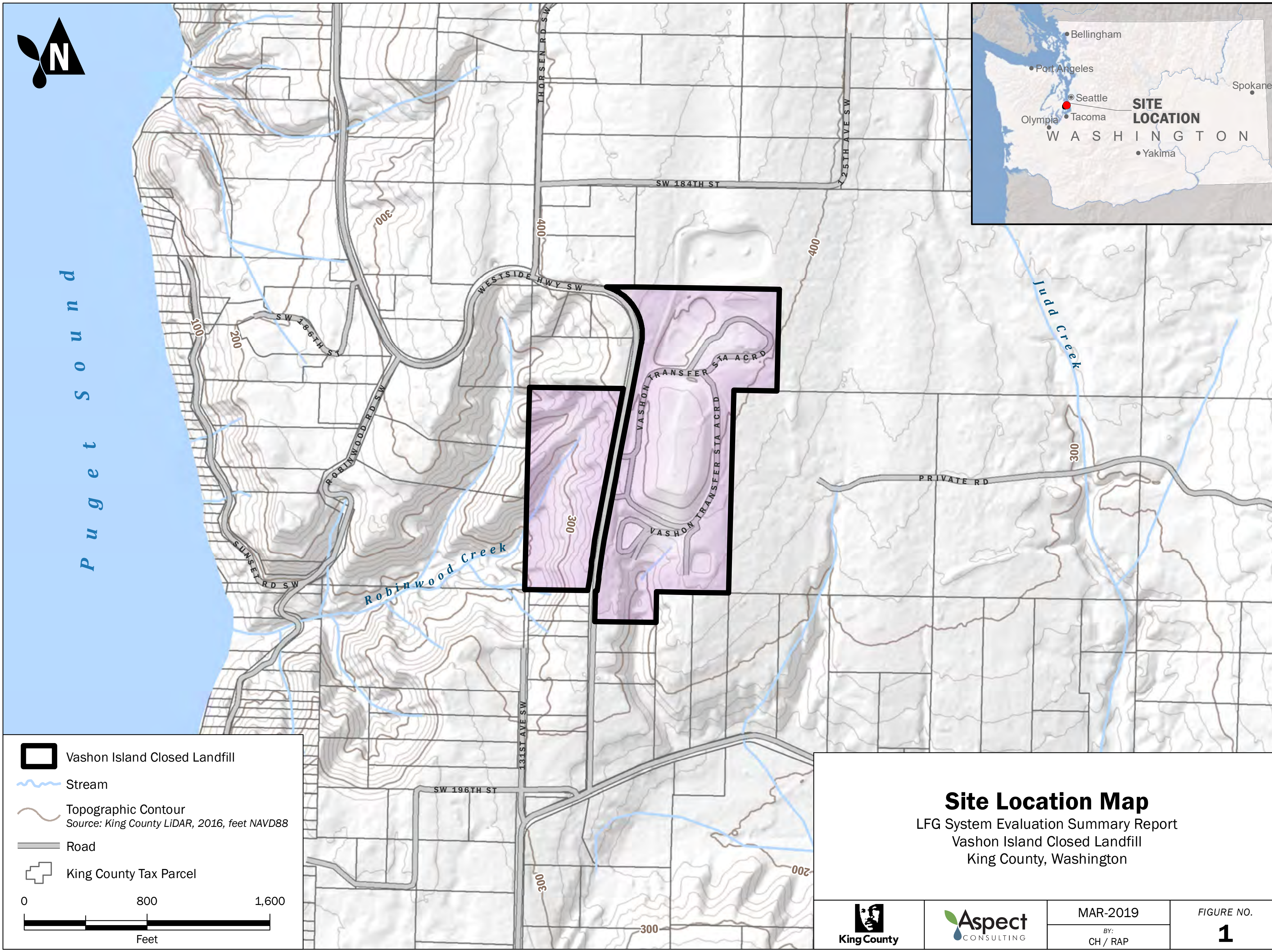
E indicates the laboratory result was reported as an estimated value.

Highlighting indicates reported concentration is in ug/L and was analyzed by EPA Method 8260C. All other reported concentrations for TAPs were analyzed using EPA Method TO-15.

Highlighting indicates analyte was detected but not included on the AP-42 Analyte list or LandGem Analyte list for Landfills with waste in place prior to 1992.

Highlighting indicates analyte was included on the AP-42 Analyte list for Landfills with waste in place prior to 1992, but is not included on the WAC-173-460-150 Table for ASIL, SQER and de minimis emission values.

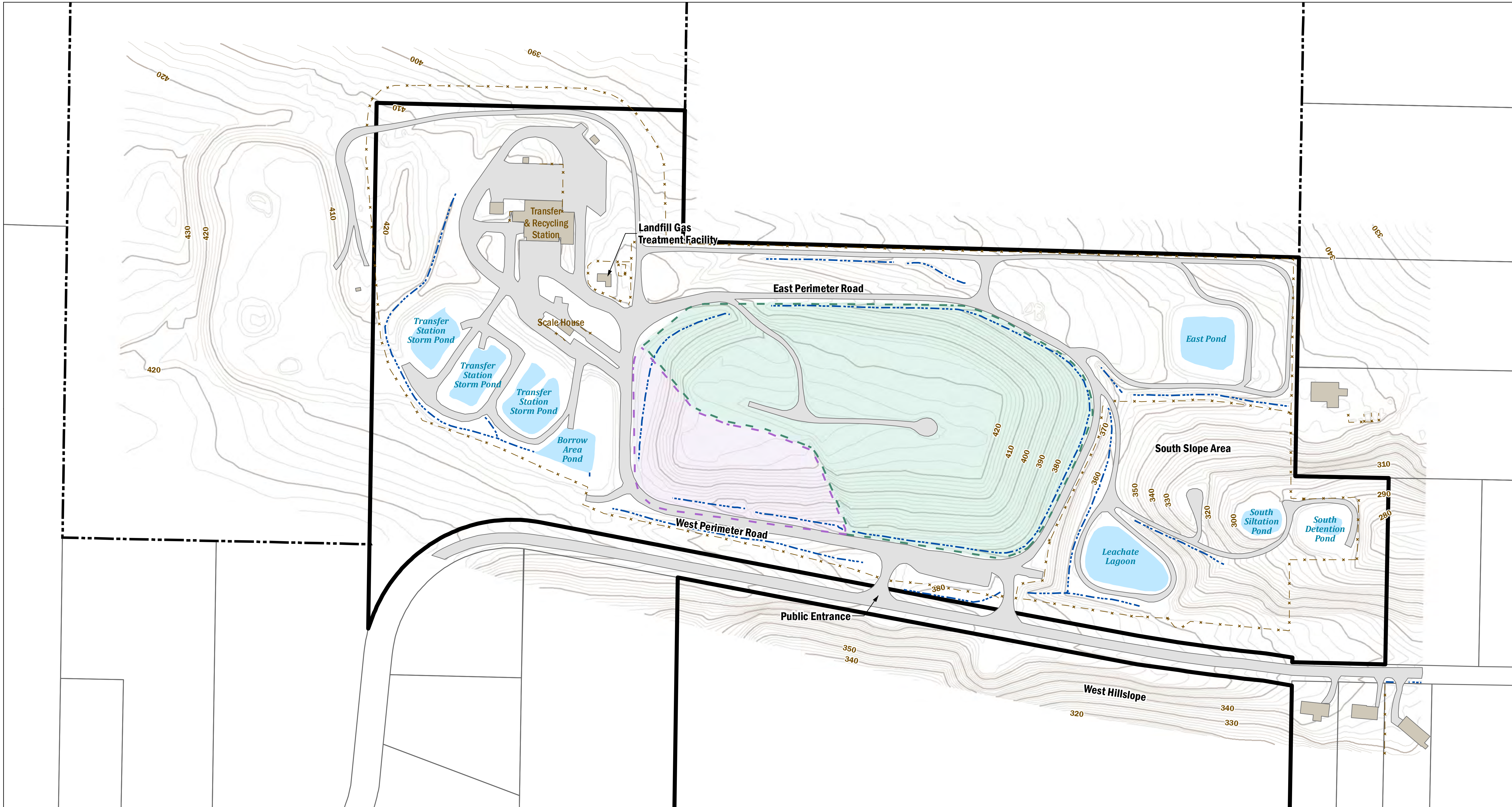
FIGURES



Site Location Map

LFG System Evaluation Summary Report
Vashon Island Closed Landfill
King County, Washington

King County | Aspect CONSULTING | MAR-2019 | BY: CH / RAP | FIGURE NO. 1



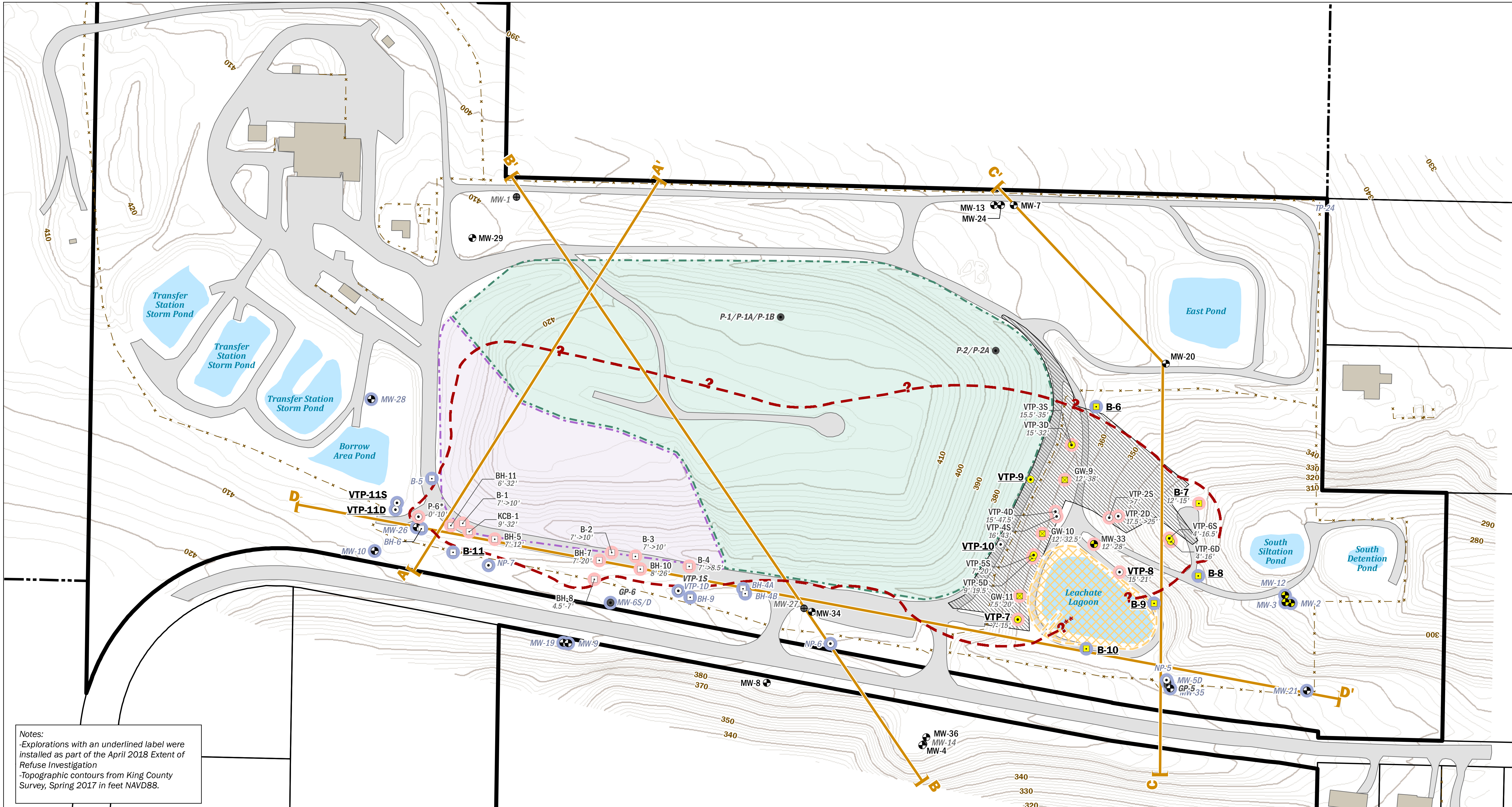
Phase 1 - 1988 Final Cover
Phase 2 - 2001 Final Cover
Pond
Ditch
Building
Road
Fence
Vashon Island Closed Landfill
Other King County-Owned Property
King County Tax Parcel

Topographic contours in feet NAVD88 from King County Survey, Spring 2017, in feet NAVD88.

0 200 400
Feet

Property Features
LFG System Evaluation Summary Report
Vashon Island Closed Landfill
King County, Washington

King County | Aspect CONSULTING | MAR-2019 BY: CH / RAP | FIGURE NO. 2



Notes:
-Explorations with an underlined label were installed as part of the April 2018 Extent of Refuse Investigation
-Topographic contours from King County Survey, Spring 2017 in feet NAVD88.

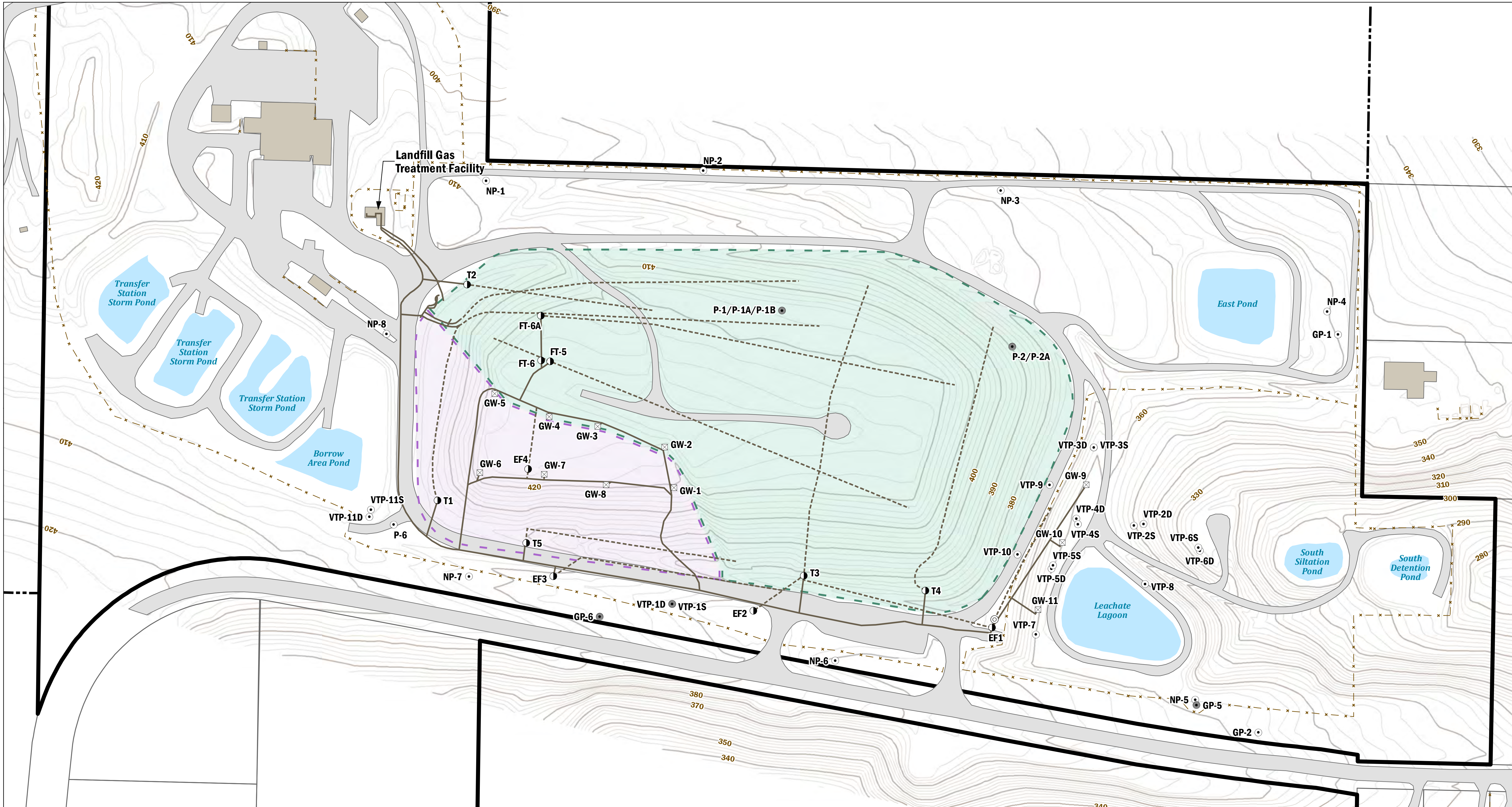
- Boring
- Gas Probe
- LFG Extraction Well
- Monitoring Well
- Monitoring Well (Decommissioned)
- Boring (Till Absent)
- Gas Probe (Till Absent)
- LFG Extraction Well (Till Absent)
- Monitoring Well (Till Absent)
- Estimated Extent of Unlined Refuse
- Extent of Geotextile Cover Beyond Landfill Liner
- Extent of Geomembrane under Leachate Lagoon
- Cross Section
- Encountered Refuse
- No Refuse, Native Soils Encountered After Fill Unit
- Phase 1 - 1988 Final Cover
- Phase 2 - 2001 Final Cover
- Pond
- Building
- Road
- Fence
- Vashon Island Closed Landfill
- Other King County-Owned Property
- King County Tax Parcel

0 150 300
Feet

Extent of Solid Waste

LFG System Evaluation Summary Report
Vashon Island Closed Landfill
King County, Washington

King County | Aspect CONSULTING | MAY-2019 BY: CH / RAP | FIGURE NO. 3



Gas Probe/Piezometer

Decommissioned Gas Probe

LFG Extraction Well

LFG Trench Riser

LFG Pipe

LFG Pipe (Perforated)

Phase 1 - 1988 Final Cover

Phase 2 - 2001 Final Cover

Pond

Building

Road

Fence

Vashon Island Closed Landfill

Other King County-Owned Property

King County Tax Parcel

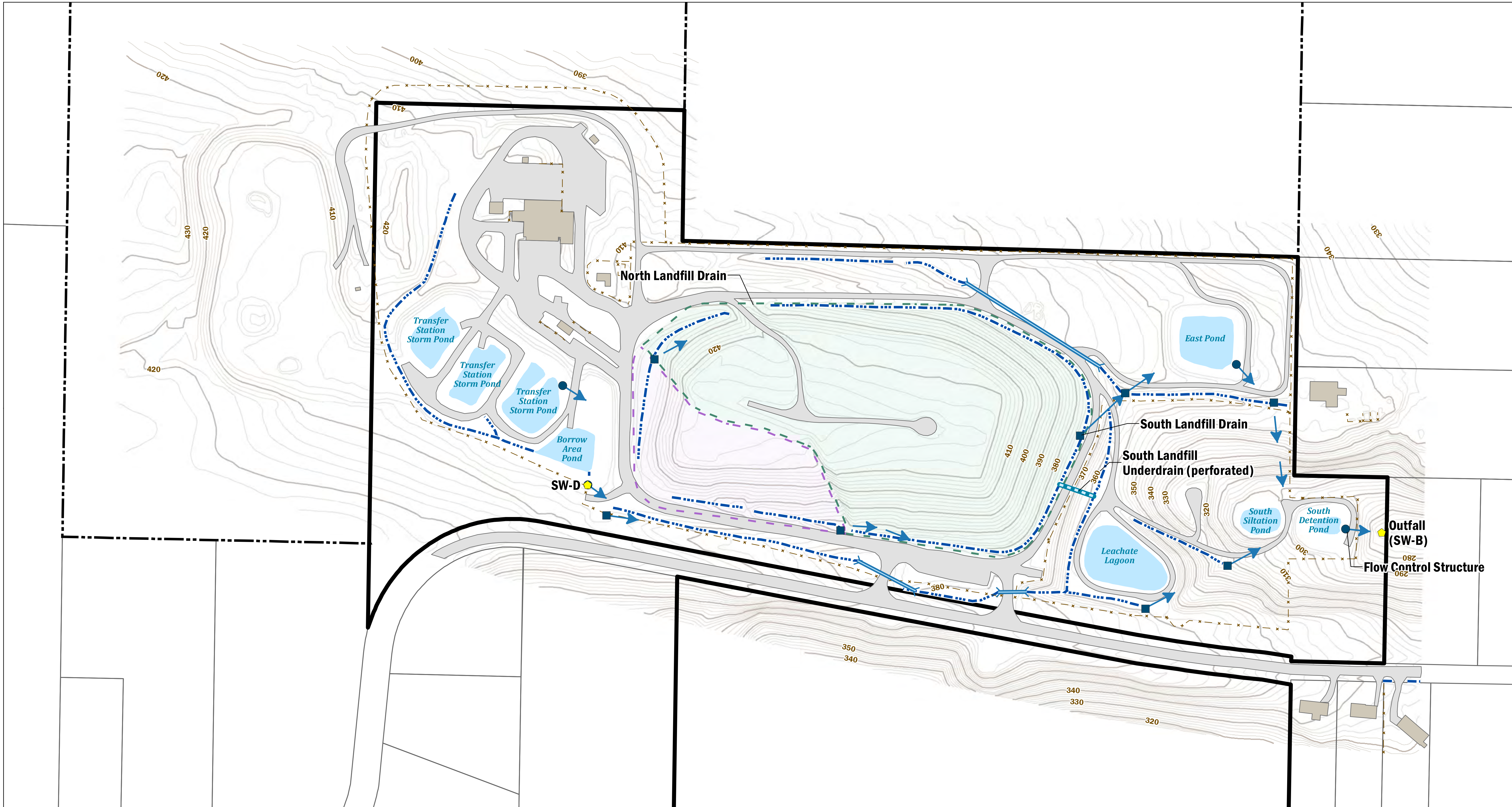
Topographic contours from King County Survey, Spring 2017, in feet NAVD88. Landfill gas system features are approximated from as-built locations, and revised to match survey data where available.

0 140 280
Feet

Landfill Gas Collection and Monitoring Systems

LFG System Evaluation Summary Report
Vashon Island Closed Landfill
King County, Washington

King County | Aspect CONSULTING | MAR-2019 BY: CH / RAP | FIGURE NO. 4



- Ponded Stormwater Enters Storm Drain Pipe for Conveyance
- Surface Water Flow Enters Storm Pipe for Conveyance
- Former Surface Water Monitoring Station
- Culvert
- Underdrain
- General Direction of Flow
- Ditch (Asphalt or Unlined)
- Phase 1 - 1988 Final Cover
- Phase 2 - 2001 Final Cover
- Pond
- Building
- Road
- Fence
- Vashon Island Closed Landfill
- Other King County-Owned Property
- King County Tax Parcel

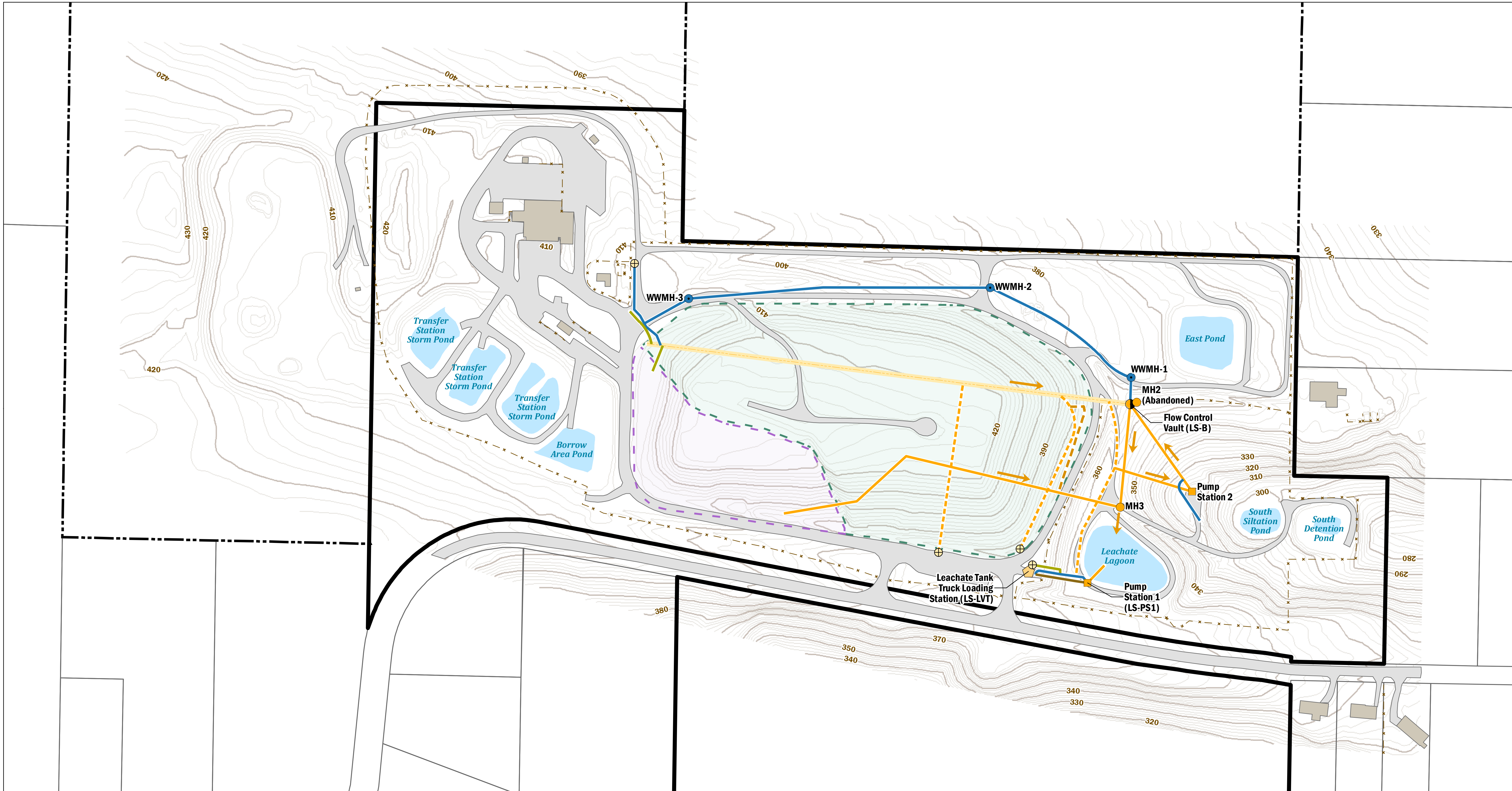
Topographic contours from King County Survey, Spring 2017, in feet NAVD88.

0 200 400
Feet

Surface Water Drainage Features

LFG System Evaluation Summary Report
Vashon Island Closed Landfill
King County, Washington

King County | Aspect CONSULTING | MAR-2019 BY: CH / RAP | FIGURE NO. 5



- Manhole
- Pump Station
- Loading Station
- Flow Control Vault
- Wastewater Manhole
- Cleanout
- General Direction of Flow
- Leachate Collection Pipe
- Leachate Collection Pipe (Perforated)
- Leachate Collection Trench
- Leachate Forcemain
- Condensate Pipe
- Wastewater Pipe
- Underdrain Pipe
- Phase 1 - 1988 Final Cover
- Phase 2 - 2001 Final Cover
- Pond
- Building
- Road
- Fence
- Vashon Island Closed Landfill
- Other King County-Owned Property
- King County Tax Parcel

Topographic contours from King County Survey, Spring 2017, in feet NAVD88.

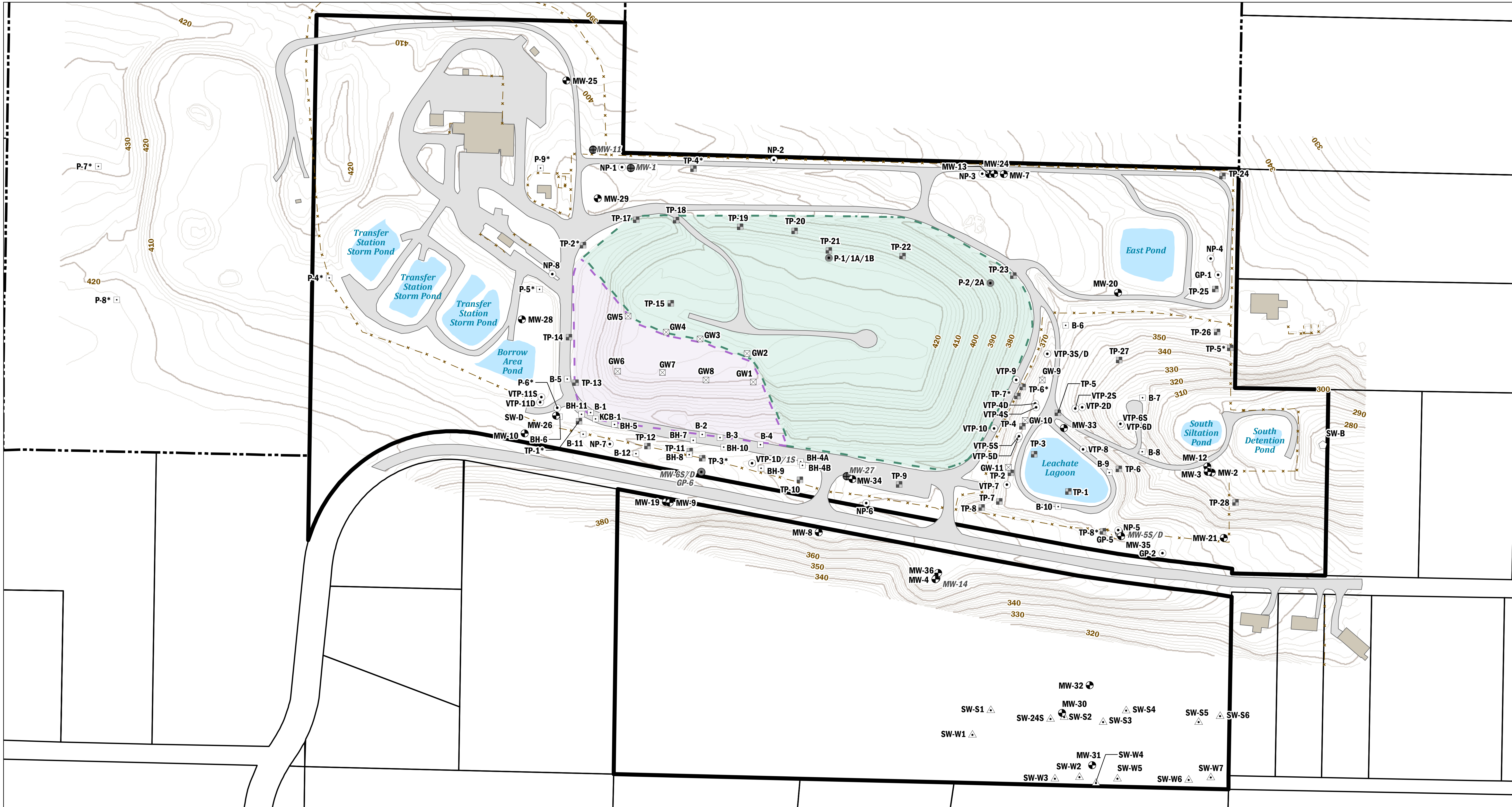
0 200 400
Feet

Leachate Collection and Monitoring Systems

LFG System Evaluation Summary Report
Vashon Island Closed Landfill
King County, Washington

King County | Aspect CONSULTING | AUG-2019 BY: CH / RAP | FIGURE NO. 6

GIS Path: T:\projects_8\KingCounty_SolidWaste\VashonIslandLandfill\Delivered\LFG System Evaluation Summary Report\06 Leachate Collection and Monitoring Systems.mxd || Coordinate System: NAD 1983 HARN StatePlane Washington North FIPS 4601 Feet || Date Saved: 8/29/2019 || User: rpepin || Print Date: 8/29/2019



Boring	Monitoring Well
Gas Probe	Decommissioned Gas Probe
LFG Extraction Well	Decommissioned Monitoring Well
Test Pit	Phase 1 - 1988 Final Cover
Seep/Weir Sampling Location	Phase 2 - 2001 Final Cover
Former Surface Water Monitoring Station	

Pond
Building
Road
Fence

Vashon Island Closed Landfill
Other King County-Owned Property
King County Tax Parcel

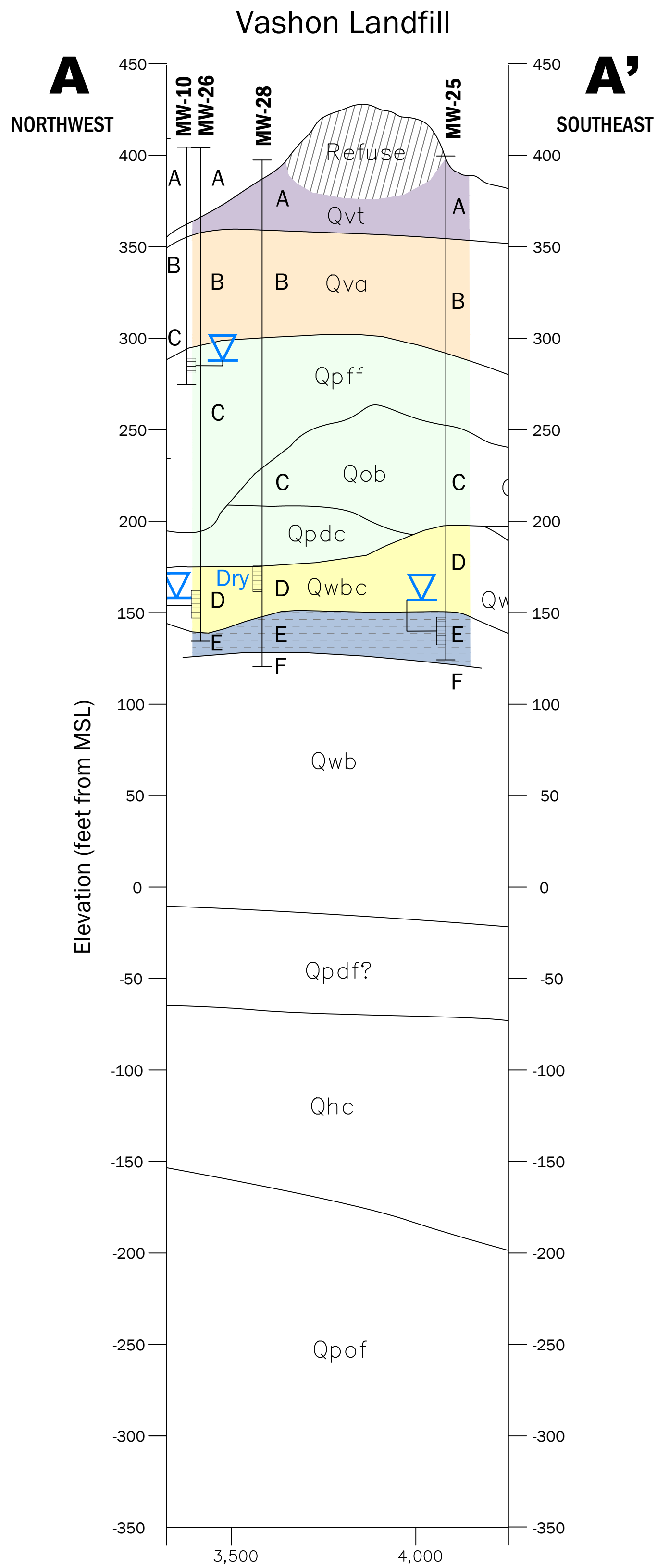
0 200 400
Feet

** indicates exploration from Golder, 1986*
Topographic contours from King County Survey, Spring 2017, in feet NAVD88.

Exploration Locations

LFG System Evaluation Summary Report
Vashon Island Closed Landfill
King County, Washington

King County | Aspect CONSULTING | MAY-2019 BY: CH / RAP | FIGURE NO. 7



Geologic Units

Qvt Vashon Till
Qva Advance Outwash
Qob Olympia Beds
Qpdc Possession Drift, Coarse-Grained Facies
Qpdf Possession Drift, Fine-Grained Facies
Qwbc Whidbey Beds, Coarse-Grained Facies
Qwb Whidbey Beds, Undifferentiated
Qhc Hamm Creek Formation
Qpof Pre-Olympia Deposits, Fine-Grained Facies
Qpff Pre-Fraser Glaciation Deposits, Fine-Grained Facies

Refuse/Fill
Unit A
Unit B
Unit C
Coarse Fine
Unit D
Unit E

Static Water Level
Screen Interval

Note: DW well ID's indicate water quality sample was collected by county. Refer to Section 6 for data.

Source: Modified from Troost, 2004.

Horizontal Scale: 1" = 500'
Vertical Scale: 1" = 100'
Vertical Exaggeration 5x

0 500 1000 Feet

Geologic Cross Section A-A'

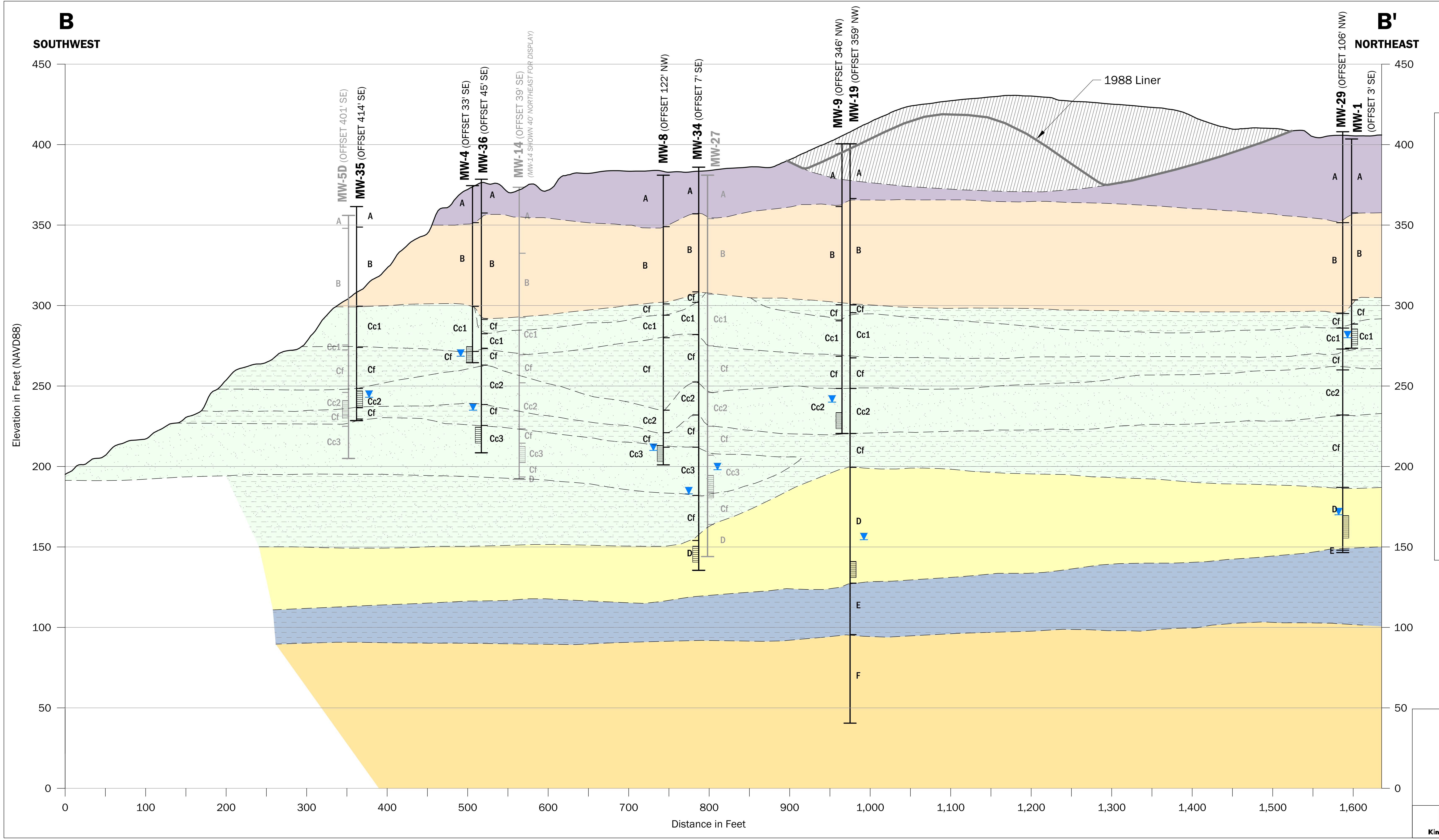
LFG System Evaluation Summary Report
Vashon Island Closed Landfill
King County, Washington

King County
Aspect CONSULTING

Mar-2019
BY: CH/SCC

FIGURE NO.
8

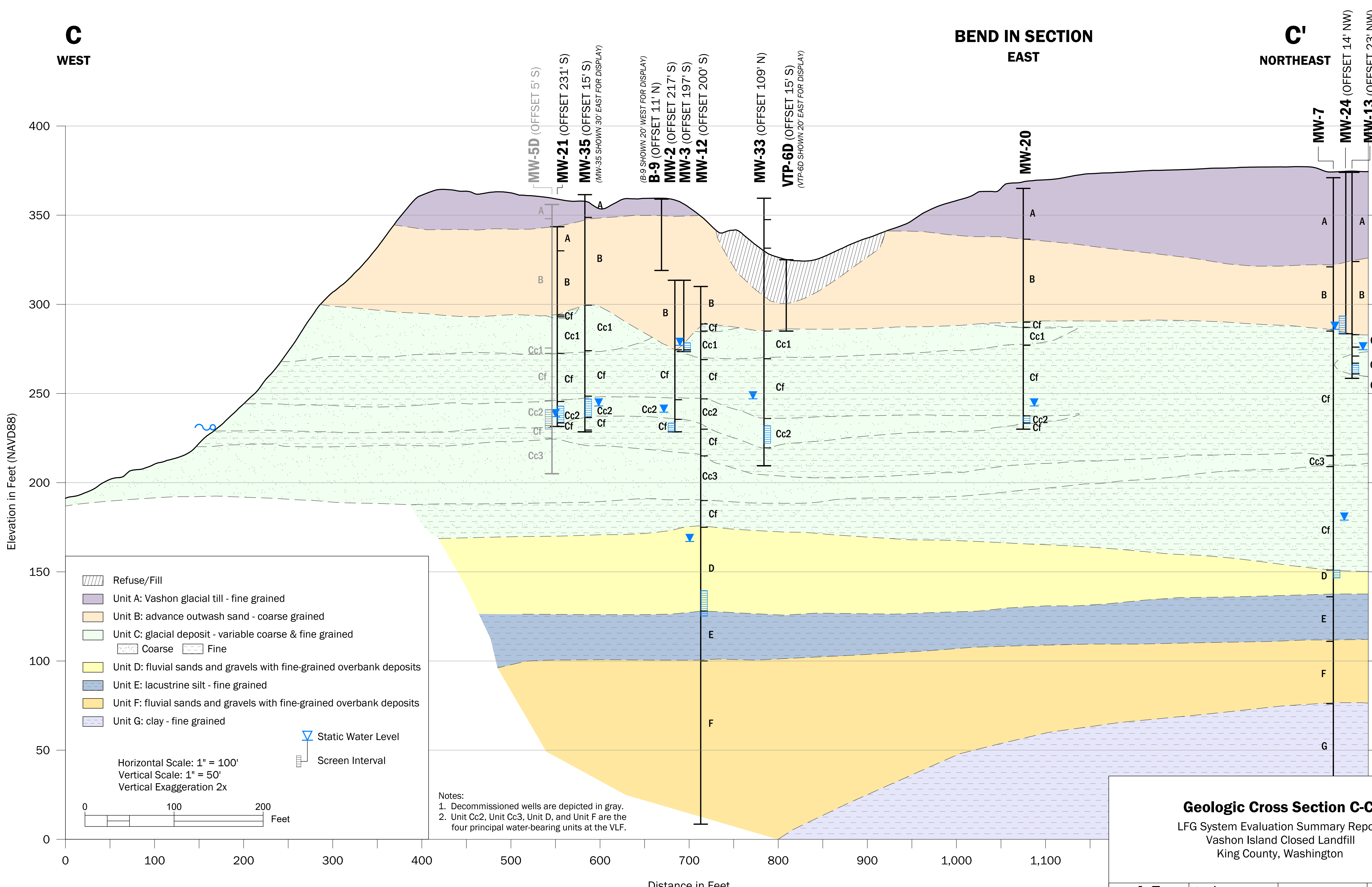
CAD Path: Q:\King County\090057 Vashon Island Landfill\2019-03 LFG System Evaluation Summary Report\090057-AA.dwg Section A-A' Letter P || Date Saved: Mar 12, 2019 10:51am || User: scudd



Geologic Cross Section B-B'

LFG System Evaluation Summary Report
Vashon Island Closed Landfill
King County, Washington

King County | Aspect Consulting | Mar-2019 | BY: CH/SCC | FIGURE NO. 9

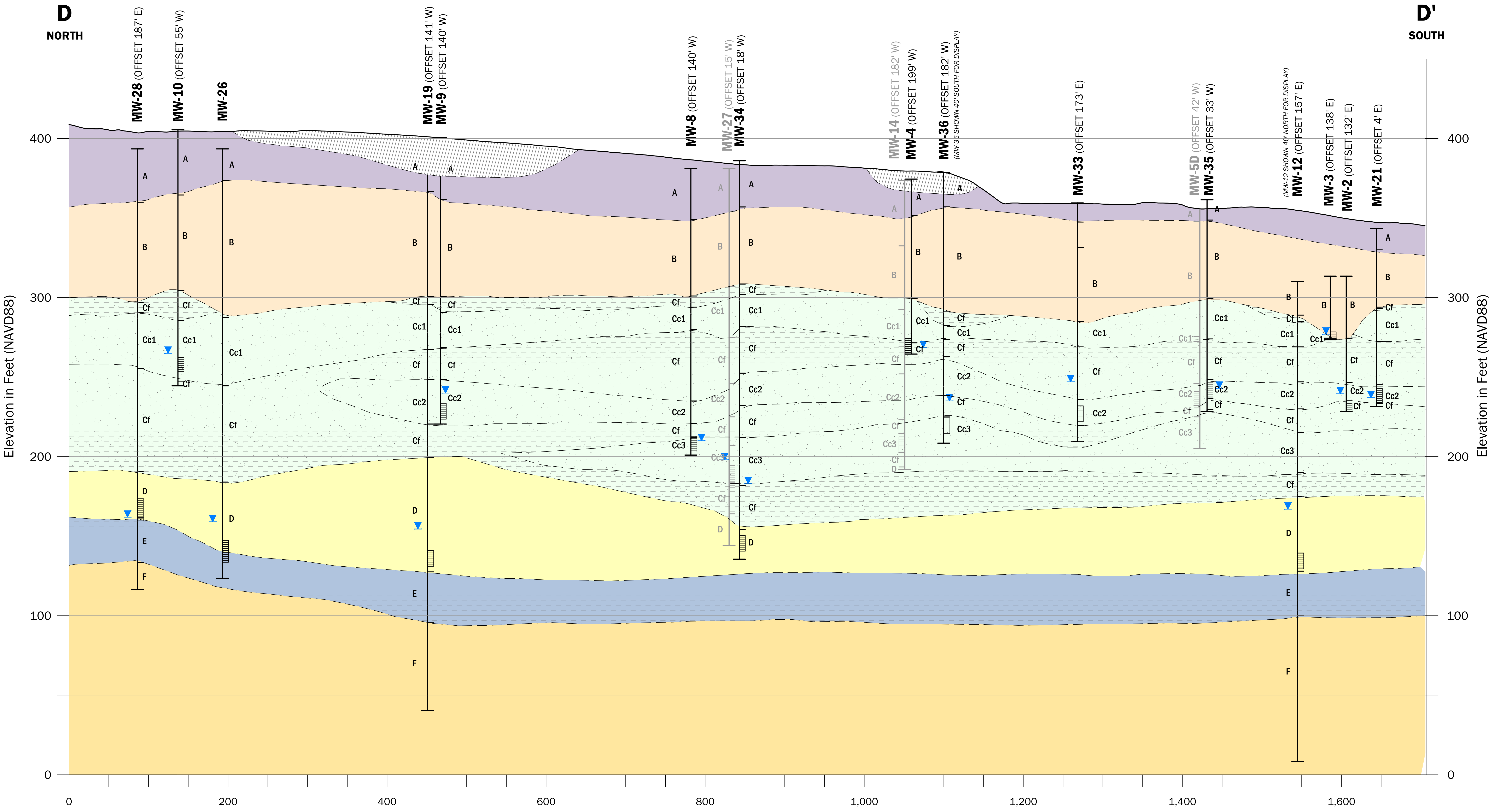


Geologic Cross Section C-C'

LFG System Evaluation Summary Report
Vashon Island Closed Landfill
King County, Washington

King County | Aspect CONSULTING | Mar-2019 | BY: CH/SCC | FIGURE NO. 10

CAD Path: Q:\King County\090057 Vashon Island Landfill\2019-03 LFG System Evaluation Summary Report\090057-CC.dwg 11x17 Landscape || Coordinate System: NAD 1983 State Plane Washington North FIPS 4601 Feet || Date Saved: Mar 12, 2019 10:57am || User: scudd



Refuse/Fill

Unit A: Vashon glacial till - fine grained

Unit B: advance outwash sand - coarse grained

Unit C: glacial deposit - variable coarse & fine grained (Coarse / Fine)

Unit D: fluvial sands and gravels with fine-grained overbank deposits

Unit E: lacustrine silt - fine grained

Unit F: fluvial sands and gravels with fine-grained overbank deposits

Static Water Level

Screen Interval

Horizontal Scale: 1" = 100'
Vertical Scale: 1" = 50'
Vertical Exaggeration 2x

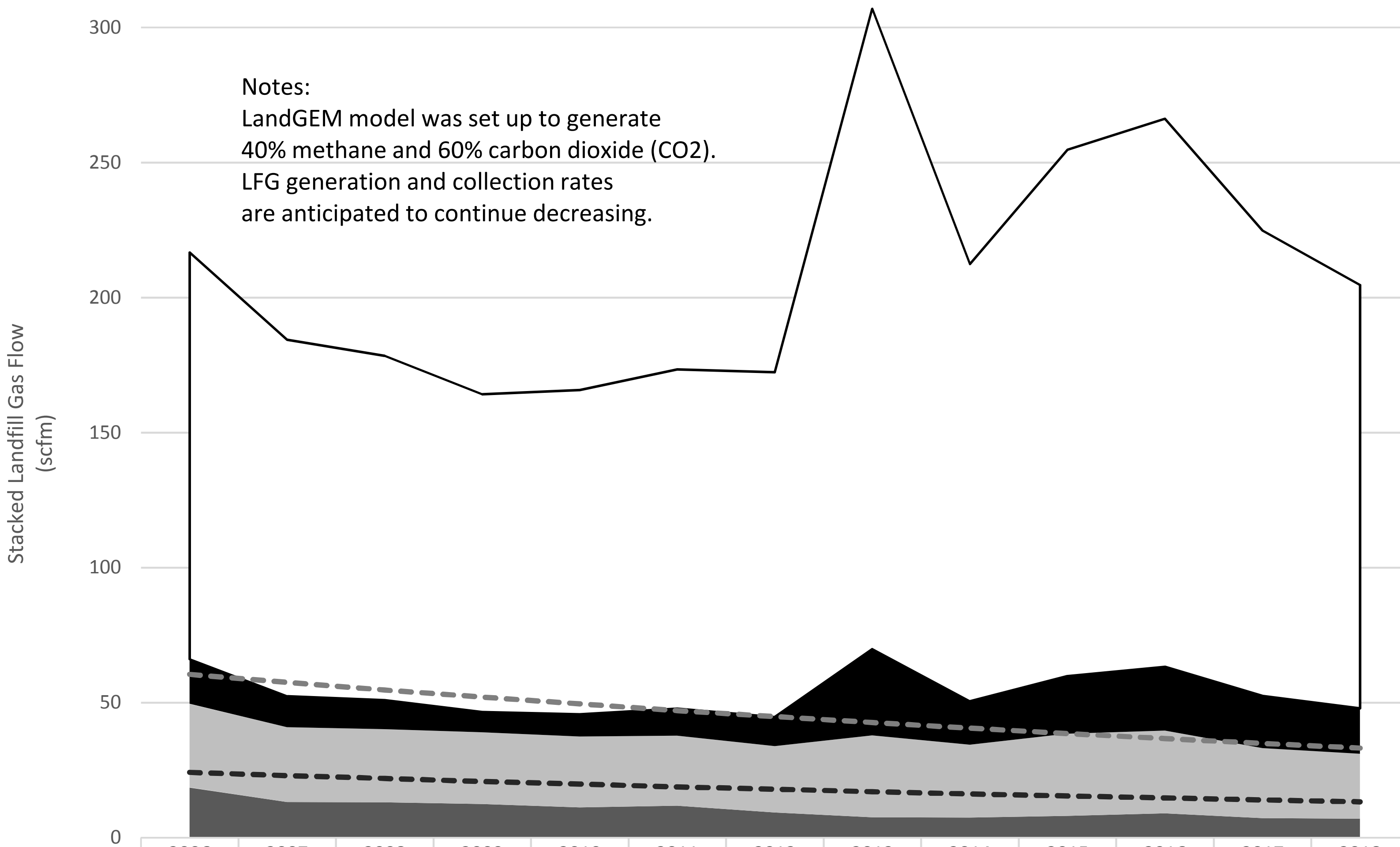
0 100 200 Feet

Notes:
1. Decommissioned wells are depicted in gray.
2. Unit Cc2, Unit Cc3, Unit D, and Unit F are the four principal water-bearing units at the VLF.

Geologic Cross Section D-D'

LFG System Evaluation Summary Report
Vashon Island Closed Landfill
King County, Washington

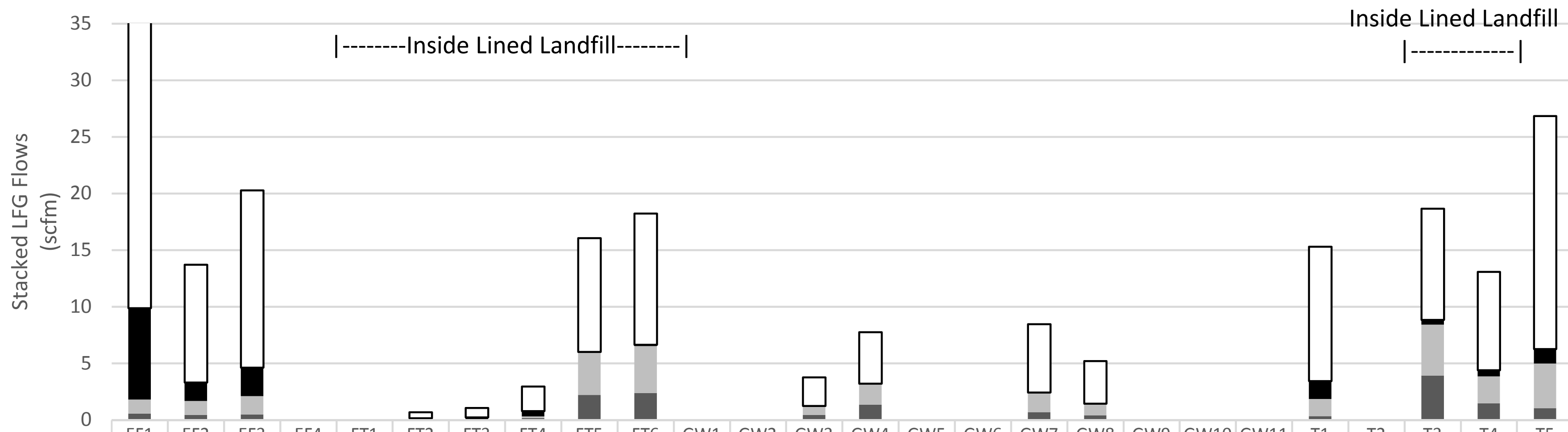
King County | Aspect CONSULTING | Mar-2019 | BY: CH/SCC | FIGURE NO. 11



	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Balance	151	132	128	118	120	126	128	237	162	195	203	172	157
Oxygen	17	11	11	8	8	10	11	32	16	21	24	19	17
CO2	31	28	27	27	26	26	25	30	27	30	31	26	24
Methane	19	13	13	12	11	12	9	8	7	8	9	7	7
LandGEM CO2	36	35	33	31	30	28	27	26	24	23	22	21	20
LandGEM CH4	24	23	22	21	20	19	18	17	16	15	15	14	13

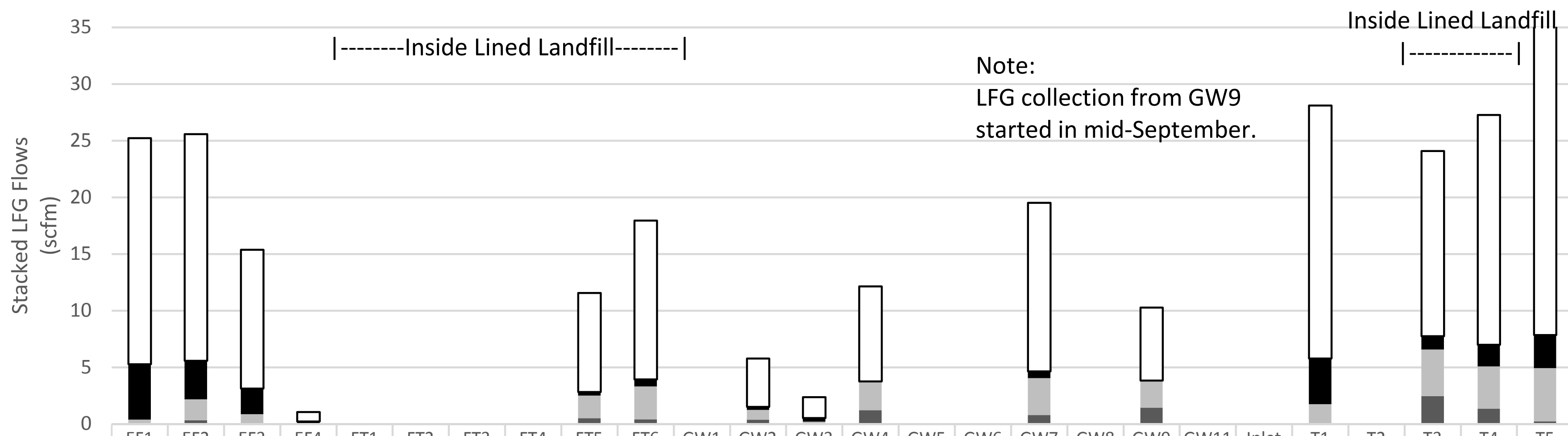
Figure 12
Observed LFG Collection and LandGEM Model Results Over Time

LFG Collection in 2006



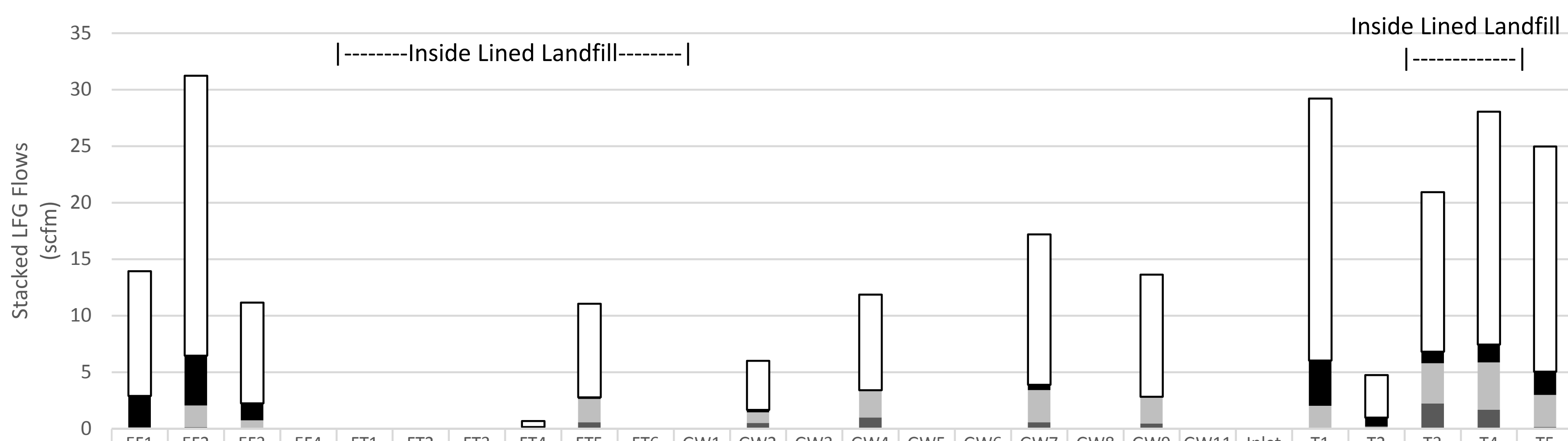
	EF1	EF2	EF3	EF4	FT1	FT2	FT3	FT4	FT5	FT6	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8	GW9	GW10	GW11	T1	T2	T3	T4	T5
□ Balance	35	10	16	0	0	1	1	2	10	12	0	0	3	5	0	0	6	4	0	0	0	12	0	10	9	21
■ O2	8	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	1
■ CO2	1	1	2	0	0	0	0	0	4	4	0	0	1	2	0	0	2	1	0	0	0	2	0	4	2	4
■ CH4	1	0	0	0	0	0	0	0	2	2	0	0	0	1	0	0	1	0	0	0	0	0	0	4	1	1

LFG Collection in 2016



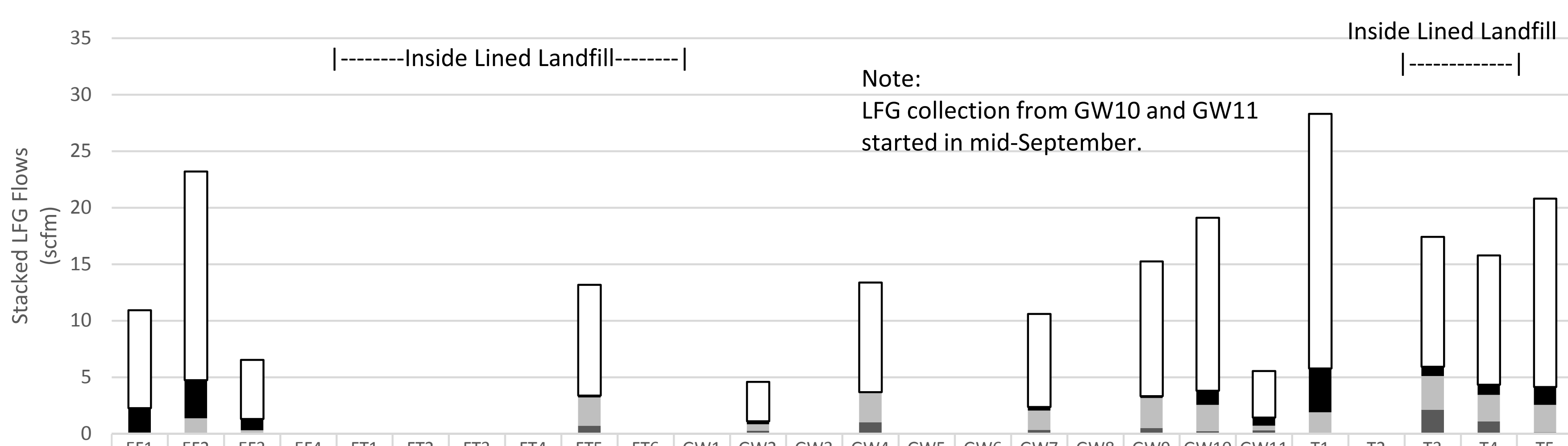
	EF1	EF2	EF3	EF4	FT1	FT2	FT3	FT4	FT5	FT6	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8	GW9	GW11	Inlet	T1	T2	T3	T4	T5
□ Balance	20	20	12	1	0	0	0	0	9	14	0	4	2	8	0	0	15	0	6	0	0	22	0	16	20	32
■ O2	5	3	2	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	4	0	1	2	3
■ CO2	0	2	1	0	0	0	0	0	2	3	0	1	0	3	0	0	3	0	2	0	0	2	0	4	4	5
■ CH4	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0	1	0	0	0	0	2	1	0

LFG Collection in 2017

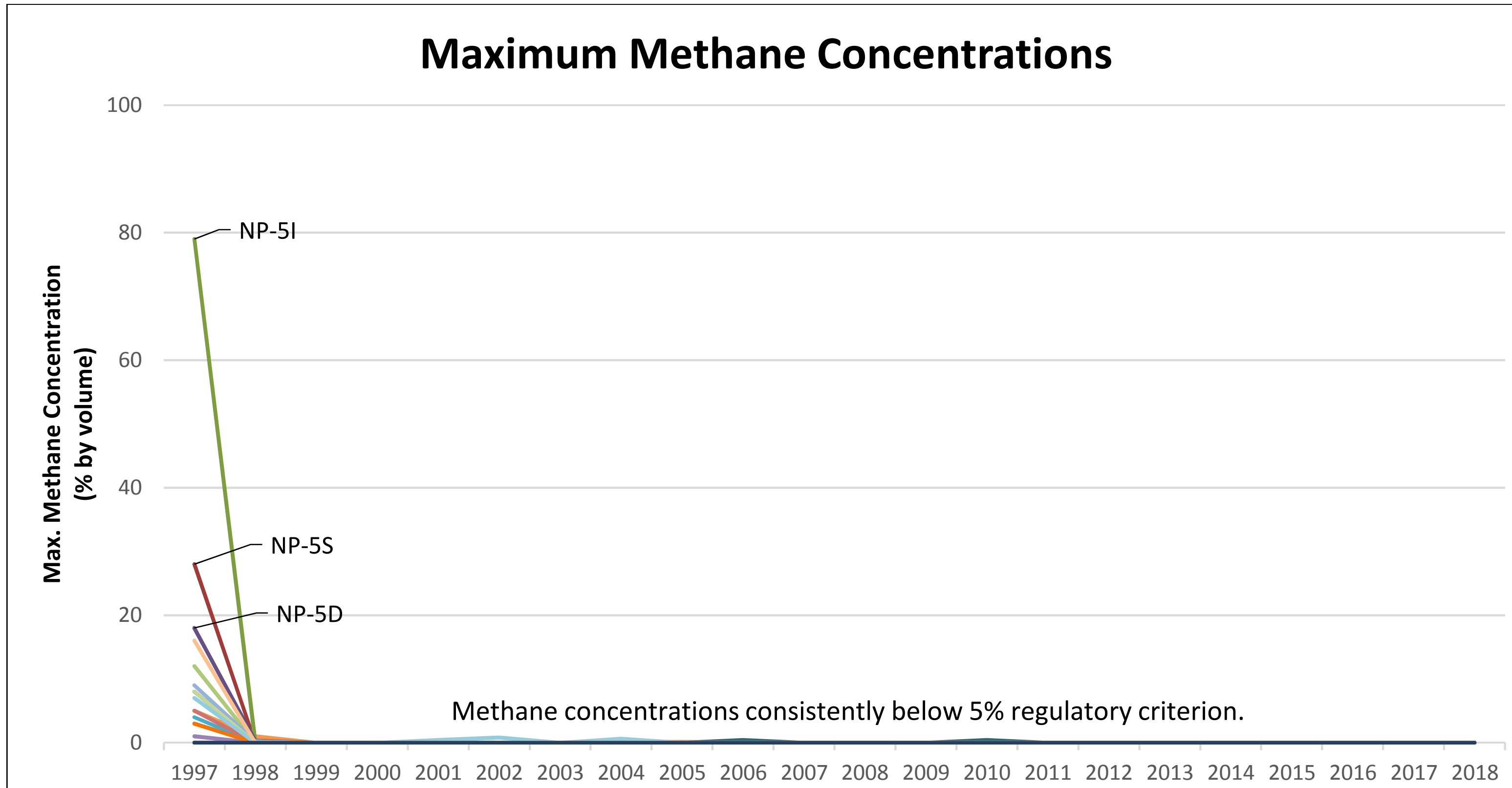


	EF1	EF2	EF3	EF4	FT1	FT2	FT3	FT4	FT5	FT6	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8	GW9	GW11	Inlet	T1	T2	T3	T4	T5
□ Balance	11	25	9	0	0	0	0	1	8	0	0	4	0	8	0	0	13	0	11	0	0	23	4	14	21	20
■ O2	3	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	1	2	2
■ CO2	0	2	1	0	0	0	0	0	2	0	0	1	0	2	0	0	3	0	2	0	0	2	0	4	4	3
■ CH4	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	1	0	0	0	0	0	0	2	2	0

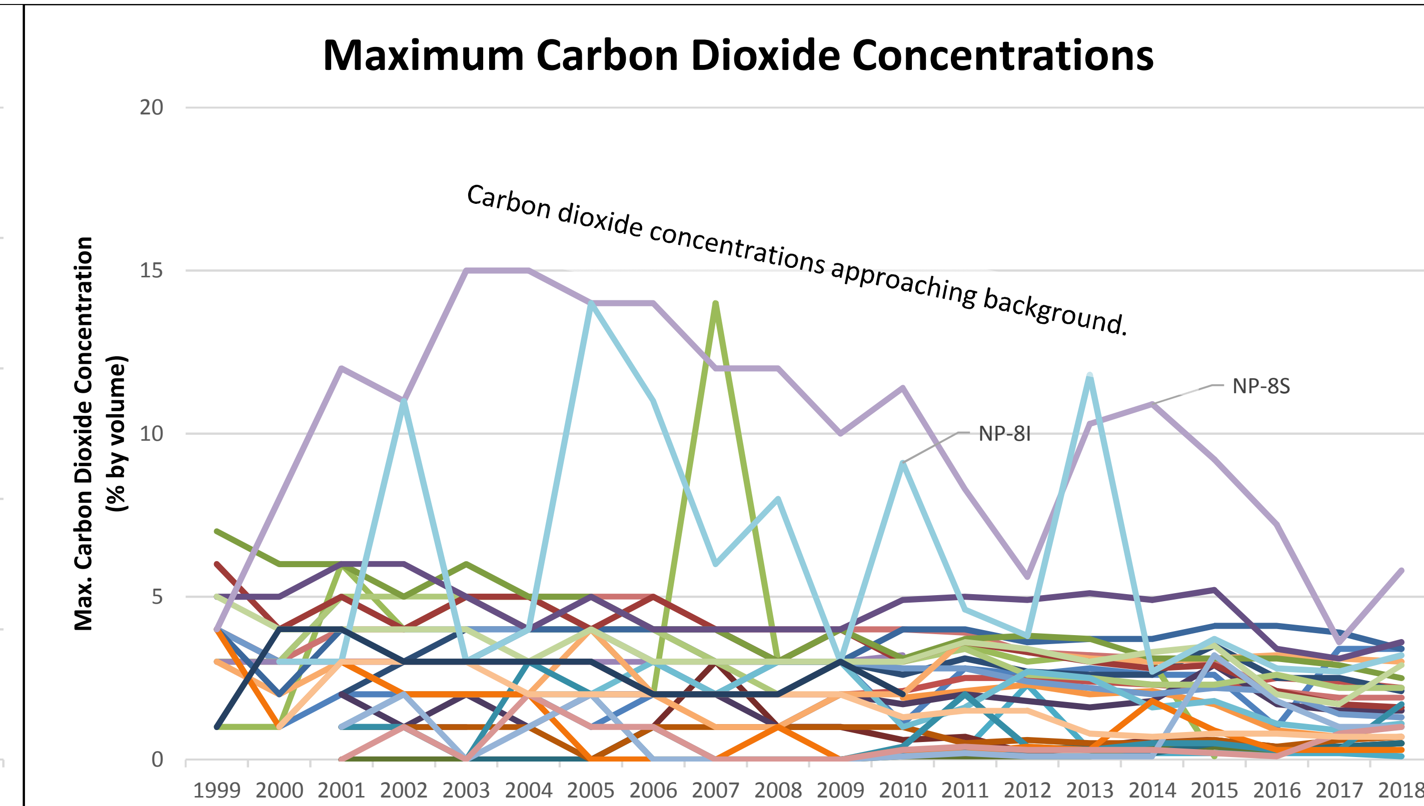
LFG Collection in 2018



	EF1	EF2	EF3	EF4	FT1	FT2	FT3	FT4	FT5	FT6	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8	GW9	GW10	GW11	T1	T2	T3	T4	T5
□ Balance	9	18	5	0	0	0	0	0	10	0	0	3	0	10	0	0	8	0	12	15	4	23	0	11	11	17
■ O2	2	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	4	0	1	1	2
■ CO2	0	1	0	0	0	0	0	0	3	0	0	1	0	3	0	0	2	0	3	2	0	2	0	3	2	2
■ CH4	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	2	1	0



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
GP-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GP-2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GP-5	5	1	0	0	0	0	0	0.1	0.1	0	0	0	0	0	0	0	0	0	0			
GP-6	0	0	0	0	0	0	0															
MW-13														0	0	0	0	0	0	0	0	0
MW-24														0	0	0	0	0	0	0	0	0
NP-1S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NP-1I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NP-1D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NP-2S	0	0	0	0	0	0	0	0	0	0.4	0	0	0	0.4	0	0	0	0	0	0	0	0
NP-2I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NP-2D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NP-3S	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NP-3I	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NP-3D	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NP-4S	0	0	0	0	0	0	0	0	0	0	0	0	0	0								
NP-4I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NP-4D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NP-5S	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NP-5I	79	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NP-5D	18	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NP-6S	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NP-6I	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NP-6D	9	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NP-7S	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NP-7I	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NP-7D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NP-8S	7	0	0	0	0.4	0.8	0	0.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NP-8I	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NP-8D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P-1	3	0	0	0	0	0	0	0	0	0	0	0	0	0								



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
GP-1		1	2	2	2	2	1	2	2	2	3	1.1	2.8	2.6	2.8	2.6	2.6	1	3.4	3.4
GP-2	4	3	3	3	3	3	3	2	2	2	2	2.1	2.5	2.5	2.4	2.3	2.2	2.5	2.4	2.2
GP-5	1	1	6	4	5	5	4	2	14	3	3	3	3.5	3	3.2	3	0.1			
GP-6			2	1	1															
MW-13												0.1	0.3	2.3	0.3	0.2	0.2	0.2	0.2	0.1
MW-24												1.9	2.1	2.3	2	2.1	1.7	0.9	0.7	1.1
NP-1S	2		2	3	4	4	4	4	3	3	3	2.6	3.1	2.7	2.6	2.6	3.5	2.5	2.5	2.1
NP-1I			0	0	0	0	0	1	3	1	1	0.6	0.7	0.2	0.4	0.6	0.6	0.4	0.4	0.5
NP-1D			0	0	0	0	0	0	0	0	0	0.1	0.1	0.1	0.1	0.4	0.4	0.3	0.4	0.5
NP-2S			2	1	2	1	2	2	2	1	2	1.7	2	1.8	1.6	1.8	2.9	1.7	1.5	1.5
NP-2I			1	1	0	0	0	1	0	0	0	0.2	0.3	0.3	0.4	0.2	0.5	0.4	0.4	0.5
NP-2D			1	1	1	1	0	1	1	1	1	1	0.5	0.6	0.5	0.5	0.6	0.4	0.6	0.7
NP-3S	4	3	5	4	4	4	4	3	2	3	3	2.8	2.8	2.4	2.2	2	2.2	2.1	1.4	1.3
NP-3I	3	3	4	4	5	5	5	5	4	4	4	4	3.9	3.3	3.2	3.1	3	2.1	1.9	1.9
NP-3D	3	3	5	5	5	4	4	4	3	2	3	3	3.4	2.6	2.5	2.3	2.3	2.6	2.2	2.2
NP-4S	3	3	3	3	3	3	3	3	3	3	3	3.2								
NP-4I			1	2	2	2	2	3	2	3	3	1	1.6	2.7	2.5	1.6	1.8	1.1	0.9	1.1
NP-4D	3	2	3	2	2	2	4	2	1	1	2	2	3.7	3.3	3.1	3	3.1	3.2	3.1	3
NP-5S	4	2	4	3	3	4	4	4	4	3	3	4	4	3.6	3.7	3.7	4.1	4.1	3.9	3.4
NP-5I	6	4	5	4	5	5	4	5	4	3	4	3	3.6	3.3	3	2.8	2.9	2.1	1.7	1.6
NP-5D	7	6	6	5	6	5	5	4	4	3	4	3.1	3.7	3.8	3.7	3.1	3.1	3.1	2.9	2.5
NP-6S	5	5	6	6	5	4	5	4	4	4	4	4.9	5	4.9	5.1	4.9	5.2	3.4	3.1	3.6
NP-6I			1	1	0	3	2	0	0	0	0	0.4	2	0.4	0.3	0.5	0.5	0.3	0.3	1.7
NP-6D	4	1	3	2	2	2	0	0	0	1	0	0.3	0.2	0.4	0.3	1.8	0.9	0.3	0.3	0.3
NP-7S			1	2	0	1	2	0	0	0	0	0.1	0.2	0.1	0.1	0.1	3.2	1.8	1	1
NP-7I			0	1	0	2	1	1	0	0	0	0.3	0.4	0.3	0.3	0.3	0.2	0.1	0.8	1
NP-7D	5	4	4	4	4	3	4	3	3	3	3	3	3.6	3.4	3	3.3	3.5	2	1.7	2.9
NP-8S	4	8	12	11	15	15	14	14	12	12	10	11.4	8.3	5.6	10.3	10.9	9.2	7.2	3.6	5.8
NP-8I		3	3	11	3	4	14	11	6	8	3	9.1	4.6	3.8	11.8	2.7	3.7	2.8	2.7	3.2
NP-8D		1	3	3	3	2	2	2	2	2	2	1.3	1.5	1.5	0.8	0.7	0.8	0.8	0.7	0.7
P-1	1	4	4	3	3	3	3	2	2	2	3	2								

Aspect Consulting
August 2019
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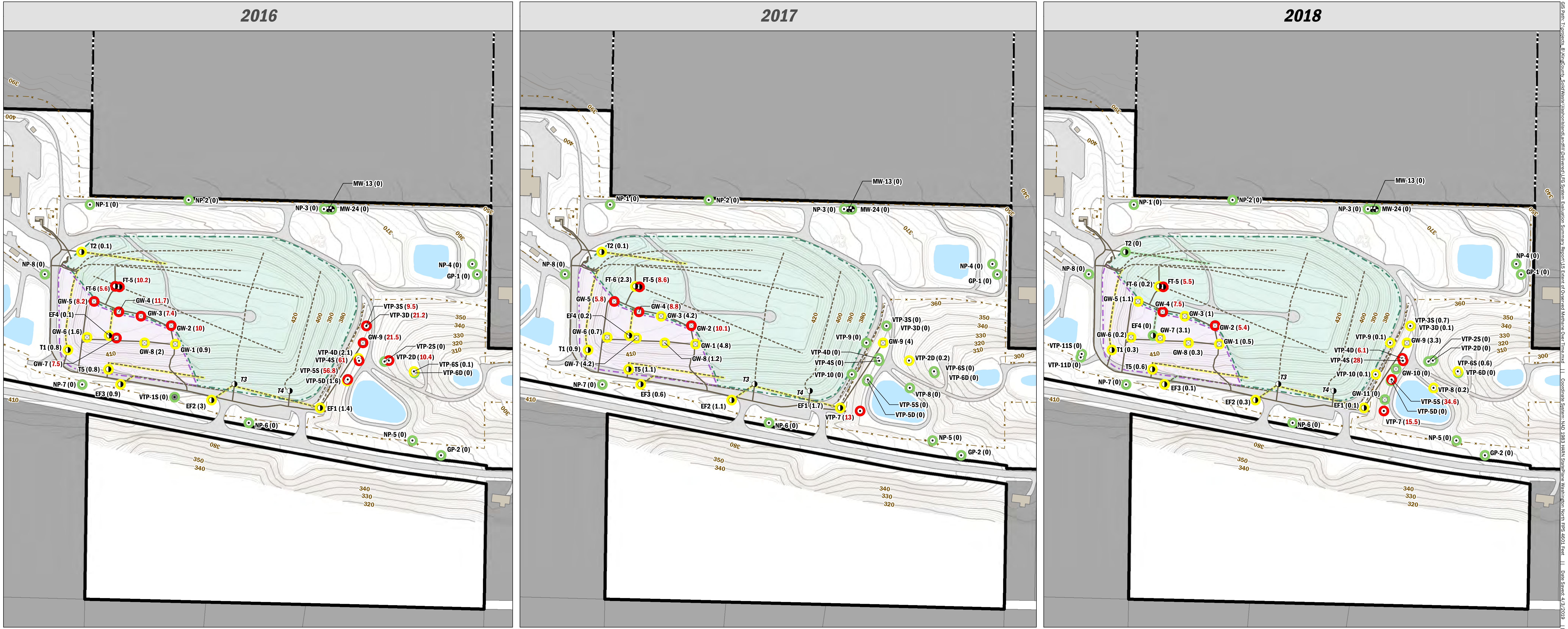
Figure 14
LFG Concentrations at Compliance Probes Over Time
LFG System Evaluation Summary Report
Vashon Island Closed Landfill



Maximum Methane Detected

- > 5 % by volume
- > 0 - 5 % by volume
- 0 % by volume

VTP-5D (1.6) Exploration Name (Methane Concentration, %)
Methane concentration in ***red, bold*** *font where concentration exceeds 5%*

- Boring
- Gas Probe
- LFG Extraction Well
- LFG Trench Riser
- Monitoring Well
- Decommissioned Monitoring Well
- LFG Pipe
- LFG Pipe (Perforated)
- Phase 1 - 1988 Final Cover
- Phase 2 - 2001 Final Cover
- Pond
- Building
- Road
- Fence
- Vashon Island Closed Landfill
- Other King County-Owned Property
- King County Tax Parcel

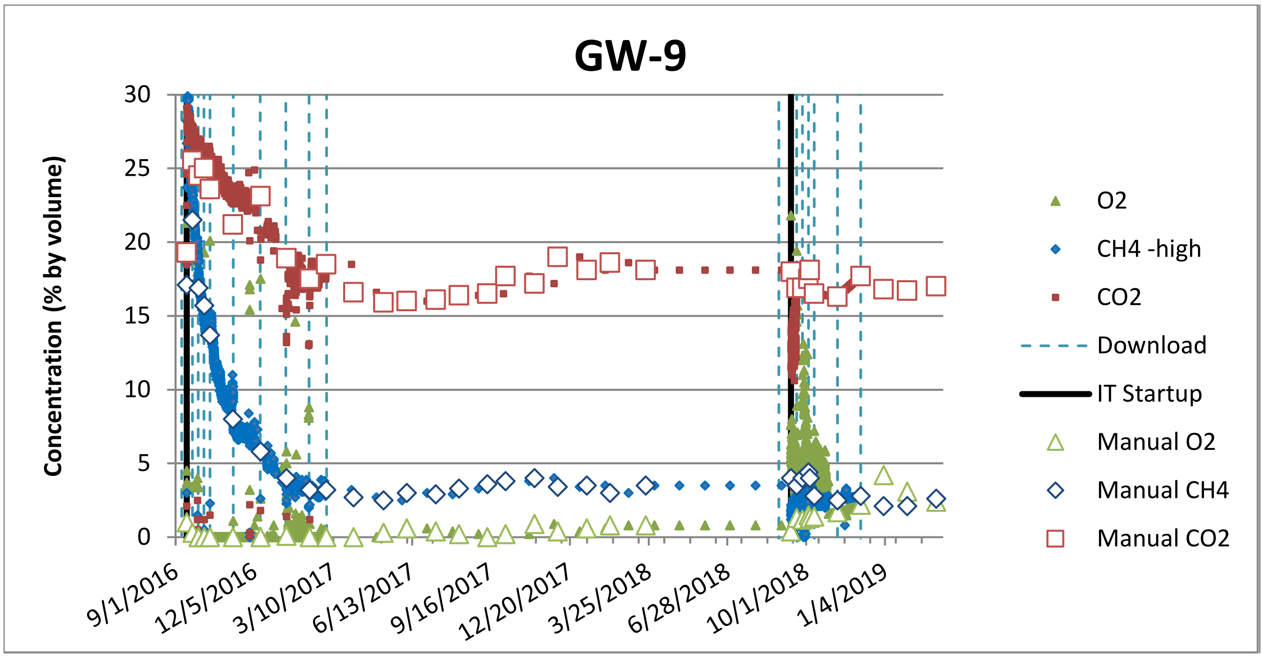
Note: Exploration locations without a colored halo have no results for a particular time period if a location was not yet installed, has been decommissioned, or location was not monitored. Topographic contours from King County Survey, Spring 2017. Landfill gas system features are approximated from as-built locations, and revised to match survey data where available.

