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SUB-SLAB DEPRESSURIZATION SYSTEM PILOT TEST REPORT AND BARRIER SOIL VAPOR EXTRACTION IMPLEMENTATION WORK PLAN FORMER TIGER OIL WEST NOB HILL BOULEVARD SITE YAKIMA, WASHINGTON

by
Haley & Aldrich, Inc.
Seattle, Washington

for
City of Yakima
Yakima, Washington

File No. 0204793-000
October 2023

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16 October 2023
File No. 0204793-000

City of Yakima, Office of the City Clerk
Yakima City Hall
129 N. 2nd Street
Yakima, Washington 98901

Attention: Bill Preston, Yakima City Engineer

Subject: Sub-Slab Depressurization System Pilot Test Report and Barrier Soil Vapor Extraction Implementation Work Plan
Former Tiger Oil West Nob Hill Boulevard Site
Facility Site ID: 469, Cleanup Site ID: 4919
2312 W. Nob Hill Blvd., Yakima, Washington 98902

Dear Mr. Preston:

Haley & Aldrich, Inc., has prepared this Sub-Slab Depressurization System (SSDS) Pilot Test Report and Barrier Soil Vapor Extraction (SVE) Implementation Work Plan (Report) for the former Tiger Oil West Nob Hill Boulevard Site (Washington State Department of Ecology [Ecology] Facility Site No. 469, Cleanup Site No. 4919), located at 2312 West Nob Hill Boulevard, in Yakima, Washington.

This Report summarizes the SSDS design and pilot testing performed in December 2022 to March 2023 to provide design parameters for the full barrier SVE for vapor mitigation at the adjoining businesses to the former Tiger Oil facility. A Barrier SVE Implementation Work Plan is also included in this submittal.

Please contact the undersigned if you have questions or comments regarding this Report and/or Implementation Work Plan.

Sincerely yours,
HALEY & ALDRICH, INC.

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SUB-SLAB DEPRESSURIZATION SYSTEM PILOT TEST REPORT AND BARRIER SOIL VAPOR EXTRACTION IMPLEMENTATION WORK PLAN
FORMER TIGER OIL WEST NOB HILL BOULEVARD SITE
YAKIMA, CALIFORNIA

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Table of Contents

List of Tables

List of Figures

List of Appendices

1. Introduction

Haley & Aldrich, Inc., (Haley & Aldrich) prepared this Sub-Slab Depressurization System (SSDS) Pilot Test Report and Barrier Soil Vapor Extraction (SVE) Implementation Work Plan (Report) on behalf of the City of Yakima (City) for the former Tiger Oil West Nob Hill Boulevard Site (Washington State Department of Ecology [Ecology] Facility Site No. 469, Cleanup Site No. 4919), located at 2312 West Nob Hill Boulevard, in Yakima, Washington (Site; Figure 1). Throughout this Report and consistent with Ecology's definition, the term "Property" refers to the real property located at 2312 West Nob Hill Boulevard, and "the Site" refers to areas where contamination has come to lie, irrespective of property boundaries.

This Report summarizes the SSDS pilot testing conducted between December 2022 and March 2023 to assess the efficacy of a sub-slab depressurization (SSD) approach for the Site to mitigate petroleum hydrocarbons and petroleum fuel and chlorinated solvent-associated volatile organic compound (VOC) vapor intrusion from shallow groundwater and sub-slab soil into the indoor air of the adjacent three businesses from the former Tiger Oil facility (the Property). As discussed in more detail in Section 3, the SSDS pilot test indicated that vacuum propagation in the subsurface near the Property is negligible to very low, and SSDS is therefore not an appropriate or effective vapor mitigation strategy. Therefore, a full-scale barrier SVE system is recommended for vapor mitigation. The barrier SVE system has the added benefit of mass removal, which will help to remediate shallow soils at the Property.

Our work was performed in accordance with Haley & Aldrich's "Proposal and Scope of Work for Task 1 SSDS Pilot Testing and Design" (Proposal) dated 5 October 2022 and approved by the City on 14 December 2022.

1.1 SITE BACKGROUND AND PRIOR INVESTIGATIONS

The former Tiger Oil facility was a retail gasoline station that operated on the Property from 1978 until 2001. Currently, there are no commercial activities at the gravel-surface, undeveloped Property. Several fuel releases at the Property during its active facility operations had resulted in gasoline petroleum fuel impacts to soil and groundwater at the Property, as well as to the adjoining parcels to the east, south, and southeast (Figure 1). Interim remediation and groundwater monitoring activities conducted at the Site are conducted under Amended Consent Decree No. 02-2-00956-22.

The Property is owned by Heyden Properties, LLC (Heyden Properties). The City was formerly the property owner until 2019. The Property is currently zoned as "B-2," with designation of future land use as Community Mixed-Use. Access to the Property is from West Nob Hill Boulevard and South 24th Avenue, adjacent north and west, respectively, of the Property.

Until it was purchased by Tiger Oil Corporation (New Tiger) in 1987, the Property was operated by the Tiger Oil Company as a retail fuel station. New Tiger operated the Property as an Exxon-branded fuel station and convenience store from 1987 until 2001. All commercial operations ceased in 2001, and the Property has remained vacant since (Maul Foster & Alongi, Inc. [MFA], 2015). The fuel station included four underground storage tanks (USTs; one 20,000-gallon, two 10,000-gallon, and one 8,000-gallon tank) and associated product lines.

It was estimated that approximately 20,000 gallons of petroleum-related product had been released from the Property's UST system in the early 1980s. Several recovery wells had been installed by early

1983 at the Property and on adjacent parcels to the east and south. By March 1984, approximately 16,000 gallons of light non-aqueous phase liquid (LNAPL) had been extracted from the recovery wells (MFA, 2015).

Groundwater monitoring was being conducted semiannually at the Site. Figure 1 presents the location of monitoring wells at the Site. Groundwater monitoring events in 2021 indicated that LNAPL thicknesses had ranged from 0.005 to 2.79 feet within the source area at the Property and at the immediate area downgradient to the east-southeast (MFA, 2021). Figure 2 presents the estimated extent of residual LNAPL. Groundwater analytical results of the 13 compliance monitoring wells sampled during the May 2021 monitoring event indicated that gasoline-range total petroleum hydrocarbon (TPH) exceedances ranged from 1,800 micrograms per liter (µg/L) to 15,000 µg/L, above the Washington State Model Toxics Control Act (MTCA) cleanup level (CUL) of 800 µg/L (MFA, 2022). Groundwater analytical results also showed that benzene exceedances had ranged from 5.1 µg/L to 680 µg/L – above the MTCA Method A CUL of 5 µg/L.

The core of the dissolved-phase plume includes monitoring wells exhibiting the highest concentrations of gasoline-range TPH and benzene, toluene, ethylbenzene, and total xylenes (BTEX) constituents. Monitoring wells YMW-1, YMW-2, YMW-3, MW-13, and S-2 are adjacent to and/or downgradient of the area where residual petroleum-contaminated soil was not accessible during the interim remedial action (Figure 2).

Additionally, groundwater at the Property is also impacted by halogenated VOCs, typically associated with solvents from dry-cleaning operations. Groundwater at the Property exhibits detections of tetrachloroethene (PCE) at concentrations (11 µg/L to 28 µg/L) above the MTCA Method A CUL (5 µg/L). Vinyl chloride, a breakdown product of PCE, was also exhibited at concentrations (0.63 µg/L and 0.98 µg/L) above its MTCA Method A CUL (0.5 µg/L) (MFA, 2022).

It is our understanding that indoor air quality assessment at the three adjoining businesses (Xochimilco Mexican Restaurant, Barber HQ, and 1Up Games; Figure 2) to the Property has indicated the presence of gasoline-range TPH and benzene at concentrations above Ecology Indoor Air Method B Cancer CULs (MFA, 2022). PCE and trans-1,2-dichloroethene were detected at the Xochimilco Mexican Restaurant (Xochimilco), albeit below their respective Indoor Air Method B CULs.

1.2 OBJECTIVES

The primary objectives of this Report are to:

- Describe the drilling and installation of the exterior and interior vapor/vacuum monitoring points (VMPs) and vapor extraction points (VEPs) for the SSDS pilot test;
- Present the results of the SSDS pilot test to aid in the design of the most effective and cost-efficient mitigation strategy, as well as to better quantify the overall magnitude and size of the required mitigation system;
- Describe an optimum system layout, SVE well radius of influence (ROI) and well placement spacing, fan/blower specifications, the number of SVE suction points/VEPs, and the fan/blower installation location (i.e., roof/wall-mounted versus a centralized on-ground skid/shed-enclosed process equipment) for a vapor mitigation system; and

- Present the tentative plan, preliminary schedule, and initial cost estimate for implementation of the full-scale barrier SVE.

2. Site Description

2.1 SITE SETTING

The Property's physical address is 2312 West Nob Hill Boulevard in Yakima, Washington. The Property, a 0.52-acre, rectangular parcel (tax assessor parcel number 18132642051), is bordered by West Nob Hill Boulevard to the north, a Safeway Shopping Center parking lot to the east and southeast, Xochimilco to the east, the former One Love Smoke Shop to the south (now occupied by Barber HQ and 1 Up Games), and South 24th Avenue to the west (Figure 2). The Property is currently an undeveloped, vacant gravel lot.

2.2 SITE GEOLOGY AND HYDROGEOLOGY

According to previous environmental investigations conducted by MFA, the Property and vicinity have been mapped as eolian (windblown sediment) deposits. These deposits, approximately 20 feet thick, are underlain by the Thorp gravel, a moderately to highly weathered sand and gravel deposit, which has been logged to a depth of approximately 135 feet below ground surface (bgs) (Kleinfelder, 1992).

The Property is underlain by fill to approximately 9 to 12 feet bgs, and by sandy clay to silty gravel below the fill to about 16 feet bgs, where gravel is present. The matrix of the unconfined shallow aquifer appears to be interbedded sands and silts (MFA, 2019). The depth to groundwater is variable at the Site, ranging approximately from 8 to 13 feet bgs, and is influenced by seasonal fluctuations in the groundwater table due to local irrigation practices. The City indicates that the annual irrigation schedule is from April through September, which appears to impact the groundwater table, causing it to rise approximately 2 to 4 feet during the seasonal irrigation period.

The direction of groundwater flow at the Property, based on the previous consecutive quarterly groundwater monitoring events (completed from November 2015 through November 2018) and semiannual groundwater monitoring events (completed up to November 2021), is generally to the southeast with tangents to the east (MFA, 2022).

3. SSDS Pilot Test Implementation

The objectives of the SSDS pilot test were to evaluate whether SSDS was a viable and effective approach for vapor mitigation at the Property, to aid in the design of the most suitable and cost-effective vapor mitigation strategy, and to better quantify the overall magnitude and size of the required vapor mitigation system.

As discussed in more detail in this Section, the results of the pilot testing indicated that vacuum propagation in the subsurface at the Property was limited; therefore, SSDS is not a viable vapor mitigation strategy at the Site. A full-scale barrier SVE system is recommended for vapor mitigation. This system has the added benefits of mass removal and remediation of the shallow soils.

The results of the SSDS pilot test were used to finalize an optimum system layout for a full-scale barrier SVE system as well as the SVE well ROI, well placement/spacing, blower specifications, the number of SVE suction points/VEPs, and blower installation location (i.e., roof/wall-mounted versus a centralized on-ground skid/shed-enclosed process equipment), as described in Section 4.

3.1 VAPOR EXTRACTION POINT AND VAPOR/VACUUM MONITORING POINT INSTALLATION

Two VEPs and six VMPs were installed between 1 and 2 February 2023 (Appendix A). The VEPs were installed on the west side of the Xochimilco building. Two exterior VMPs and four interior VMPs were installed near and inside of the Xochimilco building. Per the work plan, the well placement was selected to maximize vapor mitigation while minimizing disturbance to the building occupants. Figure 3 shows the locations of the VEPs and VMPs, nearby monitoring wells, utilities, and the location of the rental SSDS pilot test equipment.

The approximate distances from extraction wells to VMPs are summarized as follows:

VMP	Distance (feet)
Distance to VEP-1	
VMP-1	11
VMP-2	31
VMP-3	40
VMP-4	50
VMP-5	41
VMP-6	19
Distance to VEP-2	
VMP-1	32
VMP-2	9
VMP-3	44
VMP-4	54
VMP-5	40
VMP-6	29

These distances are also presented in Figures 4 through 7.

With the exception of VMP-3 through VMP-6, the remaining VEPs and VMPs were installed using a combination drill rig, GeoProbe 7822DT, with direct-push and hollow-stem auger capabilities. During drilling activities, the borings were continuously cored and logged for lithologic information and subsurface conditions. Boring and well construction logs are included in Appendix A. A hand auger was used to auger to the total depth for VMP-3 and VMP-5. A drill was used to drill a 5/8-inch-diameter hammer bit to approximately 1 inch below the concrete slab for the installation of vapor pins VMP-4 and VMP-6.

3.1.1 Utility Clearance

The Washington Utility Notification Center (UNC) was notified of the subsurface investigation at least 48 hours prior to initiating the fieldwork. UNC contacted utility owners of record, who clearly marked the position of the underground utilities on the ground surface at the Property and near the Property boundaries.

To supplement the UNC utility mark-out, a private utility survey subcontractor was also retained to mark and clear the proposed work area for the drilling and installation of the VEPs and VMPs, both at exterior and interior areas. The proposed borings were moved to a safe distance or alternative location if a subsurface utility or anomaly was encountered. No utilities were encountered during any of the field drilling or equipment installation activities.

3.1.2 Vapor Extraction Points

Two VEPs (VEP-1 and VEP-2; Figure 3) were constructed of 2-inch polyvinyl chloride (PVC), Schedule 80 riser pipe, with 0.020-inch slotted screens from 3 to 8 feet and 4 to 9 feet bgs, respectively. VEPs were completed with traffic-rated 3-foot by 2-foot steel well vaults 1 inch above the surrounding grade, air flow control gate valves, vacuum gauges, and sampling ports. Typical VEP construction details are provided in Figure 8. A combination direct-push and hollow-stem auger drilling rig was used to first advance a 2.25-inch boring to total depth for soil logging purposes, then the 2.25-inch boring was reamed with 4 1/4-inch-inside diameter augers to construct the VEPs. The borings were then backfilled with sand, and the installation was completed on 1 February 2023. The VEPs' annular space was constructed with 2/12 Silica sand filter pack sand placed from the bottom of the boring to approximately 6 inches above the top of each screen interval (Appendix A). Approximately 2 feet of hydrated bentonite chips or pellets were placed between layers of 6 inches of sand above the screen and below the PVC casing to create a seal between the target screen intervals. Six inches of sand, 6 inches of dry granular bentonite, and 2 feet of hydrated bentonite chips or pellets were placed above the upper filter pack interval to form a transition seal. Bentonite grout was placed above the transition seal to ground surface. Each soil vapor probe location was completed with a flush-mounted, 8-inch, traffic-rated cover. Boring logs are included in Appendix A.

3.1.3 Vapor Monitoring Points

Two exterior VMPs (VMP-1 and VMP-2; Figure 3) were constructed of 1-inch PVC, Schedule 40 riser pipe, with 0.020-inch slotted screens from 3 to 8 feet bgs and 5 to 10 feet bgs, respectively. The exterior VMPs were completed with traffic-rated 6-inch by 6-inch well vaults 1 inch above the surrounding grade and sampling ports. Typical VMP construction details are provided in Figure 8.

Two interior VMPs (VMP-3 and VMP-5; Figure 3) were constructed of 1-inch PVC, Schedule 40 riser pipe, with 0.020-inch slotted screens from 2.5 to 3.5 feet bgs and include flush-mounted well completion with a traffic-rated 5-inch by 12-inch steel well monument, air flow control gate valve, vacuum gauge, and sampling port. Typical VMP construction details are provided in Figure 8. The interior VMPs were installed inside of the Xochimilco building, in the kitchen area.

Additionally, two vapor pins (VMP-4 and VMP-6; Figure 3) were constructed of stainless-steel, ¼-inch-diameter points and were installed approximately 1 inch below the building concrete slab. The vapor pins include a vapor pin, flush-mounted steel cover, air flow control gate valve, vacuum gauge, and sampling port. Typical vapor pin construction details are provided in Figure 8. VMP-4 and VMP-6 were installed inside of the Xochimilco building, in the kitchen area.

Exterior VMP-1 and VMP-2 were advanced using a combination direct-push and hollow-stem auger drilling rig to first advance a 2.25-inch boring to total depth for soil logging purposes, then the 2.25-inch boring was reamed with 4 1/4-inch-inside diameter augers to construct the VMPs. Interior VMP-3 and VMP-5 were installed using a hand auger. The borings were backfilled with sand, and the installation was completed on 2 February 2023. The VMPs' annular space was constructed with 2/12 Silica sand filter pack sand placed from the bottom of the boring to approximately 6 inches above the top of each screen interval (Appendix A). Approximately 2 feet of hydrated bentonite chips or pellets were placed between layers of 6 inches of sand above the screen and below the PVC casing to create a seal between the target screen intervals. Six inches of sand, 6 inches of dry granular bentonite, and 2 feet of hydrated bentonite chips or pellets were placed above the upper filter pack interval to form a transition seal. Bentonite grout was placed above the transition seal to ground surface. Each soil vapor probe location was completed with a flush-mounted, 5-inch, traffic-rated cover.

Vapor pins VMP-4 and VMP-6 were drilled using a 5/8-inch-diameter bit, hammer drill, and a 1 ½-inch-diameter hole was drilled to approximately 1 inch into the underlying soil, below the concrete slab. The lower end of the vapor pin assembly was placed into the drilled hole, and the vapor pin was tapped into place using a dead blow hammer. A cap was placed on the vapor pin to prevent vapor loss during the construction activities. A 1 ½-inch-diameter, stainless-steel, flush-mount cover was placed on top of each vapor pin.

3.2 SSDS PILOT TEST METHODOLOGY

This section briefly describes the equipment and general procedures used during the pilot test.

3.2.1 Description of Pilot Test Equipment

The pilot test system consisted of the following:

- A 200 standard cubic feet per minute (scfm) vacuum blower skid equipped with:
  - A Rotron three-60-Hertz, 7.5-horsepower (Hp) regenerative blower;
  - A Roots Universal RAI Rotary Positive Blower, 10-Hp regenerative blower;
  - A generator;
  - A knockout tank;
  - A condensate pump with condensate water stored in 55-gallon drums;

  - A variable frequency drive;
  - A system control panel and instrumentation;
- A heat exchanger, and
- Two 150-pound drums containing granular activated carbon (GAC) for vapor treatment.

3.2.2 Pilot Test System Configuration

The pilot SSDS was used to extract soil vapor from extraction wells VEP-1 and VEP-2. Extracted vapor was conveyed to the knockout tank at the SSDS. Entrained moisture was transferred to a 55-gallon drum for off-site disposal using a condensate pump. The extracted soil vapor was treated by a particulate air filter and two 150-pound vapor-phase GAC vessels arranged in series. The first, or lead vessel, was used for primary treatment; the second, or lag vessel, was used as a redundant treatment vessel in the event the GAC in the primary vessel reached its capacity to adsorb VOCs before the lead vessel GAC could be replaced.

3.2.3 Pilot Test Implementation

Pilot testing was performed on 21 and 22 February 2023. Extraction was tested using two different blowers—a Rotron high-flow, low vacuum blower and a Roots positive displacement blower. On 21 February 2023, pilot tests were performed by first extracting from VEP-1 then from VEP-2. Due to a lack of vacuum propagation in the subsurface, additional tests were performed by extracting from VMP-3 followed by extracting from VMP-5 using the Rotron blower under varying flow-vacuum conditions. During extraction, vacuum response was measured in the surrounding VMPs to aid in ROI calculations. During each test, the pilot test system was continually monitored and adjusted to maintain target vacuum. On 22 February 2023, pilot testing was performed by extracting first from VEP-1, followed by extracting from VEP-2, VMP-3, then VMP-5 using the Roots blower under varying flow-vacuum conditions. Detailed information about the pilot test SSDS equipment is included in Appendix B.

3.2.4 Pilot Test Data Collection

The following sections describe the data that were collected during the pilot test implementation.

3.2.4.1 Baseline Data

Baseline line data, including the following parameters, were measured at each of the VEPs (VEP-1 and VEP-2) and VMPs (VMP-1 through VMP-6):

- Vacuum in inches of water column (IWC);
- Photoionization detector (PID) readings in parts per million by volume (ppmv);
- Multi-gas/PID percent lower explosive limit (% LEL);
- Multi-gas/PID oxygen percent;
- Multi-gas/PID carbon monoxide (CO) in ppmv; and
- Multi-gas/PID hydrogen sulfide (H_2S) in ppmv.

3.2.4.2 System Operation Data Collection

Data collected during the pilot SSDS operation included:

- Data at the SSDS Unit:
  - System air flow rate (scfm);
  - Influent vapor concentrations (ppmv);
  - VEP-1 and VEP-2 total VOC concentration (ppmv);
  - Blower hertz; and
  - Dilution air valve position.
- Data at VEPs:
  - Vacuum at wellhead (inches mercury or IWC).
- Data at VMPs:
  - Vacuum at wellhead (IWC).

3.2.5 Sample Collection

In addition to field monitoring data, vapor samples were collected during the pilot test period as described below.

3.2.5.1 Soil Vapor Samples

Five soil vapor samples were collected during the pilot testing and included the following samples:

- VEP1 Flow 1, collected from the VEP-1 influent during the first flow-vacuum condition;
- Static VEP1, collected from VEP-1 while the blower was off;
- Effluent VEP1, collected from the effluent of the GAC drum;
- VEP2 Flow 1, collected from VEP-2 during the first flow-vacuum condition;
- VEP2 Flow 2, collected from VEP-2 during the second flow-vacuum condition.

All vapor samples were submitted to H&P Mobile Geochemistry Inc. for laboratory analysis of the following analytes using U.S. Environmental Protection Agency (EPA) Method TO-15 for VOCs:

- VOCs - full list;
- Gasoline-range TPH;
- Naphthalene; and
- Oxygenates.

3.3 PILOT TEST RESULTS

Results of the pilot test are included in the following sections. Field monitoring data are included in Appendix C.

3.3.1 Extraction Test

The baseline conditions at each of the VEPs and VMPs are indicated in Table 1. On 21 February 2023, extraction from VEP-1, VEP-2, VMP-3, and VMP-5 was performed using the Rotron blower (Figures 6 through 9). Extraction was first tested from VEP-1 under three flow-vacuum conditions, with applied vacuums of approximately 68, 50, and 18 IWC. The corresponding soil vapor/air extraction flow rates were approximately 25, 30, and 15 scfm, respectively.

During the extraction test, vacuum was measured at VMP-1, VMP-2, VEP-2, VMP-3, VMP-4, VMP-5, and VMP-6, but no vacuum was exhibited at any of the monitoring points during the extraction test at VEP-1.

Extraction from VEP-2 was then tested using the Rotron blower under three flow-vacuum conditions, with the blower at 100 percent, 25 percent, and 50 percent capacity. The applied vacuums were approximately 42, 25, and 15 IWC, corresponding to air flow rates of 35, 24, and 18 scfm, respectively. During the first flow-vacuum condition extraction from VEP-2, vacuum was measured at VMP-1, VMP-2, VEP-1, VMP-3, VMP-4, VMP-5, and VMP-6. No vacuum was exhibited at any of the monitoring points, except for VMP-2, which exhibited vacuums ranging from -0.1 to -0.3 IWC. These vacuums are within the range exhibited at VMP-2 during the baseline data collection and are considered very low. Because VMP-2 was the closest monitoring point to VEP-2 and exhibited very low vacuum during the second and third flow-vacuum conditions, the pilot test team assumed that vacuum exhibited at farther monitoring points would be effectively zero and did not collect vacuum measurements at these points. Because the extraction tests at VEP-1 and VEP-2 were ineffective and did not result in any vacuum propagation to nearby monitoring points, additional extraction tests were performed at VMP-3 and VMP-5.

Extraction at VMP-3 was performed with applied vacuums of approximately 80, 43, and 55 IWC. Very low vacuum ranging from -0.05 to -0.1 IWC was measured at the nearest monitoring point (VMP-4), and no vacuum was measured at any other monitoring points. Extraction at VMP-5 was then performed with applied vacuums of approximately 30, 16, and 35 IWC, corresponding to flow rates of approximately 25, 16, and 30 scfm, respectively. Similarly, to the earlier extraction tests, low vacuum (0.1 IWC) was measured at the nearest monitoring point (VMP-3), and no vacuum was measured at any of other monitoring points. The measurements collected during extraction tests using the Rotron blower are indicated in Appendix C, Tables 2 through 5. Non-zero vacuum measurements are summarized in the table below.

Test Well (Rotron Blower)	Vacuum at Test Well (IWC)	Vacuum at Monitoring Points (IWC)
VMP-2 (9.44 feet from test well to VMP)		
VEP-2	43.3	–0.2
	41.5	–0.3
	25.7	–0.1
	15.8	–0.1
VMP-4 (11.03 feet from test well to VMP)		
VMP-3	81.2	–0.1
	42.9	–0.05
	55.5	–0.05
VMP-3 (10.16 feet from test well to VMP)		
VMP-5	36.8	0.1
	35.7	0.1

On 22 February 2023, extraction was tested from VEP-1, VEP-2, VMP-3, and VMP-5 using the Roots blower. Extraction was performed from VEP-1 at an applied vacuum of approximately 88 IWC, which corresponds to a flow rate of 50 scfm. No vacuum was measured at the nearest monitoring point (VMP-1); therefore, vacuum measurements were not collected at any other monitoring points.