0 240 480
Feet

Extent of Observed Methane Over Time

LFG System Evaluation Summary Report
Vashon Island Closed Landfill
King County, Washington

King County | Aspect CONSULTING | APR-2019 | BY: PSB / TDR | FIGURE NO. 15



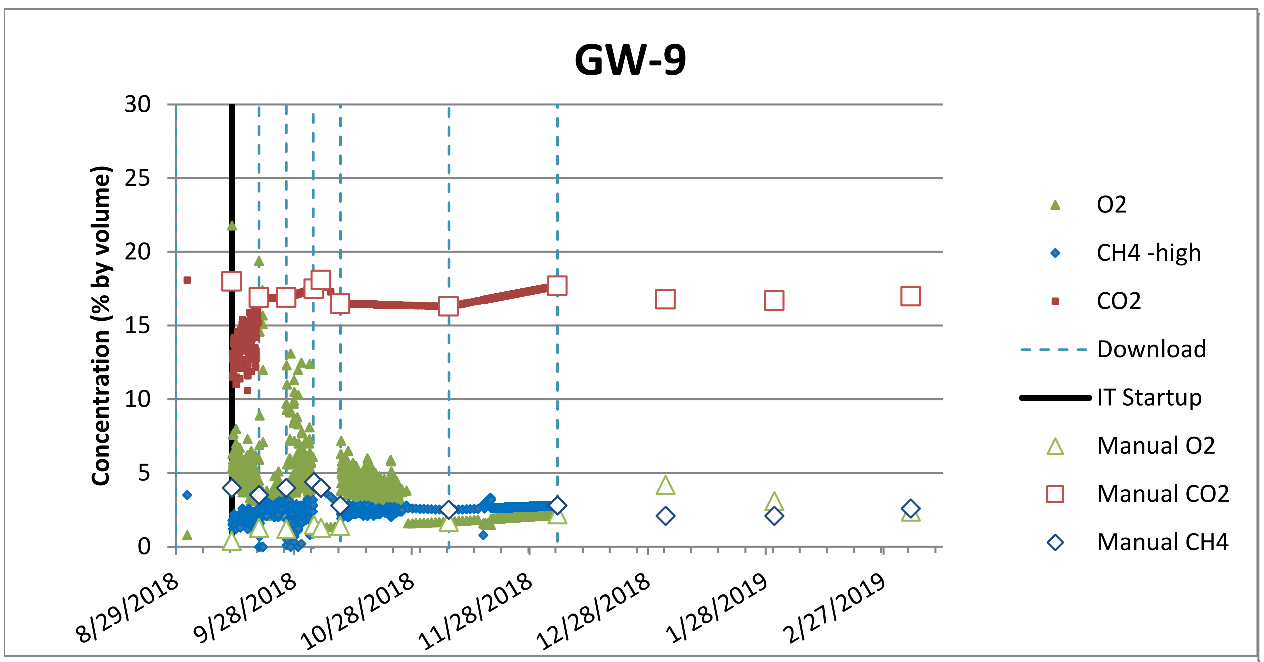
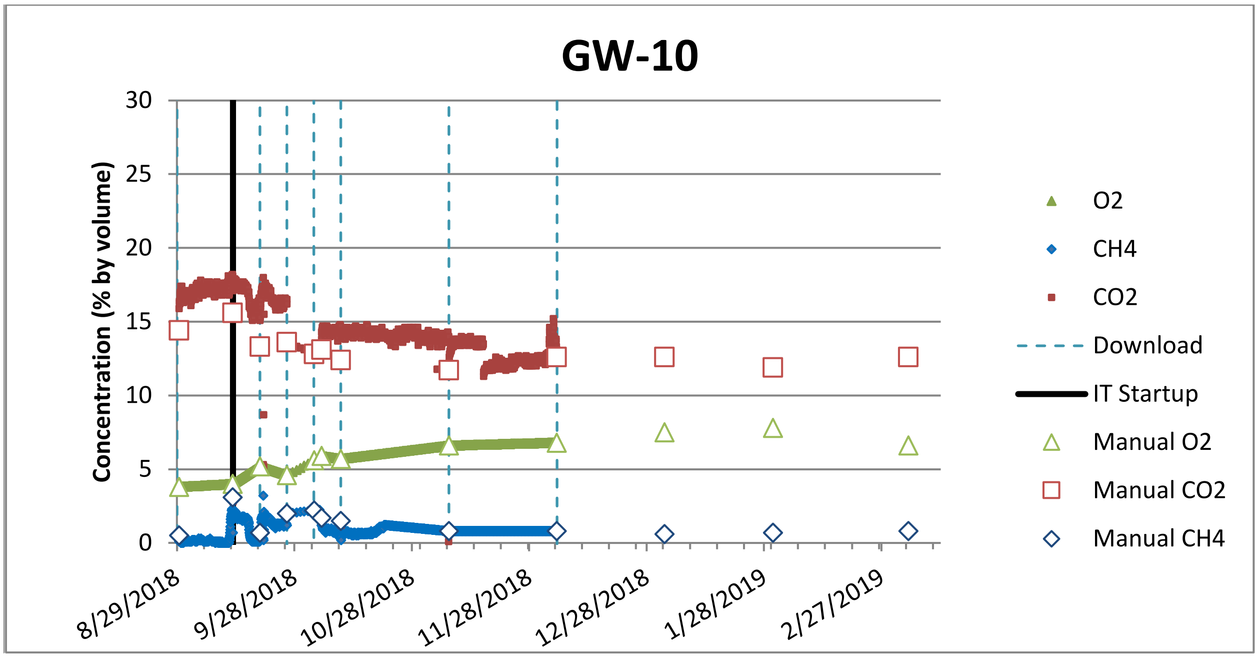


Figure 16

Extended Influence Testing - Continuous LFG Monitoring Data

Aspect Consulting
August 2019
P:\King Co Closed Landfills\Phase I\Vashon Is\Task 310.1.7.9 LFG System Evaluation \Figures\VILF GasClam Data_To KCSWD_2019.xlsx"

LFG System Evaluation Summary Report
Vashon Island Closed Landfill



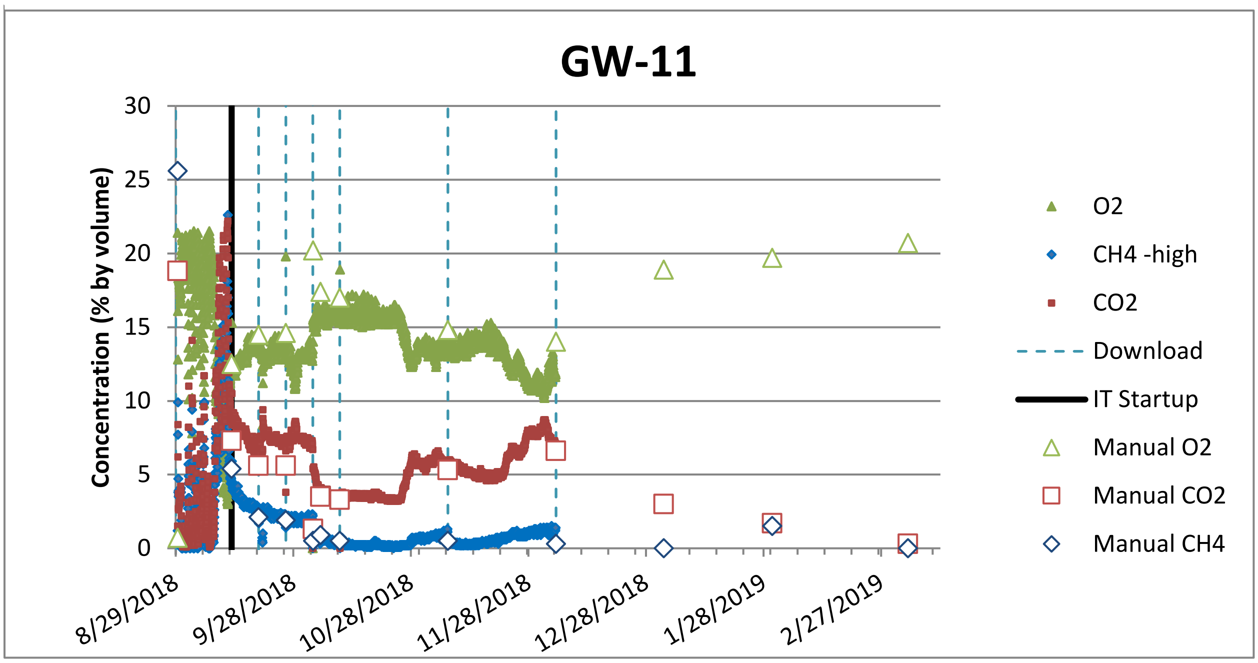
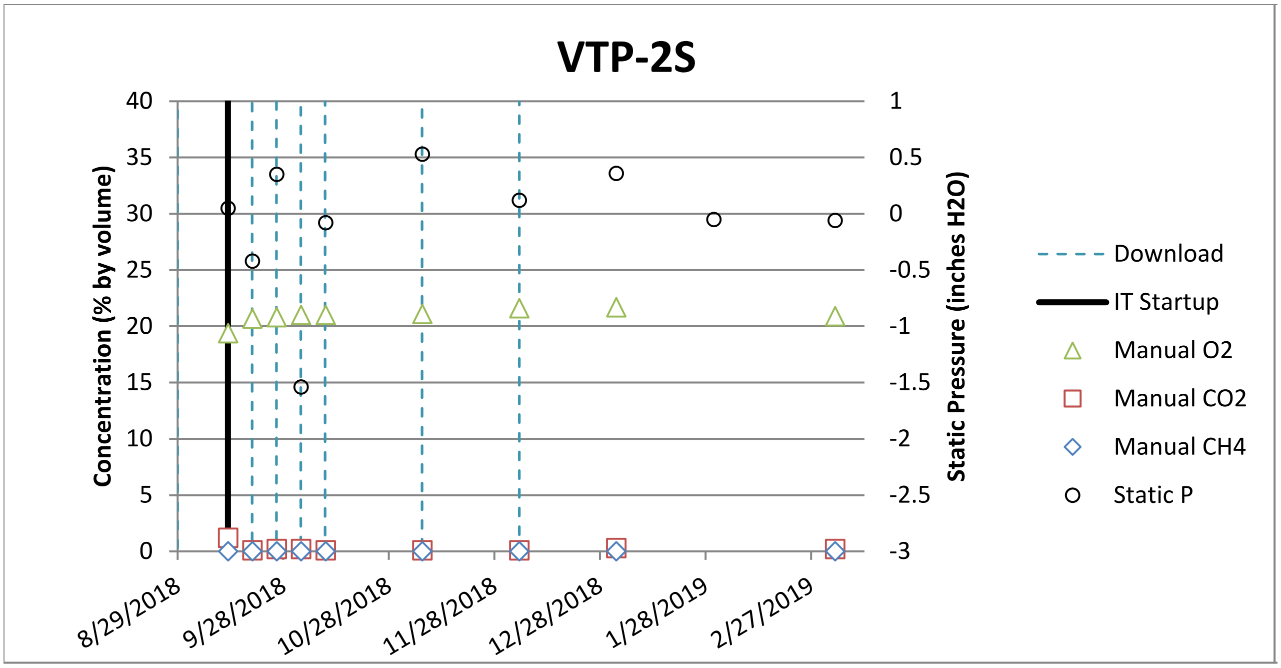


Figure 16

Extended Influence Testing - Continuous LFG Monitoring Data

LFG System Evaluation Summary Report
Vashon Island Closed Landfill

Aspect Consulting
August 2019
P:\King Co Closed Landfills\Phase I\Vashon Is\Task 310.1.7.9 LFG System Evaluation \Figures\VILF GasClam Data_To KCSWD_2019.xlsx"



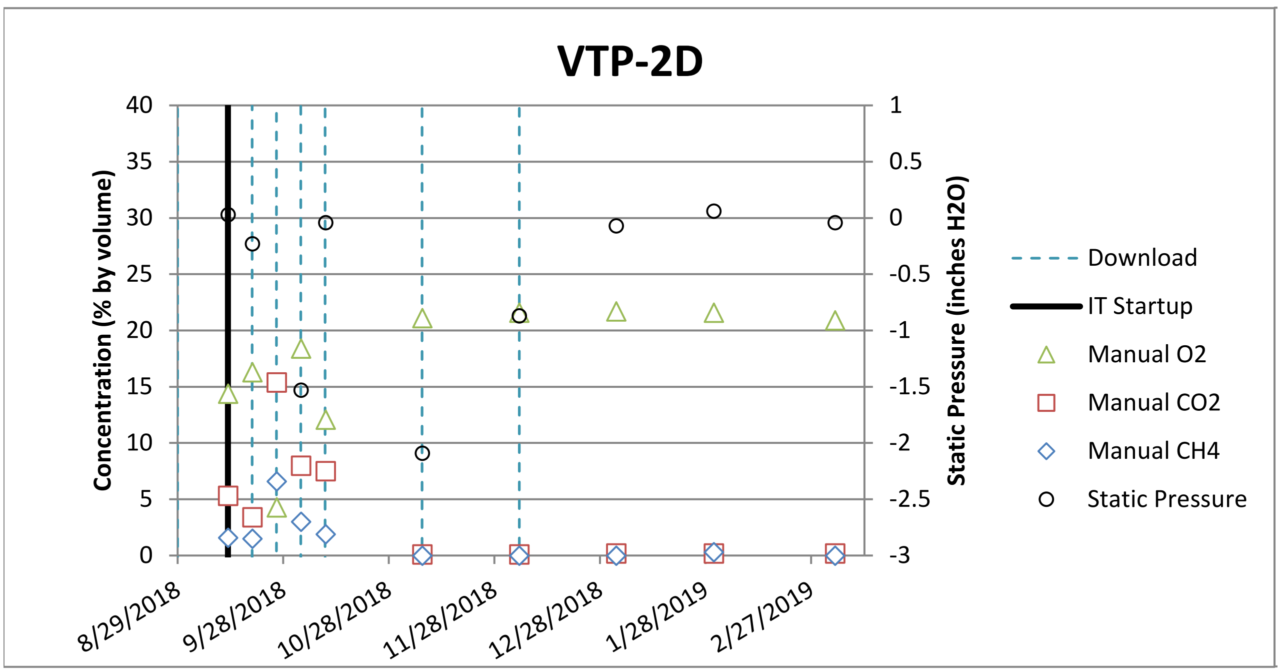
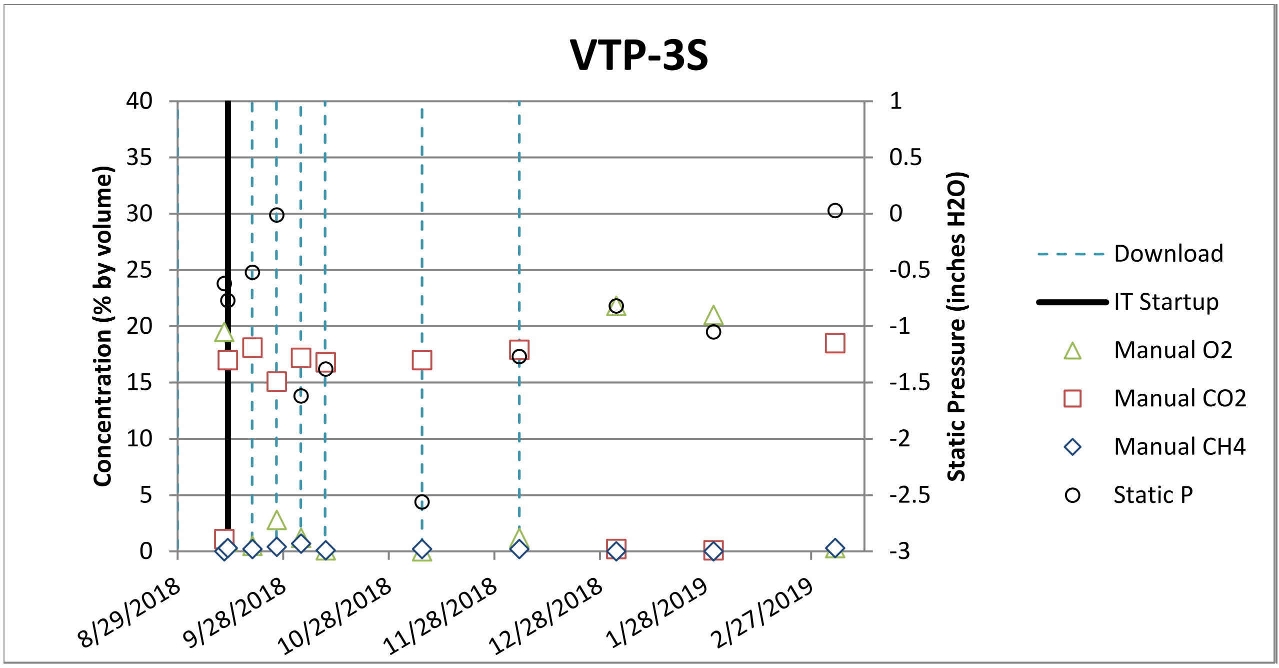


Figure 17

Extended Influence Testing - LFG Concentration Trends at Probes

LFG System Evaluation Summary Report
Vashon Island Closed Landfill

Aspect Consulting
August 2019
P:\King Co Closed Landfills\Phase I\Vashon Is\Task 310.1.7.9 LFG System Evaluation \Figures\VILF GasClam Data_To KCSWD_2019.xlsx"



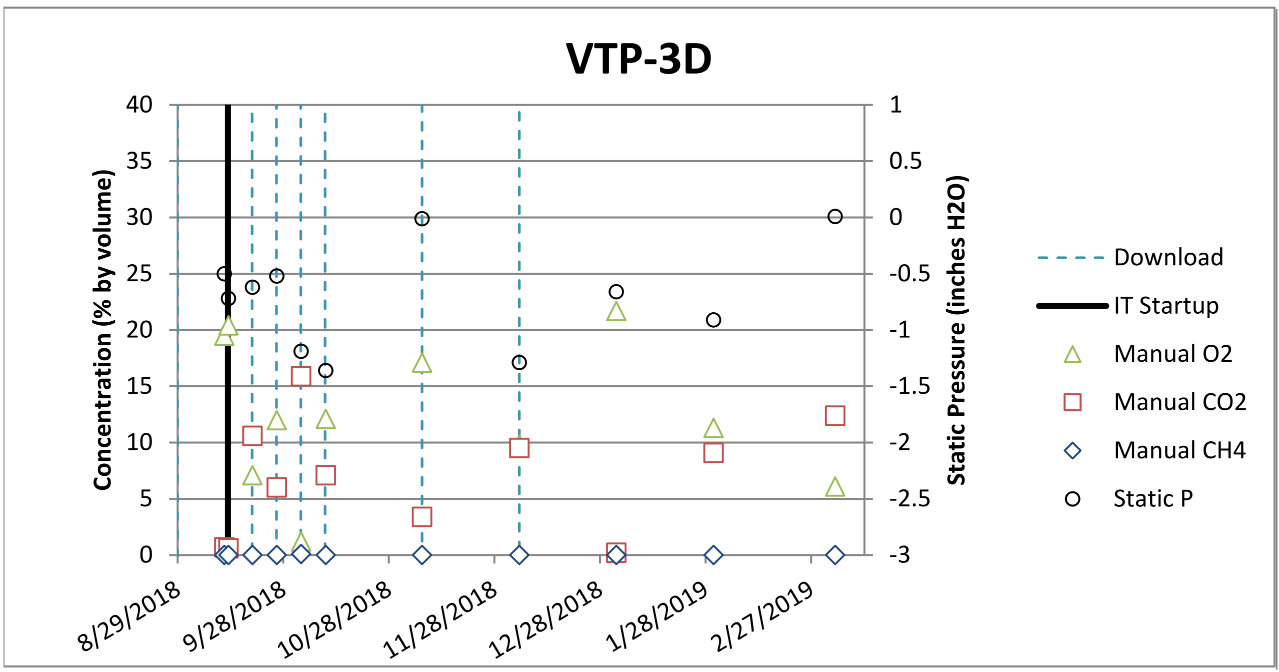
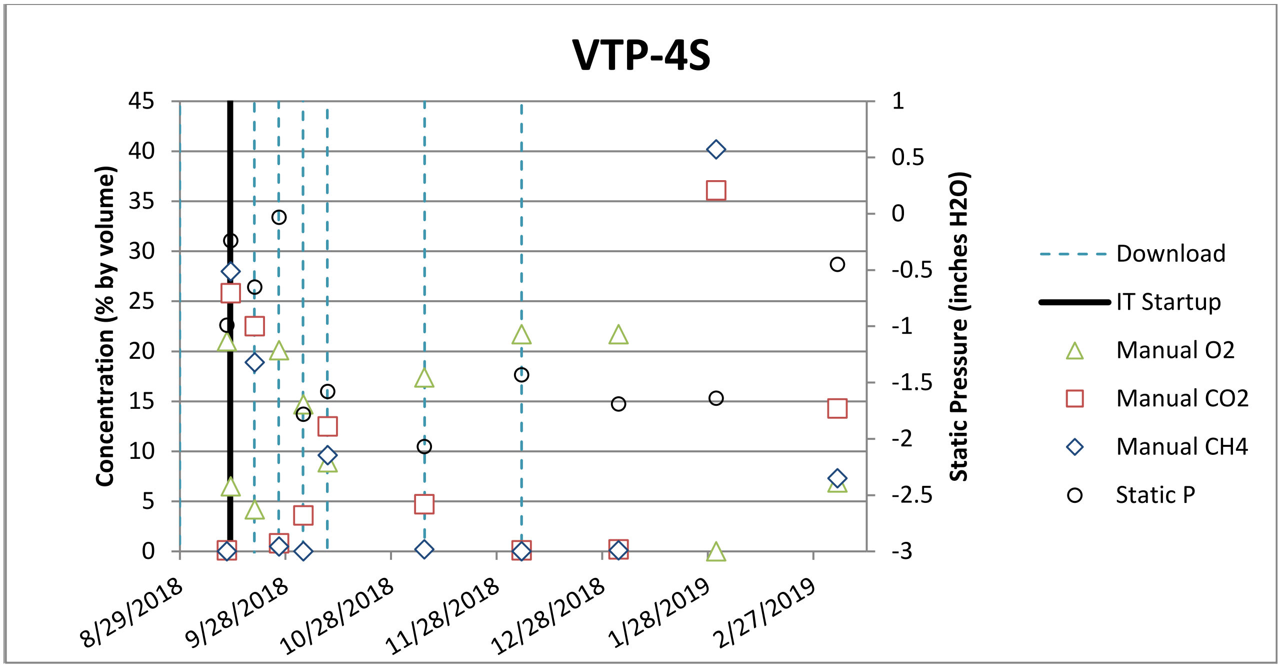


Figure 17

Extended Influence Testing - LFG Concentration Trends at Probes



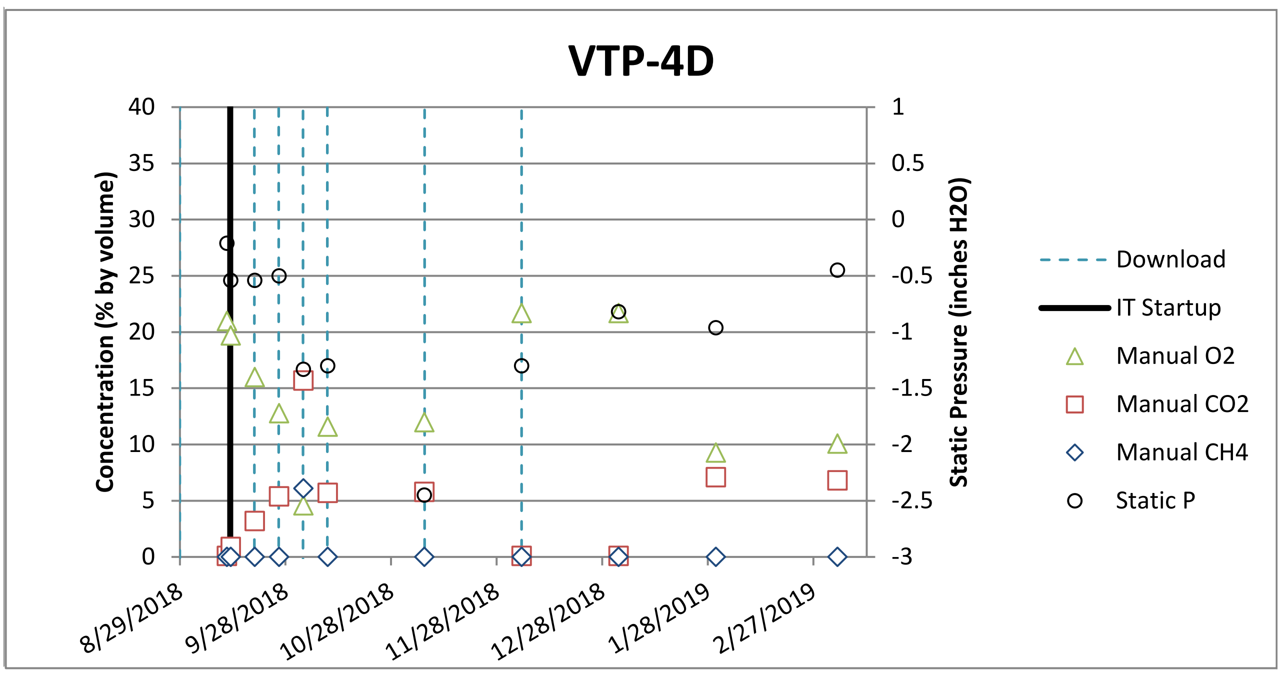
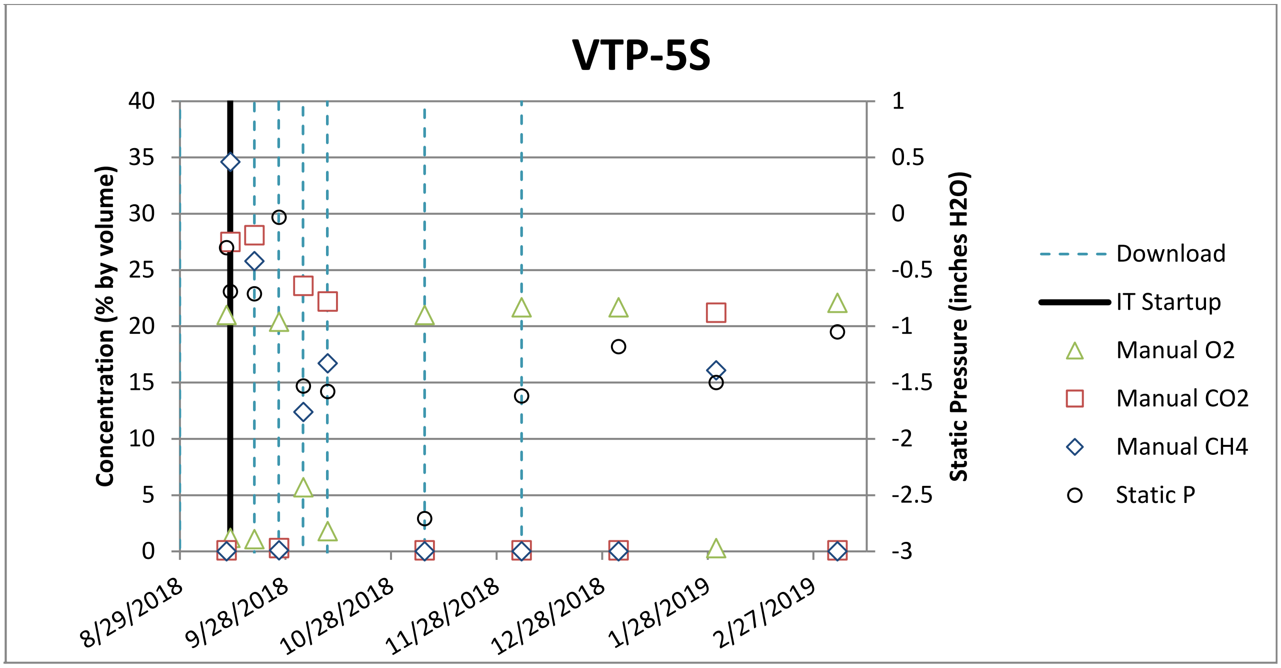


Figure 17

Extended Influence Testing - LFG Concentration Trends at Probes

LFG System Evaluation Summary Report
Vashon Island Closed Landfill



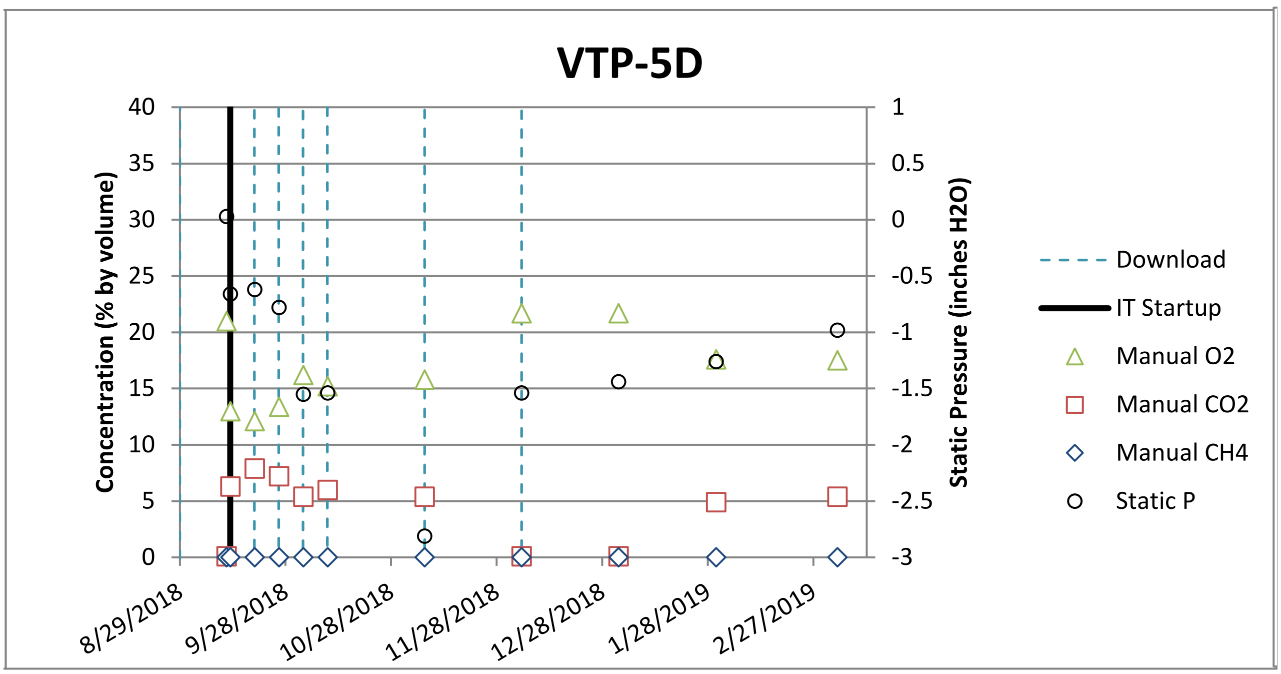
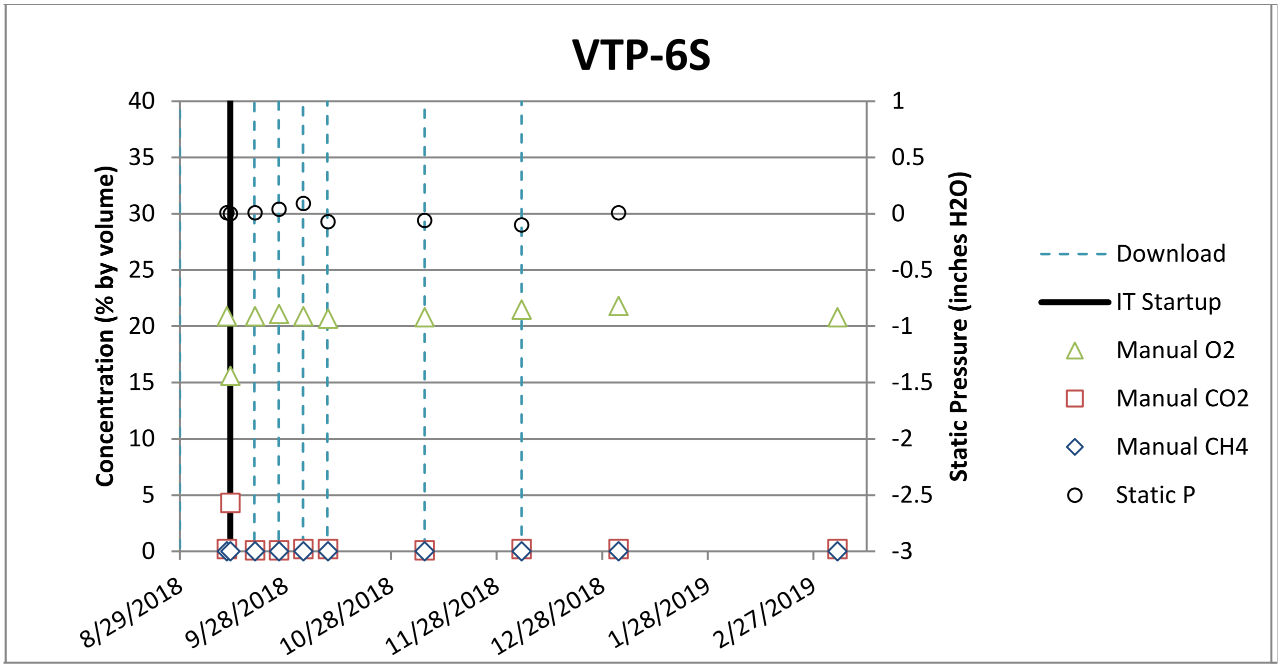


Figure 17

Extended Influence Testing - LFG Concentration Trends at Probes

LFG System Evaluation Summary Report
Vashon Island Closed Landfill


VTP-6S
Concentration (% by volume)
Static Pressure (inches H2O)
40
35
30
25
20
15
10
5
0
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
8/29/2018
9/28/2018
10/28/2018
11/28/2018
12/28/2018
1/28/2019
2/27/2019
Download
IT Startup
Manual O2
Manual CO2
Manual CH4
Static P

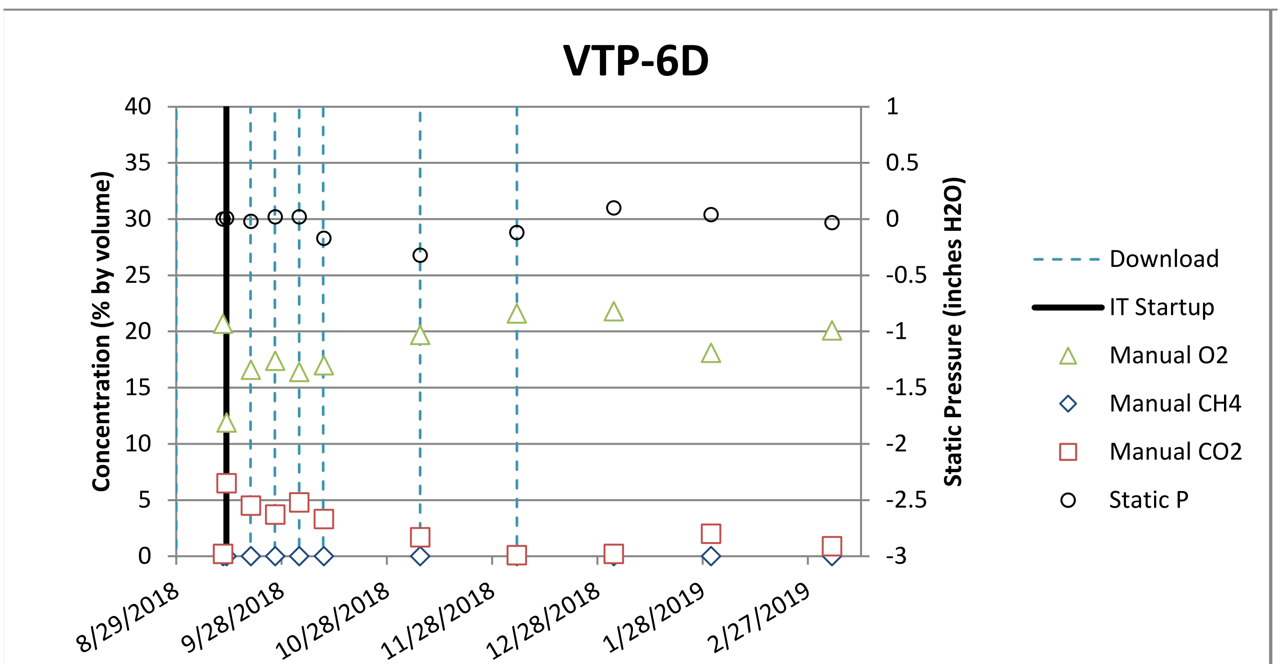
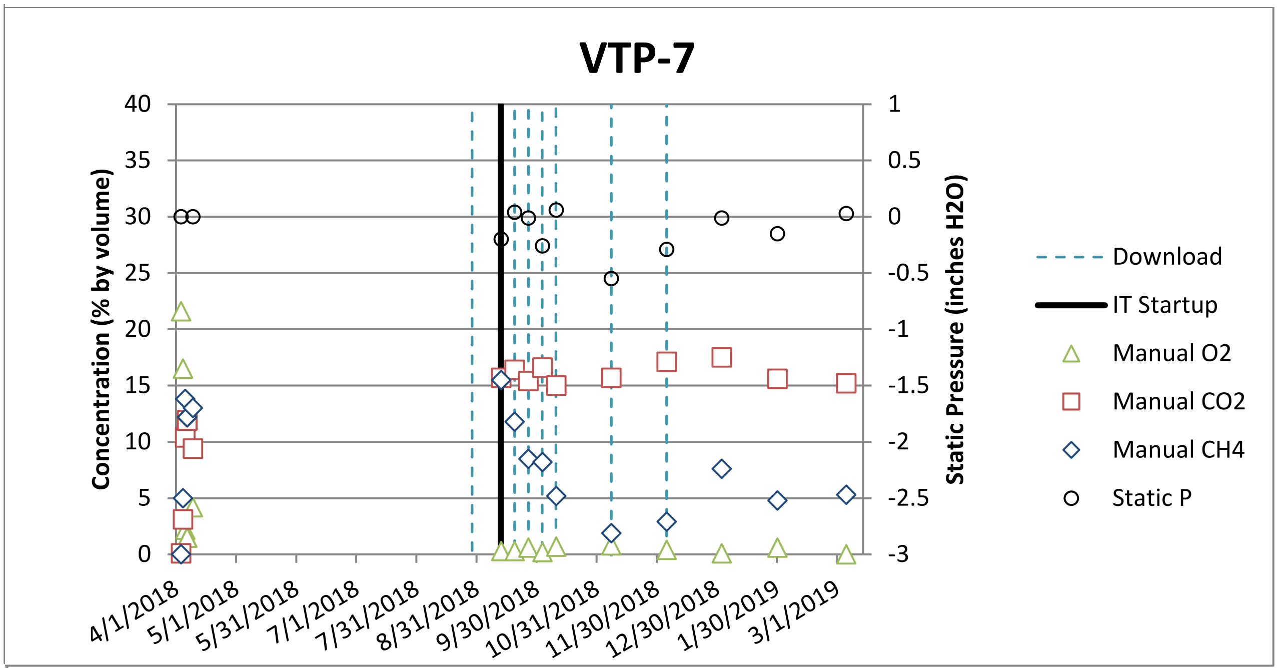

VTP-6D
Concentration (% by volume)
Static Pressure (inches H2O)
40
35
30
25
20
15
10
5
0
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
8/29/2018
9/28/2018
10/28/2018
11/28/2018
12/28/2018
1/28/2019
2/27/2019
Download
IT Startup
Manual O2
Manual CH4
Manual CO2
Static P

Figure 17



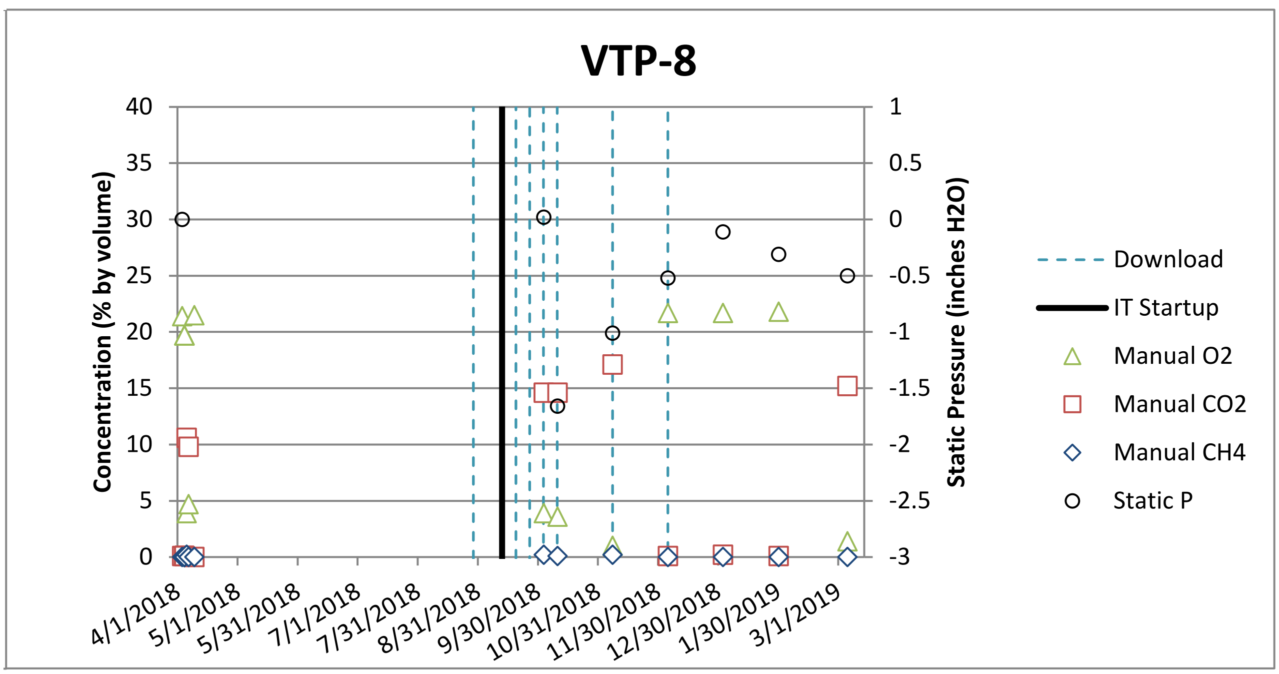


Figure 17

Extended Influence Testing - LFG Concentration Trends at Probes

LFG System Evaluation Summary Report
Vashon Island Closed Landfill

Aspect Consulting
August 2019
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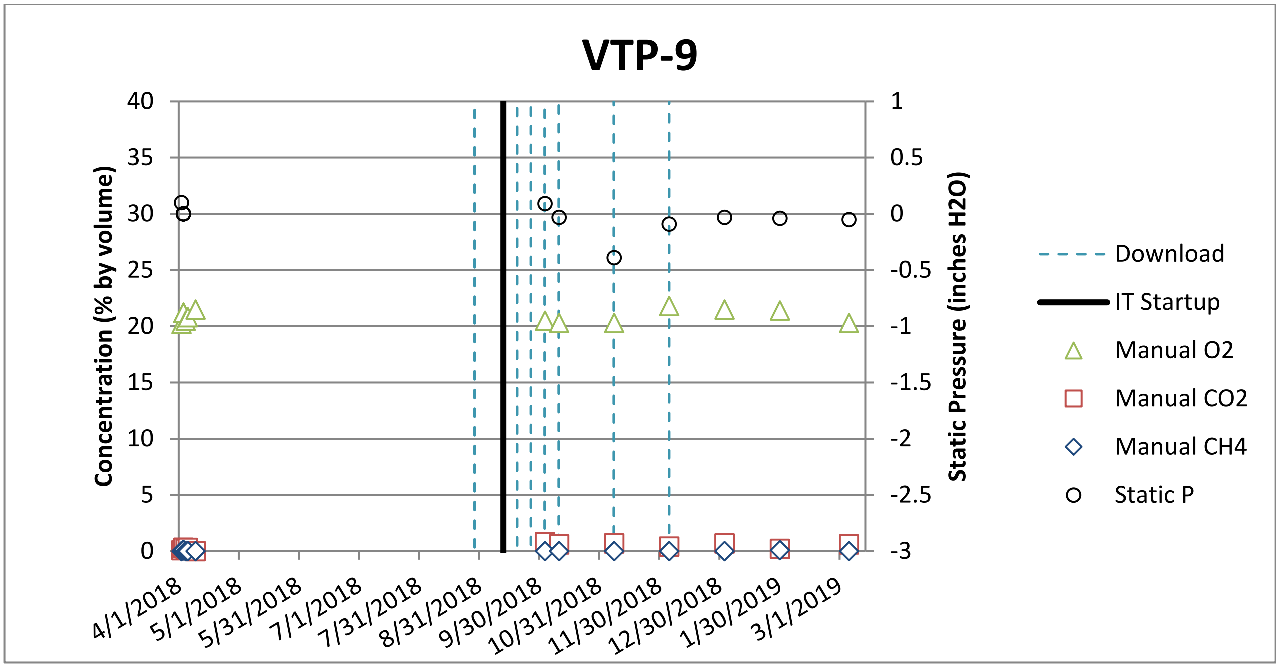


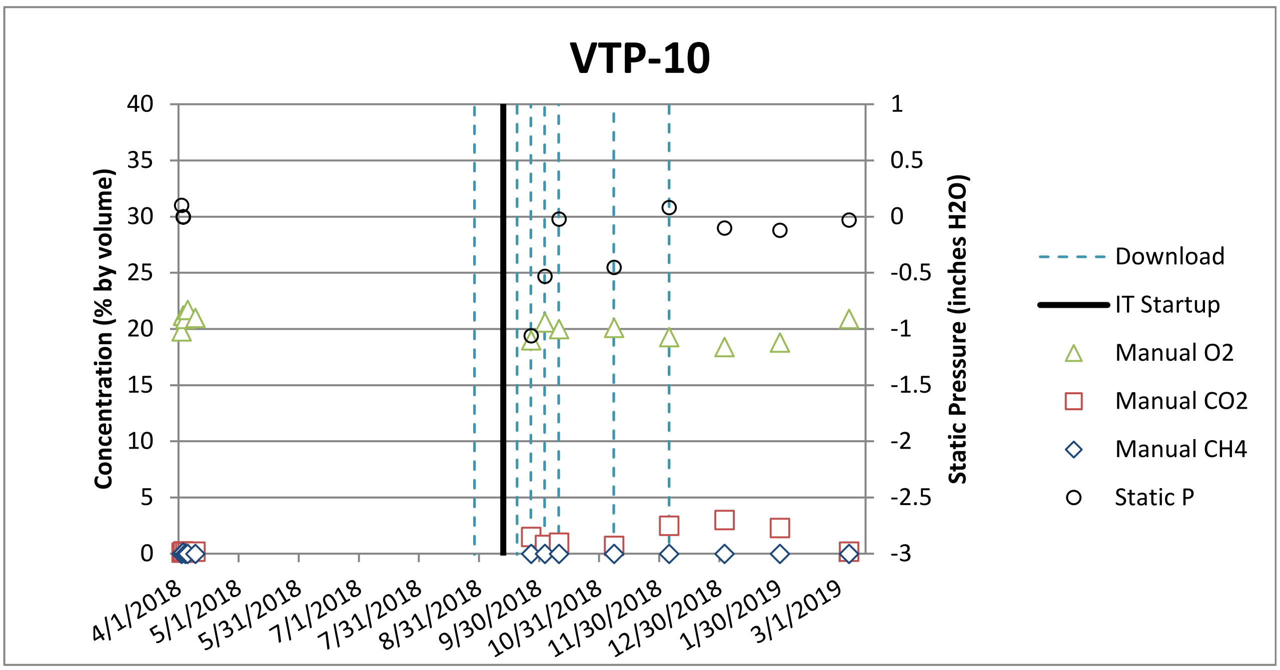
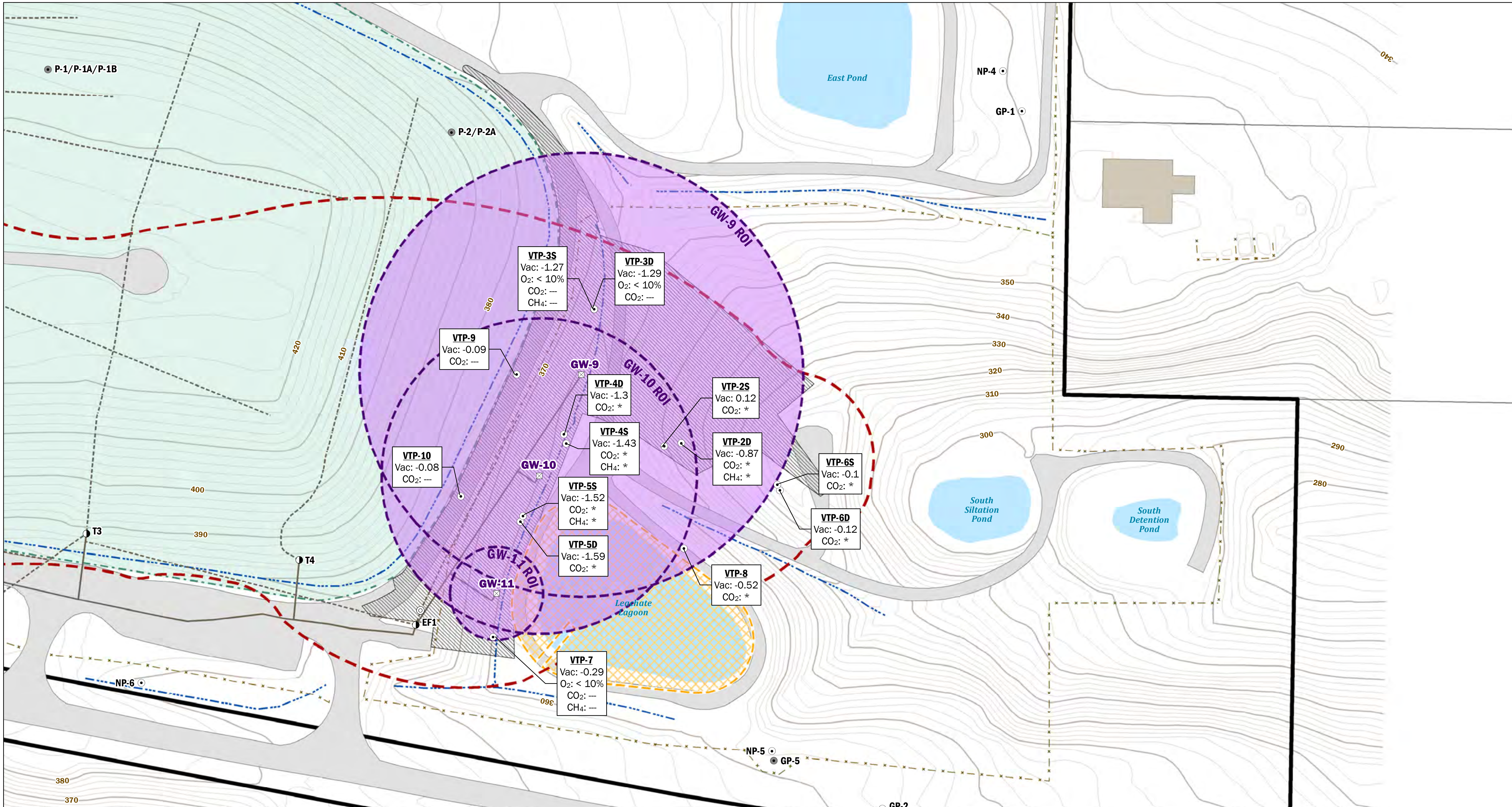


Figure 17

Extended Influence Testing - LFG Concentration Trends at Probes



- Gas Probe/Piezometer
- Decommissioned Gas Probe
- LFG Extraction Well
- LFG Trench Riser
- LFG Extraction Well Radius of Influence (ROI)
- Estimated Extent of Unlined Refuse
- Extent of Geotextile Cover Beyond Landfill Liner
- Extent of Geomembrane under Leachate Lagoon
- Phase 2 - 2001 Final Cover
- Pond
- Ditch
- Building
- Road
- Fence
- Vashon Island Closed Landfill
- King County Tax Parcel

Topographic contours from King County Survey, Spring 2017, in feet NAVD88.

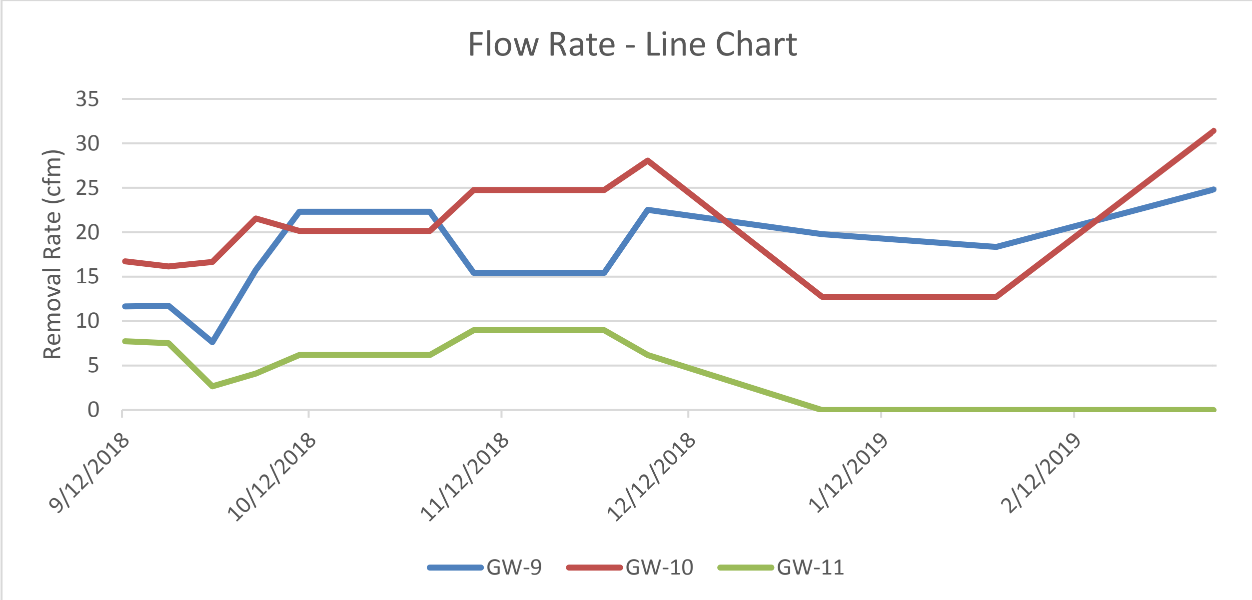
-"Vac" indicates static pressure reading on December 5, 2018
- "---" indicates analyte was present at the end of extended influence testing
- "" indicates an initial increase in analyte, then decreased to not present at the end of extended influence testing (≤ 0.2%)*

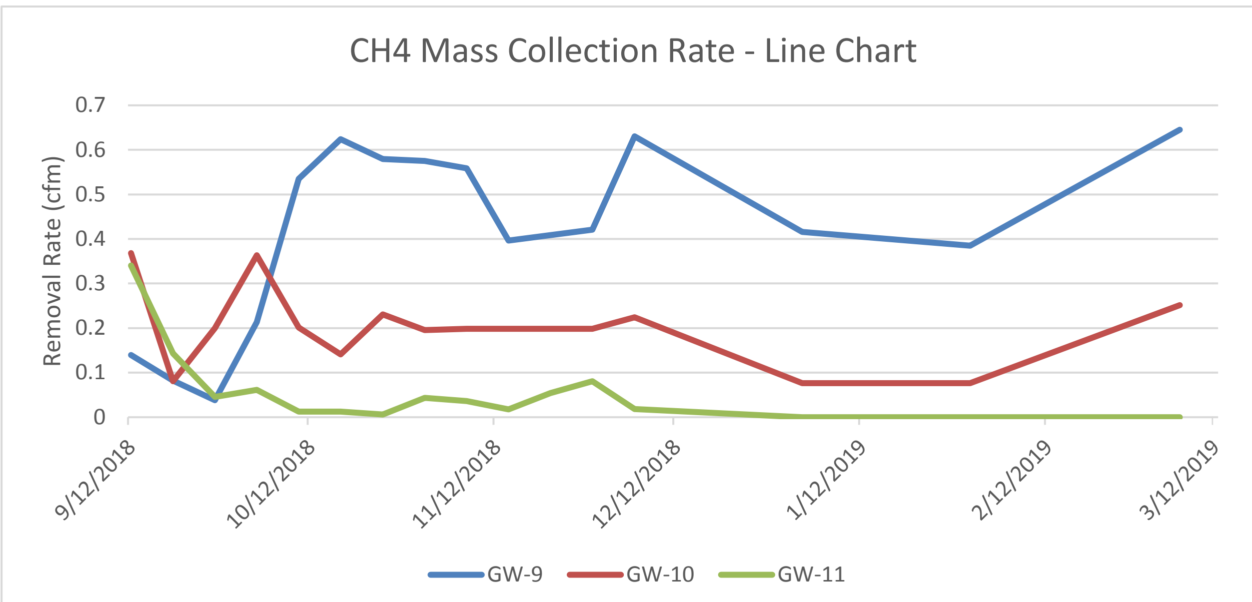
0 80 160
Feet

Extended Influence Testing Observed Vacuum and ROIs

LFG System Evaluation Summary Report
Vashon Island Closed Landfill
King County, Washington

King County | Aspect CONSULTING | MAR-2019 BY: CH / RAP | FIGURE NO. 18





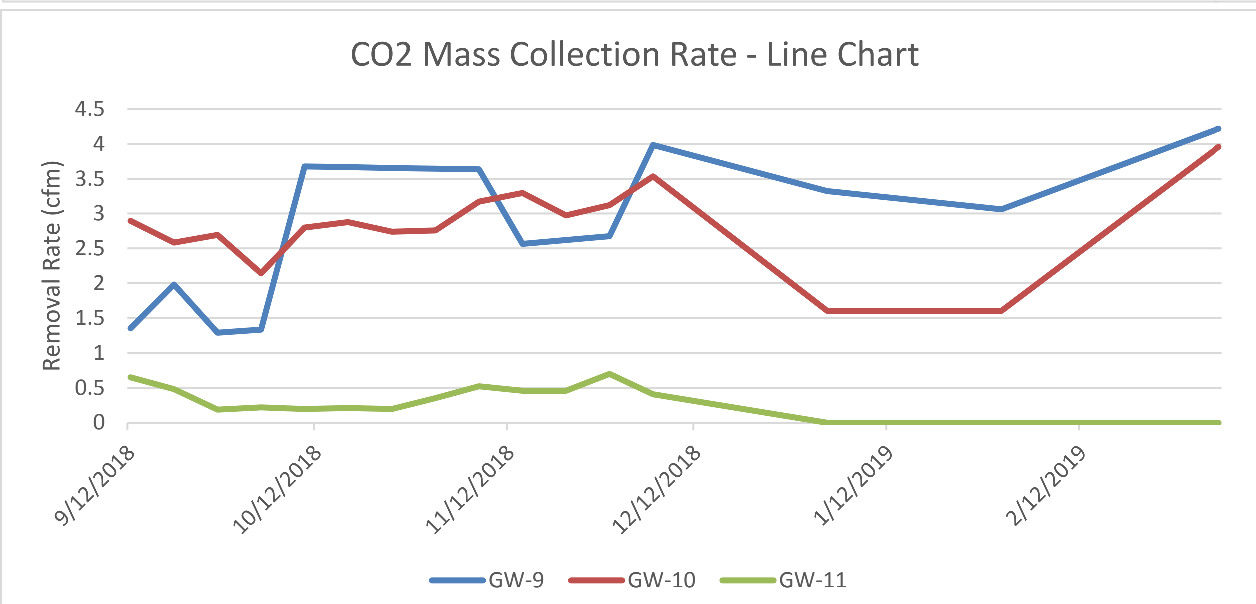


Figure 19

LFG Collection Rates in South Slope Area

Aspect Consulting
August 2019
P:\King Co Closed Landfills\Phase I\Vashon Is\Task 310.1.7.9 LFG System Evaluation \Figures\VILF GasClam Data_To KCSWD_2019.xlsx"

LFG System Evaluation Summary Report
Vashon Island Closed Landfill

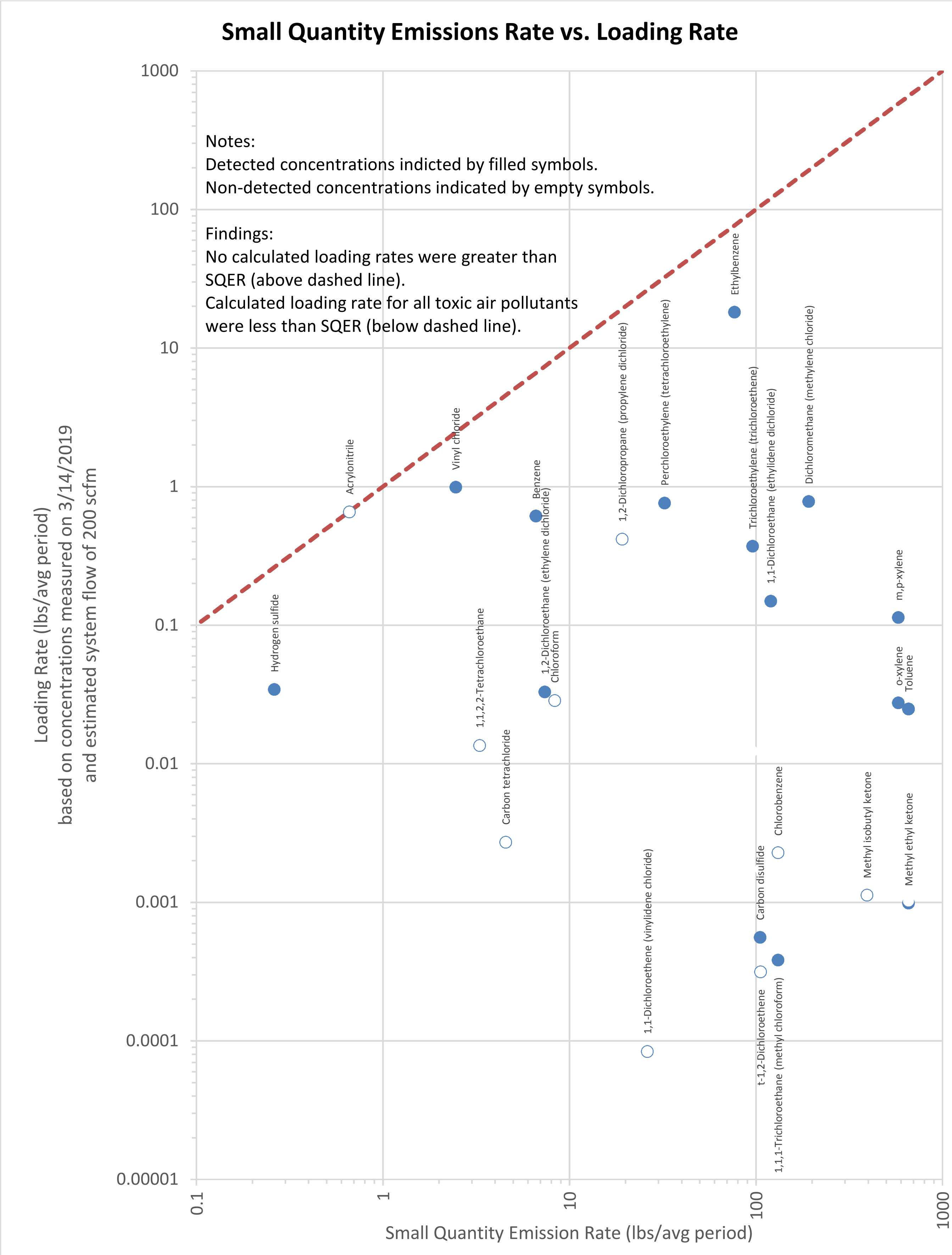


Figure 20

Analysis of Observed VOCs in Landfill Gas

Vashon Island Closed Landfill Remedial Investigation

Aspect Consulting

August 2019

P:\King Co Closed Landfills\Phase I\Vashon Is\Task 310.1.7.9 LFG System Evaluation\LFG Data to Herrera\Vashon Probes 1997 to 2019_Aspect.xlsx

APPENDIX A

Daily Field Reports
(Extent of Refuse Investigation and Extended Influence Testing)

Aspect CONSULTING

DAILY REPORT

350 Madison Avenue North
Bainbridge Island, Washington 98110
(206) 780-9370

401 Second Avenue S, Suite 201
Seattle, Washington 98104
(206) 328-7443

DATE: 04/02/18	**PROJECT NO.** 090057 TASK 310.1.7.7	**WEATHER:** MOSTLY SUNNY, 50'S
PROJECT NAME: Vashon Landfill		**CLIENT:** KCSWD
EQUIPMENT USED: PID, GEM 5000, Field Camera, Chip trays.		**PROJECT LOCATION:** VASHON ISLAND, WA

THE FOLLOWING WAS NOTED:
Arrival Time: 0730
Activities: Drill and Install VTP-9 and VTP-10, GPS existing wells
Personnel/Visitors: Matthew Lewis (Aspect), Pete (Holt driller) with support truck and Vac-Truck, Dan Swope (KCSWD), Aaron (Alder Tank Rentals).
Departure Time: 16:00
Field Forms Used: Field Notebook, boring logs, gas monitoring forms

Summary of Activities:
Aspect arrived on site at 0730, donned PPE and calibrated the PID. Holt Services arrived on site at 0810. Aspect and Holt hold a safety meeting and begin unloading the drill rig and preparing for work. Dan Swope arrives on site at 0900.

The vac-truck sets up on VTP-9 and begins work. Due to the thickness of asphalt at VTP-9 Holt positions drill rig on hole to use cookie cutter attachment to cut the asphalt, but it breaks due to asphalt thickness (about 14 inches) , and they finish with jackhammer.

At 1000 Alder Tank Rentals drops the roll box off along the side of the perimeter road near the southeast corner. Holt reaches about 6 feet depth with air-knife and no HDPE can be observed down the hole. Holt begins drilling VTP-9 while the vac-truck begins work on VTP-10. After drilling is completed at 10 ft bgs, Holt installs VTP-9 with screen between 7.5 and 10 feet and pea-gravel 7 and 10 feet. Bentonite chips are hydrated on top of filter pack.

Holt reaches 6 ft with air knife on VTP-10 and no HDPE liner is observed down-hole. The vac-truck leaves the site at about 1200. Holt drills VTP-10 down to 10 feet and installs the screen from 7.5 to10 feet bgs and pea-gravel 6.75 to 10 feet bgs. Bentonite chips are hydrated on top of filter pack. Dan Swope leave the site during installation at about 1410.

After installation, Holt completes both probes with surfaces seals, 12-inch flush monuments, and valved PVC slip caps while Aspect confirms GPS locations of existing monitoring wells on site.

The gate is locked and Aspect and Holt leave the site at 1600.

Plan for 4/3/18 – Drill VTP-7 and VTP-8.

Problems Encountered: No problems.

COPIES TO: File, Client	**Aspect Consulting PROJECT MANAGER:** HHH
	FIELD REP.: MML

DAILY REPORT

350 Madison Avenue North
Bainbridge Island, Washington 98110
(206) 780-9370

401 Second Avenue S, Suite 201
Seattle, Washington 98104
(206) 328-7443

DATE: 04/03/18	**PROJECT NO.** 090057 TASK 310.1.7.7	**WEATHER:** CLOUDY, 50'S
PROJECT NAME: Vashon Landfill	**CLIENT:** KCSWD	
EQUIPMENT USED: PID, GEM 5000, Field Camera, Chip trays.	**PROJECT LOCATION:** VASHON ISLAND, WA	

THE FOLLOWING WAS NOTED:
Arrival Time: 0730
Activities: Drill and Install VTP-7 and VTP-8, drill B-9 and B-10
Personnel/Visitors: Matthew Lewis (Aspect), Nathan (DH Environmental), Pete (Holt driller) with support truck, Lawrence Curly (KCSWD)
Departure Time: 16:00
Field Forms Used: Field Notebook, boring logs, gas monitoring forms

Summary of Activities:
DH Environmental arrived at 0730 and Aspect arrived on site at 0740, donned PPE and calibrated the PID. Holt Services arrived on site at 0810. Aspect and Holt hold a safety meeting and begin preparing the drill rig for work. KCSWD arrives on site at 0950.

Holt drilled VTP-7 and VTP-8 and installed temporary vapor probes screened within the debris that was observed in the core samples. Due to the presence of debris in these borings, Holt also drilled contingent borings B-9 and B-10. B-9 was drilled down to 40 feet bgs and only a trace of debris (<1%) was observed between 8.5 and 9 ft bgs. B-10 was drilled to 30 feet and no debris was observed in the cores. The borings were backfilled with hydrated bentonite chips.

DH environmental was offsite at 15:45 Aspect locked the gate and Holt and Aspect were off site at 16:10.

The plan tomorrow is to complete the VTP-7 and VTP-8 monuments, drill B-6, B-7, and B-8, and mobilize the drill rig to the West Perimeter Road borings.

Problems Encountered: No problems.

Borings B-6 through B-12 were originally named B-1 through B-7 respectively, but were renamed after drilling was completed. The daily reports and field logs have been corrected to reflect this change.

COPIES TO: File, Client	**Aspect Consulting PROJECT MANAGER:** HHH
Page 1 of 1	**FIELD REP.:** MML

DAILY REPORT

350 Madison Avenue North
Bainbridge Island, Washington 98110
(206) 780-9370

401 Second Avenue S, Suite 201
Seattle, Washington 98104
(206) 328-7443

DATE: 04/04/18	**PROJECT NO.** 090057 TASK 310.1.7.7	**WEATHER:** RAINY, 50'S
PROJECT NAME: Vashon Landfill		**CLIENT:** KCSWD
EQUIPMENT USED: PID, GEM 5000, Field Camera, Chip trays.		**PROJECT LOCATION:** VASHON ISLAND, WA

THE FOLLOWING WAS NOTED:
Arrival Time: 0730
Activities: Drill B-6, B-7, and B-8, repair MW-27 surface seal
Personnel/Visitors: Matthew Lewis (Aspect), Nathan (DH Environmental), Pete (Holt driller) with support truck, Lawrence Curly (KCSWD)
Departure Time: 15:00
Field Forms Used: Field Notebook, boring logs, gas monitoring forms

Summary of Activities:
Aspect arrived on site at 0740 and DH Environmental arrived at 0745, donned PPE and calibrated equipment. Holt Services arrived on site at 0810. Aspect and Holt hold a safety meeting and begin preparing the drill rig for work. KCSWD arrives on site at 0950.

Holt drilled B-7 down to 25 feet. Debris was primarily observed between 12 and 15 ft bgs with trace amounts down to 20.5 ft bgs. B-8 was also drilled down to 25 feet and no debris was observed in the core samples. Holt drilled B-6 down to 25 ft bgs and no debris was observed in the core samples. All borings were immediately backfilled with hydrated bentonite chips before moving to the next location. DH environmental was offsite at 1300.

Holt completed flush monuments at VTP-7 and VTP-8 and repaired the surface patch at decommissioned MW-27. Aspect and Holt mobilized the drill rig to the West Perimeter Road site and observed site conditions to estimate sufficient dunnage supplies for access to B-11.

Aspect locked the gate and Holt covered the roll box. Both were off site at 15:00.

The plan tomorrow is to drill B-11, B-12 and begin drilling VTP-11D. VTP-11S will be drilled and installed on Friday, April 6.

Problems Encountered: No problems.

Borings B-6 through B-12 were originally named B-1 through B-7 respectively, but were renamed after drilling was completed. The daily reports and field logs have been corrected to reflect this change.

COPIES TO: File, Client	**Aspect Consulting PROJECT MANAGER:** HHH
Page 1 of 1	**FIELD REP.:** MML

DAILY REPORT

350 Madison Avenue North
Bainbridge Island, Washington 98110
(206) 780-9370

401 Second Avenue S, Suite 201
Seattle, Washington 98104
(206) 328-7443

DATE: 04/05/18	**PROJECT NO.** 090057 TASK 310.1.7.7	**WEATHER:** RAINY, 50'S
PROJECT NAME: Vashon Landfill		**CLIENT:** KCSWD
EQUIPMENT USED: PID, GEM 5000, Field Camera, Chip trays.		**PROJECT LOCATION:** VASHON ISLAND, WA

THE FOLLOWING WAS NOTED:
Arrival Time: 0740
Activities: Drill B-11 and B-12, Drill and Install VTP-11D
Personnel/Visitors: Matthew Lewis (Aspect), Nathan (DH Environmental), Pete (Holt driller) with support truck, and KCSWD field crew (Nina, Samantha, +1)
Departure Time: 15:45
Field Forms Used: Field Notebook, boring logs, gas monitoring forms

Summary of Activities:
Aspect and DH Environmental arrived on site at 0740, donned PPE and calibrated equipment. Holt Services arrived on site at 0810, and the KCSWD field crew arrived at 0815. Aspect and Holt hold a safety meeting and begin preparing the drill rig for work.

Holt built a platform with railroad ties and drilled B-11 to 20 feet. No debris was observed except two shards of glass at the surface. Holt then drilled B-12 to 20 feet bgs and no debris was observed. Both borings were backfilled with hydrated bentonite chips immediately after drilling.

KCSWD left the site at 1100 as Holt was preparing to set up on VTP-11D. It was drilled down to 45 ft bgs and no debris was observed. The temporary probe was screened in Outwash Sand between 31 and 41 feet bgs with pea-gravel filter pack between 30 and 42 feet bgs.

Aspect locked the gate and Holt covered the roll box. All parties were off site at 15:45.

The plan tomorrow is to drill and install VTP-11S and demobilize.

Problems Encountered: No problems.

Borings B-6 through B-12 were originally named B-1 through B-7 respectively, but were renamed after drilling was completed. The daily reports and field logs have been corrected to reflect this change.

COPIES TO: File, Client	**Aspect Consulting PROJECT MANAGER:** HHH	
	Page 1 of 1	**FIELD REP.:** MML

Aspect CONSULTING

DAILY REPORT

350 Madison Avenue North
Bainbridge Island, Washington 98110
(206) 780-9370

401 Second Avenue S, Suite 201
Seattle, Washington 98104
(206) 328-7443

DATE: 04/06/18	**PROJECT NO.** 090057 TASK 310.1.7.7	**WEATHER:** CLOUDY, 50'S
PROJECT NAME: Vashon Landfill		**CLIENT:** KCSWD
EQUIPMENT USED: PID, GEM 5000, Field Camera, Chip trays.		**PROJECT LOCATION:** VASHON ISLAND, WA

THE FOLLOWING WAS NOTED:
Arrival Time: 0915
Activities: Drill and install VTP-11S, complete monuments
Personnel/Visitors: Matthew Lewis (Aspect), Nathan, Pete (Holt driller) with support truck, Dan Swope (KCSWD), Tim O'Connor (Ecology), Darshan Dhillon (Public Health)
Departure Time: 15:45
Field Forms Used: Field Notebook, boring logs, gas monitoring forms

Summary of Activities:
Aspect met KCSWD on site at 0915, donned PPE and calibrated equipment. Holt Services arrived on site at 1000. Aspect and Holt hold a safety meeting and begin preparing the drill rig for work. Ecology and DH&S arrive on site at 1100 and Holt begins drilling VTP-11S. The soil cores showed no signs of debris. A probe was installed with a screen interval between 6 and 11 feet bgs and gravel pack between 5 and 12 feet bgs. Ecology and DH&S leave the site at 12:30, KCSWD leaves the site at 13:20. After installation, Holt completed flush monuments for VTP-11D and -11S, and began preparing for demobilization while Aspect took LFG readings from the new wells.

Aspect locked the gate and Holt covered the roll box. Both were off site at 15:45.

The plan for Monday is for Holt to finish deconning, demobilizing, and site restoration work, and Aspect to take additional LFG readings.

Problems Encountered: No problems.

COPIES TO: File, Client	**Aspect Consulting PROJECT MANAGER:** HHH
	FIELD REP.: MML

DAILY REPORT

350 Madison Avenue North
Bainbridge Island, Washington 98110
(206) 780-9370

401 Second Avenue S, Suite 201
Seattle, Washington 98104
(206) 328-7443

DATE: 04/09/18	**PROJECT NO.** 090057 TASK 310.1.7.7	**WEATHER:** SUNNY, 50'S
PROJECT NAME: Vashon Landfill	**CLIENT:** KCSWD	
EQUIPMENT USED: GEM 5000, Field Camera.	**PROJECT LOCATION:** VASHON ISLAND, WA	

THE FOLLOWING WAS NOTED:
Arrival Time: 0730
Activities: Site Restoration and demobilization
Personnel/Visitors: Matthew Lewis (Aspect), Pete (Holt driller) with support truck.
Departure Time: 12:45
Field Forms Used: Field Notebook, boring logs, gas monitoring forms

Summary of Activities:
Aspect arrived on site at 0730, donned PPE, and calibrated equipment. Holt Services arrived on site at 0810. Holt began site restoration efforts (including smoothing out disturbed soil/grass and spreading straw over affected areas), deconning drill rods, and loading vehicles. Aspect confirms GPS locations of remaining wells, and takes LFG measurements from probes.

1000 Holt needs to make some repairs to the support truck, Aspect gives the driller a ride to the auto parts store and back, then resumes taking LFG measurements.

Aspect locked the gate and Holt covered the roll box. Both were off site at 12:45. This ends the scheduled field activities. There is one drum of decon water at the SW corner of Perimeter Road near the red roll box (which is about 1/3 full).

Problems Encountered: Holt truck repairs.

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	FIELD REP.: MML

APPENDIX B

Investigation Logs

Major Division	Subgroup	Fines	Symbol	Description
Coarse-Grained Soils - More than 50% [1] Retained on No. 200 Sieve	Gravels - More than 50% [1] of Coarse Fraction Retained on No. 4 Sieve	≤5% Fines [5]	GW	Well-graded gravel and gravel with sand, little to no fines
			GP	Poorly-graded gravel and gravel with sand, little to no fines
		≥15% Fines [5]	GM	Silty gravel and silty gravel with sand
			GC	Clayey gravel and clayey gravel with sand
	Sands - 50% [1] or More of Coarse Fraction Passes No. 4 Sieve	≤5% Fines [5]	SW	Well-graded sand and sand with gravel, little to no fines
			SP	Poorly-graded sand and sand with gravel, little to no fines
		≥15% Fines [5]	SM	Silty sand and silty sand with gravel
			SC	Clayey sand and clayey sand with gravel
Fine-Grained Soils - 50% [1] or More Passes No. 200 Sieve	Silts and Clays Liquid Limit Less than 50		ML	Silt, sandy silt, gravelly silt, silt with sand or gravel
			CL	Clay of low to medium plasticity; silty, sandy, or gravelly clay, lean clay
			OL	Organic clay or silt of low plasticity
	Silts and Clays Liquid Limit 50 or More		MH	Elastic silt, clayey silt, silt with micaceous or diatomaceous fine sand or silt
			CH	Clay of high plasticity, sandy or gravelly clay, fat clay with sand or gravel
			OH	Organic clay or silt of medium to high plasticity
Highly Organic Soils			PT	Peat, muck and other highly organic soils

Terms Describing Relative Density and Consistency

	Density	SPT [2] blows/foot
Coarse-Grained Soils	Very Loose	0 to 4
	Loose	4 to 10
	Medium Dense	10 to 30
	Dense	30 to 50
	Very Dense	>50

	Consistency	SPT [2] blows/foot
Fine-Grained Soils	Very Soft	0 to 2
	Soft	2 to 4
	Medium Stiff	4 to 8
	Stiff	8 to 15
	Very Stiff	15 to 30
	Hard	>30

Test Symbols

- FC = Fines Content
- G = Grain Size
- M = Moisture Content
- A = Atterberg Limits
- C = Consolidation
- DD = Dry Density
- K = Permeability
- Str = Shear Strength
- Env = Environmental
- PiD = Photoionization Detector

Component Definitions

Descriptive Term	Size Range and Sieve Number
Boulders	Larger than 12"
Cobbles	3" to 12"
Gravel	3" to No. 4 (4.75 mm)
Coarse Gravel	3" to 3/4"
Fine Gravel	3/4" to No. 4 (4.75 mm)
Sand	No. 4 (4.75 mm) to No. 200 (0.075 mm)
Coarse Sand	No. 4 (4.75 mm) to No. 10 (2.00 mm)
Medium Sand	No. 10 (2.00 mm) to No. 40 (0.425 mm)
Fine Sand	No. 40 (0.425 mm) to No. 200 (0.075 mm)
Silt and Clay	Smaller than No. 200 (0.075 mm)

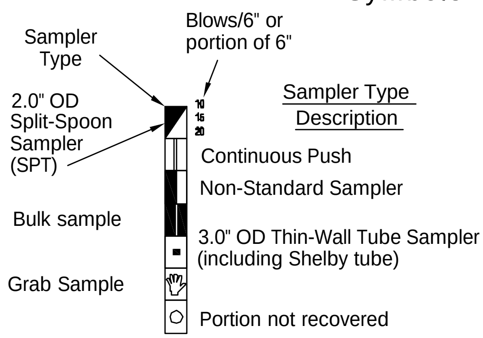
[3] Estimated Percentage

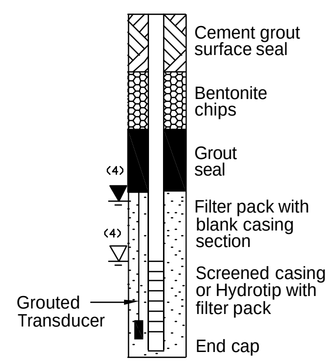
Percentage by Weight	Modifier
<5	Trace
5 to 15	Slightly (sandy, silty, clayey, gravelly)
15 to 30	Sandy, silty, clayey, gravelly)
30 to 49	Very (sandy, silty, clayey, gravelly)

Moisture Content

- Dry - Absence of moisture, dusty, dry to the touch
- Slightly Moist - Perceptible moisture
- Moist - Damp but no visible water
- Very Moist - Water visible but not free draining
- Wet - Visible free water, usually from below water table

Symbols





(1) Percentage by dry weight
(2) (SPT) Standard Penetration Test (ASTM D-1586)
(3) In General Accordance with Standard Practice for Description and Identification of Soils (ASTM D-2488)
(4) Depth of groundwater
∇ ATD = At time of drilling
▼ Static water level (date)

(5) Combined USCS symbols used for fines between 5% and 15% as estimated in General Accordance with Standard Practice for Description and Identification of Soils (ASTM D-2488)

BGS = below ground surface

Classifications of soils in this report are based on visual field and/or laboratory observations, which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field or laboratory testing unless presented herein. Visual-manual and/or laboratory classification methods of ASTM D-2487 and D-2488 were used as an identification guide for the Unified Soil Classification System.

Aspect CONSULTING

Exploration Log Key

DATE:	PROJECT NO.
DESIGNED BY:	
DRAWN BY:	FIGURE NO.
REVISED BY:	B-1

Q:_ACAD Standards\Standard Details\Exploration Log Key B1.dwg

Major Division	Sub-division	Fines	Symbol	Group Name
Coarse-Grained Soils - More than 50%¹ Retained on No. 200 Sieve	Gravels - More than 50%[1] of Coarse Fraction Retained on No. 4 Sieve	≤5% Fines	GW	Well-graded GRAVEL Well-graded GRAVEL WITH SAND
			GP	Poorly-graded GRAVEL Poorly-graded GRAVEL WITH SAND
		≥15% Fines	GM	SILTY GRAVEL SILTY GRAVEL WITH SAND
			GC	CLAYEY GRAVEL CLAYEY GRAVEL WITH SAND
	Sands - 50%[1] or More of Coarse Fraction Passes No. 4 Sieve	≤5% Fines	SW	Well-graded SAND Well-graded SAND WITH GRAVEL
			SP	Poorly-graded SAND Poorly-graded SAND WITH GRAVEL
		≥15% Fines	SM	SILTY SAND SILTY SAND WITH GRAVEL
			SC	CLAYEY SAND CLAYEY SAND WITH GRAVEL
Fine-Grained Soils - 50%¹ or More Passes No. 200 Sieve	Silts and Clays Liquid Limit Less than 50%		ML	SILT SANDY or GRAVELLY SILT SILT WITH SAND SILT WITH GRAVEL
			CL	LEAN CLAY SANDY or GRAVELLY LEAN CLAY LEAN CLAY WITH SAND LEAN CLAY WITH GRAVEL
			OL	ORGANIC SILT SANDY or GRAVELLY ORGANIC SILT ORGANIC SILT WITH SAND ORGANIC SILT WITH GRAVEL
	Silts and Clays Liquid Limit 50% or More		MH	ELASTIC SILT SANDY or GRAVELLY ELASTIC SILT ELASTIC SILT WITH SAND ELASTIC SILT WITH GRAVEL
			CH	FAT CLAY SANDY or GRAVELLY FAT CLAY FAT CLAY WITH SAND FAT CLAY WITH GRAVEL
			OH	ORGANIC CLAY SANDY or GRAVELLY ORGANIC CLAY ORGANIC CLAY WITH SAND ORGANIC CLAY WITH GRAVEL
Highly Organic Soils			PT	PEAT and other mostly organic soils

"WITH SILT" or "WITH CLAY" means 5 to 15% silt and clay, denoted by a "-" in the group name; e.g., SP-SM • "SILTY" or "CLAYEY" means >15% silt and clay • "WITH SAND" or "WITH GRAVEL" means 15 to 30% sand and gravel. • "SANDY" or "GRAVELLY" means >30% sand and gravel. • "Well-graded" means approximately equal amounts of fine to coarse grain sizes • "Poorly graded" means unequal amounts of grain sizes • Group names separated by "/" means soil contains layers of the two soil types; e.g., SM/ML.

Soils were described and identified in the field in general accordance with the methods described in ASTM D2488. Where indicated in the log, soils were classified using ASTM D2487 or other laboratory tests as appropriate. Refer to the report accompanying these exploration logs for details.

1. Estimated or measured percentage by dry weight
2. (SPT) Standard Penetration Test (ASTM D1586)
3. Determined by SPT, DCPT (ASTM STP399) or other field methods. See report text for details.

GEOTECHNICAL LAB TESTS

MC	=	Natural Moisture Content
GS	=	Grain Size Distribution
FC	=	Fines Content (% < 0.075 mm)
GH	=	Hydrometer Test
AL	=	Atterberg Limits
C	=	Consolidation Test
Str	=	Strength Test
OC	=	Organic Content (% Loss by Ignition)
Comp	=	Proctor Test
K	=	Hydraulic Conductivity Test
SG	=	Specific Gravity Test

CHEMICAL LAB TESTS

Organic Chemicals

BTEX	=	Benzene, Toluene, Ethylbenzene, Xylenes
TPH-Dx	=	Diesel and Oil-Range Petroleum Hydrocarbons
TPH-G	=	Gasoline-Range Petroleum Hydrocarbons
VOCs	=	Volatile Organic Compounds
SVOCs	=	Semi-Volatile Organic Compounds
PAHs	=	Polycyclic Aromatic Hydrocarbon Compounds
PCBs	=	Polychlorinated Biphenyls

Metals

RCRA8	=	As, Ba, Cd, Cr, Pb, Hg, Se, Ag, (d = dissolved, t = total)
MTCA5	=	As, Cd, Cr, Hg, Pb (d = dissolved, t = total)
PP-13	=	Ag, As, Be, Cd, Cr, Cu, Hg, Ni, Pb, Sb, Se, Tl, Zn (d=dissolved, t=total)

FIELD TESTS

PID	=	Photoionization Detector
Sheen	=	Oil Sheen Test
SPT[2]	=	Standard Penetration Test
NSPT	=	Non-Standard Penetration Test
DCPT	=	Dynamic Cone Penetration Test

COMPONENT DEFINITIONS

Descriptive Term		*Size Range and Sieve Number*
Boulders	=	Larger than 12 inches
Cobbles	=	3 inches to 12 inches
Coarse Gravel	=	3 inches to 3/4 inches
Fine Gravel	=	3/4 inches to No. 4 (4.75 mm)
Coarse Sand	=	No. 4 (4.75 mm) to No. 10 (2.00 mm)
Medium Sand	=	No. 10 (2.00 mm) to No. 40 (0.425 mm)
Fine Sand	=	No. 40 (0.425 mm) to No. 200 (0.075 mm)
Silt and Clay	=	Smaller than No. 200 (0.075 mm)

ESTIMATED[1] PERCENTAGE

% by Weight		*Modifier*	*% by Weight*		*Modifier*
<1	=	Subtrace	15 to 25	=	Little
1 to <5	=	Trace	30 to 45	=	Some
5 to 10	=	Few	>50	=	Mostly

MOISTURE CONTENT

Dry	=	Absence of moisture, dusty, dry to the touch
Slightly Moist	=	Perceptible moisture
Moist	=	Damp but no visible water
Very Moist	=	Water visible but not free draining
Wet	=	Visible free water, usually from below water table

RELATIVE DENSITY

Non-Cohesive or Coarse-Grained Soils

Density³		*SPT² Blows/Foot*	*Penetration with 1/2" Diameter Rod*
Very Loose	=	0 to 4	≥ 2'
Loose	=	5 to 10	1' to 2'
Medium Dense	=	11 to 30	3" to 1'
Dense	=	31 to 50	1" to 3"
Very Dense	=	> 50	< 1"

CONSISTENCY

Cohesive or Fine-Grained Soils

Consistency³		*SPT² Blows/Foot*	*Manual Test*
Very Soft	=	0 to 1	Penetrated >1" easily by thumb. Extrudes between thumb & fingers.
Soft	=	2 to 4	Penetrated 1/4" to 1" easily by thumb. Easily molded.
Medium Stiff	=	5 to 8	Penetrated >1/4" with effort by thumb. Molded with strong pressure.
Stiff	=	9 to 15	Indented ~1/4" with effort by thumb.
Very Stiff	=	16 to 30	Indented easily by thumbnail.
Hard	=	> 30	Indented with difficulty by thumbnail.

GEOLOGIC CONTACTS

Observed and Distinct — Observed and Gradual — Inferred

Aspect CONSULTING

Exploration Log Key

AI Path: Q:_ACAD Standards\FIELD REFERENCE\MASTERS\Exploration Log Key-2018.ai // user: jinman // last saved: 09/26/2018

Aspect CONSULTING	King County Vashon Island Landfill - 090057		Environmental Exploration Log	
	Project Address & Site Specific Location		*Coordinates (SPN NAD83 ft)*	*Exploration Number*
	Vashon Island, East side of South Slope		E:1228104 N:162678	**B-06**
Contractor	*Equipment*	*Sampling Method*	*Ground Surface (GS) Elev. (NAVD88)*	
Holt Services, Inc	Rotary drill rig	Rotary core	365.183'	
Operator	*Exploration Method(s)*	*Work Start/Completion Dates*	*Top of Casing Elev. (NAVD88)*	*Depth to Water (Below GS)*
Pete	Sonic	4/4/2018	NA	No Water Encountered

Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Analytical Sample Number & Lab Test(s)	Field Tests	Material Type	Description	Depth (ft)
	365	Gravel and topsoil surface restoration.	S1		PID= 52.7		Dry to slightly moist, brown, Topsoil; fine to medium sand, fine subrounded gravel, numerous organics (root mass, grass)	
		3/8-inch Bentonite chip backfill 1-25 ft bgs			PID= 151		**Fill** Slightly moist, brown, gravelly, silty SAND (SM); fine to medium sand, fine subrounded to subangular gravel.	
5	360				PID= 41.2			5
			No Soil Sample Recovery					
10	355		S2		CH4= 0% PID= 204			10
					PID= 98.1			
15	350							15
					PID= 224			
					PID= 970 CH4= 0%		**Vashon Advance Outwash/Unit B** Moist, brown, SAND (SP); fine to medium sand, fine subrounded gravel.	
20	345		S3		PID= 146			20
					PID= 98.9			
					PID= 25.0			
25	340				CH4= 0%		Bottom of exploration at 25 ft. bgs.	25

Legend

Sample Method
- No Soil Sample Recovery
- Continuous core 4" ID

Water Level
- No Water Encountered

See Exploration Log Key for explanation of symbols

Logged by: MML
Approved by: JJS

Exploration Log B-06

Sheet 1 of 1

King County Vashon Island Landfill - 090057	Environmental Exploration Log	
Project Address & Site Specific Location	*Coordinates (SPN NAD83 ft)*	*Exploration Number*
Vashon Island, South east corner of South Slope	E:1227949 N:162513	**B-07**

Contractor	*Equipment*	*Sampling Method*	*Ground Surface (GS) Elev. (NAVD88)*
Holt Services, Inc	Rotary drill rig	Rotary core	322.485'

Operator	*Exploration Method(s)*	*Work Start/Completion Dates*	*Top of Casing Elev. (NAVD88)*	*Depth to Water (Below GS)*
Pete	Sonic	4/4/2018	NA	No Water Encountered

Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Analytical Sample Number & Lab Test(s)	Field Tests	Description
0		Gravel and topsoil surface restoration.	S1 (continuous core 0–6 ft)			Dry to slightly moist, brown, Topsoil; fine to medium sand, fine subrounded gravel, numerous organics (root mass, grass)
	320	3/8-inch Bentonite chip backfill 1-25 ft bgs			PID= 131.1	**Fill** Moist, brown, slightly gravelly, silty SAND (SM); fine to medium sand, fine subrounded to subangular gravel, rare root fibers.
					PID= 108.3	
5					PID= 21.9	
	315		No Soil Sample Recovery (6–10 ft)			
10			S2 (continuous core 10–16 ft)		CH4= 0%	
					PID= 86.5	
	310				PID= 123.5	**Landfill Debris** Very moist, black to gray, silty, sandy, gravelly Fill; plastic scraps, paper, cardboard, glass, garbage bags, etc.
15					PID= 18.7	Moist, brown SAND (SP); trace silt, fine to medium sand, trace root fibers, 5-10% debris (plastic scraps, garbage bags, glass).
	305		No Soil Sample Recovery (16–20 ft)			
20			S3 (continuous core 20–25 ft)		CH4= 0%	Landfill debris becomes rare (~1%) with roots and branches.
					PID= 13.5	**Vashon Advance Outwash/Unit B** Moist, brown, SAND (SP); fine to medium sand, fine subrounded gravel.
	300				PID= 20.1	
25					CH4= 0%	Bottom of exploration at 25 ft. bgs.
	295					

Legend

Sample Method:
- No Soil Sample Recovery
- Continuous core 4" ID

Water Level: No Water Encountered

See Exploration Log Key for explanation of symbols

Logged by: MML
Approved by: JJS

Exploration Log B-07

Sheet 1 of 1

Aspect CONSULTING	King County Vashon Island Landfill - 090057			Environmental Exploration Log	
	Project Address & Site Specific Location			*Coordinates (SPN NAD83 ft)*	*Exploration Number*
	Vashon Island, South end of South Slope			E:1227832 N:162514	**B-08**
Contractor	*Equipment*	*Sampling Method*		*Ground Surface (GS) Elev. (NAVD88)*	
Holt Services, Inc	Rotary drill rig	Rotary core		331.764'	
Operator	*Exploration Method(s)*	*Work Start/Completion Dates*		*Top of Casing Elev. (NAVD88)*	*Depth to Water (Below GS)*
Pete	Sonic	4/4/2018		NA	No Water Encountered

Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Analytical Sample Number & Lab Test(s)	Field Tests	Material Type	Description	Depth (ft)
		Gravel and topsoil surface restoration.			PID= 62.8		Dry to slightly moist, brown, Topsoil; fine to medium sand, fine subrounded gravel, numerous organics (root mass, grass)	
	330	3/8-inch Bentonite chip backfill 1-25 ft bgs			PID= 330		**Fill** Moist, brown, slightly gravelly, silty SAND (SM); fine to medium sand, fine subrounded to subangular gravel, rare root fibers.	
					PID= 362			
5			S1		CH4= 0.1%			5
					PID= 50.7			
	325				PID= 398		**Vashon Advance Outwash/Unit B** Moist, brown, gravelly SAND (SP); fine to medium sand, fine subrounded gravel.	
					PID= 35.2			
10					CH4= 0%			10
					PID= 86.5		Sand becomes fine between 11 and 11.5 ft bgs.	
	320							
					PID= 301			
15			S2				Sand becomes fine to coarse 15 to 16.5 ft bgs.	15
					PID= 247			
	315							
					PID= 51.0		3-inch lens of brittle, slightly silty sand.	
20					CH4= 0%			20
	310				PID= 78.5			
			S3					
					PID= 69.6		1.5-inch silty sand lens.	
25					CH4= 0%		Bottom of exploration at 25 ft. bgs.	25
	305							

Legend

Sample Method: Continuous core 4" ID

Water Level: No Water Encountered

See Exploration Log Key for explanation of symbols

Logged by: MML
Approved by: JJS

Exploration Log B-08

Sheet 1 of 1

Aspect CONSULTING	King County Vashon Island Landfill - 090057		Environmental Exploration Log	
	Project Address & Site Specific Location		*Coordinates (SPN NAD83 ft)*	*Exploration Number*
	Vashon Island, South end of South Slope		E:1227788 N:162585	**B-09**
Contractor	*Equipment*	*Sampling Method*	*Ground Surface (GS) Elev. (NAVD88)*	
Holt Services, Inc	Rotary drill rig	Rotary core	358.793'	
Operator	*Exploration Method(s)*	*Work Start/Completion Dates*	*Top of Casing Elev. (NAVD88)*	*Depth to Water (Below GS)*
Pete	Sonic	4/4/2018	NA	No Water Encountered

Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Analytical Sample Number & Lab Test(s)	Field Tests	Description
0–10	358.8–348.8	Gravel and topsoil surface restoration. 3/8-inch Bentonite chip backfill 1-40 ft bgs	S1		PID= 132; PID= 213; PID= 95.6; PID= 40.1; CH4= 0%	**Fill** Moist, brown, gravelly, silty SAND (SM); fine to medium sand, fine to coarse subrounded to subangular gravel, rare root fibers, cobbles. Becomes brown gray. Grades to dark brown gray.
10–20	348.8–338.8		S2		PID= 91.5; PID= 142.6; PID= 54.2; PID= 45.1; CH4= 0%	**Alluvium** (15 ft) Moist, orange brown, gravelly, SAND (SP); trace silt, fine to medium sand, fine subround to subangular gravel. Grades to brown. Woody branches, and twigs between 17.5 to 18. **Vashon Advance Outwash/Unit B** (18 ft) Moist, gray brown, gravelly SAND (SP); fine to medium sand, fine subrounded gravel.
20–30	338.8–328.8		S3		PID= 38.4; PID= 149.1; PID= 144.9; PID= 36.3	Sand becomes fine between 29 to 29.5.
30–40	328.8–318.8		S4		PID= 108; PID= 65.4; PID= 17.2; PID= 35.1; CH4= 0%	Sand becomes fine to coarse; gravel becomes trace, fine, and subrounded. Sand becomes fine 39 to 40.
40						Bottom of exploration at 40 ft. bgs.

Legend

Sample Method: Continuous core 4" ID

Water Level: No Water Encountered

See Exploration Log Key for explanation of symbols

Logged by: MML
Approved by: JJS

Exploration Log B-09

Sheet 1 of 1

Aspect CONSULTING	King County Vashon Island Landfill - 090057			Environmental Exploration Log	
	Project Address & Site Specific Location			*Coordinates (SPN NAD83 ft)*	*Exploration Number*
	Vashon Island, Southwest corner of South Pond			E:1227715 N:162694	**B-10**
Contractor	*Equipment*	*Sampling Method*		*Ground Surface (GS) Elev. (NAVD88)*	
Holt Services, Inc	Rotary drill rig	Rotary core		359.497'	
Operator	*Exploration Method(s)*	*Work Start/Completion Dates*		*Top of Casing Elev. (NAVD88)*	*Depth to Water (Below GS)*
Pete	Sonic	4/3/2018		NA	No Water Encountered

Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Analytical Sample Number & Lab Test(s)	Field Tests	Material Type	Description	Depth (ft)
0		Gravel and topsoil surface restoration. 3/8-inch Bentonite chip backfill 1-30 ft bgs					**Fill** Moist, brown, gravelly, silty SAND (SM); fine to medium sand, fine to coarse subrounded to subangular gravel, rare root fibers, cobbles.	
					PID= 221			
5	355		S1		PID= 150.8			5
					PID= 116			
10	350		(No Soil Sample Recovery)		CH4= 0%		**Vashon Advance Outwash/Unit B** Moist, brown, slightly gravelly SAND (SP); fine to medium sand, fine subrounded gravel.	10
					PID= 20.1			
15	345		S2		CH4= 0% PID= 8.1			15
					PID= 10.7		Oxidized layer 0.5 inches thick.	
					PID= 3.8			
20	340				CH4= 0%			20
					PID= 48.8			
25	335		S3		CH4= 0% PID= 22.1			25
					PID= 12.1			
							Sand becomes silty and fine between 28 to 28.5.	
					PID= 23.5			
30	330						Bottom of exploration at 30 ft. bgs.	30

Legend

Sample Method:
- No Soil Sample Recovery
- Continuous core 4" ID

Water Level: No Water Encountered

See Exploration Log Key for explanation of symbols

Logged by: MML
Approved by: JJS

Exploration Log B-10

Sheet 1 of 1

Aspect Consulting	King County Vashon Island Landfill - 090057			Environmental Exploration Log	
	Project Address & Site Specific Location			*Coordinates (SPN NAD83 ft)*	*Exploration Number*
	Vashon Island, Outside of fence on West Perimeter Road			E:1227868 N:163713	**B-11**
Contractor	*Equipment*	*Sampling Method*		*Ground Surface (GS) Elev. (NAVD88)*	
Holt Services, Inc	Rotary drill rig	Rotary core		405.979'	
Operator	*Exploration Method(s)*	*Work Start/Completion Dates*		*Top of Casing Elev. (NAVD88)*	*Depth to Water (Below GS)*
Pete	Sonic	4/5/2018		NA	No Water Encountered

Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Analytical Sample Number & Lab Test(s)	Field Tests	Description	Depth (ft)
0		Gravel and topsoil surface restoration.				Dry to slightly moist, brown, silty, sandy Topsoil; fine to medium sand, fine subrounded gravel, numerous organics (root mass, grass)	
	405				PID= 219	**Fill** Moist, brown, gravelly, silty SAND (SM); fine to medium sand, fine subrounded to subangular gravel, rare root fibers, rare scattered pieces of glass (<1%).	
		3/8-inch Bentonite chip backfill 1-20 ft bgs				**Vashon Till/Unit A** Moist, brown, gravelly silty SAND (SM); fine to medium sand, fine to coarse subrounded to subangular gravel.	
					PID= 102		
5			S1			Becomes gray.	5
	400				PID= 176		
					PID= 146		
			No Soil Sample Recovery				
10					CH4= 0.1%		10
	395				PID= 240		
					PID= 271		
15			S2				15
	390				PID= 216		
					PID= 267		
20					CH4= 0%	Bottom of exploration at 20 ft. bgs.	20
	385						

Legend

Sample Method:
- ◯ No Soil Sample Recovery
- ◫ Continuous core 4" ID

Water Level: No Water Encountered

See Exploration Log Key for explanation of symbols

Logged by: MML
Approved by: JJS

Exploration Log B-11

King County Vashon Island Landfill - 090057	Environmental Exploration Log

Project Address & Site Specific Location	Coordinates (SPN NAD83 ft)	Exploration Number
Vashon Island, Outside of fence on West Perimeter Road	E:1227829 N:163599	B-12

Contractor	Equipment	Sampling Method	Ground Surface (GS) Elev. (NAVD88)
Holt Services, Inc	Rotary drill rig	Rotary core	402.774'

Operator	Exploration Method(s)	Work Start/Completion Dates	Top of Casing Elev. (NAVD88)	Depth to Water (Below GS)
Pete	Sonic	4/5/2018	NA	No Water Encountered

Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Analytical Sample Number & Lab Test(s)	Field Tests	Material Type	Description	Depth (ft)
0		Gravel and topsoil surface restoration.					Dry to slightly moist, brown, silty, sandy Topsoil; fine to medium sand, fine subrounded gravel, numerous organics (root mass, grass)	
					PID= 209		**Fill** Moist, brown, gravelly, SAND (SP); fine to medium sand, fine subrounded to subangular gravel, rare root fibers, rare scattered pieces of glass (<1%).	
	400	3/8-inch Bentonite chip backfill 1-20 ft bgs						
					PID= 94.4		**Vashon Till/Unit A** Moist, brown, gravelly silty SAND (SM); fine to medium sand, fine to coarse subrounded to subangular gravel.	
5			S1				Becomes gray.	5
					PID= 915			
	395				PID= 472			
			(No Soil Sample Recovery)					
10					CH4= 0%			10
					PID= 383			
	390							
					PID= 560			
15			S2					15
					PID= 398		Includes cobbles.	
	385				PID= 748			
20					CH4= 0.1%		Bottom of exploration at 20 ft. bgs.	20

Legend

Sample Method
- No Soil Sample Recovery
- Continuous core 4" ID

Water Level
No Water Encountered

See Exploration Log Key for explanation of symbols

Logged by: MML
Approved by: JJS

Exploration Log
B-12
Sheet 1 of 1

ASPECT STANDARD EXPLORATION LOG TEMPLATE \\BISERVER1.ASPECT.LOCAL\PROJECTS\GINTW\PROJECTS\KC VASHON_AUGUST 2016 AND LATER.GPJ October 3, 2018

(TP-7)

King County Vashon Island Landfill - 090057	Monitoring Well Log	
Project Address & Site Specific Location: Vashon Island, West side of South Slope	*Coordinates (SPN NAD83 ft)*: E:1227762 N:162804	*Exploration Number*: **VTP-7**

Contractor	*Equipment*	*Sampling Method*	*Ground Surface (GS) Elev. (NAVD88)*	Ecology Well Tag No.
Holt Services, Inc	Rotary drill rig	Rotary core	359.775'	BKX-135

Operator	*Exploration Method(s)*	*Work Start/Completion Dates*	*Top of Casing Elev. (NAVD88)*	*Depth to Water (Below GS)*
Pete	Sonic	4/3/2018	359.199'	No Water Encountered

Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Analytical Sample Number & Lab Test(s)	Field Tests	Description	Depth (ft)
0		12-inch steel flush monument; Valved hose barb				Dry to slightly moist, brown, Topsoil; fine to medium sand, fine subrounded gravel, numerous organics (root mass, grass)	
1		Concrete surface seal	S1		PID= 39.6	**Fill** Moist, brown, gravelly, silty SAND (SM); predominantly fine to medium sand, fine subrounded to subangular gravel.	
3		3/8-inch Bentonite chip backfill 2-8 ft bgs			PID= 69		
5	355	2-inch SCH 40 PVC 0-9 ft bgs			PID= 24.0		5
7					PID= 162	Becomes gray brown.	
7						**Landfill Debris** Very moist, black to gray, silty, sandy, gravelly Fill; plastic scraps, thin aluminum sheets, paper, cardboard, garbage bags, etc. Becomes moist.	
8		Gravel filter pack 8-15 ft bgs					
9		2-inch 0.020 slot SCH 40 screen 9-14 ft bgs			PID= 414		
10	350		S2		CH4= 1.6%		10
12					PID= 70.0		
14					PID= 66.7	Fiberglass fibers	
						Plywood at bottom of debris contact.	
15	345	3/8-inch Bentonite chip backfill 15-20 ft bgs	S3		CH4= 0% PID= 345	**Vashon Advance Outwash/Unit B** Moist, gray brown, SAND (SP); fine to medium sand, fine subrounded to subangular gravel.	15
17					PID= 27.3		
19					PID= 13.6		
20	340				CH4= 0%	Bottom of exploration at 20 ft. bgs.	20

Legend

Sample Method: Continuous core 4" ID

Water Level: No Water Encountered

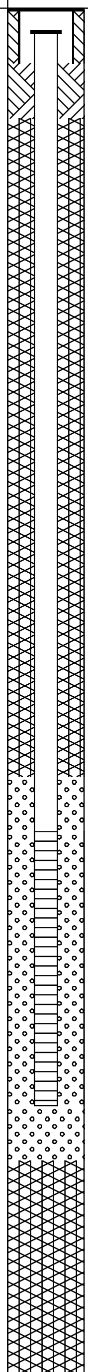
See Exploration Log Key for explanation of symbols

Logged by: MML
Approved by: JJS

Exploration Log VTP-7

(TP-8)

Aspect Consulting	King County Vashon Island Landfill - 090057			Monitoring Well Log	
	Project Address & Site Specific Location			*Coordinates (SPN NAD83 ft)*	*Exploration Number*
	Vashon Island, East side of leachate pond			E:1227838 N:162641	**VTP-8**
Contractor	*Equipment*	*Sampling Method*		*Ground Surface (GS) Elev. (NAVD88)*	Ecology Well Tag No. BKX-134
Holt Services, Inc	Rotary drill rig	Rotary core		359.315'	
Operator	*Exploration Method(s)*	*Work Start/Completion Dates*		*Top of Casing Elev. (NAVD88)*	*Depth to Water (Below GS)*
Pete	Sonic	4/3/2018		358.892'	No Water Encountered



Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Analytical Sample Number & Lab Test(s)	Field Tests	Description
0		12-inch steel flush monument; Valved hose barb	S1			Topsoil; fine to medium sand, rare root fibers.
		Concrete surface seal			PID= 280	**Fill** Slightly moist, brown, slightly gravelly, silty SAND (SM); fine to medium sand, fine subrounded gravel.
		3/8-inch Bentonite chip backfill 2-14 ft bgs			PID= 713	
	355					
5		2-inch SCH 40 PVC 0-15 ft bgs			PID= 455	Becomes gray brown.
					PID= 304	Becomes dark gray brown with coarse subrounded gravel and subrounded cobbles. silty SAND (SM)
	350					
10			S2		CH4= 0% PID= 134	Becomes brown. Becomes gray and siltier.
					PID= 280	
						Becomes brown.
					PID= 207	
	345	Gravel filter pack 14-21 ft bgs				Root fiber organics.
15		2-inch 0.020 slot SCH 40 screen 15-20 ft bgs	S3		CH4= 0% PID= 513	**Landfill Debris** Very moist, black to gray, sandy, gravelly Fill; red and blue plastic scraps, paper, cardboard, garbage bags, white fibers, glass.
					PID= 570	
						Becomes silty.
					PID= 5073	
	340					
20			S4		CH4= 0%	
					PID= 2877	
		3/8-inch Bentonite chip backfill 21-25 ft bgs				**Fill** Moist, brown, gravelly, silty SAND (SM); fine to medium sand, fine to coarse subrounded to subangular gravel.
					PID= 1312	**Vashon Advance Outwash/Unit B** Moist, gray brown, SAND (SP); trace silt, fine to medium sand, fine subrounded to subangular gravel.
	335					
25					CH4= 0%	Bottom of exploration at 25 ft. bgs.

Legend

Sample Method: Continuous core 4" ID

Water Level: No Water Encountered

See Exploration Log Key for explanation of symbols

Logged by: MML
Approved by: JJS

Exploration Log VTP-8

Sheet 1 of 1

(TP-9)

Monitoring Well Log

Aspect CONSULTING	King County Vashon Island Landfill - 090057			Monitoring Well Log	
	Project Address & Site Specific Location Vashon Island, South Perimeter Road			*Coordinates (SPN NAD83 ft)* E:1227987 N:162784	*Exploration Number* **VTP-9**
Contractor Holt Services, Inc	*Equipment* Rotary drill rig	*Sampling Method* Rotary core		*Ground Surface (GS) Elev. (NAVD88)* 373.646'	Ecology Well Tag No. BKX-132
Operator Pete	*Exploration Method(s)* Sonic	*Work Start/Completion Dates* 4/2/2018		*Top of Casing Elev. (NAVD88)* 373.223'	*Depth to Water (Below GS)* No Water Encountered

Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Analytical Sample Number & Lab Test(s)	Field Tests	Material Type	Description	Depth (ft)
0		12-inch steel flush monument; Valved hose barb				Asphalt	14-inch thick Asphalt.	
		Concrete surface seal					**Fill** Moist, gray brown, gravelly, silty SAND (SM); fine to medium sand, fine to coarse subrounded to subangular gravel.	
	370	3/8-inch Bentonite chip backfill 2-7 ft bgs						
5		2-inch SCH 40 PVC 0-7.5 ft bgs					Geotextile at 6 ft.	5
			S1		CH4= 0.1% PID= 204		Moist, gray brown, gravelly, silty SAND (SM); fine to coarse sand, fine to coarse subrounded to subangular gravel.	
		Gravel filter pack 7-10 ft bgs						
	365	2-inch 0.020 slot SCH 40 screen 7.5-10 ft bgs			PID= 506			
10					CH4= 0% PID= 405		Bottom of exploration at 10 ft. bgs. Note: Vaccumed down to 6 ft bgs	10
	360							
15								15
	355							

Legend

Sample Method: Continuous core 4" ID

Water Level: No Water Encountered

See Exploration Log Key for explanation of symbols

Logged by: MML
Approved by: JJS

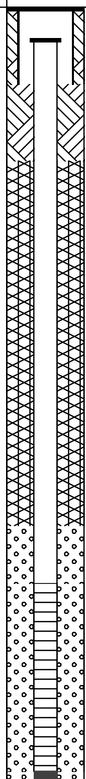
Exploration Log VTP-9

Sheet 1 of 1

(TP-10)

Aspect Consulting	King County Vashon Island Landfill - 090057		Monitoring Well Log	
	Project Address & Site Specific Location Vashon Island, South perimeter road		*Coordinates (SPN NAD83 ft)* E:1227882 N:162832	*Exploration Number* **VTP-10** Ecology Well Tag No. BKX-133
Contractor Holt Services, Inc	*Equipment* Rotary drill rig	*Sampling Method* Rotary core	*Ground Surface (GS) Elev. (NAVD88)* 376.139'	
Operator Pete	*Exploration Method(s)* Sonic	*Work Start/Completion Dates* 4/2/2018	*Top of Casing Elev. (NAVD88)* 375.311'	*Depth to Water (Below GS)* No Water Encountered

Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Analytical Sample Number & Lab Test(s)	Field Tests	Material Type	Description	Depth (ft)
0		12-inch steel flush monument Valved hose barb					7-inch thick Asphalt.	
	375	Concrete surface seal					Slightly moist, brown, gravelly, slightly silty SAND (SP-SM); fine to medium sand, fine to coarse subrounded to subangular gravel.	
		3/8-inch Bentonite chip backfill 2-6.75 ft bgs					**Fill** Slightly moist to dry, gray brown, gravelly, silty SAND (SM); fine to medium sand, fine to coarse subrounded to subangular gravel.	
5		2-inch SCH 40 PVC 0-7.5 ft bgs						5
	370		S1		CH4= 0%		Geotextile at 6.75 ft.	
		Gravel filter pack 6.75-10 ft bgs			PID= 213		Moist, brown, gravelly, slightly silty SAND (SP-SM); fine to medium sand, fine subrounded gravel.	
		2-inch 0.020 slot SCH 40 screen 7.5-10 ft bgs					Moist, gray brown, gravelly, silty SAND (SM); fine to medium sand, fine to coarse subrounded to subangular gravel. Sand becomes predominantly fine.	
10					PID= 72.4 CH4= 0%		Bottom of exploration at 10 ft. bgs. Note: Vaccumed down to 6 ft bgs	10
	365							
15								15
	360							



Legend

Sample Method: Continuous core 4" ID

Water Level: No Water Encountered

See Exploration Log Key for explanation of symbols

Logged by: MML
Approved by: JJS

Exploration Log VTP-10

Sheet 1 of 1

Aspect Consulting	King County Vashon Island Landfill - 090057			Monitoring Well Log	
	Project Address & Site Specific Location			*Coordinates (SPN NAD83 ft)*	*Exploration Number*
	Vashon Island, Northwest perimeter road			E:1227950 N:163802	**VTP-11S**
Contractor	*Equipment*	*Sampling Method*		*Ground Surface (GS) Elev. (NAVD88)*	Ecology Well Tag No. BKX-137
Holt Services, Inc	Rotary drill rig	Rotary core		401.479'	
Operator	*Exploration Method(s)*	*Work Start/Completion Dates*		*Top of Casing Elev. (NAVD88)*	*Depth to Water (Below GS)*
Pete	Sonic	4/6/2018		400.832'	No Water Encountered

Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Analytical Sample Number & Lab Test(s)	Field Tests	Description	Depth (ft)
0		12-inch steel flush monument; Valved hose barb				Moist, brown, silty, sandy Topsoil; fine to medium sand, abundant root mass.	
	400	Concrete surface seal				**Fill** Moist, brown, slightly gravelly, slightly silty SAND (SP-SM); fine to medium sand, fine subrounded gravel.	
					PID= 23.9	Slightly moist, gray brown, gravelly, silty SAND (SM); predominantly fine to medium sand, fine to coarse subrounded to subangular gravel.	
		3/8-inch Bentonite chip backfill 2-5 ft bgs					
		2-inch SCH 40 PVC 0-6 ft bgs					
5		Gravel filter pack 5-12 ft bgs	S1		PID= 60.5		5
	395	2-inch 0.020 slot SCH 40 screen 6-11 ft bgs				Becomes slightly silty SAND (SP-SM).	
					PID= 33.9	**Vashon Till/Unit A** Slightly moist, gray brown, gravelly, silty SAND (SM); predominantly fine to medium sand, fine to coarse subrounded to subangular gravel.	
					PID= 66.9		
10					CH4= 0%		10
					PID= 14.1		
	390		S2				
		3/8-inch Bentonite chip backfill 12-15 ft bgs			PID= 31.4		
15					PID= 38.5 CH4= 0%	Bottom of exploration at 15 ft. bgs.	15
	385						

Legend

Sample Method: Continuous core 4" ID

Water Level: No Water Encountered

See Exploration Log Key for explanation of symbols

Logged by: MML
Approved by: JJS

Exploration Log VTP-11S

Sheet 1 of 1

(TP-11D)

Aspect Consulting	King County Vashon Island Landfill - 090057			Monitoring Well Log	
	Project Address & Site Specific Location			*Coordinates (SPN NAD83 ft)*	*Exploration Number*
	Vashon Island, Northwest perimeter road			E:1227938 N:163804	**VTP-11D**
Contractor	*Equipment*	*Sampling Method*		*Ground Surface (GS) Elev. (NAVD88)*	Ecology Well Tag No.
Holt Services, Inc	Rotary drill rig	Rotary core		402.145'	BKX-136
Operator	*Exploration Method(s)*	*Work Start/Completion Dates*		*Top of Casing Elev. (NAVD88)*	*Depth to Water (Below GS)*
Pete	Sonic	4/5/2018		401.479'	No Water Encountered

Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Analytical Sample Number & Lab Test(s)	Field Tests	Material Type	Description	Depth (ft)
		12-inch steel flush monument Valved hose barb					Moist, brown, silty, sandy Topsoil; fine to medium sand, abundant root mass.	
		Concrete surface seal			PID= 35.5		**Fill** Moist, brown, slightly gravelly, slightly silty SAND (SP-SM); fine to medium sand, fine subrounded gravel.	
	400	3/8-inch Bentonite chip backfill 2-30 ft bgs					Slightly moist, gray brown, gravelly, silty SAND (SM); predominantly fine to medium sand, fine to coarse subrounded to subangular gravel.	
5		2-inch SCH 40 PVC 0-31 ft bgs	S1		PID= 54.3			5
	395				PID= 50.8		Becomes slightly silty SAND (SP-SM).	
					PID= 107		**Vashon Till/Unit A** Slightly moist, gray brown, gravelly, silty SAND (SM); predominantly fine to medium sand, fine to coarse subrounded to subangular gravel.	
10					CH4= 0%			10
	390				PID= 201			
			S2		PID= 463			
15					PID= 579			15
	385				PID= 820			
			S3		CH4= 0%		Becomes slightly silty SAND (SP-SM).	
20					PID= 15,000		Moist, gray brown, gravelly, silty SAND (SM); predominantly fine to coarse sand, fine to coarse subrounded to subangular gravel.	20
	380		S4		PID= 326			

Legend

Sample Method: Continuous core 4" ID

Water Level: No Water Encountered

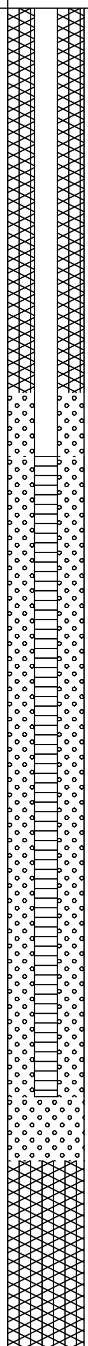
See Exploration Log Key for explanation of symbols

Logged by: MML
Approved by: JJS

Exploration Log VTP-11D

(TP-11D)

Aspect Consulting	King County Vashon Island Landfill - 090057		Monitoring Well Log	
	Project Address & Site Specific Location		*Coordinates (SPN NAD83 ft)*	*Exploration Number*
	Vashon Island, Northwest perimeter road		E:1227938 N:163804	**VTP-11D**
Contractor	*Equipment*	*Sampling Method*	*Ground Surface (GS) Elev. (NAVD88)*	Ecology Well Tag No.
Holt Services, Inc	Rotary drill rig	Rotary core	402.145'	BKX-136
Operator	*Exploration Method(s)*	*Work Start/Completion Dates*	*Top of Casing Elev. (NAVD88)*	*Depth to Water (Below GS)*
Pete	Sonic	4/5/2018	401.479'	No Water Encountered



Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Analytical Sample Number & Lab Test(s)	Field Tests	Material Type	Description	Depth (ft)
			S4				Moist, gray brown, gravelly, silty SAND (SM); predominantly fine to coarse sand, fine to coarse subrounded to subangular gravel. (continued)	
25					PID= 2420			25
	375				PID= 140			
30		Gravel filter pack 30-42 ft bgs			CH4= 0.1%		**Vashon Advance Outwash/Unit B** Moist, brown, gravelly SAND (SP); trace silt, predominantly fine to medium sand, fine to coarse subrounded to subangular gravel.	30
	370	2-inch 0.020 slot SCH 40 screen 31-41 ft bgs					Gravel becomes trace between 32 and 33.5 ft bgs.	
35			S5				Gravel becomes trace between 35 and 36 ft bgs.	35
	365						Gravely silty sand (SM) lens.	
40					CH4= 0%			40
	360	3/8-inch Bentonite chip backfill 42-45 ft bgs	S6					
45							Bottom of exploration at 45 ft. bgs. Note: Elevated PID readings due to hot drilling conditions.	45
	355							

Legend

Sample Method: Continuous core 4" ID

Water Level: No Water Encountered

See Exploration Log Key for explanation of symbols

Logged by: MML
Approved by: JJS

Exploration Log VTP-11D

Aspect CONSULTING	King County Vashon Island Landfill - 090057			Monitoring Well Log	
	Project Address & Site Specific Location: 18900 Westside Highway SW, Vashon, WA 98070, North of leachate lagoon, between VTP-4S and VTP-5S.			Coordinates (SPN NAD83 ft): E:-122.500 N:47.4340	Exploration Number: **GW-10**
Contractor: Holt Services, Inc.	Equipment: Rotary drill rig	Sampling Method: Rotary core		Ground Surface (GS) Elev. (NAVD88): 359.9499'	Ecology Well Tag No. BKX482
Operator: Pete	Exploration Method(s): Sonic	Work Start/Completion Dates: 6/25/2018 to 6/26/2018		Top of Casing Elev. (NAVD88): 363.7966'	Depth to Water (Below GS): No Water Encountered

Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Analytical Sample Number & Lab Test(s)	Field Tests	Material Type	Description	Depth (ft)
		Sealed top flange gasket						
		HDPE Tee-joint						
0	360	Concrete surface seal, 0 to 2 feet bgs					**FILL** SILTY SAND WITH GRAVEL (SM); Moist, light brown; medium to coarse gravels, fine to coarse sand, non-cohesive material.	0
					PID = 5.7			
		4-inch Sch 80 HDPE, +3.85 to 15.5 feet bgs					Geotextile fabric observed at 3.5 feet bgs	
5	355				PID = 20.8		SANDY SILT WITH GRAVEL (ML); Moist, dark gray; fine to coarse sands, medium to coarse gravels, more cohesive.	5
		3/8-inch bentonite chip backfill, 2 to 14.5 feet bgs						
					PID = 8.0			
							SILTY SAND WITH GRAVEL (SM); Moist, dark gray; fine to coarse gravels with cobbles, fine to coarse sand.	
10	350				PID = 20.2 CH4 = 0.0			10
							SAND WITH SILT (SP-SM); Moist, light brown; fine to coarse sand.	
					PID = 57.8		**LANDFILL DEBRIS** SILTY SAND WITH GRAVEL (SM); Moist, dark gray to black; plastic bags, plastic, glass, metal scraps.	
15	345				PID = 112.5			15
		3/4-inch to 1-inch gravel filter pack, 14.5 to 29.5 feet bgs					Debris includes red plastic, red painted lumber, plywood, woody debris, metal scraps.	
		4-inch Sch 80 HDPE screen with 1/2-inch perforations, 15.5 to 28.5 feet bgs			PID = 29.0		Debris includes glass, plastic bags, textiles, woody debris, newspaper	
20	340				PID = 33.9 CH4 = 0.0			20

Legend

Sample Method: Continuous core 7" ID

Water Level: No Water Encountered

See Exploration Log Key for explanation of symbols

Logged by: ACO
Approved by: MVA/PSB

Exploration Log GW-10

Aspect Consulting	King County Vashon Island Landfill - 090057			Monitoring Well Log	
	Project Address & Site Specific Location: 18900 Westside Highway SW, Vashon, WA 98070, North of leachate lagoon, between VTP-4S and VTP-5S.			Coordinates (SPN NAD83 ft): E:-122.500 N:47.4340	Exploration Number: **GW-10**
Contractor: Holt Services, Inc.	Equipment: Rotary drill rig	Sampling Method: Rotary core		Ground Surface (GS) Elev. (NAVD88): 359.9499'	Ecology Well Tag No. BKX482
Operator: Pete	Exploration Method(s): Sonic	Work Start/Completion Dates: 6/25/2018 to 6/26/2018		Top of Casing Elev. (NAVD88): 363.7966'	Depth to Water (Below GS): No Water Encountered

Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Analytical Sample Number & Lab Test(s)	Field Tests	Description	Depth (ft)
					PID = 59.6	**LANDFILL DEBRIS** SILTY SAND WITH GRAVEL (SM); Moist, dark gray to black; plastic bags, plastic, glass, metal scraps. (continued) Debris includes blue plastic jugs, glass, aluminum cans, lumber, egg cartons, concrete	
25	335				PID = 85.5	Debris includes charcoal, ash debris, glass, metal, burned paper (appears visibly burnt)	25
		Welded endcap			PID = 37.1	Debris includes blue plastic, glass, wood debris	
30	330	Backfilled with bentonite chips to 35 feet bgs			PID = 14.4 CH4 = 0.0		30
						SILTY SAND (SM); Moist, light brown; charcoal debris, trace lumber debris	
					PID = 8.8	**Vashon Advance Outwash/B unit** SAND (SP); Moist, light brown; trace silt, fine to coarse sand, trace fine to coarse gravels, no visible landfill debris.	
35	325				PID = 4.1	Bottom of exploration at 35 ft. bgs.	35
40	320						40
45	315						45

Legend

Sample Method: Continuous core 7" ID

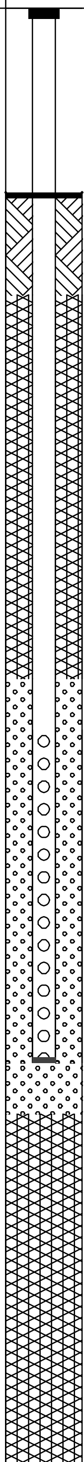
Water Level: No Water Encountered

See Exploration Log Key for explanation of symbols

Logged by: ACO
Approved by: MVA/PSB

Exploration Log GW-10

King County Vashon Island Landfill - 090057			Monitoring Well Log	
Aspect CONSULTING	*Project Address & Site Specific Location* 18900 Westside Highway SW, Vashon, WA 98070, Northwest of leachate lagoon, between VTP-7 and VTP-5D.		*Coordinates (SPN NAD83 ft)* E:-122.501 N:47.4341	*Exploration Number* **GW-11**
Contractor Holt Services, Inc.	*Equipment* Rotary drill rig	*Sampling Method* Rotary core	*Ground Surface (GS) Elev. (NAVD88)* 360.1557'	Ecology Well Tag No. BKX483
Operator Pete	*Exploration Method(s)* Sonic	*Work Start/Completion Dates* 6/25/2018 to 6/26/2018	*Top of Casing Elev. (NAVD88)* 363.6807'	*Depth to Water (Below GS)* No Water Encountered



Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Analytical Sample Number & Lab Test(s)	Field Tests	Material Type	Description	Depth (ft)
		Sealed top flange gasket						
		HDPE Tee-joint						
0	360	Concrete surface seal, 0 to 2 feet bgs					TOPSOIL; Dry, light brown; root mass, non-cohesive material.	0
					PID = 3.2		**FILL** SAND WITH SILT AND GRAVEL (SW-SM); Moist, dark brown; fine to coarse sand, fine to coarse gravels, minor orange staining.	
		4-inch Sch 80 HDPE, +3.53 to 10.5 feet bgs						
5	355				PID = 3.2			5
		3/8-inch bentonite chip backfill, 2 to 9.5 feet bgs					Geotextile fabric at 6.5 feet bgs	
					PID = 11.1		**LANDFILL DEBRIS** SILTY SAND WITH GRAVEL (SM); Moist, dark brown to black; debris includes plastic, metal, glass shards, brick, plastic dish gloves.	
10	350				PID = 7.0 CH4 = 1.1			10
		3/4-inch to 1-inch gravel filter pack, 9.5 to 18 feet bgs						
		4-inch Sch 80 HDPE screen with 1/2-inch perforations, 10.5 to 17 feet bgs			PID = 35.0		Debris includes wood debris, plastic, metal	
15	345				PID = 290.0		Debris includes fiberglass, shredded paper, metal wires	15
		Welded endcap						
					PID = 132.1		Debris includes plastic, plastic bags, cardboard, lumber	
							SAND (SP); Moist, dark blue-gray; trace gravel, and trace plastic debris.	
20	340	Backfilled with bentonite chips to 25 feet bgs			PID = 202.7 CH4 = 0.0		**Vashon Advance Outwash/B Unit** SAND (SW); Moist, dark gray; trace gravel and trace silt, no debris observed, noticeable refuse odor.	20
					PID = 19.3			
25	335				PID = 11.9		Bottom of exploration at 25 ft. bgs.	25

Legend

Sample Method: Continuous core 7" ID

Water Level: No Water Encountered

See Exploration Log Key for explanation of symbols

Logged by: ACO
Approved by: MVA/PSB

Exploration Log GW-11

Sheet 1 of 1

NEW STANDARD LOG FORM P:\GINTWPROJECTS\2018_090057-310.1.7.6_VASHONLF.GPJ July 18, 2018

APPENDIX C

Geophysical Investigation Report

King County Department of Natural Resources and Parks

Solid Waste Division

Phase 1 – Vashon Island Closed Landfill

CONTRACT NO. E00102E08

Task No. 310.1.7.7 - D310.1.7.7.2

Geophysical **Investigation Report**

Prepared by
Aspect Consulting, LLC
401 Second Ave S, #201
Seattle, WA 98104
(206) 328-7443

In Conjunction with
Phillip H. Duoos, Geophysical Consultant

King County
Department of
Natural Resources and Parks
Solid Waste Division

Waste Prevention | Resource Recovery | Waste Disposal

www.kingcounty.gov/solidwaste

January 2018

FINAL

GEOPHYSICAL INVESTIGATION REPORT

VASHON ISLAND CLOSED LANDFILL

WEST PERIMETER ROAD AREA
SOUTH SLOPE AREA

KING COUNTY SOLID WASTE DIVISION
PROJECT NO. : 090057-310.1.7.7

FOR

ASPECT CONSULTING, LLC
SEATTLE, WASHINGTON

JANUARY 2018

PHILIP H. DUOOS
GEOPHYSICAL CONSULTANT

January 29, 2018 Our Ref.: 1262-17

Mr. Erick Miller
Aspect Consulting, LLC
350 Madison Ave. N.
Bainbridge Island, WA 98110

Draft Report: Geophysical Investigation
Vashon Island Landfill Site, Washington
Project No. 090057.310.1.7.7

Dear Mr. Miller:

This report provides the results of the geophysical investigation that I performed during the period of December 12-14, 2017 at the site. The purpose of the investigation was to better define the lateral and vertical extent of buried refuse in the vicinity of the West Perimeter Road and in the South Slope Area to the south of the 2001 Closure Area.

Several types of geophysical methods were used at the two areas to provide the best possible results for the conditions in each area, including the presence of possible sources of interference (metal fences, utilities, and other structures) and the anticipated depth of burial of the refuse. Brief descriptions of the various geophysical methods are provided in **Appendix A**.

A discussion of the West Perimeter Road Area survey is presented below, followed by the South Slope Area.

WEST PERIMETER ROAD SURVEY

In the West Perimeter Road Area, the depth to the top of the refuse is fairly shallow, observed at 0.5' to 10' deep in existing borings and test pits. The depth to the base of the refuse has been observed in the range of 5.5' to 32' deep. This area has underground power lines and a fence along the west edge of the area which can adversely affect electromagnetic and magnetometry methods.

Geophysical Methodology, West Perimeter Road Area

Ground Penetrating Radar (GPR) and Dual-EM methods were employed in the West Perimeter Road Area, with the Dual-EM method providing the best indications of buried refuse. A preliminary test of the GPR method indicated that it did not provide a distinct difference between native materials and buried refuse. The presence of the underground utilities also complicated the GPR data. Therefore, the GPR method was not pursued further.

Preliminary evaluation of the shallow electromagnetic method (Dual-EM instrument; effective to a depth of 18 feet) indicated that a reasonable change in EM conductivity could be observed between the native materials and the refuse based on the boring and test pit information.

The Dual-EM data were recorded along lines that run approximately perpendicular to the West Perimeter Road. The lines were spaced at 50- to 70-foot intervals using a surveyor's wheel and heading north along the road. Line 0 N is located along the north edge of the entrance to the site. Each survey line was marked at 10-foot intervals using a 300-foot tape measure and pink paint and/or PVC pin flags. The beginning (Station 0') of most of the lines is located at the chain link fence along the west edge of the grassy area about 30 to 50 feet west of the West Perimeter Road. GPS coordinates were recorded at Station 30E and 90E along each line and provided to Aspect Consulting to incorporate the line locations into the site map.

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One Dual-EM line was proposed to run north-south, 20 feet west of the chain link fence, if access conditions allowed. This area has very heavy brush and large trees and was not accessible and therefore, this line was not included.

Geophysical Results, West Perimeter Road Area

The interpretation of the Dual-EM data was difficult due to the interference from utilities and the fence on the west side of the road. One utility appears to run along the west edge of the road, and another a few feet east of the chain link fence that is located at Station 0E for most of the lines. Delineation of the western limit of refuse was not possible. The data do provide information on the northern and southern extent of the refuse below the road, and also are interpreted to indicate thicker refuse to the east of the road.

The interpretation relied primarily on the Vertical Conductivity Data (milliseimens / meter, or mS/m), which has an effective depth of about 18 feet and is shown by the blue data points. General landfill refuse has a higher electrical conductivity than the native sand and gravel and fill material at the site.

Figure 1 (West Perimeter Road Area, Dual-EM Interpretation Results Map) presents the data as shaded areas with similar conductivity values. Borings and test pits with observed refuse are in red, and those in blue did not encounter refuse. **Appendix B** shows all of the data profiles for the Dual-EM survey lines in the West Perimeter Road Area. Nearby boring or test pit information are superimposed on the data profiles. The road and the center of the topographic low area to the east of the road are also shown on the profiles.

The region on the east side of the West Perimeter Road Area with conductivity values above 20 mS/m (red shaded area) is interpreted to be an area with very thick refuse, primarily associated with the main landfill. To the west of this thick refuse zone is an area with conductivity values above 10 mS/m (yellow shading). This area is interpreted to indicate a thinner zone of refuse, perhaps related to other stages of burial outside the main landfill area. This area extends below the West Perimeter Road and correlates well with the refuse observed in borings in the road. While these changes in conductivity are interpreted to provide some information on the relative thickness of the refuse, an accurate estimate of the thickness or depth of the refuse cannot be determined based on the Dual-EM data alone.

The lower conductivity values on the north and south ends of the survey area below 10 mS/m (green shading) generally correlate with the absence of refuse observed in the nearby borings and test pits. To the west of the West Perimeter Road, the data is complicated by the utilities and fence, as observed in the rapid changes in the data. Negative conductivity values (blue shading) indicate underground utilities. The fence on the west side typically causes very high values (red shading). The western extent of the refuse could not be interpreted from the conductivity data in this area due to the interference.

Other collected Dual EM data include the EM in-phase and Horizontal Conductivity data, but these data were not found to be useful in the interpretation of refuse extent. The EM in-phase data (parts/thousand) is better suited for locating large metal objects such as storage tanks or large metal debris. The Horizontal Conductivity mode data provides better information if the instrument can be towed close to the ground, but that requires a smooth, flat ground surface. The instrument was worn on the hip as is standard for surveys over irregular terrain, so the horizontal mode data (effective depth of 9 feet) was not helpful.

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SOUTH SLOPE AREA SURVEY

The South Slope Area is an area of refuse that extends to the south of the 2001 Closure Area. The borings, monitoring wells, and test pits in this area indicate depths to the top of the refuse ranging from about 4' to 18'. The base of the refuse has been observed ranging from about 16' to 48' deep. This area has an underground electrical power line that runs east-west along the north side of the Leachate Lagoon and then turns south towards a vault to the north of the South Siltation Pond. This power line did affect the data to some degree, but is not believed to have seriously affected the interpretation results.

Geophysical Methodology, South Slope Area

A magnetometer/gradiometer survey (magnetometer survey), EM-34 conductivity meter survey, and electrical resistivity imaging were run on the South Slope Area to determine the horizontal extent of refuse and provide some relative information on the depth of burial. These methods were selected based on the greater depth of refuse in this area.

A magnetometer survey was performed over and beyond the area of previously mapped refuse to provide more detail on the extent of the refuse. The magnetometer measures anomalies related to buried ferrous material within the refuse. The locations of the magnetometer survey lines are presented on **Figure 2**. Detailed magnetic data (total field and vertical gradient data) were obtained at approximate half-foot intervals along lines spaced about 50 feet or less in the areas of interest. In the main area to the east of the Leachate Lagoon, the lines were oriented in two directions (north-south and east-west). West of the lagoon, most of the lines were oriented east-west. The heavy brush and steep terrain in the southern end of the site limited data collection in this area. One line was run at an angle along the crest of the slope above the South Siltation Pond. Magnetometer data were also recorded along the ERI Profile Line that runs NW to SE across the northern portion of the site.

An electromagnetic survey using an EM-34 Conductivity Meter with a 10-meter coil spacing was used to record horizontal and vertical dipole data (effective depths of 25 and 45 feet, respectively) over the eastern portion of the site. The EM-34 lines are shown on **Figure 3**.

Both the magnetometer and the EM-34 methods provided good information on the lateral extent of buried landfill refuse. In addition, higher magnitude anomalies observed in the magnetometer and conductivity data may be correlated to a greater relative thickness of the refuse. Due to the greater depth of refuse in this area, the Dual-EM instrument (effective depth of 18 feet) was not used.

One Electrical Resistivity Imaging (ERI) profile was located running approximately east-west across the South Slope Area in an attempt to provide better information on the possible depth of burial of the refuse. The ERI profile correlated very well with the depth of the base of the refuse observed in several borings and wells, although it was not able to delineate the depth to the top of the refuse.

None of the employed methods were found effective at delineating the thickness of cover soil overlying the refuse. The cover materials above the refuse may either be too thin to be modelled properly with the ERI method, or are of finer-grained materials (such as silt, clay, and organics) and have low electrical resistivity properties similar to the refuse. The native material below the refuse observed in the borings is primarily sand and gravel, which has a much higher resistivity and provides a good contrast with the refuse.

The geophysical surveys were referenced to a grid system established using 300-foot tape measure and pink spray paint and/or PVC pin flags. The locations of most of the grid points were obtained with a sub-meter GPS system and provided to Aspect Consulting to incorporate into the existing site maps.

Magnetometer Survey Results

The magnetic survey results, the reference grid system (yellow lines), the magnetic survey lines (black dashed lines) and the various reference features at the South Slope Area are shown on **Figure 2**. The approximate location of the abandoned 12-inch SD pipe is shown as adapted from another site reference map, and this location also corresponds to a magnetic anomaly observed in the data along this path.

The magnetic response is characterized into four different anomalous zones based on the magnitude of the total magnetic field (measured in nanoteslas, or nT). Interpretation of the data relied on analysis of each of the data profile lines and the data map provided on **Figure 4** (Total Magnetic Field Data Map). This figure shows the data points with various colored symbols for various ranges of values. Lower values are dark blue to green, moderate values are browns and yellow, and the higher values are indicated by red and magenta. The higher values may be related to a greater thickness of refuse, or a greater concentration of metallic material.

Appendix C shows the magnetometer data profiles. The total magnetic field from the top sensor (blue data points) were the primary data used for the interpretation. Values of about 53,500 nT are the background values at this site. Values generally between 53,500 and 54,000 nT are categorized as moderate anomalous zones, and about 54,000 nT are considered high anomalous zones. Probable sources of interference (fences, vaults, utilities, etc.) are shown with respect to the higher frequency anomalies that indicate surface features or features at shallow depths.

The interpretation results on **Figure 2** indicate that the high anomalous zone is interpreted to have two different lobes trending south and south-east in the main portion of the South Slope Area. However, the lower magnitude values between these two lobes is in the vicinity of the underground power line in this area, which will have some influence on the magnetic data and lower the values in proximity to the power line.

The moderate anomalous zone (blue line) probably indicates the horizontal extent of the refuse for most of the area, and correlates well with the EM-34 data results in most areas. The extent of refuse along the southern end of the site is less clear. Interference from the pump station vaults near coordinate 450E, 150N make interpretation of the data slightly more difficult in this area. This southern area has a less distinct change in the data and is characterized by a low anomalous zone (dark green), which may indicate a thin layer of buried refuse. Line 420E extends to the south down a steep hill towards the South Siltation Pond. Along this slope, the magnetometer data appear to indicate scattered shallow debris.

The fence along the north and west sides of the South Slope Area greatly affected the data. Along the west side however, the fence is far enough away from interpreted refuse that it does not affect the interpretation, with the exception perhaps in the northwest corner of the site along Line 350N, which also has the power line in the area. However, I believe the interpretation is still reasonable in this area as well.

In the northeastern portion of the site, the effect of the fence (and perhaps underground utilities in this area) may have complicated the interpretation of the magnetic data. These interferences appear to cause the magnetic values to be too low, in spite of being relatively close to borings with a large thickness of refuse. The extent of the moderate anomalous zone in this area is queried, indicating that it is questionable. The extent of the EM-34 moderate anomalous zone is shown in this area by the light blue line and appears to be a more reasonable boundary for the refuse based on the nearby boring information.

Electromagnetic (EM-34) Survey Results

EM-34 conductivity data were recorded at 5-meter (approximately 16-foot) intervals along numerous lines oriented east-west across the main portion of the South Slope Area. One EM-34 line was oriented north-south extending down towards the South Siltation Pond. The data were recorded with a 10-meter coil spacing in both the horizontal and vertical dipole mode. The horizontal mode has more of a response near the surface, and has an effective depth of about 25 feet at this spacing. The vertical mode has a maximum response at a depth of about 16 feet, and an effective depth of about 45 feet. The vertical mode is also more susceptible to interference from buried metal and utilities.

Figure 3 shows the EM-34 Survey Interpretation Results. The black dashed lines indicate the locations of the various EM-34 survey lines. The EM-34 data is characterized into four different anomalous zones based on the magnitude of the horizontal and vertical dipole data mS/m. The horizontal and dipole data were similar in magnitude over most of the area. The horizontal data was smoother and not as affected by underground utilities, and was used for much of the interpretation near the edge of the interpreted refuse.

The EM-34 data maps are presented on **Figure 5** (horizontal dipole mode) and **Figure 6** (vertical dipole mode) and represent the data in a similar manner as the magnetic data. Some of the increase in magnitude along Line 350N between Borings VTP- 4 and VTP-5 may be caused by the nearby underground power line running parallel near this alignment.

Appendix D shows the EM-34 data profiles. The interpreted edges of the refuse are shown on each profile, as well as possible sources of interference on the data. The vertical dipole data shows greater variations as it is more susceptible to buried metal and utilities.

For the interpretation results (**Figure 3**), the high anomalous zone (indicated in red) was observed in both the horizontal and vertical data. The horizontal extent of this zone is based on the deeper penetrating vertical data, and may indicate a greater thickness of refuse.

The moderately high anomalous zone **(Figure 3)** is indicated by an orange line and may indicate a moderately thick layer of refuse. The moderate anomalous zone (blue line) shows the interpreted lateral extent of the refuse for most of the area. In the southern portion of the site, slightly elevated conductivity values are shown by the questionable low anomalous zone (green line), which may indicate a relatively thin layer of refuse. This area is also in the vicinity of the large vaults and the edge of the steep hill to the south, which may have also affected the data. However, the EM-34 and magnetometer results are in general agreement in this area, indicating the strong possibility of small amounts of buried refuse in portions of the questionable low anomalous zone.

Electrical Resistivity Imaging (ERI) Profile Results

The ERI data were recorded with an IRIS Syscal Pro Electrical system using 48 electrodes spaced at 10-foot intervals along a straight line. The location of the ERI line is shown on **Figures 2 and 3**, and also on **Figures 4-6,** along with selected electrode positions.

Data were recorded using the Schlumberger Array method. This array uses two outer electrode locations to generate the electrical current. Two inner electrode locations are used to measure the voltage. The instrument automatically records data from hundreds of iterations of current-source electrode and voltage-receiving electrode combinations. Closely spaced electrode combinations provide detailed shallow information, while combinations with larger spacings provide greater depth but less resolution. For final interpretation, the apparent resistivity values are plotted against electrode spacing, and then interpreted using RES2D Inverse, a commercially available computer-assisted modeling software package for resistivity data.

The electrical resistivity model profile is shown on **Figure 7**. The electrode locations are shown along the ground surface. Elevation changes along the line were obtained with a hand level, and referenced to the known elevation of MW-33 near Electrode 18. The ground surface is estimated to be within 1 foot of the actual elevation across the profile. The depth scale on the right side of the figure is in feet, and is exaggerated with respect to the horizontal scale.

The data contours show the model results and are logarithmic. The model indicates lower resistivity materials near the surface (blue and green colors), and higher resistivities (orange and red colors) at depth. The results from nearby borings show the top of the refuse indicated by a thin horizontal line, and the base of the refuse is shown by a bold horizontal line. The base of the highly variable low resistivity zone correlates well with the base of refuse observed in Borings VTP-5D (near Electrode 10) and the interpolated depth at Electrode 19 which is approximately midway between MW-33 and VTP4S. VTP-2D is near Electrode 26, and the boring indicates the base of refuse is greater than 25 feet deep. The model indicates a depth to the interpreted base at about 40 feet deep near Electrode 26.

The top of the refuse is not clear from the ERI profile data, which is either a result of the overlying soils being relatively thin, and/or their electrical properties being similar to the refuse. The more consistent native materials at depth have a much higher electrical resistivity, and probably indicate sand and gravel.

Figure 8 shows a simple profile of the surface elevation and interpreted depth to the base of the refuse. **Table 1** shows the data used to create Figure 8, and includes the interpreted depth and elevation below each electrode. The deepest portion of the interpreted base of refuse is in the vicinity of Electrode 29 with a depth of about 42 feet. This deeper region also coincides with a high magnetometer anomalous zone and a moderately high to high EM-34 anomalous zone. However, the correlation may also be due to the increased concentration of conductive refuse such as metallic materials. The eastern boundary of the suspected refuse is not easily observed in the ERI profile. The underground 12-inch SD pipe is located near Electrode 37 and may be interfering with the ERI data in this area.

The eastern extent of the refuse interpreted from the magnetometer data is in the vicinity of ERI Electrode 37. Due to the possible interference in this area from the SD pipe, the base of the interpreted refuse is queried in this area to fit with the data from the magnetometer and

EM-34 surveys. The very low resistivity values to the east of Electrode 37 may also be caused by natural changes in the soils including increased moisture or finer-grained materials.

Integrated Interpretation Results, South Slope Area

Figure 9 (Integrated Interpretation Results Map) shows the interpreted extent of refuse and an area with possible greater thickness in the South Slope Area. This map presents an overall, general interpretation of the data from the magnetometer and EM-34 surveys and the resistivity profiling.

The probable limit of refuse (blue line) is interpreted primarily from the magnetometer data. On the east side and the northwest corner of the site, the probable limit is based on the moderate magnetic anomalous zone. On the south side of the site, the probable extent of refuse is interpreted based on the extent of the low magnetic anomalous zone, which may indicate thinner amounts of refuse.

The questionable limit indicated by the green line is based on the limited magnetometer and EM-34 data in the area, but is a worst-case estimate on the extent of buried refuse. This area may include minor amounts of shallow refuse or debris on the slope above the South Siltation Pond.

A broad linear feature (orange line) is interpreted from the data and may indicate the deepest portion of a buried valley that runs generally south towards the South Siltation Pond. This feature is based primarily on the EM-34 data and the electrical resistivity profile. Some refinement of the feature was made using the magnetometer results and the boring information.

While Figure 9 provides a helpful summary, Figures 3 and 4 (magnetometer and EM-34 results, respectively) provide more detailed information to guide any additional investigations.

SUMMARY

The survey in the West Perimeter Road Area provides some information on the northern and southern extent of the refuse below the road. The interpretation results west of the road were complicated by the numerous sources of interference, which prevented delineation of the west edge of refuse.

In the South Slope Area, the geophysical results correlate fairly well with the known boring information, as well as the various geophysical methods (magnetometer, EM-34, and ERI) correlating with each other. The areas with moderate to high anomalous zones indicate a high confidence for the presence of buried refuse. Questionable and/or low anomalous zones are less distinct and may indicate smaller amounts of refuse and/or natural changes in subsurface conditions.

The level of detail for the various surveys was reasonable with regard to the size of the area of refuse and the budget constraints of the investigation. While use of these various methods can help evaluate and categorize areas of concern, only intrusive methods such as test pits, borings, or other means can ultimately characterize the subsurface conditions.

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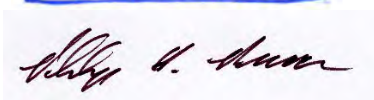
Please contact me if you have any questions or comments regarding this information, or if you require further assistance.

Respectfully submitted,



Philip H. Duoos
Geophysical Consultant

ATTACHMENTS

Geophysical Investigation Report
Vashon Closed Landfill
King County Project No. 090057.310.1.7.7

Figure 1: West Perimeter Road Area, Dual-EM Interpretation Results Map

Figure 2: South Slope Area, Magnetometer Interpretation Results Map

Figure 3: South Slope Area, EM-34 Interpretation Results Map

Figure 4: South Slope Area, Magnetometer Data Map

Figure 5: South Slope Area, EM-34, Horizontal Dipole (25-foot depth) Data Map

Figure 6: South Slope Area, EM-34, Vertical Dipole (45-foot depth) Data Map

Figure 7: South Slope, Electrical Resistivity Imaging (ERI) Model Contour Profile

Figure 8: South Slope, Electrical Resistivity Imaging (ERI) Depth Profile

Figure 9: South Slope Area, Integrated Interpretation Results Map

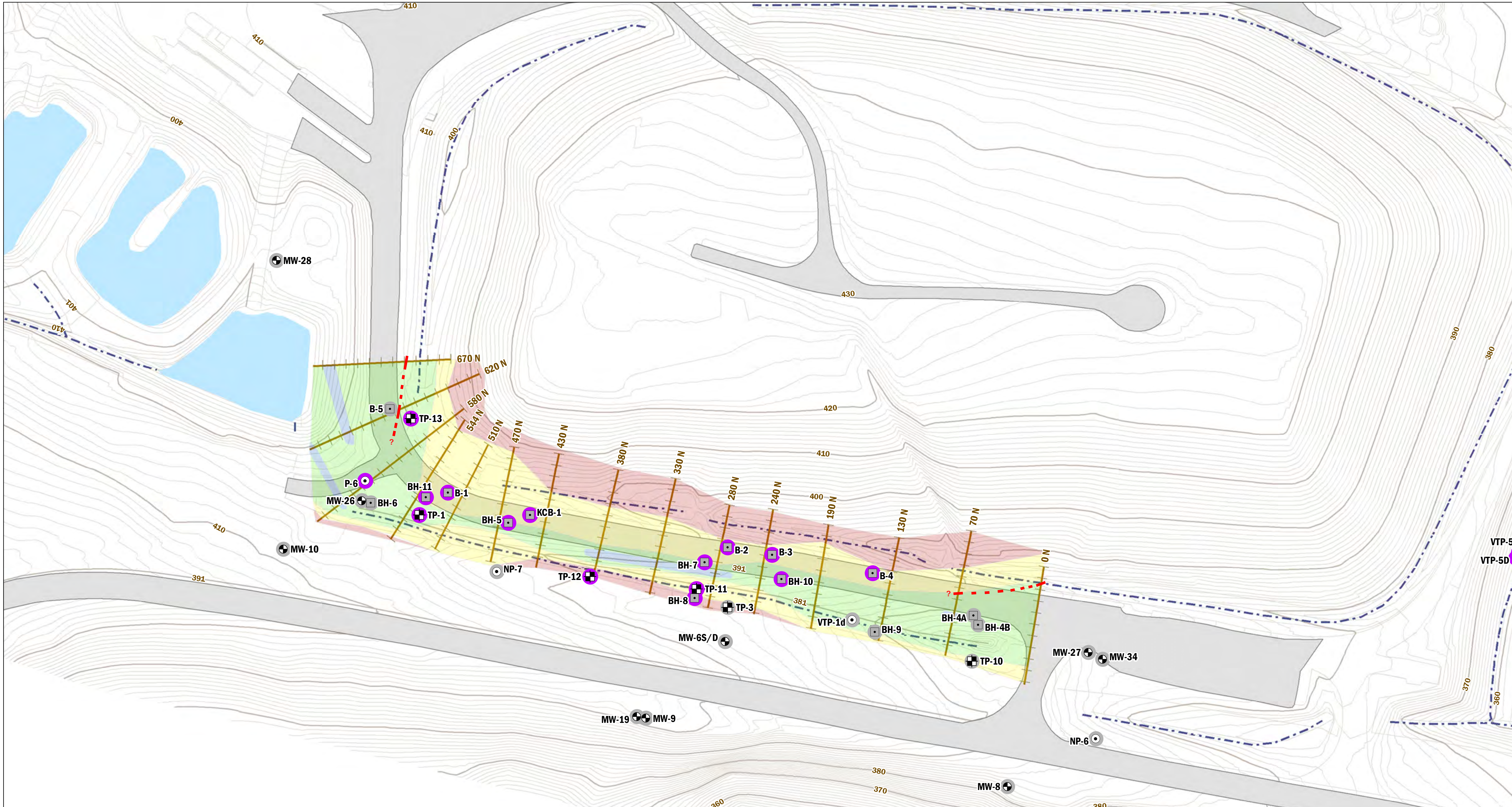
Table 1: South Slope, Electrical Resistivity Imaging (ERI) Depth Data Table

Appendix A: Description of Techniques

Appendix B: West Perimeter Road, Dual-EM Data Profiles

Appendix C: South Slope Area, Magnetometer Data Profiles

Appendix D: South Slope Area, EM-34 Conductivity Data Profiles



Boring	Exploration with Refuse Present	Ditch	<0 mS/m	Interpreted Northern and Southern Extent of Refuse
Gas Probe	Exploration with No Refuse Present	Road	0-10 mS/m	
Monitoring Well		Geophysical Survey Grid	10-20 mS/m	
Test Pit	Pond	Distance Marker (10 ft)	> 20 mS/m	

Notes:

Geophysical Survey Grid locations approximate.

Locations of KCB-1 and B-1 from CAD files provided by KCSWD (12/11/17). Location varies from original source.

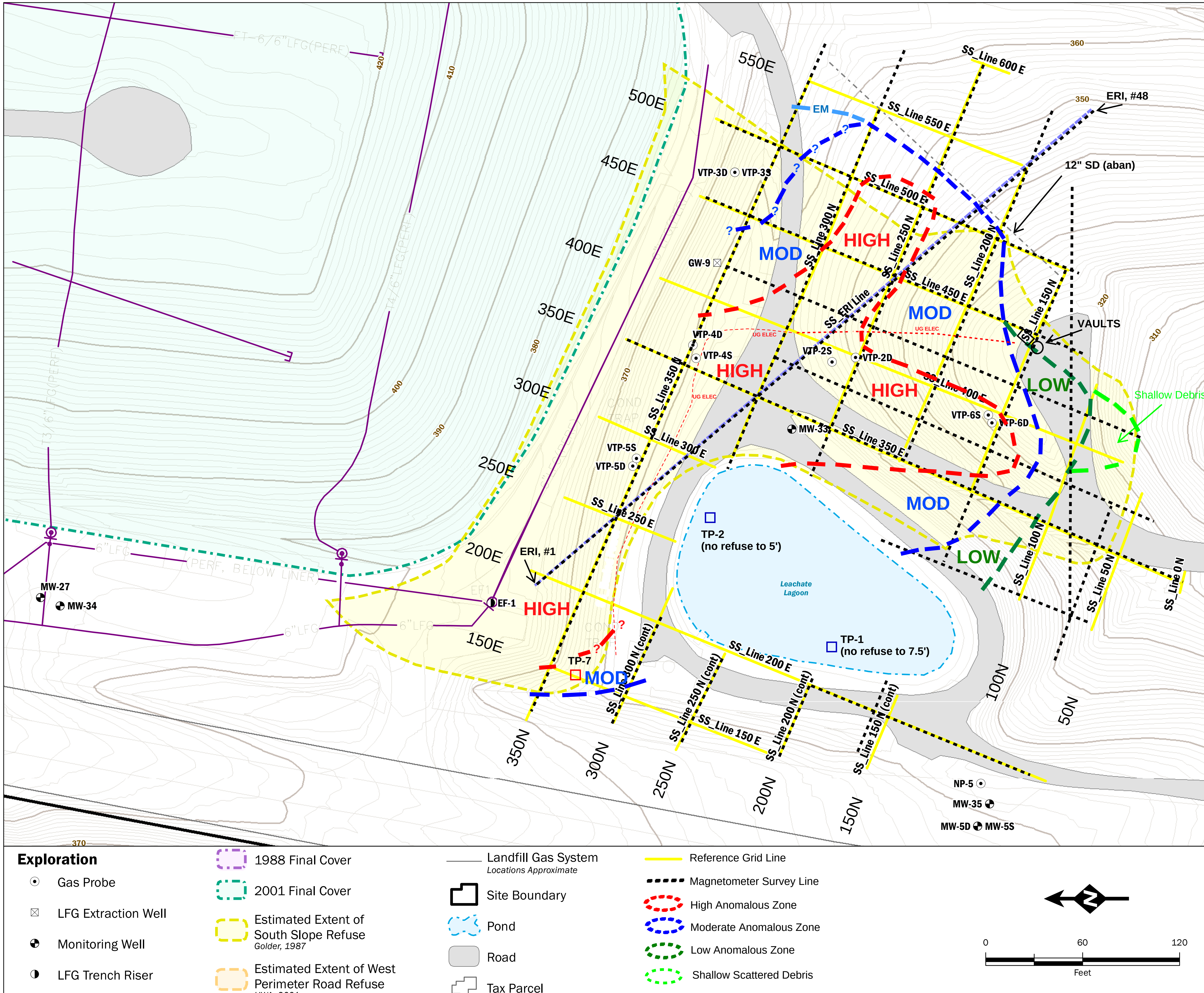
0 80 160

Feet

WEST PERIMETER ROAD AREA DUAL-EM SURVEY INTERPRETATION RESULTS MAP

Vashon Island Closed Landfill
King County, Washington

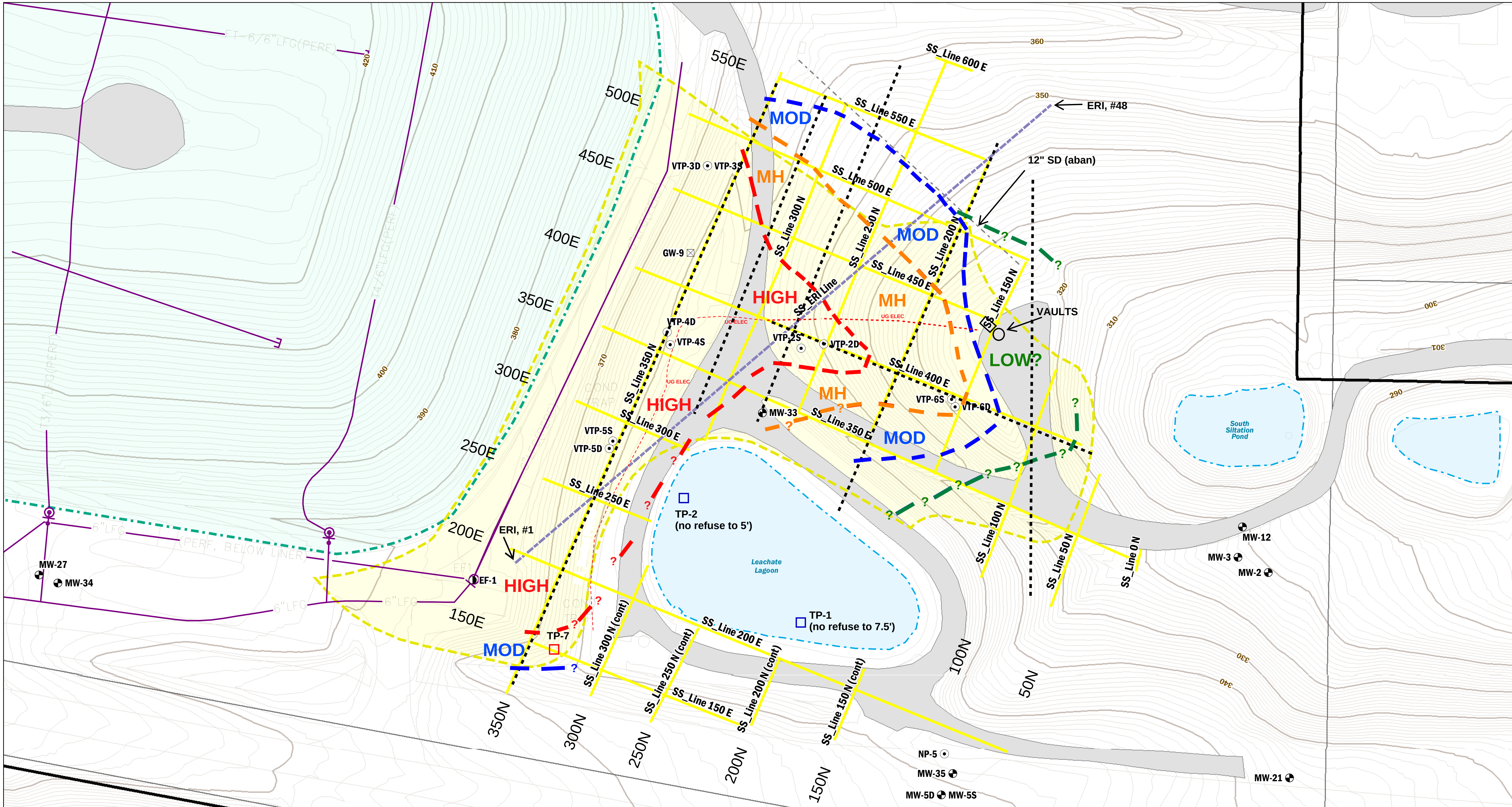
King County | Aspect CONSULTING | JAN-2018 | BY: AHP / RAP / PPW | FIGURE NO. 1



MAGNETOMETER SURVEY INTERPRETATION RESULTS MAP SOUTH SLOPE AREA

Vashon Island Closed Landfill
King County, Washington

King County | Aspect CONSULTING | JAN-2018 | BY: AHP / RAP | FIGURE NO. 2



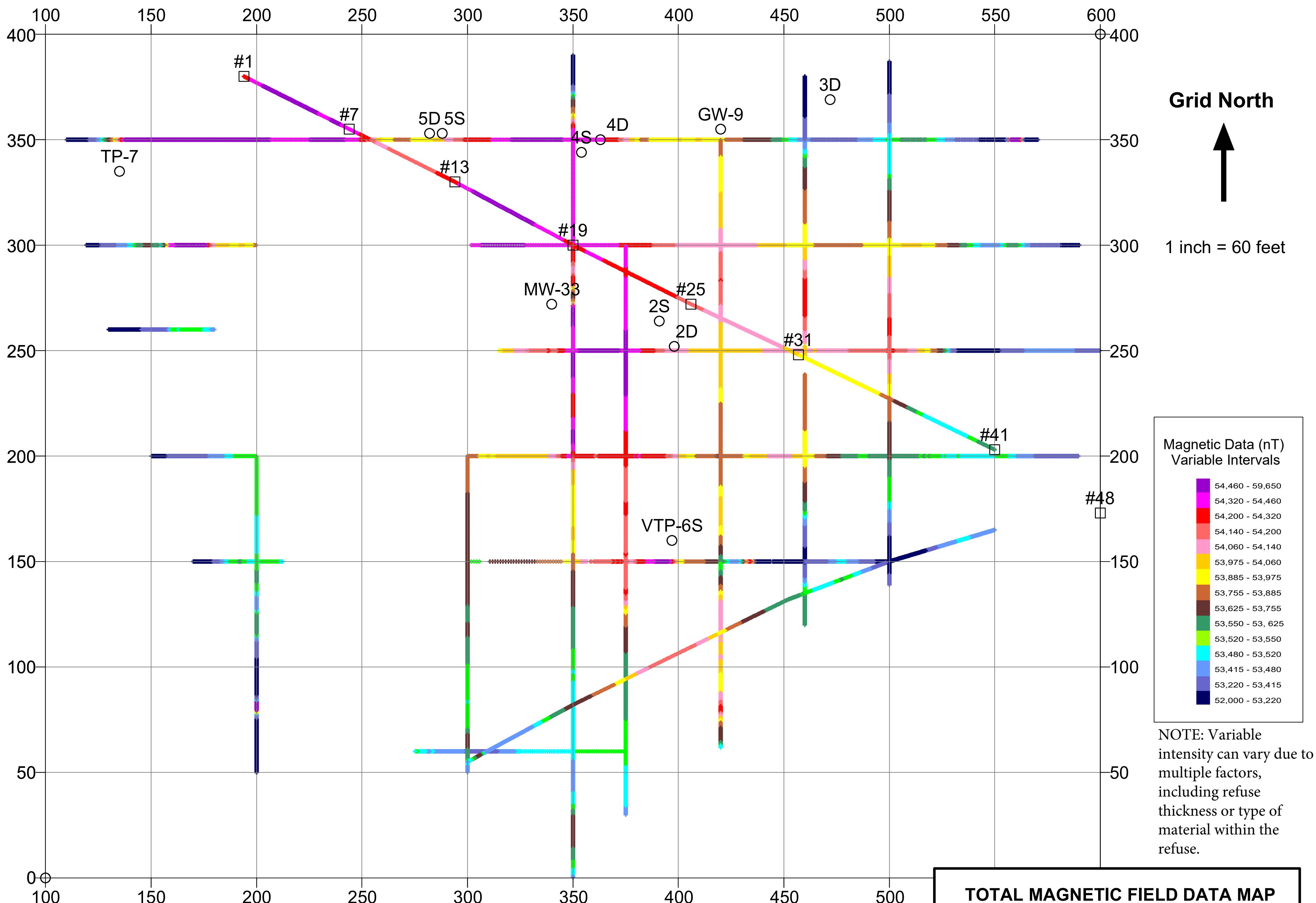
Exploration

- Gas Probe
- LFG Extraction Well
- Monitoring Well
- LFG Trench Riser
- 1988 Final Cover
- 2001 Final Cover
- Estimated Extent of South Slope Refuse *Golder, 1987*
- Estimated Extent of West Perimeter Road Refuse *HWA, 2001*
- Landfill Gas System *Locations Approximate*
- Site Boundary
- Pond
- Road
- Tax Parcel
- Reference Grid Line
- Electromagnetic (EM-34) Survey Line
- High Anomalous Zone
- Moderate High Anomalous Zone
- Moderate Anomalous Zone
- Questionable Low Anomalous Zone

0 60 120
Feet

SOUTH SLOPE AREA
ELECTROMAGNETIC (EM-34) SURVEY
INTERPRETATION RESULTS MAP
Vashon Island Closed Landfill
King County, Washington

King County | Aspect CONSULTING | JAN-2018 BY: AHP / RAP | FIGURE NO. 3



Philip H. Duoos, Geophysical Consultant for Aspect Consulting, LLC

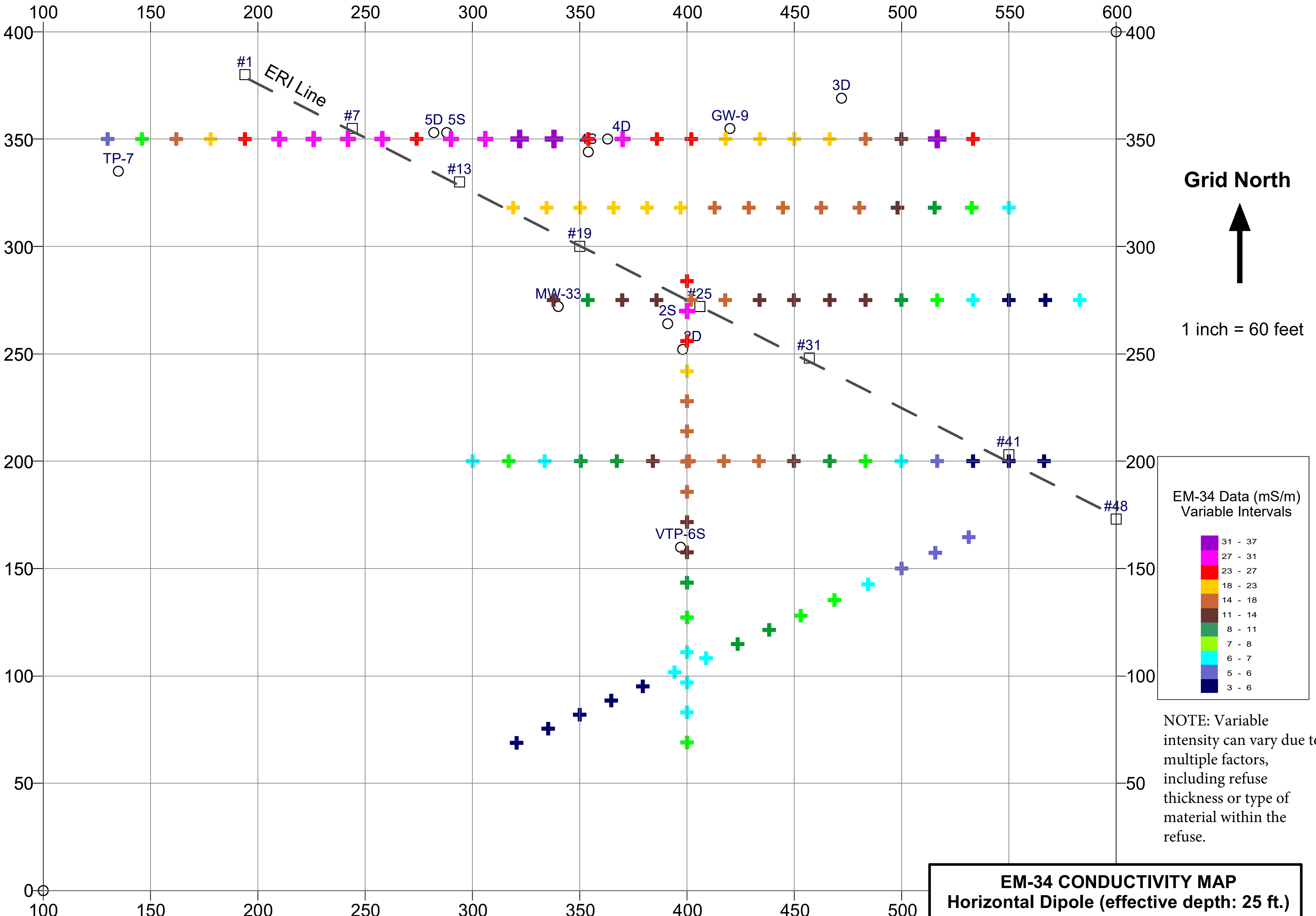
Project No.: 090057.310.1.7.7

TOTAL MAGNETIC FIELD DATA MAP

Vashon Island Landfill
South Slope Area

January, 2018

FIG. 4



NOTE: Variable intensity can vary due to multiple factors, including refuse thickness or type of material within the refuse.

Philip H. Duoos, Geophysical Consultant for Aspect Consulting, LLC

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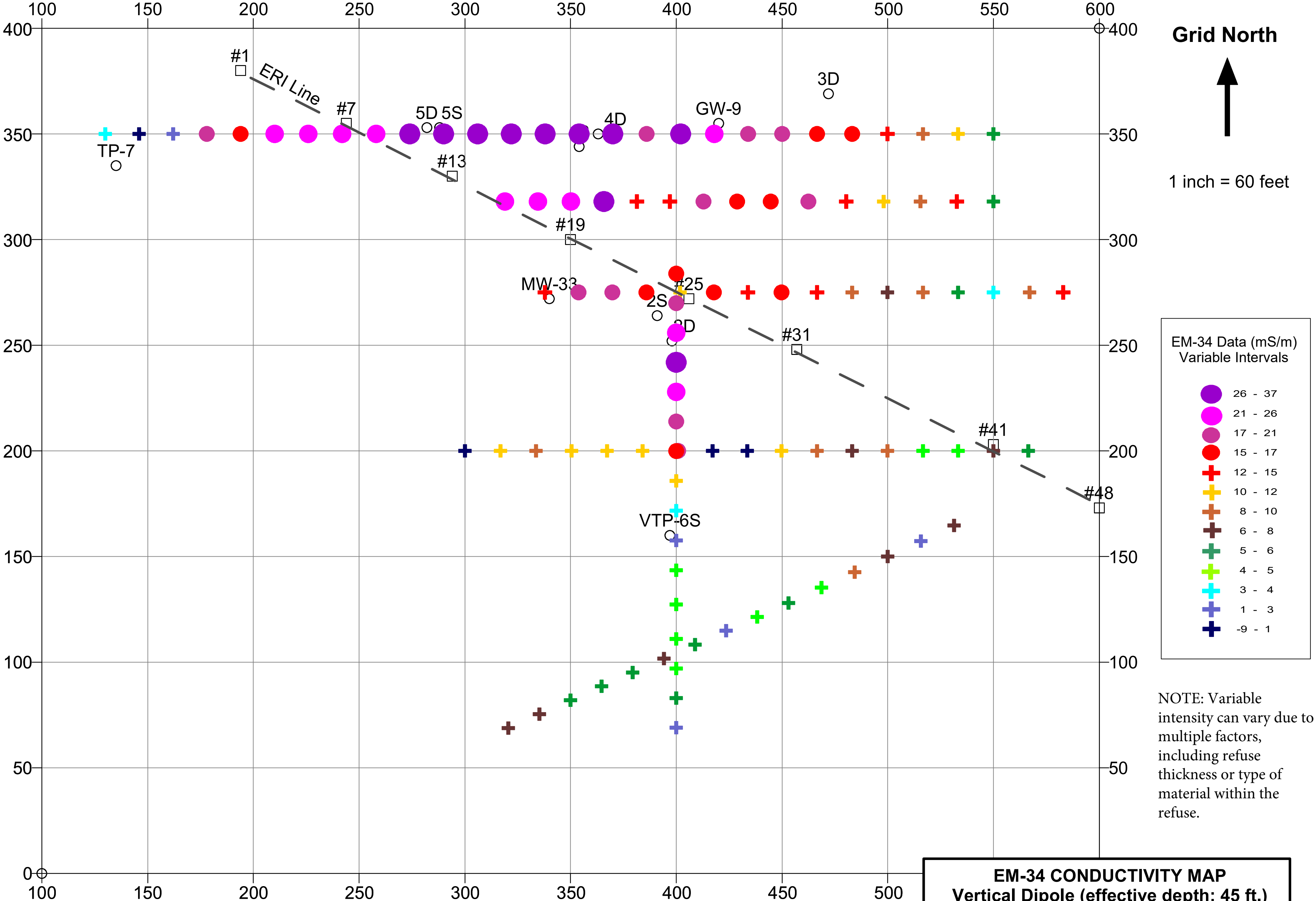
EM-34 CONDUCTIVITY MAP
Horizontal Dipole (effective depth: 25 ft.)
Vashon Island Landfill
South Slope Area

January, 2018

FIG. 5



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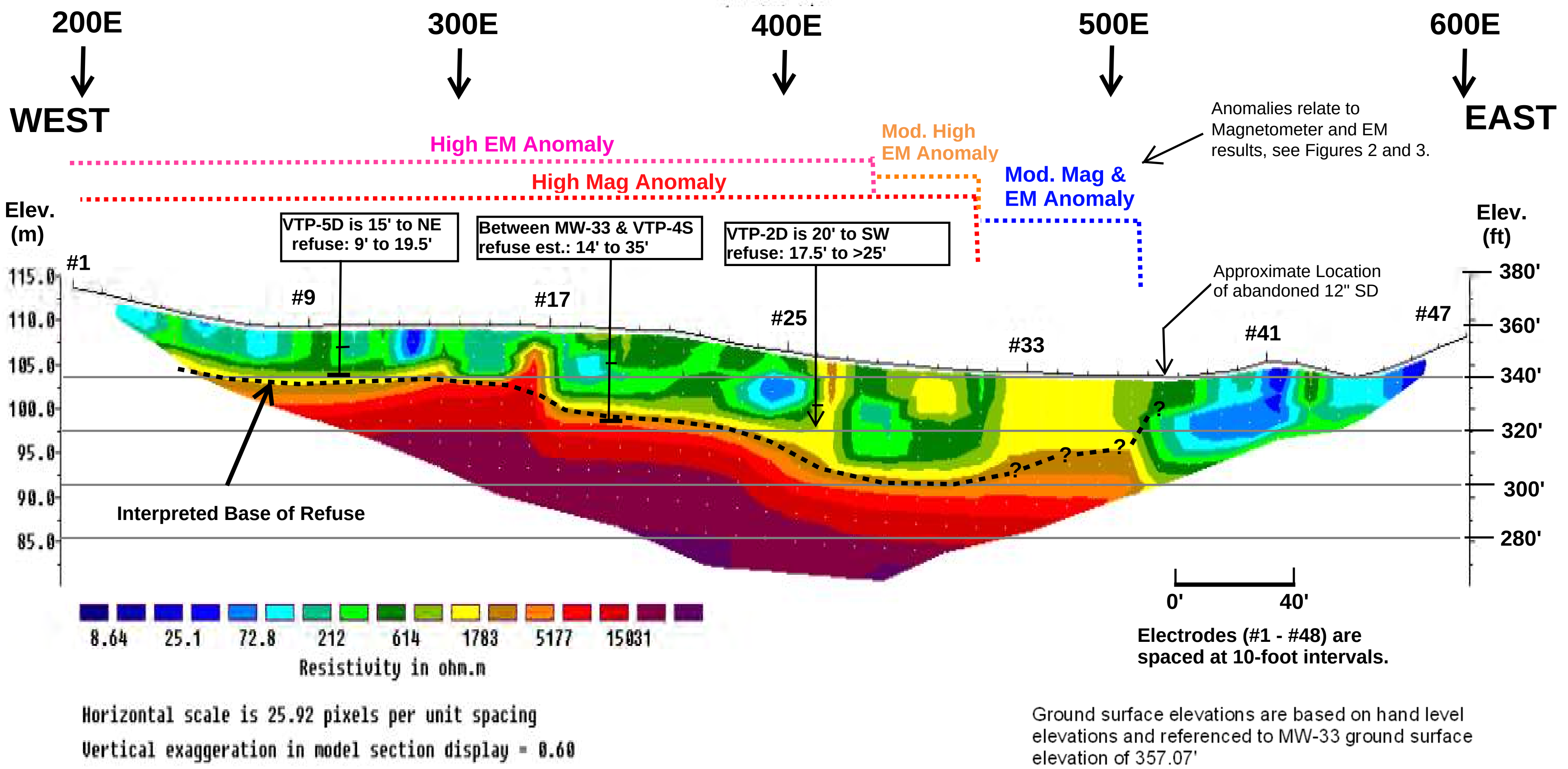
EM-34 CONDUCTIVITY MAP
Vertical Dipole (effective depth: 45 ft.)
Vashon Island Landfill
South Slope Area

January, 2018

FIG. 6



Philip H. Duoos, Geophysical Consultant
for Aspect Consulting, LLC

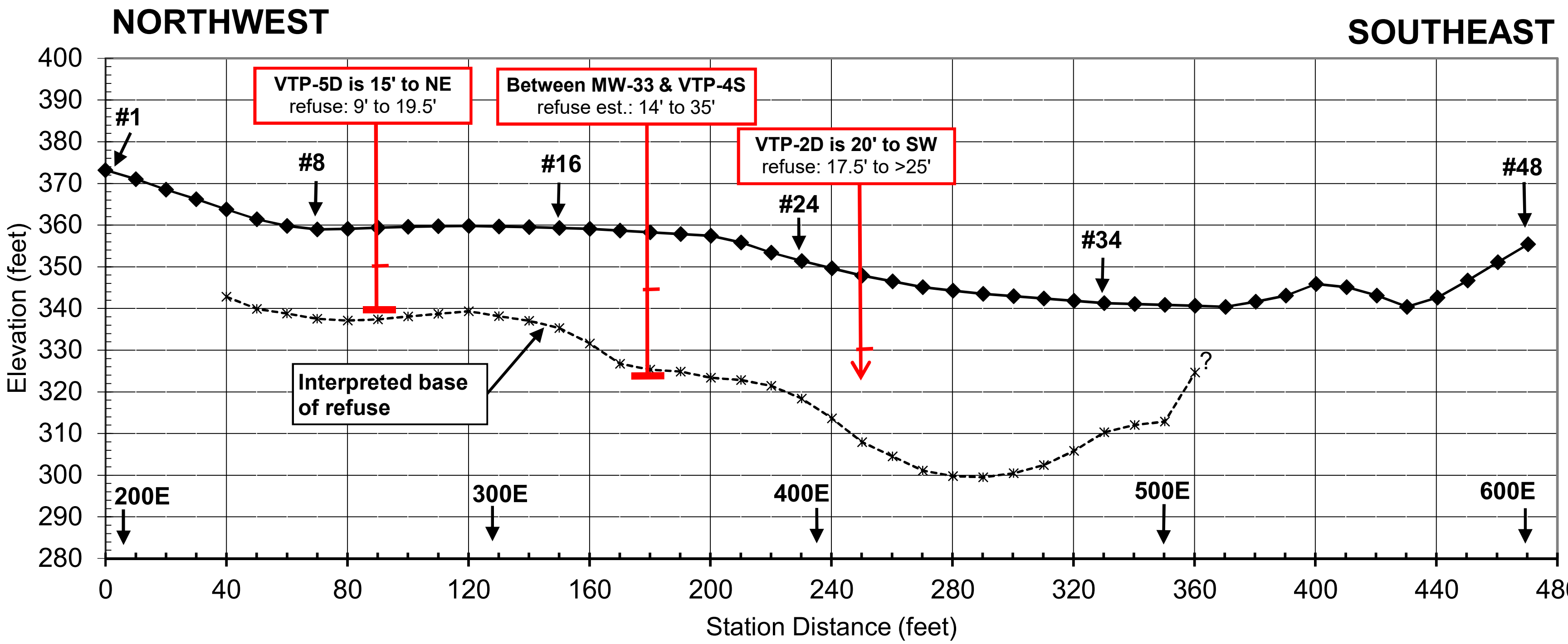
Project No. 090057.310.1.7.7

ELECTRICAL RESISTIVITY IMAGING PROFILE

VASHON ISLAND LANDFILL
SOUTH SLOPE AREA

January, 2018

FIGURE 7



Not to Scale

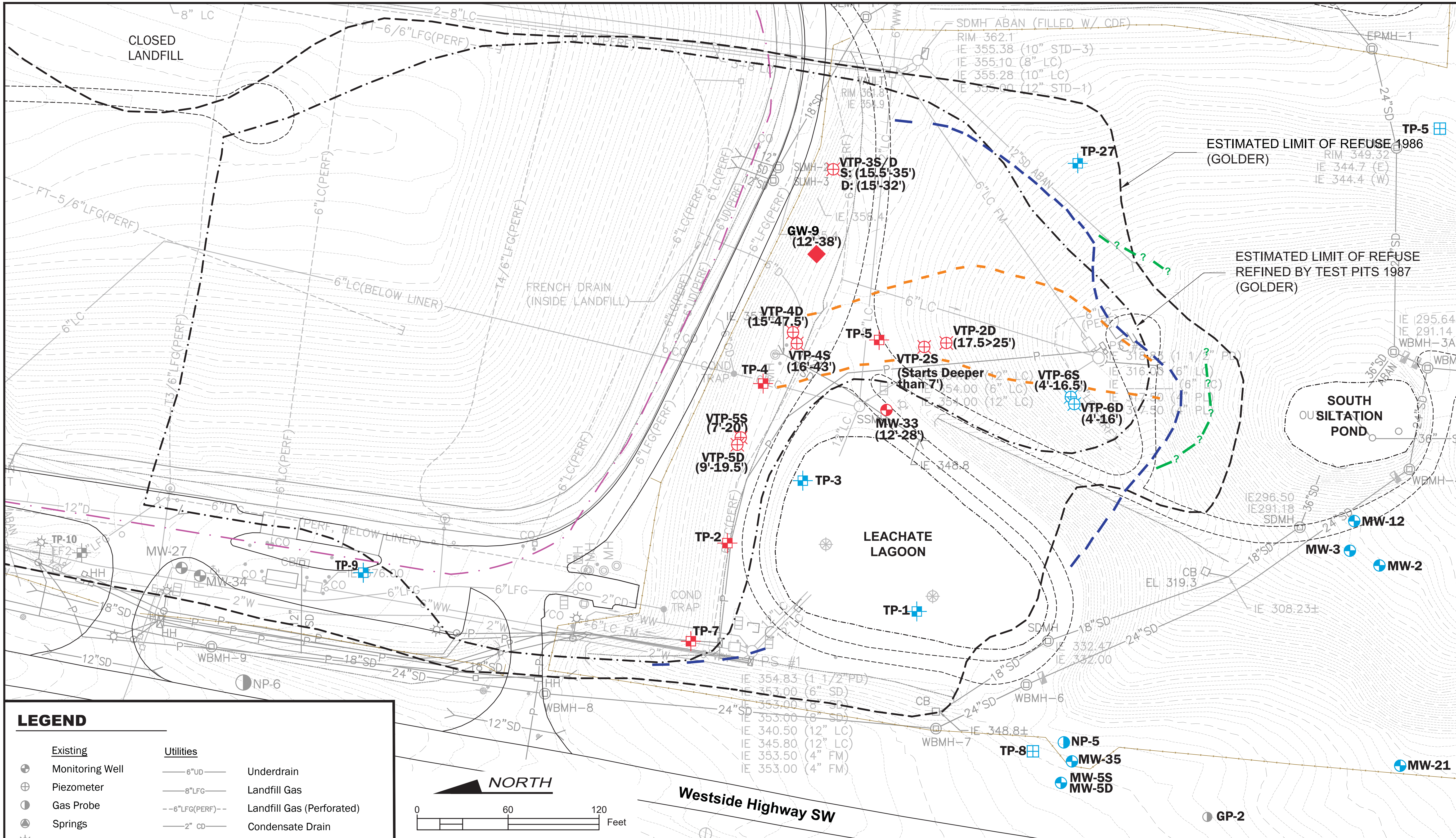
Ground surface elevations are based on hand level elevations and referenced to MW-33 ground surface elevation of 357.07'

Vashon Landfill Investigation
Philip H. Duoos, Geophysical Consultant
Job. 1262-17, January 2018

ELECTRICAL RESISTIVITY IMAGING INTERPRETATION RESULTS DEPTH TO BASE OF REFUSE

South Slope Area

FIGURE 8



LEGEND

Existing		Utilities	
Monitoring Well		6"UD	Underdrain
Piezometer		8"LFG	Landfill Gas
Gas Probe		6"LFG(PERF)	Landfill Gas (Perforated)
Springs		2" CD	Condensate Drain
Decomissioned		P	Underground Electric
Gas Extraction Well			LFG Trench Riser
Temporary Gas Probe		GW1	LFG Extraction WellBranch Pipe
Boring		BV1	Station
Test Pit		MV1	Gas Manifold Wye Station

Cover Limit (2001)

Geophysical Interpretation Results
- Probable Limit of Refuse
- Questionable Limit
- Buried Valley

Depth of Refuse Below Ground Surface
- (Blue indicates no refuse found)
- (Red indicates refuse found)

King County

SOUTH SLOPE AREA
INTEGRATED INTERPRETATION RESULTS MAP

Geophysical Investigation
Vashon Island Landfill, King County, Washington

DATE:	Oct-2017
DESIGNED BY:	BG/EWM
DRAWN BY:	SCC/CMV
REVISED BY:	MS/SCC
PROJECT NO.	090057
FIGURE NO.	9

CAD Path: Q:\King County\090057 Vashon Island Landfill\2017-10 Work Plan\090057-04.dwg 04-Refuse Depths-South Slope || Coordinate System: NAD 1983 State Plane Washington North FIPS 4601 Feet || Date Saved: Oct 30, 2017 3:46pm || User: cvanslyke

Electrode	Station Distance Feet	Surface Elevation	Depth (ft) of Refuse Base	Elevation Refuse Base
1	0.00	373.2	#N/A	#N/A
2	10.01	371	#N/A	#N/A
3	20.01	368.5	#N/A	#N/A
4	30.02	366.2	#N/A	#N/A
5	40.03	363.8	21	342.8
6	50.04	361.4	21.5	339.9
7	60.04	359.8	21	338.8
8	70.05	359	21.5	337.5
9	80.06	359.1	22	337.1
10	90.06	359.35	22	337.35
11	100.07	359.6	21.5	338.1
12	110.08	359.7	21	338.7
13	120.08	359.8	20.5	339.3
14	130.09	359.65	21.5	338.15
15	140.10	359.5	22.5	337
16	150.11	359.3	24	335.3
17	160.11	359.1	27.5	331.6
18	170.12	358.7	32	326.7
19	180.13	358.3	33	325.3
20	190.13	357.85	33	324.85
21	200.14	357.4	34	323.4
22	210.15	355.8	33	322.8
23	220.16	353.4	32	321.4
24	230.16	351.4	33	318.4
25	240.17	349.65	36	313.65
26	250.18	347.9	40	307.9
27	260.18	346.5	42	304.5
28	270.19	345.1	44	301.1
29	280.20	344.3	44.5	299.8
30	290.20	343.5	44	299.5
31	300.21	342.95	42.5	300.45
32	310.22	342.4	40	302.4
33	320.23	341.85	36	305.85
34	330.23	341.3	31	310.3
35	340.24	341.06	29	312.06
36	350.25	340.84	28	312.84
37	360.25	340.62	16	324.62
38	370.26	340.4	#N/A	#N/A
39	380.27	341.6	#N/A	#N/A
40	390.27	343.1	#N/A	#N/A
41	400.28	345.9	#N/A	#N/A
42	410.29	345.1	#N/A	#N/A
43	420.30	343.1	#N/A	#N/A
44	430.30	340.4	#N/A	#N/A
45	440.31	342.6	#N/A	#N/A
46	450.32	346.7	#N/A	#N/A
47	460.32	351.1	#N/A	#N/A
48	470.33	355.4	#N/A	#N/A

TABLE 1
ERI PROFILE RESULTS

APPENDIX A
DESCRIPTION OF TECHNIQUES

MAGNETOMETRY

A magnetometer is a rapid, effective and non-destructive instrument used to locate buried ferrous material (drums, pipes, mineral deposits, archaeological objects, etc.). The instrument is operated and carried by one person, and contains a digital memory for data storage.