Extraction was then performed from VEP-2 at an applied vacuum of approximately 75 IWC which corresponds to a flow rate of 55 scfm. Very low vacuum of -0.3 IWC was observed at the nearest monitoring point (VMP-2), and no vacuum was observed at the next nearest monitoring point (VEP-1). Therefore, vacuum measurements were not collected at any other monitoring points.

Extraction was then performed from VMP-3 at an applied vacuum of 90 IWC and 190 IWC, corresponding to air flow rates of 17 and 33 scfm, respectively. Vacuum measurements were collected only from the three nearest monitoring points (VMP-4, VMP-5, and VMP-6). No vacuum was observed in any monitoring points during the first flow condition, and only very low vacuum of -0.1 IWC was observed at the VMP-4 during the second flow condition.

Finally, extraction was tested from VMP-5 under applied vacuum of approximately 65 IWC, and very low vacuum (0.1 IWC) was observed at VMP-3. Non-zero vacuum measurements are summarized in the table below.

Test Well (Roots Blower)	Vacuum at Test Well (IWC)	Vacuum at Monitoring Points, IWC (Distance from Test Well to Monitoring Point, feet)
VMP-2 (9.44 feet)		
VEP-2	74.5	–0.3
VMP-4 (11.03 feet)		
VMP-3	194.5	–0.1
VMP-3 (10.16 feet)		
VMP-5	72.2	0.1

3.3.2 Radius of Influence Modeling Results

Select pilot test data was utilized to perform ROI estimation calculations using two methods. Since the pilot test data collected during testing at the vapor extraction point VEP-2 using both the Roots and the Rotron blowers showed consistent subsurface vacuum response at the nearby monitoring points, data sets from these two tests were used in the ROI estimation calculations. Using the system data and vacuum response data at the surrounding vapor monitoring probes located at various distances from VEP-2, a linear regression model was used to calculate the SVE well ROI at the applied vacuums of 74.5 IWC (Roots Blower test) and 43.3 IWC (refer to Section 3.3.2.1). Pneumatic modeling using a two-dimensional pneumatic model MDFIT™ was also performed to verify the calculated ROI using the linear regression model and to calculate subsurface pore vapor/air velocity, and pore vapor/air volume exchange rates at a depth of 8.5 feet bgs (refer to Appendix D and Section 3.3.2.2). The depth of 8.5 feet bgs was selected for modeling simulation since this represent the mid-point of the vapor extraction point well screen interval (6 to 11 feet bgs).

3.3.2.1 Radius of Influence Estimation Using Linear Regression

For the linear regression model, EPA and Johnson and Ettinger indicated an effective vacuum response is between 0.1 or 1.0 IWC (EPA, 1994; Johnson and Ettinger, 1994). A threshold vacuum response of 0.1 IWC was selected for this application to ensure vacuum influence at the boundary condition of the ROI. Readings collected from VEP-1, VMP-1, VMP-2, VMP-3, and VMP-5 were used in the calculation, as readings collected from VMP-4 and VMP-6 did not exhibit any response throughout the pilot testing most likely given the subsurface low permeability and heterogeneity in that area/zone. The calculated ROI for each vacuum condition are shown in the table below; the ROI calculations using linear regression model are included in Appendix D.

Applied Vacuum at VEP-2 (IWC)	Estimated ROI Using Linear Regression Depth interval (6 to 11 feet bgs)
43.3 (Rotron Blower)	20 feet
74.5 (Roots Blower)	21 feet

3.3.2.2 Radius of Influence Estimation Using MDFIT™ Pneumatic Modeling

The field data and the Site observations collected during the pilot test activities were used as inputs to the MDFIT™ pneumatic model, which simulates air flow field in an unsaturated zone and determines the correlation between applied vacuum and vapor/air extraction flow rate at the test well and the resultant subsurface vacuum propagation, vapor/air flow rate (i.e., pore vapor/air velocity), and pore vapor/air volume exchange rates at varying distances from the test well. The MDFIT™ pneumatic model was used to determine the Site-specific subsurface pneumatic parameters (i.e., heterogeneity, anisotropy, air intrinsic permeability, vacuum propagation, and pore volume exchanges) required to design the full-scale SSDS capable of effectively mitigating the potential vapor intrusion inside the adjacent buildings. The proposed full-scale SSDS's key design parameters, as determined based on the pilot test, linear regression model, and MDFIT™ pneumatic modeling results include vapor extraction well ROI, well spacing, and the required vapor extraction wellhead flow rates and vacuums.

Initially, the results of the pilot testing were used as the input parameters to MDFIT™ to estimate the Site-specific air intrinsic permeability of the target unsaturated zone soils. Multiple vapor/air extraction flow rates and applied vacuum conditions during pilot testing were used in MDFIT™ to estimate, as well as calibrate, the air intrinsic permeability outputs of the model. A comprehensive array of vapor/air extraction flow conditions (i.e., low to high) was tested to adequately understand the pneumatic characteristics of the target media in the test area. The calculated average air intrinsic permeability value of the target unsaturated zone soils was also compared with the literature permeability values for the silty sand/sandy silt (with sand and gravel layers) target lithology. A conservative range of the selected air intrinsic permeability values of the target unsaturated zone soils was then used to estimate and model the achievable ROI of the proposed SSDS at varying vapor/air extraction flow rates via MDFIT™.

The above-mentioned computations were performed using MDFIT™ through several systematic steps, including the estimation of the target unsaturated zone air intrinsic permeability and anisotropy, the calibration of air intrinsic permeability, and the simulation of Site-specific subsurface pneumatic characteristics (i.e., achievable ROI, vacuum propagation, subsurface pore vapor/air velocity, and pore vapor/air volume exchange rates). Each step is discussed in further detail herein. The MDFIT™ pneumatic modeling steps and simulation results are included in Appendix D.

<u>Estimation of Air Intrinsic Permeability</u>
A preliminary estimate of the air intrinsic permeability in both the lateral (Kr) and vertical (Kz) directions of the target unsaturated zone, as well as the gravel upper confining layer (Kc), was computed for the pilot test area. Estimations of heterogeneity and anisotropy of the target unsaturated zone were also considered as part of this step. These estimations were performed using the vacuum-flow relationships that were derived from the pilot test results at the test area. The model also took into account Site-specific characteristics, including subsurface temperature, unsaturated zone thickness, and depth to groundwater. The initial estimates of the target unsaturated zone air intrinsic permeability were consistent with the pilot test observations. A summary of these estimates along with the MDFIT™ model output files are included in Appendix D. The initial estimate of the target unsaturated zone average air intrinsic permeability was 8.78E-08 square centimeters (cm^2).

<u>Comparison of the Estimated Air Intrinsic Permeability with the Literature Values</u>
Following the initial estimation of air intrinsic permeability for the target unsaturated zone, these estimated values were compared with the literature permeability values for the silty sand/sandy silt (with sand and gravel layers) target lithology (i.e., Kr = horizontal air intrinsic permeability range = 5E-08 to 5E-06 cm^2 – Literature Reference: "Groundwater" Handbook by Freeze and Cherry, 1979, Table 2-2, page 29). The model estimated average Kr value (8.78E-08 cm^2) matched closely with the lower range (5E-08 cm^2) of the literature permeability values.

<u>Selected Air Intrinsic Permeability Values for the Design Simulation Runs</u>
As a result of the model estimated air intrinsic permeability values (for the target unsaturated zone) comparison with the literature permeability values (for the silty sand/sandy silt [with sand and gravel layers] target lithology), the following overall representative air intrinsic permeability values for both the target unsaturated zone and upper confining gravel layer were selected for the design modeling simulation runs.

Estimated Air Intrinsic Permeabilities		
Horizontal Air Intrinsic Permeability, Kr	5E-08 to 5E-06 cm^2	Silty Sands/Sandy Silts (with Sand and Gravel Layers)
Vertical Air Intrinsic Permeability, Kz	1E-08 to 1E-06 cm^2	Silty Sands/Sandy Silts (with Sand and Gravel Layers)
Upper (Surface) Confining Gravel/Dirt Layer Air Intrinsic Permeability, Kc	1E-09 to 1E-08 cm^2	Gravel/Dirt

Design MDFIT™ Pneumatic Modeling Simulation Runs

Using the above-described air intrinsic permeability values, model simulations were performed at a design vapor/air extraction flow rate of 50 scfm (achievable vapor/air extraction flow rate at a reasonable applied vacuum during February 2023 pilot testing) to simulate subsurface vacuum and pore vapor/air velocity propagation. Design vacuum propagation, pore vapor/air velocity propagation, and pore vapor/air volume exchange rate curves at depth interval between 6 and 11 feet bgs are included in Appendix D.

Similar to the linear regression method, a threshold vacuum response of 0.1 IWC was selected for this application to ensure vacuum influence at the boundary condition of the ROI. The estimated ROI values at the 8.5-foot bgs depth interval for the selected range of air intrinsic permeability values are summarized in below table. The depth of 8.5 feet bgs was selected for modeling simulation since this represent the mid-point of the vapor extraction point well screen interval (6 to 11 feet bgs).

Model Simulated Applied Vacuum (IWC)	**Air Intrinsic Permeability Values Range**			**Estimated ROI Using MDFIT™ Modeling Depth Interval 8.5 feet bgs**
	Kr	**Kz**	**Kc**	
178.59	5E-08 cm^2	1E-08 cm^2	1E-08 cm^2	**10 to 20***
16.83	5E-07 cm^2	1E-07 cm^2	1E-08 cm^2	35
1.83	5E-06 cm^2	1E-06 cm^2	1E-08 cm^2	30
229	5E-08 cm^2	1E-08 cm^2	1E-09 cm^2	60
18.78	5E-07 cm^2	1E-07 cm^2	1E-09 cm^2	>95
2.01	5E-06 cm^2	1E-06 cm^2	1E-09 cm^2	90
Notes: ** Conservative range of ROI selected for design.*				

Estimated Subsurface Pore Vapor/Air Volume Exchanges and Pore Vapor/Air Velocity

SSDS well placement is based upon the predicted ROI of the vapor extraction wells. For typical SVE systems with the remedial objective of constituent of concern (COC) mass removal, ROI is the maximum distance from a single SVE well where a minimum amount of air flushing occurs. The minimum air flushing rate is typically expressed as a pore vapor/air volume exchange rate per year. Based on our experience for the types of COCs being treated (primarily gasoline-range TPH and BTEX) and the target lithology (silty sand/sandy silt), an overall air flushing design target of at least 5,000 to 10,000 pore volume exchanges per year (PV/year) is recommended to be achieved at the SVE well ROI. The estimated subsurface PV/year pore vapor/air velocity values at the 8.5-foot bgs depth interval and at the varying distances from the extraction well for the range of air intrinsic permeability values modeled are provided in Appendix D and summarized in below table (for a conservatively selected SVE well ROI of approximately 10 to 20 feet [e.g., SSDS well spacing of approximately 20 to 40 feet on center]).

ROI (feet)	Estimated Pore Vapor/Air Volume Exchanges Per Year (PV/Year)	Estimated Pore Vapor/Air Velocity (feet/sec)
10	25,302	4.43E-03
20	278	7.19E-05

3.3.3 Laboratory Analytical Results

Tabulated soil vapor samples laboratory analytical results are presented in Table 2. The laboratory report is included in Appendix E.

3.3.3.1 Vapor-Phase Analytical Results

Three soil gas samples were collected in association with VEP-1 during the pilot testing, using the Roots blower (10-Hp), and extraction from VEP-1. The samples include the following:

- A soil gas sample (VEP1 Flow 1-20230222) was collected during the extraction at VEP-1 with the flow vacuum condition of dilution valve at 100 percent closed, and the blower at maximum capacity;
- A static soil gas sample (Static VEP1-20230222) was also collected at VEP-1 with the blower shut off; and
- An effluent sample (Effluent VEP1-20230222) was collected at the GAC units during the extraction at VEP-1.

Two soil gas samples were collected in association with VEP-2 during the pilot testing, using the Roots blower (10-Hp), and extraction from VEP-2. The samples include the following:

- A soil gas sample (VEP2 Flow 1-20230222) was collected during the first flow extraction at VEP-2, with the flow vacuum condition of dilution valve at 100 percent closed, and the blower at maximum capacity;
- A second soil gas sample (VEP2 Flow 2-20230222) was collected during the second flow extraction at VEP-2.

The vapor sampling results are summarized in Table 2 and included in Appendix E, and vapor sampling results show that:

- The main VOC measured in vapor samples with the blower on was gasoline-range TPH which ranged from 1,000,000 micrograms per cubic meter (μg/m^3) to 2,500,000 μg/m^3. Toluene and m,p-xylenes were measured in the second flow VEP-2 sample only, at 11,000 μg/m^3 and 8,900 μg/m^3. No other VOCs were detected in vapor samples collected with the blower on. Due to high dilutions required for analysis of TPH, reporting limits for analytes that were not detected ranged from 400 μg/m^3 to 34,000 μg/m^3.
- VOCs measured in the vapor sample from VEP-1 collected with the blower was shut off included gasoline-range TPH (170,000 μg/m^3), 1,2,4-Trimethylbenzene (41 μg/m^3), 2-butanone (also known as methyl ethyl ketone; 19 μg/m^3), benzene (1.7 μg/m^3), ethylbenzene (170 μg/m^3),

m,p-Xylenes (570 µg/m^3), o-xylene, (84 milligrams per cubic meter [mg/m^3]), and toluene (830 µg/m^3).

3.3.3.2 *Vapor-Phase Mass Removal Rates*

The vapor-phase mass removal rate was determined using the analytical data collected from VEP-1 and VEP-2 during the extraction tests using the Rotron blower on 22 February 2023. Mass removal calculations are presented in Table 3. Average flow rates were multiplied by the flow durations to determine the volume of extracted vapors from VEP-1 and VEP-2, and each volume was multiplied by the respective total VOC concentrations to estimate the total mass removed during the extraction tests.

The mass removal rates in VEP-1 and VEP-2 calculated using analytical data were 0.01 and 0.02 pounds, respectively. The relatively small mass removal rates are a function of the limited duration for the extraction tests, which lasted for 37 minutes and 57 minutes for VEP-1 and VEP-2, respectively. The mass removals calculated during the extraction tests were used to estimate daily mass removal rates that could be expected under similar conditions over 24 hours of continuous extraction. The calculated daily mass removal rates from VEP-1 and VEP-2 are 0.36 and 0.59 pounds per day, respectively.

3.3.4 Permit Compliance

Due to the pilot testing nature of this test and the extracted soil vapor was treated by a particulate air filter and two 150-pound vapor-phase GAC vessels, Ecology had concluded that an air quality permit was not necessary.

3.4 WASTE MANAGEMENT

Investigation-derived waste (IDW) such as equipment wash and rinse water and soil cuttings were placed into 55-gallon Department of Transportation (DOT)-approved drums and temporarily stored on Site. The drums were sealed, labeled, and stored on Site pending receipt and evaluation of analytical results. All IDW will be disposed as non-hazardous waste.

3.5 VARIANCES FROM THE APPROVED PROPOSAL

The field activities were performed in accordance with the approved pilot test Proposal (Haley and Aldrich, 2022). There were no variances from the approved Proposal during the pilot testing.

3.6 SSDS PILOT TEST CONCLUSIONS AND RECOMMENDATIONS

Conclusions and results from the pilot testing and subsequent ROI calculations/modeling are summarized below:

- The estimated ROI at depth interval of 6 to 11 feet bgs based on the linear regression method at 43.3 and 74.5 IWC applied vacuum yielded 20 feet and 21 feet, respectively.
- A conservative range of ROI at depth interval of 6 to 11 feet bgs based on the MDFIT™ pneumatic modeling was estimated to be 10 to 20 feet.
- Based on the MDFIT™ pneumatic modeling, the estimated PV/year at a conservatively estimated vapor extraction well ROI range of 10 to 20 feet were approximately 25,302 (PV/year) and 278 (PV/year), respectively.

- Based on the subsurface vacuum propagation response measurements taken during pilot testing, a conservative ROI of 9.44 feet (rounded to 10 feet) was observed where at least the selected threshold vacuum response of 0.1 IWC was achieved. Therefore, this conservative ROI of 10 feet was selected for the design of the full-scale vapor intrusion mitigation system for the Site.
- Total inlet extraction air flow rate during extraction testing ranged from 15 to 55 scfm at applied casing vacuums ranging from 15 to 190 IWC.
- Estimated daily mass removal rates from VEP-1 and VEP-2 were 0.36 and 0.59 pounds per day, respectively.

The pilot test results showed that little to no vacuum was observed at VMPs under any of the flow conditions tested with either blower. Given the lack of vacuum propagation in the subsurface during the pilot test, conventional SSDS is not an effective technique for vapor mitigation at the Site.

It is therefore recommended that a barrier SVE system is installed outside of the two adjoining buildings housing the Xochimilco building and Barber HQ and 1Up Video for vapor mitigation. Using a barrier SVE system has the added benefit of providing mass removal and shallow soil remediation while also providing vapor intrusion mitigation for the two adjoining buildings and thereby protecting human health.

4. Proposed Barrier SVE Design and Implementation Plan

This section of the Report presents the proposed barrier SVE design based on the results of the February 2023 SSDS pilot test, the implementation plan for construction of the proposed barrier SVE system, and the proposed barrier SVE implementation schedule. The planning level initial engineering cost estimate will be presented under separate cover in a Technical Memorandum.

4.1 OVERALL DESIGN BASIS AND APPROACH

The results of the February 2023 SSDS pilot test and the subsequent analysis (i.e., ROI estimation using the Linear Regression and MDFIT™ pneumatic modeling methods) as presented in Section 3 were used to finalize the design basis for the barrier SVE system for the Site.

The overall mitigation approach for the Site consists of barrier SVE to mitigate vapor intrusion from shallow groundwater and sub-slab soil into the indoor air of the adjacent three businesses and to remediate the source through vapor-phase mass removal. The proposed barrier SVE will consist of a blower that draws vapors from the soil beneath the building through vapor extraction wells/points and discharges the vapors to the atmosphere through a series of pipes. The system is designed to extract vapors that migrate from the source area to the adjacent buildings and vent them to the atmosphere, preventing vapors from entering the buildings where they could pose a threat to human health.

Key design elements and parameters of the proposed SVE/vapor mitigation system as well as the plan for construction and implementation are outlined in the subsequent sections of this Report.

4.2 PERMITTING AND SITE PREPARATION ACTIVITIES

4.2.1 Health and Safety

Prior to the start of field activities, the Site-specific Health and Safety Plan (HASP) will be updated to address potential health and safety concerns for the proposed field activities. The HASP will be prepared in accordance with the Washington State Department of Labor and Industries, Division of Occupational Safety and Health requirements and the United States Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulations 1910.120, Hazardous Waste Operations and Emergency Response. All contractors will be responsible for the health and safety of their own employees.

4.2.2 Permitting, Site Access, and Site Clearance

The proposed barrier SVE includes active process equipment components and GAC units for the treatment of extracted soil vapors; therefore, it will need to be permitted by Ecology prior to initiation of the SVE system startup and operational activities.

Haley & Aldrich will coordinate with the City and Ecology to discuss and request access for working and drilling at the adjoining parking lots to the Property.

Haley & Aldrich's subcontractor will obtain a building permit and an electrical permit from the City prior to initiating installation of the SVE process equipment container that is planned to be located at the southeastern corner of the Property. The electrical power requirement for the SVE process equipment will necessitate complete installation of the electrical pole (electrical power drop) that will also require planning and coordination with Thunder Electric and Pacific Power and permits from the City.

Encroachment permits may be needed and obtained from the City for installation of limited below-grade SVE conveyance piping and the SVE process equipment container at the southeastern corner of the Property.

Haley & Aldrich will mark each of the planned VEP and VMP installation location at the Property and notify the underground utility service alert (i.e., Washington Utility Notification Center Call at 811) prior to the start of drilling activities. The SVE conveyance piping trench locations will also be marked at the Site and notified to the underground utility service alert prior to the start of trench excavation activities. Each boring and piping trench location will be screened and cleared for utilities by a private utility locator and cleared to a depth of approximately 5 feet bgs as a final check for subsurface utilities.

All field activities will be coordinated with the property owner (Heyden Properties, LLC), the City, and the Ecology Site Manager, as well as the three adjoining businesses (Xochimilco, Barber HQ, and 1Up Games) to the Site, and the subcontractors. The City and Ecology will be notified prior to the start of field activities.

4.3 DRILLING/WELL INSTALLATION

This section provides the conceptual design details for installation of the VEPs and VMPs, as well as the details of the drilling subcontractor's scope of services, role, and responsibilities for drilling and installation of the wells associated with the SVE. The scope for the well drilling and installation activities consists of underground utility clearance, drilling, installation of VEPs and VMPs, and the proper disposal of all IDW resulting from these activities. The required well drilling and installation activities are to be completed per the design specifications described herein. All drilling and well installation work shall be performed by a Washington licensed driller.

4.3.1 Well Radius of Influence and Proposed Well Locations

The barrier SVE well placement is based upon the ROI of the VEPs installed for the SVE pilot test. Based on the on-site and off-site extent and distribution of the COCs, soil vapor concentrations, groundwater impacts, indoor air COC concentration exceedance locations at the three adjoining businesses to the Site, and the observed and modeled/estimated vapor extraction well ROI of 10 feet (equivalent to a center-to-center well spacing design of approximately 20-feet on center), the SVE design consists of a total of 12 vertical VEP locations, two of which were installed for the SSDS pilot test (VEP-1 and VEP-2). The locations of existing VEP-1 and VEP-2 as well as the locations of the 10 additional proposed VEP locations are shown on Figure 9. In addition to the 12 vertical VEP locations, 13 total VMPs will be installed, including the six VMPs already installed during the SSDS pilot test. The VEPs will be screened from approximately 6 to 11 feet bgs, and the VMPs will be screened from approximately 5 to 10 feet bgs. Typical SVE well (extraction point) construction details are shown on Figure 8. The final well depths and locations will be adjusted and determined during well installation activities based on the field conditions.

The need and feasibility of installing horizontal SVE wells instead of the previously proposed vertical SVE wells was also evaluated. Based on the observed relatively higher vacuum requirements at the pilot test extraction wells, observed limited well ROI, and the potential for horizontal well screens to be clogged with shallow perched groundwater (i.e., infiltration water accumulating within the horizontal well screen low points and the encasing coarse and porous well filter pack material) under the applied high extraction well vacuum conditions, the use of horizontal SVE wells is not recommended for the Site-specific conditions.

4.3.2 Design Well Depth Intervals and Well Materials of Construction

The proposed VEPs and VMPs will be installed as follows:

- For the VEPs, underlying soil conditions will be logged from 0 to 12 feet bgs. Continuous soil cores will be collected using a split spoon sampler (or equivalent). Soil cores will be examined visually for geological characteristics and logged, by a Project Geologist. A combination direct-push and hollow-stem auger drilling rig (truck- or track-mounted) will be used to first advance a 2.25-inch-diameter boring to 12 feet for soil logging purposes, then ream the boring with 6-inch or 8-inch-diameter augers to construct the VEP.
- The VEPs will be constructed using a 2-inch-diameter, PVC Schedule 80 casing and one 5-foot-long PVC Schedule 80, machine-slotted, well screen (0.020-inch slot) with # 2 filter pack sand placed from the bottom of the boring to approximately 6 inches above the top of each screen interval (Figure 8). VEPs will be screened at approximately 6 to 11 feet bgs.
- Six inches of dry granular bentonite, and 2 feet of hydrated bentonite chips or pellets will be placed above the upper filter pack interval to form a transition seal. Cement-bentonite grout will be placed above the transition seal to ground surface.
- All VEP casing risers will be sealed with a 3-foot-diameter geomembrane/well borehole seal near the surface completion location at approximately 3 feet bgs.
- All VEPS will be completed with a 3-feet (long) by 2-feet (wide) by 2.5-feet deep flush-mounted, traffic-rated, precast steel vault/road box with lockable watertight lid.
- For each VEP, a 2-inch-diameter PVC Schedule 80 transition tee fitting will be installed at the well casing within the well vault at approximately 2 feet bgs to connect the well casing to the below grade SSDS conveyance piping.
- For each VEP, an air-water tight well casing cap and well controls including a sample port, a vacuum gauge, and a gate valve will be installed at the top of well casing within the well vault.
- The VMPs will be installed using direct-push technology to an approximate depth of 11 feet bgs.
- The VMPs will be constructed using a 1-inch-diameter, PVC Schedule 40 casing and one 5-foot-long PVC Schedule 40, machine-slotted, well screen (0.020-inch slot) with # 2 filter pack sand placed from the bottom of the boring to approximately 6 inches above the top of each screen interval (Figure 8). The VMPs will be screened at approximately 5 to 10 feet bgs.
- Six inches of dry granular bentonite, and two feet of hydrated bentonite chips or pellets will be placed above the upper filter pack interval to form a transition seal. Cement-bentonite grout will be placed above the transition seal to ground surface.
- All VMPs will be completed with a 6-inch, flush-mounted, traffic rated cover/well box.
- For each VMP, an air-water tight well casing cap (with a lockable plug) and a sample port will be installed at the top of well casing within the well box.

The location of the VEPs and VMPs will be professionally surveyed with coordinates reported as longitude and latitude relative to North American Datum of 1983. The ground surface and top-of-casing elevation will be surveyed relative to North American Vertical Datum of 1988.

IDW generated during drilling and well installation activities, such as equipment wash and rinse water and soil cuttings will be placed into 55-gallon DOT-approved drums and temporarily stored on Site. The waste will be characterized and disposed of within approximately 90 days once the drilling activities have been completed.