Interpretation of magnetometer data includes recognizing and characterizing local changes in the intensity of the earth's magnetic field. Analysis usually involves contouring and profiling the data. The size, shape, and magnitude of an anomaly depends on the mass, orientation and depth of the buried target (drums, mineral deposits, etc.). Modelling of the data can provide a rough estimate of the mass and depth of the target, but is usually reserved for large-scale geological surveys.

Several factors can limit the effectiveness of the magnetometry method including the proximity of cultural interferences (such as buildings, fences and reinforced concrete), and the size, depth and magnetic susceptibility of the target.

ELECTROMAGNETICS (Dual-EM)

The Dual-EM instrument measures subsurface conductance using the principles of electromagnetic induction. The Dual-EM is portable, rapid and non-destructive. It has a fixed boom containing the transmitter and receiver coils so that handling and data gathering is easily achieved by one operator.

Factors which may increase subsurface conductivities include higher moisture content, greater amounts of finer materials, increased clay and/or silt content, soil contamination and/or ground water contamination. The presence of buried metal can also affect the conductivity data. The instrument can also record the inphase component of the signal which increases the ability to detect metal objects (buried pipes, drums, etc.).

Several factors can affect the effectiveness of the EM method including the proximity of cultural interferences (such as buildings, fences and reinforced concrete) the presence of highly conductive materials (such as clays and water), and the size, depth and conductivity contrast of the target.

ELECTROMAGNETICS (EM-34)

The EM-34 measures subsurface conductivity using the same principles of electromagnetic induction as the Dual-EM. The EM-34 is portable, rapid and non-destructive and can explore up to 180 feet deep. It has a separate transmitter and receiver coil, connected by either a 10, 20, or 40 meter cable which determines the general depth range to be explored. In addition to being able to change cable lengths, the operator can change the transmitter and receiver coil orientation (horizontal and vertical dipole modes) to gather subsurface conductivity from two effective depth ranges. The 10 meter cable provides depth penetrations of 25 and 45 feet. Longer cables are more affected by external interferences (powerlines, fences, etc.)

ELECTRICAL RESISTIVITY IMAGING

Electrical resistivity imaging methods use DC Resistivity techniques to measure changes in the electrical properties of the subsurface. This technique employs a series of electrodes in a straight line. A DC current is induced into the ground through the two current electrodes, and the potential difference measured between the two potential electrodes. As the electrode spacing is increased, resistivity data (ohm-meters) is obtained from greater depths. For final interpretation, the apparent resistivity values are plotted against electrode spacing, and is then interpreted using computer-assisted forward modeling.

Factors which may decrease subsurface resistivities include higher moisture content, greater amounts of finer materials, increased clay and/or silt content, soil contamination and/or ground water contamination.

Several factors can affect the effectiveness of the resistivity method including the proximity of cultural interferences (such as underground utilities, fences and reinforced concrete), and the size, depth, and resistivity contrast of the target.

GROUND PENETRATING RADAR

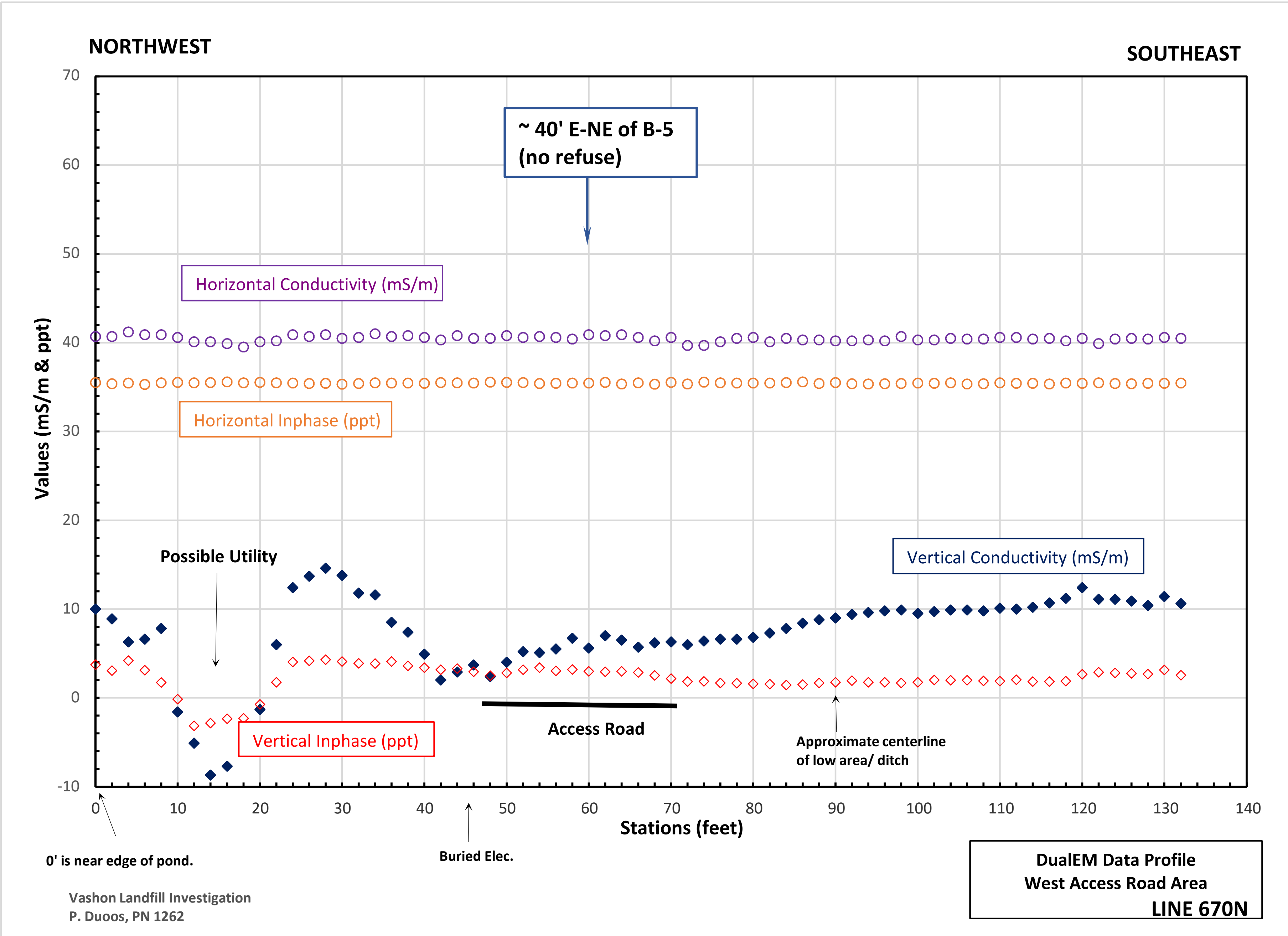
Some of the uses of GPR include locating buried tanks and drums, delineating boundaries of landfills and trenches, and defining voids and geologic stratigraphy. GPR is less affected by cultural interferences such as overhead powerlines, buildings, and fences. GPR can also provide higher resolution of the target in many cases.

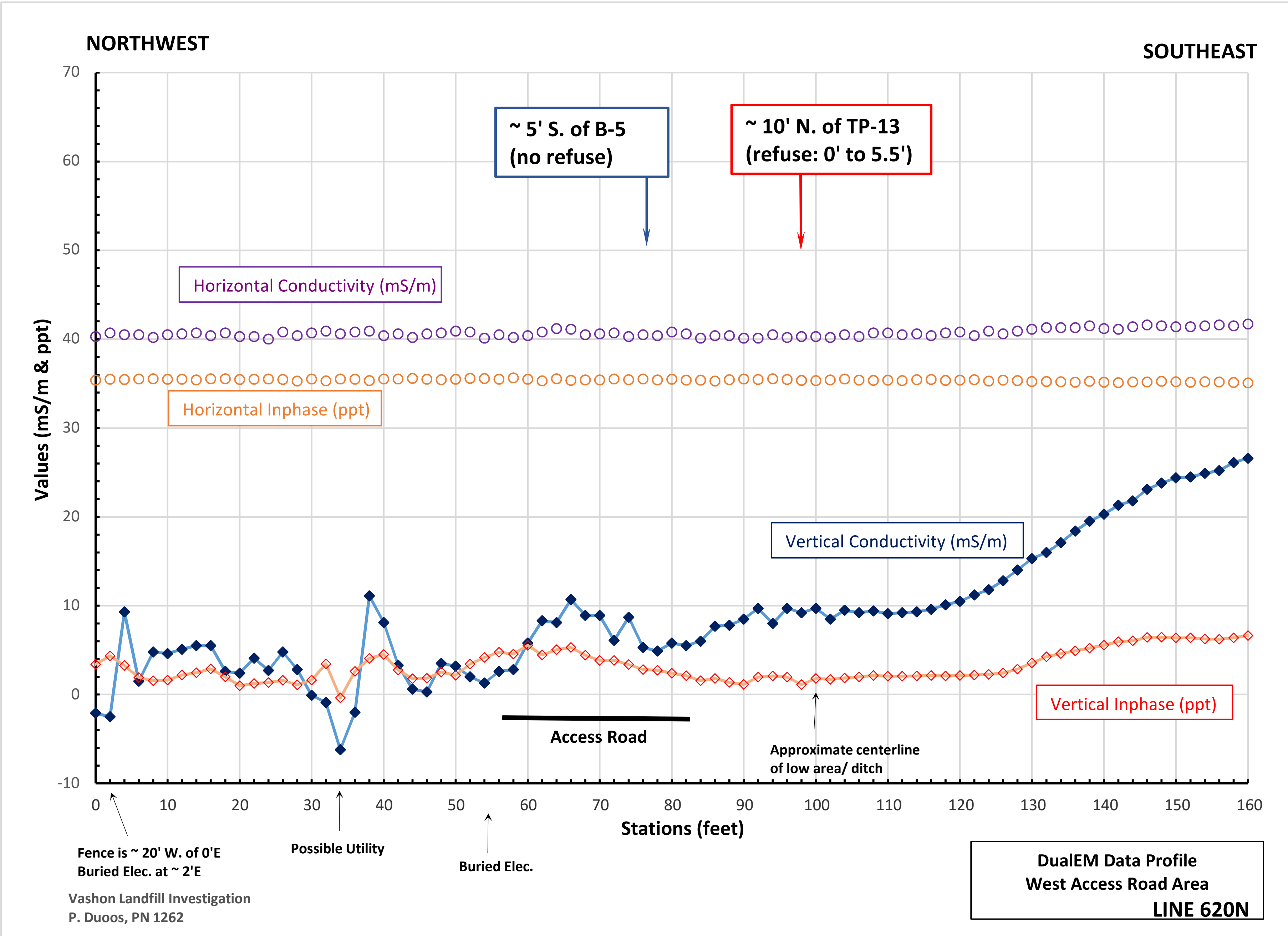
The antenna can either be moved manually by an operator or towed by a vehicle. Depths of exploration can vary widely, from just a few feet in water saturated clayey materials to hundreds of feet in glacial ice. Resolution of shallow objects requires higher frequencies, while lower frequencies work better for deeper investigations.

Several factors can affect the effectiveness of the GPR method including reinforced concrete at the surface, the presence of highly conductive materials (such as clays and water), the size, depth, and physical property of the target and; in stratigraphic investigations, the conductivity contrast between stratigraphic units. The presence of numerous buried objects may mask objects and/or stratigraphy below them.

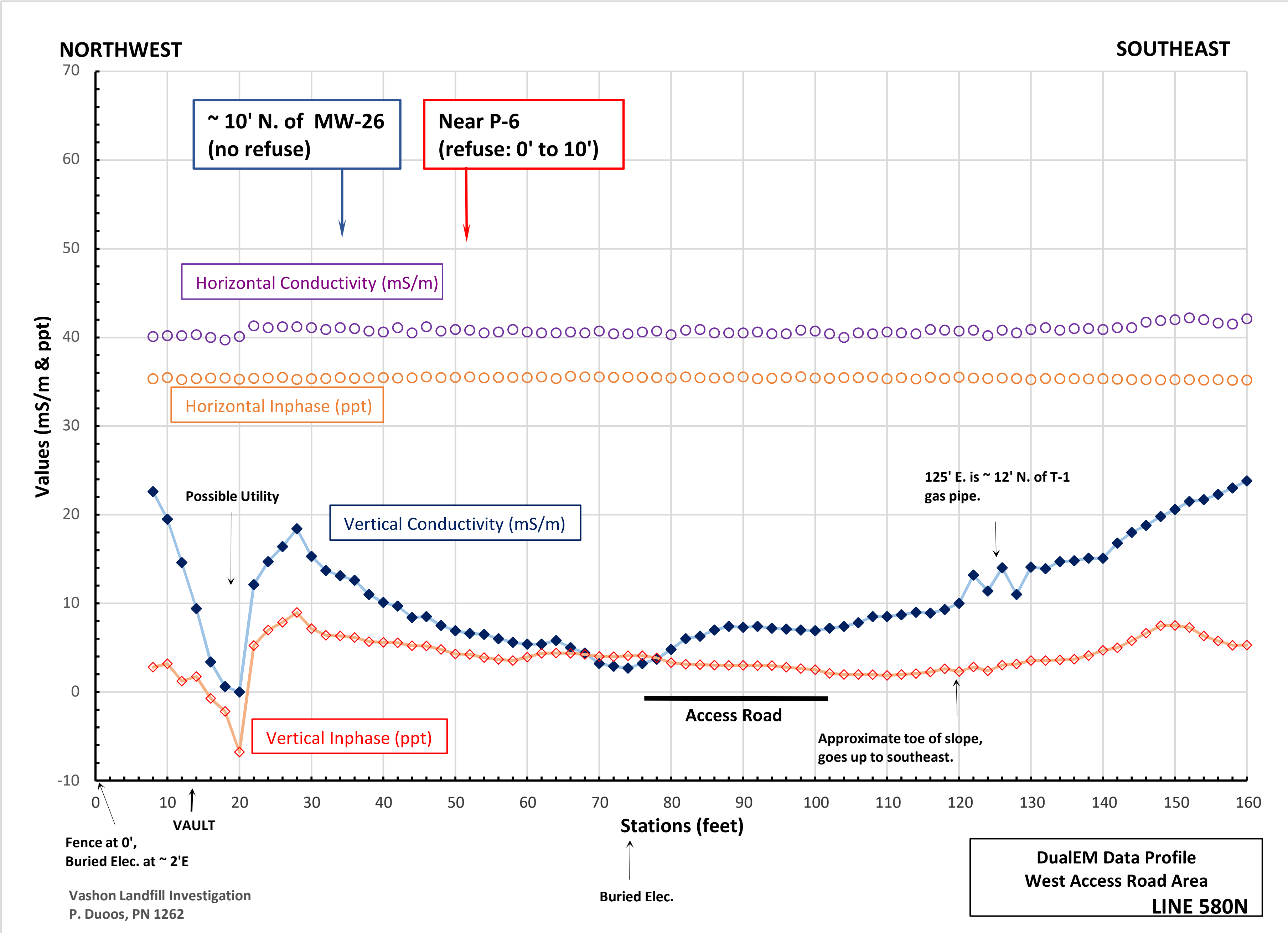
Appendix B

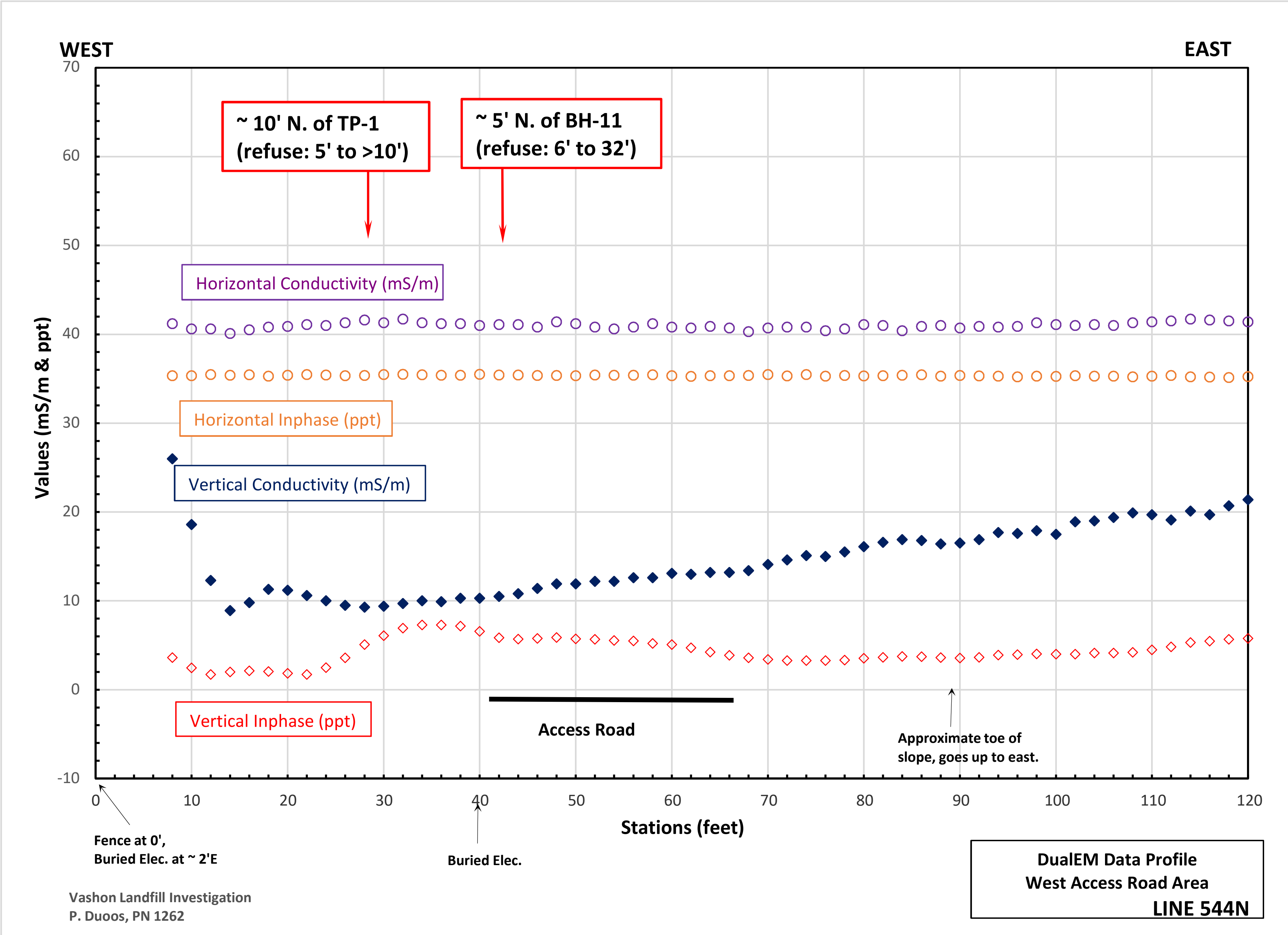
West Perimeter Road Area
Dual-EM Data Profiles

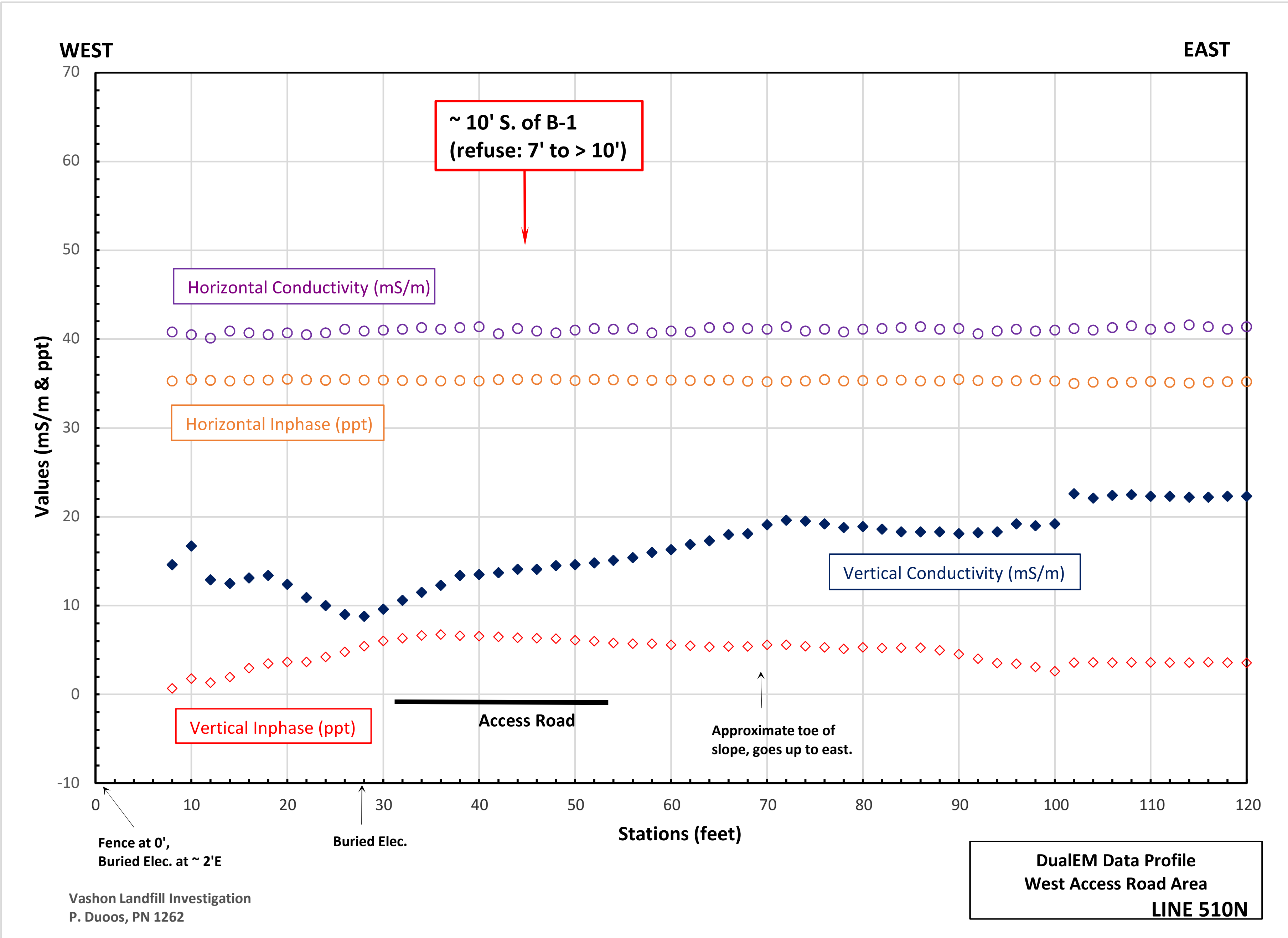

NORTHWEST
SOUTHEAST
~ 40' E-NE of B-5
(no refuse)
Horizontal Conductivity (mS/m)
Horizontal Inphase (ppt)
Values (mS/m & ppt)
Possible Utility
Vertical Conductivity (mS/m)
Vertical Inphase (ppt)
Access Road
Approximate centerline
of low area/ ditch
70
60
50
40
30
20
10
0
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
Stations (feet)
0' is near edge of pond.
Buried Elec.
Vashon Landfill Investigation
P. Duoos, PN 1262
DualEM Data Profile
West Access Road Area
LINE 670N

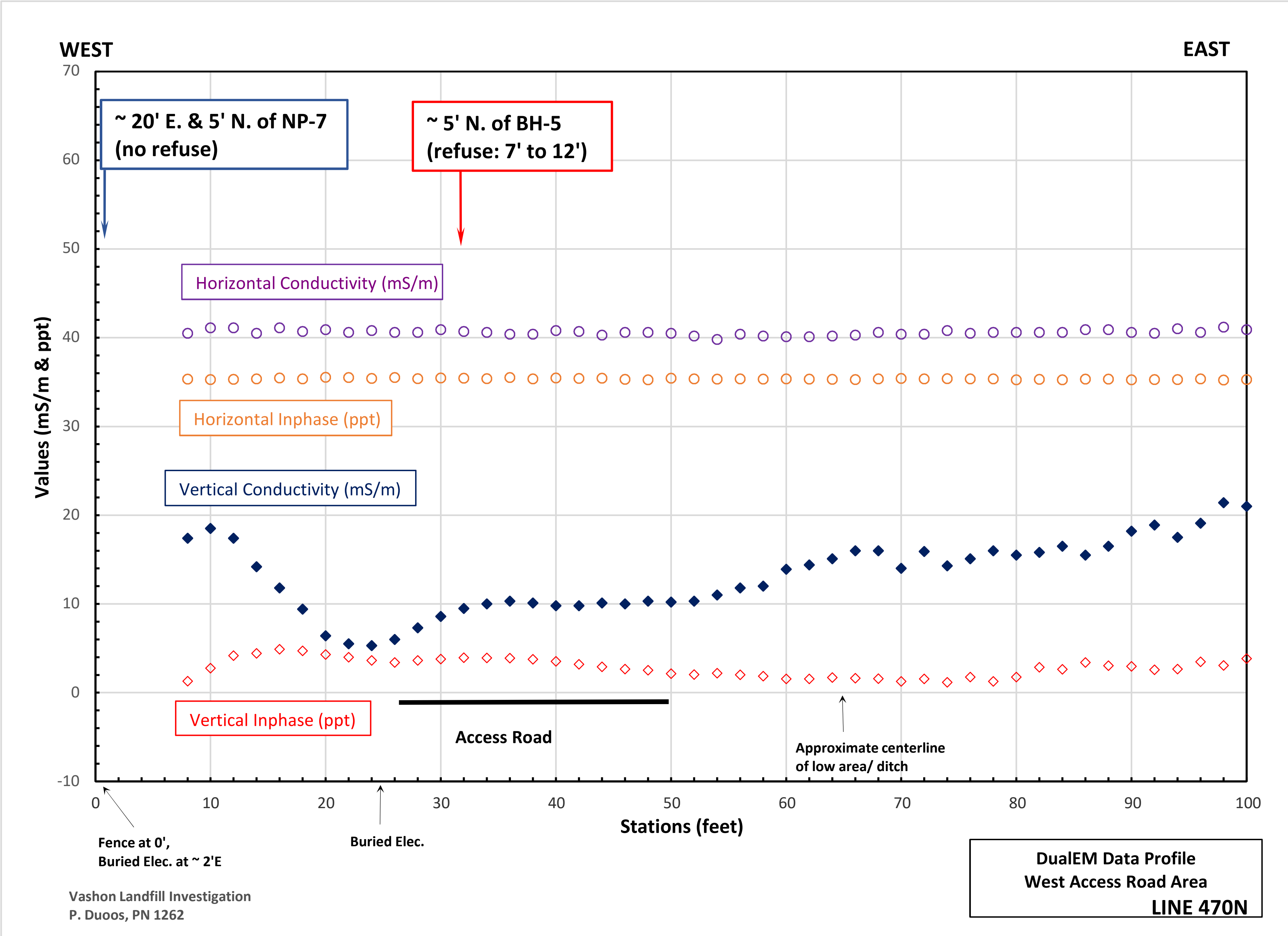


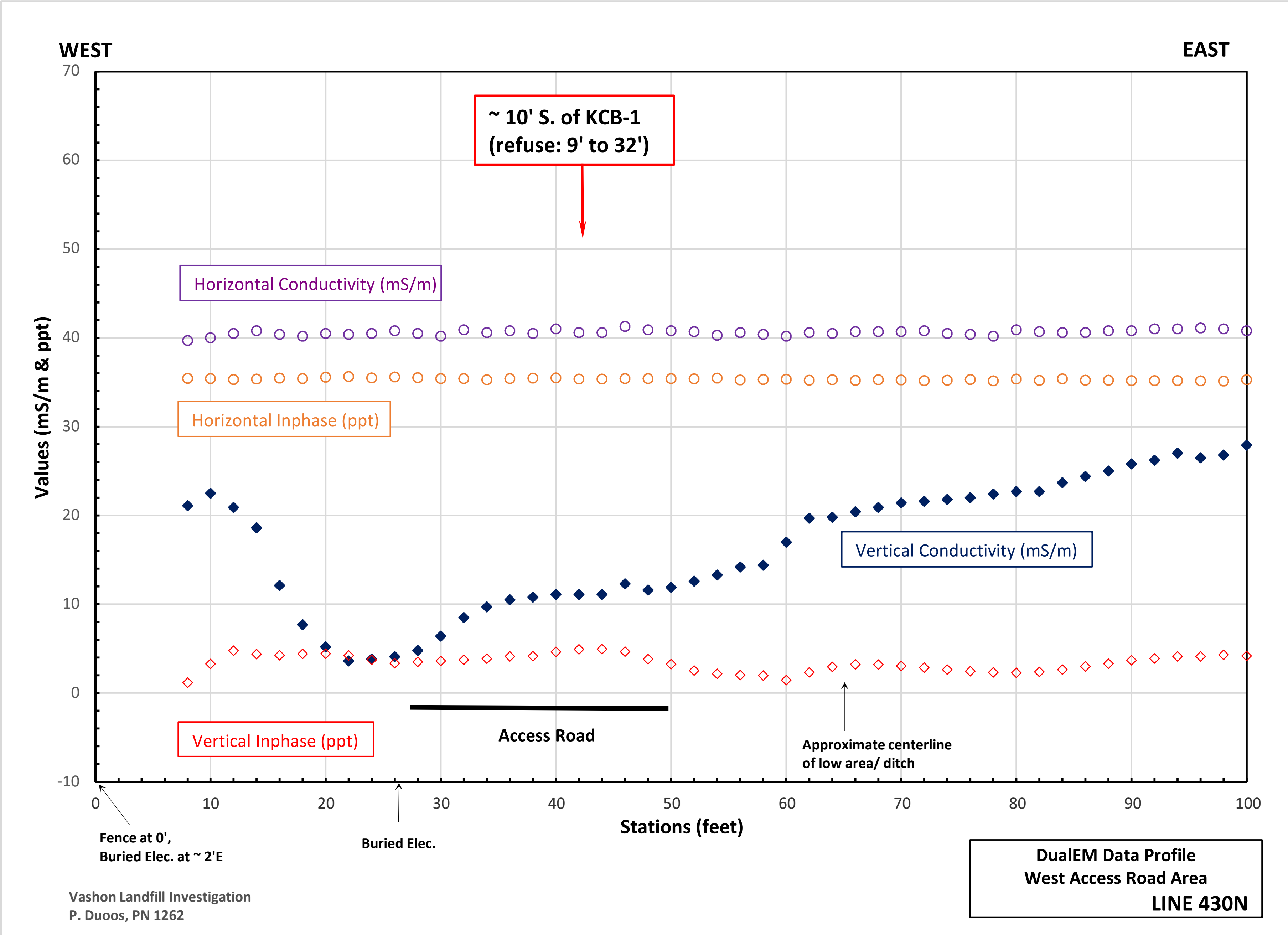
NORTHWEST
SOUTHEAST
70
60
50
40
30
20
10
0
-10
Values (mS/m & ppt)
~ 5' S. of B-5
(no refuse)
~ 10' N. of TP-13
(refuse: 0' to 5.5')
Horizontal Conductivity (mS/m)
Horizontal Inphase (ppt)
Vertical Conductivity (mS/m)
Vertical Inphase (ppt)
Access Road
Approximate centerline
of low area/ ditch
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
Stations (feet)
Fence is ~ 20' W. of 0'E
Buried Elec. at ~ 2'E
Possible Utility
Buried Elec.
Vashon Landfill Investigation
P. Duoos, PN 1262
DualEM Data Profile
West Access Road Area
LINE 620N

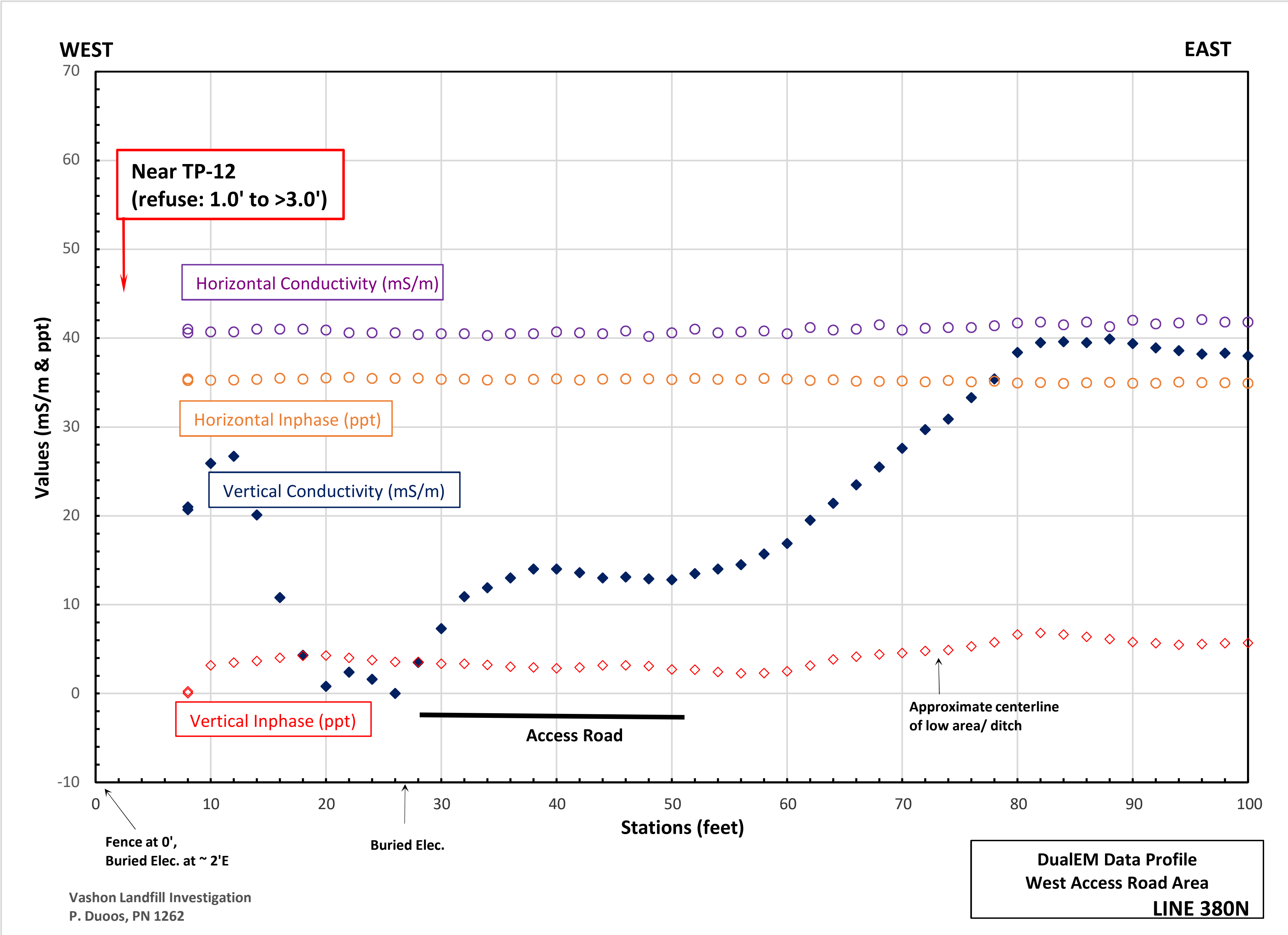

NORTHWEST
SOUTHEAST
~ 10' N. of MW-26
(no refuse)
Near P-6
(refuse: 0' to 10')
Horizontal Conductivity (mS/m)
Horizontal Inphase (ppt)
Vertical Conductivity (mS/m)
Vertical Inphase (ppt)
Possible Utility
125' E. is ~ 12' N. of T-1
gas pipe.
Access Road
Approximate toe of slope,
goes up to southeast.
Values (mS/m & ppt)
Stations (feet)
VAULT
Fence at 0',
Buried Elec. at ~ 2'E
Buried Elec.
Vashon Landfill Investigation
P. Duoos, PN 1262
DualEM Data Profile
West Access Road Area
LINE 580N

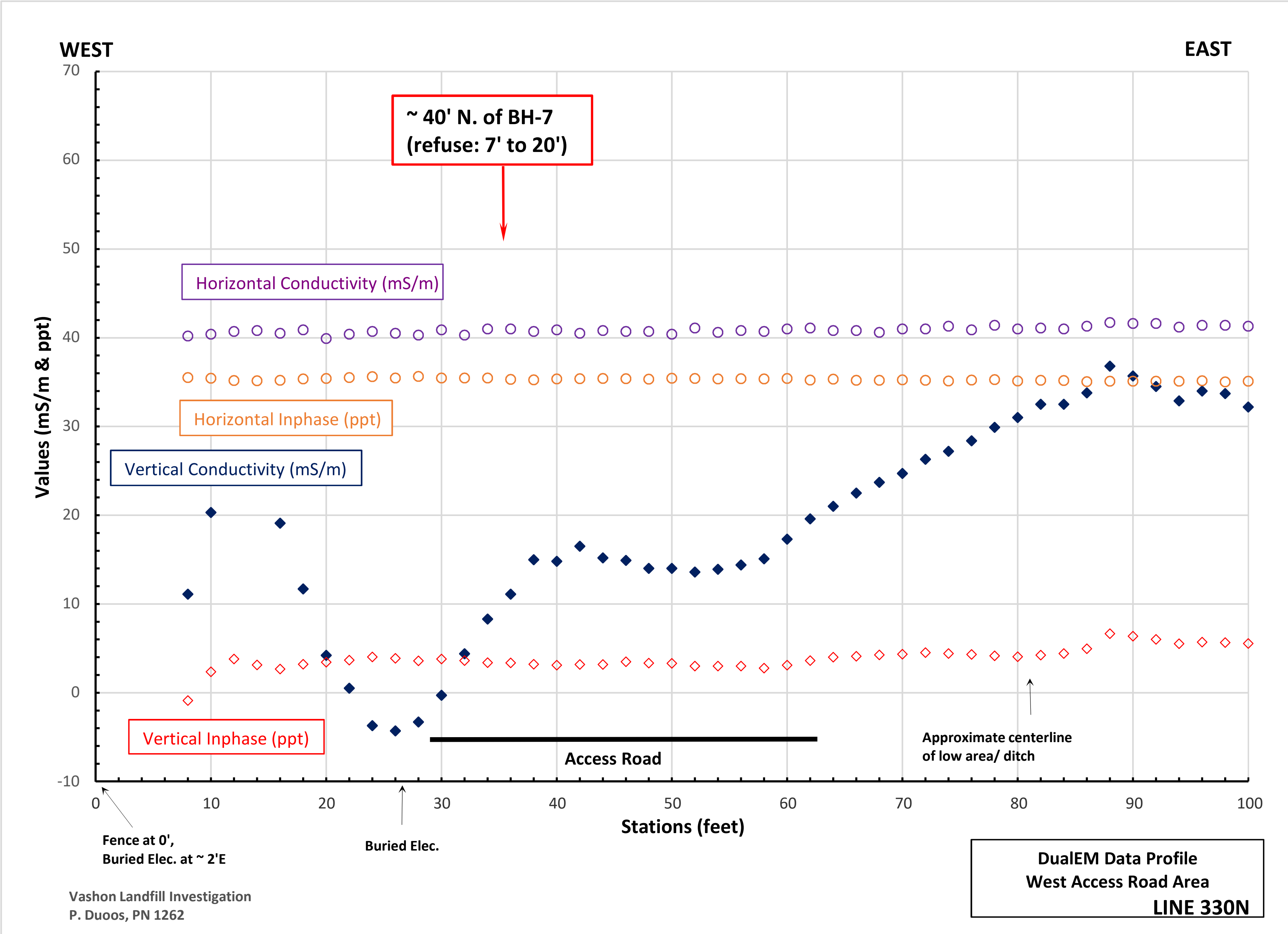

WEST
EAST
~ 10' N. of TP-1
(refuse: 5' to >10')
~ 5' N. of BH-11
(refuse: 6' to 32')
Horizontal Conductivity (mS/m)
Horizontal Inphase (ppt)
Vertical Conductivity (mS/m)
Vertical Inphase (ppt)
Access Road
Approximate toe of
slope, goes up to east.
Values (mS/m & ppt)
70
60
50
40
30
20
10
0
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
Stations (feet)
Fence at 0',
Buried Elec. at ~ 2'E
Buried Elec.
Vashon Landfill Investigation
P. Duoos, PN 1262
DualEM Data Profile
West Access Road Area
LINE 544N

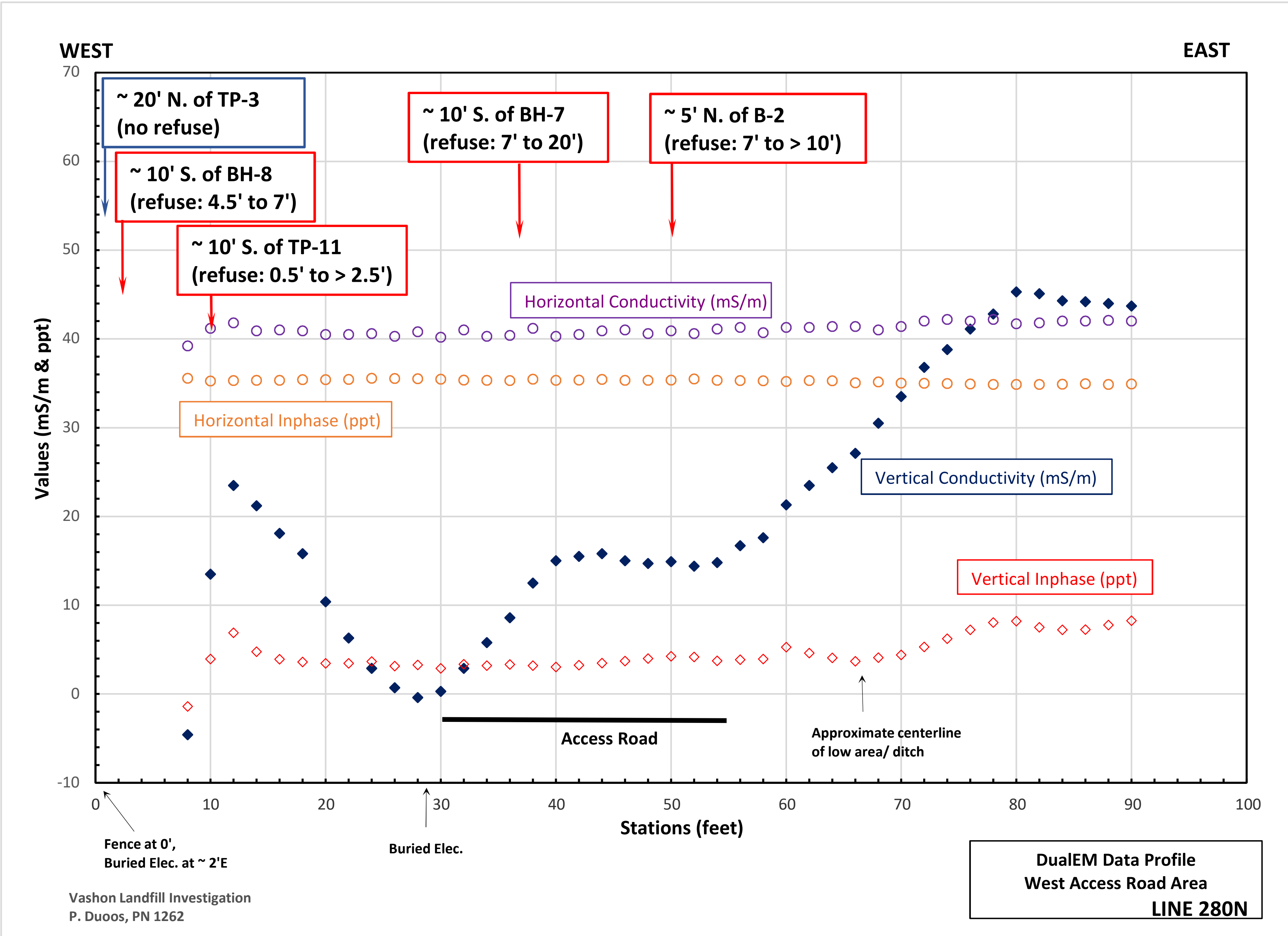

WEST
EAST
~ 10' S. of B-1
(refuse: 7' to > 10')
Horizontal Conductivity (mS/m)
Horizontal Inphase (ppt)
Vertical Conductivity (mS/m)
Vertical Inphase (ppt)
Access Road
Approximate toe of slope, goes up to east.
Values (mS/m & ppt)
Stations (feet)
Fence at 0',
Buried Elec. at ~ 2'E
Buried Elec.
Vashon Landfill Investigation
P. Duoos, PN 1262
DualEM Data Profile
West Access Road Area
LINE 510N


WEST
EAST
~ 20' E. & 5' N. of NP-7
(no refuse)
~ 5' N. of BH-5
(refuse: 7' to 12')
Horizontal Conductivity (mS/m)
Horizontal Inphase (ppt)
Vertical Conductivity (mS/m)
Vertical Inphase (ppt)
Access Road
Approximate centerline
of low area/ ditch
Values (mS/m & ppt)
70
60
50
40
30
20
10
0
-10
0
10
20
30
40
50
60
70
80
90
100
Stations (feet)
Fence at 0',
Buried Elec. at ~ 2'E
Buried Elec.
Vashon Landfill Investigation
P. Duoos, PN 1262
DualEM Data Profile
West Access Road Area
LINE 470N

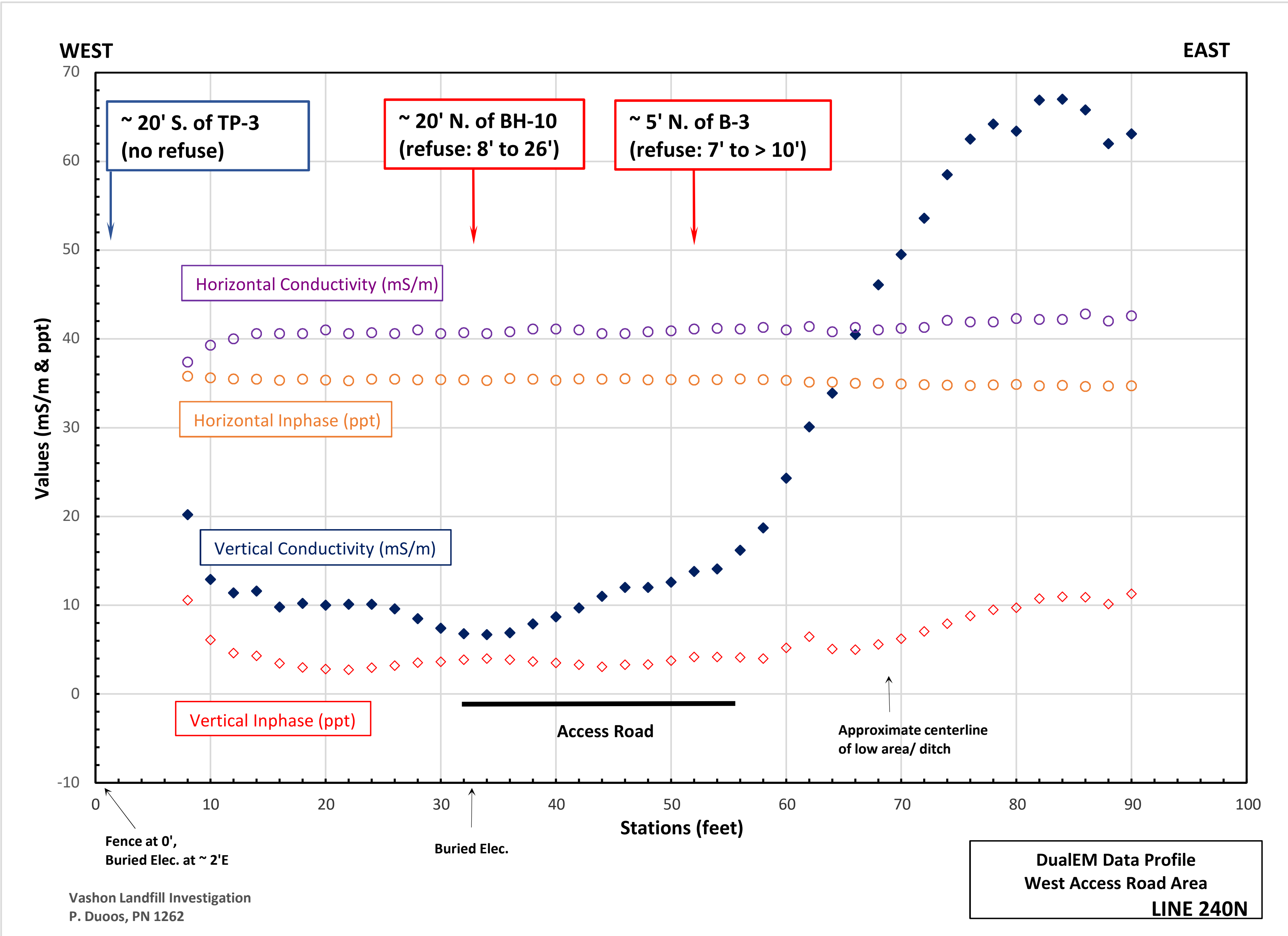

WEST
EAST
~ 10' S. of KCB-1
(refuse: 9' to 32')
Horizontal Conductivity (mS/m)
Horizontal Inphase (ppt)
Vertical Conductivity (mS/m)
Vertical Inphase (ppt)
Access Road
Approximate centerline
of low area/ ditch
Values (mS/m & ppt)
70
60
50
40
30
20
10
0
-10
0
10
20
30
40
50
60
70
80
90
100
Stations (feet)
Fence at 0',
Buried Elec. at ~ 2'E
Buried Elec.
DualEM Data Profile
West Access Road Area
LINE 430N
Vashon Landfill Investigation
P. Duoos, PN 1262

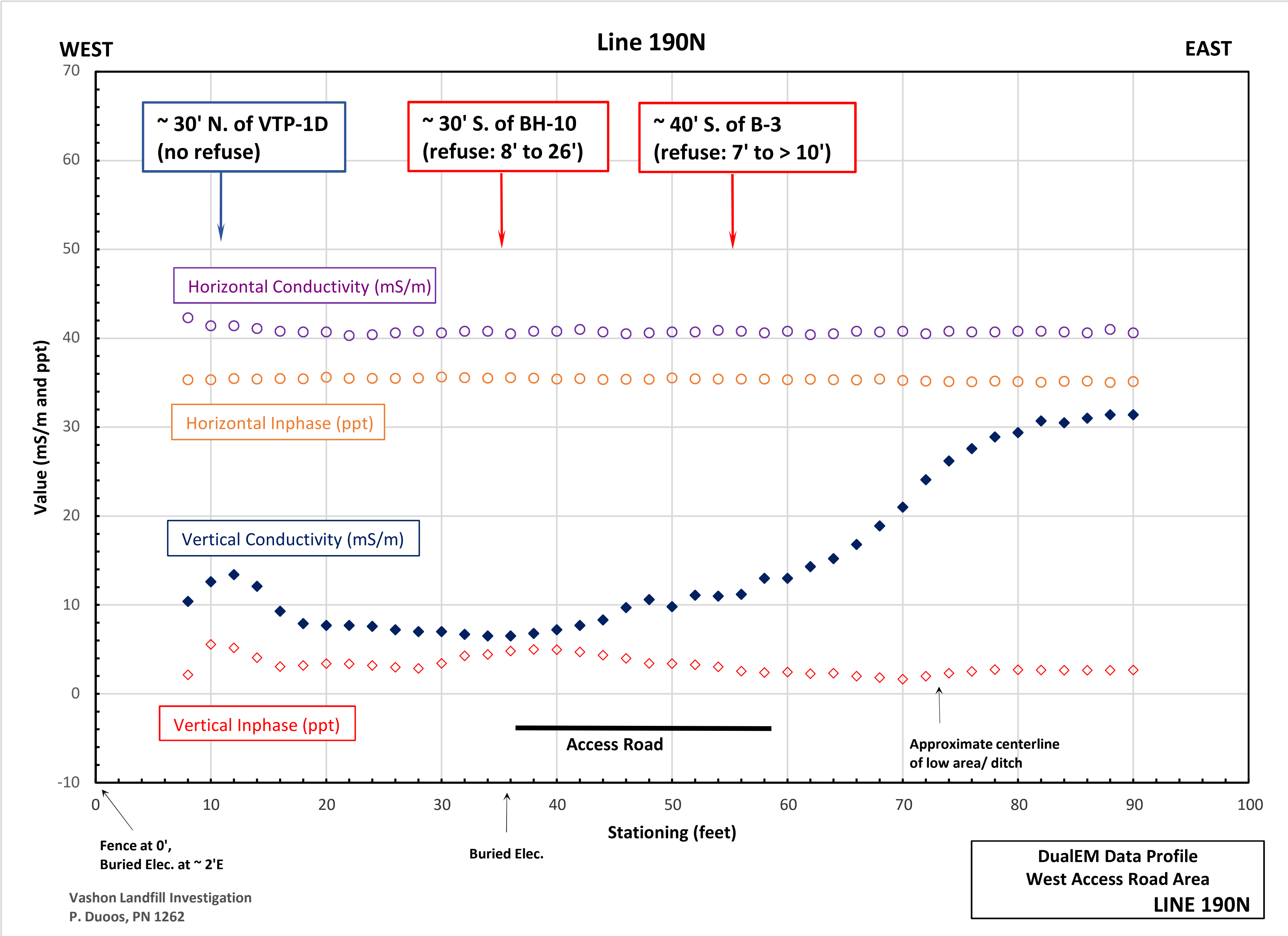

WEST
EAST
Near TP-12
(refuse: 1.0' to >3.0')
Horizontal Conductivity (mS/m)
Horizontal Inphase (ppt)
Vertical Conductivity (mS/m)
Vertical Inphase (ppt)
Access Road
Approximate centerline
of low area/ ditch
Values (mS/m & ppt)
Stations (feet)
Fence at 0',
Buried Elec. at ~ 2'E
Buried Elec.
70
60
50
40
30
20
10
0
-10
0
10
20
30
40
50
60
70
80
90
100
Vashon Landfill Investigation
P. Duoos, PN 1262
DualEM Data Profile
West Access Road Area
LINE 380N


WEST
EAST
~ 40' N. of BH-7
(refuse: 7' to 20')
Horizontal Conductivity (mS/m)
Horizontal Inphase (ppt)
Vertical Conductivity (mS/m)
Vertical Inphase (ppt)
Values (mS/m & ppt)
70
60
50
40
30
20
10
0
-10
0
10
20
30
40
50
60
70
80
90
100
Access Road
Approximate centerline
of low area/ ditch
Stations (feet)
Fence at 0',
Buried Elec. at ~ 2'E
Buried Elec.
DualEM Data Profile
West Access Road Area
LINE 330N
Vashon Landfill Investigation
P. Duoos, PN 1262

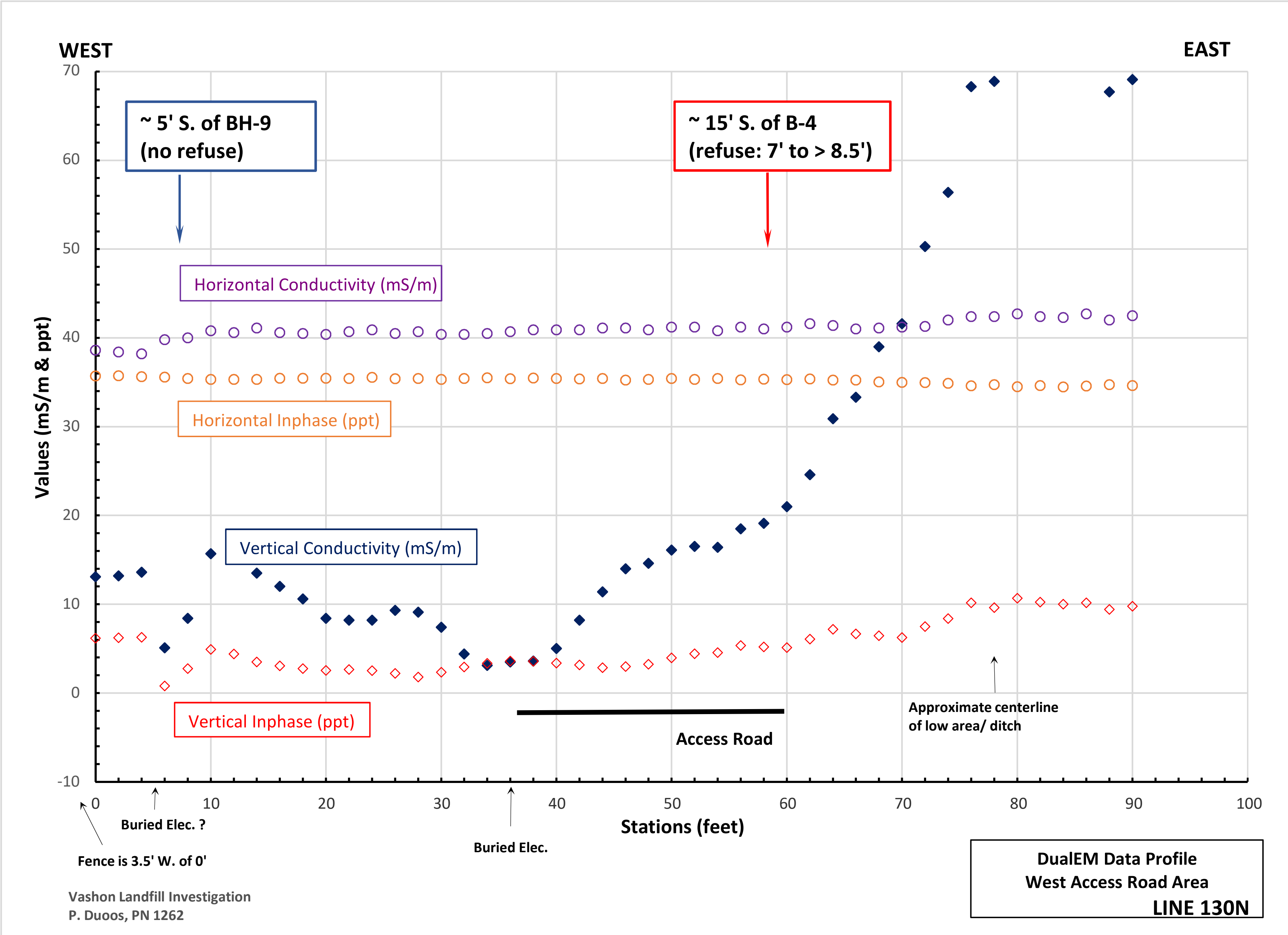


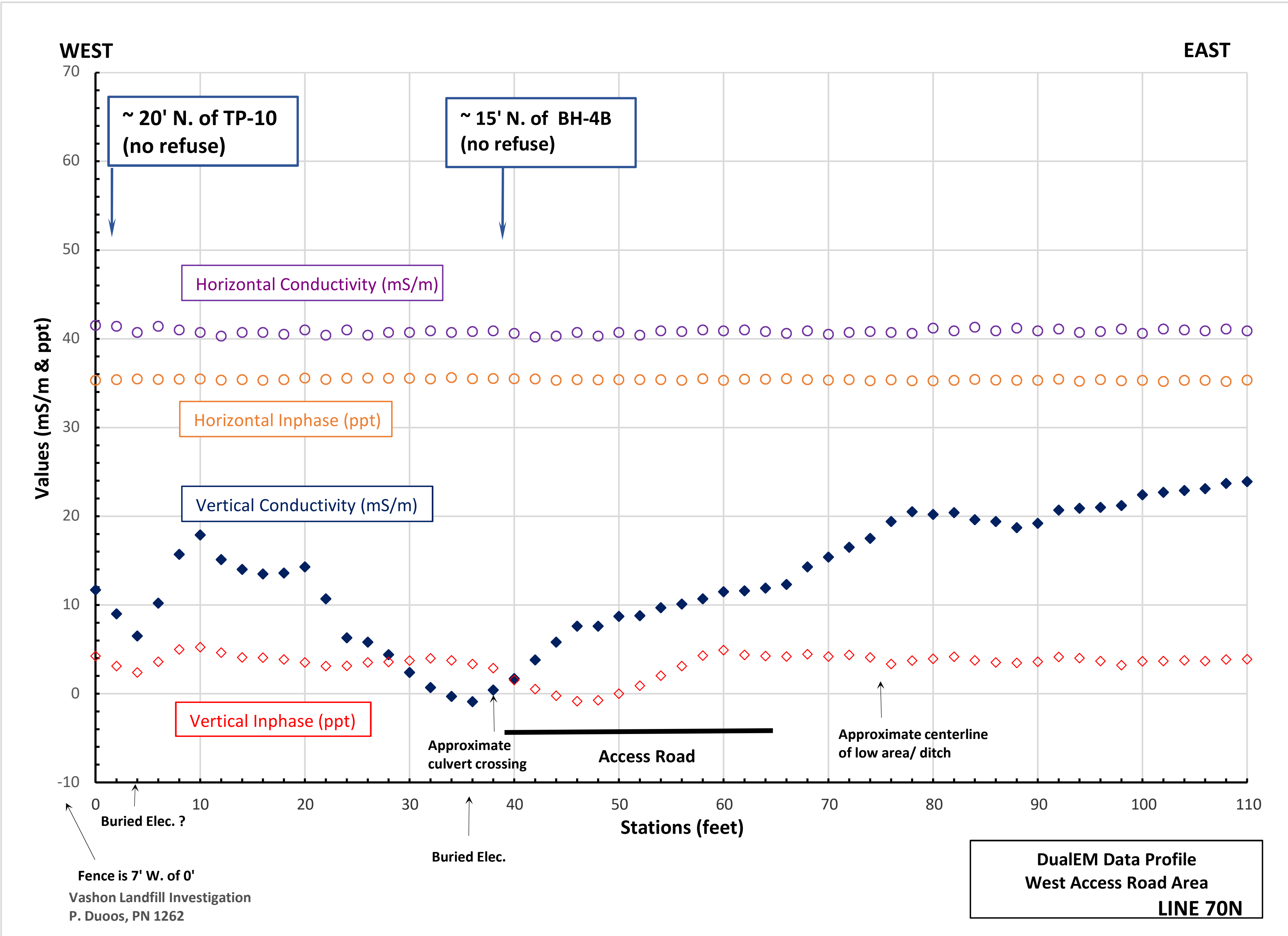
WEST
EAST
~ 20' N. of TP-3
(no refuse)
~ 10' S. of BH-8
(refuse: 4.5' to 7')
~ 10' S. of TP-11
(refuse: 0.5' to > 2.5')
~ 10' S. of BH-7
(refuse: 7' to 20')
~ 5' N. of B-2
(refuse: 7' to > 10')
Horizontal Conductivity (mS/m)
Horizontal Inphase (ppt)
Vertical Conductivity (mS/m)
Vertical Inphase (ppt)
Values (mS/m & ppt)
70
60
50
40
30
20
10
0
-10
0
10
20
30
40
50
60
70
80
90
100
Stations (feet)
Access Road
Approximate centerline
of low area/ ditch
Fence at 0',
Buried Elec. at ~ 2'E
Buried Elec.
Vashon Landfill Investigation
P. Duoos, PN 1262
DualEM Data Profile
West Access Road Area
LINE 280N


WEST
EAST
~ 20' S. of TP-3
(no refuse)
~ 20' N. of BH-10
(refuse: 8' to 26')
~ 5' N. of B-3
(refuse: 7' to > 10')
Horizontal Conductivity (mS/m)
Horizontal Inphase (ppt)
Vertical Conductivity (mS/m)
Vertical Inphase (ppt)
Access Road
Approximate centerline
of low area/ ditch
Values (mS/m & ppt)
70
60
50
40
30
20
10
0
-10
0
10
20
30
40
50
60
70
80
90
100
Stations (feet)
Fence at 0',
Buried Elec. at ~ 2'E
Buried Elec.
Vashon Landfill Investigation
P. Duoos, PN 1262
DualEM Data Profile
West Access Road Area
LINE 240N

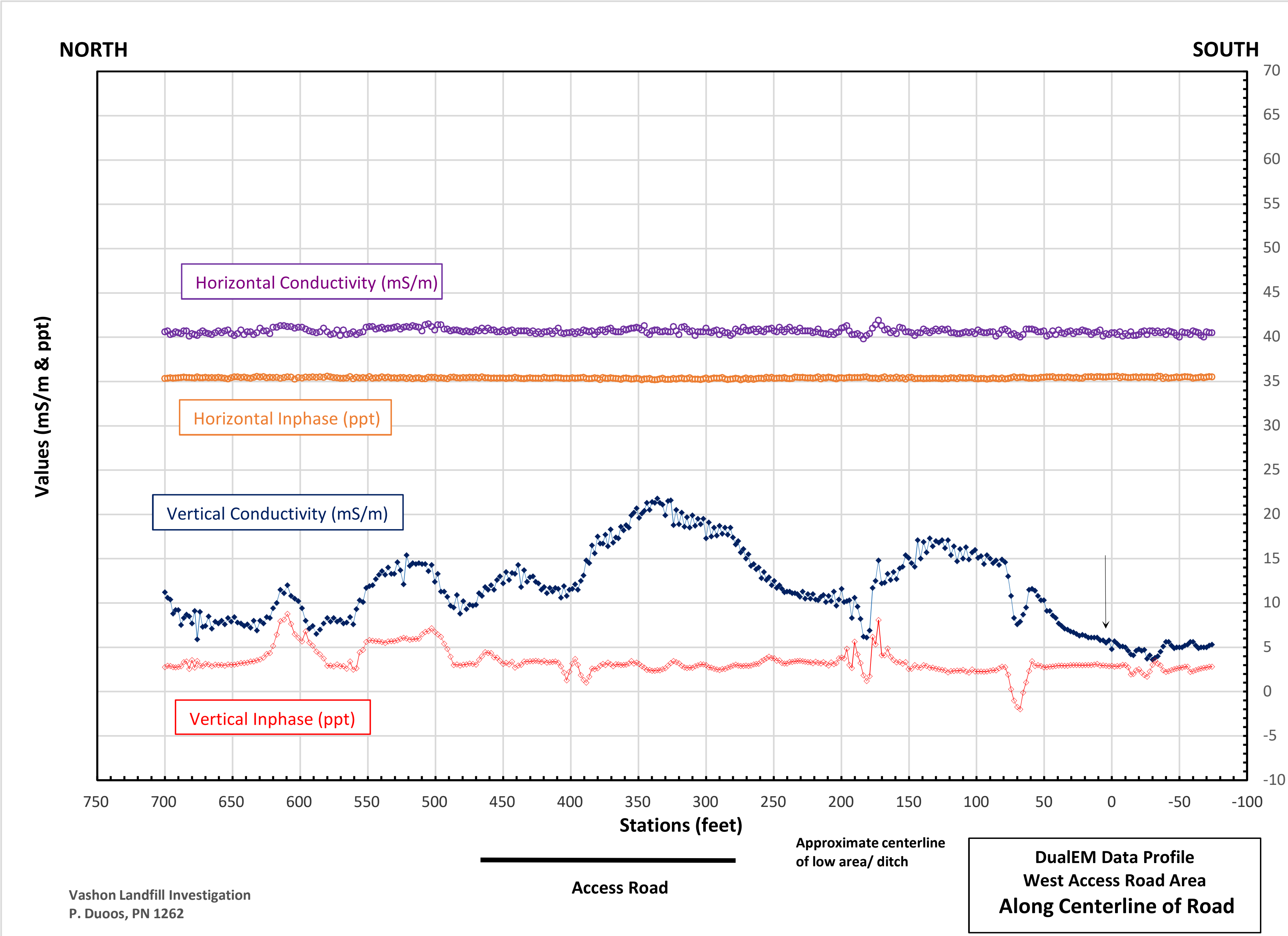


Line 190N
WEST
EAST
~ 30' N. of VTP-1D
(no refuse)
~ 30' S. of BH-10
(refuse: 8' to 26')
~ 40' S. of B-3
(refuse: 7' to > 10')
Horizontal Conductivity (mS/m)
Horizontal Inphase (ppt)
Vertical Conductivity (mS/m)
Vertical Inphase (ppt)
Access Road
Approximate centerline
of low area/ ditch
Value (mS/m and ppt)
70
60
50
40
30
20
10
0
-10
0
10
20
30
40
50
60
70
80
90
100
Stationing (feet)
Fence at 0',
Buried Elec. at ~ 2'E
Buried Elec.
Vashon Landfill Investigation
P. Duoos, PN 1262
DualEM Data Profile
West Access Road Area
LINE 190N


WEST
EAST
~ 5' S. of BH-9
(no refuse)
~ 15' S. of B-4
(refuse: 7' to > 8.5')
Horizontal Conductivity (mS/m)
Horizontal Inphase (ppt)
Vertical Conductivity (mS/m)
Vertical Inphase (ppt)
Access Road
Approximate centerline
of low area/ ditch
Values (mS/m & ppt)
70
60
50
40
30
20
10
0
-10
0
10
20
30
40
50
60
70
80
90
100
Stations (feet)
Buried Elec. ?
Fence is 3.5' W. of 0'
Buried Elec.
Vashon Landfill Investigation
P. Duoos, PN 1262
DualEM Data Profile
West Access Road Area
LINE 130N



WEST
EAST
~ 20' N. of TP-10 (no refuse)
~ 15' N. of BH-4B (no refuse)
Horizontal Conductivity (mS/m)
Horizontal Inphase (ppt)
Vertical Conductivity (mS/m)
Vertical Inphase (ppt)
Values (mS/m & ppt)
70
60
50
40
30
20
10
0
-10
0
10
20
30
40
50
60
70
80
90
100
110
Stations (feet)
Approximate culvert crossing
Access Road
Approximate centerline of low area/ ditch
Buried Elec. ?
Buried Elec.
Fence is 7' W. of 0'
Vashon Landfill Investigation
P. Duoos, PN 1262
DualEM Data Profile
West Access Road Area
LINE 70N


NORTH
SOUTH
Values (mS/m & ppt)
Horizontal Conductivity (mS/m)
Horizontal Inphase (ppt)
Vertical Conductivity (mS/m)
Vertical Inphase (ppt)
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
-5
-10
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
-50
-100
Stations (feet)
Approximate centerline
of low area/ ditch
Access Road
DualEM Data Profile
West Access Road Area
Along Centerline of Road
Vashon Landfill Investigation
P. Duoos, PN 1262

Appendix C

South Slope Area
Magnetometer Data Profiles

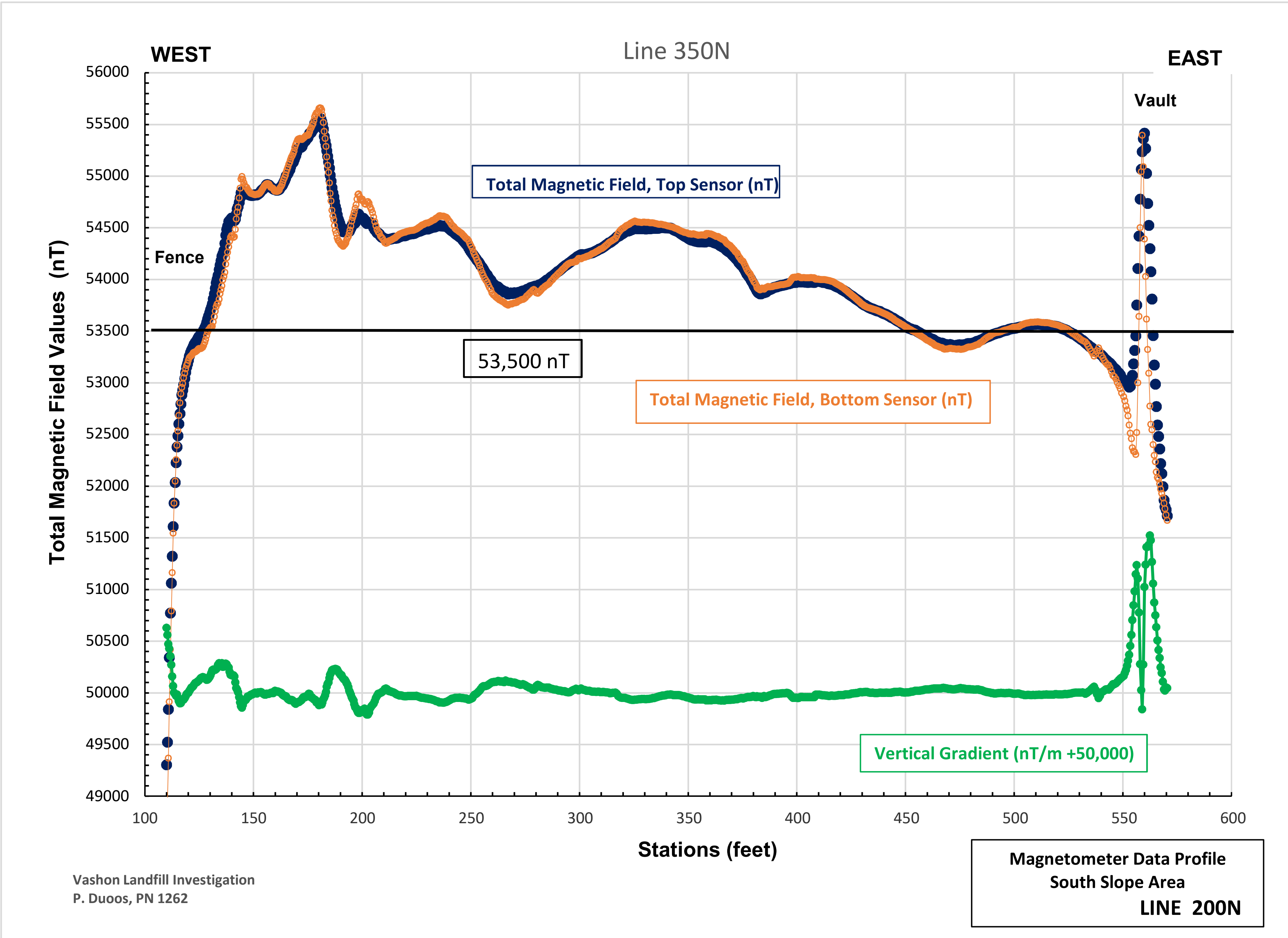
Lines Oriented West – East:

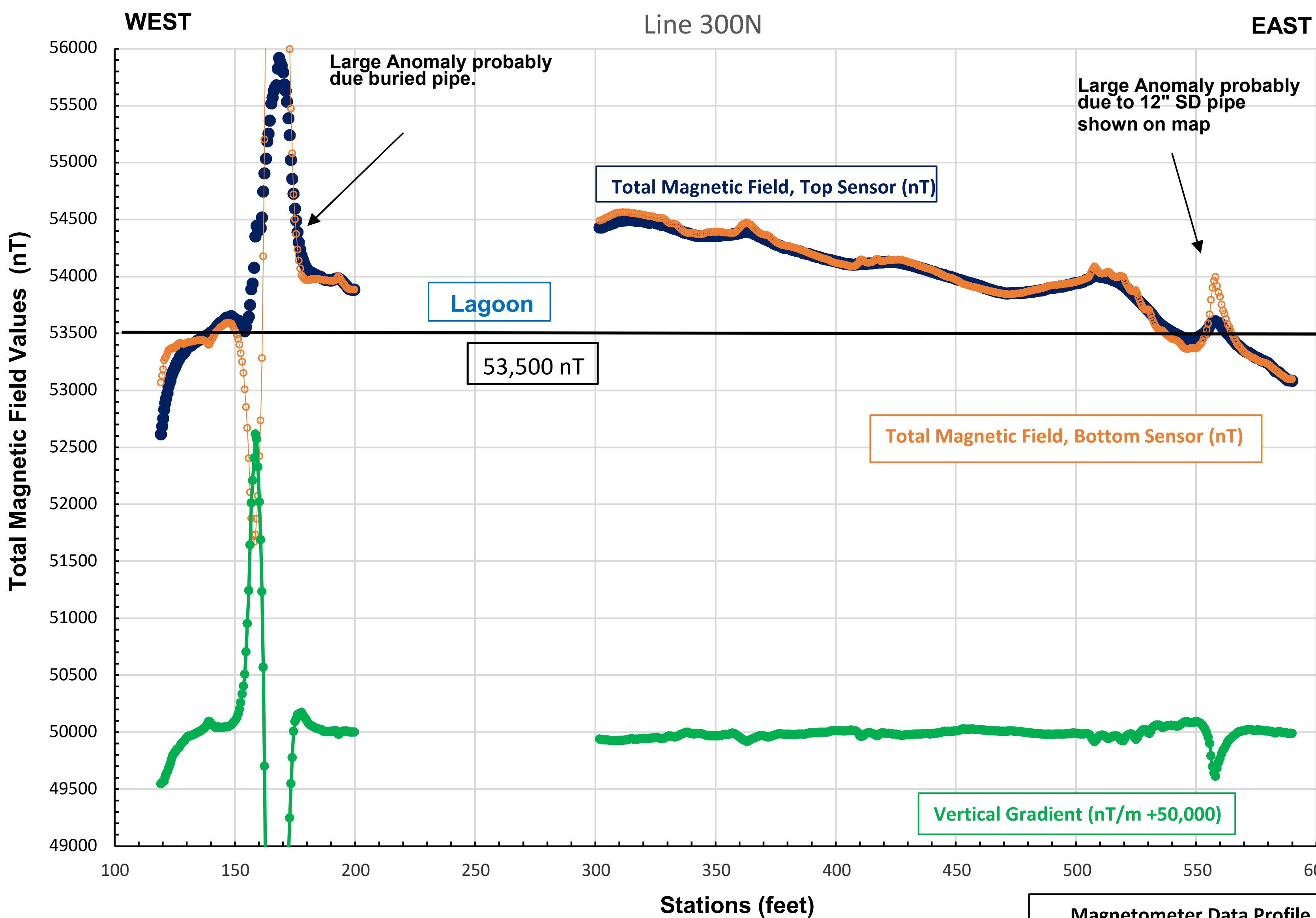
Line 350N
Line 300N
Line 250-260N
Line 200N
Line 150N
Line 60N

Angled Line Along ERI Profile
Angled Line Along South Edge

Lines Oriented South – North:

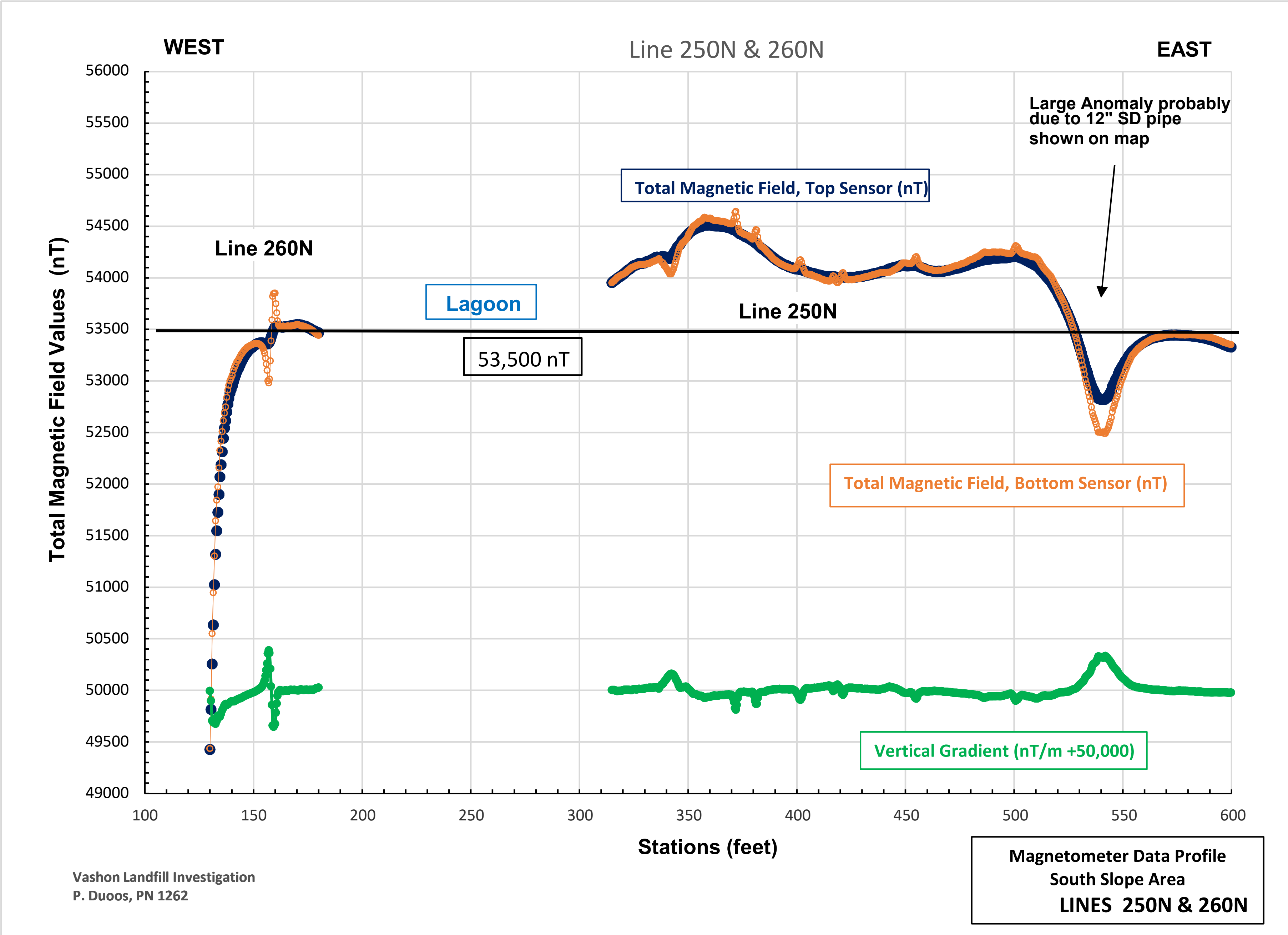
Line 200E
Line 300E
Line 350E
Line 375E
Line 420E
Line 460E
Line 500E

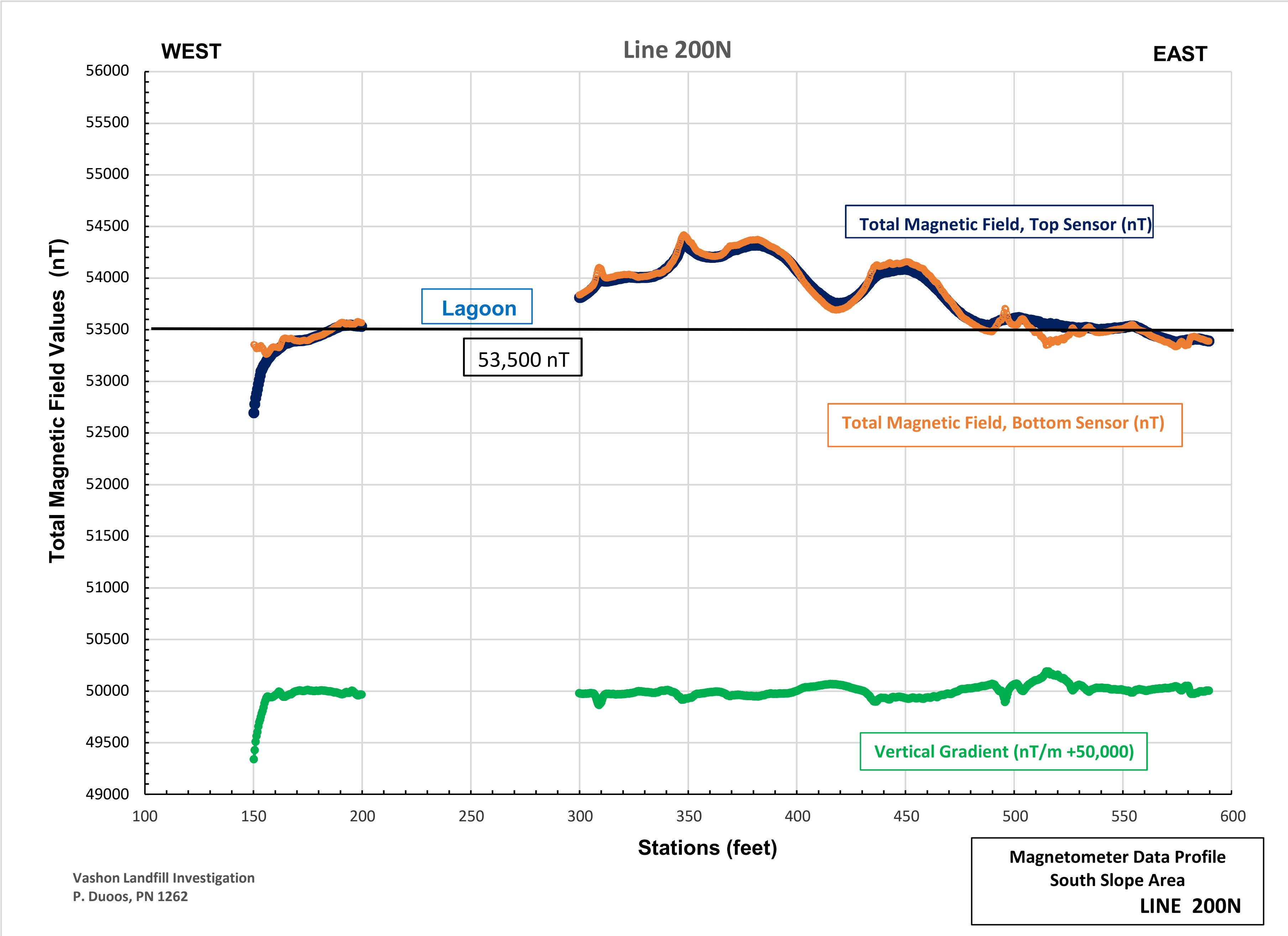

WEST
Line 350N
EAST
Vault
Fence
Total Magnetic Field, Top Sensor (nT)
53,500 nT
Total Magnetic Field, Bottom Sensor (nT)
Vertical Gradient (nT/m +50,000)
Total Magnetic Field Values (nT)
56000
55500
55000
54500
54000
53500
53000
52500
52000
51500
51000
50500
50000
49500
49000
100
150
200
250
300
350
400
450
500
550
600
Stations (feet)
Vashon Landfill Investigation
P. Duoos, PN 1262
Magnetometer Data Profile
South Slope Area
LINE 200N

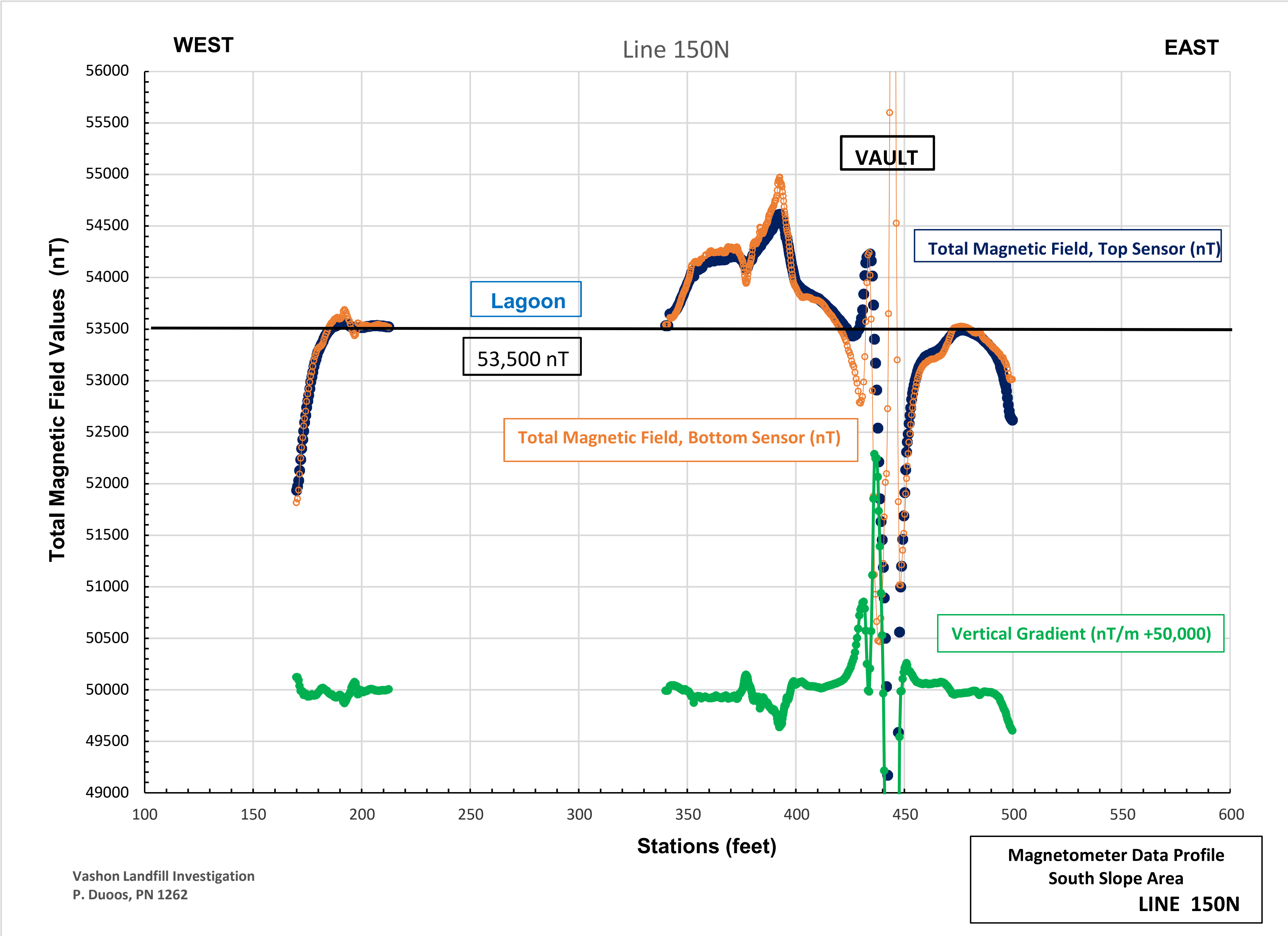


Vashon Landfill Investigation
P. Duoos, PN 1262

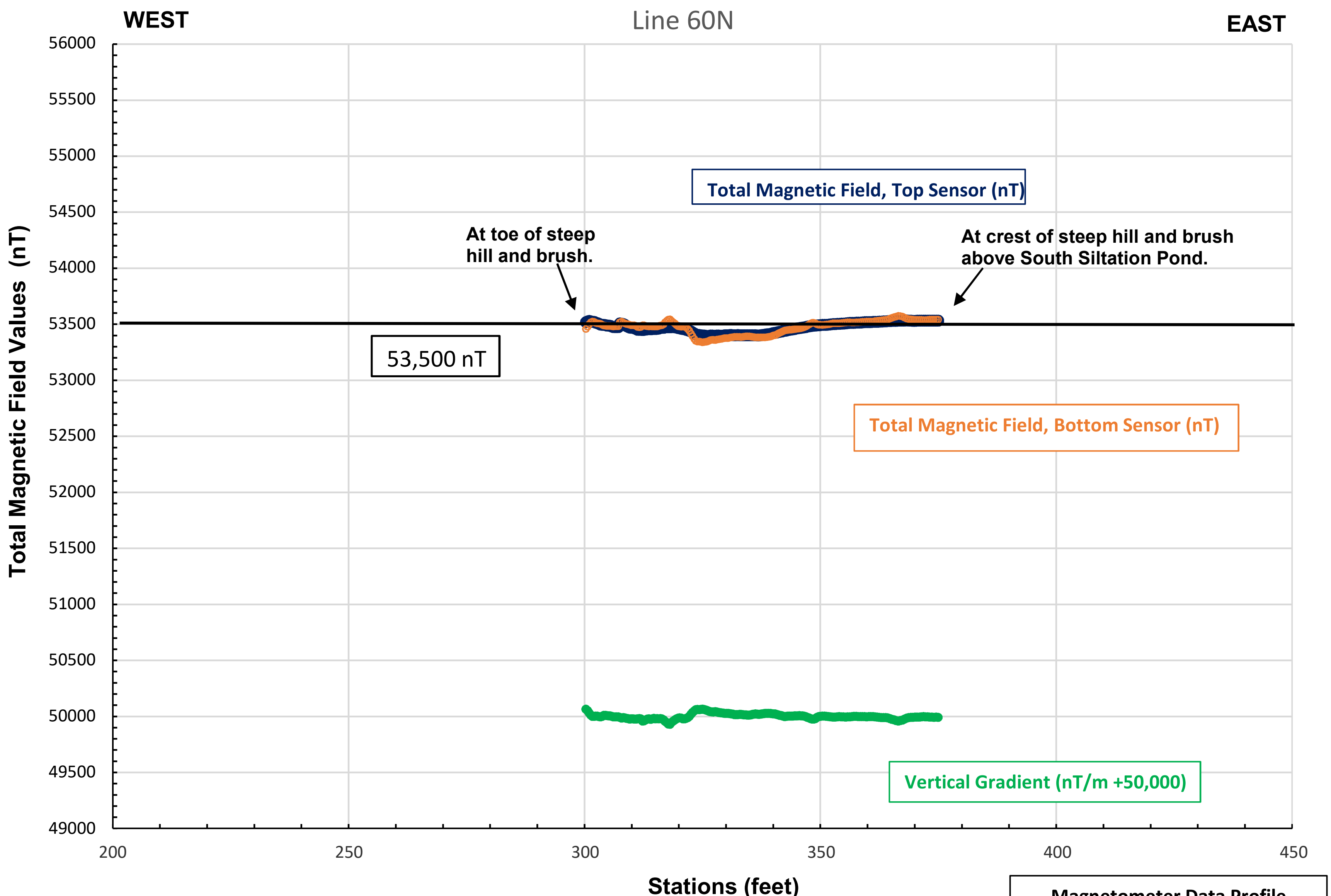
Magnetometer Data Profile
South Slope Area
LINE 300N


WEST
Line 250N & 260N
EAST
Large Anomaly probably due to 12" SD pipe shown on map
Total Magnetic Field, Top Sensor (nT)
Line 260N
Lagoon
Line 250N
53,500 nT
Total Magnetic Field, Bottom Sensor (nT)
Vertical Gradient (nT/m +50,000)
Total Magnetic Field Values (nT)
Stations (feet)
56000
55500
55000
54500
54000
53500
53000
52500
52000
51500
51000
50500
50000
49500
49000
100
150
200
250
300
350
400
450
500
550
600
Vashon Landfill Investigation
P. Duoos, PN 1262
Magnetometer Data Profile
South Slope Area
LINES 250N & 260N


WEST
Line 200N
EAST
Total Magnetic Field Values (nT)
56000
55500
55000
54500
54000
53500
53000
52500
52000
51500
51000
50500
50000
49500
49000
Total Magnetic Field, Top Sensor (nT)
Lagoon
53,500 nT
Total Magnetic Field, Bottom Sensor (nT)
Vertical Gradient (nT/m +50,000)
100
150
200
250
300
350
400
450
500
550
600
Stations (feet)
Vashon Landfill Investigation
P. Duoos, PN 1262
Magnetometer Data Profile
South Slope Area
LINE 200N

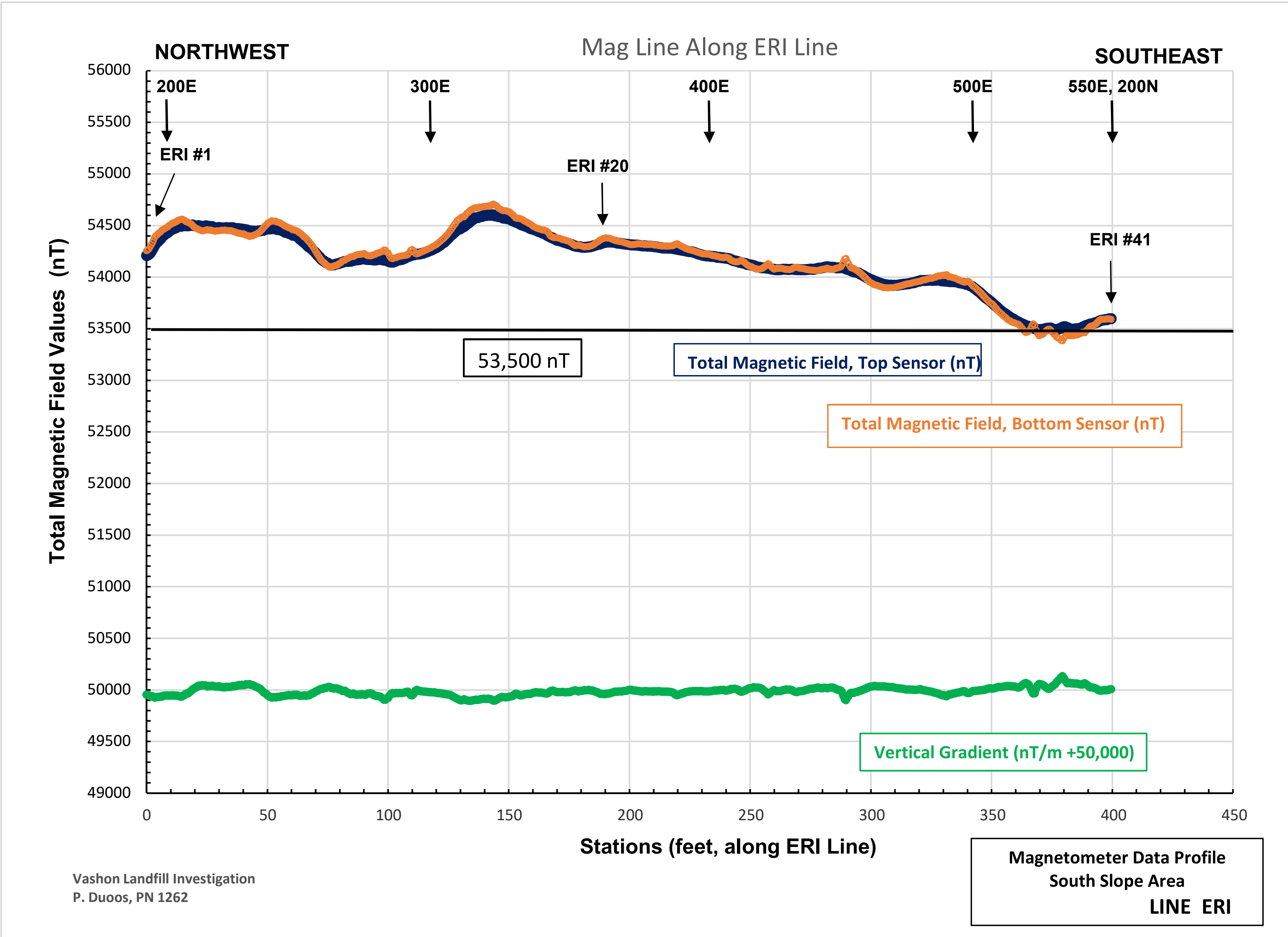


WEST
Line 150N
EAST
VAULT
Total Magnetic Field, Top Sensor (nT)
Lagoon
53,500 nT
Total Magnetic Field, Bottom Sensor (nT)
Vertical Gradient (nT/m +50,000)
Total Magnetic Field Values (nT)
56000
55500
55000
54500
54000
53500
53000
52500
52000
51500
51000
50500
50000
49500
49000
100
150
200
250
300
350
400
450
500
550
600
Stations (feet)
Vashon Landfill Investigation
P. Duoos, PN 1262
Magnetometer Data Profile
South Slope Area
LINE 150N

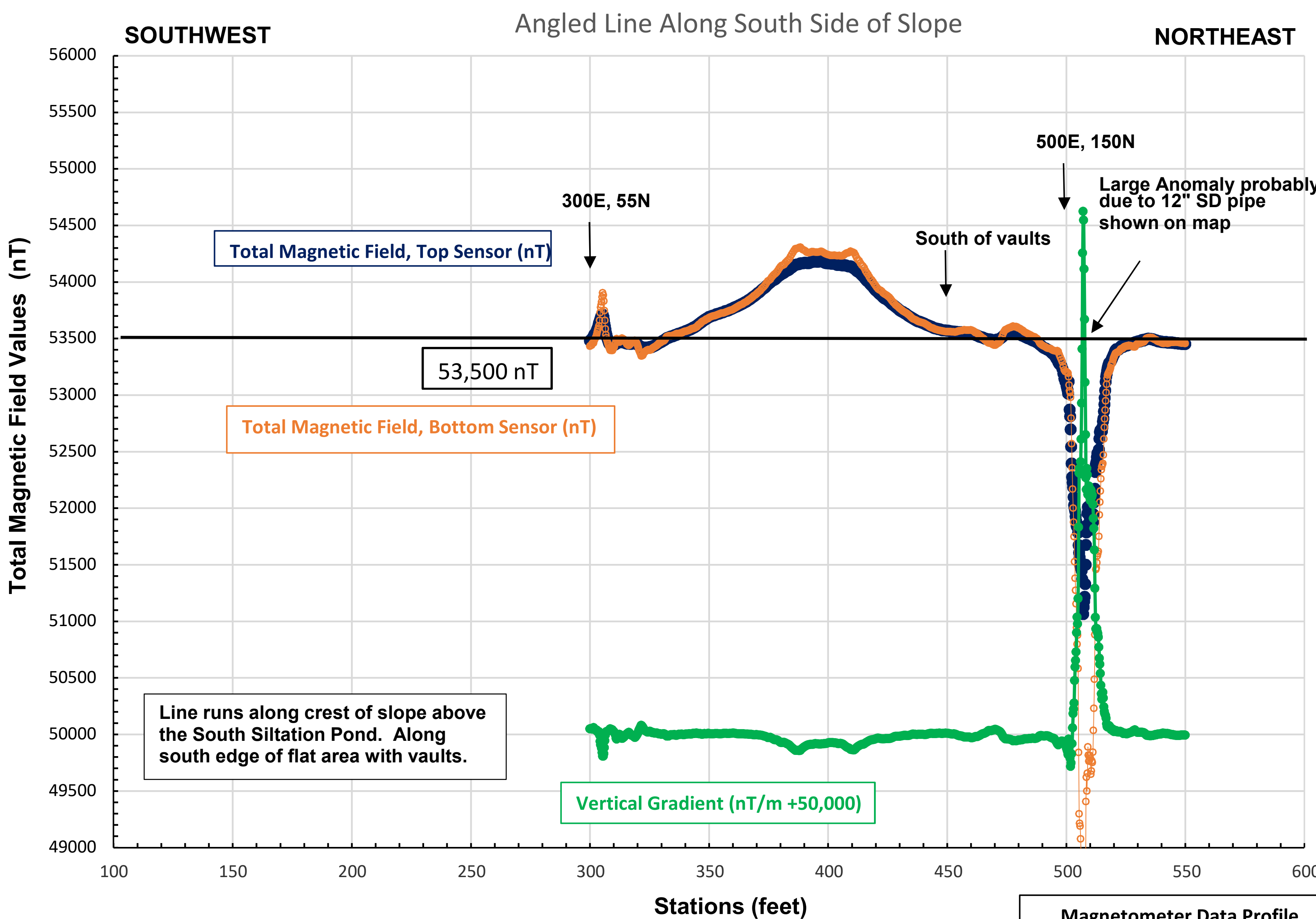


Vashon Landfill Investigation
P. Duoos, PN 1262

Magnetometer Data Profile
South Slope Area
LINE 60N

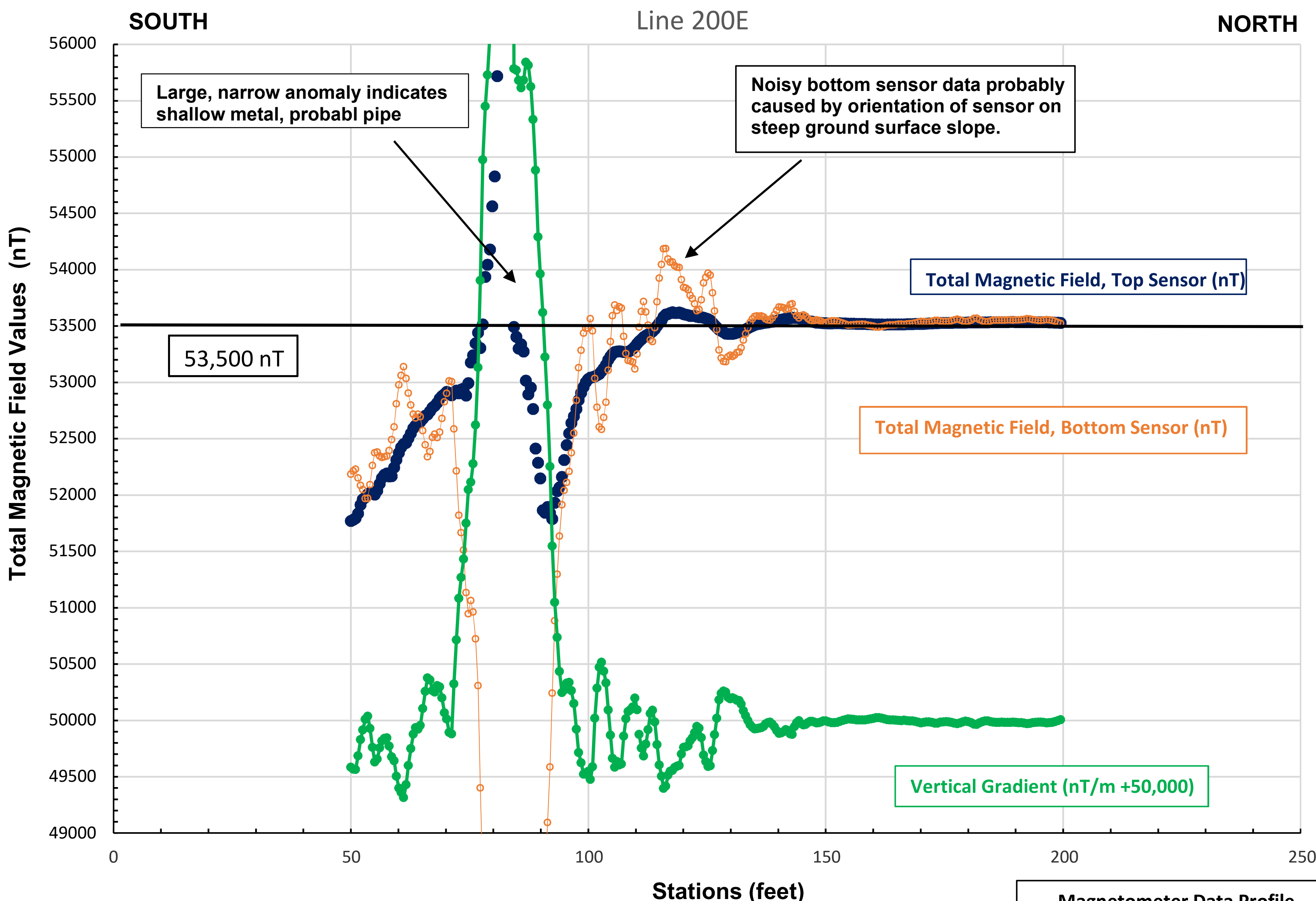


Mag Line Along ERI Line
NORTHWEST
SOUTHEAST
200E
300E
400E
500E
550E, 200N
ERI #1
ERI #20
ERI #41
53,500 nT
Total Magnetic Field, Top Sensor (nT)
Total Magnetic Field, Bottom Sensor (nT)
Vertical Gradient (nT/m +50,000)
Total Magnetic Field Values (nT)
56000
55500
55000
54500
54000
53500
53000
52500
52000
51500
51000
50500
50000
49500
49000
0
50
100
150
200
250
300
350
400
450
Stations (feet, along ERI Line)
Vashon Landfill Investigation
P. Duoos, PN 1262
Magnetometer Data Profile
South Slope Area
LINE ERI



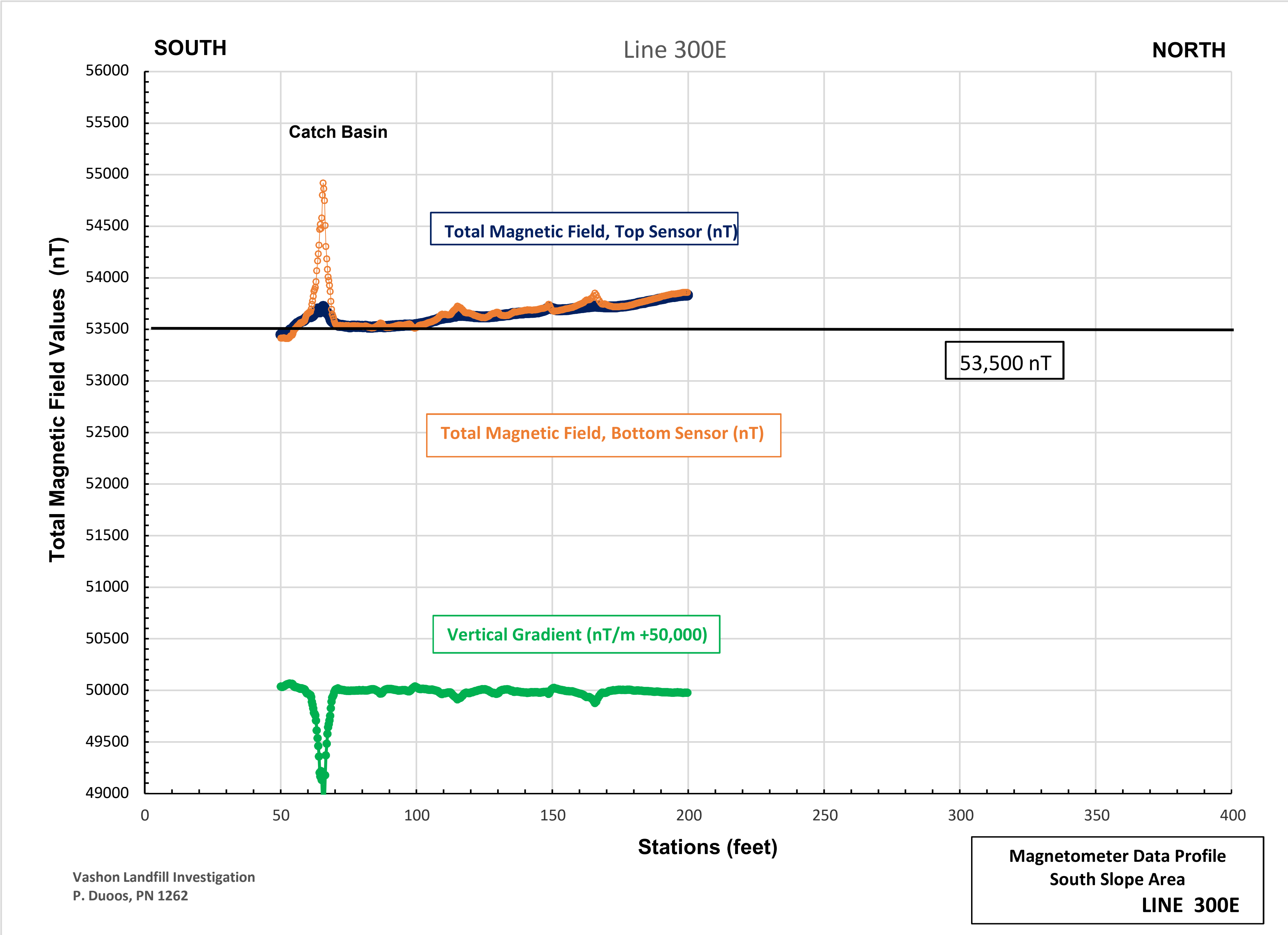
Vashon Landfill Investigation
P. Duoos, PN 1262

Magnetometer Data Profile
South Slope Area
SOUTH ANGLED LINE

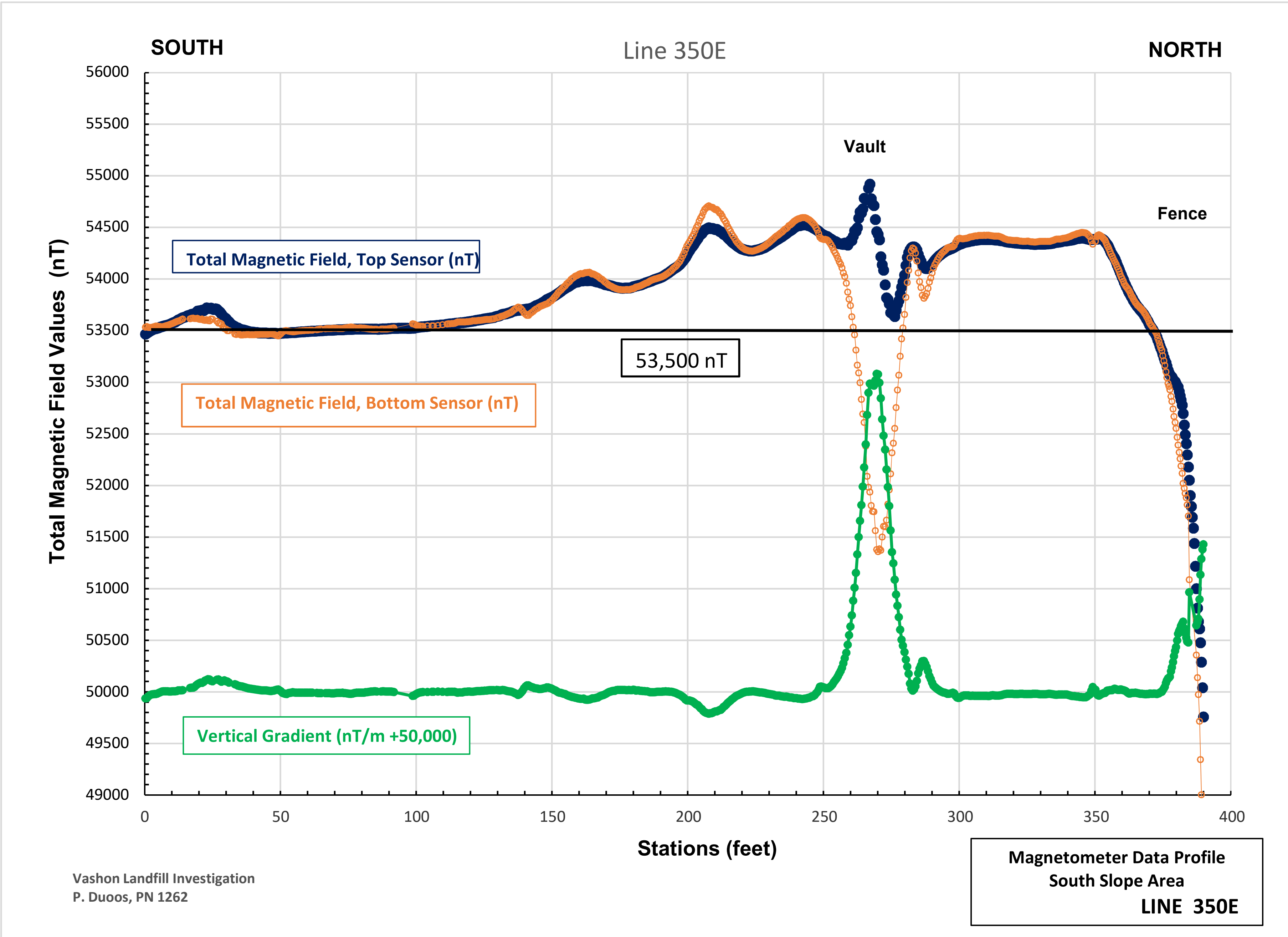


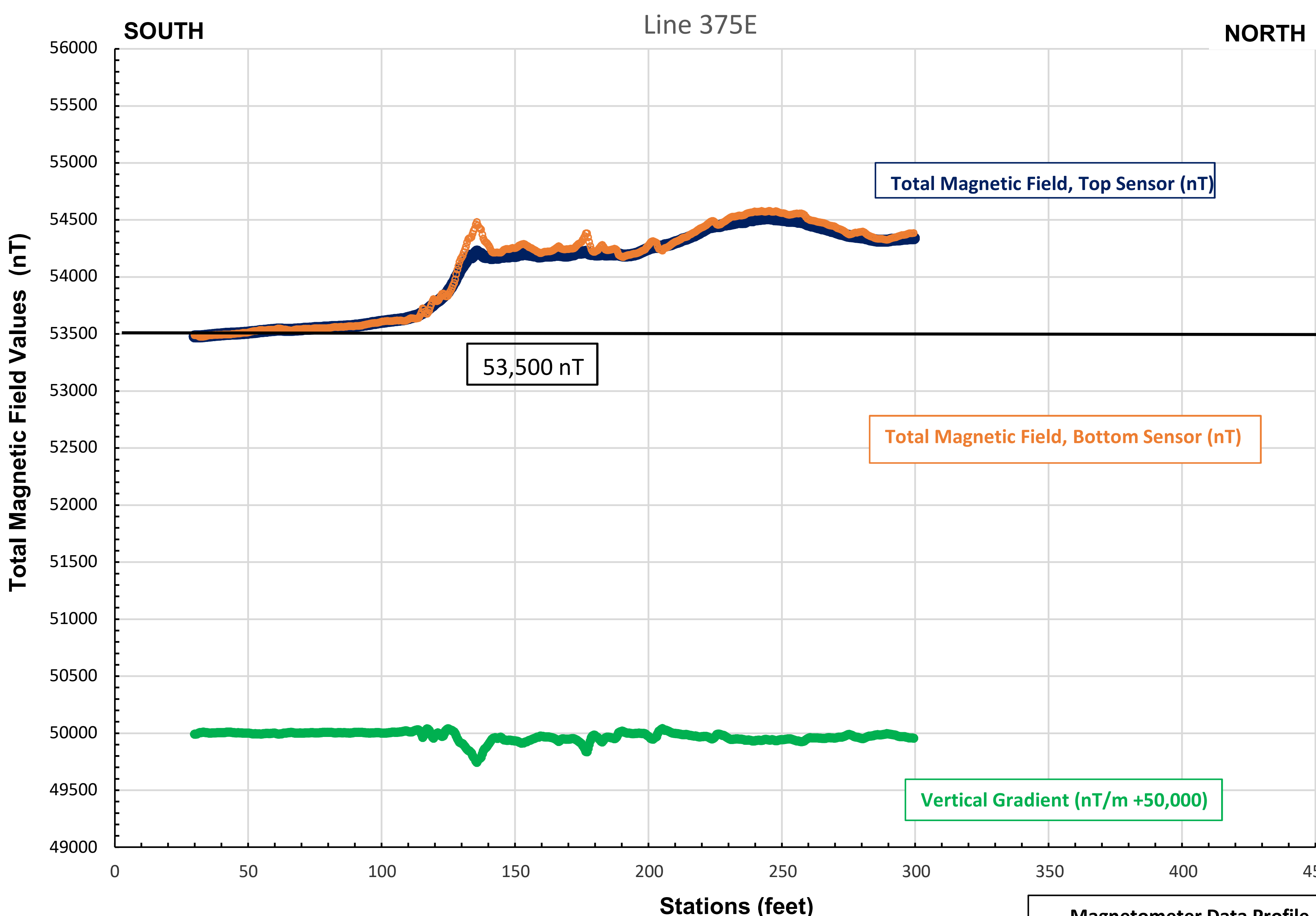
Vashon Landfill Investigation
P. Duoos, PN 1262

Magnetometer Data Profile
South Slope Area
LINE 200E



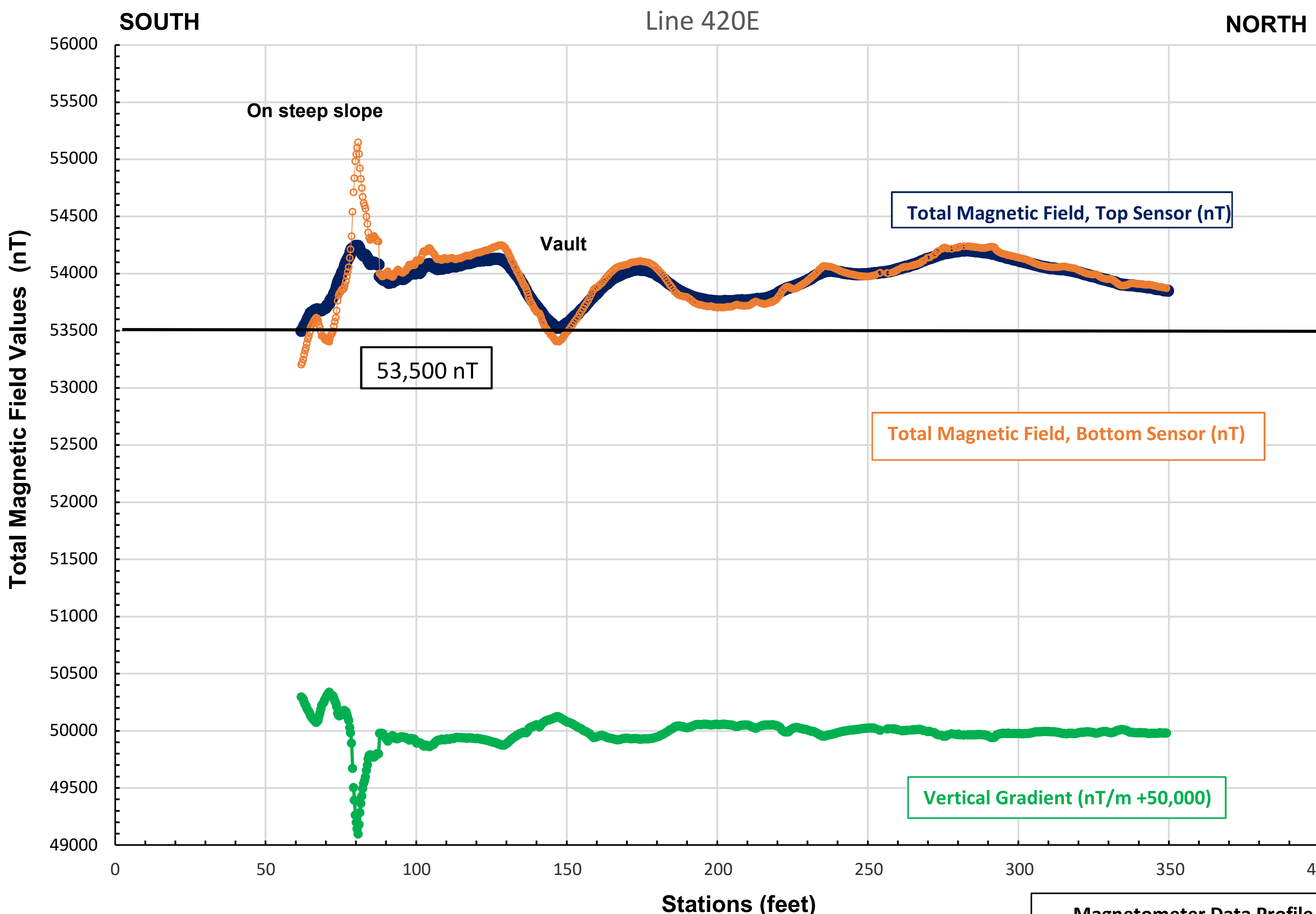
SOUTH
Line 300E
NORTH
Catch Basin
Total Magnetic Field, Top Sensor (nT)
53,500 nT
Total Magnetic Field, Bottom Sensor (nT)
Vertical Gradient (nT/m +50,000)
Total Magnetic Field Values (nT)
56000
55500
55000
54500
54000
53500
53000
52500
52000
51500
51000
50500
50000
49500
49000
0
50
100
150
200
250
300
350
400
Stations (feet)
Magnetometer Data Profile
South Slope Area
LINE 300E
Vashon Landfill Investigation
P. Duoos, PN 1262


SOUTH
Line 350E
NORTH
Vault
Fence
Total Magnetic Field, Top Sensor (nT)
Total Magnetic Field, Bottom Sensor (nT)
53,500 nT
Vertical Gradient (nT/m +50,000)
Total Magnetic Field Values (nT)
56000
55500
55000
54500
54000
53500
53000
52500
52000
51500
51000
50500
50000
49500
49000
0
50
100
150
200
250
300
350
400
Stations (feet)
Vashon Landfill Investigation
P. Duoos, PN 1262
Magnetometer Data Profile
South Slope Area
LINE 350E



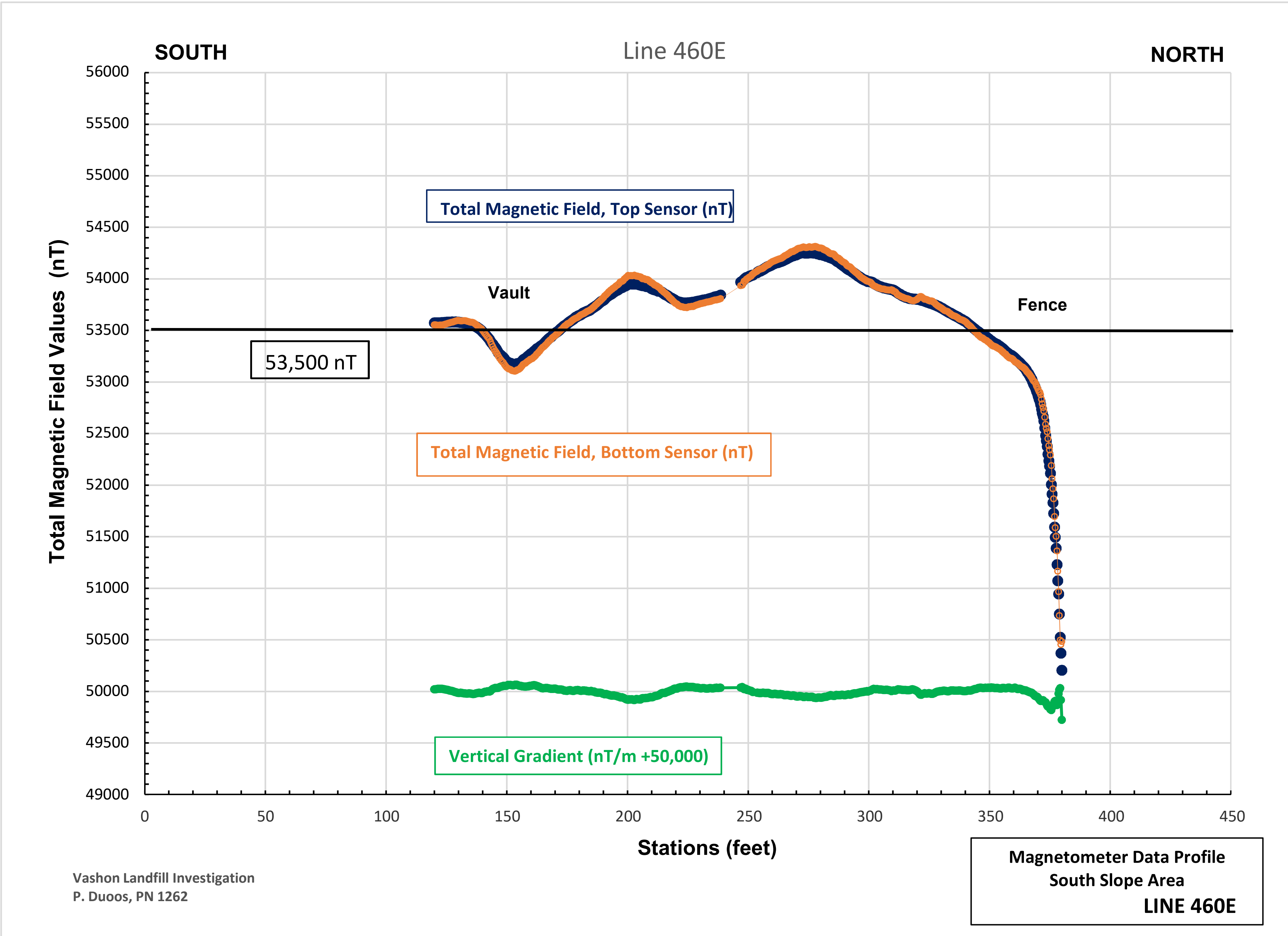
Vashon Landfill Investigation
P. Duoos, PN 1262

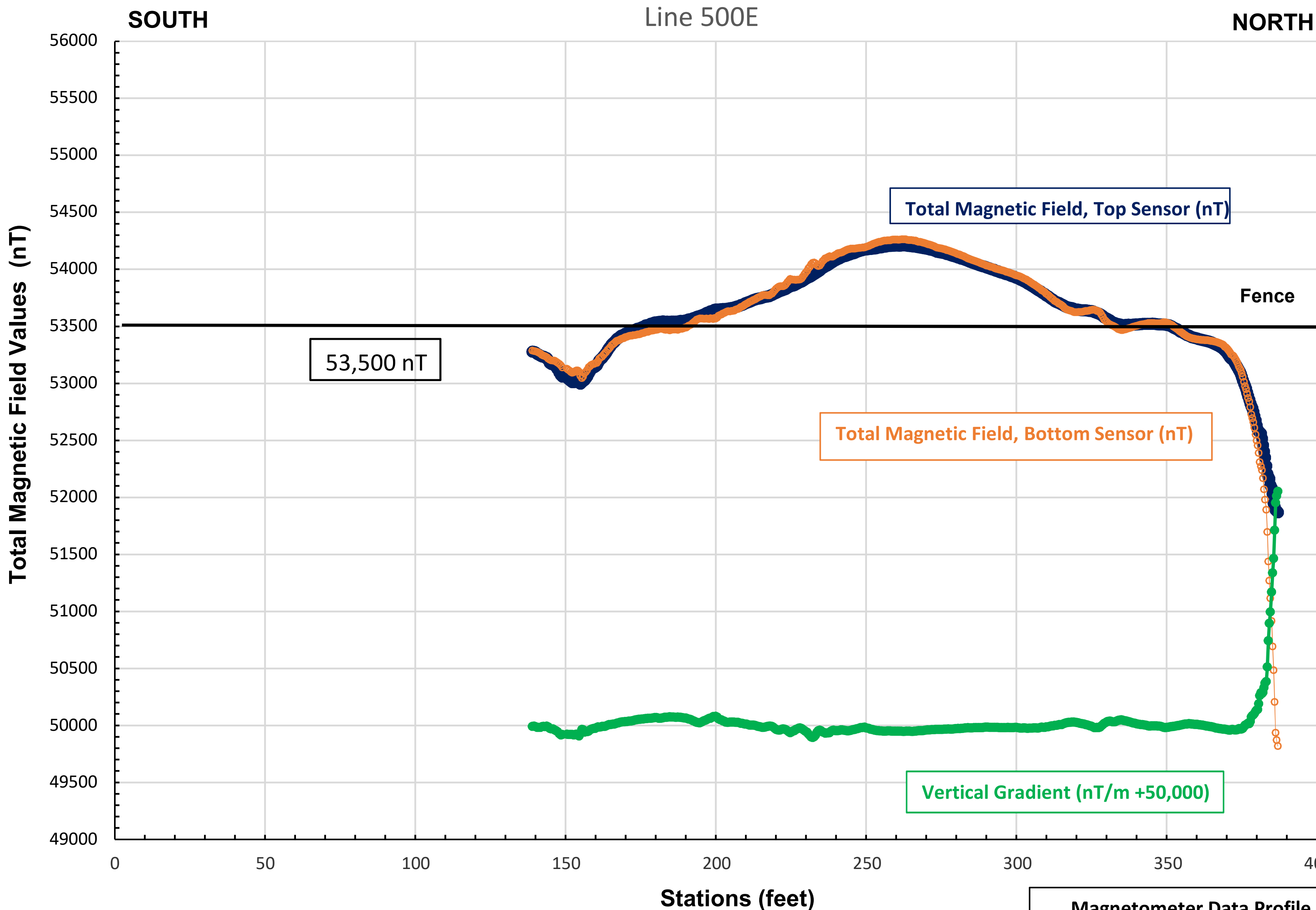
Magnetometer Data Profile
South Slope Area
LINE 375E



Vashon Landfill Investigation
P. Duoos, PN 1262

Magnetometer Data Profile
South Slope Area
LINE 420E


Line 460E
SOUTH
NORTH
Total Magnetic Field Values (nT)
56000
55500
55000
54500
54000
53500
53000
52500
52000
51500
51000
50500
50000
49500
49000
Total Magnetic Field, Top Sensor (nT)
Vault
Fence
53,500 nT
Total Magnetic Field, Bottom Sensor (nT)
Vertical Gradient (nT/m +50,000)
0
50
100
150
200
250
300
350
400
450
Stations (feet)
Vashon Landfill Investigation
P. Duoos, PN 1262
Magnetometer Data Profile
South Slope Area
LINE 460E



Vashon Landfill Investigation
P. Duoos, PN 1262

Magnetometer Data Profile
South Slope Area
LINE 500E

Appendix D

South Slope Area
EM-34 Conductivity Data Profiles

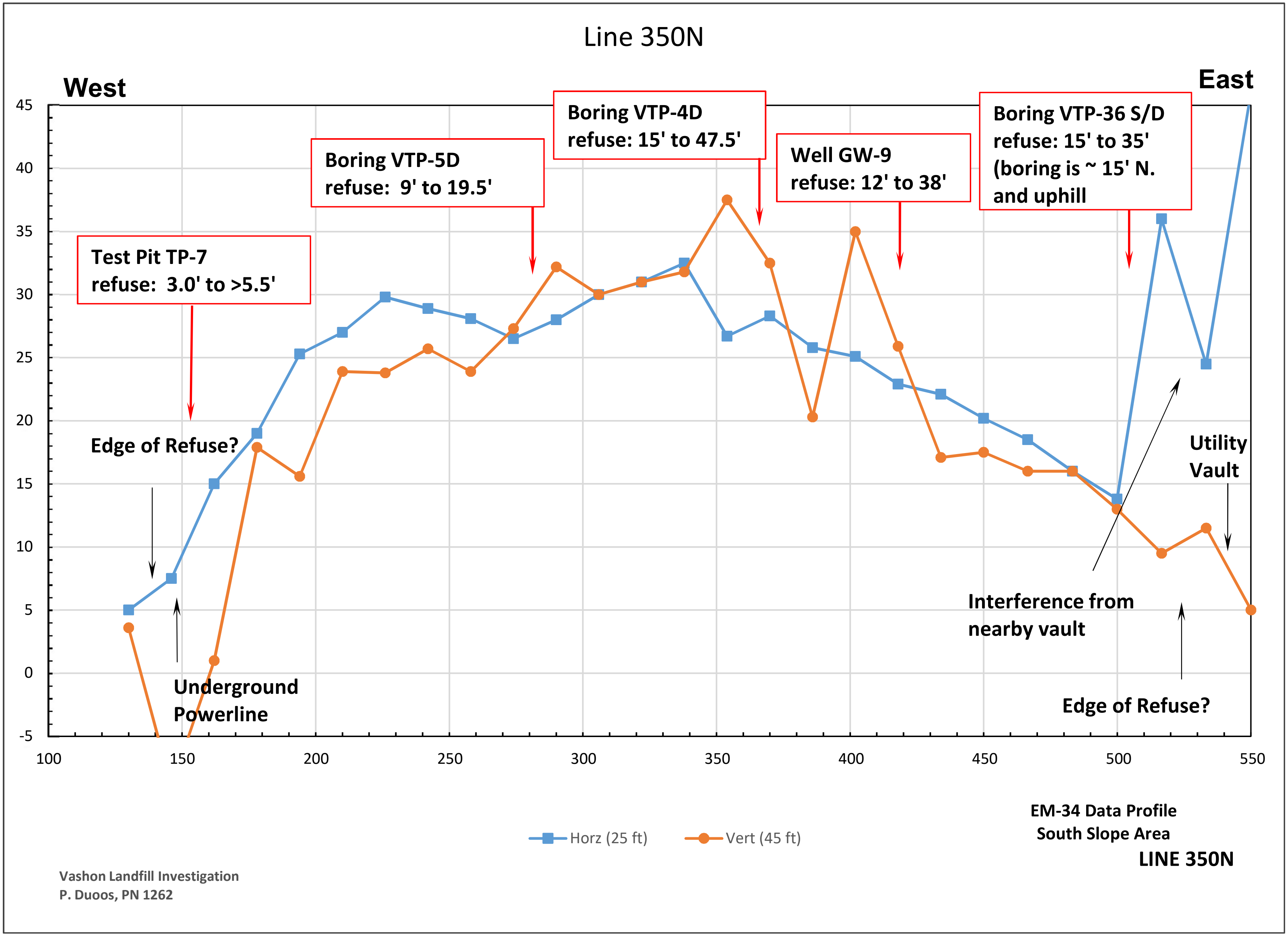
Lines Oriented West – East:

Line 350N
Line 318N
Line 275N
Line 200N

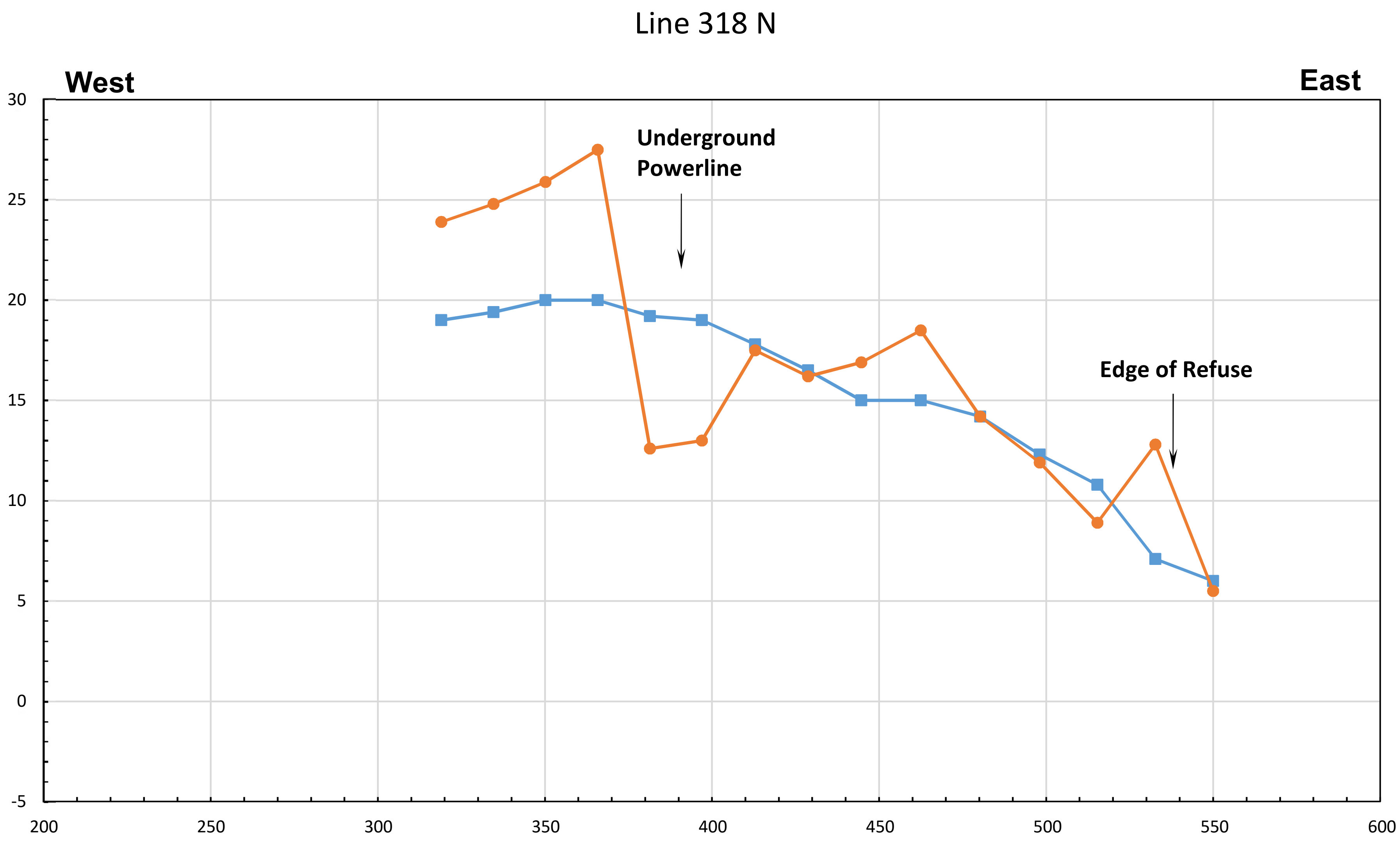
Angled Line Along South Edge

Lines Oriented South – North:

Line 400E

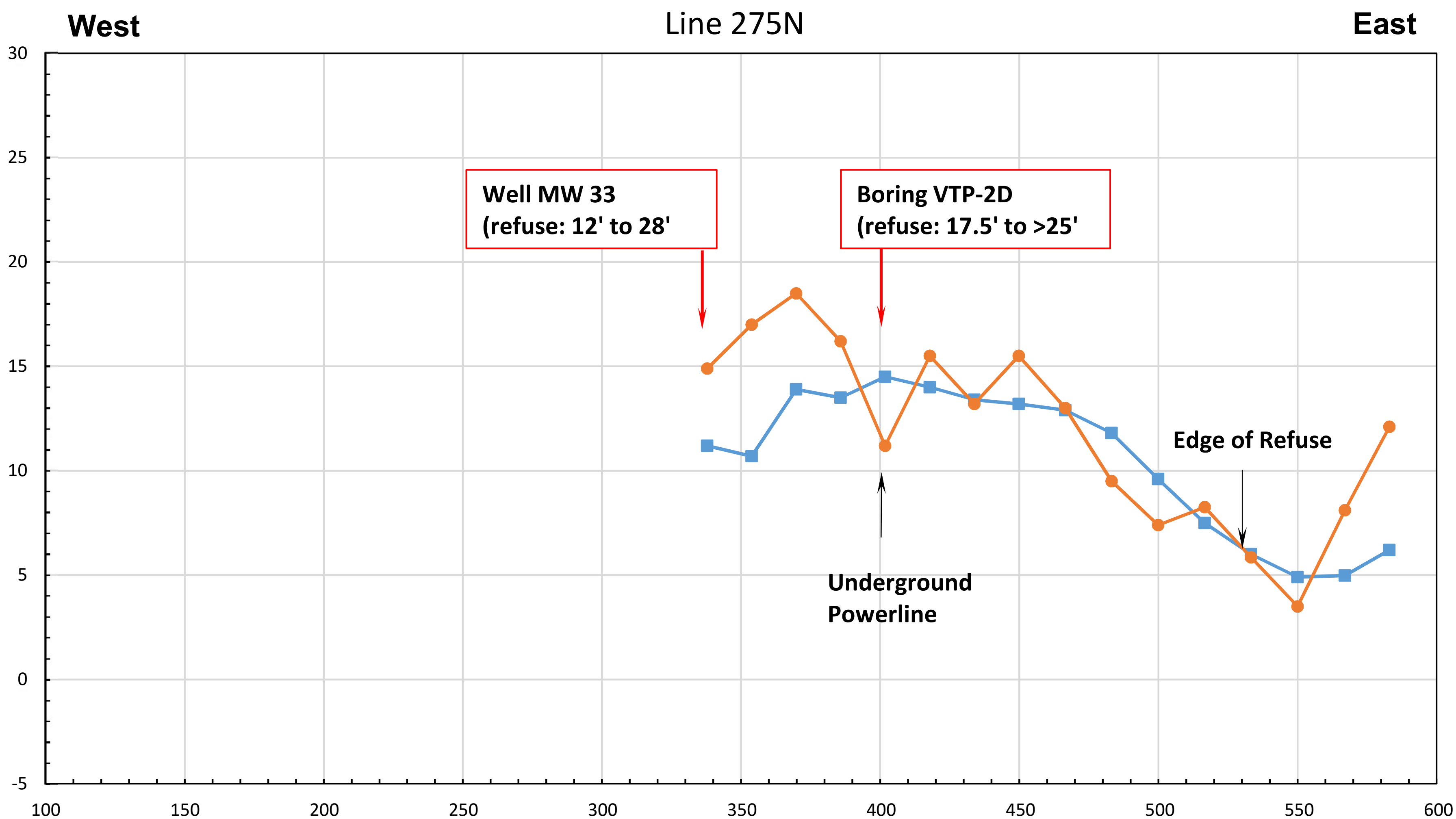


Line 350N
West
East
Test Pit TP-7
refuse: 3.0' to >5.5'
Boring VTP-5D
refuse: 9' to 19.5'
Boring VTP-4D
refuse: 15' to 47.5'
Well GW-9
refuse: 12' to 38'
Boring VTP-36 S/D
refuse: 15' to 35'
(boring is ~ 15' N.
and uphill
Edge of Refuse?
Underground
Powerline
Utility
Vault
Interference from
nearby vault
Edge of Refuse?
45
40
35
30
25
20
15
10
5
0
-5
100
150
200
250
300
350
400
450
500
550
Horz (25 ft)
Vert (45 ft)
EM-34 Data Profile
South Slope Area
LINE 350N
Vashon Landfill Investigation
P. Duoos, PN 1262



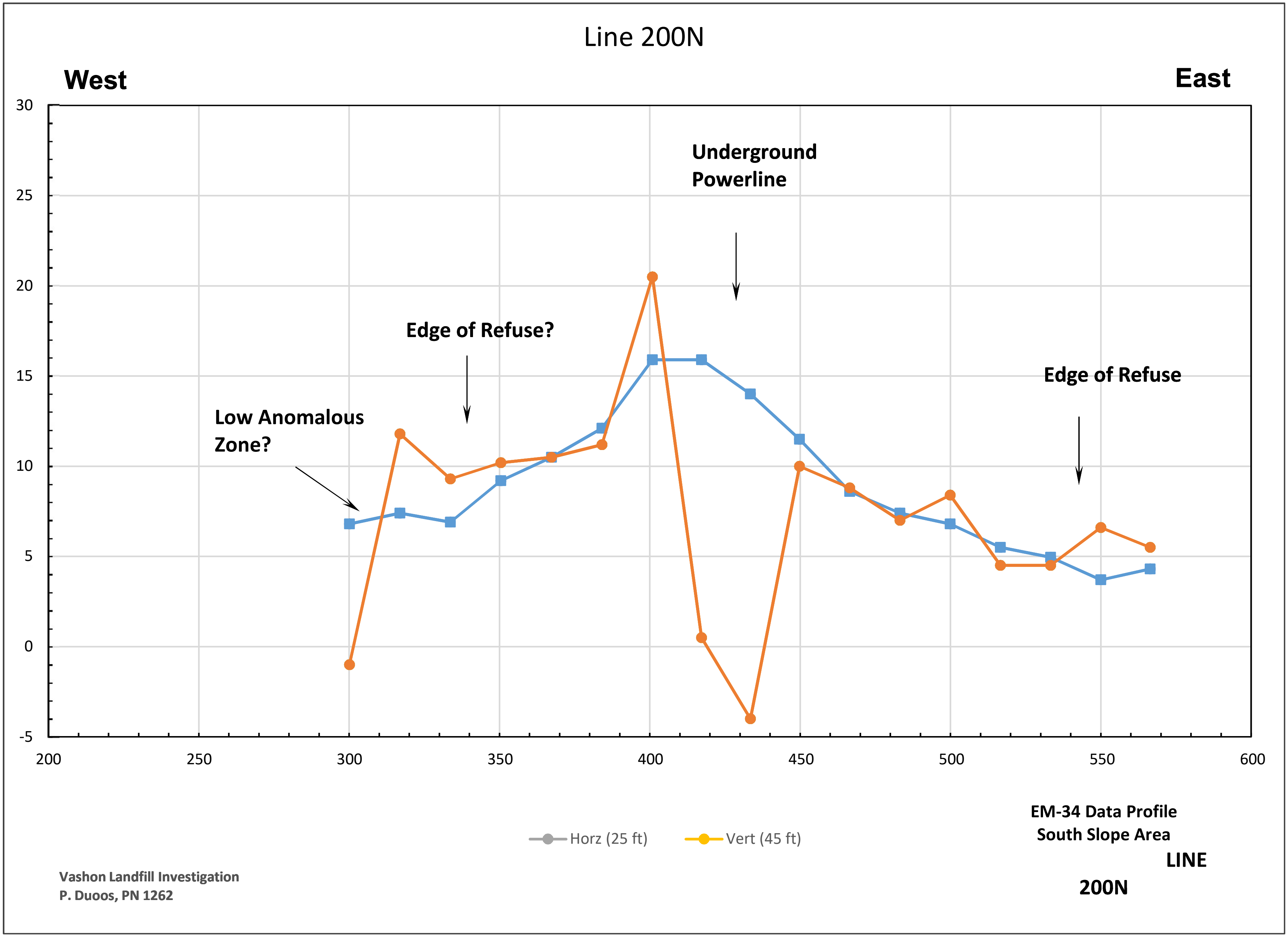
EM-34 Data Profile
South Slope Area
LINE 318N

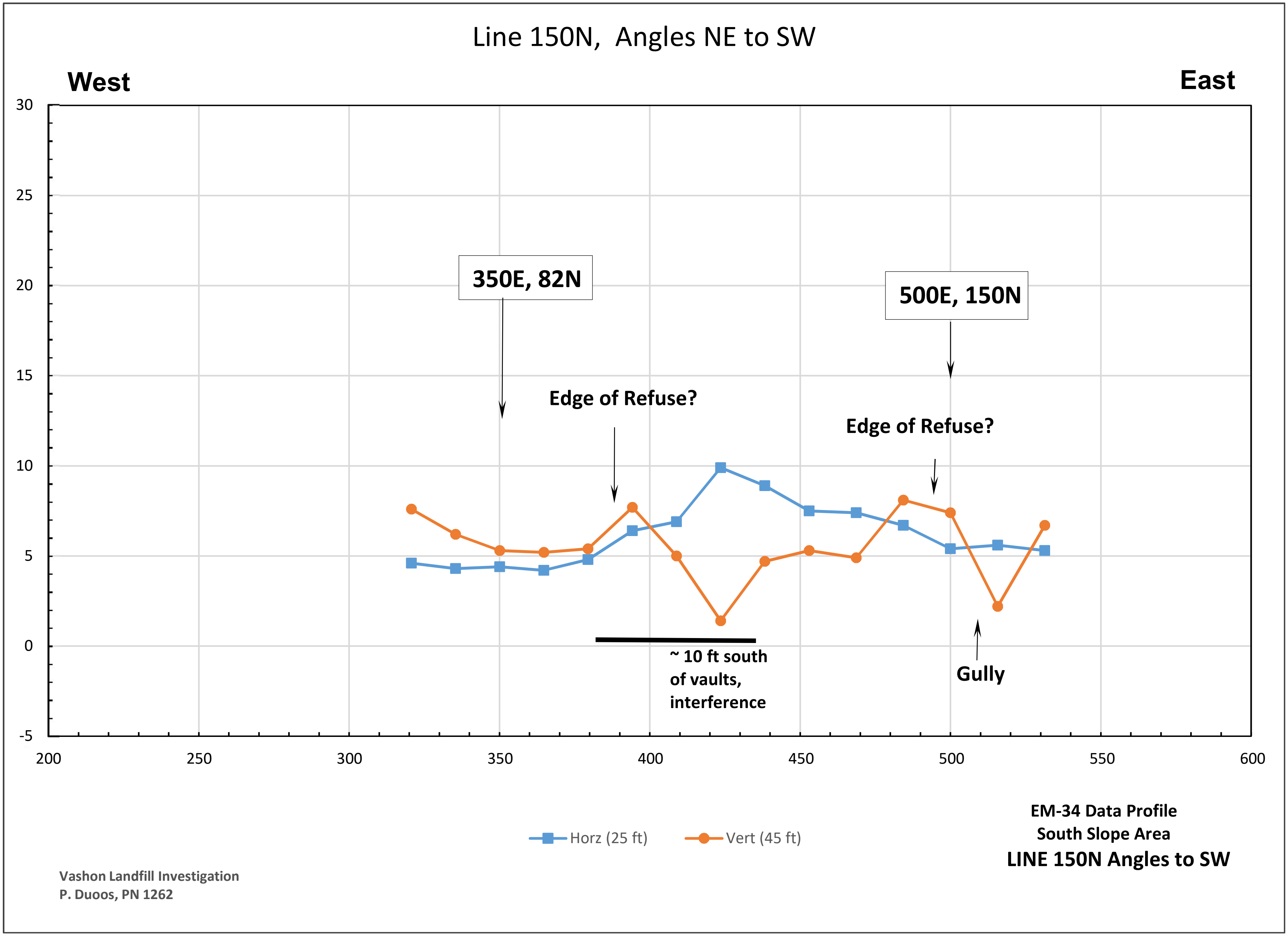
Vashon Landfill Investigation
P. Duoos, PN 1262

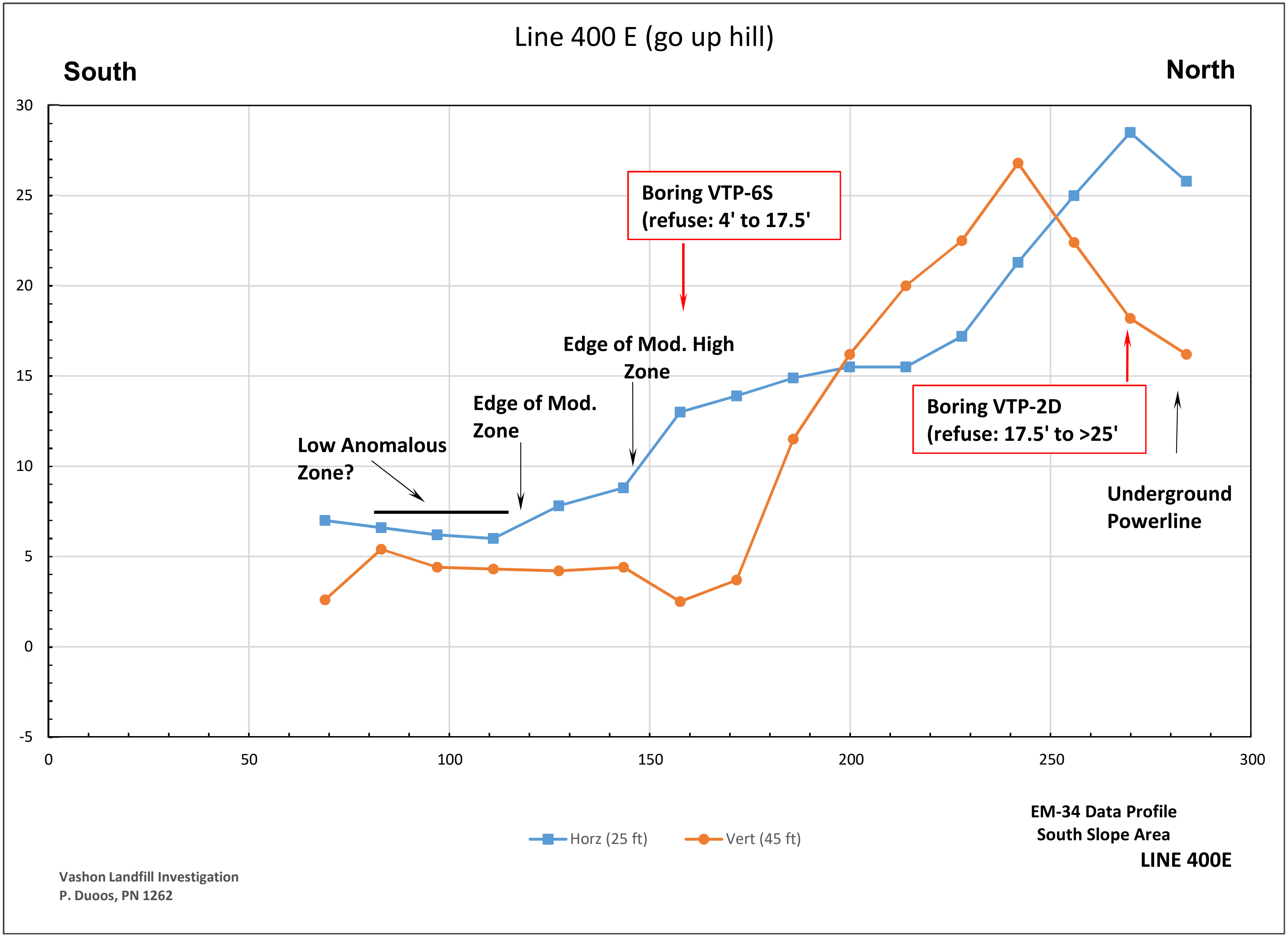


EM-34 Data Profile
South Slope Area
LINE 275N

Vashon Landfill Investigation
P. Duoos, PN 1262


Line 200N
West
East
Underground
Powerline
Edge of Refuse?
Edge of Refuse
Low Anomalous
Zone?
30
25
20
15
10
5
0
-5
200
250
300
350
400
450
500
550
600
Horz (25 ft)
Vert (45 ft)
EM-34 Data Profile
South Slope Area
LINE
200N
Vashon Landfill Investigation
P. Duoos, PN 1262


Line 150N, Angles NE to SW
West
East
350E, 82N
500E, 150N
Edge of Refuse?
Edge of Refuse?
~ 10 ft south
of vaults,
interference
Gully
30
25
20
15
10
5
0
-5
200
250
300
350
400
450
500
550
600
Horz (25 ft)
Vert (45 ft)
EM-34 Data Profile
South Slope Area
LINE 150N Angles to SW
Vashon Landfill Investigation
P. Duoos, PN 1262


Line 400 E (go up hill)
South
North
30
25
20
15
10
5
0
-5
0
50
100
150
200
250
300
Boring VTP-6S
(refuse: 4' to 17.5'
Edge of Mod. High
Zone
Edge of Mod.
Zone
Low Anomalous
Zone?
Boring VTP-2D
(refuse: 17.5' to >25'
Underground
Powerline
Horz (25 ft)
Vert (45 ft)
EM-34 Data Profile
South Slope Area
LINE 400E
Vashon Landfill Investigation
P. Duoos, PN 1262

APPENDIX D

LFG Equipment Evaluation Report

King County Department of Natural Resources and Parks

Solid Waste Division

MULTI-DISCIPLINARY ENVIRONMENTAL CONTROLS SYSTEM
WORK ORDER CONTRACT
CONTRACT NO. E00404E16, WORK ORDER 13, TASK 400.2

VASHON CUSTODIAL LANDFILL – LANDFILL GAS EQUIPMENT EVALUATION

Prepared by

Herrera Environmental Consultants, Inc.
2200 Sixth Avenue, Suite 1100
Seattle, Washington 98121
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Follett Engineering
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Seattle Washington 98115
425.765.6304

King County
Department of
Natural Resources and Parks
Solid Waste Division

Waste Prevention · Resource Recovery · Waste Disposal

www.kingcounty.gov/solidwaste

August 31, 2018

Note:
Some pages in this document have been purposely skipped or blank pages inserted so that this document will copy correctly when duplexed.

VASHON CUSTODIAL LANDFILL – LANDFILL GAS EQUIPMENT EVALUATION

WORK ORDER 13, TASK 400.2

Prepared for

King County

Department of Natural Resources and Parks
Solid Waste Division
201 South Jackson Street, Room 701
Seattle, Washington 98104

by

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August 31, 2018

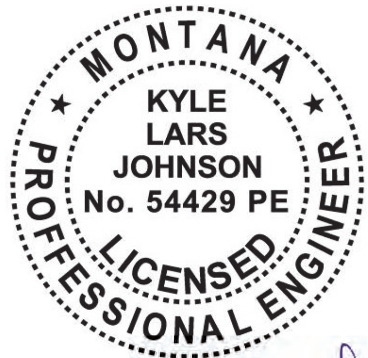
PRINTED ON RECYCLED PAPER

ENGINEERS' STAMPS

This report has been prepared under the supervision of registered professional engineers.

Michael M. Spillane, PE
Project Engineer
mspillane@herrerainc.com

Date: August 31, 2018



Kyle L. Johnson, PE
Project Engineer
kjohnson@herrerainc.com

Date: August 31, 2018

Vincent M. Follett, PE
Electrical Engineer
vince@FollettEngineering.com

Date: August 31, 2018

TABLE OF CONTENTS

Engineers' Stamps i
List of Figures iv
List of Attachments iv
1.0 Introduction 1
1.1 Background 1
1.2 Data Review 2
2.0 Site Inspections and Condition Assessment 3
2.1 LFG Blowers and Motors 3
2.2 Blower and Motor Electrical 3
3.0 Repair/Replacement Evaluation 4
3.1 Blower and Motors 4
3.2 Blower and Motor Electrical 5
4.0 Recommendations 6
4.1 Blower and Motors 6
4.2 Blower and Motor Electrical 6

LIST OF FIGURES

Figure 1. Project Location Map. Figures-1
Figure 2. Site Layout. Figures-3
Figure 3. LFG Blower/Motor Figures-5

LIST OF ATTACHMENTS

Attachment A Site Inspection Write-Up
Attachment B Opinions of Probable Construction Costs
Attachment C Vendor Quotes
Attachment D Vendor Cut Sheets

1.0 INTRODUCTION

Critical equipment components of the environmental control systems at multiple King County Solid Waste Division (KCSWD) Custodial and Closed Landfills are nearing or have passed their design lifespan. This report presents the inspection and evaluation to determine if the current landfill gas treatment system at the Vashon Landfill meets:

- The original design specification
- Current function and operating requirements
- Equipment interchangeability/standardization criteria between landfills

Currently installed equipment requires either maintenance, repair, and/or replacement to maintain the continued functionality for the environmental controls systems. Recommendations for alternatives for maintenance, repair, and/or replacement are provided addressing:

- Equipment specification
- Equipment vendor/supplier
- Cost estimates for implementation
- Estimated schedule for implementation

1.1 Background

Treatment of landfill gas (LFG) at the Vashon Closed Landfill is performed by a fixed fan transporting the LFG to a series of granulated activated carbon (GAC) containers and then vented into the atmosphere. There are eight total GAC containers, with two working at a time, rotated monthly. The existing fan is a Hauck model TBGB-090-250B-11, with a belt-drive 7.5 horsepower (HP) motor, producing an actual fan speed of 3,756 rpm. At 6 amps and 480 volts, the resulting power used by the motor equates to approximately 4.5 BHp.

The LFG has a relatively low (~2 percent) methane content pulled from various wells that are expected to have restricted airflow. The main header near the sinking road at the north end of the landfill has a low point, and water collects in the header, which mobilizes during system operation, which causes the system to surge. If this restriction and low point is fixed, the expected flow rate would likely increase.

Our evaluation will include options for replacing the existing blower and motor with a direct-drive system, along with an option to modify the single blower configuration to a duplex blower configuration.

1.2 Data Review

The documents listed below were reviewed as part of the equipment evaluation. These documents will be provided electronically.

- 1997 Vashon Landfill Interior Gas Collection and Treatment System O&M Manual
- Vashon Landfill Final Closure (March 2001)
- Vashon Island Closed Landfill Plan of Operations and Post-Closure Plan, Volumes I of III, Parts 1 through 4 (December 2005)

2.0 SITE INSPECTIONS AND CONDITION ASSESSMENT

This section describes the findings during the site inspections. A complete site visit write-up is provided in Attachment A.

2.1 LFG Blowers and Motors

The current system is operational, consisting of one Hauck belt-drive blower with a Class 1 Division 1 rated motor. The system is operating at 32 to 33 inches water column (w.c.) vacuum at the blower and has a discharge pressure of 3 to 7 inches w.c. There is a noticeable surging in the system noted as condensate in the manifold sag at the corner of the entrance road where the road is also sagging.

The gas concentration at the blower is 2.5 percent methane, 10.9 percent methane, and 9.2 percent oxygen with a temperature of 58 degrees Fahrenheit. The manifold piping is 6-inch HDPE with an inside diameter (ID) of approximately 5.5 inches. The blower has an outlet diameter of 6 inches and inlet diameter of 10 inches.

The blower is mounted on a 69- by 39-inch concrete pedestal, which will need to be modified to accommodate a direct-drive motor. The pedestal would need to be further modified to accommodate a duplex system. The blower-frame anchor bolts are not installed correctly, and the nuts are not seated. The 6-inch flex couplings are deteriorated and need replacement.

The eight GAC vessels are operational, but the hoses are showing wear; and the gate valve at the tee adjacent to GAC vessel 1 is broken. The drain valve on the stainless steel GAC inlet manifold is heat traced and jacketed; however, the valve is capped. Its use may or may not be needed based on the original design drawings.

Magnehelic gages are installed upstream and downstream of the air diffuser; however, the tubing is broken at the inlet to the gages. Another pressure gage is mounted on the discharge side of the blower and is functional. Flow is approximately 300 SCFM, but the flow meter indicator reads 90 to 100 SCFM and is not registering correctly. The calibration of the flow meter needs to be verified; and, if a new flow meter is needed, it should be monitored by supervisory control and data acquisition (SCADA) and will need to have adequate upstream and downstream clear distances.

2.2 Blower and Motor Electrical

The existing blower motor starter is functional and is wired for 230/460 volt 3,485 rpm at 7.5 BHp but is beyond its service life and should be replaced to maintain reliable operation of the blower. The electrical panel for the motor starter is rusted and should be replaced. An old derelict rain gage wiring harness should be removed from the panels.

Along with replacing the motor starter components, replacement of the conduit and conductors between the blowers and the motor starter will be necessary and potentially some or all of the control wiring will need to be replaced.

3.0 REPAIR/REPLACEMENT EVALUATION

This section describes condition assessment and repair/replacement evaluations. See Attachment B: Opinions of Probable Construction Costs, for a breakdown of each option. For repair/replacement options (vendor options, cut sheets, model numbers, curves, and costs), see Vendor Quotes and Vendor Cut Sheets in Attachments C and D.

3.1 Blower and Motors

The current system is operational but should be upgraded to extend the service life. Options for upgrade include replacing the current motor and blower with a direct-drive configuration, or replacing the existing belt-drive motor and blower, both maintaining the same flow rate. A second option is to modify the system to a duplex configuration with a manual switch. For each of the options, performance criteria are similar to the existing system but represent multiple vendors to eliminate the potential for sole sourcing.

In all options, hoses, wiring, and gaging will need to be replaced as described above to match the serviceable life of the upgraded system.

Option 1A – Replace Motor and Blower (direct drive)

Single New York Blower 2206A10 Pressure Blower with aluminum radial bladed wheel, arrangement 8 direct-drive configuration with Baldor model EM7174T-I 10 HP motor.

- Implementation Cost: $22,500 to $27,500.
- Implementation Schedule: Allow 4 weeks for submittal and review, 5 to 7 weeks to ship, 1 week transit time, and 1 week installation time; totaling 11 to 13 weeks.

Option 1B – Replace Motor and Blower (belt drive)

Single New York Blower 2606 Pressure Blower with aluminum radial bladed wheel, arrangement 1 belt-drive configuration with Baldor TEFC Severe Duty 7.5 HP motor.

- Implementation Cost: $25,000 to $30,000.
- Implementation Schedule: Allow 4 weeks for submittal and review, 5 to 7 weeks to ship, 1 week transit time, and 1 week installation time; totaling 11 to 13 weeks.

Single Hoffman Lamson, by Gardner Denver Tubotron Exhauster Package with explosion-proof 10 HP motor.

- Implementation Cost: $40,000 to $45,000.
- Implementation Schedule: Allow 4 weeks for submittal and review, 12 to 14 weeks lead time, 1 week transit time, and 1 week installation time; totaling 18 to 20 weeks.

Option 2A – Replace Motor and Blower with Duplex System (direct drive)

Duplex New York Blowers 2206A10 Pressure Blower with aluminum radial bladed wheel, arrangement 8 direct drive configuration with Baldor model EM7174T-I 10 HP motor.

- Implementation Cost: $35,000 to $40,000.
- Implementation Schedule: Allow 4 weeks for submittal and review, 5 to 7 weeks to ship, 1 week transit time, and 1 week installation time; totaling 11 to 13 weeks.

Option 2B – Replace Motor and Blower with Duplex System (belt drive)

Duplex New York Blower 2606 Pressure Blowers with aluminum radial-bladed wheel, arrangement 1 belt-drive configuration with Baldor TEFC Severe Duty 7.5 HP motors.

- Implementation Cost: $40,000 to $45,000.
- Implementation Schedule: Allow 4 weeks for submittal and review, 5 to 7 weeks to ship, 1 week transit time, and 2 weeks installation time; totaling 12 to 14 weeks.

Duplex Hoffman Lamson, by Gardner Denver Tubotron Exhauster Package with explosion-proof 10 HP motors.

- Implementation Cost: $65,000 to $70,000.
- Implementation Schedule: Allow 4 weeks for submittal and review, 12 to 14 weeks lead time, 1 week transit time, and 2 weeks installation time; totaling 19 to 21 weeks.

3.2 Blower and Motor Electrical

Option 1 – Replace Motor and Blower (Single)

Repair/replace electrical covers and fittings that are damaged along with the blower motor starter and related components. No modifications to existing system.

- Implementation Costs: $15,000 to $20,000.

Option 2 – Replace Motor and Blower (duplex)

Repair/replace electrical covers and fittings that are damaged along with the blower motor starter and related components. Modifications to existing system to accommodate duplex system included.

- Implementation Costs: $20,000 to $30,000.

4.0 RECOMMENDATIONS

4.1 Blower and Motors

The existing motor and blower are functional. However, as the service life of the existing blower and motor have nearly expired, it is our recommendation that they be replaced. Additional upgrades and maintenance to the GAC system piping, valving, and fittings can be completed at the same time, at a benefit to the system as a whole. We also recommend the modification of the system to accommodate a manual switch, duplex system to allow for easier maintenance options and to further extend the service life.

Due to cost and interchangeability/standardization with equipment at other landfill sites, it is our recommendation that the replacement be New York Blower 2206A10 Pressure Blowers with aluminum radial-bladed wheel, arrangement 8 direct-drive configuration with Baldor model EM7174T-I 10 HP motor.

4.2 Blower and Motor Electrical

The existing blower motor starter is functional and is wired for 230/460 volt 3,485 rpm at 7.5 BHp but is beyond its service life and should be replaced to maintain reliable operation of the blower.

Along with replacing the motor starter components, supporting work will also require replacement of the wire between the blowers and the motor starter and potentially some or all of the control wiring.

Figures

King County DNRP

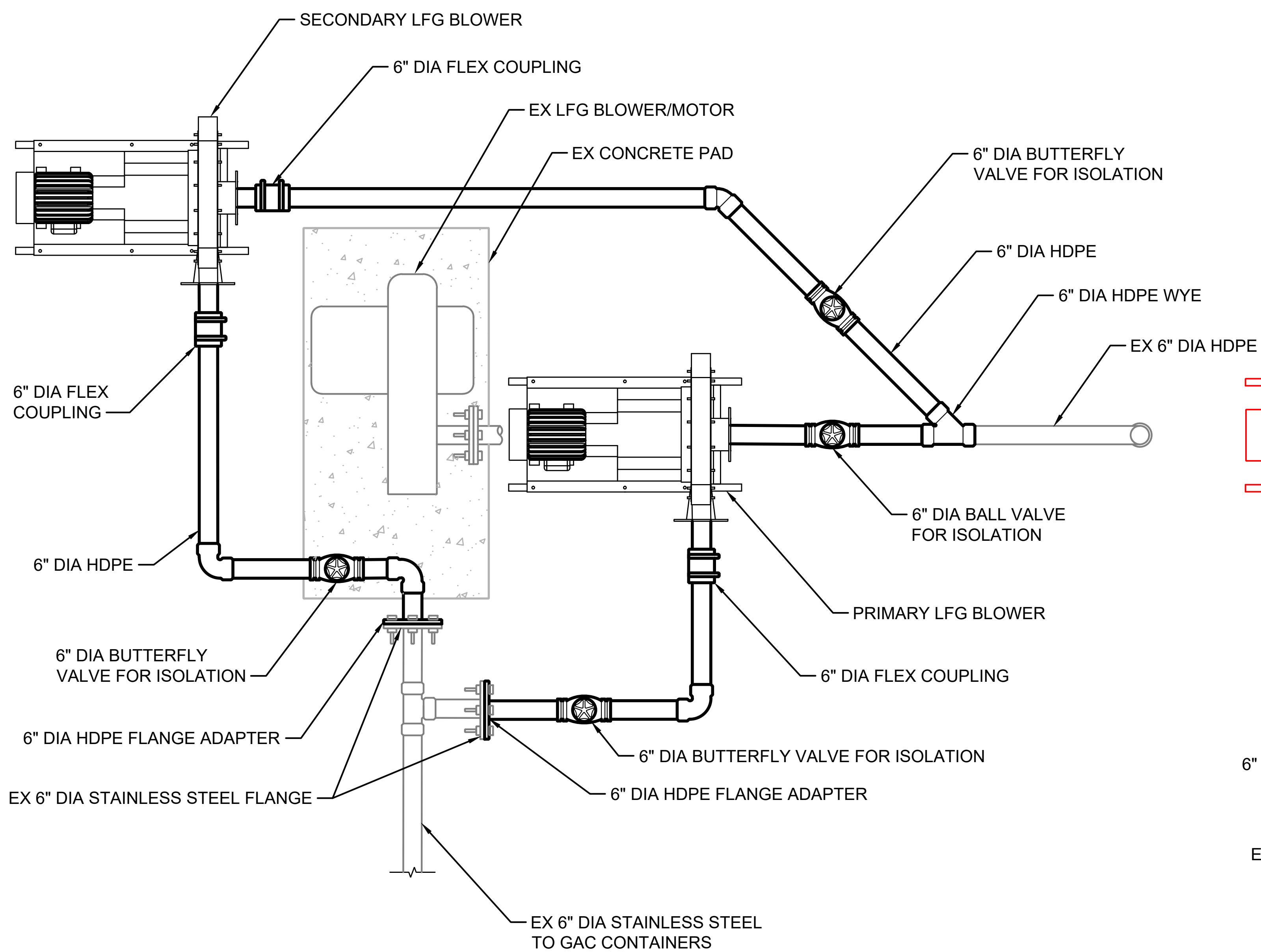
HERRERA

VASHON CUSTODIAL LANDFILL

PROJECT LOCATION MAP

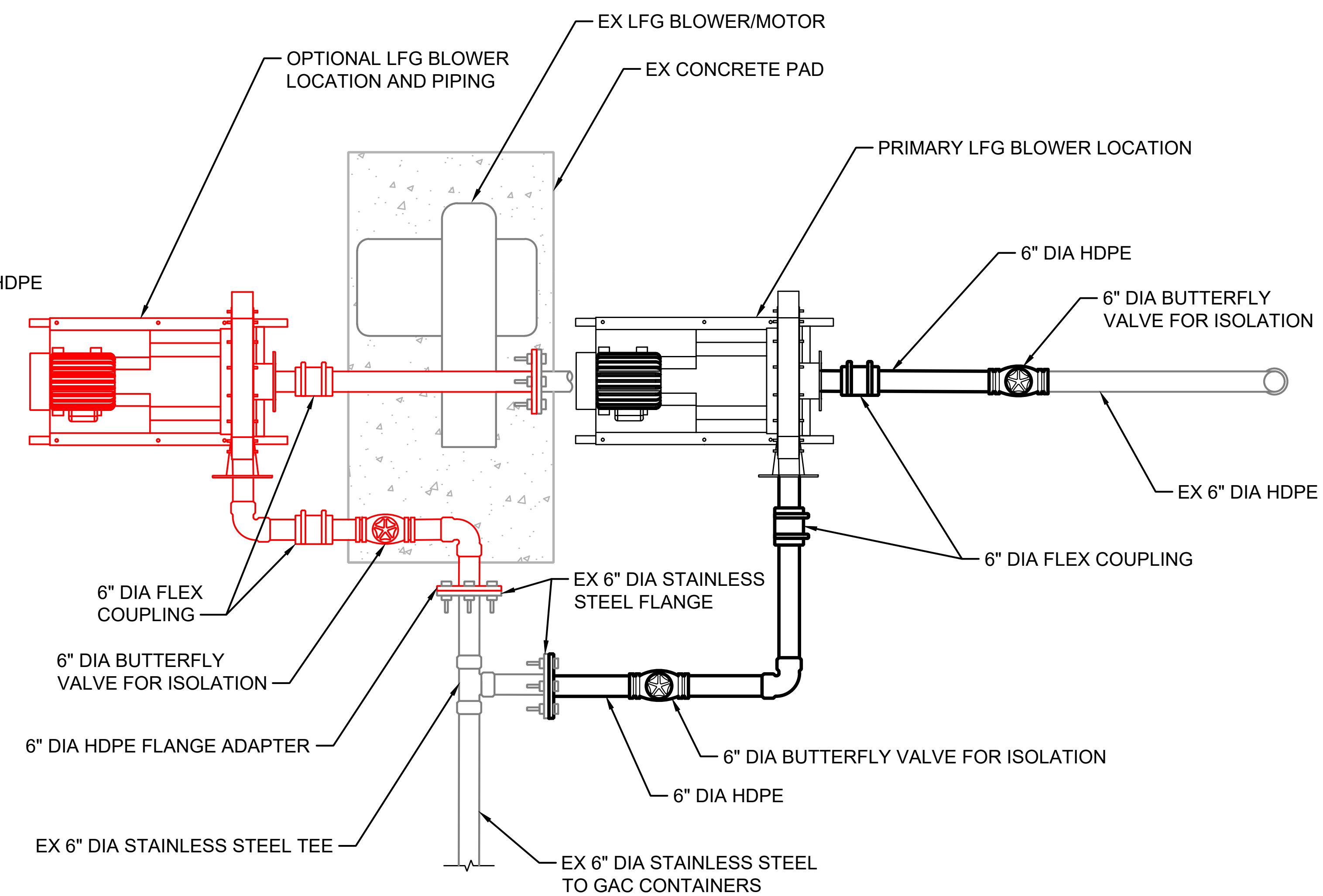
FIGURE 1

O:\proj\Y2016\16-06231-016\CAD\Dwg\LFG Eval\Figure 1.dwg



OPTION 1 - DUAL BLOWER CONFIGURATION

SCALE: NTS



OPTION 2 - SINGLE BLOWER CONFIGURATION

SCALE: NTS

King County DNRP

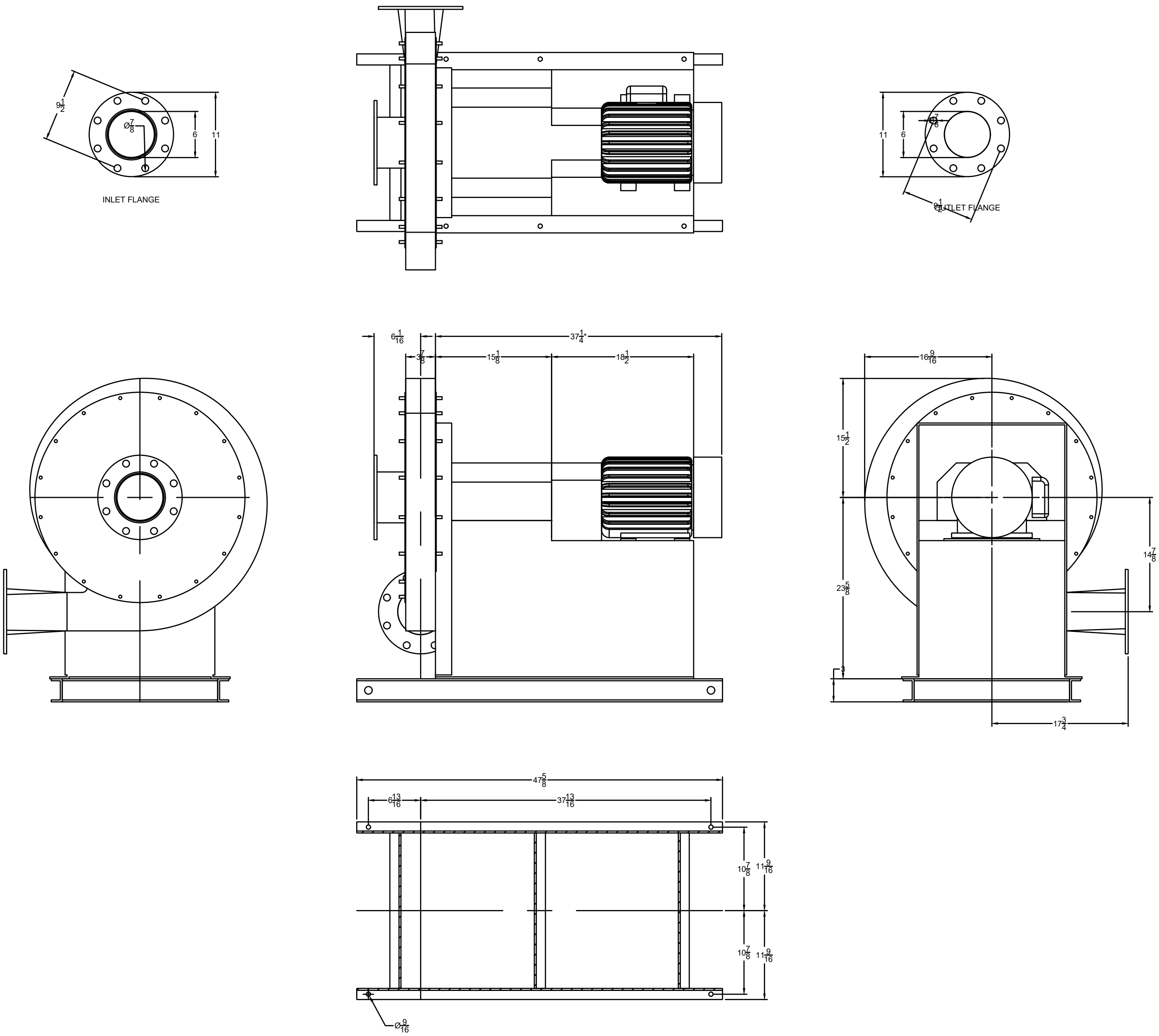
HERRERA

O:\proj\Y2016\16-06231-016\CAD\Dwg\LFG Eval\Figure 2.dwg

VASHON CUSTODIAL LANDFILL

SITE LAYOUT

FIGURE 2



King County
DNRP

HERRERA

VASHON CUSTODIAL LANDFILL

LFG BLOWER/MOTOR

FIGURE 3

O:\proj\Y2016\16-06231-016\CAD\Dwg\LFG Eval\Figure 3.dwg

Attachment A

Site Inspection Write-Up

MEETING SUMMARY

Work Order No.	13 - Duvall, Vashon Equipment Evaluation
Contract Number	E00404E16
Task	300.2 LFG Blower and Motor Field Notes and Photos
Date | Time	May 1, 2018 | 9:00am to 11:30 am
Location	Vashon Landfill

Re: Work Order No. 13 - Custodial & Closed Landfill - Landfill Gas Environmental Control System Equipment Evaluation and Alternatives Analysis at Vashon – Task 300.2 Site Visits.