4.4 TRENCHING AND CONVEYANCE PIPING CONSTRUCTION

This section provides the details of the general contractor's scope of services, role, and responsibilities for the construction of the barrier SVE. The scope for the general construction activities consists of underground utility clearance, trenching, construction of the below-grade SVE conveyance piping, and installation of VEPs wellhead assemblies and well vaults. The SVE conveyance piping and VEP well vault construction activities are to be completed per the design specifications described herein. All SVE construction work shall be performed by a Washington-licensed general contractor.

Below-grade conveyance piping and trenching will be used to connect VEPs to the SVE process equipment. The SVE process equipment will be housed in a container that is planned to be located at the Property. An aboveground manifold will connect the SSDS conveyance lines from the VEP wellfield to the process equipment. Individual branch lines (2-inch PVC, Schedule 80 pipes) will run from the main SVE conveyance lines (4-inch PVC, Schedule 80 pipes) to each VEP wellhead. The proposed VEP locations, below-grade conveyance piping layout, and process equipment container location are shown on Figure 9. As shown on Figure 9, the system design consists of a total of two main conveyance lines (conveyance piping Legs A and B) as follows:

- Leg A connects the process equipment to the six VEPs located at the former Xochimilco building.
- Leg B connects the process equipment to the six VEPs wells located at the Barber HQ and 1Up Games businesses.

All below-grade conveyance piping (main lines and individual branch lines) will be installed in trenches. Below grade trenching and piping will consist of:

- Trenches will be approximately 2.5 to 3 feet deep and approximately 1 to 1.5 feet wide. The majority of trenching will need to be performed at locations that are currently covered with gravel-finished surface, with some trenching will be performed at the current hardscaped (asphalt parking lot) areas. Asphalt saw-cutting will be performed at areas with hardscape (asphalt parking lot) finished surface prior to initiating trench excavation activities.
- The total trenching length is estimated to be approximately 380 feet, of which approximately 120 feet are located at the current hardscaped (asphalt parking lot) areas and approximately 260 feet are located at the current gravel-covered finished surface areas.
- All individual VEP wellhead branch lines will be constructed of 2-inch-diameter PVC Schedule 80 piping and fittings and the main SVE conveyance lines will be constructed of 4-inch-diameter PVC Schedule 80 piping and fittings.

- The connection between the branch lines and the VEP wellheads will be provided at the precast steel vault/road box locations with the use of a 2-inch-diameter, vacuum-rated flexible hose (KANAFLEX™ or LANDTEC™ or approved equivalent).
- All spoils (i.e., asphalt and soil) from the trenching work will be placed into roll-off containers supplied by the contractor and temporarily stored on Site. The spoils will be characterized and disposed of within 90 days once the trenching activities have been completed.
- Following completion of the below-grade piping installation marking/warning tape (with tracing wire) will be installed over the pipe and trenches will be backfilled with a certified clean fill material or with the native soil backfill material (if deemed suitable) and compacted.
- Following completion of the trench backfilling activities, all areas will be restored to their original conditions; asphalt parking lot and surfaces that were cut for trenching will be reconstructed and restored to their original thickness and finish. All gravel covered areas will also be restored to their original conditions, as applicable, and surface finish.

4.5 SVE PROCESS EQUIPMENT

This section provides the details of the equipment supplier/fabricator's scope of services, role, and responsibilities for the fabrication and delivery of the process equipment for the SVE. The scope of work for the process equipment fabrication activities consists of the procurement, fabrication, assembly, testing, and delivery of all process equipment, and associated equipment enclosure, to the Site. The scope also includes the technical labor support (for one field day) required during the system shakedown and startup to test the functionality of the system's process equipment and instrumentation. The process equipment fabrication activities are to be completed per the design specifications described herein.

New or used SVE process equipment will be installed at the Site in a container/shed or a temporary equipment trailer meeting the design specifications as provided in this section will be used. The SVE process equipment will be equipped with the capacity to extract vapors at approximately 50 scfm per well at an applied wellhead vacuum of approximately 3 to 4 inches Mercury (Hg) (total air flow rate capacity of approximately 600 scfm at approximately 5 inches Hg or 68 inches water [H_2O] vacuum measured at the inlet of the blower skid; factoring in the pipe air flow frictional head losses and the design safety factor). A schematic of the proposed SVE process equipment is provided in Figure 10. The SVE process equipment will primarily consist of:

- Two regenerative blowers, with variable frequency drives (VFDs), assembled and manifolded in parallel, each with an air flow rate capacity of approximately 300 scfm (total combined air flow rate capacity of approximately 600 scfm) at approximately 5 inches Hg or 68 inches H_2O vacuum measured at the inlet of the blowers;
- One dilution air valve;
- One inline particulate filter;
- One 100-gallon capacity air moisture separator with demister;
- One water/condensate transfer pump rated for 10 gallons per minute flow capacity at a total discharge pressure head capacity of 50 feet;
- One flame arrestor;

- Two 500- to 1,000-pound GAC units (depending upon the select blower sizing), in series (housed outside of the equipment container), to be sized by the equipment supplier based on the SVE design total air flow rate and anticipated low levels of vapor concentrations in the system influent;
- A heat exchanger, if needed based upon the selected blowers air discharge temperature (housed outside of the equipment container);
- Silencers, if needed, based on noise generated by the blowers and the effectiveness of noise dampening measures that can be installed in the container or trailer;
- One 20-foot-long air discharge stack constructed of a 6-inch diameter PVC Schedule 40 solid pipe with supports (housed outside of the equipment container);
- Valves, instrumentation, and controls, as required; and
- One Programable Logic Controller (PLC) with telemetry capabilities or a telemetry system with cell phone autodialer.

The SVE process equipment, instrumentation, and wiring associated with the enclosure will be constructed to Class I, Division II Standards. All equipment for the Class I, Division II skids or enclosure shall be constructed of the non-incendive, non-sparking, purged/pressurized, hermetically sealed, or sealed device types as per National Fire Protection Association (NFPA) National Electric Code (NEC) and standards (e.g., NFPA 70 and NFPA 496) and Underwriter Laboratories (UL) 1604 standards. Automatic controls will be provided to protect the process equipment. Process gauges/indicators will be provided as required to monitor the performance of each system. The equipment will be configured in accordance with all manufacturers' required specifications for all process monitoring devices (e.g., flow meters).

All equipment will have Hand/Off/Auto (HOA) switches and panel lights to indicate operational status. Alarm indicator lights with first-fault lockout will be provided for all major equipment and process sensors/switches. If any shutdown due to an alarm condition occurs, the operator will be notified via the cell phone autodialer (via phone, fax, and/or email). The operational status of the SVE and the system/process analog data (i.e., air flow rate, vacuum, pressure, and temperature readings) will be monitored remotely via a telemetry system installed in the main system control panel. The main control panel for the SVE will be located inside of the preassembled enclosure and will be constructed to National Electrical Manufacturer Association (NEMA) 4X standards. Both the autodialer and telemetry system will be equipped with battery backup.

The equipment container will be constructed to the following minimum specifications:

- Conformance to all state (Washington) and local (City) building and safety codes, as applicable.
- Connections for electrical, SVE system influent piping, SVE blowers discharge/effluent manifold to the outside heat exchanger (if required) and GAC units.
- Ventilation fan(s) and automatic and manually controlled louvered vents.
- Minimum of one man-door with holdbacks and an access door for equipment repairs/ maintenance.
- Noise control will include installation of noise dampening material as required to prevent nuisance noise.

- Electricity will be supplied to the equipment container via an overhead connection. The electrical service is anticipated to be 480/230-volt, 3-phase, 100 ampere (amp) power drop; however, these specifications will be finalized upon receipt of the equipment design specifications from the equipment vendor.

4.6 MECHANICAL AND ELECTRICAL CONNECTIONS

The SVE equipment installation will include setup and field connections of equipment that has been pre-fabricated by an equipment vendor. Qualified mechanical and electrical subcontractors will be contracted for the field piping and manifold/electrical connections.

4.6.1 Mechanical Connections

This section provides the details of the general contractor's scope of services, role, and responsibilities after the drilling, trenching, and SVE conveyance piping construction activities have been completed and the SVE process equipment container has been delivered to the Site. The scope for the general construction activities during this phase consists of placement of the process equipment trailer on Site and all required final mechanical connections at the process equipment container including:

- SVE aboveground manifold construction near the process equipment container;
- Connection of the SVE below-grade conveyance piping to the aboveground manifold;
- Connection of the aboveground manifold to the equipment container inlet piping;
- Connection of the heat exchanger (if required) and GAC units to the equipment container using flexible hoses (to be provided by the equipment supplier);
- Installation and connection of a 20-foot-long, 6-inch-diameter PVC Schedule 40 vertical air discharge stack; and
- Installation of a chain-linked fence (approximately 80 linear feet) around the equipment container and associated access gates; one standard man gate and one 12-foot-wide chain linked fence gate for carbon changeouts.

All SVE construction work shall be performed by a Washington-licensed general contractor.

4.6.2 Electrical Connections

This section provides the details of the electrical contractor's scope of services, role, and responsibilities for providing main power drop to the SVE process equipment. The scope for the electrical work consists of completion of required permit(s), coordination with the local utility provider (Pacific Power), installing a new electric power drop at the Site, powering the SVE process equipment control and electrical panel(s), and making final electrical connections to the process equipment. The scope also includes the technical labor support (for one field day) required during the system shakedown and startup to test all the electrical connections and control wire connections. The electrical work is to be completed per the design specifications described herein. All electrical work shall be performed by a Washington-licensed electrician.

Power service for the proposed SVE process equipment is required to be 480/230-volt, 3-phase, 100 amp (subject to changed based upon the actual size of the process equipment provided by the equipment fabricator). Note that there is an existing power pole on the north side of Barber HQ. We may be able to obtain the power drop from this existing pole or from some other nearby pole located at the City's right-of-way. Haley & Aldrich will verify this with the City's electricians. It is estimated that the distance between the City' power pole (or the existing pole located north side of Barber HQ) to the temporary new pole to be located at the southeast corner of the former Tiger Oil facility is approximately 150 feet.

The materials and equipment to be supplied by the electrical contractor include:

- An electrical meter to be procured from the utility company.
- An electrical disconnect panel rated for a 100-amp electrical service.
- Appropriately sized insulated electrical wiring installed within a watertight conduit, to be run below grade from the temporary electrical pole and rise aboveground near the SVE process equipment enclosure control panel to provide 480/230-volt electrical service. It is estimated that the distance between the temporary electrical pole and the SVE process equipment is approximately 20 feet.
- The subcontractor shall provide all equipment necessary to properly, safely, and efficiently perform all required activities to complete the installation and inspection of the required electrical wiring to carry the 480/230-volt, 3-phase, 100 amp, five-wire electrical service from the Site electrical drop to the process equipment control panel.

The electrical work will include the following items:

- Mobilization to the Site for a pre-construction meeting and discussion of health and safety procedures.
- Completion of a utility survey and underground utility service alert (i.e., Washington Utility Notification Center Call at 811) by the electrical contractor prior to starting any intrusive activities.
- Coordination with the local utility provider (Pacific Power) for the on-Site power drop and provision of support during the installation of the required electrical service/pole and an electrical meter.
- Procure a Washington State Department of Labor and Industries (L&I) electrical permit for electrical services prior to installing the permanent electrical drop, electrical panel, system control panel, and any electrical process equipment/instrumentation.
- The required electrical wiring to carry the 480/230-volt, 3-phase, 100 amp, five-wire electrical service (subject to changed based upon the actual size of the process equipment provided by the equipment fabricator) shall be run below grade in a conduit from the electrical meter located on the electrical service/pole installed on-site to the process equipment container. The process equipment container will be placed no further than 20 feet from the electrical service/pole installed on Site. If determine necessary, an additional electrical pole may be installed on Site. The proposed location of the SVE equipment enclosure is depicted on Figure 9. The location of the electrical drop and electrical service pole will be determined following coordination with Pacific Power.
- All electrical wiring run below grade must be installed below the site frost line (i.e., 2.5 feet below grade) and installed within water-tight conduit. All electrical conduits will be leak-tested

to ensure it is air and water-tight. A demarcation barrier shall also be installed above all below-grade electrical conduit before backfilling. A secondary conduit shall also be installed in parallel with the required conduit below grade and caped aboveground for future use, if required.

- The electrical service, once run to the process equipment container, must be wired and connected to the electrical control panel(s) within the container, powering the container and the process equipment within.
- A schematic of the proposed SVE process equipment is provided in Figure 10. The final sizing of the process equipment, final piping and instrumentation diagrams (P&IDs), and the equipment and control panel electrical wiring diagram will be provided by the process equipment fabricator.
- All SVE process equipment, instrumentation, and system main electrical breakers and system control panel(s) are to be provided by the equipment fabricator within a pre-assembled process equipment container with some loose components (i.e., heat exchanger, GAC and GAC hoses). All electrical instrumentation and wiring inside the control panel will be marked and properly labeled by the equipment fabricator so that the final connections and terminations, if any, can be provided in the field by the electrical contractor. This task includes installation of any necessary wiring connections between the process equipment and instrumentation, the power panel(s), and the control panel(s).
- Facilitate and attend the final electrical inspection from the local township electrical inspector.
- One day of equipment shakedown and startup support to inspect and test all the electrical connections and control wire connections.

4.7 STARTUP

Following the completion of all construction activities and before the system startup is initiated, an equipment shakedown and pre-startup inspection will be performed by the Haley & Aldrich team to verify mechanical and electrical functionality of all unit processes, system controls, and fail-safe mechanisms and to ensure that all individual automation and safety controls are functional. The equipment shakedown is intended to individually test each system’s inherent safety features as well as mechanical performance. Any electrical problems encountered during the pre-startup inspection, shakedown, and testing will be addressed by the electrician and equipment fabricator, as applicable, prior to the startup and optimization of the system. Prior to the startup of the barrier SVE system, an operations, maintenance, and monitoring (OM&M) plan, documenting the system operational procedures, monitoring program, and routine and non-routine maintenance and repair protocols, will be prepared and submitted to the City and Ecology for approval.

4.8 TENTATIVE PROJECT SCHEDULE

The proposed barrier SVE will be implemented after receiving approvals from the City and Ecology. The preliminary schedule proposed for each of the key tasks is listed below. The anticipated schedule is contingent upon the approval of the SVE Implementation Work Plan from the City and Ecology.

Event/Task	Duration	Anticipated Timeline
Permitting and Site Preparation Activities	8 weeks	March to April 2024
Drilling/Well Installation	2 weeks	April 2024
Trenching and Conveyance Piping Construction	2 weeks	April to May 2024
Process Equipment Procurement	12 weeks	June to August 2024
Mechanical and Electrical Connections	4 weeks	August 2024
SVE Startup	1 week	August to September 2024
System OM&M Initiation	---	October 2024

5. Conclusions

This Report presents the conceptual design, implementation plan, and schedule for the barrier SVE vapor mitigation system based on the results of the February 2023 SSDS pilot test and subsequent analysis (i.e., ROI estimation using the Linear Regression and MDFIT^{TM} pneumatic modeling methods). Key results and conclusions are summarized below:

- The results of the February 2023 SSDS pilot test indicated that vacuum propagation in the subsurface at the Property is negligible to very low; therefore, a conventional SSDS is not an effective vapor mitigation approach at the Site. As a result, a barrier SVE system is proposed to mitigate vapors at the Site and remediate shallow soil.
- A conservatively estimated ROI of 10 feet is used as the design basis for the proposed barrier SVE well network.
- The proposed final barrier SVE design consists of 12 vertical SVE well and 13 VMP locations. These locations were selected based on the known on-Site and off-property extent of the COC impacts in soil, soil gas, and groundwater, the ease of access of a drill rig at the off-property locations, and the logistics and constructability of the SVE conveyance piping.

6. Limitations

All data, findings, observations, and recommendations are based solely upon Site conditions in existence at the time of performance of services. Haley & Aldrich is unable to report on, or accurately predict events that may impact the Site following conduct of the described services, whether occurring naturally or caused by external forces. Services hereunder were performed in accordance with our agreement and understanding with, and solely for the use of the City and Ecology. Haley & Aldrich assumes no responsibility for conditions we were not authorized to investigate, or conditions not generally recognized as environmentally unacceptable at the time services were performed. We are not responsible for the subsequent separation, detachment, or partial use of this document. Any reliance on this Report by a third party shall be at such party's sole risk.

References

1. Freeze, R.A. and Cherry, J.A., 1979. Groundwater. Prentice-Hall, Inc., Englewood Cliffs, Vol. 7632, 604 pp.
2. Johnson and Ettinger, 1994. *Considerations for the Design of In Situ Vapor Extraction Systems: Radius of Influence vs. Zone of Remediation.* August.
3. Kleinfelder, Inc., 1992. *RI/FS Work Plan, Tiger Oil Facility, West Nob Hill Boulevard and South 24th Avenue, Yakima, Washington*. 29 January.
4. Maul Foster & Alongi, Inc., 2015. *Groundwater Monitoring Plan, former Tiger Oil Site, Yakima, Washington*. 26 August.
5. Maul Foster & Alongi, Inc., 2019. *Draft Final High-Resolution Site Characterization Report, former Tiger Oil Site, Yakima, Washington*. 22 March.
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7. Maul Foster & Alongi, Inc., 2022. *Draft Semiannual Groundwater Monitoring Report – November 2021, former Tiger Oil Site, Yakima, Washington*. 22 March.
8. U.S. Environmental Protection Agency, 1994. *Soil Vapor Extraction Treatment Technology Resource Guide*. EPA 542-B-94-007. September.

TABLES

TABLE 1
SSDS PILOT TEST FIELD MONITORING BASELINE DATA
FORMER TIGER OIL WEST NOB HILL BOULEVARD SITE
YAKIMA, WASHINGTON

Project No: 0204793-000 Task 04

Test Well: none

Date: 2/21/2023 - 2/22/2023

Weather: cold (27° F), windy, sunny

Field Instrumentation Models & Calibration:

Multi-Gas Meter with PID #1 = MultiRAE Lite

Multi-Gas Meter with PID #2 = N.A.

Digital Manometer = Dwyer Series 477B Handheld Digital Manometer

Pitot Tube = N.A.

Air Velocity Meter = N.A.

Field Instrumentation Baseline Readings:

Multi-Gas Meter with PID #1 = MultiRAE Lite

Multi-Gas Meter with PID #2 = N.A.

Digital Manometer = Dwyer Series 477B Handheld Digital Manometer

Pitot Tube = N.A.

Air Velocity Meter = N.A.

Reading	Monitoring Points (Initial Reading) - February 21, 2023										Monitoring Points (Final Reading) - February 22, 2023							
	VEP-1 (0 ft) [SI= 3' - 8']		VMP-1 (11.03 ft) [SI= 3' - 8']	VMP-2 (30.72 ft) [SI= 5' - 10']		VEP-2 (21.28 ft) [SI= 4' - 9']	VMP-3 (22.06 ft) [SI= 2.5' - 3.5']	VMP-4 (41.52 ft) [vapor pin]	VMP-5 (29.30 ft) [SI= 2.5' - 3.5']	VMP-6 (10.80 ft) [vapor pin]	VEP-1 (0 ft) [SI= 3' - 8']	VMP-1 (11.03 ft) [SI= 3' - 8']	VMP-2 (30.72 ft) [SI= 5' - 10']	VEP-2 (21.28 ft) [SI= 4' - 9']	VMP-3 (22.06 ft) [SI= 2.5' - 3.5']	VMP-4 (41.52 ft) [vapor pin]	VMP-5 (29.30 ft) [SI= 2.5' - 3.5']	VMP-6 (10.80 ft) [vapor pin]
Time	0950	0955	0915	1006	1010	1002	0915	1015	1021	1030	1506	1421	1413	1418	1428	1430	1433	1425
Vacuum (IWC)	-0.3	-0.3	-0.2	-0.3	-0.3	0	-0.2	-0.4	-0.2	-0.2	0	0	0	0	0	0	0	0
PID - TVOCs (ppmv)	45	49	3	368	370	62	3	56	11	7	35	6	76	12	9	3	21	3
PID/Multi-Gas %LEL	0	0	0	19	19	0	0	0	0	0	0	0	0	0	0	0	0	0
PID/Multi-Gas O2 (%)	20.9	20.9	20.9	20.3	19.7	20.9	20.9	19.1	13.2	18.6	20.2	20.4	20.4	20.6	20.2	20.2	19.5	20.1
PID/Multi-Gas CO (ppmv)	0	0	0	13	13	0	0	0	0	0	0	0	0	0	0	0	0	0
PID/Multi-Gas H2S (ppmv)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes:
SSDS: Sub-Slab Depressurization System
LEL: Lower Explosive Limit %
ft/min - feet/minute
%LEL = percent lower explosive limit
inHg = inch of mercury
IWC = inches of water column
ppmv = part per million

TABLE 2
SUMMARY OF SOIL GAS ANALYTICAL RESULTS
SSDS PILOT TEST
FORMER TIGER OIL WEST NOB HILL BOULEVARD SITE
YAKIMA, WASHINGTON

Location Name	Effluent VEP1	VEP1		VEP2	
Sample Name	Effluent VEP1-20230222	Static VEP1-20230222	VEP1 Flow 1-20230222	VEP2 Flow 1-20230222	VEP2 Flow 2-20230222
Sample Date	02/22/2023	02/22/2023	02/22/2023	02/22/2023	02/22/2023
Lab Sample ID	E303001-03	E303001-05	E303001-02	E303001-01	E303001-04
Field Comment	-	blower was shut off	-	-	second flow
Volatile Organic Compounds (µg/m3)					
1,1,1,2-Tetrachloroethane	2.8 U	56 U	2000 U	2000 U	3400 U
1,1,1-Trichloroethane	2.2 U	44 U	2000 U	2000 U	3400 U
1,1,2,2-Tetrachloroethane	2.8 U	56 U	2000 UJ	2000 UJ	3400 UJ
1,1,2-Trichloroethane	2.2 U	44 U	2000 U	2000 U	3400 U
1,1-Dichloroethane	1.6 U	33 U	2000 U	2000 U	3400 U
1,1-Dichloroethene	1.6 U	32 U	2000 U	2000 U	3400 U
1,2,4-Trichlorobenzene	7.5 U	150 U	2000 U	2000 U	3400 U
1,2,4-Trimethylbenzene	3	41	2000 U	2000 U	3400 U
1,2-Dibromoethane (Ethylene Dibromide)	3.1 U	62 U	2000 U	2000 U	3400 U
1,2-Dichlorobenzene	2.4 U	49 U	2000 U	2000 U	3400 U
1,2-Dichloroethane	1.6 U	33 U	400 U	400 U	690 U
1,2-Dichloropropane	1.9 U	37 U	2000 U	2000 U	3400 U
1,2-Dichlorotetrafluoroethane (CFC 114)	2.8 U	56 U	-	-	-
1,3,5-Trimethylbenzene	2 U	40 U	2000 U	2000 U	3400 U
1,3-Dichlorobenzene	21	49 U	2000 U	2000 U	3400 U
1,4-Dichlorobenzene	2.4 U	49 U	2000 U	2000 U	3400 U
2-Butanone (Methyl Ethyl Ketone)	19	1900	10000 U	10000 U	17000 U
2-Hexanone (Methyl Butyl Ketone)	3.3 U	66 U	10000 U	10000 U	17000 U
4-Ethyltoluene (1-Ethyl-4-Methylbenzene)	2 U	40 U	-	-	-
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	3.3 U	140	10000 U	10000 U	17000 U
Benzene	1.7	22	400 U	400 U	690 U
Bromodichloromethane	2.7 U	54 U	2000 U	2000 U	3400 U
Bromoform	4.2 U	84 U	2000 U	2000 U	3400 U
Bromomethane (Methyl Bromide)	1.6 U	32 U	2000 U	2000 U	3400 U
Carbon disulfide	1.3 U	25 U	2000 U	2000 U	3400 U
Carbon tetrachloride	1.3 U	26 U	400 U	400 U	690 U
Chlorobenzene	1.9 U	37 U	400 U	400 U	690 U
Chloroethane	1.1 U	21 U	2000 UJ	2000 UJ	3400 UJ
Chloroform (Trichloromethane)	1 U	20 U	400 U	400 U	690 U
Chloromethane (Methyl Chloride)	1.5	17 U	2000 U	2000 U	3400 U
cis-1,2-Dichloroethene	1.6 U	32 U	2000 U	2000 U	3400 U
cis-1,3-Dichloropropene	1.8 U	37 U	2000 U	2000 U	3400 U
Dibromochloromethane	3.5 U	69 U	2000 U	2000 U	3400 U
Dichlorodifluoromethane (CFC-12)	4 U	80 U	2000 U	2000 U	3400 U
Diisopropyl ether (DIPE)	3.4 U	68 U	4000 U	4000 U	6900 U
Ethylbenzene	3.1	170	2000 U	2000 U	3400 U
Hexachlorobutadiene	11 U	210 U	2000 U	2000 U	3400 U
m,p-Xylenes	17	570	2000 U	2000 U	8900
Methyl Tert Butyl Ether (MTBE)	2.9 U	58 U	2000 U	2000 U	3400 U
Methylene chloride (Dichloromethane)	1.4 U	28 U	2000 U	2000 U	3400 U
Naphthalene	2.1 U	42 U	400 U	400 U	690 U
o-Xylene	5.1	84	2000 U	2000 U	3400 U
Styrene	1.7 U	35 U	2000 U	2000 U	3400 U
Tert-Amyl Methyl Ether (TAME)	3.4 U	68 U	4000 U	4000 U	6900 U
Tert-Butyl Alcohol (tert-Butanol)	6.1 U	120 U	20000 U	20000 U	34000 U
Tert-Butyl Ethyl Ether (ETBE)	3.4 U	68 U	4000 U	4000 U	6900 U
Tetrachloroethene	2.8 U	55 U	400 U	400 U	690 U
Toluene	29	830	4000 U	4000 U	11000
Total Petroleum Hydrocarbons (C5-C12)	640	170000	1700000	1000000	2500000
trans-1,2-Dichloroethene	1.6 U	32 U	2000 U	2000 U	3400 U
trans-1,3-Dichloropropene	1.8 U	37 U	2000 U	2000 U	3400 U
Trichloroethene	2.2 U	44 U	400 U	400 U	690 U
Trichlorofluoromethane (CFC-11)	6.1	45 U	2000 U	2000 U	3400 U
Trifluorotrichloroethane (Freon 113)	3.1 U	62 U	2000 U	2000 U	3400 U
Vinyl chloride	0.5 U	10 U	200 U	200 U	340 U