Attendees:

Sendy Jimenez, King County	Michael Spillane, Herrera Environmental Consultants
Jeff Dye, King County	Vince Follett, Follett Engineering
Rusty Bogart, King County	Dan Bureau, Baxter Air
Dan Swope, King County	

Additional Attendees: Inspected leachate wet well and pump station. (Field notes for inspection will be submitted separately.)

Marissa Baptista, King County	Matt McCullum, King County
Karen Wilcock, King County	Aaron Werner, BHC
Jim Bagger, King County	

Agenda

Vashon Landfill

- Introduction
- Safety Moment
- Blower Inspection
- Conclusion

Field Notes

Vashon LFG Blower

- Herrera requested maintenance logs and a history of repairs on blower and GAC vessels.
- System is operational. Has one Hauck belt drive blower with Class 1 Div. 1 rated motor.
- System operating at 32 to 33 inches of water column (wc) vacuum at blower and discharge pressure of 3 to 7 inches. There is noticeable surging in the system noted as condensate in manifold sag and corner of entrance road where the road is also sagging.
- Gas concentration at blower is 2.5% methane, 10.9% CO_2, and 9.2% oxygen. Temp is 58 degrees Fahrenheit.
- Manifold piping is 6-inch HDPE with ID of 5.5 inches approximately.
- Blower has 6-inch outlet and 10-inch inlet.
- 6-inch Flex couplings are deteriorated and need replacement.
- Gate valve at tee to adjacent GAC vessel 1 is broken and needs to be replaced.
- Blower is mounted on 69x39 inch concrete pedestal. The pedestal will need to be modified to accommodate direct drive motors. Will need to modify piping to accommodate duplex station and or to swap out single blower configuration. There is adequate room to install blowers direct drive configuration.
- Flow instrument, if replaced will need to have adequate upstream and downstream clear distances.
- Magnehelic gages are installed upstream and downstream of the air diffuser however the tubing is broken at the inlet to the gages. Another pressure gage is mounted on the discharge side of the blower and is functional.
- Electrical panel for motor starter is rusted and should be replaced.
- Old derelict rain gage wiring should be removed from panels.
- Blowers are wired for 230/460 3485 rpm at 7.5 HP.
- There are 8 GAC vessels. Two of them actively used in treatment train.
- Hoses show wear.
- Drain valve on stainless steel GAC inlet manifold is heat traced and jacketed however valve is capped. Need to verify use and need with original design drawings.
- Flow is approximately 300 SCFM. Flow meter indicator reads 90 to 100 and is not registering correctly. Need to verify calibration and if new flow meter is needed and if it is to be monitored by SCADA.
- Condensate (below grade) knockout vessel is working. High level alarm is monitored by SCADA.
- Need to layout two options for blower configurations. There is 17 feet to diffuser 90 on manifold. Diffuser is not needed. Another 7.25 feet to blower.
- Blower frame anchor bolts are not installed correctly. Nuts are not seated.

General

- Costing improvements will include upgrading blower to direct drive and piping necessary for duplex system manually switched.

- Motor starter panel for blower needs to be replaced and upgraded to accommodate two blowers.

Information Requested From KCSWD

- Need to confirm current SCADA function (and what is currently monitored) and future needs at Vashon. Kris to check with ED Turner.
- Need to confirm if redundant blower is needed.

Photos

See Attached photos and photo log.

Vashon Landfill LFG Blower System Photographic Log

Photo Number	Photo Description
1	GAC Vessels
2	Blower inlet piping
3	Blower inlet piping
4	Knock out and condensate pump
5	Knock out and condensate pump
5	GAC outlet fitting
6	Broken valve flange at GAC manifold
7	Hauck Blower
8	Flex fitting and valve
9	Inlet monitoring station
10	Inlet pressure gage. Broken tubing.
11	Flow instrument
12	Flow readout, showing 96.
13	Flow readout
14	Flow tag
15	Inlet flow reader downstream of diffuser
16	Blower tag
17	Blower tag
18	Power supply to motor
19	Belt cover
20	Discharge flex fitting
21	Discharge butterfly valve
22	Valve tag
23	Blower inlet fittings 6 to 10 inch
24	Blower inlet
25	GAC vessel
26	GAC vessel hatch
27	Vessel tag
28	Vessel tag
29	Blower belts
30	Blower belt
31	Heat traced drain valve
32	Heat traced drain valve
33	Flow instrument tag
34	Flow instrument tag
35	Blower motor tag
36	Blower motor tag
37	GAC inlet hose
38	GAC inlet fitting
40	GAC inlet hose
41	GAC inlet hose
42	GAC vessels

Photo Number	Photo Description
43	Electrical panels
44	Electrical panels
45	Disconnect
46	Electrical panel – showing old weather station wire
47	Electrical panel
48	Panel seal-offs
49	Blower pad anchor bolts
50	Blower skid
51	Condensate pump control
52	Blower tag
53	Blower panel
54	Vessel tag
55	Storage box
56	Storage box
57	Blower inlet flex fitting
58	Blower inlet flex fitting
59	Diffuser valve. Fully closed.
60	Diffuser valve.
61	Expansion fitting
62	Flow instrument
63	Power supply to motor
64	Flow instrument
65	Control panel
66	Permit
67	Heat traced drain valve
68	Heat traced drain valve
69	GAC gallery
70	GAC stainless steel 4-inch manifold
71	Blower starter motor

1. GAC Vessels 1

2. Blower inlet piping

3. Blower inlet piping

4. Knock out and condensate pump

5. Knockout and condensate pump

6. Broken valve flange at GAC manifold

7. Hauck BLower

8. Flex fitting and valve

9. Inlet monitoring station

10. Inlet pressure gauge; broken tubing

11. Flow instrument

12. Flow readout, showing 96

13. Flow readout

14. Flow tag

15. Inlet flow reader downstream of diffuser

16. Blower tag

17. Blower tag


18. Power supply to motor

19. Belt cover

20. Discharge flex fitting

21. Discharge butterfly valve

22. Valve tag

23. Blower inlet fittings 6 to 10 inch

24. Blower inlet

25. GAC vessels

26. GAC vessel hatch

27. Vessel tag

28. Vessel tag

29. Blower belts

30. Blower belt

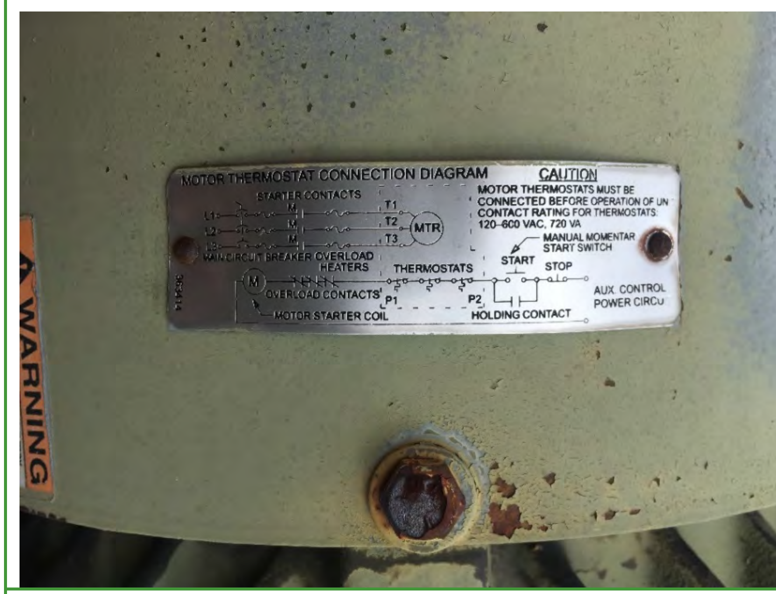
31. Heat traced drain valve

32. Heat traced drain valve

33. Flow instrument tag

34. Flow instrument tag

35. Blower motor tag



36. Blower motor tag

37. Gas inlet hose

38. GAC inlet fitting

39. Gas outlet fitting

40. GAC inlet hose

41. GAC inlet hose

42.Gas vessel

43.Electgrical panels

44. Electrical panels

45. Disconnect

46. Electrical panel showing old weather station wire

47. Electrical panels

48. Panel seal-offs

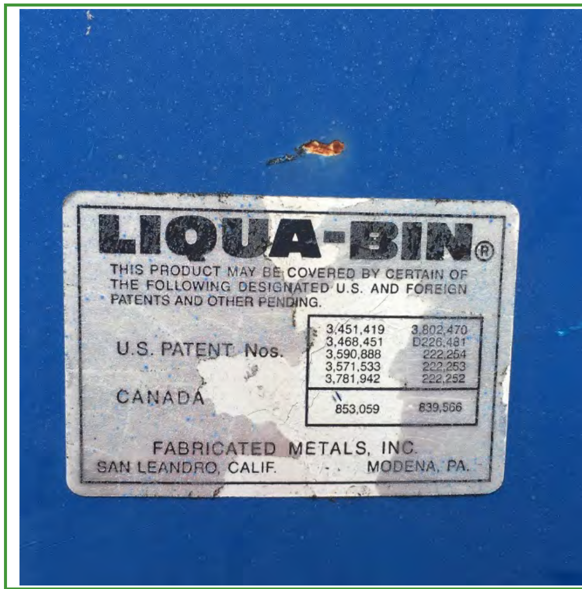
49. Blower pad anchor bolts

50. Blower skid

51. Condensate pump control

52. Blower tag

53. Blower panel



54. Vessel tag

55. Storage box

56. Storage box

57. Blower inlet flex fitting

58. Blower inlet flex fitting

59. Diffuser valve. Fully closed

60. Diffuser valve

61. Expansion fitting

62. Flow instrument

63.Power supply to motor

64. Flow instrument

65. Control Panel

66. Permit

67. Heat traced drain valve

68. Heat traced drain valve

69. GAC gallery

70. GAC stainless steel 4-inch manifold

71. Blower starter motor

Attachment B

Opinions of Probable Construction Costs

Vashon
OPINION OF PROBABLE CONSTRUCTION COST
May 15, 2018

Schedules

	Blower/Motor Replacement Costs – Single Blower System					
	Item	**Unit**	**Quantity**	**Unit Price**	**Amount**	**Comment**
1	**Mobilization**	LS	1	$4,866.40	**$4,866.40**	at 10%
2	**Preparation**					
	Surveying	LS	1	$500.00	$500.00	
	TESC	LS	1	$750.00	$750.00	Estimate based on WSDOT Unit Bid Analysis.
	Site Health and Safety Plan	LS	1	$2,500.00	$2,500.00	
	Spill Containment Kit	EA	4	$186.00	$744.00	12.5 Gal. Pig Spill Kit
	Preparation Total:				**$4,494.00**	
	Blower and Motor Replacement					
3	**Demolition/Relocation**					
	Disconnect blower and Motor and skid	EA	2	$1,040.00	$2,080.00	
	Remove inlet and outlet piping	EA	2	$1,020.00	$2,040.00	
	Demolition Total:				**$4,120.00**	
4	**Mechanical**					
	Replace Flow Meter (GF90)	EA	1	$5,000.00	$5,000.00	
	Freight for blowers	LS	1	$2,000.00	$2,000.00	
	Inlet and Outlet piping modifications	LS	1	$2,500.00	$2,500.00	
	Inlet and outlet flex couplings	EA	1	$250.00	$250.00	
	Direct Drive Motor and Blower and skid	EA	1	$7,800.00	$7,800.00	Baxter Air - New York Blowers 2206A10 with 10HP Baldor motor
	Blower and motor installation	LS	1	$5,000.00	$5,000.00	
	Skid fabrication or extend concrete pedistol	EA	1	$1,000.00	$1,000.00	
	Miscellaneous piping, valving, and fittings	LS	1	$6,000.00	$6,000.00	
	MechanicalTotal:				**$22,550.00**	
5	**Electrical**					
	Implementation of new system electrical complete	LS	1	$17,500.00	$17,500.00	Average of costs provided by Follet Engineering
	Remove and reinstall power conductors from panel					
	Blower connections and explosion proof flex.					
	New Motor starters					
	Commissioning and testing of controls					
	GF90 Flow meter wiring and conduit					
	Electrical Total:				**$17,500.00**	
	Blower and Motor Replacement Total				**$44,170.00**	
6	**Schedule Subtotals:**				$53,530.40	
7	**Sales Tax 9.2%**				$4,924.80	
8	**Schedule Totals:**				**$58,455.20**	
9	**Contingency 40%**				$23,382.08	
10	**Total with Contingency**				**$81,900.00**	

Vashon
OPINION OF PROBABLE CONSTRUCTION COST
May 15, 2018

Schedules

	Item	Unit	Quantity	Unit Price	Amount	Comment
	Blower/Motor Replacement Costs – Duplex Blower System					
1	**Mobilization**	LS	1	$10,211.40	**$10,211.40**	at 10%
2	**Preparation**					
	Surveying	LS	1	$500.00	$500.00	
	TESC	LS	1	$750.00	$750.00	Estimate based on WSDOT Unit Bid Analysis.
	Site Health and Safety Plan	LS	1	$2,500.00	$2,500.00	
	Spill Containment Kit	EA	4	$186.00	$744.00	12.5 Gal. Pig Spill Kit
	Preparation Total:				**$4,494.00**	
	Blower and Motor Replacement					
3	**Demolition/Relocation**					
	Disconnect blower and Motor and skid	EA	2	$1,040.00	$2,080.00	
	Remove inlet and outlet piping	EA	2	$1,020.00	$2,040.00	
	Demolition Total:				**$4,120.00**	
4	**Mechanical**					
	Replace Flow Meter (GF90)	EA	1	$5,000.00	$5,000.00	
	Freight for blowers	LS	1	$2,000.00	$2,000.00	
	Inlet and Outlet piping modifications	LS	1	$2,500.00	$2,500.00	
	Inlet and outlet flex couplings	EA	2	$250.00	$500.00	
	Direct Drive Motor and Blower and skid	EA	2	$23,000.00	$46,000.00	Baxter Air - New York Blowers 2206A10 with 10HP Baldor motor
	Blower and motor installation	LS	1	$5,000.00	$5,000.00	
	Skid fabrication or extend concrete pedistol	LS	1	$2,000.00	$2,000.00	
	Miscellaneous piping, valving, and fittings replacement including labor	EA	2	$6,000.00	$12,000.00	
	MechanicalTotal:				**$61,000.00**	
5	**Electrical**					
	Implementation of new system electrical complete	LS	1	$32,500.00	$32,500.00	Average of costs provided by Follet Engineering
	Remove and reinstall power conductors from panel					
	Blower connections and explosion proof flex.					
	New Motor starters					
	Commissioning and testing of controls					
	GF90 Flow meter wiring and conduit					
	Electrical Total:				**$32,500.00**	
	Blower and Motor Replacement Total				**$97,620.00**	
6	**Schedule Subtotals:**				$112,325.40	
7	**Sales Tax 9.2%**				$10,333.94	
8	**Schedule Totals:**				**$122,659.34**	
9	**Contingency 40%**				$49,063.73	
10	**Total with Contingency**				**$171,800.00**	

Attachment C

Vendor Quotes

Please reply to **BAXTER AIR ENGINEERING**
16932 Wood-Red Rd NE A208 – Woodinville, WA 98072
Tel: (425) 486-6666 Fax: (425) 486-8260
Email: dan@baxair.com Web: www.baxair.com

The New York Blower Company®

QUOTATION

FOB factory, IN, IL, or KY with no freight allowed.
Terms: 30 days net. Subject to conditions of sale.
This quotation, for equipment manufactured by **NYB**, is valid for acceptance within 15 days. Purchased components such as motors, drives and vibration bases are subject to adjustment to price in effect at time of shipment. **NYB** reserves the right to qualify and correct clerical errors before acceptance.

May 8, 2018

Michael Spillane
Herrera Environmental Consultants
2200 Sixth Avenue, Suite 1100
Seattle, WA 98121

Tel: 206-441-9080
Cell: 206-909-4343

RE: Vashon Island Landfill blower

Dear Michael:
Thank you for the opportunity to work with you on these landfill gas fan projects. Per our site meeting on 5/1/2018, I have come up with the following.

Vashon Island Landfill

Fixed fan blowing into (2) GAC containers in series. Note (2) of (8) available, changed monthly.

(1) Hauck model TBGB9-060-250B-11, belt drive with 7.5 HP motor. Actual fan speed 3756 rpm. Hauck is no longer in business.

- Fan pulls low (~2%) methane from various wells that are expected to have restricted airflow.
- Main duct at last corner near sinking road at the fan end of the landfill has a low point and water that sloshes around which causes the system to surge. If this low point is fixed, expect flow rate to increase and static pressure to decrease. BHp increases with increasing flow.
- -29 to -32" WC near fan inlet. +4 to +8" WC near fan discharge (~36" WC across fan).
- 300 CFM measured.
- 4" discharge ductwork and flex hose between carbon vessels limits the likely practical airflow to 300-600 CFM max.
- 6 amps on 7.5 HP motor at 480V results in ~4.5 BHp used.
- Fan discharge into (2) carbon bed vessels in series and then to atmosphere.

- If the fan built for Houghton Landfill (2206A10 Pressure Blower, shop number 2018-04252) was installed into this system, I would expect the flow rate to be almost identical to what the existing fan is providing, but at 3.3 BHp instead of 4.5 BHp.
- Note that the Houghton fan had a 10 HP motor and the existing fan has a 7.5 HP motor. This fan can be run with either size motor as long as the BHp requirement is lower than the motor nameplate HP. Expect 900 CFM max for a 7.5 HP motor and 1300 CFM max for a 10 HP motor.
- A 10 HP motor has a 215T frame motor while a 7.5 HP motor has a 213T frame motor. The only physical difference between the two motors is the motor length and location of the outer motor mounting bolts (1.5" more distance). It is probably easier to use a 7.5 HP motor on this fan than to upgrade existing power supply.
- Existing CCW, BH fan orientation is identical to the Houghton Landfill blower orientation.

- The direct drive 33-5/8” long fan is about the same size as the existing 34” wide concrete fan pedestal. Alternately, there is enough room to mount it on either side of the concrete pedestal if required. To make sure that the inlet centerline is around the same height as on the existing fan (so that condensation drains back into the ductwork rather than into the fan since there is no drain immediately ahead of the fan), I would normally recommend adding a unitary base and RIS vibration isolation to the fan. New York Blower’s standard unitary base is longer than the fan though and so it might be easier to use a smaller base, different or no isolation, or lower the inlet ductwork. Since the overall concrete pad has plenty of space, it may make sense to mount the fan ahead of the existing concrete block on the unitary base with RIS isolation, and lower the ductwork to match fan inlet.

1 – New York Blower size 2206A10 Pressure Blower with aluminum radial bladed wheel, arrangement 8 direct drive configuration.

- 10 HP Premium Efficiency, TEFC Severe Duty (Class 1, Group D) 3-60-230/460V 3600 rpm motor, Baldor model EM7174T-I
- Direct drive flexible coupling
- Flanged standard pipe size 6” inlet with standard 125/150# drilling pattern
- Flanged standard pipe size 6” outlet with standard 125/150# drilling pattern
- LL1 Low Leakage construction, to include solid drive side plate, double the number of inlet studs, interior housing seams welded, and full face gasketing
- Wheel type AMCA B spark-resistant construction
- Double lip Teflon shaft seal
- Drain
- Housing access door
- Coupling guard
- Shaft and bearing guard
- Safety yellow powder coating on guards
- Heresite VR514 coating on airstream surfaces for corrosion resistance
- Standard (powder coated) green/gray finish on all exterior surfaces
- CCW rotation, BH discharge
- Reference shop number 2016-12982 or 2018-04252

Net Price……………………………………………………………………………………$7,737.00
Above fan with 7.5 HP motor in lieu of 10 HP motor………………………………………..$7,560.00

Add for a standard unitary base with RIS vibration isolation…………………………………..$469.00

Lead time is 5-7 weeks to ship, plus 1 week transit time. FOB Effingham, IL, no freight included. Budget an additional $750 for freight per fan.

Thank you for the opportunity to work with you on this project. Call with any questions or comments.

Regards,

Dan Bureau

Please reply to **BAXTER AIR ENGINEERING**
16932 Wood-Red Rd NE A208 – Woodinville, WA 98072
Tel: (425) 486-6666 Fax: (425) 486-8260
Email: dan@baxair.com Web: www.baxair.com

The New York Blower Company®

QUOTATION

FOB factory, IN, IL, or KY with no freight allowed.
Terms: 30 days net. Subject to conditions of sale.
This quotation, for equipment manufactured by **NYB**, is valid for acceptance within 15 days. Purchased components such as motors, drives and vibration bases are subject to adjustment to price in effect at time of shipment. **NYB** reserves the right to qualify and correct clerical errors before acceptance.

May 17, 2018

Michael Spillane
Herrera Environmental Consultants
2200 Sixth Avenue, Suite 1100
Seattle, WA 98121

Tel: 206-441-9080
Cell: 206-909-4343

RE: Vashon Island Landfill blower

Dear Michael:

Thank you for the opportunity to work with you on these landfill gas fan projects. Per your request, to duplicate the existing Hauck blower's performance with a similar New York Blower fan based on the Hauck fan bulletin, I recommend using a 2606A Pressure Blower with a 7.5 HP motor, belt driven. The Hauck fan is catalogued at providing 300 CFM at 45" WC for air at standard conditions. Note that this is similar in size to the 2608A Pressure Blowers at Puyallup, but the 2606A Pressure Blower has a 6" outlet and is generally sized for lower airflow.

1 – New York Blower size 2606 Pressure Blower with aluminum radial bladed wheel, arrangement 1 belt drive configuration.

- 7.5 HP Premium Efficiency, TEFC Severe Duty (Class 1, Group D) 3-60-230/460V 3600 rpm motor, ABB
- Constant pitch V-belt drive
- Plain pipe 8" inlet
- Flanged standard pipe size 6" outlet with standard 125/150# drilling pattern
- LL1 Low Leakage construction, to include solid drive side plate, double the number of inlet studs, interior housing seams welded, and full face gasketing
- Wheel type AMCA B spark-resistant construction
- Double lip Teflon shaft seal
- Drain
- Housing access door
- Belt guard
- Shaft and bearing guard
- Safety yellow powder coating on guards
- Heresite VR514 coating on airstream surfaces for corrosion resistance
- Standard (powder coated) green/gray finish on all exterior surfaces
- Unitary base with RIS vibration isolation
- CCW rotation, BH discharge, motor position Z

Net Price……………………………………………………………………………………$8,910.00

Lead time is 5-7 weeks to ship, plus 1 week transit time. FOB Effingham, IL, no freight included. Budget an additional $750 for freight.

Thank you for the opportunity to work with you on this project. Call with any questions or comments.

Regards,

Dan Bureau

COURTNEY & NYE INC.

ENGINEERED PRODUCT SALES

3622 S. Jefferson Drive, Spokane, WA 99203
Office (509) 474-9937
Email: NSimons@courtneyandnye.com

June 1, 2018

Attention: Kyle L. Johnson
Herrera
kjohnson@herrerainc.com

Reference: C&N Quote # 18-S-073

Dear Kyle,

In response to your request, we are pleased to provide the following quote.

Item No.	Qty.	Description	USD / Each	Extended	Lead Time
1	**1**	**Turbotron Exhauster**	**$23,626.14**	**$23,626.14**	**14-16 wks**
		See Below Scope of Supply with Individual Price			
	1	- Turbotron, Package, Gas, ANSI, Belt, 184-T365TS - "C" P/N TBSCGas……..		$19,963.54	
	1	- Motor, Explosion Proof, 3/60/230-460, 10 HP, 215T - P/N XP10……………..		$1,716.58	
	2	- Drain with SST Plug and Valve - P/N DRAINTBT…………………………………….		$214.55	
	1	- Xylan Coating, I/O Head - P/N XCIOT…………………………………………………..		$844.75	
	1	- Xylan Coating, Impeller - P/N XCIT……………………………………………………….		$779.76	
	1	- Gas Leak Test (Add Hydro Test if Gas Test Greater than 8 psig) - 732 - P/N GLT732……………………………………………………………………………………………….		$106.96	
2	**1**	**Blower Package 73202**	**$31,275.52**	**$31,275.52**	**12-14 wks**
		See Below Scope of Supply with Individual Price			
	1	- 73202, 6" Flange in/out, Blower, Base and Coupling - P/N 73202……………		$19,162.73	
	1	- Motor, Explosion Proof, 3/60/230-460, 15 HP, 254T - P/N XP15……………..		$3,026.72	
	1	- Double Carbon Ring in lieu of Labyrinth Seal, Per Blower 732 - P/N DCR732……………………………………………………………………………………………………..		$4,641.42	
	2	- SST Pipe/Valve at Drain - Per Section - 732 - P/N DRAIN732…………………..		$815.31	
	2	- Baked Phenolic Coating, Heat (per Impeller) - 732 - P/N BPCH732………..		$1,031.01	
	2	- Baked Phenolic Coating, Impeller (per Impeller) - 732 - P/N BPCI732…..		$1,113.52	
	1	- Baked Phenolic Coating, Section (per Section) - 732 - P/N BPCS732………		$1,143.52	
	1	- Gas Leak Test (Add Hydro Test if Gas Test Greater than 8 psig) - 732 - P/N GLT732……………………………………………………………………………………………….		$106.96	
	1	- Aluminum Coupling Guard; Non-Sparking - 732 - P/N AlumGrd732……….		$234.33	

• Prices are Net 30 days.
• Prices are EX Works, factory unless otherwise stated.
• Freight, sales or other taxes not included in price.

Please note that if an order should result from this proposal, it should be made written to:

Gardner Denver
PO Box 130
Bentleyville, PA 15314

Thank you for your interest in Hoffman Lamson products. If you have any questions or require additional information, please feel free to contact us.

Sincerely,

Neil Simons
Sales Engineer
Courtney and Nye
Cell (206) 883-4501

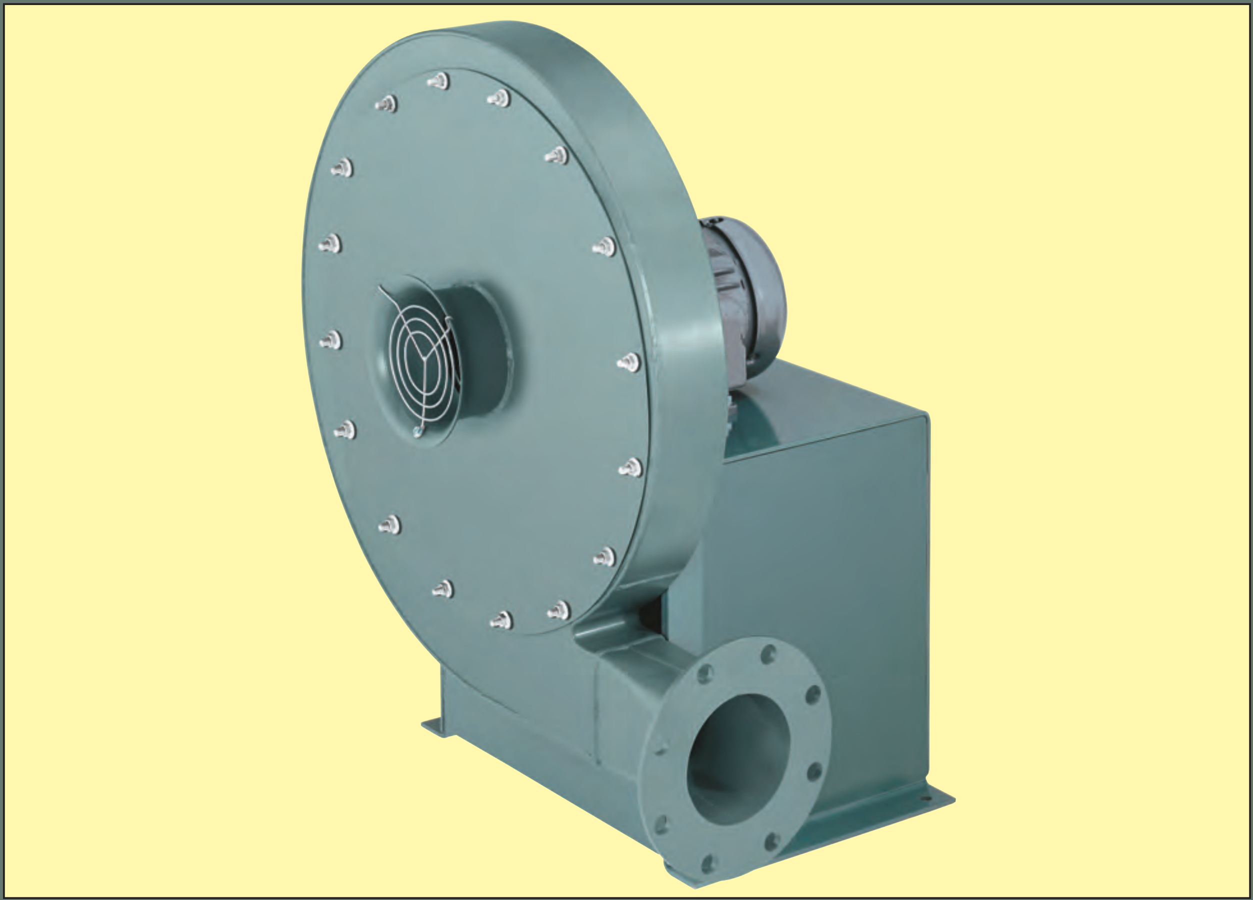
Attachment D

Vendor Cut Sheets

BULLETIN 451
MARCH, 2014

PRESSURE BLOWERS

- Capacities to 5,200 CFM
- Two wheel choices
- Static pressures to 58″WG
- Temperatures to 600°F.

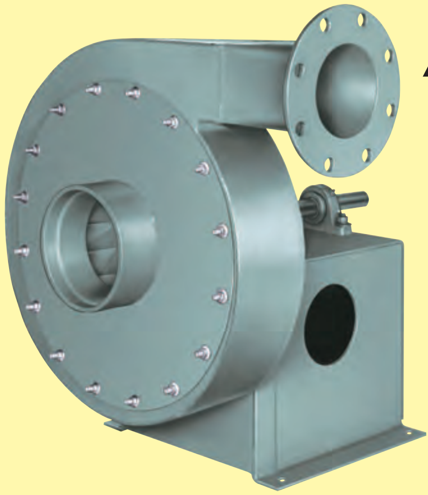


THE NEW YORK BLOWER COMPANY
7660 Quincy Street
Willowbrook, IL 60527-5530
Visit us on the Web: http://www.nyb.com
Phone: (800) 208-7918 Email: nyb@nyb.com

For greater pressures and capacities: see Type HP Pressure Blowers

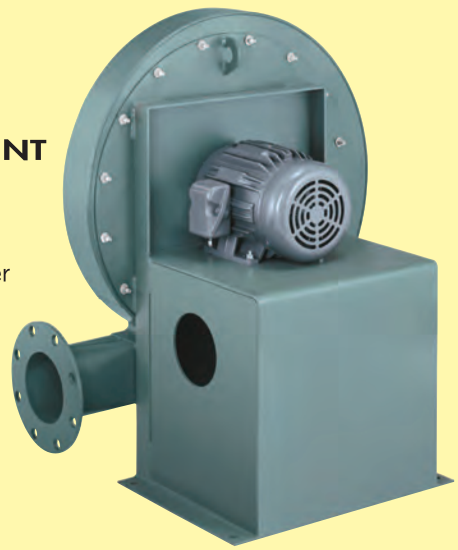
Pressure Blowers

...for process systems



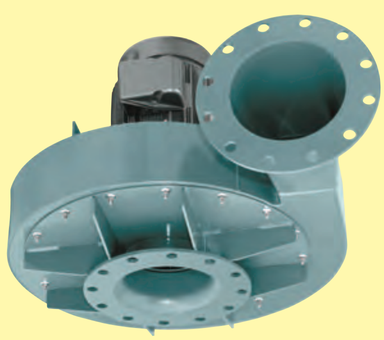
ARRANGEMENT 1

Pressure Blower with plain pipe inlet.



ARRANGEMENT 4

Pressure Blower with motor.



ARRANGEMENT 4-V

Pressure Blower with motor.

The New York Blower Company certifies that the Pressure Blowers shown herein are licensed to bear the AMCA Seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Publication 211 and comply with the requirements of the AMCA Certified Ratings Program.

DESIGN FEATURES

- Pressures to 58″WG.
- Capacities to 5,200 CFM.
- Stable performance . . . the pressure curve remains stable from wide-open to closed-off . . . fan instability, or pulsation, is eliminated even when “turn-down” approaches zero flow.
- Choice of wheel designs . . . standard aluminum wheel for optimum efficiency or optional steel wheel for more rugged applications.
- Efficiency . . . advanced wheel and aerodynamic housing design combine for air-handling efficiency superior to conventional radial-wheel designs.
- Variable wheel diameters and a choice of six outlet sizes enable efficient fan selection across a wide range of volumes and pressures.
- Choice of arrangements . . . direct-drive and belt-drive.
- Wide application range . . . designed for continuous operation in combustion, cooling, conveying, drying, and various process systems.

CONSTRUCTION FEATURES

- All-welded steel housings . . . heavy-gauge housings are designed specifically to prevent “flexing” at high pressures.
- Flanges . . . continuously welded flanges match ANSI Class 125/150 hole pattern.
- Balance . . . all wheels are precision-balanced prior to assembly . . . fans with motors and drives mounted by **nyb** are given a final trim balance check at the specified running speed.
- Shafting . . . straightened to close tolerance to minimize “run-out” and ensure smooth operation.
- Inlet configuration . . . a choice of three inlet types allows units to be tailored to specific application requirements.
- Lifting eyes . . . standard on all units for ease of handling and installation.
- Finish . . . medium-green industrial coating.

ACCESSORIES/MODIFICATIONS

- **COMPANION FLANGES**
Designed to fit flush with fan inlet and outlet flanges, provided with a matching hole pattern.

- **DRAINS**
Tank flange is welded to the lowest point of the housing scroll . . . female pipe thread.

- **INLET FILTER**
Filters are available with a choice of three element types: wire mesh, hi-flow polyester, and ultra-synthetic. High-efficiency filter is flange-mounted. Furnished standard with outboard support bracket and available with or without protective hood.

- **SILENCERS**
Available to match standard inlet or outlet flange sizes. Heavy-welded construction filled with high-density, acoustical absorption material.

- **OUTLET DAMPERS**
Available as either an integral outlet design for fixed damper control or as a separate wafer design for variable-flow applications [shown]. Wafer damper is available with an optional actuator and positioner.

- **SHAFT SEALS**
Ceramic-felt shaft seals consist of compressed ceramic felt elements. Lubricated lip seals [Buna, Teflon®, and Viton®] and gas-purgeable, segmental bushing seals are also available. See your **nyb** representative for availability.
[Teflon and Viton are registered trademarks of DuPont and DuPont Dow Elastomers, respectively.]

- **ACCESS DOOR**
Gasketed, flush-bolted door opens to provide access to the wheel.

- **HEAT-FAN CONSTRUCTION**
Available on Arrangements 1, 8, 9, and 10 steel wheel Pressure Blowers up to 600°F. Modifications include shaft cooler and shaft-cooler guard.

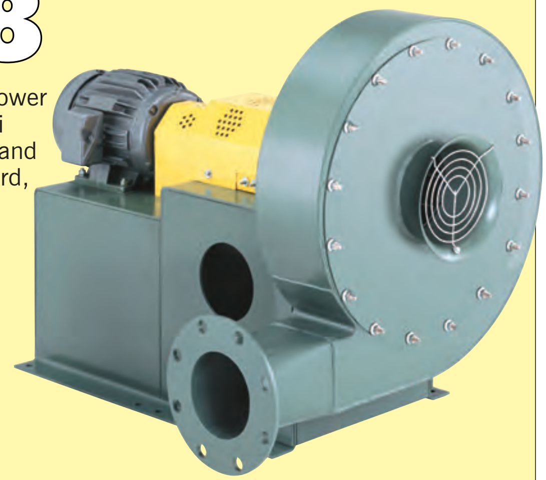
- **LL-1 LOW LEAKAGE CONSTRUCTION**
Special construction to minimize leakage includes lip-type shaft seal, non-rotatable housing with solid drive side, double studs, and neoprene gasketing. Maximum temperature 200°F. due to gasketing limitations. Not available with heat-fan construction. Contact your **nyb** representative for other options.

- **SPECIAL ALLOY CONSTRUCTION**
Airstream components can be constructed of a wide range of alternate alloys for corrosive applications.

- **UNITARY BASE**
Fan, motor, and guards can be mounted and shipped on a rugged, structural-steel base. Factory-assembled and run-tested prior to shipment.

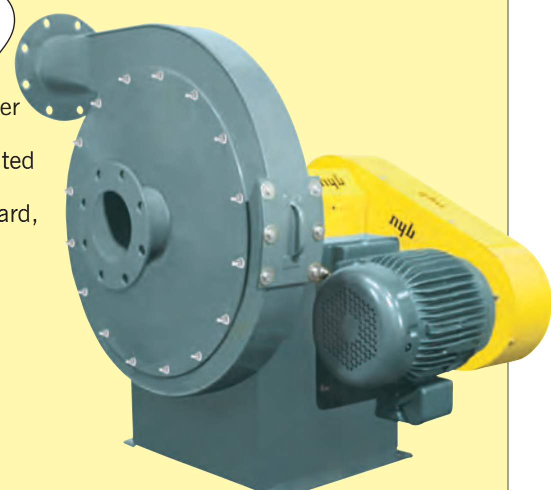
ARRANGEMENT 8

Pressure Blower with Venturi inlet, shaft and bearing guard, coupling guard, and motor.



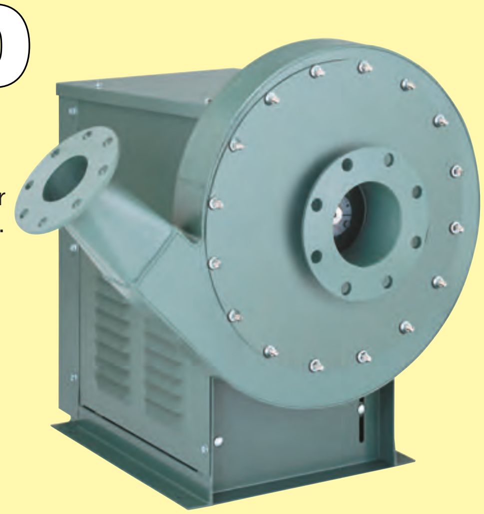
ARRANGEMENT 9

Pressure Blower with flanged inlet, flush-bolted cleanout door, motor, belt guard, and shaft and bearing guard.



ARRANGEMENT 10

Pressure Blower with flanged inlet and optional weather cover/belt guard.

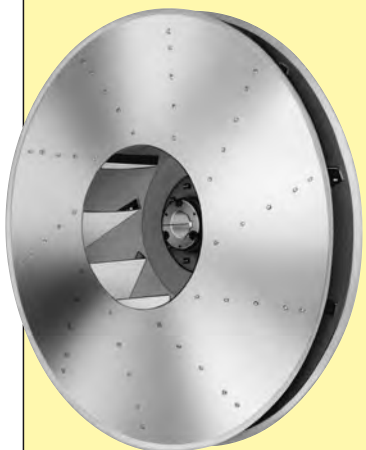


WHEELS

STANDARD ALUMINUM

The unique Aluminum Pressure Blower wheel is designed to provide efficient performance and reduced sound levels ... the dual-taper design concept on all but the narrowest wheel sizes yields typical efficiencies up to 10 percentage points greater than conventional straight radial wheels. Riveted high-strength aluminum alloy blades and side plates minimize overhung wheel weight and starting inertia. Ductile-iron, taper-lock hubs make wheels easily removable.

Note: Maximum operating temperature of aluminum wheel is 200°F.



OPTIONAL STEEL

Either welded steel or stainless-steel wheel construction is available in straight radial design. AMCA Certified Ratings Seal applies to Pressure Blowers with aluminum-wheel design only. Air volume and pressure capabilities are the same as the dual-taper aluminum wheel, but brake horsepower requirements are typically higher. Refer to The New York Blower Company's fan-selection program for details.

Note: Maximum operating temperature of steel wheel with heat fan construction is 600°F. Some fan-and-motor combinations with steel wheels may be restricted due to starting torque requirements. Consult **nyb**.

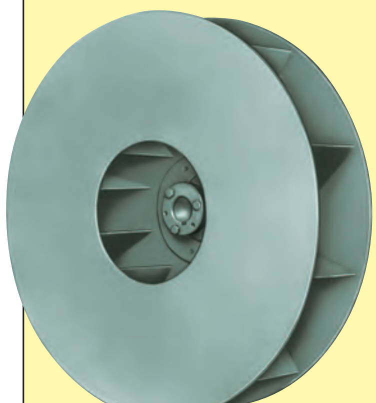


CHART II

STEEL WHEEL HORSEPOWER CORRECTIONS

18" Pressure Blower with 04 outlet to handle 400 CFM at 23½"SP at .075 lbs./ft.³ density. Aluminum wheels require 2.6 BHP as shown on page 7. Steel or stainless-steel wheels require [1.15 x 2.6] 3.0 BHP.

Outlet size	Wheel size	BHP correction factors
03	14 to 22 23 to 26	0.96 1.02
04	14 to 26	1.15
06	14 to 18 19 to 26	1.06 1.15
08	15 to 22 23 to 26	1.06 1.15
10	19 to 26	1.06
12	19 to 26	1.06

SPARK-RESISTANT CONSTRUCTION [SRC]

Intended to minimize the potential for any two or more fan components to generate sparks within the airstream by rubbing or striking during operation.

The following types are available:

AMCA A [AIRSTREAM] SRC

To include all airstream parts constructed of a spark-resistant alloy . . . maximum temperature: 200°F.

AMCA B [WHEEL] SRC

To include the fan wheel constructed of a spark-resistant alloy and a buffer plate around the housing shaft-hole opening . . . maximum temperature: 200°F.

CHART I

MAXIMUM SAFE SPEEDS [RPM]†

Wheel diameter	Aluminum wheel	Steel wheel	
	All Arr.	Arr. 1, 4, 4-V, 8, 9	Arr. 10
14	4000	4000	4000
15	4000	4000	4000
16	4000	4000	4000
17	4000	4000	4000
18	4000	4000	4000
19	3900	3900	2992
20	3900	3900	2918
21	3900	3900	2851
22	3900	3900	2787
23	3800	3800	3178
24	3800	3800	3121
25	3800	3800	3068
26	3800	3800	3017

† derate for temperature not required.
* Arr. 9 fans may have additional speed limits based on pedestal length.

SAFETY EQUIPMENT

Safety accessories are available from **nyb**, but selection of the appropriate devices is the responsibility of the system-designer who is familiar with the particular installation, or application, and can provide for guards for all exposed moving parts as well as protection from access to high-velocity airstreams. Neither **nyb** nor its sales representatives is in a position to make such a determination. Users and/or installers should read "Recommended Safety Practices for Air Moving Devices" as published by the Air Movement and Control Association International, Arlington Heights, Illinois.

PERFORMANCE

USING PERFORMANCE CURVES

Performance is shown according to outlet sizes for quick reference to duct diameter. Brake horsepower increments are identified on each curve. Recommended standard blower size and motor combinations, which are based on the most efficient area of operation, are listed on page 14 for Arrangements 4, 4-V, and 8. Nonstandard combinations are generally available, but are usually less efficient than the standard combinations.

SIZING NOMENCLATURE

7-digit model number designates the wheel diameter, outlet size, wheel type, and nominal motor horsepower.

Note: the last two digits showing motor horsepower are not required for Arrangement 1 Pressure Blowers.

EXAMPLE

21	06	A	7½
Wheel diameter	Outlet size [inches]	Wheel type A = aluminum S = steel/ stainless steel	Nominal horse-power

PROCEDURE	STEPS	EXAMPLE
Determine the appropriate outlet size.	1	The 06 outlet is selected for 800 CFM at 32″SP.
Plot the CFM and SP [standard] and select a performance curve for the fan size that meets or slightly exceeds the required performance.	2	A Size 2106A will provide 800 CFM at 33.6″SP.
Determine the BHP required for the point of operation . . . see page 4 for steel or stainless-steel wheel factors.	3	2106A requires 6.3 BHP. 2106S requires 7.2 BHP [6.3 x 1.15].
Read to the right to select motor horsepower.	4	A 7½ HP motor will cover both wheel types.

Note: The horsepower coverage of a given motor will increase 15% when a 1.15 service factor motor is utilized.

CORRECTION FACTORS

Performance is based on actual cubic feet per minute [ACFM] at the blower inlet at standard density [.075 lbs./ft.^{3}] and static pressure at the blower outlet. Static pressure capabilities are shown in inches water gauge [″WG].

Air density corrections are necessary for proper selection when air density varies from the standard .075 lbs./ft.^{3} at 70˚F. at sea level. This also occurs when negative static pressure exists [rarefication] on the inlet side of the fan. Multiply the required static pressure at conditions by the appropriate factors in Charts III, IV, and V to obtain corrected pressure for blower selection. Pressure and BHP will be reduced at conditions by the inverse of these factors. Multiply one factor by the other if temperature, altitude, and rarefication are non-standard. For example: If the installation is located at an altitude of 4000 feet, the gas temperature is 300°F., and the inlet pressure is –40″WG, the correction factor is 1.84 [1.16 x 1.43 x 1.11].

CHART III
ALTITUDE [ft.] CORRECTIONS

Alt.	Factor
0	1.00
500	1.02
1000	1.04
1500	1.06
2000	1.08
2500	1.10
3000	1.12
3500	1.14
4000	1.16
4500	1.18
5000	1.20
6000	1.25
7000	1.30
8000	1.35
9000	1.40
10000	1.45

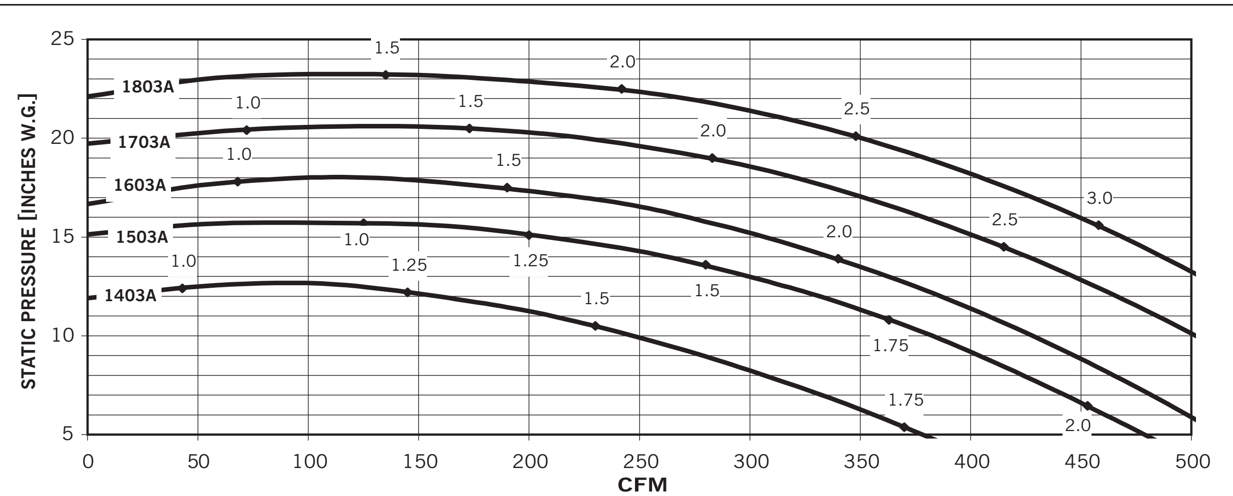
CHART IV
TEMPERATURE CORRECTIONS

Temp.˚F.	Factor
0	.87
20	.91
40	.94
60	.98
70	1.00
80	1.02
100	1.06
120	1.09
140	1.13
160	1.17
180	1.21
200	1.25
300	1.43
400	1.62
500	1.81
600	2.00

CHART V
RAREFICATION CORRECTIONS

Neg. inlet pressure "WG	Factor
15	1.04
20	1.05
25	1.07
30	1.08
35	1.09
40	1.11
45	1.12
50	1.14
55	1.16
60	1.17
65	1.19
70	1.21
75	1.23
85	1.26

1403A-1803A

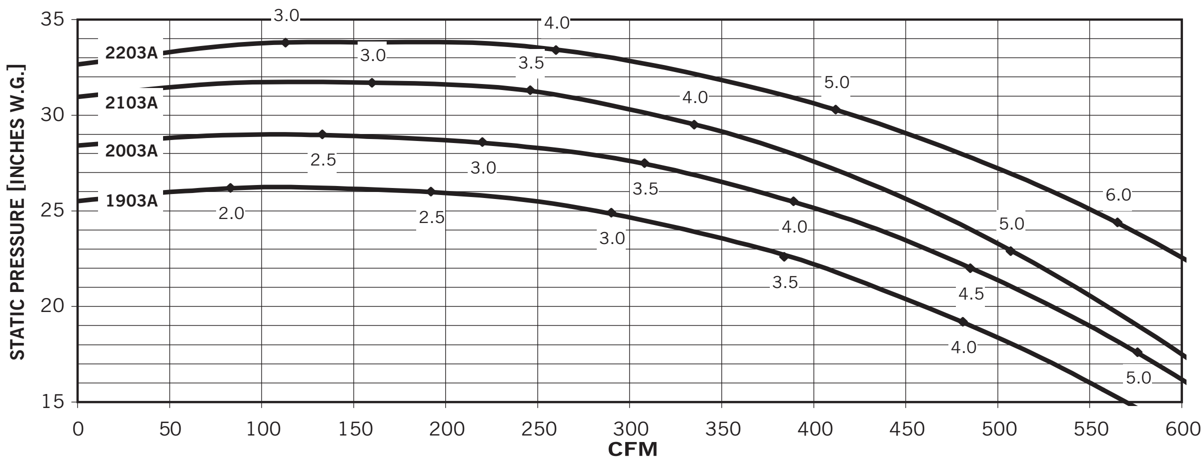


PERFORMANCE AT 3500 RPM

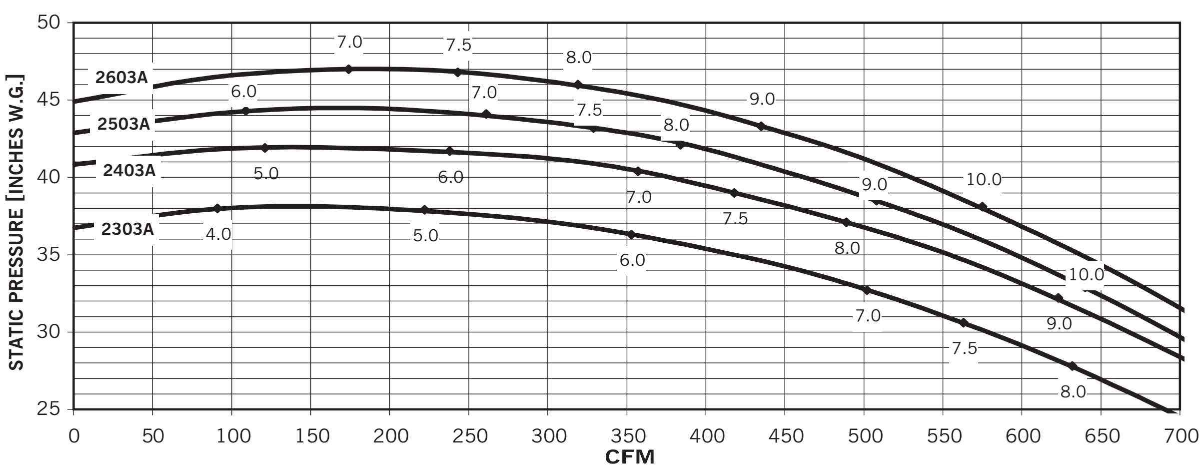
Aluminum Wheel
Pressure Blower

NOTE: Values shown on curves indicate brake horsepower [BHP] required.

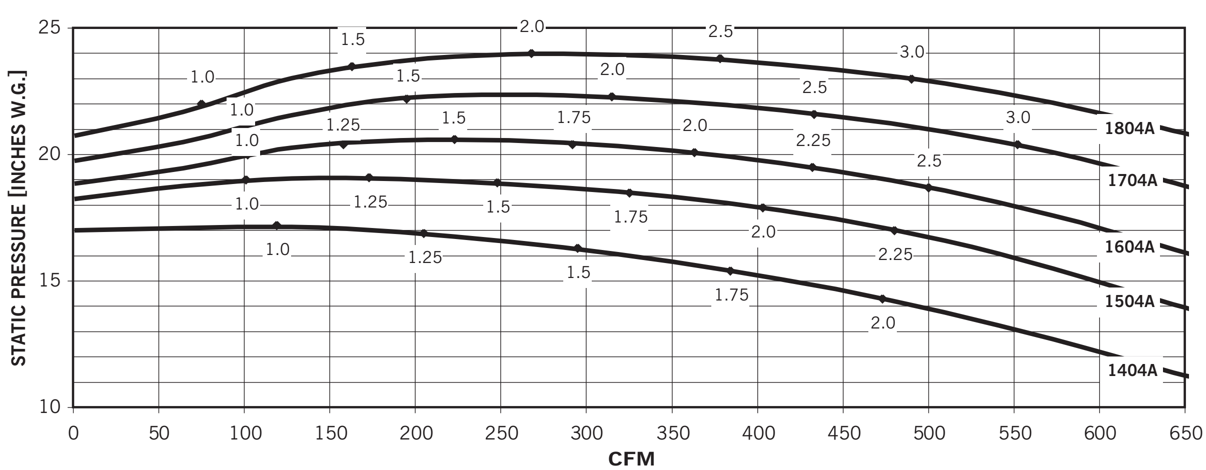
1903A-2203A



2303A-2603A



1404A-1804A



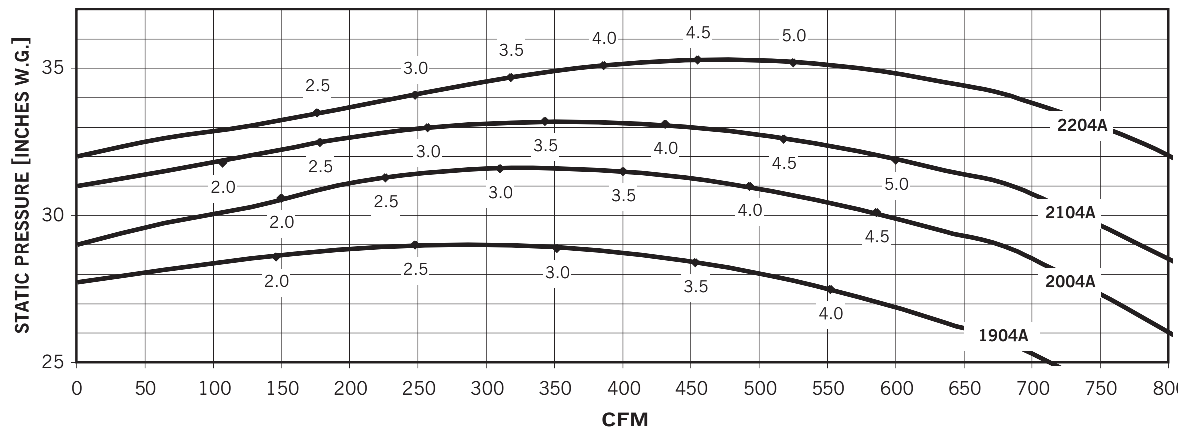
Performance certified is installation Type B: Free inlet, Ducted outlet. Power rating (BHP) does not include transmission losses. Performance ratings do not include the effects of appurtenances (accessories).

Performance at 3500 RPM

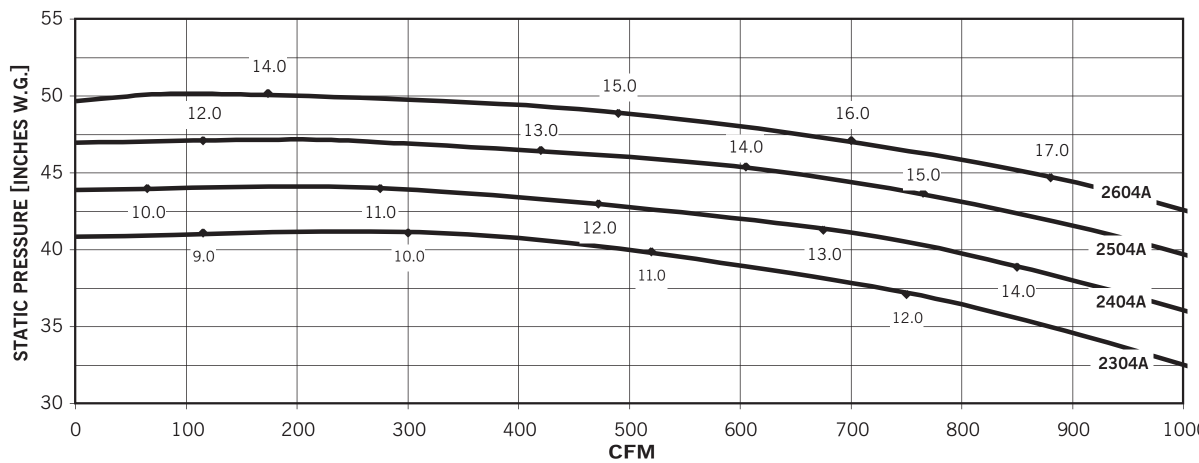
Aluminum Wheel
Pressure Blower

NOTE: Values shown on curves indicate brake horsepower [BHP] required.

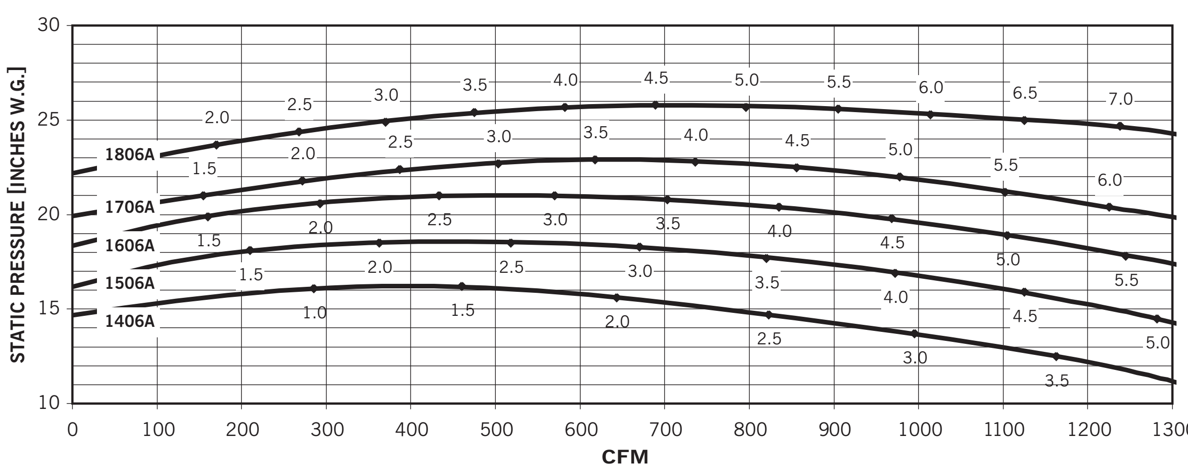
1904A-2204A



2304A-2604A



1406A-1806A

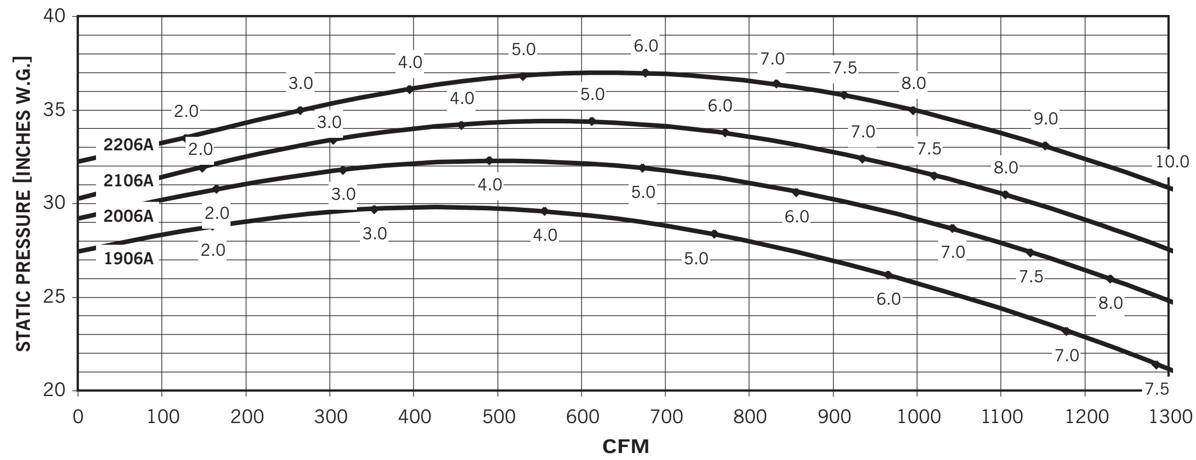
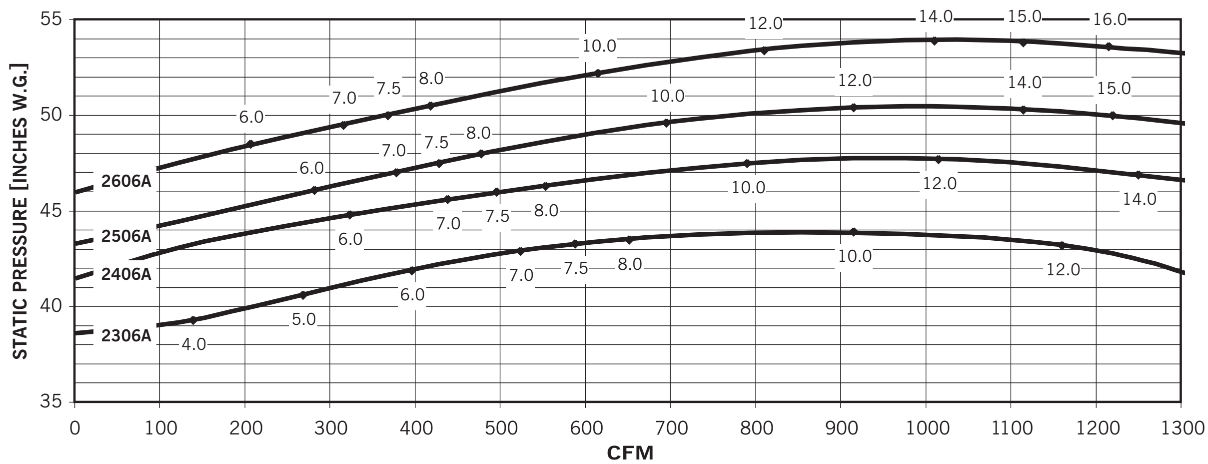
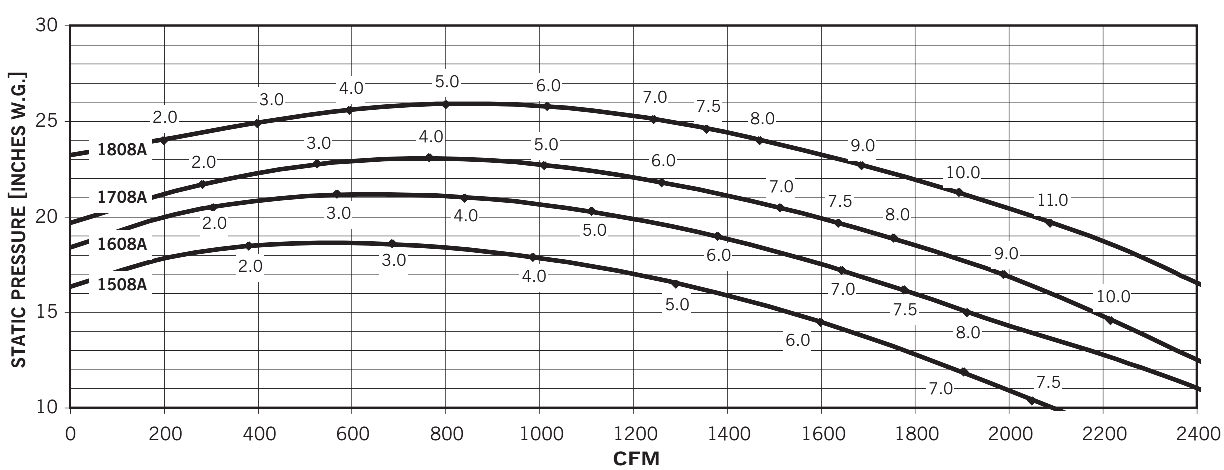


Performance certified is installation Type B: Free inlet, Ducted outlet. Power rating (BHP) does not include transmission losses. Performance ratings do not include the effects of appurtenances (accessories).

Performance at 3500 RPM

Aluminum Wheel
Pressure Blower

NOTE: Values shown on curves indicate brake horsepower [BHP] required.

1906A-2206A	
2306A-2606A	
1508A-2208A	

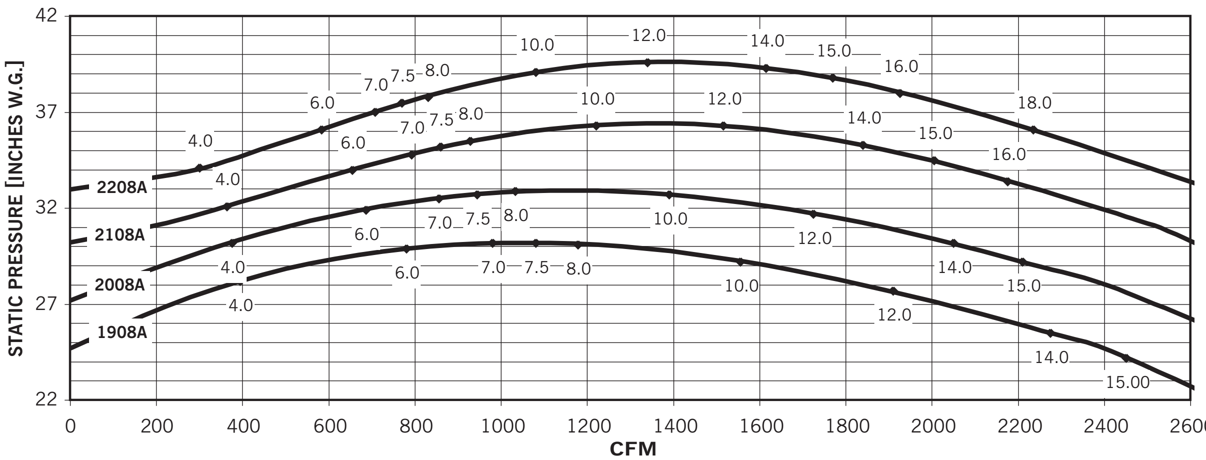
Performance certified is installation Type B: Free inlet, Ducted outlet. Power rating (BHP) does not include transmission losses. Performance ratings do not include the effects of appurtenances (accessories).

PERFORMANCE AT 3500 RPM

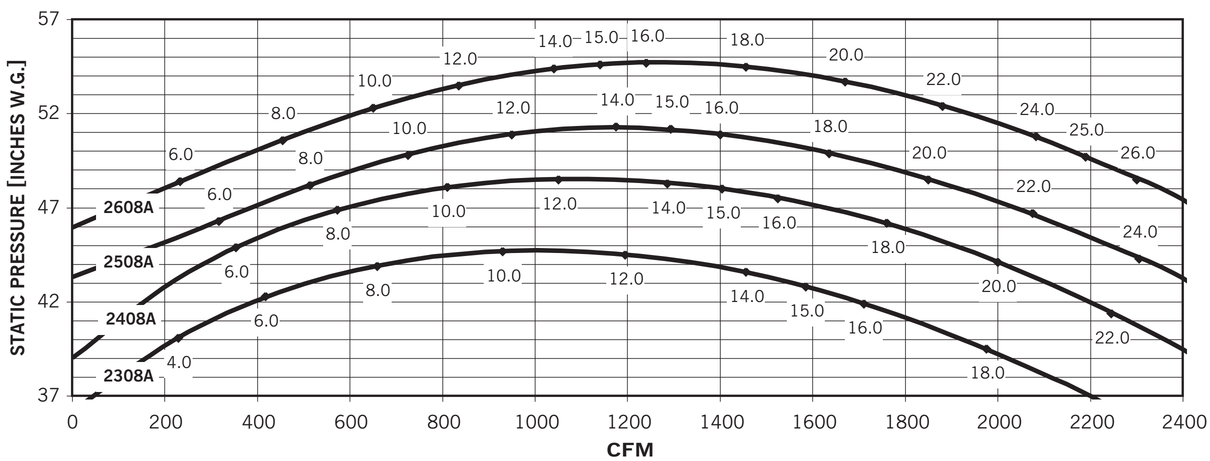
Aluminum Wheel
Pressure Blower

NOTE: Values shown on curves indicate brake horsepower [BHP] required.

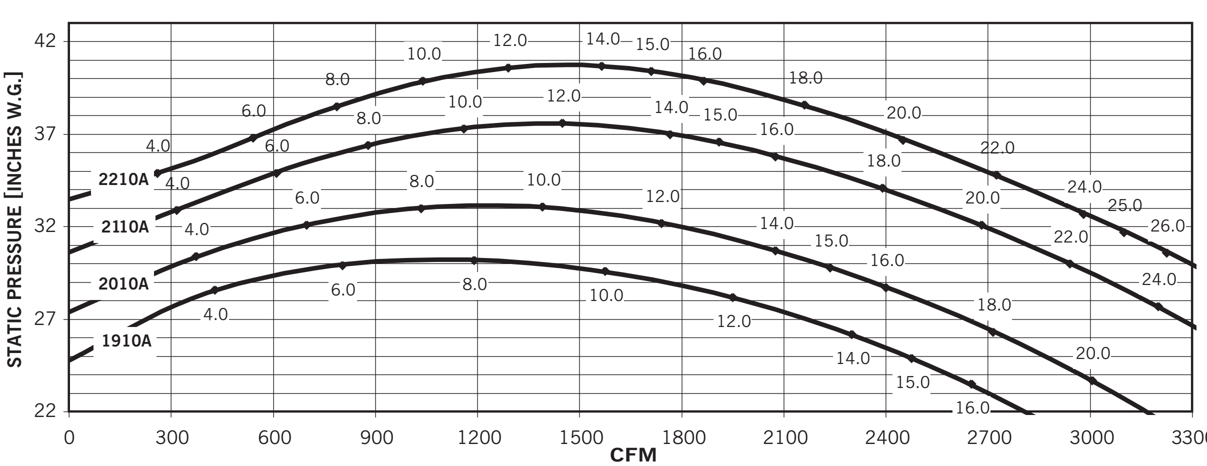
1908A-2208A



2308A-2608A



1910A-2210A



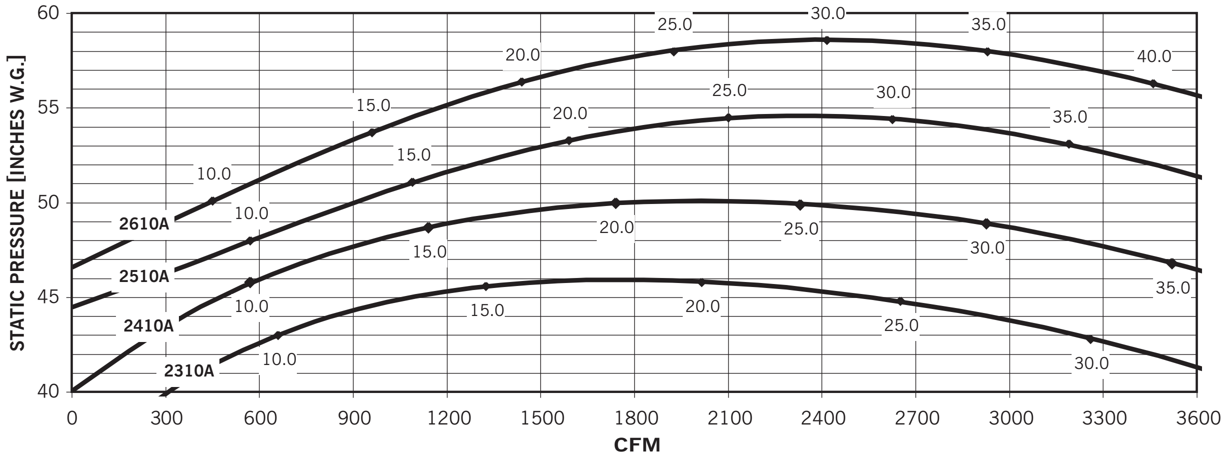
Performance certified is installation Type B: Free inlet, Ducted outlet. Power rating (BHP) does not include transmission losses. Performance ratings do not include the effects of appurtenances (accessories).

Performance at 3500/3550 RPM

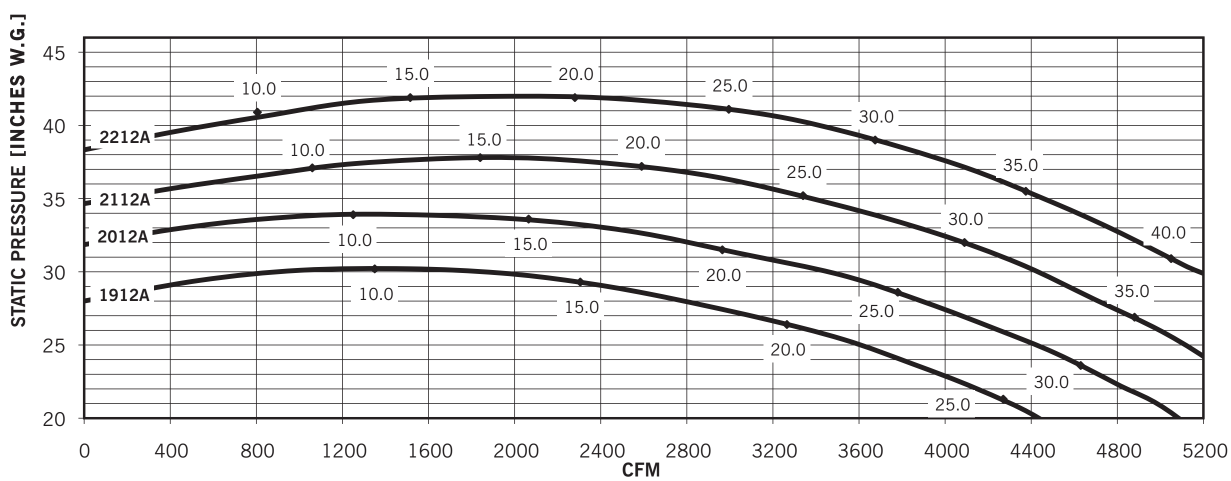
Aluminum Wheel
Pressure Blower

NOTE: Values shown on curves indicate brake horsepower [BHP] required.

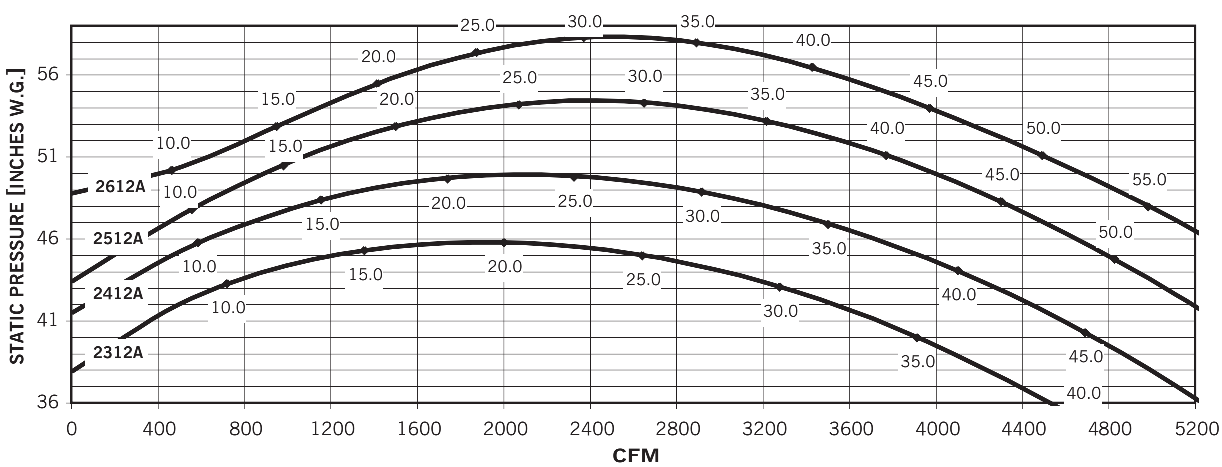
2310A-2610A



1912A-2212A



2312A-2612A



Performance certified is installation Type B: Free inlet, Ducted outlet. Power rating (BHP) does not include transmission losses. Performance ratings do not include the effects of appurtenances (accessories).

SPECIFICATIONS

U.S. standard sheet gauge to 7 gauge. Dimensions in inches. Weights in pounds. WR^2 in lb.-ft.^{2}.

WHEEL SPECIFICATIONS

Size	Aluminum		Steel	
	Wt.	WR^2	Wt.	WR^2
1403	10.1	0.96	19.7	2.74
1404	8.5	1.43	18.0	3.04
1406	11.7	2.40	20.5	3.46
1503	10.8	1.23	21.8	3.59
1504	8.8	1.69	19.0	3.68
1506, 1508	11.8	2.40	21.5	4.16
1603	11.5	1.53	23.9	4.56
1604	9.0	1.98	20.0	4.41
1606, 1608	12.1	2.50	23.0	5.07
1703	12.3	1.93	26.3	5.79
1704	9.3	2.30	21.0	5.22
1706, 1708	12.2	2.60	24.5	6.09
1803	13.0	2.36	28.6	7.16
1804	9.5	2.65	22.0	6.13
1806, 1808	12.4	2.60	26.0	7.25
1903	14.2	2.92	31.1	8.42
1904, 1906	12.0	3.73	29.5	9.16
1908, 1910	15.1	5.10	34.5	10.72
1912	12.9	5.07	32.8	10.15
2003	15.1	5.02	33.7	10.23
2004, 2006	12.3	4.22	31.0	10.67
2008, 2010	15.3	5.20	36.5	12.56
2012	13.1	5.21	36.1	12.37
2103	16.0	4.24	36.5	12.31
2104, 2106	12.5	4.74	32.5	12.33
2108, 2110	15.5	5.30	38.0	14.42
2112	13.3	5.34	39.4	14.91
2203	17.1	5.02	39.3	14.70
2204, 2206	12.8	5.31	34.0	14.16
2208, 2210	15.6	5.40	40.0	16.66
2212	13.5	5.48	42.9	17.80
2303	18.3	6.07	49.4	20.83
2304	19.8	6.50	52.5	22.27
2306, 2308	18.5	8.42	45.0	20.93
2310, 2312	21.7	10.60	53.5	24.35
2403	19.4	7.16	53.1	24.50
2404	20.9	7.80	56.4	26.14
2406, 2408	18.8	9.29	48.0	23.79
2410, 2412	21.9	10.80	56.0	27.75
2503	20.5	8.33	56.9	28.64
2504	22.0	9.00	60.4	30.49
2506, 2508	19.0	10.22	50.0	26.89
2510, 2512	21.9	11.00	58.5	31.46
2603	21.8	9.63	60.9	33.27
2604	23.1	10.30	64.5	35.36
2606, 2608	19.3	11.20	52.0	30.24
2610, 2612	22.3	11.20	61.0	35.48

MATERIAL SPECIFICATIONS

HOUSING

Wheel diameter	Sides	Scroll	Inlet plate	Drive plate
14-18	10	10	1/4	10
19-22	10	10	1/4	10
23-26	10	10	1/4	10

SHAFT DIAMETER

Wheel diameter	Arrangement 1		Arrangement 8	
	Standard	Heat Fan with Shaft Seal	Standard	Heat Fan with Shaft Seal
14-18	1 7/16	1 7/16	1 7/16	1 7/16
19-22	1 7/16	1 11/16	1 7/16	1 7/16
23-26	1 11/16	1 15/16‡	1 7/16	1 11/16

SHAFT DIAMETER

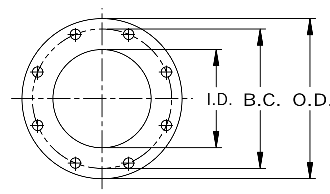
Wheel diameter	Arrangement 9		Arrangement 10	
	Standard	Heat Fan with Shaft Seal	Standard	Heat Fan
14-18	1 7/16	1 7/16	1 7/16	1 7/16
19-22	1 11/16	1 11/16	1 7/16	1 7/16
23-26	1 15/16	1 15/16	1 11/16	1 11/16

BEARINGS*

Wheel diameter	Arrangement 1/9		Arrangement 8	Arrangement 10
	Inboard	Outboard		
14-18	A	A‡	A	A
19-22	B	B	A	B
23-26	C	B‡	A	B

A–200 Series ball bearing. B–22400 Series roller bearing.
C–300 Series ball bearing.
* **nyb** reserves the right to substitute bearings of equal rating.
‡ Fans with heat fan construction and shaft seal:
Arr. 1: Sizes 23-26 include a shaft turndown at the outboard bearing, with a bearing size of 1 11/16″. Inboard bearing size is 1 15/16″.
Arr. 9: Sizes 14-18 include a Type B outboard bearing, in lieu of the standard Type

FLANGE



DIMENSIONS [INCHES]

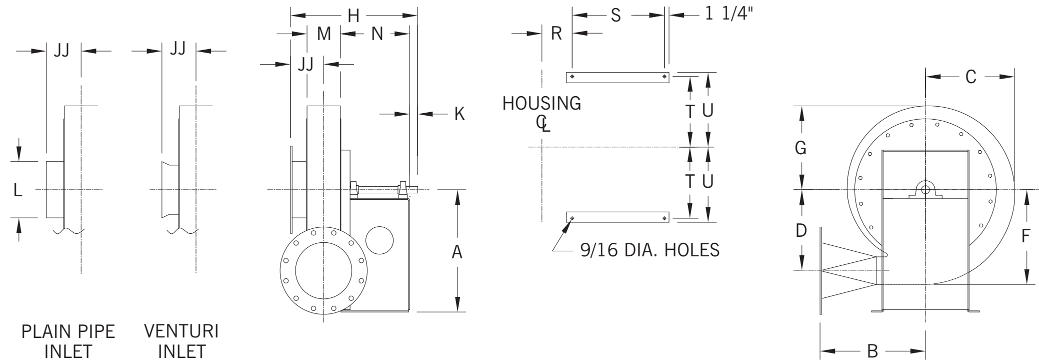
Size	I.D.	O.D.	Bolt circle	Holes† No. – size
03	3	7 1/2	6	4 – 3/4″
04	4	9	7 1/2	8 – 3/4″
05	5	10	8 1/2	8 – 7/8″
06	6	11	9 1/2	8 – 7/8″
08	8	13 1/2	11 3/4	8 – 7/8″
10	10	16	14 1/4	12 – 1″
12	12	19	17	12 – 1″

† Holes straddle centerline. ANSI Class 125/150 hole pattern. Flange thickness 3/8″

ARRANGEMENTS 1/9

PRESSURE BLOWERS

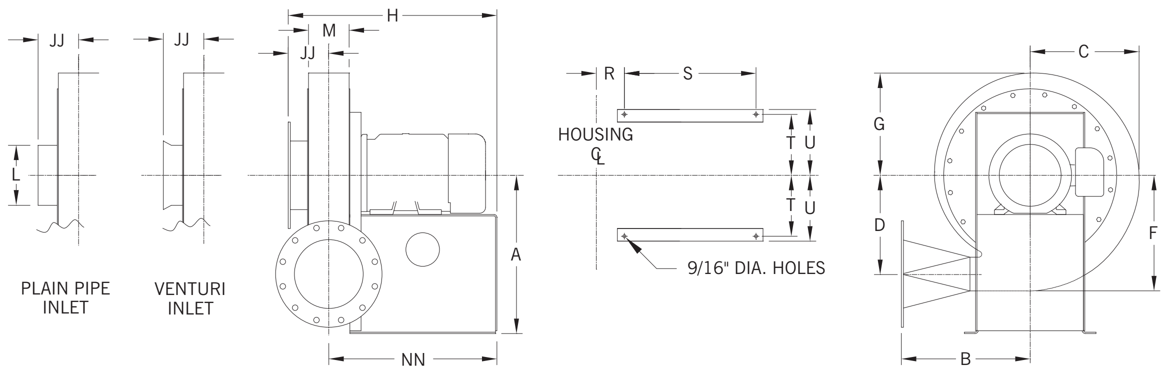
Maximum Airstream Temperature:
200°F. – aluminum wheel.
300°F. – steel wheel.
600°F. – heat fan.



ARRANGEMENT 4

PRESSURE BLOWERS

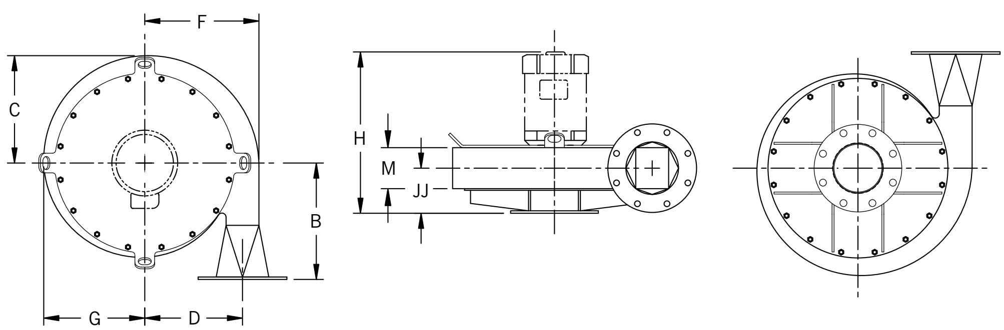
Maximum Airstream Temperature:
180°F.



ARRANGEMENT 4-V

PRESSURE BLOWERS

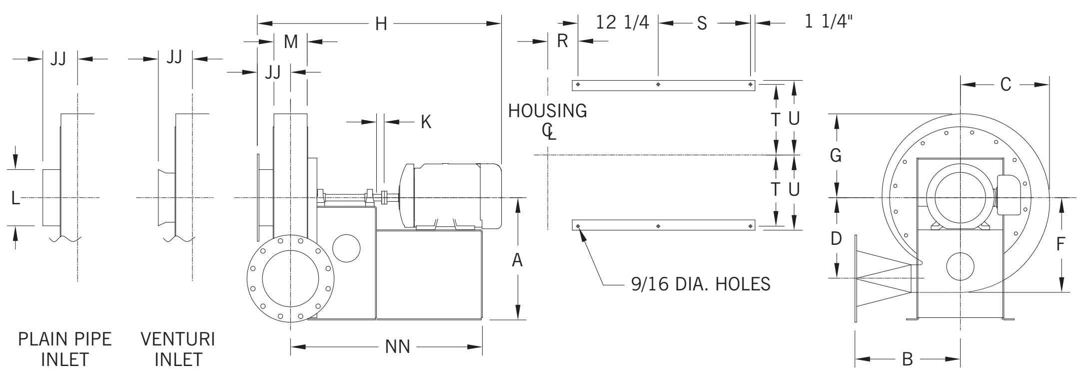
Maximum Airstream Temperature:
120°F.



ARRANGEMENT 8

PRESSURE BLOWERS

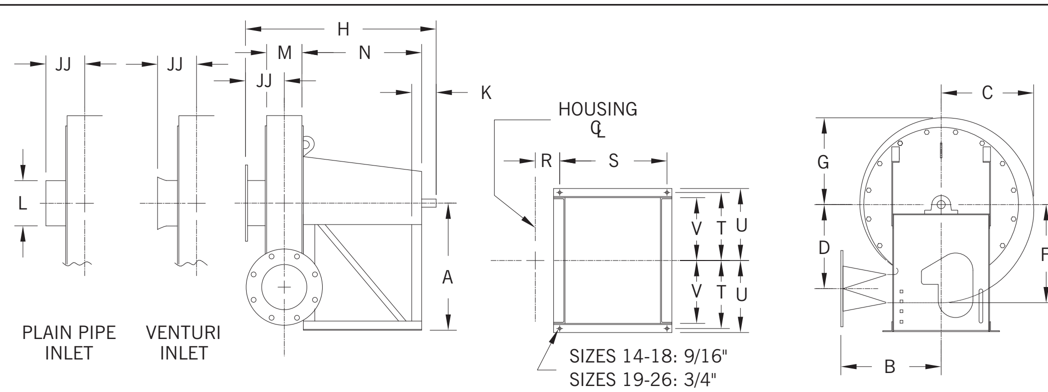
Maximum Airstream Temperature:
200°F. – aluminum wheel.
300°F. – steel wheel.
600°F. – heat fan.