Notes:
µg/m3: micrograms per cubic meter
J: Value is estimated
SSDS = sub-slab depressurization system
U: not detected, value is the laboratory reporting limit

TABLE 3
MASS REMOVAL CALCULATIONS
SSDS PILOT TEST
FORMER TIGER OIL WEST NOB HILL BOULEVARD SITE
YAKIMA, WASHINGTON

VEP	Average Flow Rate (scfm)	Flow Duration (minutes)	Total VOC Concentration (µg/m3)[1]	Mass removed (lbs)	Pounds per day (estimated)
VEP-1	23	37	1,700,000	0.01	0.36
VEP-2	26	57	2,519,900	0.02	0.59

Notes:
[1]Concentration in VEP-1 determined in sample VEP1Flow1-20230222, collected with blower on; Concentration in VEP-2 determined in sample VEP2Flow2-20230222, collected under second flow condition
lbs - pounds
scfm - standard cubic feet per minute
µg/m3 - micrograms per cubic meters
VEP - vapor extraction point

FIGURES

LEGEND

- GROUNDWATER MONITORING NETWORK WELL
- MONITORING WELL
- SENTRY MONITORING WELL
- FORMER TIGER OIL FACILITY PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. ASSESSOR PARCEL DATA SOURCE: YAKIMA COUNTY
3. SITE DATA SOURCE: MAUL FOSTER & ALONGI, INC., 2016
4. AERIAL IMAGERY SOURCE: NEARMAP, 11 MAY 2021

N

0 50 100
SCALE IN FEET

HALEY ALDRICH

CITY OF YAKIMA
FORMER TIGER OIL WEST NOB HILL BOULEVARD SITE
YAKIMA, WASHINGTON

FORMER TIGER OIL
SITE PLAN

JUNE 2023

FIGURE 1

LEGEND

- GROUNDWATER MONITORING NETWORK WELL
- MONITORING WELL
- SENTRY MONITORING WELL
- ESTIMATED RESIDUAL EXTENT OF LNAPL, HALEY & ALDRICH, 2022
- FORMER TIGER OIL FACILITY PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. LNAPL = LIGHT NON-AQUEOUS PHASE LIQUID
3. ASSESSOR PARCEL DATA SOURCE: YAKIMA COUNTY
4. SITE DATA SOURCE: MAUL FOSTER & ALONGI, INC., 2016
5. AERIAL IMAGERY SOURCE: NEARMAP, 11 MAY 2021

N

0 50 100
SCALE IN FEET

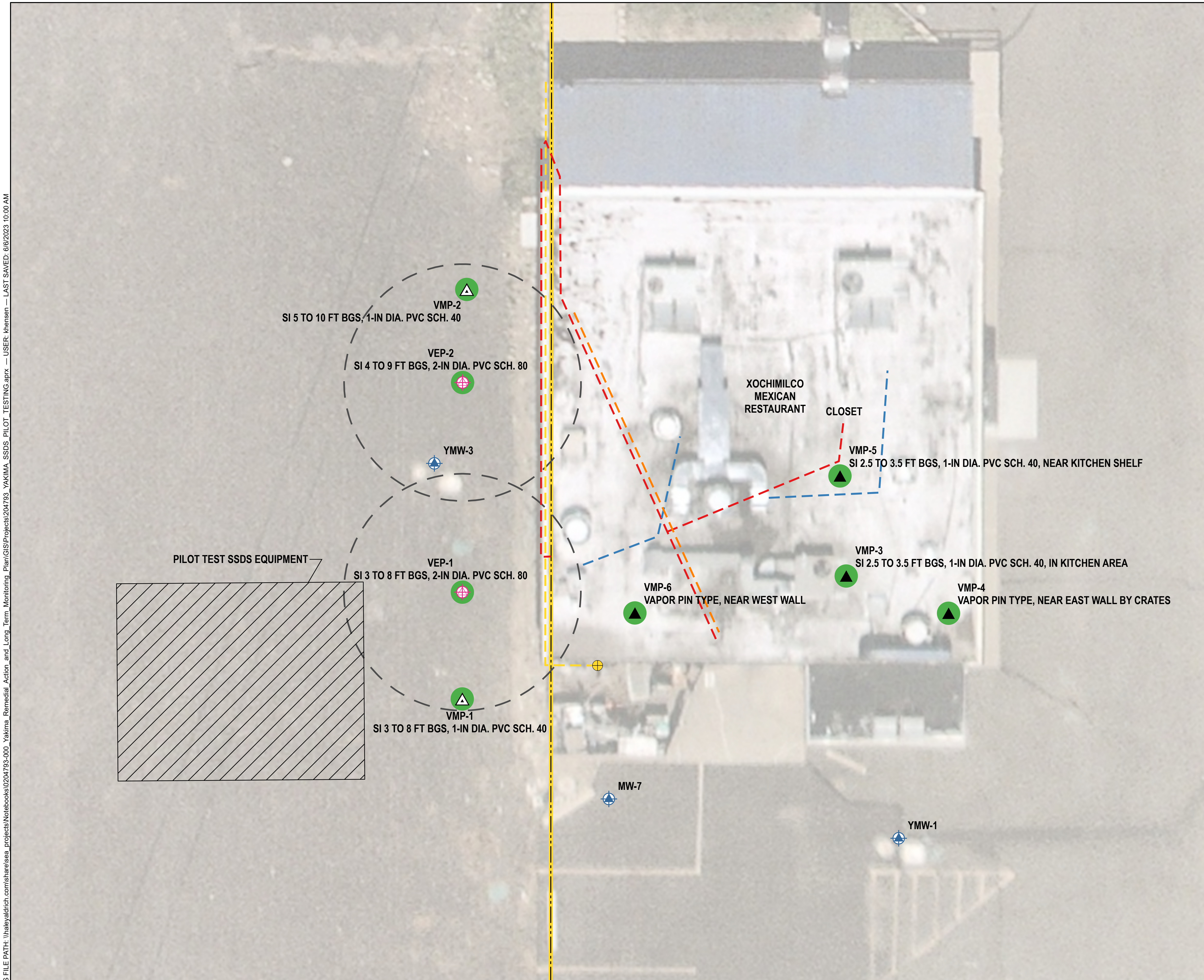
HALEY ALDRICH

CITY OF YAKIMA
FORMER TIGER OIL WEST NOB HILL BOULEVARD SITE
YAKIMA, WASHINGTON

ESTIMATED EXTENT OF RESIDUAL LNAPL

JUNE 2023

FIGURE 2



LEGEND

- GAS METER
- SSDS SUCTION/VAPOR EXTRACTION POINT (VEP)
- GROUNDWATER MONITORING NETWORK WELL
- INTERIOR VAPOR/VACUUM MONITORING POINT (VMP)
- EXTERIOR VAPOR/VMP
- SSDS PILOT TEST WELL NETWORK

UTILITY TYPE

- COMMUNICATION
- ELECTRICAL
- GAS
- WATER
- LOCATION OF THE RENTAL PILOT TEST EQUIPMENT AND CHAIN-LINKED FENCE
- 10-FT VAPOR EXTRACTION RADIUS OF INFLUENCE (ROI)
- FORMER TIGER OIL FACILITY PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. ABBREVIATIONS:
BGS = BELOW GROUND SURFACE
FT = FEET/FOOT
DIA. = DIAMETER
PVC = POLYVINYL CHLORIDE
SCH = SCHEDULE
SSDS = SUB-SLAB DEPRESSURIZATION SYSTEM
SI = SCREEN INTERVAL
VEP = VAPOR EXTRACTION POINT
VMP = VAPOR MONITORING POINT
3. FORMER TIGER OIL FACILITY SITE BOUNDARY AND WELL DATA SOURCE: MAUL FOSTER & ALONGI, INC., 2016
4. ASSESSOR PARCEL DATA SOURCE: YAKIMA COUNTY
5. AERIAL IMAGERY SOURCE: NEARMAP, 14 JULY 2022

N

0 10 20
SCALE IN FEET

HALEY ALDRICH

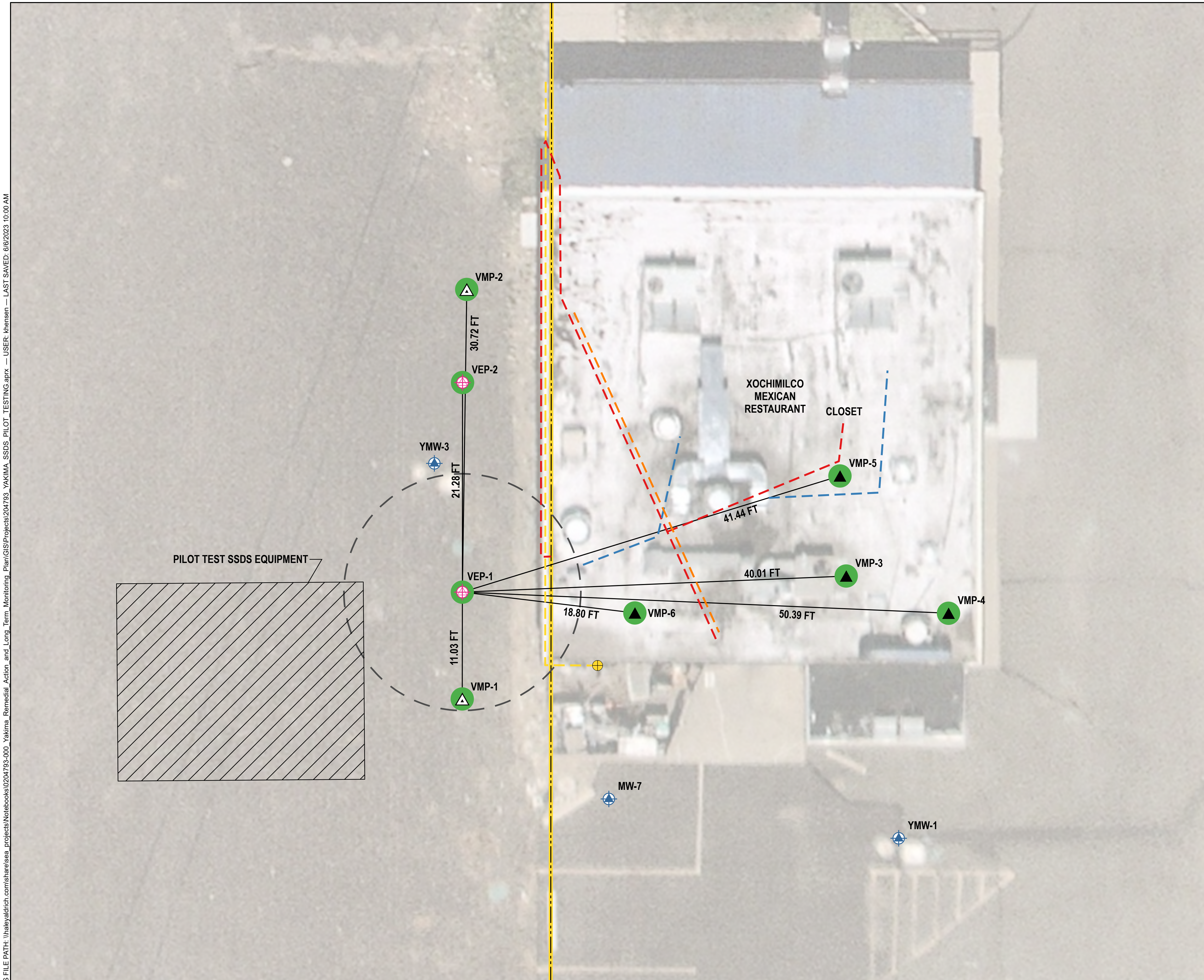
CITY OF YAKIMA
FORMER TIGER OIL WEST NOB HILL BOULEVARD SITE
YAKIMA, WASHINGTON

SSDS PILOT TEST VEP AND VMP LOCATIONS

JUNE 2023

FIGURE 3

GIS FILE PATH: \\haleyaldrich.com\share\sea_projects\Notebooks\0204793-000_Yakima_Remedial_Action_and_Long_Term_Monitoring_Plan\GIS\Projects\204793_YAKIMA_SSDS_PILOT_TESTING.aprx — USER: khensen — LAST SAVED: 6/6/2023 10:00 AM



LEGEND

- GAS METER
- SSDS VEP
- GROUNDWATER MONITORING NETWORK WELL
- INTERIOR VMP
- EXTERIOR VMP
- SSDS PILOT TEST WELL NETWORK

UTILITY TYPE

- COMMUNICATION
- ELECTRICAL
- GAS
- WATER
- LOCATION OF THE RENTAL PILOT TEST EQUIPMENT AND CHAIN-LINKED FENCE
- 10-FT VAPOR EXTRACTION RADIUS OF INFLUENCE (ROI)
- FORMER TIGER OIL FACILITY PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.

2. ABBREVIATIONS:
BGS = BELOW GROUND SURFACE
FT = FEET/FOOT
DIA. = DIAMETER
PVC = POLYVINYL CHLORIDE
SCH = SCHEDULE
SSDS = SUB-SLAB DEPRESSURIZATION SYSTEM
VEP = VAPOR EXTRACTION POINT
VMP = VAPOR MONITORING POINT

3. FORMER TIGER OIL FACILITY SITE BOUNDARY AND WELL DATA SOURCE: MAUL FOSTER & ALONGI, INC., 2016

4. ASSESSOR PARCEL DATA SOURCE: YAKIMA COUNTY

5. AERIAL IMAGERY SOURCE: NEARMAP, 14 JULY 2022

N

0 10 20
SCALE IN FEET

HALEY ALDRICH

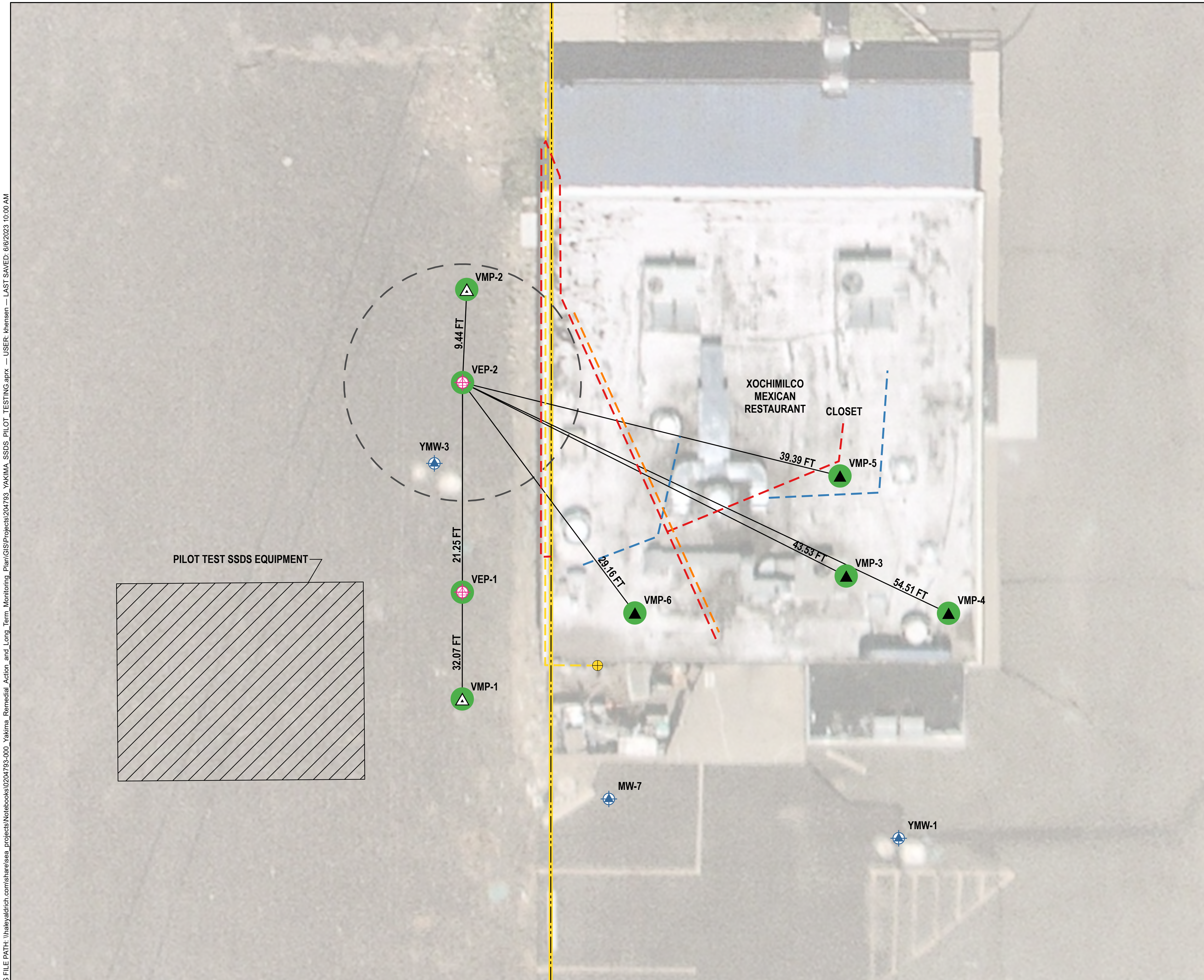
CITY OF YAKIMA
FORMER TIGER OIL WEST NOB HILL BOULEVARD SITE
YAKIMA, WASHINGTON

SSDS PILOT TEST LOCATIONS
EXTRACTION FROM VEP-1

JUNE 2023

FIGURE 4

GIS FILE PATH: \\haleyaldrich.com\share\sea_projects\Notebooks\0204793-000 Yakima Remedial Action and Long Term Monitoring Plan\GIS\Projects\204793 YAKIMA SSDS PILOT TESTING.aprx — USER: khensen — LAST SAVED: 6/6/2023 10:00 AM



LEGEND

- GAS METER
- SSDS VEP
- GROUNDWATER MONITORING NETWORK WELL
- INTERIOR VMP
- EXTERIOR VMP
- SSDS PILOT TEST WELL NETWORK

UTILITY TYPE

- COMMUNICATION
- ELECTRICAL
- GAS
- WATER
- LOCATION OF THE RENTAL PILOT TEST EQUIPMENT AND CHAIN-LINKED FENCE
- 10-FT VAPOR EXTRACTION RADIUS OF INFLUENCE (ROI)
- FORMER TIGER OIL FACILITY PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.

2. ABBREVIATIONS:
BGS = BELOW GROUND SURFACE
FT = FEET/FOOT
DIA. = DIAMETER
PVC = POLYVINYL CHLORIDE
SCH = SCHEDULE
SSDS = SUB-SLAB DEPRESSURIZATION SYSTEM
VEP = VAPOR EXTRACTION POINT
VMP = VAPOR MONITORING POINT

3. FORMER TIGER OIL FACILITY SITE BOUNDARY AND WELL DATA SOURCE: MAUL FOSTER & ALONGI, INC., 2016

4. ASSESSOR PARCEL DATA SOURCE: YAKIMA COUNTY

5. AERIAL IMAGERY SOURCE: NEARMAP, 14 JULY 2022

N

0 10 20
SCALE IN FEET

HALEY ALDRICH

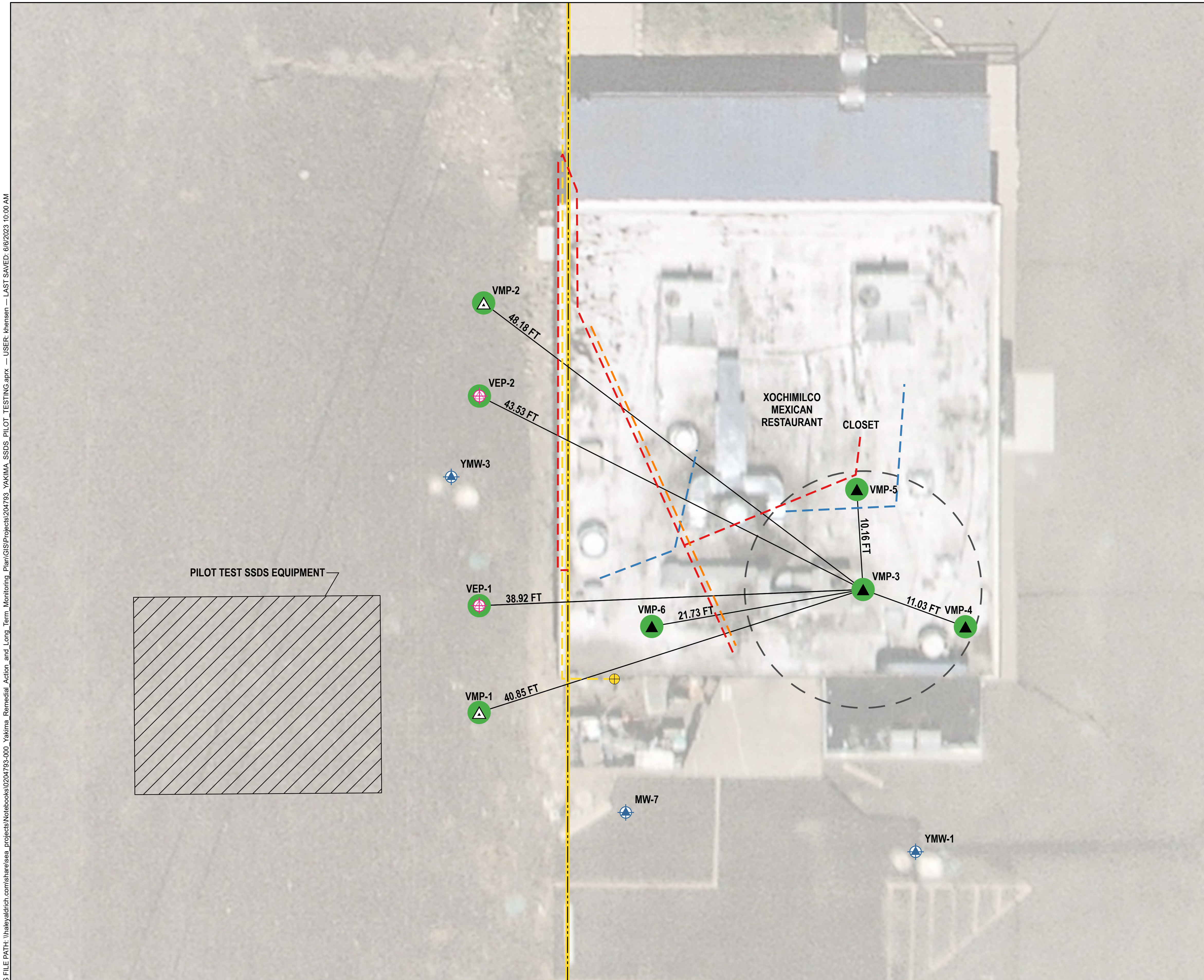
CITY OF YAKIMA
FORMER TIGER OIL WEST NOB HILL BOULEVARD SITE
YAKIMA, WASHINGTON

SSDS PILOT TEST LOCATIONS
EXTRACTION FROM VEP-2

JUNE 2023

FIGURE 5

GIS FILE PATH: \\haleyaldrich.com\share\sea_projects\Notebooks\0204793-000_Yakima_Remedial_Action_and_Long_Term_Monitoring_Plan\GIS\Projects\204793_YAKIMA_SSDS_PILOT_TESTING.aprx — USER: khensen — LAST SAVED: 6/6/2023 10:00 AM



LEGEND

- GAS METER
- SSDS VEP
- GROUNDWATER MONITORING NETWORK WELL
- INTERIOR VMP
- EXTERIOR VMP
- SSDS PILOT TEST WELL NETWORK

UTILITY TYPE

- COMMUNICATION
- ELECTRICAL
- GAS
- WATER
- LOCATION OF THE RENTAL PILOT TEST EQUIPMENT AND CHAIN-LINKED FENCE
- 10-FT VAPOR EXTRACTION RADIUS OF INFLUENCE (ROI)
- FORMER TIGER OIL FACILITY PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.

2. ABBREVIATIONS:
BGS = BELOW GROUND SURFACE
FT = FEET/FOOT
DIA. = DIAMETER
PVC = POLYVINYL CHLORIDE
SCH = SCHEDULE
SSDS = SUB-SLAB DEPRESSURIZATION SYSTEM
VEP = VAPOR EXTRACTION POINT
VMP = VAPOR MONITORING POINT

3. FORMER TIGER OIL FACILITY SITE BOUNDARY AND WELL DATA SOURCE: MAUL FOSTER & ALONGI, INC., 2016

4. ASSESSOR PARCEL DATA SOURCE: YAKIMA COUNTY

5. AERIAL IMAGERY SOURCE: NEARMAP, 14 JULY 2022

N

0 10 20
SCALE IN FEET

HALEY ALDRICH

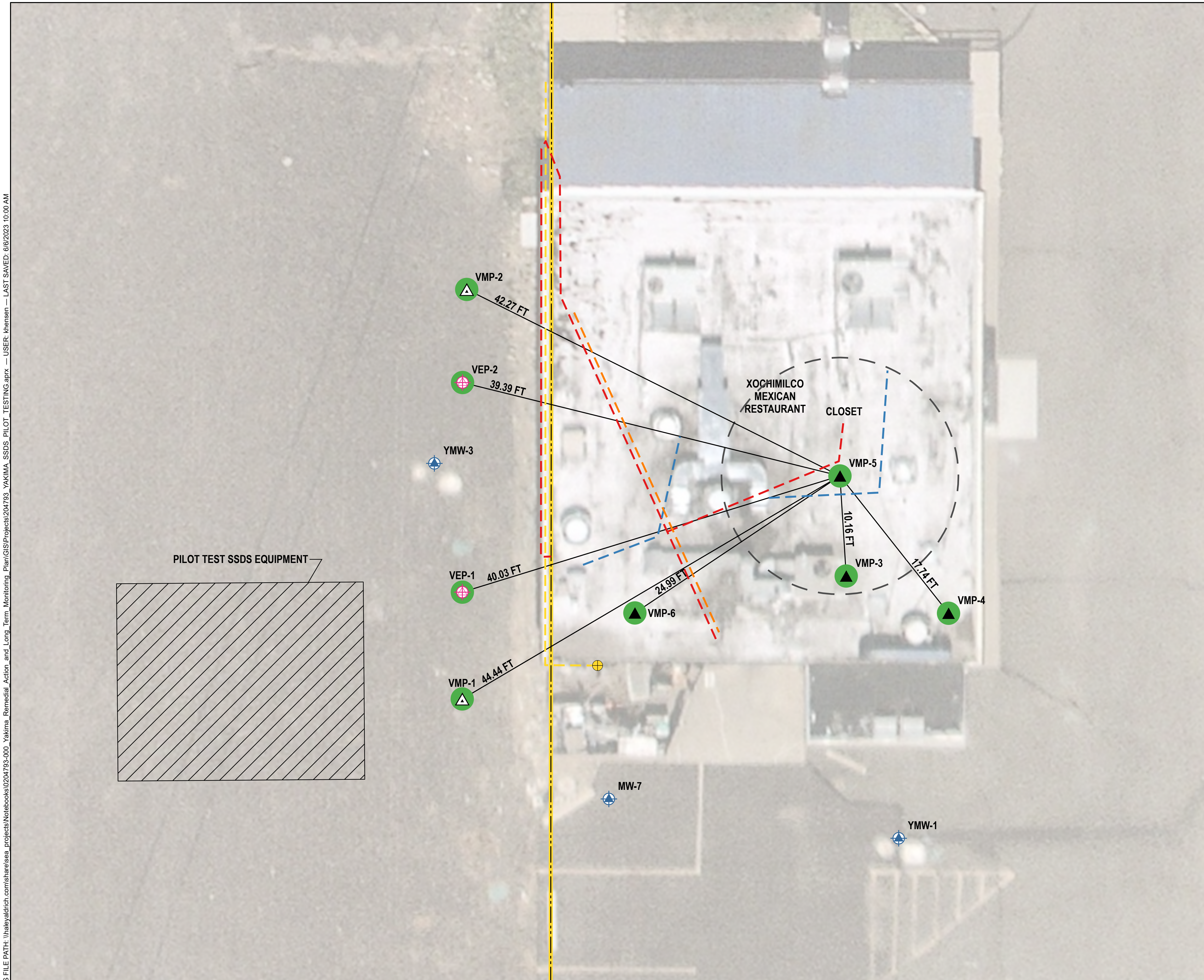
CITY OF YAKIMA
FORMER TIGER OIL WEST NOB HILL BOULEVARD SITE
YAKIMA, WASHINGTON

SSDS PILOT TEST LOCATIONS
EXTRACTION FROM VMP-3

JUNE 2023

FIGURE 6

GIS FILE PATH: \\haleyaldrich.com\share\sea_projects\Notebooks\0204793-000_Yakima_Remedial_Action_and_Long_Term_Monitoring_Plan\GIS\Projects\204793_YAKIMA_SSDS_PILOT_TESTING.aprx — USER: khensen — LAST SAVED: 6/6/2023 10:00 AM



LEGEND

- GAS METER
- SSDS VEP
- GROUNDWATER MONITORING NETWORK WELL
- INTERIOR VMP
- EXTERIOR VMP
- SSDS PILOT TEST WELL NETWORK

UTILITY TYPE

- COMMUNICATION
- ELECTRICAL
- GAS
- WATER
- LOCATION OF THE RENTAL PILOT TEST EQUIPMENT AND CHAIN-LINKED FENCE
- 10-FT VAPOR EXTRACTION RADIUS OF INFLUENCE (ROI)
- FORMER TIGER OIL FACILITY PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.

2. ABBREVIATIONS:
BGS = BELOW GROUND SURFACE
FT = FEET/FOOT
DIA. = DIAMETER
PVC = POLYVINYL CHLORIDE
SCH = SCHEDULE
SSDS = SUB-SLAB DEPRESSURIZATION SYSTEM
VEP = VAPOR EXTRACTION POINT
VMP = VAPOR MONITORING POINT

3. FORMER TIGER OIL FACILITY SITE BOUNDARY AND WELL DATA SOURCE: MAUL FOSTER & ALONGI, INC., 2016

4. ASSESSOR PARCEL DATA SOURCE: YAKIMA COUNTY

5. AERIAL IMAGERY SOURCE: NEARMAP, 14 JULY 2022

N

0 10 20
SCALE IN FEET

HALEY ALDRICH

CITY OF YAKIMA
FORMER TIGER OIL WEST NOB HILL BOULEVARD SITE
YAKIMA, WASHINGTON

SSDS PILOT TEST LOCATIONS
EXTRACTION FROM VMP-5

JUNE 2023

FIGURE 7

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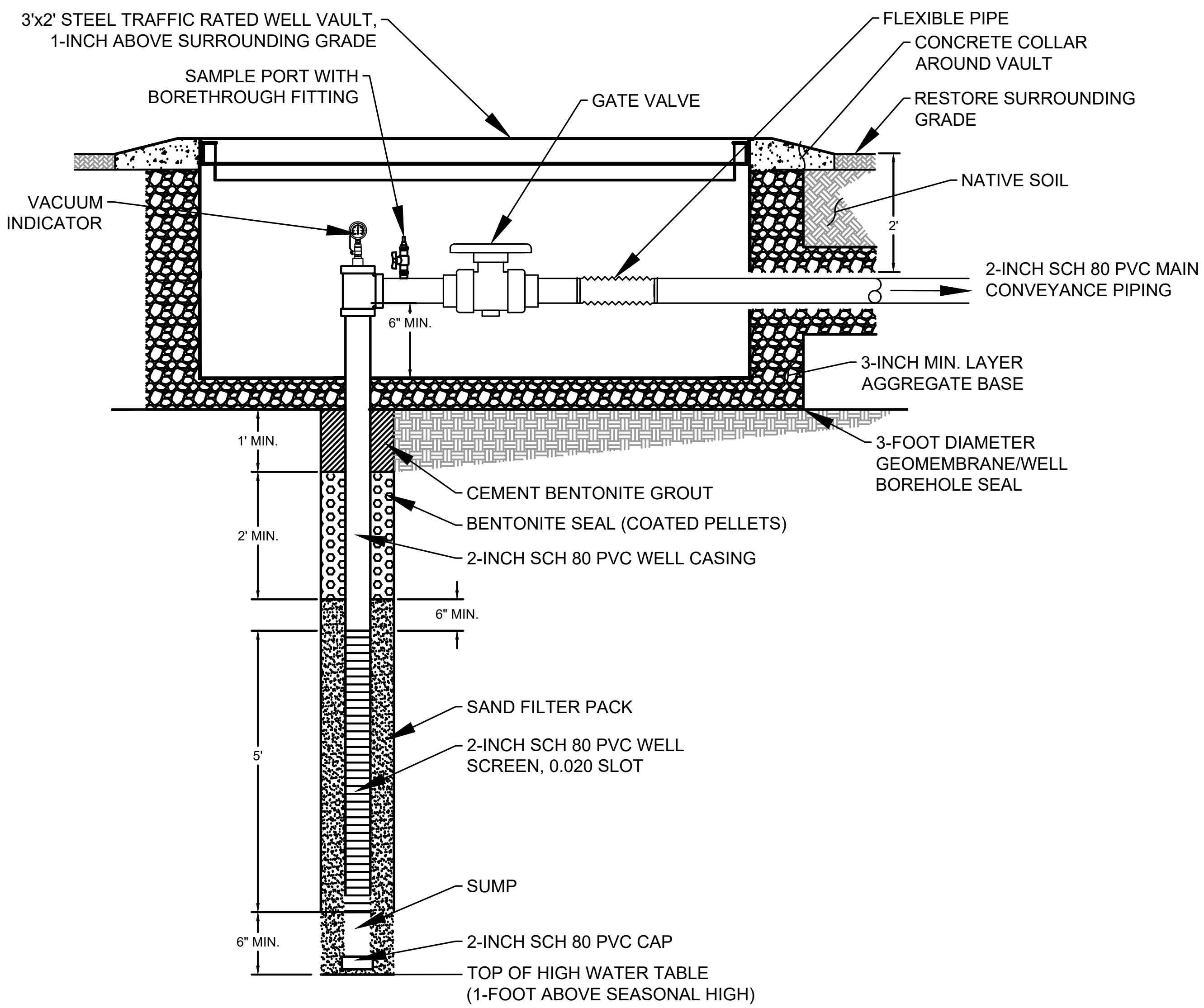
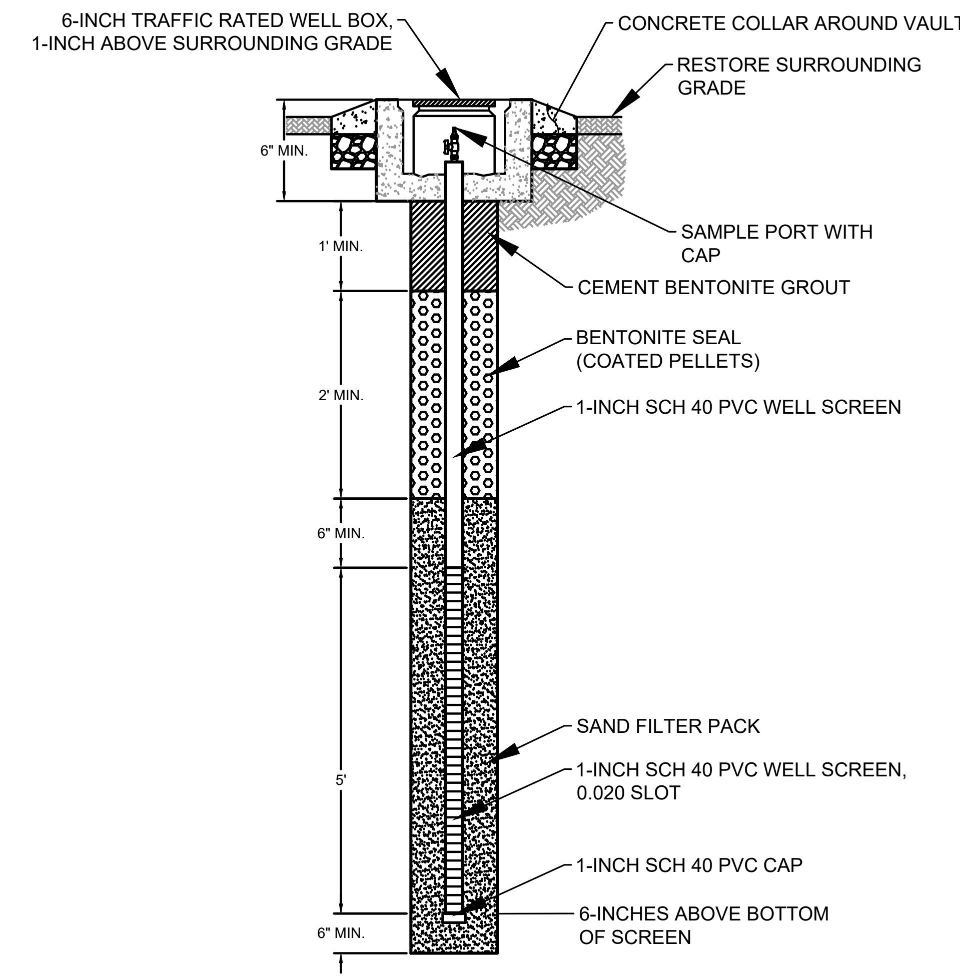
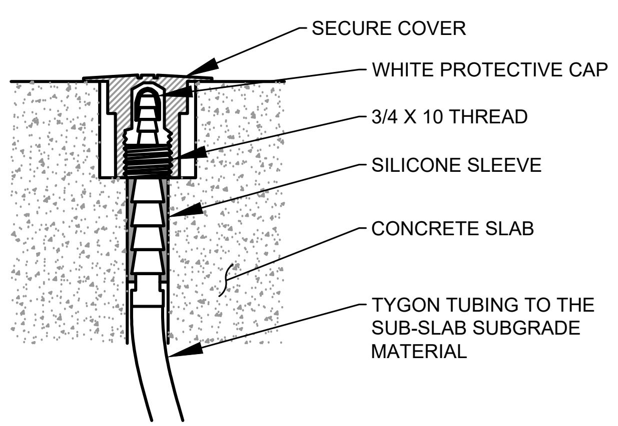


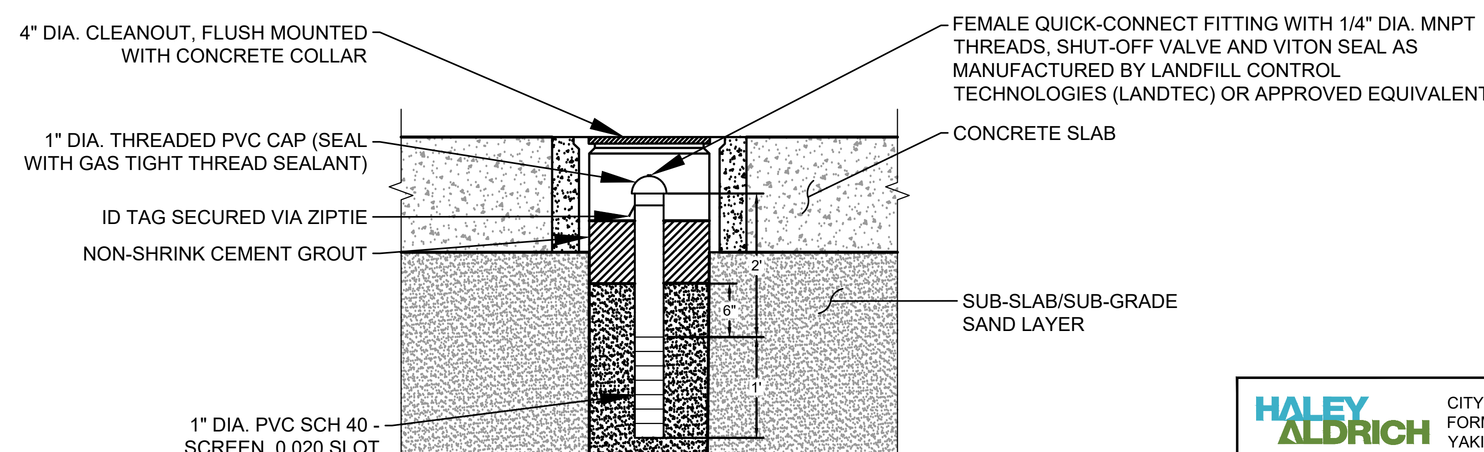
A — TYPICAL VAPOR EXTRACTION POINT (VEP)
NOT TO SCALE



B — TYPICAL EXTERIOR VACUUM MONITORING POINT (VMP)
NOT TO SCALE



D — TYPICAL INTERIOR VACUUM MONITORING POINT (VMP) - VAPORPIN TYPE (TYPE 1)
NOT TO SCALE



E — TYPICAL INTERIOR VACUUM MONITORING POINT (VMP) - DEEP VMP TYPE (TYPE 2)
NOT TO SCALE

HALEY ALDRICH

CITY OF YAKIMA
FORMER TIGER OIL WEST NOB HILL BOULEVARD SITE
YAKIMA, WASHINGTON

VEP AND VMP TYPICAL CONSTRUCTION DETAILS

SCALE: NOT TO SCALE
JUNE 2023

FIGURE 8

LEGEND

- GROUNDWATER MONITORING NETWORK WELL
- PROPOSED SVE SUCTION/VAPOR EXTRACTION POINT (VEP)
- EXISTING VEP
- MONITORING WELL
- SENTRY MONITORING WELL
- INTERIOR VAPOR/VACUUM MONITORING POINT (VMP)
- EXTERIOR VAPOR/VMP
- SVE/VAPOR MITIGATION HORIZONTAL BELOW GRADE CONVEYANCE PIPING (4-INCH PVC SCH 80)
- 10-FT VAPOR EXTRACTION RADIUS OF INFLUENCE (ROI)
- PROPOSED FULL-SCALE SVE PROCESS EQUIPMENT (I.E. BLOWER) CENTRALIZED ENCLOSURE
- FORMER TIGER OIL FACILITY PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. ASSESSOR PARCEL DATA SOURCE: YAKIMA COUNTY
3. PROPOSED SVE SUCTION/VAPOR EXTRACTION POINTS WILL BE SET APPROXIMATELY 20 FEET CENTER-TO-CENTER SPACING, WITH 2-IN PVC SCH 80 RISER PIPE, 20-SLOT SCREEN, SCREEN INTERVAL: 6 TO 11 FT BGS
4. ABBREVIATIONS:
BGS = BELOW GROUND SURFACE
FT = FEET/FOOT
PVC = POLYVINYL CHLORIDE
SCH = SCHEDULE
SSDS = SUB-SLAB DEPRESSUREIZATION SYSTEM
SVE = SOIL VAPOR EXTRACTION
5. FORMER TIGER OIL FACILITY SITE BOUNDARY AND WELL DATA SOURCE: MAUL FOSTER & ALONGI, INC., 2016
6. AERIAL IMAGERY SOURCE: NEARMAP, 11 MAY 2021

N

0 30 60
SCALE IN FEET

HALEY ALDRICH

CITY OF YAKIMA
PROPOSED REMEDIAL ACTION AND LONG TERM MONITORING PLAN
YAKIMA, WASHINGTON

PROPOSED BARRIER SVE CONCEPTUAL DESIGN

JUNE 2023

FIGURE 9

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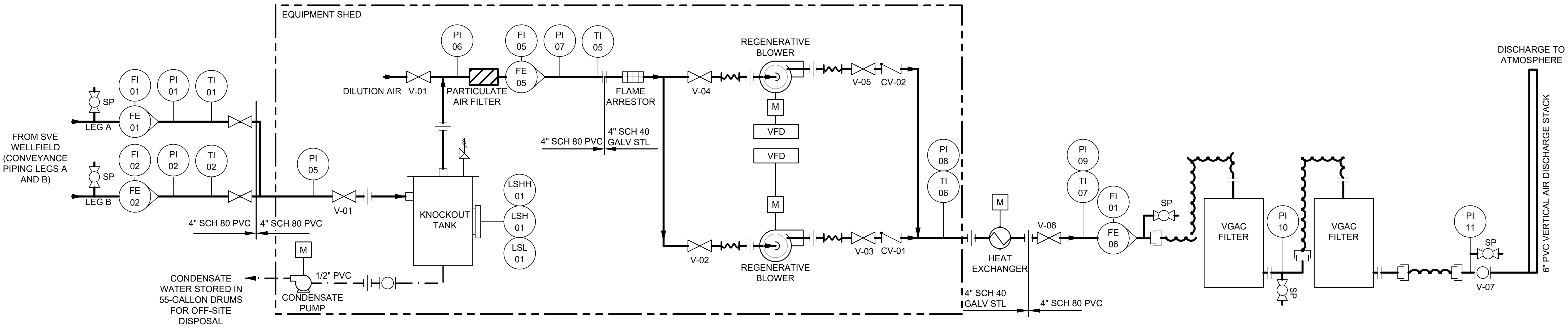


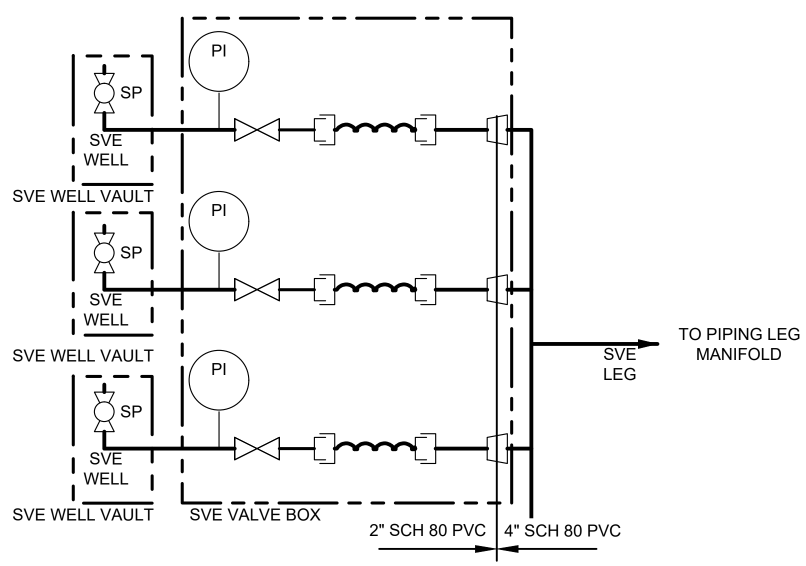
LEGEND:

- VAPOR LINE
- CONDENSATE WATER LINE
- FLEX HOSE
- TREATMENT SHED BOUNDARY
- GATE VALVE
- SAMPLE PORT
- CAMLOCK FITTING
- BALL VALVE
- UNION
- FLANGE CONNECTION
- VACUUM RELIEF VALVE
- REGENERATIVE BLOWER
- HEAT EXCHANGER

FE	FLOW ELEMENT (PITOT TUBE)
FI	FLOW INDICATOR
IN. HG	INCHES OF MERCURY
LSH	LEVEL SWITCH (HIGH)
LSL	LEVEL SWITCH (LOW)
LSHH	LEVEL SWITCH (HIGH-HIGH)
PI	PRESSURE/VACUUM INDICATOR (GAUGE)
SCFM	STANDARD CUBIC FEET PER MINUTE
SP	SAMPLE PORT
SVE	SOIL VAPOR EXTRACTION
VGAC	VAPOR-PHASE GRANULAR ACTIVATED CARBON

NOTE

EACH REGENERATIVE BLOWER SHALL HAVE AIR FLOW OF 300 SCFM AT 5 IN. HG VACUUM AT BLOWER INLET.



HALEY ALDRICH

CITY OF YAKIMA
FORMER TIGER OIL WEST NOB HILL BOULEVARD SITE YAKIMA, WASHINGTON

PROPOSED BARRIER SVE PROCESS EQUIPMENT SCHEMATIC

SCALE: NOT TO SCALE
JUNE 2023

FIGURE 10

APPENDIX A
VEPs and VMPs Boring Logs

Date Started: 02/01/2023	Date Completed: 02/01/2023
Logged by: Y. Van	Checked by: O. Uppal
Location: former Tiger Oil site	
Ground Surface Elevation:	
Contractor/Crew: Cascade Drilling, L.P. / S. Busby	
Rig Model/Type: GeoProbe® 7822DT	
Hole Diameter: 4.25 inches	Well Casing Diameter: ID: 2 inches
Total Depth: 15 feet	Depth to Groundwater: 8.5 feet
Comments: Well Tag ID: BPR-056	

Elevation (feet)	Depth (feet)	Graphic Log	Material Description	Water Level	Well Construction	Depth (feet)
	0		gravel at surface			0
	0–4.75		SILTY SAND WITH GRAVEL (SM), moist, yellow-brown, fine to medium sand, fine to coarse angular gravel. [FILL]			
	4.75–9.75		CLAY (CL), moist, brown, high plasticity, minor silt			5
			becomes wet, moderate to strong petroleum-like hydrocarbon odor	ATD ▽		
	9.75–15		POORLY GRADED SAND (SP), moist, gray, medium sand, well sorted.			10
			moderate to strong petroleum-like hydrocarbon odor			
	15					15

2-inch Schedule 80 0.020-inch screen
Bottom of Borehole at 15.0 feet.

General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material stratum lines are interpretive and actual changes may be gradual. Solid lines indicate distinct contacts and dashed lines indicate gradual or approximate contacts.
3. USCS designations are based on visual-manual identification (ASTM D 2488), unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.
5. Location and ground surface elevations are approximate.