ARRANGEMENT 10

PRESSURE BLOWERS

Maximum Airstream Temperature:
200°F. – aluminum wheel.
300°F. – steel wheel.
600°F. – heat fan.



ARRANGEMENTS 1, 4, 4-V, 8, 9, 10

Dimensions not to be used for construction unless certified. Bare fan weight does not include wheel or motor. Weights in pounds. Wheel weights on page 11.

HOUSING DIMENSIONS [INCHES]

Fan Size	Outlet Size	Inlet Size	B	C	D	F	G	M	JJ [Inlet types] Flanged	JJ [Inlet types] Plain pipe	JJ [Inlet types] Venturi	L
14-18	03	05	18 1/4	13 5/8	11 3/4	14 3/8	12 3/4	2 7/8	5 1/16	4 11/16	4 9/16	5 9/16
	04	06						3 7/8	5 9/16	5 3/16	4 13/16	6 5/8
	06	08						6 1/4	6 3/4	6 3/8	6 3/8	8 5/8
	08	08										
19-22	03	05	17 3/4	16 1/2	14 7/8	17 1/2	15 1/2	2 7/8	5 9/16	5 3/16	5 3/16	5 9/16
	04	06						3 7/8	6 1/16	5 11/16	5 5/16	6 5/8
	06	06										
	08	08						6 1/4	6 3/4	6 3/8	6 3/8	8 5/8
	10	10	21 3/4									
	12	12	23		14 1/2			7 1/4	7 1/4	6 7/8	6 7/8	10 3/4
23-26	03	05	19	19 1/2	17 5/8	20 5/8	18 1/4	3 5/8	6 5/16	5 15/16	5 9/16	5 9/16
	04	06						5	7	6 5/8	6 5/8	6 5/8
	06	08										8 5/8
	08	08										
	10	10	23					7 1/4	7 1/4	6 7/8	6 7/8	10 3/4
	12	12										

Tolerance: ± 1/8″

BARE FAN WEIGHTS AND MOTOR LIMITATIONS

Fan Size	Outlet Size	Inlet Size	Arr. 1 Wt.	Motor Frame Size (Arr. 4, 8)	Weight Arr. 4	Weight Arr. 8	Arr. 4-V Motor Frame Size	Arr. 4-V Weight
14-18	03	05	200	143T-145T	145	285	182TC-184TC	120
				182T-184T	170			
	04	06	205	143T-145T	150	295	182TC-184TC	130
				182T-184T	175			
	06	08	220	143T-145T	165	300	182TC-184TC	135
				182T-184T	190			
				213T-215T		305	213TC-215TC	
15-18	08	08	220	182T-184T	190	310	182TC-184TC	145
				213T-215T		315	213TC-215TC	
19-22	03	05	270	143T-145T	235	370	182TC-184TC	160
				182T-184T		375		
				213T-215T		380	213TC-215TC	
	04	06	275	143T-145T	245	385	182TC-184TC	170
				182T-184T				
				213T-215T		390	213TC-215TC	
	06	06	275	143T-145T	245	385	182TC-184TC	175
				182T-184T		390		
				213T-215T		395	213TC-215TC	
	08	08	290	182T-184T	260	410	182TC-184TC	190
				213T-215T		415	213TC-215TC	
				254T-256T	290	430	254TC-256TC	
	10	10	300	213T-215T	270	415	213TC-215TC	190
				254T-256T	300	430	254TC-256TC	
				284TS-286TS			284TSC-286TSC	
	12	12	320	254T-256T	320	445	254TC-256TC	215
				284T-286T		455	284TSC-286TSC	
				324TS-326TS	345	460	324TSC-326TSC	
23-26	03	05	330	182T-184T	270	435	182TC-184TC	205
				213T-215T		445	213TC-215TC	
				254T-256T	300	460	254TC-256TC	
	04	06	350	182T-184T	275	465	182TC-184TC	230
				213T-215T		470	213TC-215TC	
				254T-256T	300	490	254TC-256TC	
	06	08	365	182T-184T	285	460	182TC-184TC	230
				213T-215T		465	213TC-215TC	
				254T-256T	315	485	254TC-256TC	
	08	08	365	213T-215T	290	475	213TC-215TC	235
				254T-256T	320	495	254TC-256TC	
				284TS-286TS		495	284TSC-286TSC	
	10	10	385	254T-256T	335	500	254TC-256TC	255
				284TS-286TS			284TSC-286TSC	
				324TS-326TS	360	505	324TSC-326TSC	
	12	12	395	284TS-286TS	345	515	284TSC-286TSC	265
				324TS-326TS	370	520	324TSC-326TSC	

N/A: Not Available due to motor shaft/wheel fit.

Fan Size	Outlet Size	Arr. 9 Pedestal Number	Arr. 9 Weight	Arr. 10 Weight	Arr. 10 Max. Motor Size ODP	Arr. 10 Max. Motor Size TEFC	Arr. 10 Max. Motor Size C-NW
14-18	03	1	190	220	215T	215T	16 5/8
		2	225				
		3	260				
		4	300				
	04	1	195	230			
		2	235				
		3	265				
		4	305				
	06,08	1	210	245			
		2	250				
		3	280				
		4	325				
19-22	03	5	280	290	256T	254T	18 5/8
		6	300				
		7	340				
		8	360				
		9	370				
	04,06	5	295	305			
		6	315				
		7	355				
		8	375				
		9	385				
	08,10	5	315	325			
		6	335				
		7	375				
		8	395				
		9	405				
	12	5	340	350			
		6	360				
		7	405				
		8	420				
		9	430				
23-26	03,04	10	435	355	256T	254T	18 5/8
		11	455				
		12	465				
		13	550				
	06,08	10	440	360			
		11	460				
		12	470				
		13	555				
	10,12	10	460	375			
		11	480				
		12	490				
		13	570				

Tolerance: ± 1/8″

Arrangements 4, 4-V, 8

Dimensions not to be used for construction unless certified. Note: See page 12 for dimensional drawings.

Wheel dia.	Outlet Size	Inlet flange	Arr. 4 & 8 Motor Frame Size	A		H*		Arr. 4-V Motor Frame Size	H*	K	NN		R	S		T		U	
				Arr. 4	Arr. 8†	Arr. 4	Arr. 8		Arr. 4-V	Arr. 8	Arr. 4	Arr. 8		Arr. 4	Arr. 8	Arr. 4	Arr. 8	Arr. 4	Arr. 8
14-18	03	05	143T-145T	17¾	19½	18	38	182TC-184TC	20⅞	3⅜	12 15/16	31 5/16	2 13/16	8⅝	15	8⅞	9⅛	9¾	10
			182T-184T	19		23½	40⅝				17 13/16	32 13/16		14⅛	16½				
	04	06	143T-145T	17¾		19	39	182TC-184TC	21⅞		13 7/16	31 13/16	3 5/16	8⅝	15				
			182T-184T	19		24½	41⅝				18 5/16	33 5/16		14⅛	16½				
	06	08	143T-145T	17¾		21⅜	41⅜	182TC-184TC	24¼		14⅝	33	4½	8⅝	15				
			182T-184T	19		26⅞	44				20⅛	34½		14⅛	16½				
			213T-215T	19¾			46⅝	213TC-215TC	25½	2⅞		36¾			18¾				
15-18	08	08	182T-184T	19	19½	26⅞	44	182TC-184TC	24¼	3⅜	20⅛	34½	4½	14⅛	16½				
			213T-215T	19¾			46⅝	213TC-215TC	25½	2⅞		36¾			18¾				
19-22	03	05	143T-145T	23	23⅝	24	38½	182TC-184TC	20⅞	3⅜	18 7/16	31 5/16	2 13/16	14⅛	15	10⅞	10⅞	11¾	11¾
			182T-184T	24			41⅛					32 13/16			16½				
			213T-215T	24¾			43¾	213TC-215TC	22⅝	2⅞		35 1/16			18¾				
	04	06	143T-145T	23		25	39½	182TC-184TC	22⅜	3⅜	18 15/16	31 13/16	3 5/16	14⅛	15				
			182T-184T	24			42⅛					33 5/16			16½				
			213T-215T	24¾			44¾	213TC-215TC	23⅝	2⅞		35 9/16			18¾				
	06	06	143T-145T	23		25	39½	182TC-184TC	22⅜	3⅜	18 15/16	31 13/16	3 5/16	14⅛	15				
			182T-184T	24			42⅛					33 5/16			16½				
			213T-215T	24¾			44¾	213TC-215TC	23⅝	2⅞		35 9/16			18¾				
	08	08	182T-184T	24		26⅞	44	182TC-184TC	24¼	3⅜	20⅛	34½	4½	14⅛	16½				
			213T-215T	24¾			46⅝	213TC-215TC	25½	2⅞		36¾			18¾				
			254T-256T	26		32¼	51⅜	254TC-256Tc	26⅝		25½	42⅛		19½	24⅛				
	10	10	213T-215T	24¾		26⅞	46⅝	213TC-215TC	25½	2⅞	20⅛	36¾	4½	14⅛	18¾				
			254T-256T	26		32¼	51⅜	254TC-256TC	26⅝		25½	42⅛		19½	24⅛				
			284TS-286TS	26¾			53⅜	284TCS-286TCS	33⅜			42⅞			24⅞				
	12	12	254T-256T	26		33¼	52⅜	254TS-256TS	27⅝	2⅞	26	42⅝	5	19½	24⅛				
			284TS-286TS	26¾			54⅜	284TSC-286TSC	34⅜			43⅜			24⅞				
			324TS-326TS	29¼		37¼	57⅞	324TSC-326TSC	36⅜		30	46⅜		23½	27⅞				
23-26	03	05	182T-184T	24	26⅝	25⅛	42¾	182TC-184TC	22½	3⅞	18 13/16	33 11/16	3 3/16	14⅛	17	10⅞	10⅞	11¾	11¾
			213T-215T	24¾			45⅜	213TC-215TC	N/A			35 15/16			19¼				
			254T-256T	26		30½	50⅛	254TC-256TC	N/A		24 3/16	41 5/16		19½	24⅝				
	04	06	182T-184T	24		26½	44⅛	182TC-184TC	23⅞	3⅞	19½	34⅜	3⅞	14⅛	17				
			213T-215T	24¾			46¾	213TC-215TC	N/A			36⅝			19¼				
			254T-256T	26		31⅞	51½	254TC-256TC	N/A		24⅞	42		19½	24⅝				
	06	08	182T-184T	24		26½	44⅛	182TC-184TC	23⅞	3⅞	19½	34⅜	3⅞	14⅛	17				
			213T-215T	24¾			46¾	213TC-215TC	25⅛	3¼		36⅝			19¼				
			254T-256T	26		31⅞	51½	254TC-256TC	26¼		24⅞	42		19½	24⅝				
	08	08	213T-215T	24¾		26½	46¾	213TC-215TC	25⅛	3¼	19½	36⅝	3⅞	14⅛	19¼				
			254T-256T	26		31⅞	51½	254TC-256TC	26¼		24⅞	42		19½	24⅝				
			284TS-286TS	26¾			53½	284TS-286TS	33			42¾			25⅜				
	10	10	254T-256T	26		33¼	52⅞	254TC-256TC	27⅝	3¼	26	43⅛	5	19½	24⅝				
			284TS-286TS	26¾			54⅞	284TCS-286TCS	34⅜			43⅞			25⅜				
			324TS-326TS	29¼		37¼	58⅝	324TCS-326TCS	36⅜		30	46⅜		23½	27⅞				
	12	12	284TS-286TS	28¼		37¼	54⅞	284TCS-286TCS	34⅜	3¼	30	43⅞	5	23½	25⅜				
			324TS-326TS	29¼			58⅝	324TCS-326TCS	36⅜			43⅞			27⅞				

N/A = Not Available

Tolerance: ± 1/8″

* Dimensions may vary slightly depending on motor manufacturer. Given “H” dimensions were based on the larger of those motors most frequently used by **nyb**. † On fan Sizes 23-26 with Size 12 outlet and Bottom Horizontal discharge, the flange extends ½″ below the floorline.

ARRANGEMENTS 1, 9, 10

Dimensions not to be used for construction unless certified. Note: See page 12 for dimensional drawings.

ARRANGEMENTS 1, 9, & 10 DIMENSIONS [INCHES]

Wheel dia.	Outlet Size	Inlet flange	A†		H		K		N		R		S		T		U		V
			Arr. 1	Arr. 10	Arr. 1	Arr. 10	Arr. 1/9	Arr. 10	Arr. 1	Arr. 10	Arr. 1/9	Arr. 10	Arr. 1	Arr. 10	Arr. 1/9	Arr. 10	Arr. 1/9	Arr. 10	Arr. 10
14-18	03	05	19 1/2	21	24 5/8	30 1/8	3	3 1/2	15 1/8	22	2 13/16	3 7/8	12 1/4	17 3/8	9 1/8	9 3/8	10	10 1/4	8 1/4
	04	06			25 5/8	31 1/8					3 5/16	4 3/8							
	06	08			28	33 1/2					4 1/2	5 1/2							
15-18	08	08																	
19-22	03	05	23 5/8	27 5/8	26 1/8	35 1/8	4	4 1/2	15 1/8	26	2 13/16	4 5/8		19 7/8	10 7/8	12 1/4	11 3/4	13	11
	04	06			27 1/8	36 1/8					3 5/16	5 1/8							
	06	06																	
	08	08			29	38					4 1/2	6 1/4							
	10	10																	
	12	12			30	39					5	6 3/4							
23-26	03	05	26 5/8	27 7/8	28 1/4	36 1/4	5	4 1/2	15 1/8	26	3 3/16	4 1/4		19 7/8	10 7/8	12 1/4	11 3/4	13	11
	04	06			29 5/8	37 5/8					3 7/8	5 5/8							
	06	08																	
	08	08																	
	10	10			31	39					5	6 3/4							
	12	12																	

† On fan sizes 12, outlet and Bottom Horizontal discharge, the flange extends 1/2″ below the floorline.

Tolerance: ± 1/8″

ARRANGEMENT 9 DIMENSIONS [INCHES]

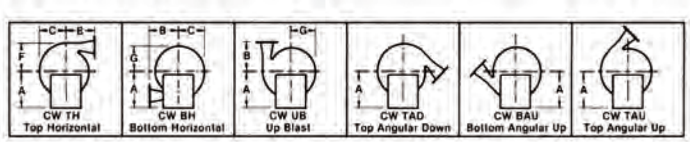
Fan Size	Outlet Size	Pedestal Number	H
14-18	03	1	24 5/8
		2	28 3/8
		3	32 1/8
		4	35 1/4
	04	1	25 5/8
		2	29 3/8
		3	33 1/8
		4	36 1/4
	06,08	1	28
		2	31 3/4
		3	35 1/2
		4	38 5/8
19-22	03	5	26 1/8
		6	29 7/8
		7	33 5/8
		8	36 3/4
		9	38 3/4
	04,06	5	27 1/8
		6	30 7/8
		7	34 5/8
		8	37 3/4
		9	39 3/4

Fan Size	Outlet Size	Pedestal Number	H
19-22	08,10	5	29
		6	32 3/4
		7	36 1/2
		8	39 5/8
		9	41 5/8
	12	5	30
		6	33 3/4
		7	37 1/2
		8	40 5/8
		9	42 5/8
23-26	03	10	35 3/4
		11	38 7/8
		12	40 7/8
		13	42 7/8
	04,06,08	10	37 1/8
		11	40 1/4
		12	42 1/4
		13	44 1/4
	10,12	10	38 1/2
		11	41 5/8
		12	43 5/8
		13	45 5/8

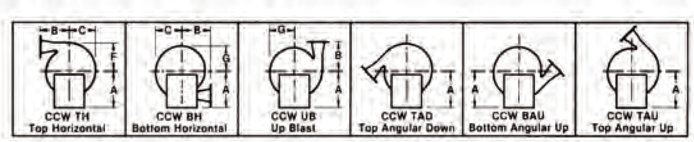
Fan Size	Pedestal Number	Max. C-NW	Max. Frame Size	A	N	S
14-18	1	13 5/8	256T	19 1/2	15 1/8	12 1/4
	2	17 3/8			18 7/8	16
	3	21 1/8			22 5/8	19 3/4
	4	24 1/4	284T	23 1/2	25 3/4	22 7/8
19-22	5	13 5/8	326T	23 5/8	15 1/8	12 1/4
	6	17 3/8			18 7/8	16
	7	21 1/8			22 5/8	19 3/4
	8	24 1/4			25 3/4	22 7/8
	9	26 1/4			27 3/4	24 7/8
23-26	10	21 1/8	326T	26 5/8	22 5/8	19 3/4
	11	24 1/4			25 3/4	22 7/8
	12	26 1/4			27 3/4	24 7/8
	13	28 1/4	365T	30 5/8	29 3/4	26 7/8

Tolerance: ± 1/8″

FAN DISCHARGES – VIEWED FROM DRIVE SIDE



Clockwise—angular discharges at 45°



Counterclockwise—angular discharges at 45°

Housings are reversible and rotatable in 22 1/2° increments except Down Blast and Bottom Angular Down which require special construction. Arrangement 10 fans Sizes 19–22 are not rotatable in the field.

Complete Selection of Air-Moving Equipment

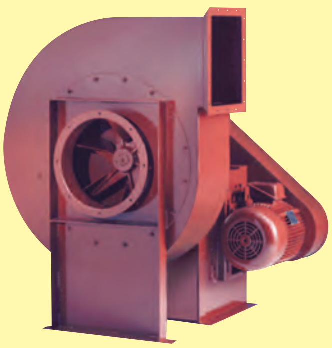
The New York Blower Company offers thousands of different types, models, and sizes of air-moving equipment. Contact your nyb representative for assistance in identifying the best fan for your application.

AIR-HANDLING [AXIAL]

For the ideal handling of clean to moderately dirty airstreams. Commercial and industrial HVAC, drying and cooling systems, fume extraction, and process-heat removal are typical applications.

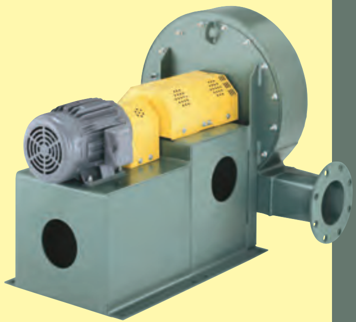
FIBERGLASS REINFORCED PLASTIC [FRP]

Choice of performance and duty for corrosive gas streams. Applications include chemical process, wastewater treatment, laboratory hood exhaust, and tank aeration.



DUST/MATERIAL HANDLING

Wide range of duty available with unique fan lines capable of handling light dust to heavy material. Typical applications include dust-collection and high-pressure process along with material-conveying.



AIR-HANDLING [CENTRIFUGAL]

Designed for clean to moderately dirty gas streams. Commercial and industrial HVAC, process cooling, light material-conveying, heat removal, and dryer exhaust are just a few of the numerous sample applications

CUSTOM PRODUCTS

Designed for unique applications. Variety of configurations, temperatures, flows, and pressures. Wide range of modifications and accessories are available to meet the most demanding specifications.

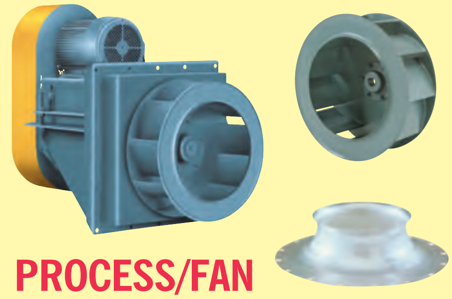
Leading the industry forward since 1889

ROOF VENTILATORS

Including both hooded and upblast ventilators, propeller fans, and centrifugal roof exhausters. These units are ideal for industrial, commercial, and institutional applications.

HEATING PRODUCTS

Industrial-duty steam unit heaters with steam heating coils are available for facility heating and process-heat transfer.



PROCESS/FAN COMPONENTS

Plug fans, plenum fans, wheels, inlet cones, and housings for a wide variety of OEM applications. Process/fan components are used in air-handling units, ovens, dryers, freezer tunnels, and filtration systems.

The New York Blower Company

Fan-to-Size
Fan Selection Data

Project:	
Location:	
Contact:	

Fan Design

Product:	Pressure Blower	Arrangement:	8
Size/Model:	2206A	Drive type:	Direct
Wheel Type:	Aluminum		
Wheel Material:	Aluminum		
Wheel Width:	100 %	Wheel Diameter:	100.0 %

Operating Conditions

Volume Flow Rate:	1,200 CFM	Fan Speed:	3500 rpm
Fan Static Pressure:	28.9 in wg	Fan Input Power:	8.31 bhp
Outlet Velocity:	6122 ft/min	VP/SP ratio:	0.0722
Altitude (above mean sea level):	0 ft	Operating Temperature:	70 Deg F
Operating Inlet Airstream Density:	0.0670 lb/ft3		
Static Efficiency:	65.68%	Mechanical Efficiency:	70.42%
Maximum Operating Temperature:	70 Deg F	Maximum Safe Operating Speed:	3900 rpm

Conditions at 70 Deg F and 0 ft

Volume Flow Rate:	1,200 CFM	Fan Speed:	3500 rpm
Fan Static Pressure:	28.9 in wg	Fan Input Power:	8.31 bhp
Density at Altitude (0 ft) :	0.0670 lb/ft3	Max. Safe Speed at 70 Deg F:	3900 rpm

Sound Power Level Ratings

Sound **Power** and sound **Pressure** levels are shown in decibels. (Power levels reference 10^{-12} watts and pressure levels reference $2x10^{-7}$ microbar.) Sound power ratings are calculated per AMCA Standard 301. Ratings do not include the effects of duct end correction. Sound levels do not include motors or drives. Pressure levels are estimated. A-weighting is per ANSI S.1.42-2001 (R2011).

Octave Bands:	1	2	3	4	5	6	7	8	
Center Frequency (Hz):	63	125	250	500	1000	2000	4000	8000	Overall
Total Fan Power Levels (dB)	74.	86.	89.	96.	93.	88.	84.	83.	99.
Inlet Sound Pressure Levels (dBA)	**30.**	**52.**	**63.**	**75.**	**76.**	**72.**	**68.**	**64.**	**80.**
Total Fan Power Levels (dB)	74.	86.	89.	96.	93.	88.	84.	83.	99.
Outlet Sound Pressure Levels (dBA)	**30.**	**52.**	**63.**	**75.**	**76.**	**72.**	**68.**	**64.**	**80.**
Total Fan Power Levels (dB)	74.	86.	89.	96.	93.	88.	84.	83.	99.
Housing-Radiated Adjustment	-6.	-10.	-15.	-17.	-14.	-14.	-15.	-16.	
Housing-Radiated Sound Pressure Levels (dBA)	**27.**	**45.**	**51.**	**61.**	**64.**	**61.**	**56.**	**51.**	**68.**

Directivity/Reflection is spherical radiation (Q = 1); Distance is 5 ft.
At 5 ft, the estimated sound pressure level:

1. outside the fan due to an open inlet OR outlet is 80 dBA.
2. housing radiated noise when inlet and outlet are ducted away from listening point is 68 dBA.

Your Representative:

The New York Blower Company certifies that the Pressure Blower fan is licensed to bear the AMCA Air Performance Seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Publication 211 and comply with the requirements of the AMCA Certified Ratings program.

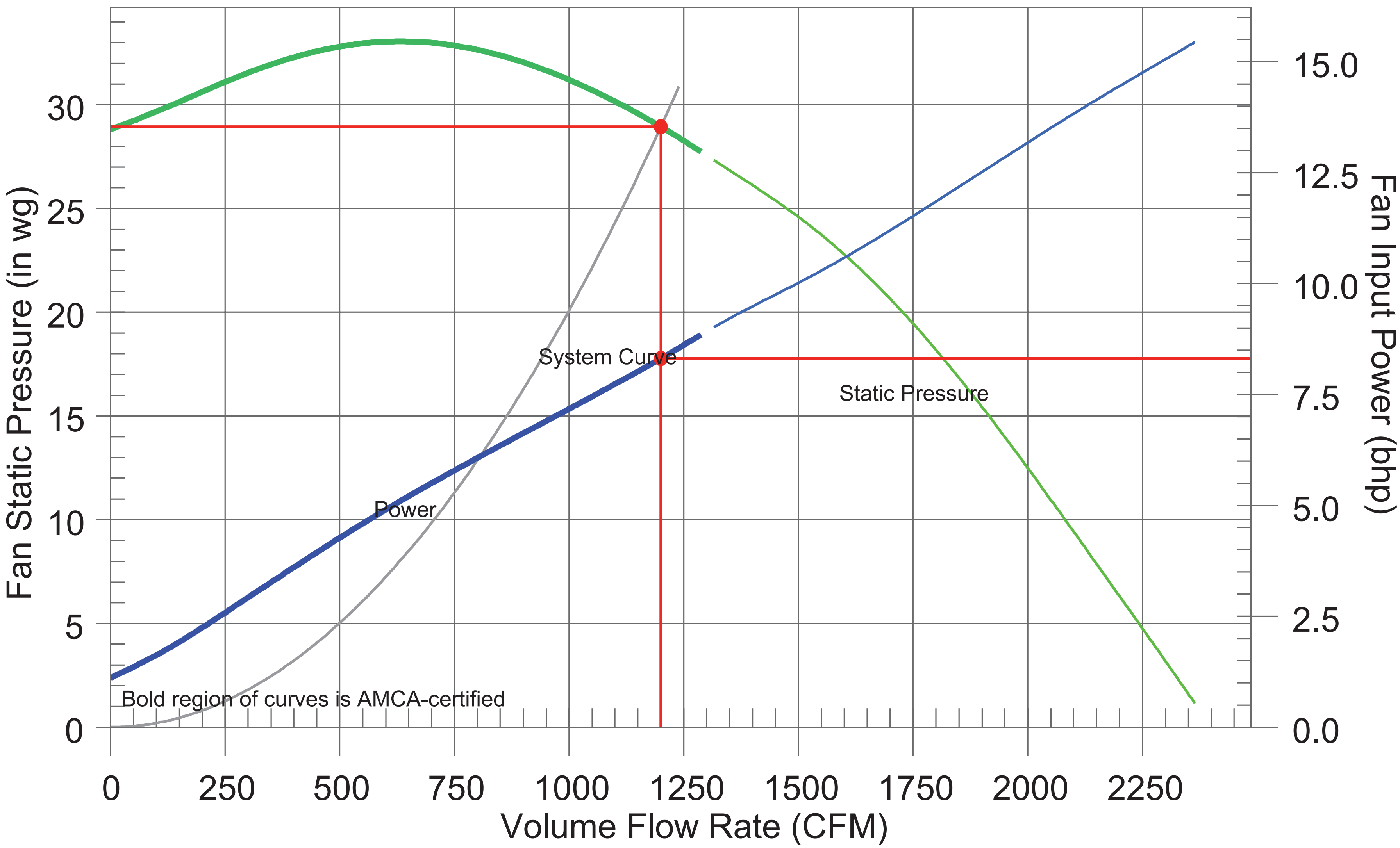
AMCA Licensed for Air Performance without Appurtenances (Accessories). Power (bhp) excludes drives.

Performance certified is for installation type: B - free inlet, ducted outlet.

The New York Blower Company

Fan-to-Size

Pressure Blower	Volume Flow Rate: 1,200 CFM	Temp.: 70 Deg F
2206 Aluminum	Fan Static Press.: 28.9 in wg	Altitude: 0 ft
Arr.: 8	Speed: 3500 rpm	Density: 0.0670 lb/ft3
	Power: 8.31 bhp	Outlet Velocity: 6122 ft/min



AMCA Licensed for Air Performance without Appurtenances (Accessories). Power (bhp) excludes drives.
Performance certified is for installation type: B - free inlet, ducted outlet.

[v1.90.00-R -- May 2016] Date Printed: 4/27/2018

The New York Blower Company
Fan-to-Size
Fan Selection Data

Project:	
Location:	
Contact:	

Fan Design

Product:	Pressure Blower	Arrangement:	1
Size/Model:	2606A	Drive type:	Belt
Wheel Type:	Aluminum		
Wheel Material:	Aluminum		
Wheel Width:	100 %	Wheel Diameter:	100.0 %

Operating Conditions

Volume Flow Rate:	300 CFM	Fan Speed:	3336 rpm
Fan Static Pressure:	45.0 in wg	Fan Input Power:	6.05 bhp
Outlet Velocity:	1531 ft/min	VP/SP ratio:	0.0033
Altitude (above mean sea level):	0 ft	Operating Temperature:	70 Deg F
Operating Inlet Airstream Density:	0.0750 lb/ft3		
Static Efficiency:	35.07%	Mechanical Efficiency:	35.19%
Maximum Operating Temperature:	70 Deg F	Maximum Safe Operating Speed:	3800 rpm

Sound Power Level Ratings

Sound **Power** and sound **Pressure** levels are shown in decibels. (Power levels reference 10^{-12} watts and pressure levels reference $2x10^{-7}$ microbar.) Sound power ratings are calculated per AMCA Standard 301. Ratings do not include the effects of duct end correction. Sound levels do not include motors or drives. Pressure levels are estimated. A-weighting is per ANSI S.1.42-2001 (R2011).

Octave Bands:	1	2	3	4	5	6	7	8	
Center Frequency (Hz):	63	125	250	500	1000	2000	4000	8000	Overall
Total Fan Power Levels (dB)	86.7	92.9	99.7	102.9	100.7	94.8	90.9	81.3	107.
Inlet Sound Pressure Levels (dBA)	**43.**	**59.**	**74.**	**82.**	**83.**	**78.**	**74.**	**63.**	**87.**
Total Fan Power Levels (dB)	86.7	92.9	99.7	102.9	100.7	94.8	90.9	81.3	107.
Outlet Sound Pressure Levels (dBA)	**43.**	**59.**	**74.**	**82.**	**83.**	**78.**	**74.**	**63.**	**87.**
Total Fan Power Levels (dB)	86.7	92.9	99.7	102.9	100.7	94.8	90.9	81.3	107.
Housing-Radiated Adjustment	-7.	-11.	-16.	-17.	-14.	-14.	-15.	-16.	
Housing-Radiated Sound Pressure Levels (dBA)	**39.**	**51.**	**61.**	**68.**	**72.**	**68.**	**62.**	**50.**	**75.**

Directivity/Reflection is spherical radiation (Q = 1); Distance is 5 ft.
At 5 ft, the estimated sound pressure level:

1. outside the fan due to an open inlet OR outlet is 87 dBA.
2. housing radiated noise when inlet and outlet are ducted away from listening point is 75 dBA.

Your Representative:

The New York Blower Company certifies that the Pressure Blower fan is licensed to bear the AMCA Air Performance Seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Publication 211 and comply with the requirements of the AMCA Certified Ratings program.

AMCA Licensed for Air Performance without Appurtenances (Accessories). Power (bhp) excludes drives.

Performance certified is for installation type: B - free inlet, ducted outlet.

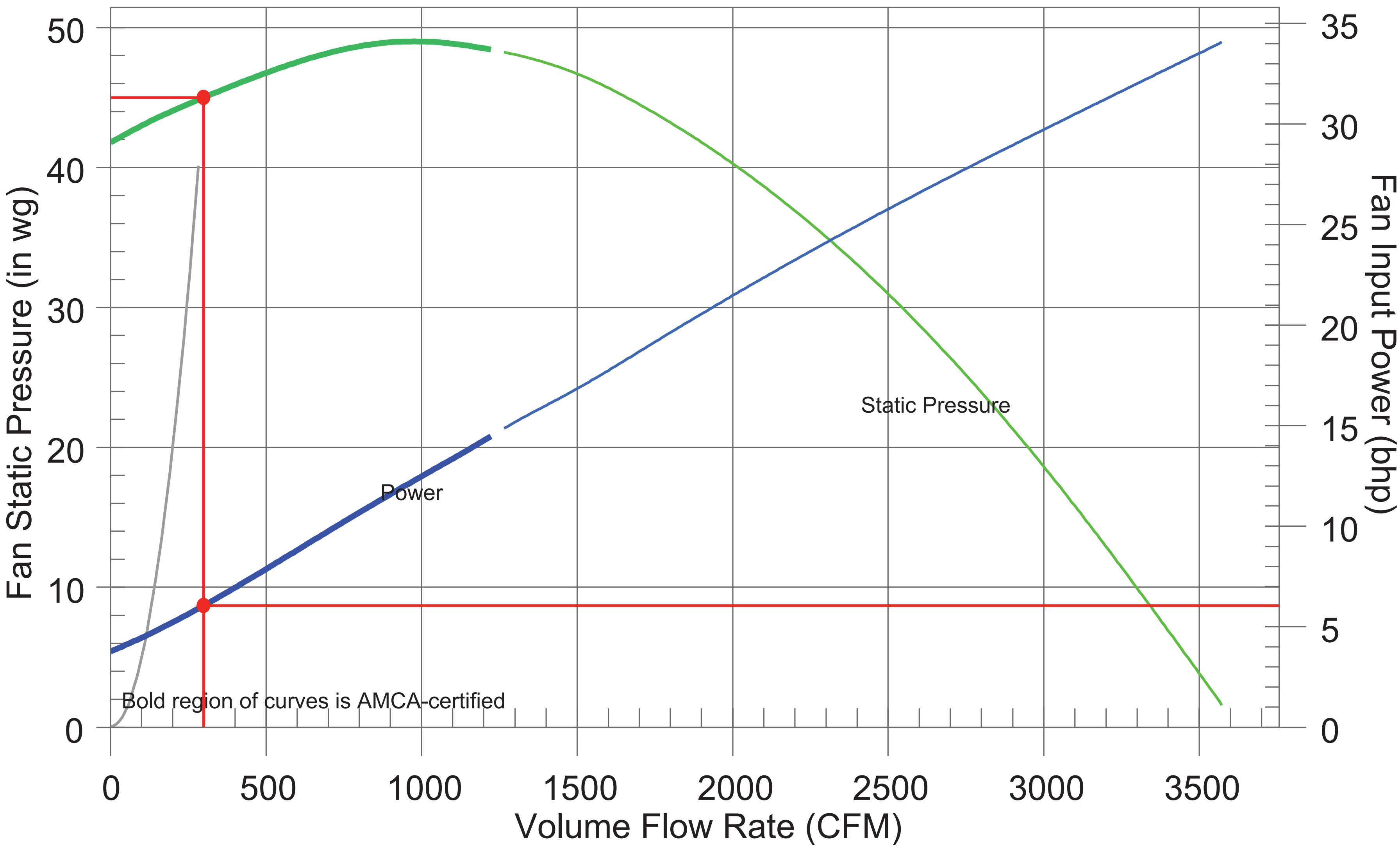
The New York Blower Company

Fan-to-Size

Pressure Blower
2606 Aluminum
Arr.: 1

Volume Flow Rate: 300 CFM
Fan Static Press.: 45.0 in wg
Speed: 3336 rpm
Power: 6.05 bhp

Temp.: 70 Deg F
Altitude: 0 ft
Density: 0.0750 lb/ft3
Outlet Velocity: 1531 ft/min

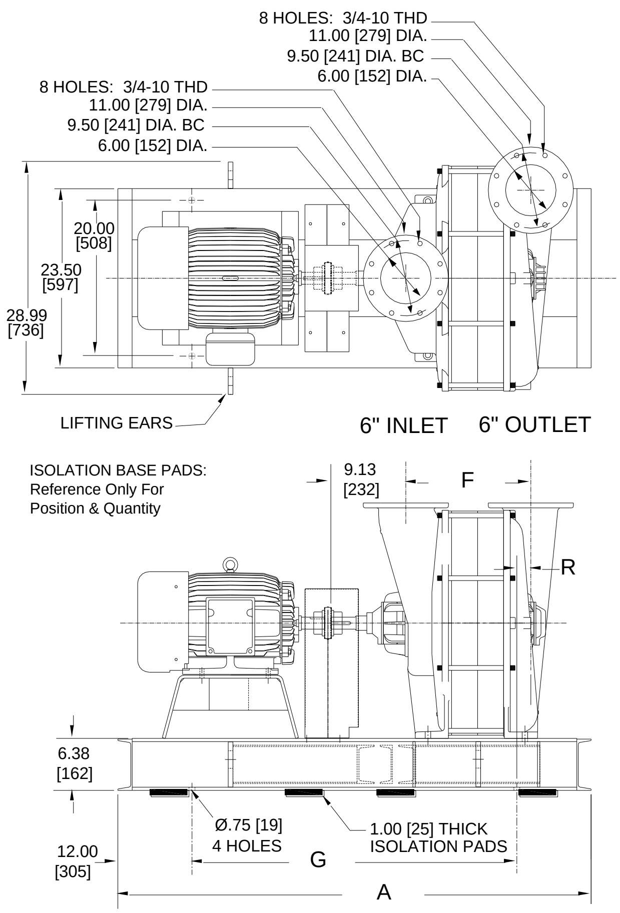


AMCA Licensed for Air Performance without Appurtenances (Accessories). Power (bhp) excludes drives.
Performance certified is for installation type: B - free inlet, ducted outlet.

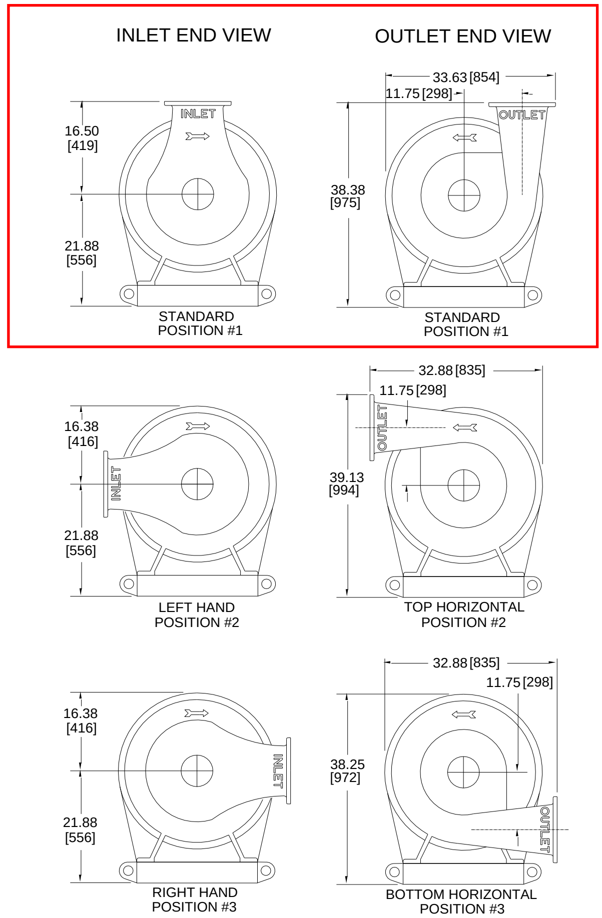
[v1.90.00-R -- May 2016] Date Printed: 5/16/2018

Dimensional Data
HOFFMAN 732 Series
Centrifugal Products

GENERAL ARRANGEMENT



FLANGE ORIENTATIONS



DIMENSIONAL DATA – inches [millimeters]

FRAME	A	F	G	R
73201	60.75 [1543]	9.25 [235]	36.75 [933]	4.25 [108]
73202	72.75 [1848]	12.88 [327]	48.75 [1238]	4.25 [108]
73203	72.75 [1848]	16.50 [419]	48.75 [1238]	4.25 [108]
73204	72.75 [1848]	20.12 [511]	48.75 [1238]	4.25 [108]
73205	84.75 [2153]	23.75 [603]	60.75 [1543]	4.25 [108]
73206	96.75 [2457]	27.38 [695]	72.75 [1848]	4.25 [108]
73207	96.75 [2457]	31.00 [787]	72.75 [1848]	4.25 [108]
73208	108.75 [2762]	34.62 [879]	84.75 [2153]	4.25 [108]
73209	108.75 [2762]	38.25 [972]	84.75 [2153]	4.25 [108]
73210	114.75 [2915]	41.88 [1064]	90.75 [2305]	4.25 [108]

WEIGHTS – lb [kg] & INERTIA – lb-ft² [kg-m²]

FRAME	PKG. LESS MOTOR	BARE UNIT	WK^2
73201	1110 [503]	710[322]	8 [0.34]
73202	1350 [612]	950 [431]	16 [0.66]
73203	1590 [721]	1190 [540]	23 [0.98]
73204	1879 [852]	1430 [649]	31 [1.30]
73205	2109 [957]	1660 [753]	39 [1.62]
73206	2349 [1065]]	1900 [862]	46 [1.94]
73207	2589 [1174]	2140 [971]	54 [2.26]
73208	2829 [1283]	2380 [1080]	62 [2.58]
73209	3059 [1388]	2610 [1184]	69 [2.91]
73210	3299 [1496]	2850 [1293]	77 [3.24]

PRODUCT NOTES

1. Information is approximate, subject to change without notice, and not for construction use unless certified
2. Position #1 is standard inlet & outlet orientation
3. A and G dimensions may vary depending on motor frame size

Gardner Denver Nash
PO Box 130, Bentleyville, PA 15314
Phone: +1 800-982-3009 / +1 724-239-1500
Fax: +1 724-239-1502
E-mail: info.HoffmanLamson@gardnerdenver.com
Web: www.**Hoffman**and**Lamson**.com

All Nash facilities are ISO 9001 certified.

Lamson TBT, 1 Stage(s) (1 x 3500), 3600 RPM

Date: 5/31/2018

Project Name:

Customer: HERRERA

Sales Order Number:

Application Engineer: DMK

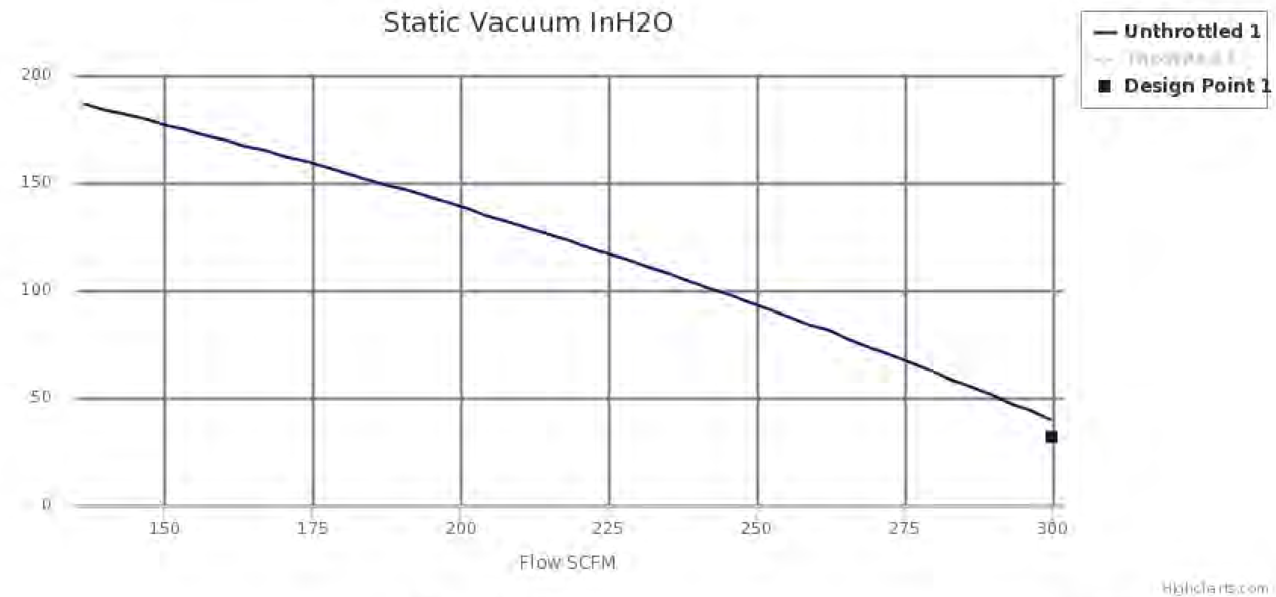
Comment: VASHON LANDFILL

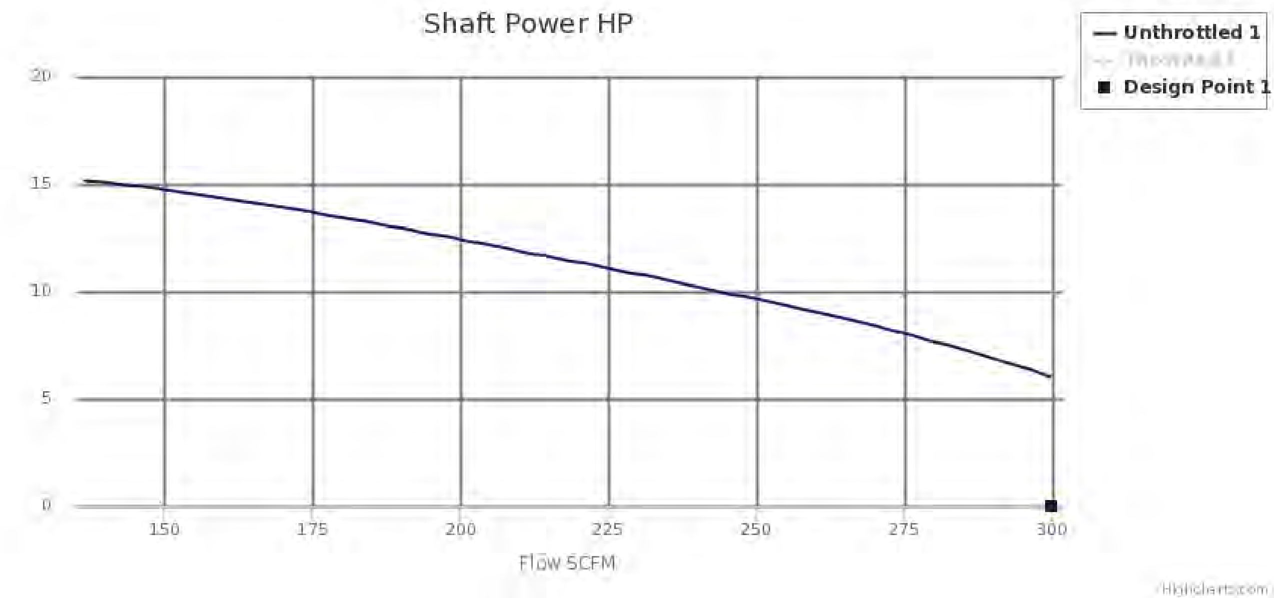
AMBIENT GAS PARAMETERS	ENGLISH UNITS	METRIC UNITS
Molecular Weight	30.026 lbm/lbmol	30.026 kg/kgmol
R Value	51.456 ft.lbf/lbm.R	0.277 kJ/kg.K
Density	0.077 lbm/ft^3	1.239 kg/m^3
Sp. Heat @ Const. P	0.300 BTU/lbm.R	1.258 kJ/kg.K
Ratio of Sp. Heats	1.287	1.287
Partial Pres. of Vapor	0.000	0.000

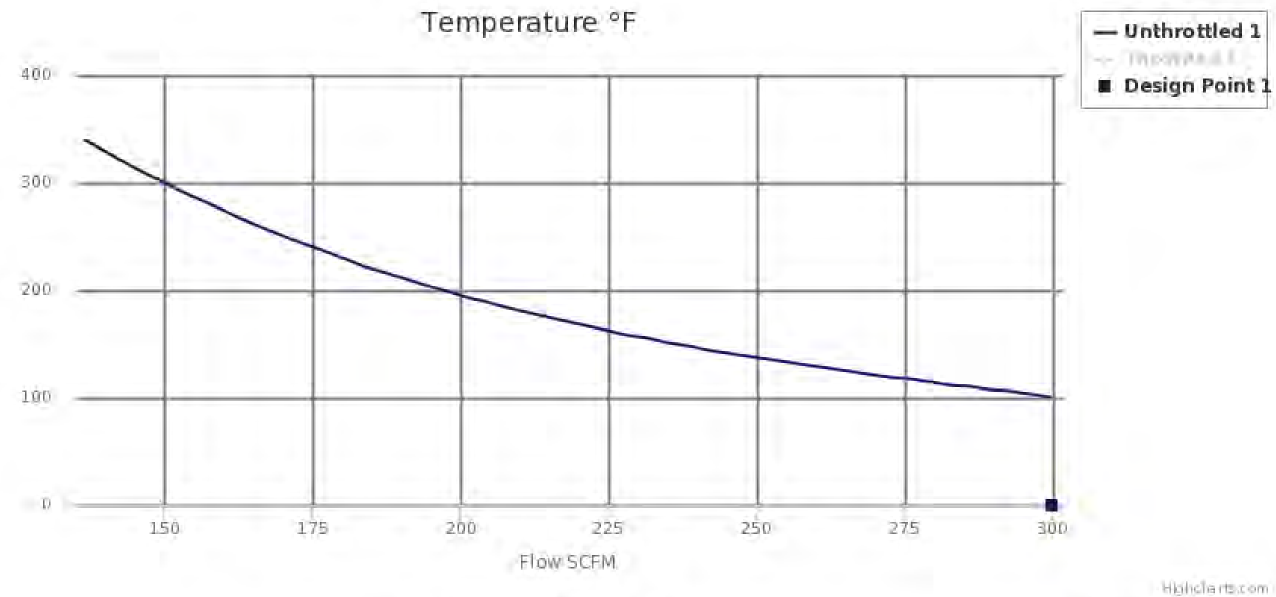
GAS MIX:	VOL
Air	0.00
Carbon Dioxide - CO2	50
Methane - CH4	50

Inlet Set 1

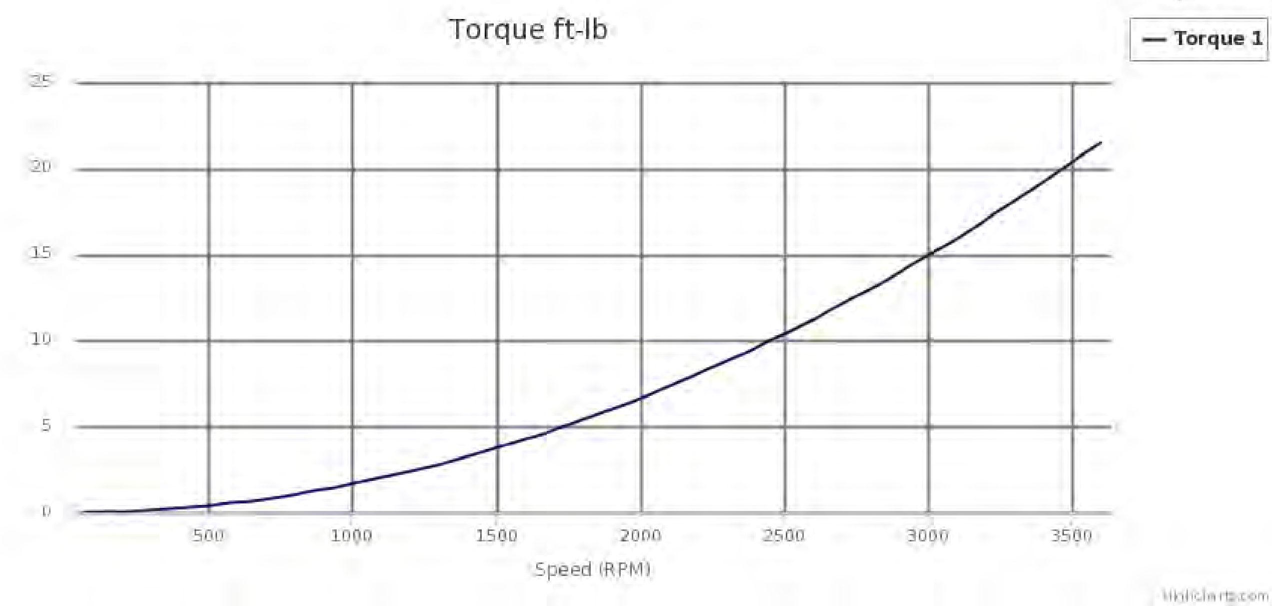
CORRECTED VALUES	ORIGINAL UNITS	ENGLISH UNITS	METRIC UNITS
Ambient Pressure	14.696 PSIA	14.70 PSIA	1.01 bar a
Relative Humidity	100%	100%	100%
Ambient Temperature	72 F	72.00 F	22.22 C
Inlet Vacuum	-32 InH2O	13.54 PSIA	0.93 bar g
Inlet Flow	300 SCFM	335 ICFM	569 m3/h
Discharge Pressure	6 InH2O	0.22 PSIG	0.01 bar g
MEASURED VALUES	**ORIGINAL UNITS**	**ENGLISH UNITS**	**METRIC UNITS**
Surge Flow Rate	136 SCFM	152 ICFM	259 m3/h
Surge Vacuum	186.79 InH2O	6.75 PSIG	0.47 bar g
Vacuum Rise to Surge	154.79 InH2O	5.59 PSIG	0.39 bar g
Max. Vol. Turndown	54.50%	54.50%	54.50%
Vacuum @ Design	32.00 InH2O	1.16 PSIG	0.08 bar g
Power @ Design	0.00 HP	0.00 HP	0.00 KW
Efficiency @ Design	0.00%	0.00%	0.00%
Tempurature @ Design	0.00 F	0.00 F	-17.78 C


Static Vacuum InH2O
Unthrottled 1
Design Point 1
200
150
100
50
0
150
175
200
225
250
275
300
Flow SCFM
Highcharts.com


Shaft Power HP
Unthrottled 1
Design Point 1
20
15
10
5
0
150
175
200
225
250
275
300
Flow SCFM
Highcharts.com


Temperature °F
Unthrottled 1
Design Point 1
400
300
200
100
0
150
175
200
225
250
275
300
Flow SCFM
Highcharts.com


Static Efficiency %
Unthrottled 1
Design Point 1
50
40
30
20
10
0
150
175
200
225
250
275
300
Flow SCFM
Highcharts.com


Torque ft-lb
Torque 1
25
20
15
10
5
0
500
1000
1500
2000
2500
3000
3500
Speed (RPM)
Highcharts.com

APPENDIX E

LandGEM Model Report

Summary Report

Landfill Name or Identifier: Vashon Island Landfill

Date: Wednesday, April 10, 2019

Description/Comments:

About LandGEM:

First-Order Decomposition Rate Equation:

$$Q_{CH_4} = \sum_{i=1}^{n} \sum_{j=0.1}^{1} kL_o \left(\frac{M_i}{10} \right) e^{-kt_{ij}}$$

Where,
Q_{CH4} = annual methane generation in the year of the calculation (*m^3/year*)
i = 1-year time increment
n = (year of the calculation) - (initial year of waste acceptance)
j = 0.1-year time increment
k = methane generation rate (*$year^{-1}$*)
L_o = potential methane generation capacity (*m^3/Mg*)

M_i = mass of waste accepted in the i^{th} year (*Mg*)
t_{ij} = age of the j^{th} section of waste mass M_i accepted in the i^{th} year (*decimal years*, e.g., 3.2 years)

LandGEM is based on a first-order decomposition rate equation for quantifying emissions from the decomposition of landfilled waste in municipal solid waste (MSW) landfills. The software provides a relatively simple approach to estimating landfill gas emissions. Model defaults are based on empirical data from U.S. landfills. Field test data can also be used in place of model defaults when available. Further guidance on EPA test methods, Clean Air Act (CAA) regulations, and other guidance regarding landfill gas emissions and control technology requirements can be found at http://www.epa.gov/ttnatw01/landfill/landflpg.html.

LandGEM is considered a screening tool — the better the input data, the better the estimates. Often, there are limitations with the available data regarding waste quantity and composition, variation in design and operating practices over time, and changes occurring over time that impact the emissions potential. Changes to landfill operation, such as operating under wet conditions through leachate recirculation or other liquid additions, will result in generating more gas at a faster rate. Defaults for estimating emissions for this type of operation are being developed to include in LandGEM along with defaults for convential landfills (no leachate or liquid additions) for developing emission inventories and determining CAA applicability. Refer to the Web site identified above for future updates.

Input Review

LANDFILL CHARACTERISTICS

Landfill Open Year	**1950**	
Landfill Closure Year (with 80-year limit)	**1999**	
Actual Closure Year (without limit)	***1999***	
Have Model Calculate Closure Year?	**No**	
Waste Design Capacity	**580,800**	*short tons*

MODEL PARAMETERS

Methane Generation Rate, k	**0.050**	*$year^{-1}$*
Potential Methane Generation Capacity, L_o	**50**	*m^3/Mg*
NMOC Concentration	**4,000**	*ppmv as hexane*
Methane Content	**40**	*% by volume*

GASES / POLLUTANTS SELECTED

Gas / Pollutant #1:	**Total landfill gas**
Gas / Pollutant #2:	**Methane**
Gas / Pollutant #3:	**Carbon dioxide**
Gas / Pollutant #4:	**NMOC**

WASTE ACCEPTANCE RATES

Year	Waste Accepted		Waste-In-Place	
	(Mg/year)	*(short tons/year)*	*(Mg)*	*(short tons)*
1950	10,560	11,616	0	0
1951	10,560	11,616	10,560	11,616
1952	10,560	11,616	21,120	23,232
1953	10,560	11,616	31,680	34,848
1954	10,560	11,616	42,240	46,464
1955	10,560	11,616	52,800	58,080
1956	10,560	11,616	63,360	69,696
1957	10,560	11,616	73,920	81,312
1958	10,560	11,616	84,480	92,928
1959	10,560	11,616	95,040	104,544
1960	10,560	11,616	105,600	116,160
1961	10,560	11,616	116,160	127,776
1962	10,560	11,616	126,720	139,392
1963	10,560	11,616	137,280	151,008
1964	10,560	11,616	147,840	162,624
1965	10,560	11,616	158,400	174,240
1966	10,560	11,616	168,960	185,856
1967	10,560	11,616	179,520	197,472
1968	10,560	11,616	190,080	209,088
1969	10,560	11,616	200,640	220,704
1970	10,560	11,616	211,200	232,320
1971	10,560	11,616	221,760	243,936
1972	10,560	11,616	232,320	255,552
1973	10,560	11,616	242,880	267,168
1974	10,560	11,616	253,440	278,784
1975	10,560	11,616	264,000	290,400
1976	10,560	11,616	274,560	302,016
1977	10,560	11,616	285,120	313,632
1978	10,560	11,616	295,680	325,248
1979	10,560	11,616	306,240	336,864
1980	10,560	11,616	316,800	348,480
1981	10,560	11,616	327,360	360,096
1982	10,560	11,616	337,920	371,712
1983	10,560	11,616	348,480	383,328
1984	10,560	11,616	359,040	394,944
1985	10,560	11,616	369,600	406,560
1986	10,560	11,616	380,160	418,176
1987	10,560	11,616	390,720	429,792
1988	10,560	11,616	401,280	441,408
1989	10,560	11,616	411,840	453,024

WASTE ACCEPTANCE RATES (Continued)

Year	Waste Accepted		Waste-In-Place	
	(Mg/year)	*(short tons/year)*	*(Mg)*	*(short tons)*
1990	10,560	11,616	422,400	464,640
1991	10,560	11,616	432,960	476,256
1992	10,560	11,616	443,520	487,872
1993	10,560	11,616	454,080	499,488
1994	10,560	11,616	464,640	511,104
1995	10,560	11,616	475,200	522,720
1996	10,560	11,616	485,760	534,336
1997	10,560	11,616	496,320	545,952
1998	10,560	11,616	506,880	557,568
1999	10,560	11,616	517,440	569,184
2000	0	0	528,000	580,800
2001	0	0	528,000	580,800
2002	0	0	528,000	580,800
2003	0	0	528,000	580,800
2004	0	0	528,000	580,800
2005	0	0	528,000	580,800
2006	0	0	528,000	580,800
2007	0	0	528,000	580,800
2008	0	0	528,000	580,800
2009	0	0	528,000	580,800
2010	0	0	528,000	580,800
2011	0	0	528,000	580,800
2012	0	0	528,000	580,800
2013	0	0	528,000	580,800
2014	0	0	528,000	580,800
2015	0	0	528,000	580,800
2016	0	0	528,000	580,800
2017	0	0	528,000	580,800
2018	0	0	528,000	580,800
2019	0	0	528,000	580,800
2020	0	0	528,000	580,800
2021	0	0	528,000	580,800
2022	0	0	528,000	580,800
2023	0	0	528,000	580,800
2024	0	0	528,000	580,800
2025	0	0	528,000	580,800
2026	0	0	528,000	580,800
2027	0	0	528,000	580,800
2028	0	0	528,000	580,800
2029	0	0	528,000	580,800

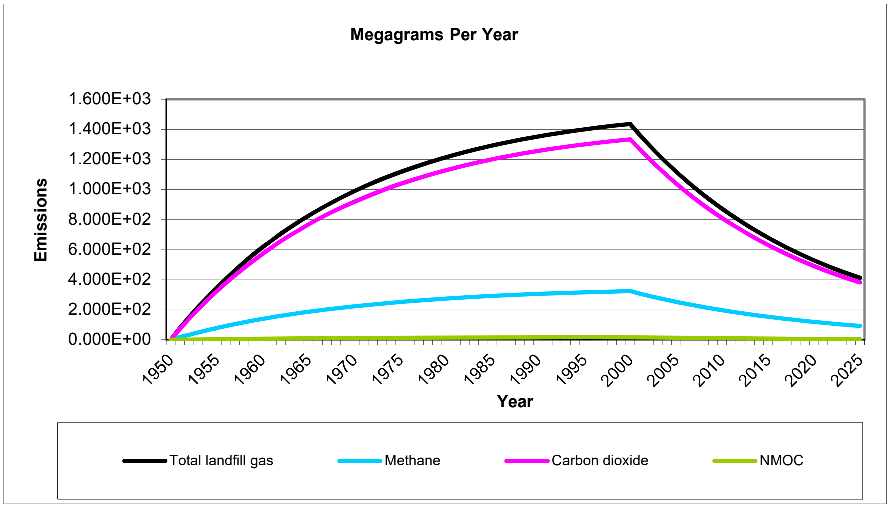
Pollutant Parameters

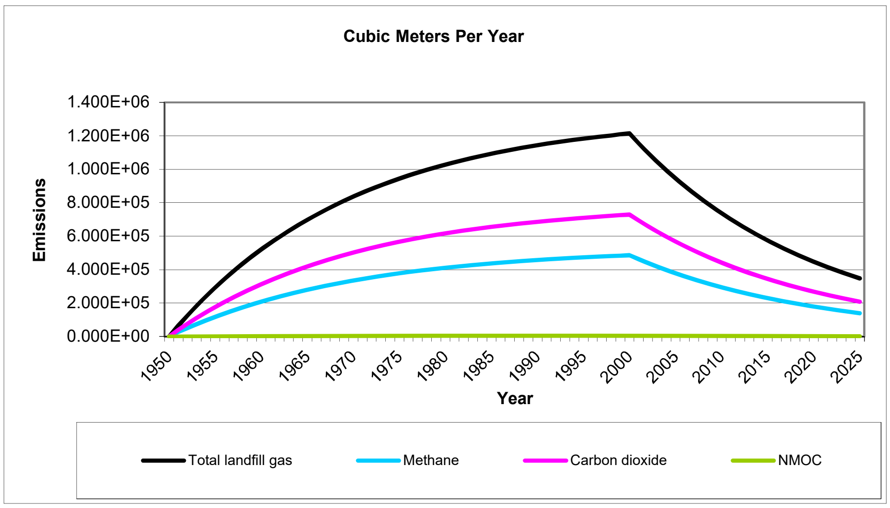
	Gas / Pollutant Default Parameters:			User-specified Pollutant Parameters:	
	Compound	Concentration (*ppmv*)	Molecular Weight	Concentration (*ppmv*)	Molecular Weight
Gases	Total landfill gas		0.00		
	Methane		16.04		
	Carbon dioxide		44.01		
	NMOC	4,000	86.18		
Pollutants	1,1,1-Trichloroethane (methyl chloroform) - HAP	0.48	133.41		
	1,1,2,2-Tetrachloroethane - HAP/VOC	1.1	167.85		
	1,1-Dichloroethane (ethylidene dichloride) - HAP/VOC	2.4	98.97		
	1,1-Dichloroethene (vinylidene chloride) - HAP/VOC	0.20	96.94		
	1,2-Dichloroethane (ethylene dichloride) - HAP/VOC	0.41	98.96		
	1,2-Dichloropropane (propylene dichloride) - HAP/VOC	0.18	112.99		
	2-Propanol (isopropyl alcohol) - VOC	50	60.11		
	Acetone	7.0	58.08		
	Acrylonitrile - HAP/VOC	6.3	53.06		
	Benzene - No or Unknown Co-disposal - HAP/VOC	1.9	78.11		
	Benzene - Co-disposal - HAP/VOC	11	78.11		
	Bromodichloromethane - VOC	3.1	163.83		
	Butane - VOC	5.0	58.12		
	Carbon disulfide - HAP/VOC	0.58	76.13		
	Carbon monoxide	140	28.01		
	Carbon tetrachloride - HAP/VOC	4.0E-03	153.84		
	Carbonyl sulfide - HAP/VOC	0.49	60.07		
	Chlorobenzene - HAP/VOC	0.25	112.56		
	Chlorodifluoromethane	1.3	86.47		
	Chloroethane (ethyl chloride) - HAP/VOC	1.3	64.52		
	Chloroform - HAP/VOC	0.03	119.39		
	Chloromethane - VOC	1.2	50.49		
	Dichlorobenzene - (HAP for para isomer/VOC)	0.21	147		
	Dichlorodifluoromethane	16	120.91		
	Dichlorofluoromethane - VOC	2.6	102.92		
	Dichloromethane (methylene chloride) - HAP	14	84.94		
	Dimethyl sulfide (methyl sulfide) - VOC	7.8	62.13		
	Ethane	890	30.07		
	Ethanol - VOC	27	46.08		

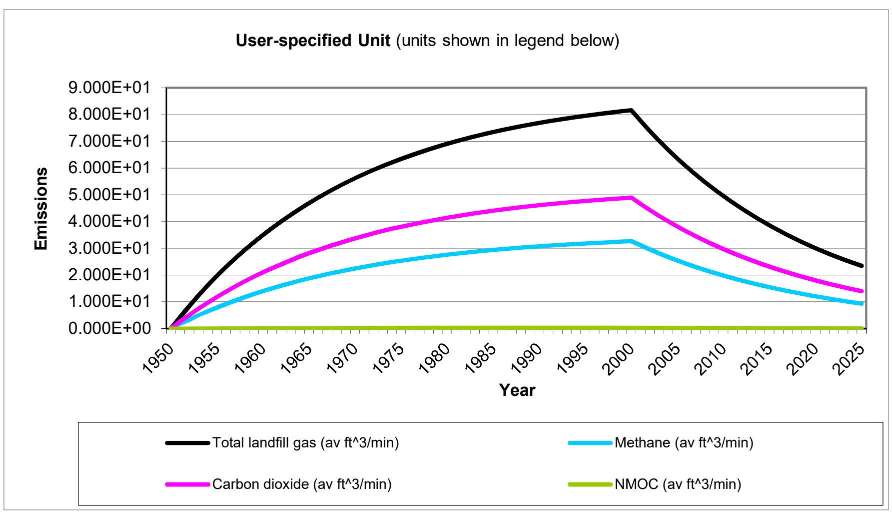
Pollutant Parameters (Continued)

	Gas / Pollutant Default Parameters:			User-specified Pollutant Parameters:	
	Compound	Concentration (*ppmv*)	Molecular Weight	Concentration (*ppmv*)	Molecular Weight
Pollutants	Ethyl mercaptan (ethanethiol) - VOC	2.3	62.13		
	Ethylbenzene - HAP/VOC	4.6	106.16		
	Ethylene dibromide - HAP/VOC	1.0E-03	187.88		
	Fluorotrichloromethane - VOC	0.76	137.38		
	Hexane - HAP/VOC	6.6	86.18		
	Hydrogen sulfide	36	34.08		
	Mercury (total) - HAP	2.9E-04	200.61		
	Methyl ethyl ketone - HAP/VOC	7.1	72.11		
	Methyl isobutyl ketone - HAP/VOC	1.9	100.16		
	Methyl mercaptan - VOC	2.5	48.11		
	Pentane - VOC	3.3	72.15		
	Perchloroethylene (tetrachloroethylene) - HAP	3.7	165.83		
	Propane - VOC	11	44.09		
	t-1,2-Dichloroethene - VOC	2.8	96.94		
	Toluene - No or Unknown Co-disposal - HAP/VOC	39	92.13		
	Toluene - Co-disposal - HAP/VOC	170	92.13		
	Trichloroethylene (trichloroethene) - HAP/VOC	2.8	131.40		
	Vinyl chloride - HAP/VOC	7.3	62.50		
	Xylenes - HAP/VOC	12	106.16		

Graphs


Megagrams Per Year
1.600E+03
1.400E+03
1.200E+03
1.000E+03
8.000E+02
6.000E+02
4.000E+02
2.000E+02
0.000E+00
Emissions
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025
Year
Total landfill gas
Methane
Carbon dioxide
NMOC


Cubic Meters Per Year
1.400E+06
1.200E+06
1.000E+06
8.000E+05
6.000E+05
4.000E+05
2.000E+05
0.000E+00
Emissions
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025
Year
Total landfill gas
Methane
Carbon dioxide
NMOC


User-specified Unit (units shown in legend below)
9.000E+01
8.000E+01
7.000E+01
6.000E+01
5.000E+01
4.000E+01
3.000E+01
2.000E+01
1.000E+01
0.000E+00
Emissions
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025
Year
Total landfill gas (av ft^3/min)
Methane (av ft^3/min)
Carbon dioxide (av ft^3/min)
NMOC (av ft^3/min)

Results

Year	Total landfill gas			Methane		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
1950	0	0	0	0	0	0
1951	7.629E+01	6.454E+04	4.336E+00	1.722E+01	2.582E+04	1.735E+00
1952	1.489E+02	1.259E+05	8.461E+00	3.361E+01	5.037E+04	3.384E+00
1953	2.179E+02	1.843E+05	1.238E+01	4.919E+01	7.373E+04	4.954E+00
1954	2.836E+02	2.399E+05	1.612E+01	6.401E+01	9.595E+04	6.447E+00
1955	3.460E+02	2.927E+05	1.967E+01	7.811E+01	1.171E+05	7.867E+00
1956	4.054E+02	3.430E+05	2.304E+01	9.153E+01	1.372E+05	9.218E+00
1957	4.620E+02	3.908E+05	2.626E+01	1.043E+02	1.563E+05	1.050E+01
1958	5.157E+02	4.363E+05	2.931E+01	1.164E+02	1.745E+05	1.173E+01
1959	5.669E+02	4.795E+05	3.222E+01	1.280E+02	1.918E+05	1.289E+01
1960	6.155E+02	5.207E+05	3.498E+01	1.389E+02	2.083E+05	1.399E+01
1961	6.618E+02	5.598E+05	3.761E+01	1.494E+02	2.239E+05	1.505E+01
1962	7.058E+02	5.971E+05	4.012E+01	1.593E+02	2.388E+05	1.605E+01
1963	7.477E+02	6.325E+05	4.250E+01	1.688E+02	2.530E+05	1.700E+01
1964	7.875E+02	6.662E+05	4.476E+01	1.778E+02	2.665E+05	1.790E+01
1965	8.254E+02	6.982E+05	4.691E+01	1.863E+02	2.793E+05	1.877E+01
1966	8.614E+02	7.287E+05	4.896E+01	1.945E+02	2.915E+05	1.958E+01
1967	8.957E+02	7.577E+05	5.091E+01	2.022E+02	3.031E+05	2.036E+01
1968	9.283E+02	7.853E+05	5.276E+01	2.096E+02	3.141E+05	2.111E+01
1969	9.593E+02	8.115E+05	5.453E+01	2.166E+02	3.246E+05	2.181E+01
1970	9.888E+02	8.365E+05	5.620E+01	2.232E+02	3.346E+05	2.248E+01
1971	1.017E+03	8.602E+05	5.780E+01	2.296E+02	3.441E+05	2.312E+01
1972	1.044E+03	8.828E+05	5.932E+01	2.356E+02	3.531E+05	2.373E+01
1973	1.069E+03	9.043E+05	6.076E+01	2.413E+02	3.617E+05	2.430E+01
1974	1.093E+03	9.247E+05	6.213E+01	2.468E+02	3.699E+05	2.485E+01
1975	1.116E+03	9.442E+05	6.344E+01	2.520E+02	3.777E+05	2.538E+01
1976	1.138E+03	9.627E+05	6.468E+01	2.569E+02	3.851E+05	2.587E+01
1977	1.159E+03	9.802E+05	6.586E+01	2.616E+02	3.921E+05	2.635E+01
1978	1.179E+03	9.970E+05	6.699E+01	2.661E+02	3.988E+05	2.679E+01
1979	1.197E+03	1.013E+06	6.806E+01	2.703E+02	4.052E+05	2.722E+01
1980	1.215E+03	1.028E+06	6.907E+01	2.743E+02	4.112E+05	2.763E+01
1981	1.232E+03	1.042E+06	7.004E+01	2.782E+02	4.170E+05	2.802E+01
1982	1.248E+03	1.056E+06	7.096E+01	2.818E+02	4.225E+05	2.838E+01
1983	1.264E+03	1.069E+06	7.184E+01	2.853E+02	4.277E+05	2.873E+01
1984	1.279E+03	1.082E+06	7.267E+01	2.886E+02	4.326E+05	2.907E+01
1985	1.292E+03	1.093E+06	7.346E+01	2.918E+02	4.373E+05	2.938E+01
1986	1.306E+03	1.105E+06	7.422E+01	2.948E+02	4.418E+05	2.969E+01
1987	1.318E+03	1.115E+06	7.493E+01	2.976E+02	4.461E+05	2.997E+01
1988	1.330E+03	1.125E+06	7.561E+01	3.003E+02	4.502E+05	3.025E+01
1989	1.342E+03	1.135E+06	7.626E+01	3.029E+02	4.540E+05	3.051E+01
1990	1.353E+03	1.144E+06	7.688E+01	3.053E+02	4.577E+05	3.075E+01
1991	1.363E+03	1.153E+06	7.747E+01	3.077E+02	4.612E+05	3.099E+01
1992	1.373E+03	1.161E+06	7.802E+01	3.099E+02	4.645E+05	3.121E+01
1993	1.382E+03	1.169E+06	7.856E+01	3.120E+02	4.677E+05	3.142E+01
1994	1.391E+03	1.177E+06	7.906E+01	3.140E+02	4.707E+05	3.162E+01
1995	1.399E+03	1.184E+06	7.954E+01	3.159E+02	4.735E+05	3.182E+01
1996	1.407E+03	1.191E+06	8.000E+01	3.177E+02	4.763E+05	3.200E+01
1997	1.415E+03	1.197E+06	8.043E+01	3.195E+02	4.788E+05	3.217E+01
1998	1.422E+03	1.203E+06	8.085E+01	3.211E+02	4.813E+05	3.234E+01
1999	1.429E+03	1.209E+06	8.124E+01	3.227E+02	4.836E+05	3.250E+01

Results (Continued)

Year	Total landfill gas			Methane		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2000	1.436E+03	1.215E+06	8.161E+01	3.241E+02	4.859E+05	3.265E+01
2001	1.366E+03	1.155E+06	7.763E+01	3.083E+02	4.622E+05	3.105E+01
2002	1.299E+03	1.099E+06	7.385E+01	2.933E+02	4.396E+05	2.954E+01
2003	1.236E+03	1.045E+06	7.025E+01	2.790E+02	4.182E+05	2.810E+01
2004	1.176E+03	9.945E+05	6.682E+01	2.654E+02	3.978E+05	2.673E+01
2005	1.118E+03	9.460E+05	6.356E+01	2.524E+02	3.784E+05	2.542E+01
2006	1.064E+03	8.999E+05	6.046E+01	2.401E+02	3.599E+05	2.418E+01
2007	1.012E+03	8.560E+05	5.751E+01	2.284E+02	3.424E+05	2.301E+01
2008	9.625E+02	8.142E+05	5.471E+01	2.173E+02	3.257E+05	2.188E+01
2009	9.156E+02	7.745E+05	5.204E+01	2.067E+02	3.098E+05	2.082E+01
2010	8.709E+02	7.367E+05	4.950E+01	1.966E+02	2.947E+05	1.980E+01
2011	8.284E+02	7.008E+05	4.709E+01	1.870E+02	2.803E+05	1.883E+01
2012	7.880E+02	6.666E+05	4.479E+01	1.779E+02	2.667E+05	1.792E+01
2013	7.496E+02	6.341E+05	4.261E+01	1.692E+02	2.536E+05	1.704E+01
2014	7.130E+02	6.032E+05	4.053E+01	1.610E+02	2.413E+05	1.621E+01
2015	6.783E+02	5.738E+05	3.855E+01	1.531E+02	2.295E+05	1.542E+01
2016	6.452E+02	5.458E+05	3.667E+01	1.456E+02	2.183E+05	1.467E+01
2017	6.137E+02	5.192E+05	3.488E+01	1.385E+02	2.077E+05	1.395E+01
2018	5.838E+02	4.939E+05	3.318E+01	1.318E+02	1.975E+05	1.327E+01
2019	5.553E+02	4.698E+05	3.156E+01	1.254E+02	1.879E+05	1.263E+01
2020	5.282E+02	4.469E+05	3.002E+01	1.192E+02	1.787E+05	1.201E+01
2021	5.025E+02	4.251E+05	2.856E+01	1.134E+02	1.700E+05	1.142E+01
2022	4.780E+02	4.043E+05	2.717E+01	1.079E+02	1.617E+05	1.087E+01
2023	4.547E+02	3.846E+05	2.584E+01	1.026E+02	1.538E+05	1.034E+01
2024	4.325E+02	3.659E+05	2.458E+01	9.763E+01	1.463E+05	9.833E+00
2025	4.114E+02	3.480E+05	2.338E+01	9.287E+01	1.392E+05	9.353E+00
2026	3.913E+02	3.310E+05	2.224E+01	8.834E+01	1.324E+05	8.897E+00
2027	3.722E+02	3.149E+05	2.116E+01	8.403E+01	1.260E+05	8.463E+00
2028	3.541E+02	2.995E+05	2.013E+01	7.993E+01	1.198E+05	8.050E+00
2029	3.368E+02	2.849E+05	1.914E+01	7.604E+01	1.140E+05	7.658E+00
2030	3.204E+02	2.710E+05	1.821E+01	7.233E+01	1.084E+05	7.284E+00
2031	3.048E+02	2.578E+05	1.732E+01	6.880E+01	1.031E+05	6.929E+00
2032	2.899E+02	2.452E+05	1.648E+01	6.544E+01	9.810E+04	6.591E+00
2033	2.758E+02	2.333E+05	1.567E+01	6.225E+01	9.331E+04	6.270E+00
2034	2.623E+02	2.219E+05	1.491E+01	5.922E+01	8.876E+04	5.964E+00
2035	2.495E+02	2.111E+05	1.418E+01	5.633E+01	8.443E+04	5.673E+00
2036	2.373E+02	2.008E+05	1.349E+01	5.358E+01	8.031E+04	5.396E+00
2037	2.258E+02	1.910E+05	1.283E+01	5.097E+01	7.640E+04	5.133E+00
2038	2.148E+02	1.817E+05	1.221E+01	4.848E+01	7.267E+04	4.883E+00
2039	2.043E+02	1.728E+05	1.161E+01	4.612E+01	6.913E+04	4.645E+00
2040	1.943E+02	1.644E+05	1.105E+01	4.387E+01	6.576E+04	4.418E+00
2041	1.848E+02	1.564E+05	1.051E+01	4.173E+01	6.255E+04	4.203E+00
2042	1.758E+02	1.487E+05	9.994E+00	3.969E+01	5.950E+04	3.998E+00
2043	1.673E+02	1.415E+05	9.507E+00	3.776E+01	5.660E+04	3.803E+00
2044	1.591E+02	1.346E+05	9.043E+00	3.592E+01	5.384E+04	3.617E+00
2045	1.513E+02	1.280E+05	8.602E+00	3.417E+01	5.121E+04	3.441E+00
2046	1.440E+02	1.218E+05	8.183E+00	3.250E+01	4.871E+04	3.273E+00
2047	1.369E+02	1.158E+05	7.783E+00	3.091E+01	4.634E+04	3.113E+00
2048	1.303E+02	1.102E+05	7.404E+00	2.941E+01	4.408E+04	2.962E+00
2049	1.239E+02	1.048E+05	7.043E+00	2.797E+01	4.193E+04	2.817E+00
2050	1.179E+02	9.971E+04	6.699E+00	2.661E+01	3.988E+04	2.680E+00

Results (Continued)

Year	Total landfill gas			Methane		
	(Mg/year)	(m^3/year)	(av ft^3/min)	(Mg/year)	(m^3/year)	(av ft^3/min)
2051	1.121E+02	9.484E+04	6.373E+00	2.531E+01	3.794E+04	2.549E+00
2052	1.066E+02	9.022E+04	6.062E+00	2.408E+01	3.609E+04	2.425E+00
2053	1.014E+02	8.582E+04	5.766E+00	2.290E+01	3.433E+04	2.306E+00
2054	9.650E+01	8.163E+04	5.485E+00	2.178E+01	3.265E+04	2.194E+00
2055	9.179E+01	7.765E+04	5.217E+00	2.072E+01	3.106E+04	2.087E+00
2056	8.732E+01	7.386E+04	4.963E+00	1.971E+01	2.955E+04	1.985E+00
2057	8.306E+01	7.026E+04	4.721E+00	1.875E+01	2.810E+04	1.888E+00
2058	7.901E+01	6.684E+04	4.491E+00	1.784E+01	2.673E+04	1.796E+00
2059	7.515E+01	6.358E+04	4.272E+00	1.697E+01	2.543E+04	1.709E+00
2060	7.149E+01	6.048E+04	4.063E+00	1.614E+01	2.419E+04	1.625E+00
2061	6.800E+01	5.753E+04	3.865E+00	1.535E+01	2.301E+04	1.546E+00
2062	6.469E+01	5.472E+04	3.677E+00	1.460E+01	2.189E+04	1.471E+00
2063	6.153E+01	5.205E+04	3.497E+00	1.389E+01	2.082E+04	1.399E+00
2064	5.853E+01	4.951E+04	3.327E+00	1.321E+01	1.981E+04	1.331E+00
2065	5.568E+01	4.710E+04	3.165E+00	1.257E+01	1.884E+04	1.266E+00
2066	5.296E+01	4.480E+04	3.010E+00	1.196E+01	1.792E+04	1.204E+00
2067	5.038E+01	4.262E+04	2.863E+00	1.137E+01	1.705E+04	1.145E+00
2068	4.792E+01	4.054E+04	2.724E+00	1.082E+01	1.622E+04	1.089E+00
2069	4.558E+01	3.856E+04	2.591E+00	1.029E+01	1.542E+04	1.036E+00
2070	4.336E+01	3.668E+04	2.465E+00	9.788E+00	1.467E+04	9.858E-01
2071	4.125E+01	3.489E+04	2.344E+00	9.311E+00	1.396E+04	9.377E-01
2072	3.923E+01	3.319E+04	2.230E+00	8.857E+00	1.328E+04	8.920E-01
2073	3.732E+01	3.157E+04	2.121E+00	8.425E+00	1.263E+04	8.485E-01
2074	3.550E+01	3.003E+04	2.018E+00	8.014E+00	1.201E+04	8.071E-01
2075	3.377E+01	2.857E+04	1.919E+00	7.623E+00	1.143E+04	7.678E-01
2076	3.212E+01	2.717E+04	1.826E+00	7.251E+00	1.087E+04	7.303E-01
2077	3.056E+01	2.585E+04	1.737E+00	6.898E+00	1.034E+04	6.947E-01
2078	2.907E+01	2.459E+04	1.652E+00	6.561E+00	9.835E+03	6.608E-01
2079	2.765E+01	2.339E+04	1.571E+00	6.241E+00	9.355E+03	6.286E-01
2080	2.630E+01	2.225E+04	1.495E+00	5.937E+00	8.899E+03	5.979E-01
2081	2.502E+01	2.116E+04	1.422E+00	5.647E+00	8.465E+03	5.688E-01
2082	2.380E+01	2.013E+04	1.353E+00	5.372E+00	8.052E+03	5.410E-01
2083	2.264E+01	1.915E+04	1.287E+00	5.110E+00	7.659E+03	5.146E-01
2084	2.153E+01	1.821E+04	1.224E+00	4.861E+00	7.286E+03	4.895E-01
2085	2.048E+01	1.733E+04	1.164E+00	4.624E+00	6.931E+03	4.657E-01
2086	1.948E+01	1.648E+04	1.107E+00	4.398E+00	6.593E+03	4.430E-01
2087	1.853E+01	1.568E+04	1.053E+00	4.184E+00	6.271E+03	4.214E-01
2088	1.763E+01	1.491E+04	1.002E+00	3.980E+00	5.965E+03	4.008E-01
2089	1.677E+01	1.419E+04	9.531E-01	3.786E+00	5.674E+03	3.813E-01
2090	1.595E+01	1.349E+04	9.067E-01	3.601E+00	5.398E+03	3.627E-01

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
1950	0	0	0	0	0	0
1951	7.088E+01	3.872E+04	2.602E+00	9.253E-01	2.582E+02	1.735E-02
1952	1.383E+02	7.556E+04	5.077E+00	1.806E+00	5.037E+02	3.384E-02
1953	2.024E+02	1.106E+05	7.431E+00	2.643E+00	7.373E+02	4.954E-02
1954	2.635E+02	1.439E+05	9.670E+00	3.439E+00	9.595E+02	6.447E-02
1955	3.215E+02	1.756E+05	1.180E+01	4.197E+00	1.171E+03	7.867E-02
1956	3.767E+02	2.058E+05	1.383E+01	4.918E+00	1.372E+03	9.218E-02
1957	4.292E+02	2.345E+05	1.575E+01	5.603E+00	1.563E+03	1.050E-01
1958	4.792E+02	2.618E+05	1.759E+01	6.255E+00	1.745E+03	1.173E-01
1959	5.267E+02	2.877E+05	1.933E+01	6.875E+00	1.918E+03	1.289E-01
1960	5.719E+02	3.124E+05	2.099E+01	7.465E+00	2.083E+03	1.399E-01
1961	6.149E+02	3.359E+05	2.257E+01	8.027E+00	2.239E+03	1.505E-01
1962	6.557E+02	3.582E+05	2.407E+01	8.561E+00	2.388E+03	1.605E-01
1963	6.947E+02	3.795E+05	2.550E+01	9.068E+00	2.530E+03	1.700E-01
1964	7.317E+02	3.997E+05	2.686E+01	9.551E+00	2.665E+03	1.790E-01
1965	7.669E+02	4.189E+05	2.815E+01	1.001E+01	2.793E+03	1.877E-01
1966	8.003E+02	4.372E+05	2.938E+01	1.045E+01	2.915E+03	1.958E-01
1967	8.322E+02	4.546E+05	3.055E+01	1.086E+01	3.031E+03	2.036E-01
1968	8.625E+02	4.712E+05	3.166E+01	1.126E+01	3.141E+03	2.111E-01
1969	8.913E+02	4.869E+05	3.272E+01	1.164E+01	3.246E+03	2.181E-01
1970	9.187E+02	5.019E+05	3.372E+01	1.199E+01	3.346E+03	2.248E-01
1971	9.448E+02	5.161E+05	3.468E+01	1.233E+01	3.441E+03	2.312E-01
1972	9.696E+02	5.297E+05	3.559E+01	1.266E+01	3.531E+03	2.373E-01
1973	9.932E+02	5.426E+05	3.646E+01	1.297E+01	3.617E+03	2.430E-01
1974	1.016E+03	5.548E+05	3.728E+01	1.326E+01	3.699E+03	2.485E-01
1975	1.037E+03	5.665E+05	3.806E+01	1.354E+01	3.777E+03	2.538E-01
1976	1.057E+03	5.776E+05	3.881E+01	1.380E+01	3.851E+03	2.587E-01
1977	1.077E+03	5.881E+05	3.952E+01	1.405E+01	3.921E+03	2.635E-01
1978	1.095E+03	5.982E+05	4.019E+01	1.429E+01	3.988E+03	2.679E-01
1979	1.112E+03	6.077E+05	4.083E+01	1.452E+01	4.052E+03	2.722E-01
1980	1.129E+03	6.168E+05	4.144E+01	1.474E+01	4.112E+03	2.763E-01
1981	1.145E+03	6.255E+05	4.202E+01	1.495E+01	4.170E+03	2.802E-01
1982	1.160E+03	6.337E+05	4.258E+01	1.514E+01	4.225E+03	2.838E-01
1983	1.174E+03	6.415E+05	4.310E+01	1.533E+01	4.277E+03	2.873E-01
1984	1.188E+03	6.489E+05	4.360E+01	1.551E+01	4.326E+03	2.907E-01
1985	1.201E+03	6.560E+05	4.408E+01	1.568E+01	4.373E+03	2.938E-01
1986	1.213E+03	6.627E+05	4.453E+01	1.584E+01	4.418E+03	2.969E-01
1987	1.225E+03	6.691E+05	4.496E+01	1.599E+01	4.461E+03	2.997E-01
1988	1.236E+03	6.752E+05	4.537E+01	1.614E+01	4.502E+03	3.025E-01
1989	1.247E+03	6.810E+05	4.576E+01	1.627E+01	4.540E+03	3.051E-01
1990	1.257E+03	6.865E+05	4.613E+01	1.641E+01	4.577E+03	3.075E-01
1991	1.266E+03	6.918E+05	4.648E+01	1.653E+01	4.612E+03	3.099E-01
1992	1.275E+03	6.968E+05	4.681E+01	1.665E+01	4.645E+03	3.121E-01
1993	1.284E+03	7.015E+05	4.713E+01	1.676E+01	4.677E+03	3.142E-01
1994	1.292E+03	7.060E+05	4.744E+01	1.687E+01	4.707E+03	3.162E-01
1995	1.300E+03	7.103E+05	4.772E+01	1.697E+01	4.735E+03	3.182E-01
1996	1.308E+03	7.144E+05	4.800E+01	1.707E+01	4.763E+03	3.200E-01
1997	1.315E+03	7.183E+05	4.826E+01	1.716E+01	4.788E+03	3.217E-01
1998	1.322E+03	7.220E+05	4.851E+01	1.725E+01	4.813E+03	3.234E-01
1999	1.328E+03	7.255E+05	4.874E+01	1.734E+01	4.836E+03	3.250E-01

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2000	1.334E+03	7.288E+05	4.897E+01	1.742E+01	4.859E+03	3.265E-01
2001	1.269E+03	6.933E+05	4.658E+01	1.657E+01	4.622E+03	3.105E-01
2002	1.207E+03	6.595E+05	4.431E+01	1.576E+01	4.396E+03	2.954E-01
2003	1.148E+03	6.273E+05	4.215E+01	1.499E+01	4.182E+03	2.810E-01
2004	1.092E+03	5.967E+05	4.009E+01	1.426E+01	3.978E+03	2.673E-01
2005	1.039E+03	5.676E+05	3.814E+01	1.356E+01	3.784E+03	2.542E-01
2006	9.883E+02	5.399E+05	3.628E+01	1.290E+01	3.599E+03	2.418E-01
2007	9.401E+02	5.136E+05	3.451E+01	1.227E+01	3.424E+03	2.301E-01
2008	8.943E+02	4.885E+05	3.282E+01	1.167E+01	3.257E+03	2.188E-01
2009	8.506E+02	4.647E+05	3.122E+01	1.110E+01	3.098E+03	2.082E-01
2010	8.092E+02	4.420E+05	2.970E+01	1.056E+01	2.947E+03	1.980E-01
2011	7.697E+02	4.205E+05	2.825E+01	1.005E+01	2.803E+03	1.883E-01
2012	7.322E+02	4.000E+05	2.687E+01	9.558E+00	2.667E+03	1.792E-01
2013	6.965E+02	3.805E+05	2.556E+01	9.092E+00	2.536E+03	1.704E-01
2014	6.625E+02	3.619E+05	2.432E+01	8.648E+00	2.413E+03	1.621E-01
2015	6.302E+02	3.443E+05	2.313E+01	8.227E+00	2.295E+03	1.542E-01
2016	5.994E+02	3.275E+05	2.200E+01	7.825E+00	2.183E+03	1.467E-01
2017	5.702E+02	3.115E+05	2.093E+01	7.444E+00	2.077E+03	1.395E-01
2018	5.424E+02	2.963E+05	1.991E+01	7.081E+00	1.975E+03	1.327E-01
2019	5.159E+02	2.819E+05	1.894E+01	6.735E+00	1.879E+03	1.263E-01
2020	4.908E+02	2.681E+05	1.801E+01	6.407E+00	1.787E+03	1.201E-01
2021	4.668E+02	2.550E+05	1.714E+01	6.094E+00	1.700E+03	1.142E-01
2022	4.441E+02	2.426E+05	1.630E+01	5.797E+00	1.617E+03	1.087E-01
2023	4.224E+02	2.308E+05	1.551E+01	5.515E+00	1.538E+03	1.034E-01
2024	4.018E+02	2.195E+05	1.475E+01	5.246E+00	1.463E+03	9.833E-02
2025	3.822E+02	2.088E+05	1.403E+01	4.990E+00	1.392E+03	9.353E-02
2026	3.636E+02	1.986E+05	1.335E+01	4.746E+00	1.324E+03	8.897E-02
2027	3.458E+02	1.889E+05	1.269E+01	4.515E+00	1.260E+03	8.463E-02
2028	3.290E+02	1.797E+05	1.208E+01	4.295E+00	1.198E+03	8.050E-02
2029	3.129E+02	1.710E+05	1.149E+01	4.085E+00	1.140E+03	7.658E-02
2030	2.977E+02	1.626E+05	1.093E+01	3.886E+00	1.084E+03	7.284E-02
2031	2.832E+02	1.547E+05	1.039E+01	3.696E+00	1.031E+03	6.929E-02
2032	2.693E+02	1.471E+05	9.887E+00	3.516E+00	9.810E+02	6.591E-02
2033	2.562E+02	1.400E+05	9.404E+00	3.345E+00	9.331E+02	6.270E-02
2034	2.437E+02	1.331E+05	8.946E+00	3.182E+00	8.876E+02	5.964E-02
2035	2.318E+02	1.266E+05	8.509E+00	3.026E+00	8.443E+02	5.673E-02
2036	2.205E+02	1.205E+05	8.094E+00	2.879E+00	8.031E+02	5.396E-02
2037	2.098E+02	1.146E+05	7.700E+00	2.738E+00	7.640E+02	5.133E-02
2038	1.995E+02	1.090E+05	7.324E+00	2.605E+00	7.267E+02	4.883E-02
2039	1.898E+02	1.037E+05	6.967E+00	2.478E+00	6.913E+02	4.645E-02
2040	1.805E+02	9.863E+04	6.627E+00	2.357E+00	6.576E+02	4.418E-02
2041	1.717E+02	9.382E+04	6.304E+00	2.242E+00	6.255E+02	4.203E-02
2042	1.634E+02	8.925E+04	5.997E+00	2.133E+00	5.950E+02	3.998E-02
2043	1.554E+02	8.489E+04	5.704E+00	2.029E+00	5.660E+02	3.803E-02
2044	1.478E+02	8.075E+04	5.426E+00	1.930E+00	5.384E+02	3.617E-02
2045	1.406E+02	7.682E+04	5.161E+00	1.836E+00	5.121E+02	3.441E-02
2046	1.338E+02	7.307E+04	4.910E+00	1.746E+00	4.871E+02	3.273E-02
2047	1.272E+02	6.951E+04	4.670E+00	1.661E+00	4.634E+02	3.113E-02
2048	1.210E+02	6.612E+04	4.442E+00	1.580E+00	4.408E+02	2.962E-02
2049	1.151E+02	6.289E+04	4.226E+00	1.503E+00	4.193E+02	2.817E-02
2050	1.095E+02	5.982E+04	4.020E+00	1.430E+00	3.988E+02	2.680E-02

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	(m^3/year)	(av ft^3/min)	(Mg/year)	(m^3/year)	(av ft^3/min)
2051	1.042E+02	5.691E+04	3.824E+00	1.360E+00	3.794E+02	2.549E-02
2052	9.909E+01	5.413E+04	3.637E+00	1.294E+00	3.609E+02	2.425E-02
2053	9.425E+01	5.149E+04	3.460E+00	1.230E+00	3.433E+02	2.306E-02
2054	8.966E+01	4.898E+04	3.291E+00	1.170E+00	3.265E+02	2.194E-02
2055	8.528E+01	4.659E+04	3.130E+00	1.113E+00	3.106E+02	2.087E-02
2056	8.113E+01	4.432E+04	2.978E+00	1.059E+00	2.955E+02	1.985E-02
2057	7.717E+01	4.216E+04	2.833E+00	1.007E+00	2.810E+02	1.888E-02
2058	7.341E+01	4.010E+04	2.694E+00	9.583E-01	2.673E+02	1.796E-02
2059	6.983E+01	3.815E+04	2.563E+00	9.115E-01	2.543E+02	1.709E-02
2060	6.642E+01	3.629E+04	2.438E+00	8.671E-01	2.419E+02	1.625E-02
2061	6.318E+01	3.452E+04	2.319E+00	8.248E-01	2.301E+02	1.546E-02
2062	6.010E+01	3.283E+04	2.206E+00	7.846E-01	2.189E+02	1.471E-02
2063	5.717E+01	3.123E+04	2.098E+00	7.463E-01	2.082E+02	1.399E-02
2064	5.438E+01	2.971E+04	1.996E+00	7.099E-01	1.981E+02	1.331E-02
2065	5.173E+01	2.826E+04	1.899E+00	6.753E-01	1.884E+02	1.266E-02
2066	4.921E+01	2.688E+04	1.806E+00	6.424E-01	1.792E+02	1.204E-02
2067	4.681E+01	2.557E+04	1.718E+00	6.110E-01	1.705E+02	1.145E-02
2068	4.452E+01	2.432E+04	1.634E+00	5.812E-01	1.622E+02	1.089E-02
2069	4.235E+01	2.314E+04	1.555E+00	5.529E-01	1.542E+02	1.036E-02
2070	4.029E+01	2.201E+04	1.479E+00	5.259E-01	1.467E+02	9.858E-03
2071	3.832E+01	2.093E+04	1.407E+00	5.003E-01	1.396E+02	9.377E-03
2072	3.645E+01	1.991E+04	1.338E+00	4.759E-01	1.328E+02	8.920E-03
2073	3.467E+01	1.894E+04	1.273E+00	4.527E-01	1.263E+02	8.485E-03
2074	3.298E+01	1.802E+04	1.211E+00	4.306E-01	1.201E+02	8.071E-03
2075	3.137E+01	1.714E+04	1.152E+00	4.096E-01	1.143E+02	7.678E-03
2076	2.984E+01	1.630E+04	1.095E+00	3.896E-01	1.087E+02	7.303E-03
2077	2.839E+01	1.551E+04	1.042E+00	3.706E-01	1.034E+02	6.947E-03
2078	2.700E+01	1.475E+04	9.912E-01	3.525E-01	9.835E+01	6.608E-03
2079	2.569E+01	1.403E+04	9.429E-01	3.353E-01	9.355E+01	6.286E-03
2080	2.443E+01	1.335E+04	8.969E-01	3.190E-01	8.899E+01	5.979E-03
2081	2.324E+01	1.270E+04	8.531E-01	3.034E-01	8.465E+01	5.688E-03
2082	2.211E+01	1.208E+04	8.115E-01	2.886E-01	8.052E+01	5.410E-03
2083	2.103E+01	1.149E+04	7.720E-01	2.746E-01	7.659E+01	5.146E-03
2084	2.001E+01	1.093E+04	7.343E-01	2.612E-01	7.286E+01	4.895E-03
2085	1.903E+01	1.040E+04	6.985E-01	2.484E-01	6.931E+01	4.657E-03
2086	1.810E+01	9.889E+03	6.644E-01	2.363E-01	6.593E+01	4.430E-03
2087	1.722E+01	9.407E+03	6.320E-01	2.248E-01	6.271E+01	4.214E-03
2088	1.638E+01	8.948E+03	6.012E-01	2.138E-01	5.965E+01	4.008E-03
2089	1.558E+01	8.511E+03	5.719E-01	2.034E-01	5.674E+01	3.813E-03
2090	1.482E+01	8.096E+03	5.440E-01	1.935E-01	5.398E+01	3.627E-03

APPENDIX F

Laboratory Report

3600 Fremont Ave. N.
Seattle, WA 98103
T: (206) 352-3790
F: (206) 352-7178
info@fremontanalytical.com

King County Environmental Laboratory
Katherine Bourbonais
322 W. Ewing St.
Seattle, WA 98119

RE: Vashon CLF
Work Order Number: 1903204

March 25, 2019

Attention Katherine Bourbonais:

Fremont Analytical, Inc. received 2 sample(s) on 3/14/2019 for the analyses presented in the following report.