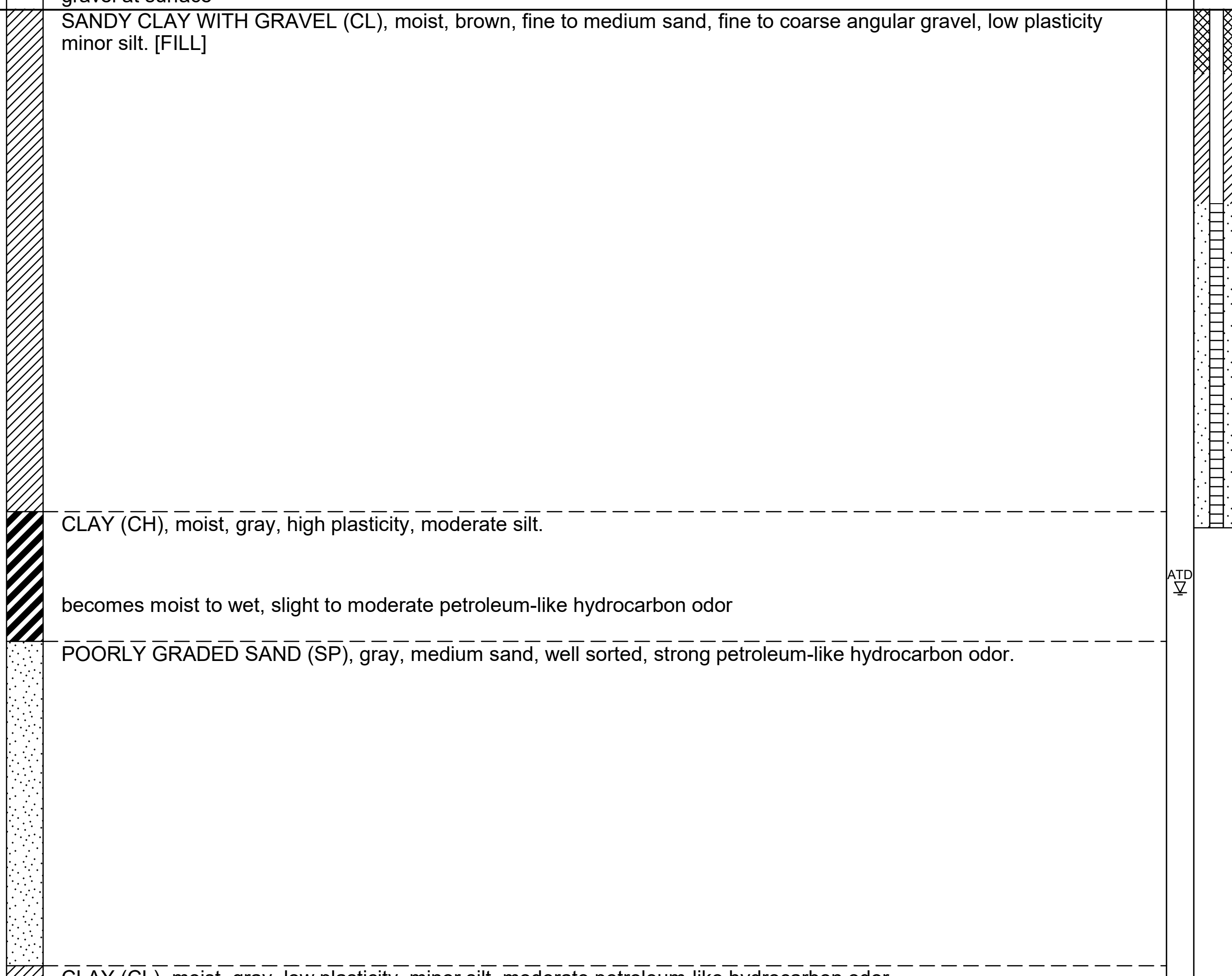
Date Started: 02/01/2023	Logged by: Y. Van	Date Completed: 02/01/2023	Contractor/Crew: Cascade Drilling, L.P. / S. Busby
Location: former Tiger Oil site		Checked by: O. Uppal	Rig Model/Type: GeoProbe® 7822DT
Ground Surface Elevation:		Hole Diameter: 4.25 inches	Well Casing Diameter: ID: 2 inches
Comments: Well Tag ID: BPR-055		Total Depth: 15 feet	Depth to Groundwater: 9.5 feet

Depth (feet)	Material Description	Water Level
	gravel at surface	
0	SILTY SAND WITH GRAVEL (SM), moist, yellow-brown, fine to medium sand, fine to coarse angular gravel. [FILL]	
8	CLAY (CL), moist, yellow-brown, high plasticity, minor silt.	
9.5	becomes wet, grades to gray, moderate petroleum-like hydrocarbon odor	ATD ▽
12	POORLY GRADED SAND (SP), moist, gray, medium sand, well sorted.	
13.5	CLAY (CH), moist to wet, gray, high plasticity, silty, moderate petroleum-like hydrocarbon odor,	
15	2-inch Schedule 80 0.020-inch screen Bottom of Borehole at 15.0 feet.	

General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material stratum lines are interpretive and actual changes may be gradual. Solid lines indicate distinct contacts and dashed lines indicate gradual or approximate contacts.
3. USCS designations are based on visual-manual identification (ASTM D 2488), unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.
5. Location and ground surface elevations are approximate.

Date Started: 02/02/2023	Date Completed: 02/02/2023	Contractor/Crew: Cascade Drilling, L.P. / S. Busby	
Logged by: Y. Van	Checked by: O. Uppal	Rig Model/Type: GeoProbe® 7822DT	
Location: former Tiger Oil site		Hole Diameter: 4.25 inches	Well Casing Diameter: ID: 1 inches
Ground Surface Elevation:		Total Depth: 15 feet	Depth to Groundwater: 9 feet

Comments: Well Tag ID: BPR-057



Depth (feet)	Material Description
	gravel at surface
0	SANDY CLAY WITH GRAVEL (CL), moist, brown, fine to medium sand, fine to coarse angular gravel, low plasticity minor silt. [FILL]
	CLAY (CH), moist, gray, high plasticity, moderate silt.
	becomes moist to wet, slight to moderate petroleum-like hydrocarbon odor (ATD)
10	POORLY GRADED SAND (SP), gray, medium sand, well sorted, strong petroleum-like hydrocarbon odor.
15	CLAY (CL), moist, gray, low plasticity, minor silt, moderate petroleum-like hydrocarbon odor.

1-inch Schedule 40 0.020-inch screen
Bottom of Borehole at 15.0 feet.

General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material stratum lines are interpretive and actual changes may be gradual. Solid lines indicate distinct contacts and dashed lines indicate gradual or approximate contacts.
3. USCS designations are based on visual-manual identification (ASTM D 2488), unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.
5. Location and ground surface elevations are approximate.

HALEY ALDRICH

Project: FORMER TIGER OIL, SSDS PILOT TEST
Location: YAKIMA, WASHINGTON
Project No.: 0204793-000

Push Probe and Monitoring Well Log
VMP-1

Figure **A**
Sheet **1 of 1**

Date Started: 02/02/2023
Date Completed: 02/02/2023
Logged by: Y. Van
Checked by: O. Uppal
Location: former Tiger Oil site
Ground Surface Elevation:
Comments: Well Tag ID: BPR-054

Contractor/Crew: Cascade Drilling, L.P. / S. Busby
Rig Model/Type: GeoProbe® 7822DT
Hole Diameter: 4.25 inches
Well Casing Diameter: ID: 1 inches
Total Depth: 15 feet
Depth to Groundwater: 11.5 feet

Elevation (feet)	Depth (feet)	Graphic Log	Material Description	Water Level	Well Construction	Depth (feet)
			gravel at surface			
	0		SILTY SAND WITH GRAVEL (SM), moist, yellow-brown, fine to medium sand, fine to coarse angular gravel. [FILL]			0
	5					5
			SILTY SAND (SM), medium dense, moist, yellow-brown, fine to medium sand.			
			becomes gray, moderate petroleum-like hydrocarbon odor			
	10					10
			SILTY SAND (SM), moist to wet, gray, medium sand, strong petroleum-like hydrocarbon odor.	ATD ∇		
			becomes wet			
			FAT CLAY (CH), moist to wet, gray, high plasticity, strong petroleum-like hydrocarbon odor.			
	15					15

1-inch Schedule 40 0.020-inch screen
Bottom of Borehole at 15.0 feet.

General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material stratum lines are interpretive and actual changes may be gradual. Solid lines indicate distinct contacts and dashed lines indicate gradual or approximate contacts.
3. USCS designations are based on visual-manual identification (ASTM D 2488), unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.
5. Location and ground surface elevations are approximate.

Date Started: 02/02/2023	Date Completed: 02/02/2023	Contractor/Crew: Cascade Drilling, L.P. / S. Busby	
Logged by: Y. Van	Checked by: O. Uppal	Rig Model/Type: Hand Auger	
Location: former Tiger Oil site		Hole Diameter: 4.25 inches	Well Casing Diameter: ID: 1 inches
Ground Surface Elevation:		Total Depth: 3.5 feet	Depth to Groundwater: Not Identified
Comments: Well Tag ID: BPR-058			

Elevation (feet)	Depth (feet)	Graphic Log	Material Description	Well Construction	Depth (feet)
	0		Concrete (3-inches thick)		0
			WELL-GRADED GRAVEL WITH SILT AND SAND (GW-GM),dry to moist, brown-black, fine to coarse sand, fine to coarse subrounded gravel. [FILL]		
			SILTY SAND (SM), dry to moist, black, fine to medium sand. [FILL]		
			1-inch Schedule 40 0.020-inch screen Bottom of Borehole at 3.5 feet.		
	5				5
	10				10
	15				15

General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material stratum lines are interpretive and actual changes may be gradual. Solid lines indicate distinct contacts and dashed lines indicate gradual or approximate contacts.
3. USCS designations are based on visual-manual identification (ASTM D 2488), unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.
5. Location and ground surface elevations are approximate.

Date Started: 02/02/2023	Date Completed: 02/02/2023	Contractor/Crew: Cascade Drilling, L.P. / S. Busby	
Logged by: Y. Van	Checked by: O. Uppal	Rig Model/Type: Hand Auger	
Location: former Tiger Oil site		Hole Diameter: 2 inches	Well Casing Diameter: NA
Ground Surface Elevation:		Total Depth: 0.27 feet	Depth to Groundwater: Not Identified

Comments: Installed vapor pin after coring through concrete foundation. Placed 1.5-inch stainless steel well cap on top of vapor pin.

Elevation (feet)	Depth (feet)	Graphic Log	Material Description	Depth (feet)
	0		Concrete foundation (2.5-inches thick)	0
			Bottom of Borehole at 0.3 feet.	
	5			5
	10			10
	15			15

General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material stratum lines are interpretive and actual changes may be gradual. Solid lines indicate distinct contacts and dashed lines indicate gradual or approximate contacts.
3. USCS designations are based on visual-manual identification (ASTM D 2488), unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.
5. Location and ground surface elevations are approximate.

Date Started: 02/02/2023	Date Completed: 02/02/2023	Contractor/Crew: Cascade Drilling, L.P. / S. Busby	
Logged by: Y. Van	Checked by:	Rig Model/Type: Hand Auger	
Location: former Tiger Oil site		Hole Diameter: 4.25 inches	Well Casing Diameter: ID: 1 inches
Ground Surface Elevation:		Total Depth: 3.5 feet	Depth to Groundwater: Not Identified
Comments: Well Tag ID: BPR-059			

Elevation (feet)	Depth (feet)	Graphic Log	Material Description	Well Construction	Depth (feet)
	0		Brick tile (0.25-inches thick)		0
			Concrete foundation underlain by base of SANDY GRAVEL		
			WELL-GRADED GRAVEL WITH SILT AND SAND (GW-GM),dry to moist, brown-black, fine to medium subrounded gravel, fine to coarse sand. [FILL]		
			POORLY GRADED SAND WITH GRAVEL (SP), dry, black, coarse sand, fine subround gravel.		
			LEAN CLAY TO CLAY WITH SILT??? (CL), low plasticity.		
			1-inch Schedule 40 0.020-inch screen Bottom of Borehole at 3.5 feet.		
	5				5
	10				10
	15				15

General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material stratum lines are interpretive and actual changes may be gradual. Solid lines indicate distinct contacts and dashed lines indicate gradual or approximate contacts.
3. USCS designations are based on visual-manual identification (ASTM D 2488), unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.
5. Location and ground surface elevations are approximate.

HALEY ALDRICH	Project: FORMER TIGER OIL, SSDS PILOT TEST Location: YAKIMA, WASHINGTON Project No.: 0204793-000	Push Probe and Monitoring Well Log **VMP-5**	Figure **A** Sheet **1 of 1**

Date Started: 02/02/2023
Date Completed: 02/02/2023
Logged by: Y. Van
Checked by:
Location: former Tiger Oil site
Ground Surface Elevation:
Contractor/Crew: Cascade Drilling, L.P. / S. Busby
Rig Model/Type: Hand Auger
Hole Diameter: 2 inches
Well Casing Diameter: NA
Total Depth: 0.27 feet
Depth to Groundwater: Not Identified
Comments: Installed vapor pin after coring through concrete foundation. Placed 1.5-inch stainless steel well cap on top of vapor pin.

Elevation (feet)	Depth (feet)	Graphic Log	Material Description	Depth (feet)
	0		Brick tile (0.25-inches thick)	0
			Concrete foundation (3-inches thick)	
			Bottom of Borehole at 0.3 feet.	
	5			5
	10			10
	15			15

General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material stratum lines are interpretive and actual changes may be gradual. Solid lines indicate distinct contacts and dashed lines indicate gradual or approximate contacts.
3. USCS designations are based on visual-manual identification (ASTM D 2488), unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.
5. Location and ground surface elevations are approximate.

HALEY ALDRICH

Project: FORMER TIGER OIL, SSDS PILOT TEST
Location: YAKIMA, WASHINGTON
Project No.: 0204793-000

Push Probe and Monitoring Well Log
VMP-6

Figure **A**
Sheet **1 of 1**

APPENDIX B
SSDS Pilot Test Equipment

GO TO GEOTECH

Wireless Portable Multi-Gas Monitor

RAE Systems MultiRAE Lite

The MultiRAE Lite is an optimal one-to-six[4]-gas monitoring solution for personal protection (including confined space entry) and multi-gas leak detection applications. Available in pumped and diffusion versions and featuring the broadest selection of sensor options in its class, it can be configured to exactly meet the needs and compliance requirements of various countries, industries, and applications.

The MultiRAE Lite's wireless capability elevates worker protection to the next level by providing safety officers real-time access to instrument readings and alarm status from any location for better visibility and faster incident response.

FEATURES

- **Highly versatile and customizable for different applications**
- **Available in pumped and diffusion versions**
- **Man Down Alarm with real-time remote wireless notification**
- **Easy maintenance with replaceable sensors, pump, and plug-and-play battery**
- **Fully automated bump testing & calibration with AutoRAE 2[1]**
- **Wireless access to real-time instrument readings and alarm status from any location[1,3]**
- **Unmistakable five-way local and remote wireless notification of alarm conditions**
- **30 interchangeable sensor options, including PID[6] for VOCs, NDIR[7] and catalytic for combustibles, and NDIR[7] for CO^2**
- **Intelligent sensors store calibration data, so they can be swapped in the field[2]**
- **Large graphical display with easy-to-use, icon-driven user interface**
- **Continuous datalogging (6 months for 5 sensors, 24 x 7)**
- **Wireless[1,3] and non-wireless configurations are available[1,3]**

APPLICATIONS

- **Industrial hygiene, personal protection, and multi-gas leak detection in industries such as:**
  - Oil and gas (downstream)
  - Chemical
  - Telecommunications
  - Food and beverage
  - Wastewater treatment
- **Fire overhaul**

MONITOR-ONLY CONFIGURATION INCLUDES:

- MultiRAE Lite monitor with sensors, battery and wireless options as specified, and protective rubber boot and filter(s) installed.
- Continuous datalogging (6 months for 5 sensors @ 1-minute intervals)
- Travel charger/PC communications adapter
- PC communication cable
- AC adapter
- Calibration adapter
- Alkaline battery adapter
- Toolkit with Hex tool and Phillips screwdriver
- Quick Start Guide
- CD with documentation
- ProRAE Studio II Instrument Configuration and Data Management Software
- Calibration and test certificate
- Warranty/registration card

The pumped model of MultiRAE Lite also includes:

- Built-in pump
- Belt clip installed
- 3 spare external filters
- PID sensor cap removal tool

Instrument ships in a cardboard box with a colorful sleeve.

Optional accessories, Confined Space Kit, calibration kits, automatic calibration systems, gas kits, individual gases and regulators, and 4-year extended warranty are available. Contact Geotech for more information.

MultiRAE Lite Diffusion Model

MultiRAE Lite Pumped Model

CALL GEOTECH TODAY (800) 833-7958

Geotech Environmental Equipment, Inc.
2650 East 40th Avenue • Denver, Colorado 80205
(303) 320-4764 • **(800) 833-7958** • FAX (303) 322-7242
email: sales@geotechenv.com website: www.geotechenv.com

Wireless Portable Multi-Gas Monitor

geotech

RAE Systems MultiRAE Lite

SPECIFICATIONS

Instrument Specifications[5]

Size	- Pumped model: 7.6" H x 3.8" W x 2.6" D (193 x 96.5 x 66 mm) - Diffusion model: 6.9" x 3.8" x 2.2" (175 x 96.5 x 56mm)
Weight	- Pumped model: 31 oz. (880 g) - Diffusion model: 26.8 oz. (760g)
Sensors	30 intelligent interchangeable field-replaceable sensors including PID for VOCs, electrochemical sensors for toxic gases and oxygen, combustible LEL and NDIR sensors, and CO_2 NDIR sensor
Battery Options	- Rechargeable Li-ion ~12-hr. (pumped)/18-hr. (diffusion) runtime, < 6-hr. recharge time - Extended duration Li-ion ~18-hr. (pumped)/28-hr. (diffusion) runtime, < 9-hr. recharge time - Alkaline adapter with 4 x AA batteries ~6-hr. (pumped)/8-hr. (diffusion) runtime
Display	Monochrome graphical LCD display (128 x 160) with backlighting. Automatic screen "flip" feature.
Display Readout	- Real-time reading of gas concentrations; PID measurement gas and correction factor; battery status; datalogging on/off; wireless on/off and reception quality. - STEL, TWA, peak, and minimum values
Keypad Buttons	3 operation and programming keys (Mode, Y/+, and N/-)
Sampling	Built-in pump or diffusion
Calibration	Automatic with AutoRAE 2 Test and Calibration System[1] or manual
Alarms	Wireless remote alarm notification; multi-tone audible (95 dB @ 30 cm), vibration, visible (flashing bright red LEDs), and on-screen indication of alarm conditions - Man Down Alarm with pre-alarm and real-time remote wireless notification
Datalogging	- Continuous datalogging (6 months for 5 sensors at 1-minute intervals, 24/7) - User-configurable datalogging intervals (from 1 to 3,600 seconds)
Communication and Data Download	- Data download and instrument set-up and upgrades on PC via charging and PC comm. cradle, travel charger, or AutoRAE 2 Automated Test and Calibration System[1] - Wireless data and alarm status transmission via built-in RF modem (optional)
Wireless Network	RAE Systems Dedicated Wireless Network
Wireless Frequency	ISM license-free bands
Wireless Range (Typical)	656 feet (200 meters)
Operating Temperature	-4° to 122°F (-20° to 50°C)
Humidity	0% to 95% relative humidity (non-condensing)
Dust and Water Resistance	IP65 (pumped); IP67 (diffusion)
Hazardous Location Approvals	CSA: CSAUS Class I, Division 1, Groups A, B, C and D, T4 ATEX: CE 0575 Ex II 2G Ex ia d IIC T4 Gb IECEx: Ex ia d IIC T4 Gb
CE Compliance (European Conformity)	EMC directive: 2004/108/EC. R&TTE directive: 1999/5/EC. ATEX directive: 94/9/EC
EMI / RFI	No effect when exposed to 0.43mW/cm^2 RF interference from a 5-watt transmitter at 12"
Performance Tests	LEL CSA C22.2 No. 152; ISA-12.13.01
Languages	Arabic, Chinese, Czech, Danish, Dutch, English, French, German, Indonesian, Italian, Japanese, Korean, Norwegian, Polish, Portuguese, Russian, Spanish, and Swedish
Warranty	- Two years on non-consumable components and catalytic LEL, CO, H_2S, and O_2 sensors - One year on all other sensors, pump, battery, and other consumable parts

Sensor Specifications[5]

Sensors	Range	Resolution
PID Sensor[6]		
VOC 10.6 eV	0 to 1,000 ppm	1 ppm
Combustible Sensors		
Catalytic LEL	0 to 100% LEL	1% LEL
NDIR (0-100% LEL Methane)[7]	0 to 100% LEL	1% LEL
NDIR (0-100% Vol. Methane)[7]	0 to 100% Vol.	0.1% Vol.
Carbon Dioxide Sensor		
Carbon Dioxide (CO_2) NDIR[7]	0 to 50,000 ppm	100 ppm
Electrochemical Sensors		
Ammonia (NH_3)	0 to 100 ppm	1 ppm
Carbon Monoxide (CO)	0 to 500 ppm	1 ppm
Carbon Monoxide (CO), Ext. Range	0 to 2,000 ppm	10 ppm
Carbon Monoxide (CO), H_2-comp.	0 to 2,000 ppm	10 ppm
Carbon Monoxide (CO) +	0 to 500 ppm	1 ppm
Hydrogen Sulfide (H_2S) Combo	0 to 200 ppm	0.1 ppm
Chlorine (Cl_2)	0 to 50 ppm	0.1 ppm
Chlorine Dioxide (ClO_2)	0 to 1 ppm	0.03 ppm
Ethylene Oxide (EtO-A)	0 to 100 ppm	0.5 ppm
Ethylene Oxide (EtO-B)	0 to 10 ppm	0.1 ppm
Ethylene Oxide (EtO-C), Ext. Range	0 to 500 ppm	10 ppm
Formaldehyde (HCHO)	0 to 10 ppm	0.01 ppm
Hydrogen (H_2)	0 to 1,000 ppm	2 ppm
Hydrogen Chloride (HCl)	0 to 15 ppm	1 ppm
Hydrogen Cyanide (HCN)	0 to 50 ppm	0.5 ppm
Hydrogen Fluoride (HF)	0 to 10 ppm	0.1 ppm
Hydrogen Sulfide (H_2S)	0 to 100 ppm	0.1 ppm
Hydrogen Sulfide (H_2S), Ext. Range	0 to 1,000 ppm	1 ppm
Methyl Mercaptan (CH_3-SH)	0 to 10 ppm	0.1 ppm
Nitric Oxide (NO)	0 to 250 ppm	0.5 ppm
Nitrogen Dioxide (NO_2)	0 to 20 ppm	0.1 ppm
Oxygen (O_2)	0 to 30% Vol.	0.1% Vol.
Phosgene ($COCl_2$)	0 to 1 ppm	0.02 ppm
Phosphine (PH_3)	0 to 20 ppm	0.1 ppm
Phosphine (PH_3), Ext. Range	0 to 1,000 ppm	1 ppm
Sulfur Dioxide (SO_2)	0 to 20 ppm	0.1 ppm

1 Contact Geotech for availability.
2 RAE Systems recommends calibrating sensors on installation.
3 Additional equipment and/or software licenses may be required to enable remote wireless monitoring and alarm transmission.
4 The CO + H_2S combo sensor is required for a 6-gas configuration.
5 Specifications are subject to change.
6 PID sensor requires a pumped configuration.
7 NDIR combustible sensors require a pumped configuration in CSA countries.

CALL GEOTECH TODAY (800) 833-7958

Geotech Environmental Equipment, Inc.
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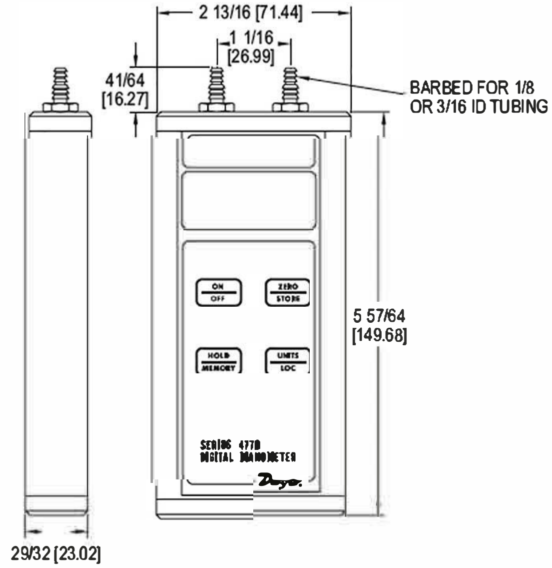
email: sales@geotechenv.com website: www.geotechenv.com

Dwyer

SERIES 477B

HANDHELD DIGITAL MANOMETER

Precise Air Pressure Measurement, ±0.1% Accuracy



The **SERIES 477B** Handheld Digital Manometers are versatile, hand-held, battery operated manometers available in several basic ranges from 0-20 in w.c. up to 100 psi. All models measure either positive, negative or differential pressures wi h ±0.10% of full scale accuracy. You can select from up to seven common English and metric pressure units so conversions are not necessary. A memory function allows storage of up to 40 readings for later recall and a backlight provides auxiliary lighting for hard-to-see locations. Also standard are a hold feature plus both visual and audible overpressure alarms.

FEATURES/BENEFITS

- Precise 0.1% FS accuracy provides four times better accuracy than most standard manometer/gages
- Aluminum housing protects instrument against damage
- 40 readings in internal memory reduces time to record data

APPLICATIONS

- Lab calibration of o her pressure instruments
- Air velocity/air flow measurements in commercial buildings

SPECIFICATIONS

Service: Air and compatible gases.
Wetted Parts: Consult factory.
Accuracy: ±0.10% FS from 60 to 78°F (15.6 to 25.6°C); ±1% FS from 32 to 60 and 78 to 104°F (0 to 15 .6 and 25.6 to 40°C).
Pressure Hysteresis: ±0.1% FS.
Pressure Limits: See chart.
Temperature Limits: 0 to 140°F (-17.8 to 60°C).
Storage Temperature Limits: -4 to 176°F (-20 to 80°C).
Display: 4-digit LCD (.425˝ H x .234˝ W digits).
Resolution: See chart.
Power Requirements: 9 volt alkaline battery. Battery included but not connected.
Connections: Two barbed connections for use with 1/8˝ (3.18 mm) or 3/16˝ (4.76 mm) I.D. tubing for 477B-1, 477B-2, 477B-3, 477B-4 and 477B-5 only. Two compression fittings for use with 1/8˝ (3.18 mm) I.D. x 1/4˝ (6.35 mm) O.D. tubing for 477B-6 and 477B-7 only.
Weight: 10.2 oz. (289 g).
Agency Approvals: CE.

MODEL CHART

Model	Range	Available Pressure Units										Maximum Pressure
		bar	psi	in Hg	kPa	in w.c.	mm Hg	mbar	ft w.c.	mm w.c.	Pa	
477B-1	0 to 20.00 in w.c.	.0498	.7225	1.471	4.982	20.00	37.36	49.82	1.667	508.0	4982	3 psig
477B-2	0 to 40.00 in w.c.	.0996	1.445	2.942	9.96	40.00	74.73	99.6	3.333	1016	9964	3 psig
477B-3	0 to 200.0 in w.c.	.4982	7.225	14.71	49.82	200.0	373.6	498.2	16.67	5080	-	15 psig
477B-4	0 to 10.00 psi	.6895	10.00	20.36	68.95	276.8	517.1	689.5	23.07	7031	-	30 psig
477B-5	0 to 30.00 psi	2.069	30.00	61.08	206.9	830.4	1551	2069	69.20	-	-	60 psig
477B-6	0 to 50.00 psi	3.447	50.00	101.8	344.7	1384	2585	3447	115.3	-	-	100 psig
477B-7	0 to 100.0 psi	6.895	100.0	203.6	689.5	2768	5171	6895	230.7	-	-	200 psig

OPTIONS

To order add suffix:	Description
-NIST	NIST traceable calibration cer ificate
Example: 477B-1-NIST	

ACCESSORIES

Model	Description
A-402A	Carrying case; tough gray nylon pouch protects any Series 477B Manometer; double zippered for quick and easy access, with a belt loop that snaps closed; 7-1/2˝H x 3˝W x 2-1/4˝D (191 x 76 x 57 mm)
UHH-C1	Soft carrying case
A-47X-BOOT	Protective magnetic rubber boot


A-402A

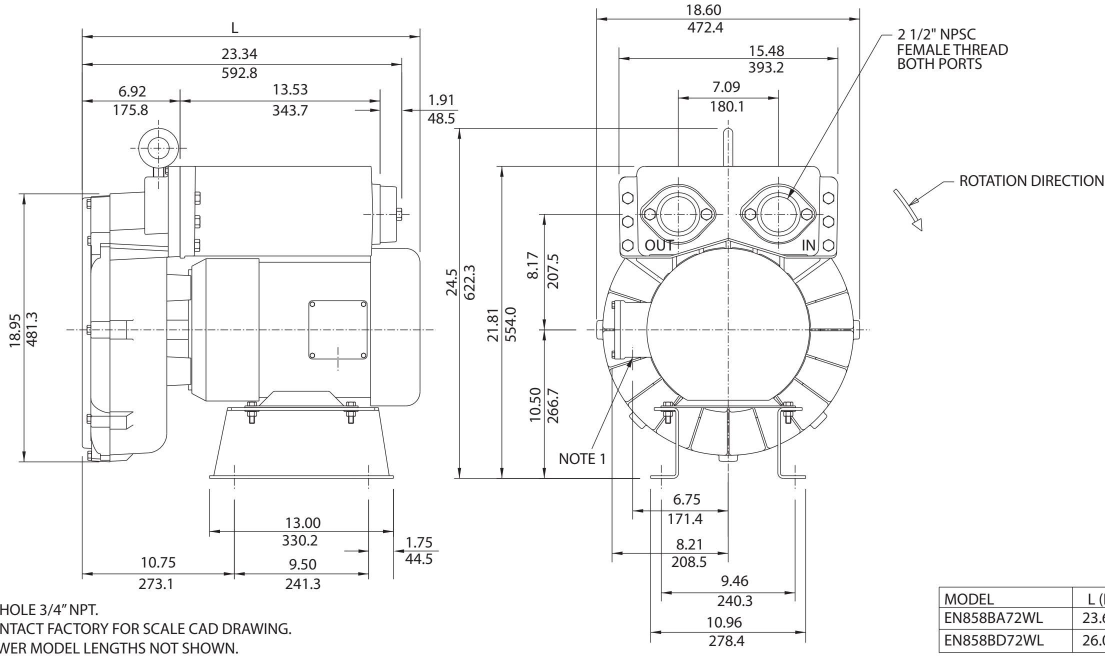

UHH-C1


A-47X-BOOT
(Manometer not included)

ROTRON®

EN 858 & CP 858

7.5 / 10.0 HP Sealed Regenerative w/Explosion-Proof Motor



IN / MM

NOTES
1 TERMINAL BOX CONNECTOR HOLE 3/4" NPT.
2 DRAWING NOT TO SCALE, CONTACT FACTORY FOR SCALE CAD DRAWING.
3 CONTACT FACTORY FOR BLOWER MODEL LENGTHS NOT SHOWN.

MODEL	L (IN/MM)
EN858BA72WL	23.65/600.7
EN858BD72WL	26.00/660.4

		Part/Model Number			
		EN858BD72WL	EN858BD86WL	EN858BA72WL	CP858FZ72WLR
Specification	Units	038744	038745	080070	038980
Motor Enclosure - Shaft Mtl.	-	10.0	10.0	7.5	10.0
Horsepower	-	Explosion-proof-CS	Explosion-proof-CS	Explosion-proof-CS	Chem XP-SS
Phase - Frequency	-	Three-60 hz	Three-60 hz	Three-60 hz	Three-60 hz
Voltage	AC	230/460	575	230/460	230/460
Motor Nameplate Amps	Amps (A)	24/12	9.6	18.6/9.3	24/12
Max. Blower Amps	Amps (A)	30/15	11.6	26/13	30/15
Locked Rotor Amps	Amps (A)	234/117	93	126/63	234/117
Service Factor	-	2/1	1	1/1	2/1
Starter Size	-	1.0	1.0	1.0	1.0
Thermal Protection	-	Class B - Pilot Duty	Class B - Pilot Duty	Class B - Pilot Duty	Class B - Pilot Duty
XP Motor Class - Group	-	I-D, II-F&G	I-D, II-F&G	I-D, II-F&G	I-D, II-F&G
Shipping Weight	Lbs	338	338	326	338
	Kg	153.3	153.3	147.9	153.3

Voltage - ROTRON motors are designed to handle a broad range of world voltages and power supply variations. Our dual voltage 3 phase motors are factory tested and certified to operate on both: **208-230/415-460 VAC-3 ph-60 Hz** and **190-208/380-415 VAC-3 ph-50 Hz**. Our dual voltage 1 phase motors are factory tested and certified to operate on both: **104-115/208-230 VAC-1 ph-60 Hz** and **100-110/200-220 VAC-1 ph-50 Hz**. All voltages above can handle a ±10% voltage fluctuation. Special wound motors can be ordered for voltages outside our certified range.

Operating Temperatures - Maximum operating temperature: Motor winding temperature (winding rise plus ambient) should not exceed 140°C for Class F rated motors or 120°C for Class B rated motors. Blower outlet air temperature should not exceed 140°C (air temperature rise plus inlet temperature). Performance curve maximum pressure and suction points are based on a 40°C inlet and ambient temperature. Consult factory for inlet or ambient temperatures above 40°C.

Maximum Blower Amps - Corresponds to the performance point at which the motor or blower temperature rise with a 40°C inlet and/or ambient temperature reaches the maximum operating temperature.

XP Motor Class - Group - See Explosive Atmosphere Classification Chart in Section I

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Customer Service Fax: +1 215.256.1338
www.ametekdfs.com

Environmental / Chemical Processing Blowers

EN 858 & CP 858

7.5 / 10.0 HP Sealed Regenerative w/Explosion-Proof Motor

ROTRON®

FEATURES

- Manufactured in the USA - ISO 9001 and NAFTA compliant
- Maximum flow: 380 SCFM
- Maximum pressure: 120 IWG
- Maximum vacuum: 95 IWG
- Standard motor: 10 HP, explosion-proof
- Cast aluminum blower housing, impeller , cover & manifold; cast iron flanges (threaded); teflon® lip seal
- UL & CSA approved motor with permanently sealed ball bearings for explosive gas atmospheres Class I Group D minimum
- Sealed blower assembly
- Quiet operation within OSHA standards

MOTOR OPTIONS

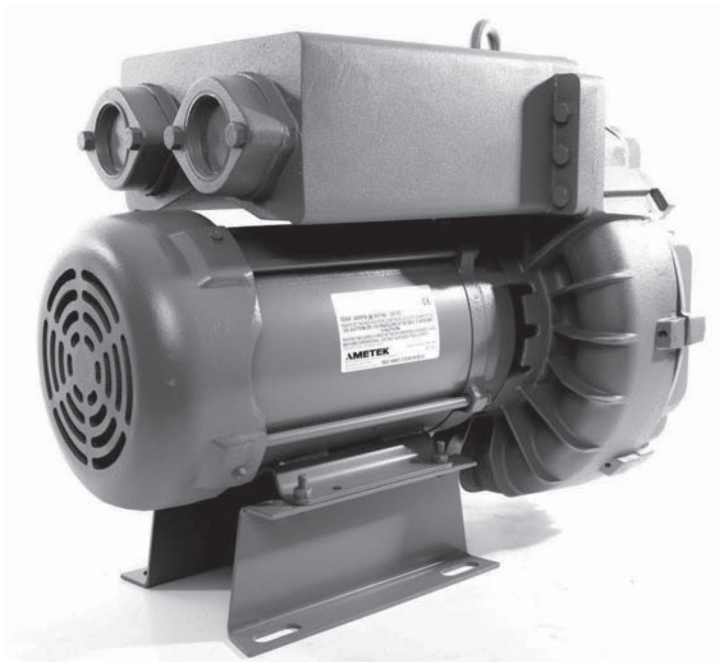
- International voltage & frequency (Hz)
- Chemical duty, high efficiency, inverter duty or industry-specific designs
- Various horsepowers for application-specific needs

BLOWER OPTIONS

- Corrosion resistant surface treatments & sealing options
- Remote drive (motorless) models
- Slip-on or face flanges for application-specific needs

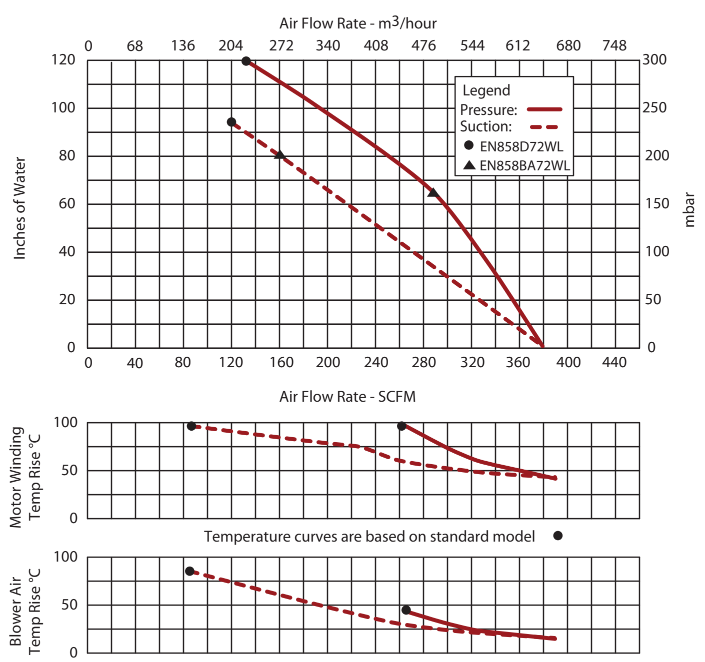
ACCESSORIES

- Flowmeters reading in SCFM
- Filters & moisture separators
- Pressure gauges, vacuum gauges, & relief valves
- Switches - air flow, pressure, vacuum, or temperature
- External mufflers for additional silencing
- Air knives (used on blow-off applications)
- Variable frequency drive package

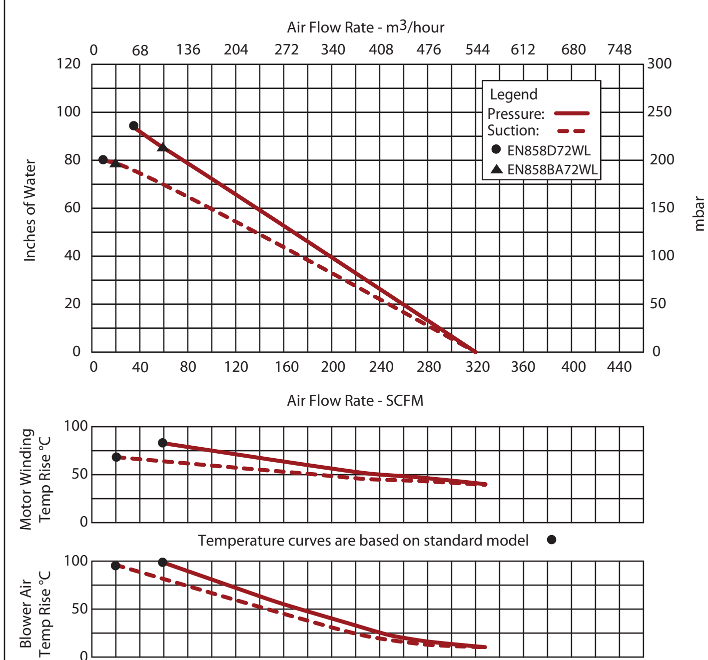


Blower Performance at Standard Conditions

60 Hz



50 Hz



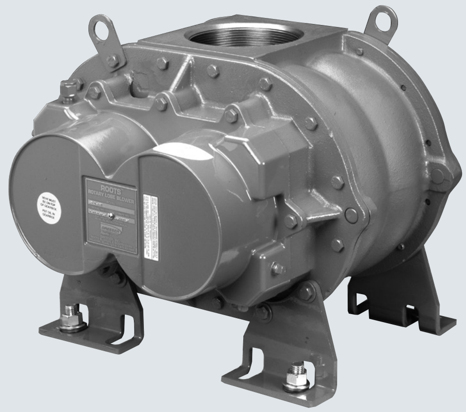
This document is for informational purposes only and should not be considered as a binding description of the products or their performance in all applications. The performance data on this page depicts typical performance under controlled laboratory conditions. AMETEK is not responsible for blowers driven beyond factory specified speed, temperature, pressure, flow or without proper alignment. Actual performance will vary depending on the operating environment and application. AMETEK products are not designed for and should not be used in medical life support applications. AMETEK reserves the right to revise its products without notification. The above characteristics represent standard products. For product designed to meet specific applications, contact AMETEK Technical & Industrial Products Sales department.

Frames 22 thru 718

ROOTS™ Universal RAI ® Rotary Positive Blowers

Design and Construction Features

- Detachable steel mounting feet
- Rigid one-piece cast iron casing
- Anti-friction bearings
- Splash oil lubricated spur timing gears
- Connections in standard pipe sizes
- Ground steel shafts
- Straight, precision machined two-lobe impellers



For further information contact

Howden Roots
900 W. Mount St.
Connersville
Indiana
USA
47331

Tel: +1 765 827 9200
Web: www.howden.com

Universal RAI blowers are heavy-duty rotary blowers designed with detachable rugged steel mounting feet that permit easy, in-field adaptability to vertical or horizontal installation requirements.

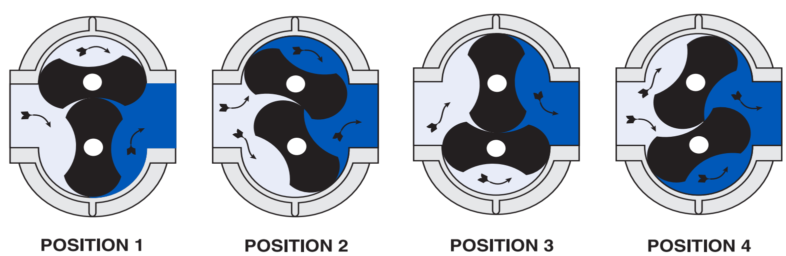
Basic blower description

The detachable mounting feet allow these units to be easily adapted to any of four drive shaft positions: right, left, bottom, or top. The compact, sturdy design is engineered for continuous service when operated in accordance with speed and pressure ratings.

The basic model consists of a cast iron casing, carburized and ground alloy steel spur timing gears secured to steel shafts with a taper mounting and locknut, and cast iron involute impellers. Oversized antifriction bearings are used, with a cylindrical roller bearing at the drive shaft to withstand V-belt pull. The Universal RAI® features splash oil lube on the gear end and grease lube on the drive end. ROOTS' exclusive "figure-eight" gearbox design improves oil distribution to maximize gear and bearing life. After testing, the unit is sprayed with a protective paint, and boxed or skid mounted for delivery.

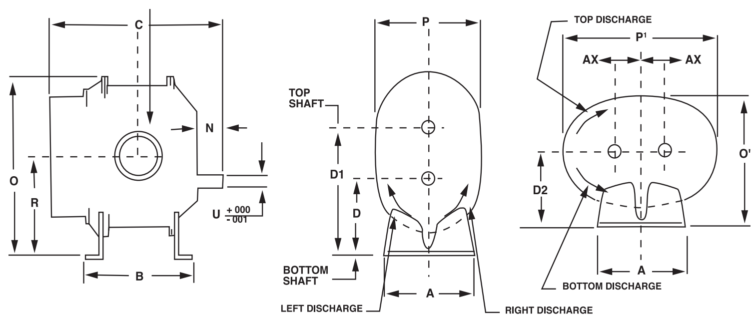
Available accessories include driver, relief valve, inlet and discharge silencers, inlet filter, check valve, extended base, V-belt or flexible coupling and drive guards.

Operating principle



Two figure-eight lobe impellers mounted on parallel shafts rotate in opposite directions. As each impeller passes the blower inlet, it traps a definite volume of air and carries it around the case to the blower outlet, where the air is discharged. With constant speed operation, the displaced volume is essentially the same regardless of pressure or temperature.

Timing gears control the impellers relative positions and maintain small but definite clearances. This allows operation without lubrication requirements inside the unit casing.



Operating principle continued

Frame Size	A	A'	B	C	D	D1	D2	M	O	O'	P	P'	R	U	Inlet Disch.	AX	Wt.
22U	5.13	5.13	5.00	9.75	3.75	6.25	3.75	5.13	9.63	6.88	6.25	9.25	5.00	.625	1.0 NPT	1.25	32
24U	5.13	5.13	7.00	11.75	3.75	6.25	3.75	6.13	9.63	6.88	6.25	9.25	9.50	.625	2.0 NPT	1.25	43
32U	7.25	7.25	6.75	11.25	5.00	8.50	5.00	5.81	12.81	8.88	7.75	12.13	6.75	.750	1.25 NPT	1.75	69
33U	7.25	7.25	7.63	12.13	5.00	8.50	5.00	6.25	12.81	8.88	7.75	12.13	6.75	.750	2.0 NPT	1.75	74
36U	7.25	7.25	10.00	14.63	5.00	8.50	5.00	7.56	12.81	8.88	7.75	12.13	6.75	.750	2.5 NPT	1.75	102
42U	8.00	8.00	7.25	13.00	6.25	10.25	6.25	6.88	15.06	10.63	8.75	13.63	8.25	.875	1.5 NPT	2.00	88
45U	8.00	8.00	10.00	15.50	6.25	10.25	6.25	8.00	15.06	10.63	8.75	13.63	8.25	.875	2.5 NPT	2.00	109
47U	8.00	8.00	11.75	17.63	6.25	10.52	6.25	9.25	15.06	10.50	8.50	13.63	8.25	.875	3.0 NPT	2.00	128
53U	10.50	10.50	8.38	15.38	6.25	11.25	6.75	8.18	17.38	11.88	10.25	17.25	8.75	1.125	2.5 NPT	2.50	143
56U	10.50	10.50	11.00	18.00	6.25	11.25	6.75	9.19	17.38	12.25	11.00	17.25	8.75	1.125	4.0 NPT	2.50	170
59U	10.50	10.50	14.00	21.18	6.25	11.25	6.75	11.19	17.38	12.25	11.00	17.25	8.75	1.125	4.0 NPT	2.50	204
65U	11.00	11.00	10.00	18.38	8.75	14.75	8.75	9.19	21.63	15.13	12.75	19.75	11.75	1.375	3.0 NPT	3.00	245
68U	11.00	11.00	13.00	21.38	8.75	14.75	8.75	10.82	21.63	15.13	12.75	19.75	11.75	1.375	5.0 NPT	3.00	285
615U	11.00	11.00	20.00	28.38	8.75	14.75	8.75	14.32	21.63	16.25	15.00	19.75	11.75	1.375	6.0 FLG	3.00	425
76U	14.00	21.00	11.75	19.94	11.00	18.00	11.00	10.00	26.13	20.69	19.38	23.25	14.50	1.562	4.0 NPT	3.50	400
711U	14.00	21.00	16.75	25.19	11.00	18.00	11.00	12.75	26.13	19.50	17.00	23.25	14.50	1.562	6.0 FLG	3.50	530
718U	14.00	21.00	23.75	32.19	11.00	18.00	11.00	16.25	26.13	19.50	17.00	23.25	14.50	1.562	8.0 FLG	3.50	650

Frame size	Speed RPM	4 PSI		5 PSI		6 PSI		7 PSI		8 PSI		9 PSI		10 PSI		12 PSI		13 PSI		14 PSI		15 PSI		VACUUM DATA		
		CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	INHGV	CFM	BHP
	2950	31	0.9	29	1.1	27	1.3	26	1.5	24	1.7	23	1.9	21	2.1									13	20	1.3
22	3550	40	1.0	39	1.3	37	1.5	35	1.8	34	2.0	32	2.3	31	2.5	28	3.0							14	28	1.7
	5275	68	1.6	66	2.0	64	2.4	63	2.7	61	3.1	60	3.5	59	3.8	56	4.6							15	53	2.8
	2950	68	1.7	65	2.1	63	2.5	60	2.9															14	48	2.8
24	3550	88	2.0	85	2.5	82	3.0	79	3.5															14	67	3.4
	5275	143	3.1	140	3.9	137	4.6	134	5.4															15	119	5.5
	1750	54	1.4	51	1.7	48	2.1	45	2.4	43	2.8	41	3.1	39	3.5	35	4.1							13	37	2.2
32	2950	108	2.4	105	3.0	102	3.6	99	4.2	97	4.7	95	5.3	93	5.9	89	7.1	87	7.6	86	8.2	84	8.8	15	84	4.3
	3550	135	3.0	132	3.7	129	4.4	126	5.1	124	5.8	122	6.5	120	7.2	116	8.6	114	9.3	114	10.0	111	10.6	16	108	5.6
	1750	75	1.9	71	2.4	67	2.9	64	3.3	61	3.8	58	4.3	56	4.7	51	5.7							13	53	3.0
33	2950	149	3.3	145	4.1	141	4.9	138	5.7	135	6.5	132	7.3	130	8.1	125	9.7							15	119	5.9
	3550	186	4.1	182	5.0	178	6.0	175	6.9	172	7.9	169	8.8	167	9.8	162	11.7							15	156	7.2
	1750	132	3.2	126	3.9	121	4.7	117	5.5															14	95	5.4
36	2950	254	5.5	249	6.8	244	8.1	239	9.4															15	212	9.8
	3550	316	6.7	310	8.3	305	9.9	300	11.5															15	273	11.9
	1750	78	1.9	74	2.4	71	2.8	69	3.3	66	3.7	64	4.2	61	4.7	57	5.6	55	6.0					14	55	3.2
42	2950	150	3.3	147	4.1	144	4.9	141	5.7	139	6.5	136	7.2	134	8.0	130	9.6	128	10.3	126	11.1	124	11.9	16	121	6.2
	3550	187	4.1	183	5.1	180	6.0	177	7.0	175	7.9	172	8.8	170	9.8	166	11.6	164	12.6	162	13.5	160	14.4	16	157	7.6
	1750	161	3.8	155	4.7	150	5.6	145	6.6	140	7.5	136	8.4	132	9.3									14	121	6.4
45	2950	306	6.7	300	8.2	295	9.8	290	11.3	285	12.9	281	14.4	277	16.0									16	253	12.5
	3550	379	8.2	373	10.1	368	12.0	363	13.9	358	15.7	354	17.6	349	19.5									16	326	15.2
	1750	215	5.0	208	6.2	201	7.4	195	8.6															14	165	8.4
47	2950	407	8.8	399	10.8	392	12.9	386	14.9															15	348	15.4
	3550	502	10.9	495	13.3	488	15.8	482	18.3															15	444	18.8
	1170	113	2.7	108	3.4	103	4.1	99	4.8	96	5.4	92	6.1	89	6.8	82	8.1							13	85	4.3
53	1750	189	4.2	184	5.2	180	6.2	176	7.2	172	8.2	168	9.2	165	10.3	159	12.3	156	13.3	153	14.3			15	151	7.5
	2850	334	7.4	329	9.0	325	10.7	321	12.3	317	14.0	313	15.6	310	17.2	304	20.5	301	22.1	298	23.8	295	25.4	16	291	13.4
	1170	196	4.6	188	5.7	182	6.9	175	8.0	170	9.1	164	10.2	159	11.4	150	13.6							14	146	7.8
56	1750	324	7.0	316	8.7	310	10.4	304	12.1	298	13.8	292	15.5	287	17.2	278	20.5	273	22.2					15	266	12.6
	2850	567	12.2	560	15.0	553	17.7	547	20.5	541	23.2	536	26.0	530	28.7	521	34.2	517	37.0					16	501	22.4
	1170	299	6.7	290	8.4	281	10.0	273	11.7															14	237	11.4
59	1750	486	10.3	477	12.8	469	15.2	461	17.7															15	414	18.4
	2850	842	18.0	832	22.0	824	26.0	816	30.0															15	770	30.8
	1170	223	5.2	215	6.4	208	7.7	202	8.6	196	10.2	190	11.5	185	12.7	175	15.2	171	16.5	166	17.7			14	171	8.7
65	1750	365	8.0	358	9.9	351	11.8	344	13.7	339	15.6	333	17.4	238	19.3	318	23.1	313	24.9	309	26.8	305	28.7	16	297	15.1
	2350	513	11.4	505	13.9	489	16.4	492	19.0	486	21.5	481	24.0	475	26.5	465	31.6	461	34.1	456	36.6	452	39.1	16	445	20.6
	1170	358	8.3	345	10.3	334	12.3	324	14.3	314	16.3	305	18.3	297	20.3	281	24.4	274	26.4	267	28.4			14	275	13.9
68	1750	587	12.7	574	15.7	563	18.7	553	21.8	544	24.8	535	27.8	526	30.8	510	36.8	503	39.8	496	42.9			16	478	24.0
	2350	824	17.8	811	21.8	800	25.9	790	29.9	781	34.0	772	38.0	763	42.1	747	50.2	740	54.2	733	58.3			16	715	32.8
	1170	670	15.4	647	19.1	626	22.9	607	26.7															11	581	20.5
615	1750	1099	23.4	1076	29.1	1055	34.7	1036	40.4															12	989	33.7
	2350	1543	32.4	1520	40.0	1499	47.6	1480	55.2															12	1433	46.0
	1170	393	8.6	383	10.6	374	12.7	367	14.8	359	16.8	352	18.9	346	21.0	333	25.1	328	27.2	322	29.2	317	31.3	15	319	15.4
76	1750	628	13.4	618	16.5	609	19.6	601	22.7	594	25.8	587	28.9	580	32.0	568	38.1	562	41.2	557	44.3	552	47.4	16	543	24.9
	2050	749	16.2	240	19.8	731	23.4	723	22.0	716	30.6	709	34.3	702	37.9	690	45.1	684	48.7	678	52.4	623	56.0	16	664	29.5
	1170	738	15.5	723	19.2	710	23.0	679	26.8	686	30.5	675	34.3	665	38.1									15	623	27.9
711	1750	1166	23.9	1151	29.5	1138	35.2	1125	40.8	1114	46.4	1103	52.0	1093	57.7									16	1035	45.0
	2050	1387	28.6	1372	35.2	1359	41.8	1347	48.4	1335	55.0	1324	61.6	1314	68.2									16	1256	53.1
	1170	1224	25.0	1202	31.1	1183	37.2																	12	122	36.3
718	1750	1920	38.2	1898	47.4	1879	56.5																	12	1818	54.8
	2050	2280	45.5	2258	56.2	2239	66.9																	12	2178	64.7

Notes: 1. Performance based on inlet air at standard pressure of 14.7 psia, standard temperature of 68° F, and specific gravity of 1.0.
2. Vacuum ratings based on inlet air at standard temperature of 68° F, discharge pressure of 30" Hg and specific gravity of 1.0.