Major Gases by EPA Method 3C
Sulfur Compounds by EPA Method TO-15
Volatile Organic Compounds by EPA Method 8260C
Volatile Organic Compounds by EPA Method TO-15

This report consists of the following:

- Case Narrative
- Analytical Results
- Applicable Quality Control Summary Reports
- Chain of Custody

All analyses were performed consistent with the Quality Assurance program of Fremont Analytical, Inc. Please contact the laboratory if you should have any questions about the results.

Thank you for using Fremont Analytical.

Sincerely,

Mike Ridgeway
Laboratory Director

CC:
Chad Hearn

DoD/ELAP Certification #L17-135, ISO/IEC 17025:2005
ORELAP Certification: WA 100009-007 (NELAP Recognized)

CLIENT: King County Environmental Laboratory
Project: Vashon CLF
Work Order: 1903204

Work Order Sample Summary

Lab Sample ID	Client Sample ID	Date/Time Collected	Date/Time Received
1903204-001	GVBLI190314	03/14/2019 11:22 AM	03/14/2019 1:10 PM
1903204-002	GVBLI190314	03/14/2019 11:26 AM	03/14/2019 1:10 PM

Note: If no "Time Collected" is supplied, a default of 12:00AM is assigned

Case Narrative

WO#: **1903204**

Date: **3/25/2019**

CLIENT: King County Environmental Laboratory

Project: Vashon CLF

I. SAMPLE RECEIPT:
Samples receipt information is recorded on the attached Sample Receipt Checklist.

II. GENERAL REPORTING COMMENTS:
Air samples are reported in ppbv and ug/m3. Major Gases are reported in %. EPA 8260 analysis is reported in ug/L.

The validity of the analytical procedures for which data is reported in this analytical report is determined by the Laboratory Control Sample (LCS) and the Method Blank (MB). The LCS and the MB are processed with the samples to ensure method criteria are achieved throughout the entire analytical process.

III. ANALYSES AND EXCEPTIONS:
Exceptions associated with this report will be footnoted in the analytical results page(s) or the quality control summary page(s) and/or noted below.

Standard temperature and pressure assumes 24.45 = (25C and 1 atm).

Rev1: Includes lower volume injection results for Hydrogen Sulfide (Sample -001).

Qualifiers:

* - Flagged value is not within established control limits
B - Analyte detected in the associated Method Blank
D - Dilution was required
E - Value above quantitation range
H - Holding times for preparation or analysis exceeded
I - Analyte with an internal standard that does not meet established acceptance criteria
J - Analyte detected below Reporting Limit
N - Tentatively Identified Compound (TIC)
Q - Analyte with an initial or continuing calibration that does not meet established acceptance criteria (<20%RSD, <20% Drift or minimum RRF)
S - Spike recovery outside accepted recovery limits
ND - Not detected at the Reporting Limit
R - High relative percent difference observed

Acronyms:

%Rec - Percent Recovery
CCB - Continued Calibration Blank
CCV - Continued Calibration Verification
DF - Dilution Factor
HEM - Hexane Extractable Material
ICV - Initial Calibration Verification
LCS/LCSD - Laboratory Control Sample / Laboratory Control Sample Duplicate
MB or MBLANK - Method Blank
MDL - Method Detection Limit
MS/MSD - Matrix Spike / Matrix Spike Duplicate
PDS - Post Digestion Spike
Ref Val - Reference Value
RL - Reporting Limit
RPD - Relative Percent Difference
SD - Serial Dilution
SGT - Silica Gel Treatment
SPK - Spike
Surr - Surrogate

Analytical Report

Work Order: **1903204**
Date Reported: **3/25/2019**

CLIENT: King County Environmental Laboratory
Project: Vashon CLF

Lab ID: 1903204-002
Client Sample ID: **GVBLI190314**
Collection Date: 3/14/2019 11:26:00 AM
Matrix: Air

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
Major Gases by EPA Method 3C				Batch ID: R50141		Analyst: AD
Carbon Dioxide	13.4	0.0500		%	1	3/15/2019 4:37:00 PM
Carbon Monoxide	ND	0.0500		%	1	3/15/2019 4:37:00 PM
Methane	3.44	0.0500		%	1	3/15/2019 4:37:00 PM
Nitrogen	70.0	0.0500		%	1	3/15/2019 4:37:00 PM
Oxygen	13.1	0.0500		%	1	3/15/2019 4:37:00 PM
Hydrogen	ND	0.0500		%	1	3/15/2019 4:37:00 PM
BTU	34.8			BTU/ft³	1	3/15/2019 4:37:00 PM
Volatile Organic Compounds by EPA Method 8260C				Batch ID: 23849		Analyst: KT
Dichlorodifluoromethane	ND	0.100		µg/L	1	3/15/2019 2:30:25 PM
Chloromethane	ND	0.100		µg/L	1	3/15/2019 2:30:25 PM
Vinyl chloride	ND	0.0200		µg/L	1	3/15/2019 2:30:25 PM
Bromomethane	ND	0.100		µg/L	1	3/15/2019 2:30:25 PM
Trichlorofluoromethane (CFC-11)	3.11	0.100		µg/L	1	3/15/2019 2:30:25 PM
Chloroethane	ND	0.100		µg/L	1	3/15/2019 2:30:25 PM
1,1-Dichloroethene	ND	0.100		µg/L	1	3/15/2019 2:30:25 PM
Methylene chloride	0.145	0.100		µg/L	1	3/15/2019 2:30:25 PM
Acrylonitrile	ND	0.100		µg/L	1	3/15/2019 2:30:25 PM
trans-1,2-Dichloroethene	ND	0.100		µg/L	1	3/15/2019 2:30:25 PM
Methyl tert-butyl ether (MTBE)	ND	0.100		µg/L	1	3/15/2019 2:30:25 PM
1,1-Dichloroethane	ND	0.100		µg/L	1	3/15/2019 2:30:25 PM
2,2-Dichloropropane	ND	0.200		µg/L	1	3/15/2019 2:30:25 PM
cis-1,2-Dichloroethene	0.301	0.100		µg/L	1	3/15/2019 2:30:25 PM
Chloroform	ND	0.100		µg/L	1	3/15/2019 2:30:25 PM
1,1,1-Trichloroethane (TCA)	ND	0.100		µg/L	1	3/15/2019 2:30:25 PM
1,1-Dichloropropene	ND	0.100		µg/L	1	3/15/2019 2:30:25 PM
Carbon tetrachloride	ND	0.100		µg/L	1	3/15/2019 2:30:25 PM
1,2-Dichloroethane (EDC)	ND	0.100		µg/L	1	3/15/2019 2:30:25 PM
Benzene	0.107	0.100		µg/L	1	3/15/2019 2:30:25 PM
Trichloroethene (TCE)	ND	0.0500		µg/L	1	3/15/2019 2:30:25 PM
1,2-Dichloropropane	ND	0.100		µg/L	1	3/15/2019 2:30:25 PM
Bromodichloromethane	ND	0.100		µg/L	1	3/15/2019 2:30:25 PM
Dibromomethane	ND	0.100		µg/L	1	3/15/2019 2:30:25 PM
cis-1,3-Dichloropropene	ND	0.100		µg/L	1	3/15/2019 2:30:25 PM
Toluene	0.834	0.100		µg/L	1	3/15/2019 2:30:25 PM
trans-1,3-Dichloropropylene	ND	0.100		µg/L	1	3/15/2019 2:30:25 PM
1,1,2-Trichloroethane	ND	0.100		µg/L	1	3/15/2019 2:30:25 PM

Analytical Report

Work Order: **1903204**
Date Reported: **3/25/2019**

CLIENT: King County Environmental Laboratory
Project: Vashon CLF

Volatile Organic Compounds by EPA Method 8260C Batch ID: 23849 Analyst: KT

1,3-Dichloropropane	ND	0.100	µg/L	1	3/15/2019 2:30:25 PM
Tetrachloroethene (PCE)	ND	0.100	µg/L	1	3/15/2019 2:30:25 PM
Dibromochloromethane	ND	0.100	µg/L	1	3/15/2019 2:30:25 PM
1,2-Dibromoethane (EDB)	ND	0.0250	µg/L	1	3/15/2019 2:30:25 PM
Chlorobenzene	ND	0.100	µg/L	1	3/15/2019 2:30:25 PM
1,1,1,2-Tetrachloroethane	ND	0.100	µg/L	1	3/15/2019 2:30:25 PM
Ethylbenzene	0.711	0.100	µg/L	1	3/15/2019 2:30:25 PM
m,p-Xylene	1.37	0.100	µg/L	1	3/15/2019 2:30:25 PM
o-Xylene	0.175	0.100	µg/L	1	3/15/2019 2:30:25 PM
Styrene	ND	0.100	µg/L	1	3/15/2019 2:30:25 PM
Isopropylbenzene	ND	0.100	µg/L	1	3/15/2019 2:30:25 PM
Bromoform	ND	0.100	µg/L	1	3/15/2019 2:30:25 PM
1,1,2,2-Tetrachloroethane	ND	0.100	µg/L	1	3/15/2019 2:30:25 PM
n-Propylbenzene	ND	0.100	µg/L	1	3/15/2019 2:30:25 PM
Bromobenzene	ND	0.100	µg/L	1	3/15/2019 2:30:25 PM
1,3,5-Trimethylbenzene	ND	0.100	µg/L	1	3/15/2019 2:30:25 PM
2-Chlorotoluene	ND	0.100	µg/L	1	3/15/2019 2:30:25 PM
4-Chlorotoluene	ND	0.100	µg/L	1	3/15/2019 2:30:25 PM
tert-Butylbenzene	ND	0.100	µg/L	1	3/15/2019 2:30:25 PM
1,2,3-Trichloropropane	ND	0.100	µg/L	1	3/15/2019 2:30:25 PM
1,2,4-Trichlorobenzene	ND	0.200	µg/L	1	3/15/2019 2:30:25 PM
sec-Butylbenzene	ND	0.100	µg/L	1	3/15/2019 2:30:25 PM
4-Isopropyltoluene	ND	0.100	µg/L	1	3/15/2019 2:30:25 PM
1,3-Dichlorobenzene	ND	0.100	µg/L	1	3/15/2019 2:30:25 PM
1,4-Dichlorobenzene	ND	0.100	µg/L	1	3/15/2019 2:30:25 PM
n-Butylbenzene	ND	0.100	µg/L	1	3/15/2019 2:30:25 PM
1,2-Dichlorobenzene	ND	0.100	µg/L	1	3/15/2019 2:30:25 PM
1,2-Dibromo-3-chloropropane	ND	0.100	µg/L	1	3/15/2019 2:30:25 PM
1,2,4-Trimethylbenzene	ND	0.100	µg/L	1	3/15/2019 2:30:25 PM
Hexachlorobutadiene	ND	0.400	µg/L	1	3/15/2019 2:30:25 PM
Naphthalene	0.195	0.100	µg/L	1	3/15/2019 2:30:25 PM
1,2,3-Trichlorobenzene	ND	0.400	µg/L	1	3/15/2019 2:30:25 PM
Surr: Dibromofluoromethane	82.8	56.4 - 141	%Rec	1	3/15/2019 2:30:25 PM
Surr: Toluene-d8	99.9	66 - 138	%Rec	1	3/15/2019 2:30:25 PM
Surr: 1-Bromo-4-fluorobenzene-BFB	101	64.7 - 128	%Rec	1	3/15/2019 2:30:25 PM

Client: **King County Environmental Laboratory**
WorkOrder: 1903204
Project: Vashon CLF

Client Sample ID:	GVBLI190314	**Date Sampled:**	3/14/2019
Lab ID:	1903204-001A	**Date Received:**	3/14/2019
Sample Type:	Summa Canister		

Sulfur Compounds by EPA Method TO-15

Analyte	Concentration (ppbv)	Concentration (ug/m³)	Reporting Limit (ppbv)	Reporting Limit (ug/m³)	Qual	Method	Date	Analyst
Carbon Disulfide	<10.0	<31.1	10.0	31.1	*	EPA-TO-15	03/15/2019	AD
Carbon Disulfide	<10.0	<31.1	10.0	31.1	H	EPA-TO-15	03/23/2019	AD
Carbonyl Sulfide	<10.0	<24.6	10.0	24.6	*	EPA-TO-15	03/15/2019	AD
Carbonyl Sulfide	<10.0	<24.6	10.0	24.6	H	EPA-TO-15	03/23/2019	AD
Dimethyl Disulfide	<10.0	<38.4	10.0	38.4	H	EPA-TO-15	03/23/2019	AD
Dimethyl Disulfide	<10.0	<38.4	10.0	38.4	*	EPA-TO-15	03/15/2019	AD
Dimethyl Sulfide	<10.0	<25.4	10.0	25.4		EPA-TO-15	03/15/2019	AD
Ethyl Mercaptan	<10.0	<25.4	10.0	25.4	*	EPA-TO-15	03/15/2019	AD
Ethyl Mercaptan	<10.0	<25.4	10.0	25.4	H	EPA-TO-15	03/23/2019	AD
Hydrogen Sulfide	1,370	1,910	100	139	H	EPA-TO-15	03/26/2019	AD
Hydrogen Sulfide	2,790	3,870	10.0	13.9	E	EPA-TO-15	03/15/2019	AD
Isobutyl Mercaptan	<10.0	<36.8	10.0	36.8		EPA-TO-15	03/15/2019	AD
Isopropyl Mercaptan	<10.0	<31.1	10.0	31.1	*	EPA-TO-15	03/15/2019	AD
Isopropyl Mercaptan	<10.0	<31.1	10.0	31.1	H	EPA-TO-15	03/23/2019	AD
Methyl Mercaptan	<10.0	<19.6	10.0	19.6		EPA-TO-15	03/15/2019	AD
n-Butyl Mercaptan	<10.0	<36.9	10.0	36.9	*	EPA-TO-15	03/15/2019	AD
n-Butyl Mercaptan	<10.0	<36.9	10.0	36.9	H	EPA-TO-15	03/23/2019	AD
n-Propyl Mercaptan	<10.0	<31.1	10.0	31.1		EPA-TO-15	03/15/2019	AD
t-Butyl Mercaptan	<10.0	<36.8	10.0	36.8		EPA-TO-15	03/15/2019	AD
Surr: 4-Bromofluorobenzene	107 %Rec	--	70-130	--		EPA-TO-15	03/15/2019	AD

NOTES:
E - Estimated value. The amount exceeds the linear working range of the instrument.
* - Flagged value is not within established control limits.

Volatile Organic Compounds by EPA Method TO-15

Analyte	Concentration (ppbv)	Concentration (ug/m³)	Reporting Limit (ppbv)	Reporting Limit (ug/m³)	Qual	Method	Date	Analyst
1,1,1-Trichloroethane	3.90	21.3	0.400	2.18		EPA-TO-15	03/16/2019	AD
1,1,2,2-Tetrachloroethane	<0.300	<2.06	0.300	2.06		EPA-TO-15	03/16/2019	AD
CFC-113	1.75	13.4	0.400	3.07		EPA-TO-15	03/16/2019	AD
1,1,2-Trichloroethane (TCA)	<0.500	<2.73	0.500	2.73		EPA-TO-15	03/16/2019	AD
1,1-Dichloroethane	5.61	22.7	0.200	0.810		EPA-TO-15	03/16/2019	AD
1,1-Dichloroethene (DCE)	1.18	4.67	0.400	1.59		EPA-TO-15	03/16/2019	AD

Client: **King County Environmental Laboratory**
WorkOrder: 1903204
Project: Vashon CLF

Client Sample ID: GVBLI190314 **Date Sampled:** 3/14/2019
Lab ID: 1903204-001A **Date Received:** 3/14/2019
Sample Type: Summa Canister

Volatile Organic Compounds by EPA Method TO-15

Analyte	Concentration (ppbv)	Concentration (ug/m³)	Reporting Limit (ppbv)	Reporting Limit (ug/m³)	Qual	Method	Date	Analyst
1,2,4-Trichlorobenzene	0.364	2.70	0.300	2.23		EPA-TO-15	03/16/2019	AD
1,2,4-Trimethylbenzene	95.2	468	3.00	14.7		EPA-TO-15	03/16/2019	AD
1,2-Dibromoethane (EDB)	0.307	2.36	0.200	1.54		EPA-TO-15	03/16/2019	AD
1,2-Dichlorobenzene	3.26	19.6	0.400	2.40		EPA-TO-15	03/16/2019	AD
1,2-Dichloroethane	1.24	5.03	0.200	0.809		EPA-TO-15	03/16/2019	AD
1,2-Dichloropropane	13.7	63.5	0.500	2.31		EPA-TO-15	03/16/2019	AD
1,3,5-Trimethylbenzene	42.6	209	3.00	14.7		EPA-TO-15	03/16/2019	AD
1,3-Butadiene	<0.500	<1.11	0.500	1.11		EPA-TO-15	03/16/2019	AD
1,3-Dichlorobenzene	1.06	6.35	0.300	1.80		EPA-TO-15	03/16/2019	AD
1,4-Dichlorobenzene	9.52	57.2	3.00	18.0		EPA-TO-15	03/16/2019	AD
1,4-Dioxane	<0.400	<1.44	0.400	1.44		EPA-TO-15	03/16/2019	AD
(MEK) 2-Butanone	18.6	55.0	1.00	2.95		EPA-TO-15	03/16/2019	AD
2-Hexanone	1.43	5.86	1.00	4.10		EPA-TO-15	03/16/2019	AD
Isopropyl Alcohol	1.63	4.00	1.00	2.46		EPA-TO-15	03/20/2019	AD
4-Methyl-2-pentanone (MIBK)	15.3	62.7	10.0	41.0		EPA-TO-15	03/16/2019	AD
Acetone	12.2	28.9	10.0	23.8		EPA-TO-15	03/16/2019	AD
Acrolein	<0.500	<1.15	0.500	1.15		EPA-TO-15	03/16/2019	AD
Benzene	29.2	93.4	0.895	2.86		EPA-TO-15	03/16/2019	AD
Benzyl chloride	6.95	36.0	0.500	2.59		EPA-TO-15	03/16/2019	AD
Dichlorobromomethane	<0.300	<2.01	0.300	2.01		EPA-TO-15	03/16/2019	AD
Bromoform	<0.200	<2.07	0.200	2.07		EPA-TO-15	03/16/2019	AD
Bromomethane	<0.500	<1.94	0.500	1.94		EPA-TO-15	03/16/2019	AD
Carbon disulfide	1.84	5.74	1.50	4.67		EPA-TO-15	03/16/2019	AD
Carbon tetrachloride	<0.0657	<0.413	0.0657	0.413		EPA-TO-15	03/16/2019	AD
Chlorobenzene	27.6	127	2.00	9.21		EPA-TO-15	03/16/2019	AD
Dibromochloromethane	<0.500	<4.26	0.500	4.26		EPA-TO-15	03/16/2019	AD
Chloroethane	13.9	36.6	0.400	1.06		EPA-TO-15	03/16/2019	AD
Chloroform	0.893	4.36	0.200	0.977		EPA-TO-15	03/16/2019	AD
Chloromethane	<5.00	<10.3	5.00	10.3		EPA-TO-15	03/16/2019	AD
cis-1,2-Dichloroethene	67.1	266	2.00	7.93		EPA-TO-15	03/16/2019	AD

Client: King County Environmental Laboratory
WorkOrder: 1903204
Project: Vashon CLF

Client Sample ID: GVBLI190314 **Date Sampled:** 3/14/2019
Lab ID: 1903204-001A **Date Received:** 3/14/2019
Sample Type: Summa Canister

Analyte	Concentration		Reporting Limit		Qual	Method	Date/Analyst	
Volatile Organic Compounds by EPA Method TO-15								
	(ppbv)	(ug/m³)	(ppbv)	(ug/m³)				
cis-1,3-dichloropropene	<0.400	<1.82	0.400	1.82		EPA-TO-15	03/16/2019	AD
Cyclohexane	90.3	311	4.00	13.8		EPA-TO-15	03/16/2019	AD
Dichlorodifluoromethane (CFC-12)	40.1	198	4.00	19.8		EPA-TO-15	03/16/2019	AD
Dichlorotetrafluoroethane (CFC-114)	13.7	96.1	0.400	2.80		EPA-TO-15	03/16/2019	AD
Ethyl acetate	<1.00	<3.60	1.00	3.60		EPA-TO-15	03/16/2019	AD
Ethylbenzene	636	2,760	4.00	17.4	E	EPA-TO-15	03/16/2019	AD
Heptane	73.2	294	4.00	16.1		EPA-TO-15	03/16/2019	AD
Hexachlorobutadiene	<1.00	<10.7	1.00	10.7		EPA-TO-15	03/16/2019	AD
m,p-Xylene	1,450	6,310	8.00	34.7	E	EPA-TO-15	03/16/2019	AD
Methyl methacrylate	<0.400	<1.64	0.400	1.64		EPA-TO-15	03/16/2019	AD
Methylene chloride	34.1	119	20.0	69.5		EPA-TO-15	03/16/2019	AD
Naphthalene	14.5	75.9	0.100	0.524		EPA-TO-15	03/16/2019	AD
n-Hexane	103	365	4.00	14.1		EPA-TO-15	03/16/2019	AD
o-Xylene	351	1,530	4.00	17.4	E	EPA-TO-15	03/16/2019	AD
4-Ethyltoluene	25.1	124	4.00	19.7		EPA-TO-15	03/16/2019	AD
Propylene	363	625	4.00	6.88	E	EPA-TO-15	03/16/2019	AD
Styrene	25.4	108	4.00	17.0		EPA-TO-15	03/16/2019	AD
Methyl tert-butyl ether (MTBE)	0.868	3.13	0.400	1.44		EPA-TO-15	03/16/2019	AD
Tetrachloroethene (PCE)	17.1	116	2.00	13.6		EPA-TO-15	03/16/2019	AD
Tetrahydrofuran	37.8	111	4.00	11.8		EPA-TO-15	03/16/2019	AD
Toluene	367	1,380	4.00	15.1	E	EPA-TO-15	03/16/2019	AD
Total Volatile Organics	32,300	151,000	10.0	46.8		EPA-TO-15	03/16/2019	AD
trans-1,2-Dichloroethene	4.42	17.5	0.200	0.793		EPA-TO-15	03/16/2019	AD
trans-1,3-dichloropropene	<0.500	<2.27	0.500	2.27		EPA-TO-15	03/16/2019	AD
Trichloroethene (TCE)	10.5	56.5	0.0649	0.349		EPA-TO-15	03/16/2019	AD
Trichlorofluoromethane (CFC-11)	242	1,360	4.00	22.5	E	EPA-TO-15	03/16/2019	AD
Vinyl acetate	1.59	5.61	1.00	3.52		EPA-TO-15	03/16/2019	AD
Vinyl chloride	59.2	151	1.07	2.74		EPA-TO-15	03/16/2019	AD
Surr: 4-Bromofluorobenzene	129 %Rec	--	70-130	--		EPA-TO-15	03/16/2019	AD

Client: **King County Environmental Laboratory**
WorkOrder: 1903204
Project: Vashon CLF

Client Sample ID: GVBLI190314 **Date Sampled:** 3/14/2019
Lab ID: 1903204-001A **Date Received:** 3/14/2019
Sample Type: Summa Canister

Analyte	Concentration		Reporting Limit		Qual	Method	Date/Analyst
Volatile Organic Compounds by EPA Method TO-15							
	(ppbv)	(ug/m³)	(ppbv)	(ug/m³)			

NOTES:

E - Estimated value. The amount exceeds the linear working range of the instrument. Lowest volume injection analyzed.

Total VOCs encompasses all peaks recorded by the mass spectrometer, possibly including analytes not reported. Results may include methane and non-methane organic compounds. Results should be considered an estimate.

Date: *3/25/2019*

Work Order: 1903204
CLIENT: King County Environmental Laboratory
Project: Vashon CLF

QC SUMMARY REPORT
Major Gases by EPA Method 3C

Sample ID **LCS-R50141** SampType: **LCS** Units: **%** Prep Date: **3/15/2019** RunNo: **50141**
Client ID: **LCSW** Batch ID: **R50141** Analysis Date: **3/15/2019** SeqNo: **984504**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Carbon Dioxide	93.0	0.0500	100.0	0	93.0	70	130				
Carbon Monoxide	93.4	0.0500	100.0	0	93.4	70	130				
Methane	93.4	0.0500	100.0	0	93.4	70	130				
Nitrogen	92.1	0.0500	100.0	0	92.1	70	130				
Oxygen	94.5	0.0500	100.0	0	94.5	70	130				
Hydrogen	92.7	0.0500	100.0	0	92.7	70	130				

Sample ID **1903170-002AREP** SampType: **REP** Units: **%** Prep Date: **3/15/2019** RunNo: **50141**
Client ID: **BATCH** Batch ID: **R50141** Analysis Date: **3/15/2019** SeqNo: **984501**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Carbon Dioxide	2.30	0.0500						2.356	2.29	30	H
Carbon Monoxide	ND	0.0500						0		30	H
Methane	93.3	0.0500						93.03	0.319	30	H
Nitrogen	3.16	0.0500						3.307	4.61	30	H
Oxygen	1.21	0.0500						1.302	7.55	30	H
Hydrogen	ND	0.0500						0		30	H
BTU	944							940.9	0.319		H

Date: *3/25/2019*

Work Order: 1903204
CLIENT: King County Environmental Laboratory
Project: Vashon CLF

QC SUMMARY REPORT

Sulfur Compounds by EPA Method TO-15

Sample ID **LCS-R50061** SampType: **LCS** Units: **ppbv** Prep Date: **3/13/2019** RunNo: **50061**
Client ID: **LCSW** Batch ID: **R50061** Analysis Date: **3/13/2019** SeqNo: **982660**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Hydrogen Sulfide	116	10.0	110.0	0	105	70	130				
Methyl Mercaptan	87.3	10.0	103.0	0	84.7	70	130				
Dimethyl Sulfide	126	10.0	144.0	0	87.5	70	130				
t-Butyl Mercaptan	82.4	10.0	95.00	0	86.7	70	130				
n-Propyl Mercaptan	84.9	10.0	97.00	0	87.5	70	130				
Isobutyl Mercaptan	81.3	10.0	92.00	0	88.3	70	130				
Surr: 4-Bromofluorobenzene	4.18		4.000		104	70	130				

Sample ID **MB-R50061** SampType: **MBLK** Units: **ppbv** Prep Date: **3/13/2019** RunNo: **50061**
Client ID: **MBLKW** Batch ID: **R50061** Analysis Date: **3/13/2019** SeqNo: **982661**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Hydrogen Sulfide	ND	10.0									
Methyl Mercaptan	ND	10.0									
Dimethyl Sulfide	ND	10.0									
t-Butyl Mercaptan	ND	10.0									
n-Propyl Mercaptan	ND	10.0									
Isobutyl Mercaptan	ND	10.0									
Surr: 4-Bromofluorobenzene	3.78		4.000		94.6	70	130				

Sample ID **LCS-R50064** SampType: **LCS** Units: **ppbv** Prep Date: **3/13/2019** RunNo: **50064**
Client ID: **LCSW** Batch ID: **R50064** Analysis Date: **3/13/2019** SeqNo: **982704**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Carbon Disulfide	91.3	10.0	103.0	0	88.6	70	130				
Ethyl Mercaptan	58.1	10.0	63.00	0	92.2	70	130				
Carbonyl Sulfide	100	10.0	112.0	0	89.6	70	130				
Isopropyl Mercaptan	56.2	10.0	62.00	0	90.7	70	130				
n-Butyl Mercaptan	69.3	10.0	78.00	0	88.8	70	130				
Dimethyl Disulfide	23.0	10.0	26.00	0	88.6	70	130				

Work Order: 1903204
CLIENT: King County Environmental Laboratory
Project: Vashon CLF

QC SUMMARY REPORT

Sulfur Compounds by EPA Method TO-15

Sample ID **LCS-R50064** SampType: **LCS** Units: **ppbv** Prep Date: **3/13/2019** RunNo: **50064**
Client ID: **LCSW** Batch ID: **R50064** Analysis Date: **3/13/2019** SeqNo: **982704**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Surr: 4-Bromofluorobenzene	4.03		4.000		101	70	130				

Sample ID **MB-R50064** SampType: **MBLK** Units: **ppbv** Prep Date: **3/13/2019** RunNo: **50064**
Client ID: **MBLKW** Batch ID: **R50064** Analysis Date: **3/13/2019** SeqNo: **982705**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Carbon Disulfide	ND	10.0									
Ethyl Mercaptan	ND	10.0									
Carbonyl Sulfide	ND	10.0									
Isopropyl Mercaptan	ND	10.0									
n-Butyl Mercaptan	ND	10.0									
Dimethyl Disulfide	ND	10.0									
Surr: 4-Bromofluorobenzene	3.81		4.000		95.4	70	130				

Sample ID **1903114-001AREP** SampType: **REP** Units: **ppbv** Prep Date: **3/13/2019** RunNo: **50061**
Client ID: **BATCH** Batch ID: **R50061** Analysis Date: **3/13/2019** SeqNo: **982663**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Hydrogen Sulfide	12,800	5,000						12,640	0.975	30	DH
Methyl Mercaptan	ND	5,000						0		30	DH
Dimethyl Sulfide	ND	5,000						0		30	DH
t-Butyl Mercaptan	ND	5,000						0		30	DH
n-Propyl Mercaptan	ND	5,000						0		30	DH
Isobutyl Mercaptan	ND	5,000						0		30	DH
Surr: 4-Bromofluorobenzene	1,870		2,000		93.6	70	130		0		DH

Fremont Analytical

Date: *3/25/2019*

Work Order: 1903204
CLIENT: King County Environmental Laboratory
Project: Vashon CLF

QC SUMMARY REPORT

Sulfur Compounds by EPA Method TO-15

Sample ID **1903114-001AREP** SampType: **REP** Units: **ppbv** Prep Date: **3/13/2019** RunNo: **50064**
Client ID: **BATCH** Batch ID: **R50064** Analysis Date: **3/13/2019** SeqNo: **982712**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Carbon Disulfide	ND	5,000						0		30	DH
Ethyl Mercaptan	ND	5,000						0		30	DH
Carbonyl Sulfide	ND	5,000						0		30	DH
Isopropyl Mercaptan	ND	5,000						0		30	DH
n-Butyl Mercaptan	ND	5,000						0		30	DH
Dimethyl Disulfide	ND	5,000						0		30	DH
Surr: 4-Bromofluorobenzene	2,050		2,000		103	70	130		0		DH

Sample ID **LCS-R50061B** SampType: **LCS** Units: **ppbv** Prep Date: **3/15/2019** RunNo: **50061**
Client ID: **LCSW** Batch ID: **R50061** Analysis Date: **3/15/2019** SeqNo: **985817**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Hydrogen Sulfide	115	10.0	110.0	0	104	70	130				
Methyl Mercaptan	77.4	10.0	103.0	0	75.1	70	130				
Dimethyl Sulfide	143	10.0	144.0	0	99.4	70	130				
t-Butyl Mercaptan	105	10.0	95.00	0	111	70	130				
n-Propyl Mercaptan	104	10.0	97.00	0	108	70	130				
Isobutyl Mercaptan	79.5	10.0	92.00	0	86.4	70	130				
Surr: 4-Bromofluorobenzene	4.35		4.000		109	70	130				

Sample ID **LCS-R50064B** SampType: **LCS** Units: **ppbv** Prep Date: **3/15/2019** RunNo: **50064**
Client ID: **LCSW** Batch ID: **R50064** Analysis Date: **3/15/2019** SeqNo: **985836**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Carbon Disulfide	2.27	10.0	103.0	0	2.20	70	130				S
Ethyl Mercaptan	0.632	10.0	63.00	0	1.00	70	130				S
Carbonyl Sulfide	0.910	10.0	112.0	0	0.813	70	130				S
Isopropyl Mercaptan	ND	10.0	62.00	0	0	70	130				S
n-Butyl Mercaptan	ND	10.0	78.00	0	0	70	130				S
Dimethyl Disulfide	20.1	10.0	26.00	0	77.2	70	130				

Date: *3/25/2019*

Work Order: 1903204
CLIENT: King County Environmental Laboratory
Project: Vashon CLF

QC SUMMARY REPORT

Sulfur Compounds by EPA Method TO-15

Sample ID **LCS-R50064B** SampType: **LCS** Units: **ppbv** Prep Date: **3/15/2019** RunNo: **50064**
Client ID: **LCSW** Batch ID: **R50064** Analysis Date: **3/15/2019** SeqNo: **985836**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Surr: 4-Bromofluorobenzene	4.52		4.000		113	70	130				

NOTES:
S - Outlying spike recovery observed (low bias). Samples will be qualified with a *.

Sample ID **MB-R50061B** SampType: **MBLK** Units: **ppbv** Prep Date: **3/15/2019** RunNo: **50061**
Client ID: **MBLKW** Batch ID: **R50061** Analysis Date: **3/15/2019** SeqNo: **985818**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Hydrogen Sulfide	ND	10.0									
Methyl Mercaptan	ND	10.0									
Dimethyl Sulfide	ND	10.0									
t-Butyl Mercaptan	ND	10.0									
n-Propyl Mercaptan	ND	10.0									
Isobutyl Mercaptan	ND	10.0									
Surr: 4-Bromofluorobenzene	4.19		4.000		105	70	130				

Sample ID **MB-R50064B** SampType: **MBLK** Units: **ppbv** Prep Date: **3/15/2019** RunNo: **50064**
Client ID: **MBLKW** Batch ID: **R50064** Analysis Date: **3/15/2019** SeqNo: **985837**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Carbon Disulfide	ND	10.0									*
Ethyl Mercaptan	ND	10.0									*
Carbonyl Sulfide	ND	10.0									*
Isopropyl Mercaptan	ND	10.0									*
n-Butyl Mercaptan	ND	10.0									*
Dimethyl Disulfide	ND	10.0									*
Surr: 4-Bromofluorobenzene	4.31		4.000		108	70	130				

NOTES:
* - Flagged value is not within established control limits.

Work Order: 1903204
CLIENT: King County Environmental Laboratory
Project: Vashon CLF

QC SUMMARY REPORT

Sulfur Compounds by EPA Method TO-15

Sample ID **1903204-001AREP** SampType: **REP** Units: **ppbv** Prep Date: **3/15/2019** RunNo: **50061**
Client ID: **GVBLI190314** Batch ID: **R50061** Analysis Date: **3/15/2019** SeqNo: **985821**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Hydrogen Sulfide	2,860	10.0						2,785	2.51	30	E
Methyl Mercaptan	ND	10.0						0		30	
Dimethyl Sulfide	ND	10.0						0		30	
t-Butyl Mercaptan	ND	10.0						0		30	
n-Propyl Mercaptan	ND	10.0						0		30	
Isobutyl Mercaptan	ND	10.0						0		30	
Surr: 4-Bromofluorobenzene	4.37		4.000		109	70	130		0		

NOTES:
E - Estimated value. The amount exceeds the linear working range of the instrument.

Sample ID **1903204-001AREP** SampType: **REP** Units: **ppbv** Prep Date: **3/15/2019** RunNo: **50064**
Client ID: **GVBLI190314** Batch ID: **R50064** Analysis Date: **3/15/2019** SeqNo: **985840**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Carbon Disulfide	ND	10.0						0		30	*
Ethyl Mercaptan	ND	10.0						0		30	*
Carbonyl Sulfide	ND	10.0						0		30	*
Isopropyl Mercaptan	ND	10.0						0		30	*
n-Butyl Mercaptan	ND	10.0						0		30	*
Dimethyl Disulfide	ND	10.0						0		30	*
Surr: 4-Bromofluorobenzene	4.50		4.000		112	70	130		0		

NOTES:
* - Flagged value is not within established control limits.

Sample ID **LCS-R502367** SampType: **LCS** Units: **ppbv** Prep Date: **3/23/2019** RunNo: **50267**
Client ID: **LCSW** Batch ID: **R50267** Analysis Date: **3/23/2019** SeqNo: **987233**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Carbon Disulfide	97.1	10.0	103.0	0	94.3	70	130				
Ethyl Mercaptan	57.6	10.0	63.00	0	91.5	70	130				
Carbonyl Sulfide	111	10.0	112.0	0	98.7	70	130				
Isopropyl Mercaptan	55.9	10.0	62.00	0	90.1	70	130				

Date: *3/25/2019*

Work Order: 1903204
CLIENT: King County Environmental Laboratory
Project: Vashon CLF

QC SUMMARY REPORT

Sulfur Compounds by EPA Method TO-15

Sample ID **LCS-R502367** SampType: **LCS** Units: **ppbv** Prep Date: **3/23/2019** RunNo: **50267**
Client ID: **LCSW** Batch ID: **R50267** Analysis Date: **3/23/2019** SeqNo: **987233**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
n-Butyl Mercaptan	75.3	10.0	78.00	0	96.5	70	130				
Dimethyl Disulfide	26.6	10.0	26.00	0	102	70	130				
Surr: 4-Bromofluorobenzene	4.16		4.000		104	70	130				

Sample ID **MB-R50267** SampType: **MBLK** Units: **ppbv** Prep Date: **3/23/2019** RunNo: **50267**
Client ID: **MBLKW** Batch ID: **R50267** Analysis Date: **3/23/2019** SeqNo: **987234**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Carbon Disulfide	ND	10.0									
Ethyl Mercaptan	ND	10.0									
Carbonyl Sulfide	ND	10.0									
Isopropyl Mercaptan	ND	10.0									
n-Butyl Mercaptan	ND	10.0									
Dimethyl Disulfide	ND	10.0									
Surr: 4-Bromofluorobenzene	4.07		4.000		102	70	130				

Sample ID **1903236-001AREP** SampType: **REP** Units: **ppbv** Prep Date: **3/24/2019** RunNo: **50267**
Client ID: **BATCH** Batch ID: **R50267** Analysis Date: **3/24/2019** SeqNo: **987243**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Carbon Disulfide	ND	10.0						0		30	H
Ethyl Mercaptan	ND	10.0						0		30	H
Carbonyl Sulfide	ND	10.0						0		30	H
Isopropyl Mercaptan	ND	10.0						0		30	H
n-Butyl Mercaptan	ND	10.0						0		30	H
Dimethyl Disulfide	ND	10.0						0		30	H
Surr: 4-Bromofluorobenzene	3.83		4.000		95.7	70	130		0		H

Date: *3/25/2019*

Work Order:	1903204
CLIENT:	King County Environmental Laboratory
Project:	Vashon CLF

QC SUMMARY REPORT

Sulfur Compounds by EPA Method TO-15

Sample ID	**LCS-R50272**	SampType:	**LCS**	Units:	**ppbv**	Prep Date:	**3/25/2019**	RunNo:	**50272**
Client ID:	**LCSW**	Batch ID:	**R50272**			Analysis Date:	**3/25/2019**	SeqNo:	**988385**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Hydrogen Sulfide	118	10.0	110.0	0	107	70	130				
Surr: 4-Bromofluorobenzene	3.57		4.000		89.3	70	130				

Sample ID	**MB-R50272**	SampType:	**MBLK**	Units:	**ppbv**	Prep Date:	**3/25/2019**	RunNo:	**50272**
Client ID:	**MBLKW**	Batch ID:	**R50272**			Analysis Date:	**3/25/2019**	SeqNo:	**988386**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Hydrogen Sulfide	ND	10.0									
Surr: 4-Bromofluorobenzene	4.27		4.000		107	70	130				

Sample ID	**1903273-002AREP**	SampType:	**REP**	Units:	**ppbv**	Prep Date:	**3/26/2019**	RunNo:	**50272**
Client ID:	**BATCH**	Batch ID:	**R50272**			Analysis Date:	**3/26/2019**	SeqNo:	**988388**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Hydrogen Sulfide	ND	19.6						0		30	DH
Surr: 4-Bromofluorobenzene	9.29		7.840		118	70	130		0		DH

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Date: *3/25/2019*

Work Order: 1903204
CLIENT: King County Environmental Laboratory
Project: Vashon CLF

QC SUMMARY REPORT

Volatile Organic Compounds by EPA Method TO-15

Sample ID **LCS-R50135**	SampType: **LCS**			Units: **ppbv**		Prep Date: **3/16/2019**		RunNo: **50135**				
Client ID: **LCSW**	Batch ID: **R50135**					Analysis Date: **3/16/2019**		SeqNo: **984422**				
Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual	
Total Volatile Organics	138	1.00	150.0	0	91.8	70	130					
Propylene	1.46	0.400	2.000	0	73.1	70	130					
Dichlorodifluoromethane (CFC-12)	2.07	0.400	2.000	0	104	70	130					
Chloromethane	2.06	0.500	2.000	0	103	70	130					
Dichlorotetrafluoroethane (CFC-114)	2.12	0.400	2.000	0	106	70	130					
Vinyl chloride	1.68	0.107	2.000	0	84.2	70	130					
1,3-Butadiene	1.72	0.500	2.000	0	86.1	70	130					
Bromomethane	1.93	0.500	2.000	0	96.6	70	130					
Trichlorofluoromethane (CFC-11)	2.10	0.400	2.000	0	105	70	130					
Chloroethane	1.82	0.400	2.000	0	91.1	70	130					
Acrolein	1.81	0.500	2.000	0	90.6	70	130					
1,1-Dichloroethene (DCE)	1.56	0.400	2.000	0	78.0	70	130					
Acetone	2.00	1.00	2.000	0	99.8	70	130					
Methylene chloride	2.06	2.00	2.000	0	103	70	130					
Carbon disulfide	1.95	1.50	2.000	0	97.7	70	130					
trans-1,2-Dichloroethene	1.67	0.200	2.000	0	83.6	70	130					
Methyl tert-butyl ether (MTBE)	1.92	0.400	2.000	0	95.8	70	130					
n-Hexane	1.71	0.400	2.000	0	85.5	70	130					
1,1-Dichloroethane	1.85	0.200	2.000	0	92.5	70	130					
Vinyl acetate	1.88	1.00	2.000	0	94.0	70	130					
cis-1,2-Dichloroethene	1.88	0.200	2.000	0	94.2	70	130					
(MEK) 2-Butanone	1.82	1.00	2.000	0	90.9	70	130					
Ethyl acetate	1.50	1.00	2.000	0	75.2	70	130					
Chloroform	2.01	0.200	2.000	0	100	70	130					
Tetrahydrofuran	1.72	0.400	2.000	0	86.0	70	130					
1,1,1-Trichloroethane	1.83	0.400	2.000	0	91.5	70	130					
Carbon tetrachloride	1.91	0.0657	2.000	0	95.4	70	130					
1,2-Dichloroethane	2.04	0.200	2.000	0	102	70	130					
Benzene	1.55	0.0895	2.000	0	77.3	70	130					
Cyclohexane	1.71	0.400	2.000	0	85.4	70	130					
Trichloroethene (TCE)	1.73	0.0649	2.000	0	86.6	70	130					

Work Order: 1903204
CLIENT: King County Environmental Laboratory
Project: Vashon CLF

QC SUMMARY REPORT

Volatile Organic Compounds by EPA Method TO-15

Sample ID **LCS-R50135** SampType: **LCS** Units: **ppbv** Prep Date: **3/16/2019** RunNo: **50135**
Client ID: **LCSW** Batch ID: **R50135** Analysis Date: **3/16/2019** SeqNo: **984422**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
1,2-Dichloropropane	2.03	0.500	2.000	0	101	70	130				
Methyl methacrylate	1.64	0.400	2.000	0	81.9	70	130				
Dichlorobromomethane	1.90	0.300	2.000	0	95.0	70	130				
1,4-Dioxane	1.49	0.400	2.000	0	74.6	70	130				
cis-1,3-dichloropropene	1.98	0.400	2.000	0	99.2	70	130				
Toluene	1.67	0.400	2.000	0	83.6	70	130				
trans-1,3-dichloropropene	1.94	0.500	2.000	0	97.1	70	130				
1,1,2-Trichloroethane (TCA)	2.04	0.500	2.000	0	102	70	130				
Tetrachloroethene (PCE)	1.99	0.200	2.000	0	99.5	70	130				
Dibromochloromethane	2.05	0.500	2.000	0	102	70	130				
1,2-Dibromoethane (EDB)	1.95	0.200	2.000	0	97.3	70	130				
Chlorobenzene	2.03	0.200	2.000	0	101	70	130				
Ethylbenzene	1.60	0.400	2.000	0	80.1	70	130				
m,p-Xylene	3.04	0.800	4.000	0	76.0	70	130				
o-Xylene	1.41	0.400	2.000	0	70.6	70	130				
Styrene	1.47	0.400	2.000	0	73.5	70	130				
Bromoform	1.88	0.200	2.000	0	94.2	70	130				
1,1,2,2-Tetrachloroethane	2.03	0.300	2.000	0	101	70	130				
1,3,5-Trimethylbenzene	1.51	0.300	2.000	0	75.7	70	130				
1,2,4-Trimethylbenzene	1.44	0.300	2.000	0	71.9	70	130				
Benzyl chloride	1.80	0.500	2.000	0	90.0	70	130				
4-Ethyltoluene	1.66	0.400	2.000	0	83.1	70	130				
1,3-Dichlorobenzene	1.63	0.300	2.000	0	81.5	70	130				
1,4-Dichlorobenzene	1.57	0.300	2.000	0	78.4	70	130				
1,2-Dichlorobenzene	1.50	0.400	2.000	0	74.9	70	130				
1,2,4-Trichlorobenzene	1.59	0.300	2.000	0	79.6	70	130				
Hexachlorobutadiene	1.92	1.00	2.000	0	95.9	70	130				
Naphthalene	1.49	0.100	2.000	0	74.4	70	130				
2-Hexanone	1.53	1.00	2.000	0	76.6	70	130				
4-Methyl-2-pentanone (MIBK)	1.50	1.00	2.000	0	75.0	70	130				
CFC-113	2.20	0.400	2.000	0	110	70	130				

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Date: *3/25/2019*

Work Order: 1903204
CLIENT: King County Environmental Laboratory
Project: Vashon CLF

QC SUMMARY REPORT

Volatile Organic Compounds by EPA Method TO-15

Sample ID **LCS-R50135** SampType: **LCS** Units: **ppbv** Prep Date: **3/16/2019** RunNo: **50135**
Client ID: **LCSW** Batch ID: **R50135** Analysis Date: **3/16/2019** SeqNo: **984422**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Heptane	1.71	0.400	2.000	0	85.3	70	130				
Surr: 4-Bromofluorobenzene	4.08		4.000		102	70	130				

Sample ID **MB-R50135** SampType: **MBLK** Units: **ppbv** Prep Date: **3/16/2019** RunNo: **50135**
Client ID: **MBLKW** Batch ID: **R50135** Analysis Date: **3/16/2019** SeqNo: **984423**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Total Volatile Organics	ND	1.00									
Propylene	ND	0.400									
Dichlorodifluoromethane (CFC-12)	ND	0.400									
Chloromethane	ND	0.500									
Dichlorotetrafluoroethane (CFC-114)	ND	0.400									
Vinyl chloride	ND	0.107									
1,3-Butadiene	ND	0.500									
Bromomethane	ND	0.500									
Trichlorofluoromethane (CFC-11)	ND	0.400									
Chloroethane	ND	0.400									
Acrolein	ND	0.500									
1,1-Dichloroethene (DCE)	ND	0.400									
Acetone	ND	1.00									
Methylene chloride	ND	2.00									
Carbon disulfide	ND	1.50									
trans-1,2-Dichloroethene	ND	0.200									
Methyl tert-butyl ether (MTBE)	ND	0.400									
n-Hexane	ND	0.400									
1,1-Dichloroethane	ND	0.200									
Vinyl acetate	ND	1.00									
cis-1,2-Dichloroethene	ND	0.200									
(MEK) 2-Butanone	ND	1.00									
Ethyl acetate	ND	1.00									

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Date: *3/25/2019*

Work Order: 1903204
CLIENT: King County Environmental Laboratory
Project: Vashon CLF

QC SUMMARY REPORT

Volatile Organic Compounds by EPA Method TO-15

Sample ID **MB-R50135** SampType: **MBLK** Units: **ppbv** Prep Date: **3/16/2019** RunNo: **50135**
Client ID: **MBLKW** Batch ID: **R50135** Analysis Date: **3/16/2019** SeqNo: **984423**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Chloroform	ND	0.200									
Tetrahydrofuran	ND	0.400									
1,1,1-Trichloroethane	ND	0.400									
Carbon tetrachloride	ND	0.0657									
1,2-Dichloroethane	ND	0.200									
Benzene	ND	0.0895									
Cyclohexane	ND	0.400									
Trichloroethene (TCE)	ND	0.0649									
1,2-Dichloropropane	ND	0.500									
Methyl methacrylate	ND	0.400									
Dichlorobromomethane	ND	0.300									
1,4-Dioxane	ND	0.400									
cis-1,3-dichloropropene	ND	0.400									
Toluene	ND	0.400									
trans-1,3-dichloropropene	ND	0.500									
1,1,2-Trichloroethane (TCA)	ND	0.500									
Tetrachloroethene (PCE)	ND	0.200									
Dibromochloromethane	ND	0.500									
1,2-Dibromoethane (EDB)	ND	0.200									
Chlorobenzene	ND	0.200									
Ethylbenzene	ND	0.400									
m,p-Xylene	ND	0.800									
o-Xylene	ND	0.400									
Styrene	ND	0.400									
Bromoform	ND	0.200									
1,1,2,2-Tetrachloroethane	ND	0.300									
1,3,5-Trimethylbenzene	ND	0.300									
1,2,4-Trimethylbenzene	ND	0.300									
Benzyl chloride	ND	0.500									
4-Ethyltoluene	ND	0.400									
1,3-Dichlorobenzene	ND	0.300									

Work Order: 1903204
CLIENT: King County Environmental Laboratory
Project: Vashon CLF

QC SUMMARY REPORT

Volatile Organic Compounds by EPA Method TO-15

Sample ID **MB-R50135** SampType: **MBLK** Units: **ppbv** Prep Date: **3/16/2019** RunNo: **50135**
Client ID: **MBLKW** Batch ID: **R50135** Analysis Date: **3/16/2019** SeqNo: **984423**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
1,4-Dichlorobenzene	ND	0.300									
1,2-Dichlorobenzene	ND	0.400									
1,2,4-Trichlorobenzene	ND	0.300									
Hexachlorobutadiene	ND	1.00									
Naphthalene	ND	0.100									
2-Hexanone	ND	1.00									
4-Methyl-2-pentanone (MIBK)	ND	1.00									
CFC-113	ND	0.400									
Heptane	ND	0.400									
Surr: 4-Bromofluorobenzene	3.59		4.000		89.7	70	130				

Sample ID **1903149-001AREP** SampType: **REP** Units: **ppbv** Prep Date: **3/16/2019** RunNo: **50135**
Client ID: **BATCH** Batch ID: **R50135** Analysis Date: **3/16/2019** SeqNo: **984428**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Propylene	1,970	0.400						1,893	4.20	30	EH
Dichlorodifluoromethane (CFC-12)	ND	0.400						0		30	H
Chloromethane	ND	0.500						0		30	H
Dichlorotetrafluoroethane (CFC-114)	ND	0.400						0		30	H
Vinyl chloride	3.90	0.107						3.726	4.49	30	H
1,3-Butadiene	ND	0.500						0		30	H
Bromomethane	ND	0.500						0		30	H
Trichlorofluoromethane (CFC-11)	ND	0.400						0		30	H
Chloroethane	ND	0.400						0		30	H
Acrolein	ND	0.500						0		30	H
1,1-Dichloroethene (DCE)	0.519	0.400						0.4794	7.94	30	H
Acetone	82.7	1.00						82.85	0.187	30	EH
Methylene chloride	14.9	2.00						15.19	1.60	30	H
Carbon disulfide	2.37	1.50						2.423	2.23	30	H
trans-1,2-Dichloroethene	1.06	0.200						1.044	1.30	30	H

Work Order: 1903204
CLIENT: King County Environmental Laboratory
Project: Vashon CLF

QC SUMMARY REPORT

Volatile Organic Compounds by EPA Method TO-15

Sample ID **1903149-001AREP** SampType: **REP** Units: **ppbv** Prep Date: **3/16/2019** RunNo: **50135**
Client ID: **BATCH** Batch ID: **R50135** Analysis Date: **3/16/2019** SeqNo: **984428**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Methyl tert-butyl ether (MTBE)	ND	0.400						0		30	H
n-Hexane	1.60	0.400						1.470	8.35	30	H
1,1-Dichloroethane	ND	0.200						0		30	H
Vinyl acetate	ND	1.00						0		30	H
cis-1,2-Dichloroethene	7.57	0.200						7.544	0.290	30	H
(MEK) 2-Butanone	1.44	1.00						1.459	1.15	30	H
Ethyl acetate	ND	1.00						0		30	H
Chloroform	0.578	0.200						0.5799	0.252	30	H
Tetrahydrofuran	ND	0.400						0		30	H
1,1,1-Trichloroethane	ND	0.400						0		30	H
Carbon tetrachloride	0.143	0.0657						0.1556	8.22	30	H
1,2-Dichloroethane	ND	0.200						0		30	H
Benzene	0.323	0.0895						0.3161	2.26	30	H
Cyclohexane	ND	0.400						0		30	H
Trichloroethene (TCE)	ND	0.0649						0		30	H
1,2-Dichloropropane	ND	0.500						0		30	H
Methyl methacrylate	ND	0.400						0		30	H
Dichlorobromomethane	ND	0.300						0		30	H
1,4-Dioxane	ND	0.400						0		30	H
cis-1,3-dichloropropene	ND	0.400						0		30	H
Toluene	3.63	0.400						3.570	1.72	30	H
trans-1,3-dichloropropene	ND	0.500						0		30	H
1,1,2-Trichloroethane (TCA)	ND	0.500						0		30	H
Tetrachloroethene (PCE)	0.559	0.200						0.6115	8.95	30	H
Dibromochloromethane	ND	0.500						0		30	H
1,2-Dibromoethane (EDB)	ND	0.200						0		30	H
Chlorobenzene	ND	0.200						0		30	H
Ethylbenzene	ND	0.400						0		30	H
m,p-Xylene	1.03	0.800						0.9799	5.32	30	H
o-Xylene	0.461	0.400						0.4306	6.76	30	H
Styrene	ND	0.400						0		30	H

Date: *3/25/2019*

Work Order: 1903204
CLIENT: King County Environmental Laboratory
Project: Vashon CLF

QC SUMMARY REPORT

Volatile Organic Compounds by EPA Method TO-15

Sample ID **1903149-001AREP** SampType: **REP** Units: **ppbv** Prep Date: **3/16/2019** RunNo: **50135**
Client ID: **BATCH** Batch ID: **R50135** Analysis Date: **3/16/2019** SeqNo: **984428**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Bromoform	ND	0.200						0		30	H
1,1,2,2-Tetrachloroethane	ND	0.300						0		30	H
1,3,5-Trimethylbenzene	ND	0.300						0		30	H
1,2,4-Trimethylbenzene	0.846	0.300						0.7832	7.69	30	H
Benzyl chloride	ND	0.500						0		30	H
4-Ethyltoluene	ND	0.400						0		30	H
1,3-Dichlorobenzene	ND	0.300						0		30	H
1,4-Dichlorobenzene	ND	0.300						0		30	H
1,2-Dichlorobenzene	ND	0.400						0		30	H
1,2,4-Trichlorobenzene	ND	0.300						0		30	H
Hexachlorobutadiene	ND	1.00						0		30	H
Naphthalene	ND	0.100						0		30	H
2-Hexanone	ND	1.00						0		30	H
4-Methyl-2-pentanone (MIBK)	ND	1.00						0		30	H
CFC-113	ND	0.400						0		30	H
Heptane	ND	0.400						0		30	H
Surr: 4-Bromofluorobenzene	4.58		4.000		115	70	130		0		H

NOTES:
E - Estimated value. The amount exceeds the linear working range of the instrument.

Sample ID **LCS-R50196** SampType: **LCS** Units: **ppbv** Prep Date: **3/20/2019** RunNo: **50196**
Client ID: **LCSW** Batch ID: **R50196** Analysis Date: **3/20/2019** SeqNo: **985867**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Isopropyl Alcohol	2.08	1.00	2.000	0	104	70	130				
Surr: 4-Bromofluorobenzene	3.89		4.000		97.4	70	130				

Work Order: 1903204
CLIENT: King County Environmental Laboratory
Project: Vashon CLF

QC SUMMARY REPORT

Volatile Organic Compounds by EPA Method TO-15

Sample ID **MB-R50196** SampType: **MBLK** Units: **ppbv** Prep Date: **3/20/2019** RunNo: **50196**
Client ID: **MBLKW** Batch ID: **R50196** Analysis Date: **3/20/2019** SeqNo: **985868**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Isopropyl Alcohol	ND	1.00									
Surr: 4-Bromofluorobenzene	3.26		4.000		81.5	70	130				

Sample ID **1903273-001AREP** SampType: **REP** Units: **ppbv** Prep Date: **3/20/2019** RunNo: **50196**
Client ID: **BATCH** Batch ID: **R50196** Analysis Date: **3/20/2019** SeqNo: **985923**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Isopropyl Alcohol	400	1.00						400.8	0.277	30	E
Surr: 4-Bromofluorobenzene	3.75		4.000		93.7	70	130		0		

NOTES:
E - Estimated value. The amount exceeds the linear working range of the instrument.

Date: *3/25/2019*

Work Order: 1903204
CLIENT: King County Environmental Laboratory
Project: Vashon CLF

QC SUMMARY REPORT

Volatile Organic Compounds by EPA Method 8260C

Sample ID **1903204-002AREP** SampType: **REP** Units: **µg/L** Prep Date: **3/15/2019** RunNo: **50132**
Client ID: **GVBLI190314** Batch ID: **23849** Analysis Date: **3/15/2019** SeqNo: **984353**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Dichlorodifluoromethane	ND	0.100						0		30	
Chloromethane	ND	0.100						0		30	
Vinyl chloride	ND	0.0200						0		30	
Bromomethane	ND	0.100						0		30	
Trichlorofluoromethane (CFC-11)	2.50	0.100						3.110	21.7	30	
Chloroethane	ND	0.100						0		30	
1,1-Dichloroethene	ND	0.100						0		30	
Methylene chloride	0.102	0.100						0.1453	35.0	30	
Acrylonitrile	ND	0.100						0		30	
trans-1,2-Dichloroethene	ND	0.100						0		30	
Methyl tert-butyl ether (MTBE)	ND	0.100						0		30	
1,1-Dichloroethane	ND	0.100						0		30	
2,2-Dichloropropane	ND	0.200						0		30	
cis-1,2-Dichloroethene	0.246	0.100						0.3008	19.8	30	
Chloroform	ND	0.100						0		30	
1,1,1-Trichloroethane (TCA)	ND	0.100						0		30	
1,1-Dichloropropene	ND	0.100						0		30	
Carbon tetrachloride	ND	0.100						0		30	
1,2-Dichloroethane (EDC)	ND	0.100						0		30	
Benzene	ND	0.100						0.1066	19.1	30	
Trichloroethene (TCE)	ND	0.0500						0		30	
1,2-Dichloropropane	ND	0.100						0		30	
Bromodichloromethane	ND	0.100						0		30	
Dibromomethane	ND	0.100						0		30	
cis-1,3-Dichloropropene	ND	0.100						0		30	
Toluene	0.690	0.100						0.8339	18.9	30	
trans-1,3-Dichloropropylene	ND	0.100						0		30	
1,1,2-Trichloroethane	ND	0.100						0		30	
1,3-Dichloropropane	ND	0.100						0		30	
Tetrachloroethene (PCE)	ND	0.100						0		30	
Dibromochloromethane	ND	0.100						0		30	

Date: *3/25/2019*

Work Order: 1903204
CLIENT: King County Environmental Laboratory
Project: Vashon CLF

QC SUMMARY REPORT

Volatile Organic Compounds by EPA Method 8260C

Sample ID **1903204-002AREP** SampType: **REP** Units: **µg/L** Prep Date: **3/15/2019** RunNo: **50132**
Client ID: **GVBLI190314** Batch ID: **23849** Analysis Date: **3/15/2019** SeqNo: **984353**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
1,2-Dibromoethane (EDB)	ND	0.0250						0		30	
Chlorobenzene	ND	0.100						0		30	
1,1,1,2-Tetrachloroethane	ND	0.100						0		30	
Ethylbenzene	0.602	0.100						0.7105	16.5	30	
m,p-Xylene	1.16	0.100						1.371	16.3	30	
o-Xylene	0.146	0.100						0.1753	18.3	30	
Styrene	ND	0.100						0		30	
Isopropylbenzene	ND	0.100						0		30	
Bromoform	ND	0.100						0		30	
1,1,2,2-Tetrachloroethane	ND	0.100						0		30	
n-Propylbenzene	ND	0.100						0		30	
Bromobenzene	ND	0.100						0		30	
1,3,5-Trimethylbenzene	ND	0.100						0		30	
2-Chlorotoluene	ND	0.100						0		30	
4-Chlorotoluene	ND	0.100						0		30	
tert-Butylbenzene	ND	0.100						0		30	
1,2,3-Trichloropropane	ND	0.100						0		30	
1,2,4-Trichlorobenzene	ND	0.200						0		30	
sec-Butylbenzene	ND	0.100						0		30	
4-Isopropyltoluene	ND	0.100						0		30	
1,3-Dichlorobenzene	ND	0.100						0		30	
1,4-Dichlorobenzene	ND	0.100						0		30	
n-Butylbenzene	ND	0.100						0		30	
1,2-Dichlorobenzene	ND	0.100						0		30	
1,2-Dibromo-3-chloropropane	ND	0.100						0		30	
1,2,4-Trimethylbenzene	ND	0.100						0		30	
Hexachlorobutadiene	ND	0.400						0		30	
Naphthalene	0.105	0.100						0.1952	60.5	30	
1,2,3-Trichlorobenzene	ND	0.400						0		30	
Surr: Dibromofluoromethane	2.02		2.500		80.8	61.1	128		0		
Surr: Toluene-d8	2.47		2.500		98.8	68.2	129		0		

Work Order: 1903204
CLIENT: King County Environmental Laboratory
Project: Vashon CLF

QC SUMMARY REPORT

Volatile Organic Compounds by EPA Method 8260C

Sample ID 1903204-002AREP	SampType: REP		Units: µg/L		Prep Date: 3/15/2019		RunNo: 50132				
Client ID: GVBLI190314	Batch ID: 23849				Analysis Date: 3/15/2019		SeqNo: 984353				
Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Surr: 1-Bromo-4-fluorobenzene-BFB	2.52		2.500		101	64.7	128		0		

Sample ID MB-23849	SampType: MBLK		Units: µg/L		Prep Date: 3/15/2019		RunNo: 50132				
Client ID: MBLKW	Batch ID: 23849				Analysis Date: 3/15/2019		SeqNo: 984357				
Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Dichlorodifluoromethane	ND	0.100									
Chloromethane	ND	0.100									
Vinyl chloride	ND	0.0200									
Bromomethane	ND	0.100									
Trichlorofluoromethane (CFC-11)	ND	0.100									
Chloroethane	ND	0.100									
1,1-Dichloroethene	ND	0.100									
Methylene chloride	ND	0.100									
Acrylonitrile	ND	0.100									
trans-1,2-Dichloroethene	ND	0.100									
Methyl tert-butyl ether (MTBE)	ND	0.100									
1,1-Dichloroethane	ND	0.100									
2,2-Dichloropropane	ND	0.200									
cis-1,2-Dichloroethene	ND	0.100									
Chloroform	ND	0.100									
1,1,1-Trichloroethane (TCA)	ND	0.100									
1,1-Dichloropropene	ND	0.100									
Carbon tetrachloride	ND	0.100									
1,2-Dichloroethane (EDC)	ND	0.100									
Benzene	ND	0.100									
Trichloroethene (TCE)	ND	0.0500									
1,2-Dichloropropane	ND	0.100									
Bromodichloromethane	ND	0.100									
Dibromomethane	ND	0.100									

Work Order: 1903204
CLIENT: King County Environmental Laboratory
Project: Vashon CLF

QC SUMMARY REPORT

Volatile Organic Compounds by EPA Method 8260C

Sample ID **MB-23849** SampType: **MBLK** Units: **µg/L** Prep Date: **3/15/2019** RunNo: **50132**
Client ID: **MBLKW** Batch ID: **23849** Analysis Date: **3/15/2019** SeqNo: **984357**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
cis-1,3-Dichloropropene	ND	0.100									
Toluene	ND	0.100									
trans-1,3-Dichloropropylene	ND	0.100									
1,1,2-Trichloroethane	ND	0.100									
1,3-Dichloropropane	ND	0.100									
Tetrachloroethene (PCE)	ND	0.100									
Dibromochloromethane	ND	0.100									
1,2-Dibromoethane (EDB)	ND	0.0250									
Chlorobenzene	ND	0.100									
1,1,1,2-Tetrachloroethane	ND	0.100									
Ethylbenzene	ND	0.100									
m,p-Xylene	ND	0.100									
o-Xylene	ND	0.100									
Styrene	ND	0.100									
Isopropylbenzene	ND	0.100									
Bromoform	ND	0.100									
1,1,2,2-Tetrachloroethane	ND	0.100									
n-Propylbenzene	ND	0.100									
Bromobenzene	ND	0.100									
1,3,5-Trimethylbenzene	ND	0.100									
2-Chlorotoluene	ND	0.100									
4-Chlorotoluene	ND	0.100									
tert-Butylbenzene	ND	0.100									
1,2,3-Trichloropropane	ND	0.100									
1,2,4-Trichlorobenzene	ND	0.200									
sec-Butylbenzene	ND	0.100									
4-Isopropyltoluene	ND	0.100									
1,3-Dichlorobenzene	ND	0.100									
1,4-Dichlorobenzene	ND	0.100									
n-Butylbenzene	ND	0.100									
1,2-Dichlorobenzene	ND	0.100									

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Date: 3/25/2019

Work Order: 1903204
CLIENT: King County Environmental Laboratory
Project: Vashon CLF

QC SUMMARY REPORT

Volatile Organic Compounds by EPA Method 8260C

Sample ID **MB-23849** SampType: **MBLK** Units: **µg/L** Prep Date: **3/15/2019** RunNo: **50132**
Client ID: **MBLKW** Batch ID: **23849** Analysis Date: **3/15/2019** SeqNo: **984357**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
1,2-Dibromo-3-chloropropane	ND	0.100									
1,2,4-Trimethylbenzene	ND	0.100									
Hexachlorobutadiene	ND	0.400									
Naphthalene	ND	0.100									
1,2,3-Trichlorobenzene	ND	0.400									
Surr: Dibromofluoromethane	2.38		2.500		95.3	56.4	141				
Surr: Toluene-d8	2.45		2.500		97.9	66	138				
Surr: 1-Bromo-4-fluorobenzene-BFB	2.53		2.500		101	64.7	128				

Sample ID **LCS-23849** SampType: **LCS** Units: **µg/L** Prep Date: **3/15/2019** RunNo: **50132**
Client ID: **LCSW** Batch ID: **23849** Analysis Date: **3/15/2019** SeqNo: **984358**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Dichlorodifluoromethane	1.92	0.100	2.000	0	96.2	38.8	143				
Chloromethane	2.00	0.100	2.000	0	99.8	42.5	131				
Vinyl chloride	1.93	0.0200	2.000	0	96.4	56.2	130				
Bromomethane	1.93	0.100	2.000	0	96.4	45.4	138				
Trichlorofluoromethane (CFC-11)	1.92	0.100	2.000	0	96.2	64.7	129				
Chloroethane	1.90	0.100	2.000	0	95.1	62.5	123				
1,1-Dichloroethene	1.88	0.100	2.000	0	93.8	60.7	146				
Methylene chloride	1.85	0.100	2.000	0	92.4	60.3	135				
Acrylonitrile	1.96	0.100	2.000	0	98.1	70	130				
trans-1,2-Dichloroethene	1.87	0.100	2.000	0	93.5	71.3	129				
Methyl tert-butyl ether (MTBE)	1.92	0.100	2.000	0	95.9	59.3	138				
1,1-Dichloroethane	1.96	0.100	2.000	0	98.0	71.3	129				
2,2-Dichloropropane	1.89	0.200	2.000	0	94.5	37.8	132				
cis-1,2-Dichloroethene	1.90	0.100	2.000	0	95.1	67.5	127				
Chloroform	1.94	0.100	2.000	0	97.2	70.3	123				
1,1,1-Trichloroethane (TCA)	1.95	0.100	2.000	0	97.6	67.9	134				
1,1-Dichloropropene	1.95	0.100	2.000	0	97.6	72.1	133				

Fremont Analytical

Date: *3/25/2019*

Work Order: 1903204
CLIENT: King County Environmental Laboratory
Project: Vashon CLF

QC SUMMARY REPORT

Volatile Organic Compounds by EPA Method 8260C

Sample ID **LCS-23849** SampType: **LCS** Units: **µg/L** Prep Date: **3/15/2019** RunNo: **50132**
Client ID: **LCSW** Batch ID: **23849** Analysis Date: **3/15/2019** SeqNo: **984358**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Carbon tetrachloride	1.84	0.100	2.000	0	92.2	64.4	133				
1,2-Dichloroethane (EDC)	2.01	0.100	2.000	0	100	65.8	126				
Benzene	1.95	0.100	2.000	0	97.6	67.1	132				
Trichloroethene (TCE)	1.94	0.0500	2.000	0	97.2	71.9	130				
1,2-Dichloropropane	1.94	0.100	2.000	0	97.0	71.9	131				
Bromodichloromethane	1.87	0.100	2.000	0	93.4	70	130				
Dibromomethane	1.98	0.100	2.000	0	99.0	74.2	125				
cis-1,3-Dichloropropene	1.79	0.100	2.000	0	89.7	62.8	135				
Toluene	1.99	0.100	2.000	0	99.3	73.6	127				
trans-1,3-Dichloropropylene	1.76	0.100	2.000	0	88.0	58.1	138				
1,1,2-Trichloroethane	1.93	0.100	2.000	0	96.5	65.4	128				
1,3-Dichloropropane	1.95	0.100	2.000	0	97.5	71.9	131				
Tetrachloroethene (PCE)	1.97	0.100	2.000	0	98.3	52.4	140				
Dibromochloromethane	1.76	0.100	2.000	0	88.1	68.7	139				
1,2-Dibromoethane (EDB)	1.88	0.0250	2.000	0	94.0	71.2	129				
Chlorobenzene	1.97	0.100	2.000	0	98.5	77.2	122				
1,1,1,2-Tetrachloroethane	1.88	0.100	2.000	0	93.9	76.2	130				
Ethylbenzene	1.94	0.100	2.000	0	96.9	78	127				
m,p-Xylene	3.84	0.100	4.000	0	96.0	77.5	130				
o-Xylene	1.99	0.100	2.000	0	99.3	77.6	126				
Styrene	1.94	0.100	2.000	0	96.9	66.8	137				
Isopropylbenzene	1.94	0.100	2.000	0	96.9	75.9	133				
Bromoform	1.98	0.100	2.000	0	98.9	54.1	146				
1,1,2,2-Tetrachloroethane	2.11	0.100	2.000	0	106	68	134				
n-Propylbenzene	2.04	0.100	2.000	0	102	77.1	133				
Bromobenzene	2.08	0.100	2.000	0	104	71.1	131				
1,3,5-Trimethylbenzene	2.01	0.100	2.000	0	100	76.2	133				
2-Chlorotoluene	2.15	0.100	2.000	0	107	67.1	137				
4-Chlorotoluene	2.05	0.100	2.000	0	102	70.7	132				
tert-Butylbenzene	2.09	0.100	2.000	0	105	71.3	139				
1,2,3-Trichloropropane	2.04	0.100	2.000	0	102	70.8	132				

Fremont Analytical

Date: *3/25/2019*

Work Order: 1903204
CLIENT: King County Environmental Laboratory
Project: Vashon CLF

QC SUMMARY REPORT

Volatile Organic Compounds by EPA Method 8260C

Sample ID **LCS-23849** SampType: **LCS** Units: **µg/L** Prep Date: **3/15/2019** RunNo: **50132**
Client ID: **LCSW** Batch ID: **23849** Analysis Date: **3/15/2019** SeqNo: **984358**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
1,2,4-Trichlorobenzene	2.05	0.200	2.000	0	103	61.4	139				
sec-Butylbenzene	2.07	0.100	2.000	0	104	77.4	136				
4-Isopropyltoluene	1.99	0.100	2.000	0	99.7	78.1	131				
1,3-Dichlorobenzene	2.04	0.100	2.000	0	102	73.5	125				
1,4-Dichlorobenzene	2.06	0.100	2.000	0	103	71.4	125				
n-Butylbenzene	2.05	0.100	2.000	0	103	69.8	138				
1,2-Dichlorobenzene	2.05	0.100	2.000	0	102	74.2	123				
1,2-Dibromo-3-chloropropane	2.10	0.100	2.000	0	105	53.6	155				
1,2,4-Trimethylbenzene	1.99	0.100	2.000	0	99.4	72.3	133				
Hexachlorobutadiene	2.06	0.400	2.000	0	103	60.9	141				
Naphthalene	1.94	0.100	2.000	0	97.1	58.2	140				
1,2,3-Trichlorobenzene	2.08	0.400	2.000	0	104	61.3	133				
Surr: Dibromofluoromethane	2.21		2.500		88.5	56.4	141				
Surr: Toluene-d8	2.46		2.500		98.4	66	138				
Surr: 1-Bromo-4-fluorobenzene-BFB	2.65		2.500		106	64.7	128				

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Sample Log-In Check List

Client Name:	**KCEL**	Work Order Number:	**1903204**
Logged by:	**Clare Griggs**	Date Received:	**3/14/2019 1:10:00 PM**

Chain of Custody

1.	Is Chain of Custody complete?	Yes ☑	No ☐	Not Present ☐
2.	How was the sample delivered?	Client		

Log In

3.	Coolers are present?	Yes ☐	No ☑	NA ☐
		Air Samples		
4.	Shipping container/cooler in good condition?	Yes ☑	No ☐	
5.	Custody Seals present on shipping container/cooler? (Refer to comments for Custody Seals not intact)	Yes ☐	No ☐	Not Required ☑
6.	Was an attempt made to cool the samples?	Yes ☐	No ☐	NA ☑
7.	Were all items received at a temperature of >0°C to 10.0°C*	Yes ☐	No ☐	NA ☑
8.	Sample(s) in proper container(s)?	Yes ☑	No ☐	
9.	Sufficient sample volume for indicated test(s)?	Yes ☑	No ☐	
10.	Are samples properly preserved?	Yes ☑	No ☐	
11.	Was preservative added to bottles?	Yes ☐	No ☑	NA ☐
12.	Is there headspace in the VOA vials?	Yes ☐	No ☐	NA ☑
13.	Did all samples containers arrive in good condition(unbroken)?	Yes ☑	No ☐	
14.	Does paperwork match bottle labels?	Yes ☑	No ☐	
15.	Are matrices correctly identified on Chain of Custody?	Yes ☑	No ☐	
16.	Is it clear what analyses were requested?	Yes ☑	No ☐	
17.	Were all holding times able to be met?	Yes ☑	No ☐	

Special Handling (if applicable)

18.	Was client notified of all discrepancies with this order?	Yes ☑	No ☐	NA ☐

Person Notified:	Chad Hearn	Date	3/14/2019
By Whom:	Clare Griggs	Via:	☑ eMail ☐ Phone ☐ Fax ☐ In Person
Regarding:	Confirming analyses.		
Client Instructions:	Include acrylonitrile for 8260		

19. Additional remarks:

Item Information

* Note: DoD/ELAP and TNI require items to be received at 4°C +/- 2°C

Air Chain of Custody Record & Laboratory Services Agreement

Fremont Analytical
3600 Fremont Ave N.
Seattle, WA 98103
Tel: 206-352-3790
Fax: 206-352-7178

Laboratory Project No (internal): 1903204

Date: 3/14/19 Page: 1 of: 1

Project Name: Vashon CLF

Project No: 090057-310.1.7.7

Location: Vashon Landfill

Collected by: David Unruh - Aspect Consulting

Reports to (PM): Katherine Bourbonais / Chad Hearn

Email (PM): katherine.bourbonais@kingcounty.gov / chearn@aspectconsulting.com

Client: King County Environmental Laboratory

Address: 322 W. Ewing St.

City, State, Zip: Seattle, WA 98119-1507

Telephone: 206-477-7112

Fax:

Special Remarks:

Air samples are disposed of one week after report is submitted to client unless otherwise requested. ☐ OK to Dispose ☐ Hold (fees may apply)

#	Sample Name	Canister / Flow Reg Serial #	Sample Date & Time	Sample Type (Matrix) *	Container Type **	Fill Time / Flow Rate	Initial Evacuation Pressure (mtorr) (Internal)	Field Initial Sample Pressure (" Hg)	Field Final Sample Pressure (" Hg)	VOCs TO15 SCAN	VOCs TO15 SCAN LL	VOCs TO15 SIM	Siloxanes TO15	Sulfur TO15	Sulfur Ext. TO15	APH TO15	Helium	Major Gases 3C	VOCs 8260	Comments	Final Pressure ("Hg) (Internal)
1	GUBLI190314-	4680	3/14/19	L	1L	Grab	10mtorr 3/7/2019	30 3/14/19	5 3/14/19	X				X							-5
2	GUBLI190314-		3/14/19	L	Tedlar bag (TB)	grab- 100 cc/min	3/14/15											X	x		
3																					
4																					
5																					

* Matrix Codes: AA = Ambient Air IA = Indoor Air L = Landfill S = Subslab / Soil Gas

** Container Codes: BV = 1 Liter Bottle Vac 6L = 6L Canister 1L = 1L Canister CYL = High Pressure Cylinder F = Filter S = Sorbent Tube TB = Tedlar Bag

I represent that I am authorized to enter into this Agreement with Fremont Analytical on behalf of the Client named above, that I have verified Client's agreement to each of the terms on the front and backside of this Agreement.

Relinquished	Date/Time	Received	Date/Time
x David Unruh	3/14/19 1310	x [signature]	3/14/19 1310
x		x	

Turn-Around Time:
☒ Standard
☐ 3 Day
☐ 2 Day
☐ Next Day
Same Day ____ (specify)

APPENDIX G

Report Limitations and Guidelines For Use

REPORT LIMITATIONS AND USE GUIDELINES

Reliance Conditions for Third Parties

This report was prepared for the exclusive use of the Client. No other party may rely on this report or the product of our services without the express written consent of Aspect Consulting, LLC (Aspect). This limitation is to provide our firm with reasonable protection against liability claims by third parties with whom there would otherwise be no contractual conditions or limitations and guidelines governing their use of the report. Within the limitations of scope, schedule and budget, our services have been executed in accordance with Contract No. E00102E08 (Agreement) and recognized standards of professionals in the same locality and involving similar conditions.

Services for Specific Purposes, Persons and Projects

Aspect has performed the services in general accordance with the scope and limitations of our Agreement. This report has been prepared for the exclusive use of the Client and their authorized third parties, approved in writing by Aspect. This report is not intended for use by others, and the information contained herein is not applicable to other properties.

This report is not, and should not, be construed as a warranty or guarantee regarding the presence or absence of hazardous substances or petroleum products that may affect the Site. The report is not intended to make any representation concerning title or ownership to the Site. If real property records were reviewed, they were reviewed for the sole purpose of determining the Site's historical uses. All findings, conclusions, and recommendations stated in this report are based on the data and information provided to Aspect, current use of the Site, and observations and conditions that existed on the date and time of the report.

Aspect structures its services to meet the specific needs of our clients. Because each environmental study is unique, each environmental report is unique, prepared solely for the specific client and Site. This report should not be applied for any purpose or project except the purpose described in the Agreement.

This Report Is Project-Specific

Aspect considered a number of unique, project-specific factors when establishing the Scope of Work for this project and report. You should not rely on this report if it was:

- Not prepared for you
- Not prepared for the specific purpose identified in the Agreement
- Not prepared for the specific real property assessed
- Completed before important changes occurred concerning the Site, project or governmental regulatory actions

If changes are made to the project or Site after the date of this report, Aspect should be retained to assess the impact of the changes with respect to the conclusions contained in the report.

Geoscience Interpretations

The geoscience practices (geotechnical engineering, geology, and environmental science) require interpretation of spatial information that can make them less exact than other engineering and natural science disciplines. It is important to recognize this limitation in evaluating the content of the report. If you are unclear how these "Report Limitations and Use Guidelines" apply to your project or site, you should contact Aspect.

Discipline-Specific Reports Are Not Interchangeable

The equipment, techniques and personnel used to perform an environmental study differ significantly from those used to perform a geotechnical or geologic study and vice versa. For that reason, a geotechnical engineering or geologic report does not usually address any environmental findings, conclusions or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Similarly, environmental reports are not used to address geotechnical or geologic concerns regarding the Site.

Environmental Regulations Are Not Static

Some hazardous substances or petroleum products may be present near the Site in quantities or under conditions that may have led, or may lead, to contamination of the Site, but are not included in current local, state or federal regulatory definitions of hazardous substances or petroleum products or do not otherwise present potential liability. Changes may occur in the standards for appropriate inquiry or regulatory definitions of hazardous substance and petroleum products; therefore, this report has a limited useful life.

Property Conditions Change Over Time

This report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time =, by events such as a change in property use or occupancy, or by natural events, such as floods, earthquakes, slope failure or groundwater fluctuations. If more than six months have passed since issuance of our report, or if any of the described events may have occurred following the issuance of the report, you should contact Aspect so that we may evaluate whether changed conditions affect the continued reliability or applicability of our conclusions and recommendations.

Historical Information Provided by Others

Aspect has relied upon information provided by others in our description of historical conditions and in our review of regulatory databases and files. The available data does not provide definitive information with regard to all past uses, operations or incidents affecting the Site or adjacent properties. Aspect makes no warranties or guarantees regarding the accuracy or completeness of information provided or compiled by others.