32 URAI

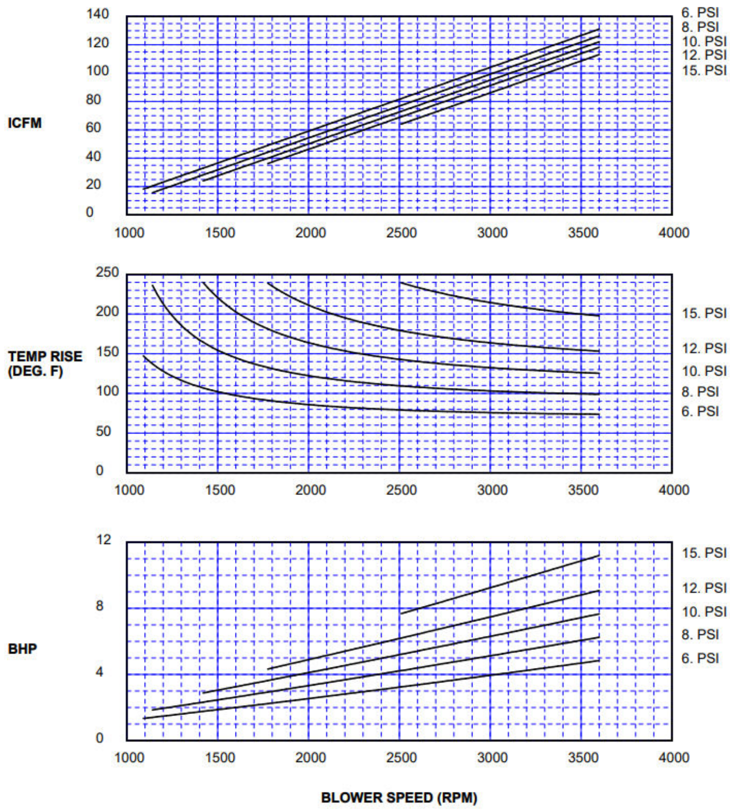
pdblowers part #: 21008.C (LHC), 21009 (RHC), 21010 (BHC), 21011 (THC)
Roots part #: 7104802L, 7104802R, 7104802B, 7104802T

Specifications

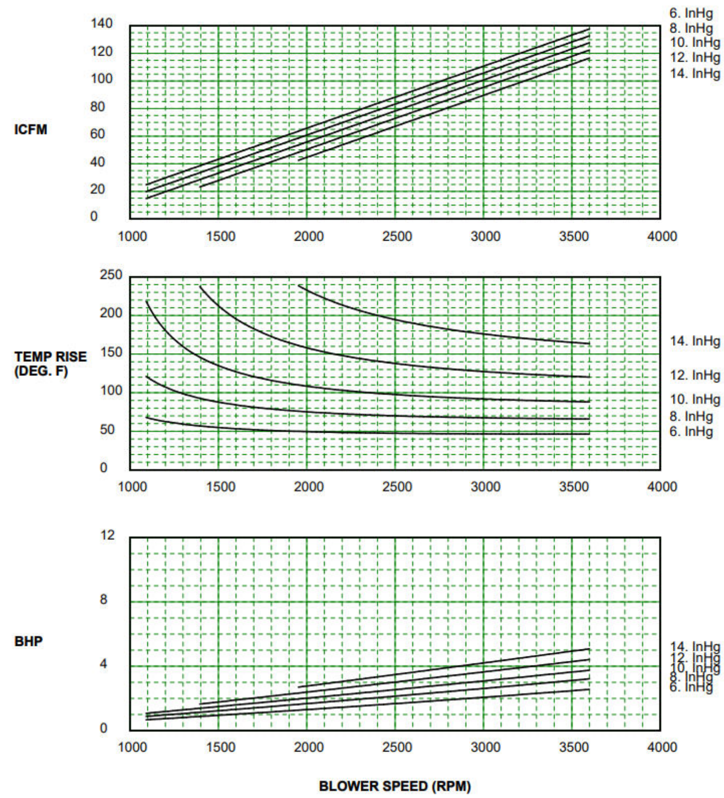
Max Flow:	144 ACFM
Min Flow:	31 ACFM
Max Pressure:	15 PSI
Max Vacuum:	16 "HG
Max RPM:	3600 RPM
Min RPM:	1090 RPM
Max ΔT:	240°F
CFR:	0.045
1 PSI Slip:	260 RPM

Connection Size:	1.25" FPT
Shaft Diameter:	0.750"
Weight:	69 lb
Shipping Weight:	98 lb
Ship Dimensions:	30x30x15"
Drive End:	Grease, Synthetic
Gear End:	Oil (8.5oz vertical, 10.5oz horizontal)

Pressure Curve



Vacuum Curve



Oil recommendations

Ambient Temp	ISO Viscosity	pdblowers part #:				
		Quart	12 Qt	Gallon	4 Gal	5 Gal
90˚ to 120˚ (32˚C)	320	54525	54529	53204	53204.C	54532
32˚to 90˚ (10˚C to 32˚C)	220	54524	54528	54527	54527.C	54531
0˚ to 32˚ (-18˚C to 0˚C)	150	54585	54586	54049	54049.C	57229
Below 0˚ (-18˚C)	100	57060	54048	50754	50754.C	54584

Oil service interval is approximately 6000 hours with an oil temp of 180˚F or less. Oil life is reduced by half for each 15˚F increase in oil temp.

Grease Recommendations

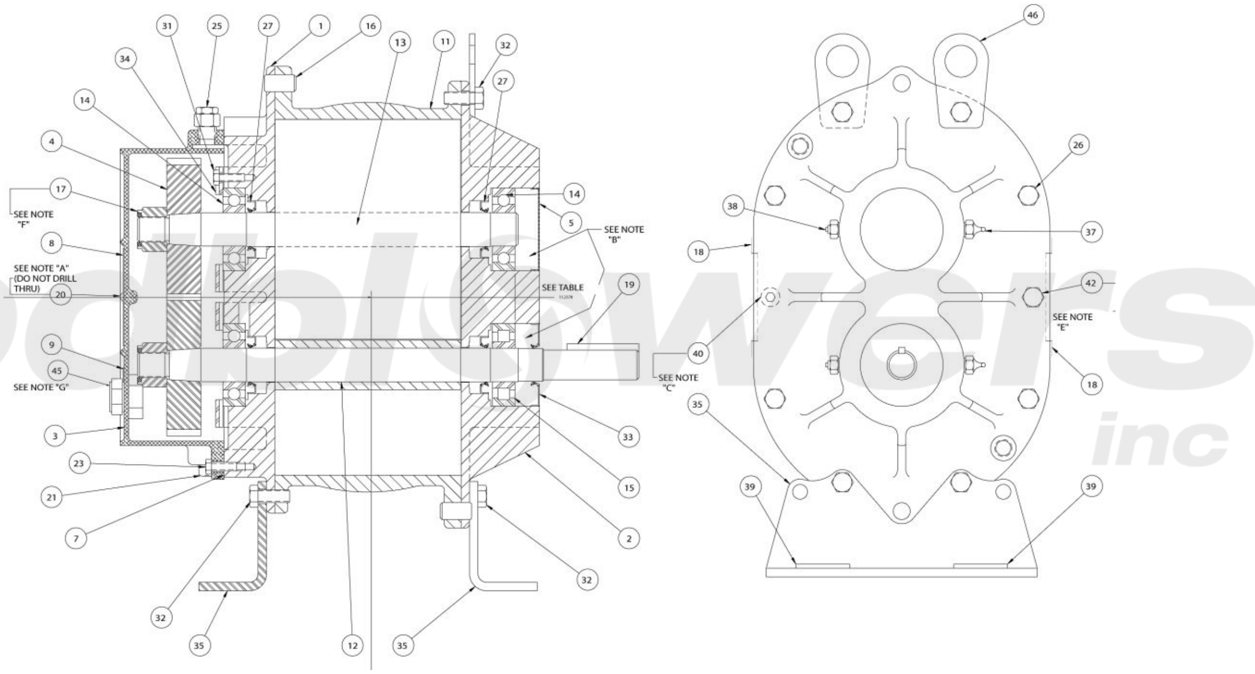
Grease is used for URAI blowers for lubrication on the drive end bearings. Blowers manufactured before 10/2016 typically use Shell Gadus grease (pdblowers part #: 54649). All blowers produced after 10/2016 use Roots synthetic grease (pdblowers part #: 25673).

Note: the two can NOT be mixed.

Speed In RPM	Operating Hours Per Day		
	8	16	24
	Greasing Interval in Weeks		
750-1000	7	4	2
1000-1500	5	2	1
1500-2000	4	2	1
2000-2500	3	1	1
2500-3000	2	1	1
3000+	1	1	1

32 URAI

Part Diagram



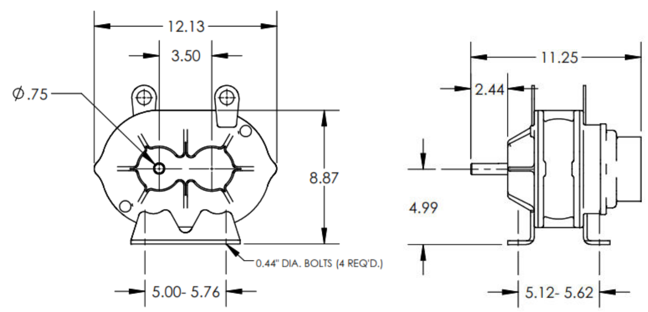
Part Listing

Ref	Description	Qty	Mfg PN	pdb PN
001	HDPL GE 3-1/2" URAI	1	64860022	26406.01
002	HDPL DE 3-1/2" URAI	1	64855022	26406.01
003	GRBX, 3-1/2" URAI	1	65332022	26406.03
004	GEAR,ASSY 3-1/2" URAI T/B	1	63889021	26406.04
005	PLUG,OPENING FOR 2.0474" BORE	1	12957003	26406.05
007	GSKT,GRBX 3-1/2"URAI TS9003	1	62752021	26406.07
011	CYL 32 URAI, Cylinder	1	71132022	
012	Drive End Impeller	1	71133022	26406.12.32
013	Driven End Impeller	1	71133S22	
014	BRG,BALL FAG #6304	3	10987002	26406.14
015	BRG,ROLLER FAG #NJ304E	1	10222035	26406.15
016	PIN,DOWEL 1/2X1.00	4	10226001	26406.16
017	NUT,HEX ESNA 5/8-18	2	10319007	26406.17
019	KEY,SQ 3/16"X 3/16"X 1-5/8"	1	10825005	26406.19
020	SCR,SELF-TPNG RNDH 8-32X.25	1	10815002	26406.20
021	PLG,PIPE 1/4 STL	3	10008002	26406.21
025	PLUG,VENT 1/4"	1	13005001	26400.25
027	SEAL,LIP(VITON) 13/16"SFT	4	10005157	26406.27
031	SCR,CAP HEXH NYL 1/4-20X.50	4	11540003	26406.31
033	SEAL,LIP(BUNA-N) 3/4" SFT	1	10005172	26406.33
034	PLT,CLAMP 3-1/2" UNIT	2	64449020	26406.34
035	BLWR,FOOT 3-1/2 URAI	2	64999021	26406.35
037	FITTING,GREASE 1/8"MPT	2	10007001	26406.37
038	PLUG,VENT 1/8"	2	13002001	26400.38
039	WSHR,OBLONG 1 1/2 SLOT	4	12892001	26406.39
046	URAI LIFTING, LUG	2	64361020	26414.42

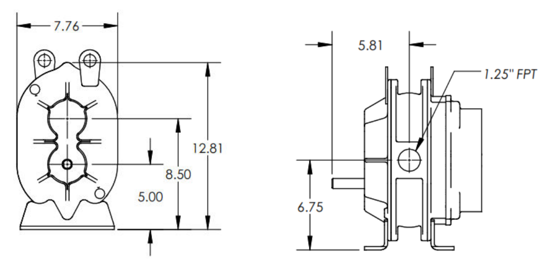
Standard Repair Kit (651050RK / 26406) includes blue highlighted items

Standard Repair Kit with Gears (651040RK/ 26405) includes blue & green items

Dimensional Drawings – Horizontal



Dimensional Drawings – Vertical



Clearances

Impeller/Impeller: 0.010–0.012″

Impeller End to Headplate

DE & GE: 0.003-0.008″

GE w/ Spring Installed: 0.003″

Impeller Tips to Cylinder:

Inlet & Discharge: 0.004-0.006″

Center: 0.002-0.003″

Critical Dimensions

Impeller Width: 5.675-5.676″

Shaft Dia. at Bearing Bore: 2.0472-2.0473″

Bearing Bore Dia.: 0.7875-0.7879″

Materials of Construction

HEADPLATE MATERIAL:	CAST IRON ASTM A48 CLASS 30B	SHAFT MATERIAL:	STEEL, PRESS THRU ASTM 108-90 & 311-90	DRIVE SHAFT SEAL:	RADIAL LIP BUNA-N
CYLINDER MATERIAL:	CAST IRON ASTM A48 CLASS 30B	HEADPLATE SEAL (4):	LABYRINTH - INTEGRAL W/ SHAFT FLANGE	GEAR MATERIAL:	SAE 8620 STEEL CARBURIZED, HT 58-62 Rc
IMPELLER MATERIAL:	CAST IRON ASTM A48 CLASS 30B	BEARING SEAL (4):	RADIAL LIP VITON	GEAR RATING:	AGMA -#11

APPENDIX C
Field Monitoring Data

Table 1

SSDS Pilot Test Field Monitoring Data - Rotron Blower Extraction from VEP-1

Former Tiger Oil West Nob Hill Boulevard Site

Yakima, WA

SSDS Pilot Test

Test Well: VEP-1 (SI = 3' - 8')
Date: 2/21/2023
Weather: cold (27° F), windy
Comments: No detections on PID at nearby VMPs during VEP-1 extraction
EXTRACTION via ROTRON BLOWER, 7.5 Hp

Field Instrumentation Models & Calibration:
Multi-Gas Meter with PID #1 = MultiRAE Lite
Multi-Gas Meter with PID #2 = N.A.
Digital Manometer = Dwyer Series 477B Handheld Digital Manometer
Pitot Tube = N.A.
Air Velocity Meter = N.A.

Field Instrumentation Baseline Readings & Time:
Multi-Gas Meter with PID #1 =
Multi-Gas Meter with PID #2 =
Digi+E:AltaI Manometer =
Pitot Tube =
Air Velocity Meter =

Test Well	Time	Air Flow Rate	Air Temperature	Vacuum	Vacuum	PID at Test Well	PID/Multi-Gas	Vacuum (IWC) at Monitoring Points							PID at Monitoring Points (ppmv)						
		(scfm)	(F°)	(inHg)	(IWC)	(ppmv)	%LEL	VMP-1 (11.03 ft) [SI= 3' - 8']	VMP-2 (30.72 ft) [SI= 5' - 10']	VEP-2 (21.28 ft) [SI= 4' - 9']	VMP-3 (40.01 ft) [SI= 2.5' - 3.5']	VMP-4 (50.39 ft) [vapor pin]	VMP-5 (41.44 ft) [SI= 2.5' - 3.5']	VMP-6 (18.80 ft) [vapor pin]	VMP-1 (11.03 ft) [SI= 3' - 8']	VMP-2 (30.72 ft) [SI= 5' - 10']	VEP-2 (21.28 ft) [SI= 4' - 9']	VMP-3 (40.01 ft) [SI= 2.5' - 3.5']	VMP-4 (50.39 ft) [vapor pin]	VMP-5 (41.44 ft) [SI= 2.5' - 3.5']	VMP-6 (18.80 ft) [vapor pin]
Flow-Vacuum Condition #1																					
VEP-1	1055	25		-5	-68.0			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Flow-Vacuum Condition #2																					
VEP-1	1125	30						0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEP-1	1130	30		-3.7	-50.0			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Flow-Vacuum Condition #3																					
VEP-1	1132	15		-1.3	-17.6			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Notes:
SSDS: Sub-Slab Depressurization System
LEL: Lower Explosive Limit %
ft/min - feet/minute

%LEL = percent lower explosive limit
inHg = inch of mercury
IWC = inches of water column
ppmv = part per million

Table 2

SSDS Pilot Test Field Monitoring Data - Rotron Blower Extraction from VEP-2

Former Tiger Oil West Nob Hill Boulevard Site

Yakima, WA

SSDS Pilot Test

HALEY ALDRICH

Project No: 0204793-000 Task 04

Test Well: VEP-2 (SI = 4' - 9')

Date: 2/21/2023

Weather: cold (27° F), windy

Comments: EXTRACTION via ROTRON BLOWER, 7.5 Hp

Field Instrumentation Models & Calibration:

Multi-Gas Meter with PID #1 = MultiRAE Lite

Multi-Gas Meter with PID #2 = N.A.

Digital Manometer = Dwyer Series 477B Handheld Digital Manometer

Pitot Tube = N.A.

Air Velocity Meter = N.A.

Field Instrumentation Basleine Readings & Time:

Multi-Gas Meter with PID #1 =

Multi-Gas Meter with PID #2 =

Digital Manometer =

Pitot Tube =

Air Velocity Meter =

Test Well	Time	Air Velocity	Air Flow Rate	Air Flow Rate	Air Temperature	Vacuum	Vacuum	PID at Test Well	PID/Multi-Gas at Test Well	Vacuum (IWC) at Monitoring Points							PID at Monitoring Points (ppmv or ppbv)							PID/Multi-Gas at Monitoring Points %LEL						
		(ft/min)	(acfm)	(scfm)	(F°)	(inHg)	(IWC)	(ppmv)	%LEL	VMP-1 (32.07 ft) [SI= 3' - 8']	VMP-2 (9.44 ft) [SI= 5' - 10']	VEP-1 (21.25 ft) [SI= 3' - 8']	VMP-3 (43.53 ft) [SI= 2.5' - 3.5']	VMP-4 (54.51 ft) [vapor pin]	VMP-5 (39.39 ft) [SI= 2.5' - 3.5']	VMP-6 (29.16 ft) [vapor pin]	VMP-1 (32.07 ft) [SI= 3' - 8']	VMP-2 (9.44 ft) [SI= 5' - 10']	VEP-1 (21.25 ft) [SI= 3' - 8']	VMP-3 (43.53 ft) [SI= 2.5' - 3.5']	VMP-4 (54.51 ft) [vapor pin]	VMP-5 (39.39 ft) [SI= 2.5' - 3.5']	VMP-6 (29.16 ft) [vapor pin]	VMP-1 (32.07 ft) [SI= 3' - 8']	VMP-2 (9.44 ft) [SI= 5' - 10']	VEP-1 (21.25 ft) [SI= 3' - 8']	VMP-3 (43.53 ft) [SI= 2.5' - 3.5']	VMP-4 (54.51 ft) [vapor pin]	VMP-5 (39.39 ft) [SI= 2.5' - 3.5']	VMP-6 (29.16 ft) [vapor pin]
Flow-Vacuum Condition #1: Blower at 100% Capacity																														
VEP-2	1151			35		-3.18	43.3			0.0	-0.2	-0.1	---	0.0	0.0	0.0														
VEP-2	1222			33		-3.07	41.5	378	3		-0.3																			
Flow-Vacuum Condition #2: Blower at 25% Capacity																														
VEP-2	1226			23		-1.85	25.2																							
VEP-2	1229			24		-1.89	25.7				-0.1																			
VEP-2	1243			22		-1.94	26.4	333	7																					
Flow-Vacuum Condition #3: Blower at 50% Capacity																														
VEP-2	1248			18		-1.16	15.8				-0.1																			

Notes:
SSDS: Sub-Slab Depressurization System
LEL: Lower Explosive Limit %
ft/min - feet/minute

SI = screen interval
acfm = actual cubic feet per minute
scfm = standard cubic feet per minute
F° = Farenheit

%LEL = percent lower explosive limit
inHg = inch of mercury
IWC = inches of water column
ppmv = part per million

Table 3

SSDS Pilot Test Field Monitoring Data - Rotron Blower Extraction from VMP-3

Former Tiger Oil West Nob Hill Boulevard Site

Yakima, WA

SSDS Pilot Test

HALEY ALDRICH

Project No: 0204793-000 Task 04

Test Well: VMP-3 (SI = 2.5' - 3.5')

Date: 2/21/2023

Weather: cold (27° F), windy

Comments: EXTRACTION via ROTRON BLOWER, 7.5 Hp
1st flow condition: at 125% blower capacity;
2nd flow condition: at 70% capacity; 44.8 Hz
3rd flow condition: at 94.8% capacity; 50.5 Hz

<u>Field Instrumentation Models & Calibration:</u>

Multi-Gas Meter with PID #1 = MultiRAE Lite

Multi-Gas Meter with PID #2 = N.A.

Digital Manometer = Dwyer Series 477B Handheld Digital Manometer

Pitot Tube = N.A.

Air Velocity Meter = N.A.

<u>Field Instrumentation Basleine Readings & Time:</u>

Multi-Gas Meter with PID #1 =

Multi-Gas Meter with PID #2 =

Digital Manometer =

Pitot Tube =

Air Velocity Meter =

Test Well	Time	Air Velocity	Air Flow Rate	Air Flow Rate	Air Temperature	Vacuum	Vacuum	PID at Test Well	PID/Multi-Gas at Test Well	Vacuum (IWC) at Monitoring Points							PID at Monitoring Points (ppmv or ppbv)							PID/Multi-Gas at Monitoring Points %LEL						
		(ft/min)	(acfm)	(scfm)	(F°)	(inHg)	(IWC)	(ppmv)	%LEL	VMP-1 (40.85 ft) [SI= 3' - 8']	VMP-2 (48.18 ft) [SI= 5' - 10']	VEP-1 (38.92 ft) [SI= 3' - 8']	VEP-2 (43.53 ft) [SI= 4' -9']	VMP-4 (11.03 ft) [vapor pin]	VMP-5 (10.16 ft) [SI= 2.5' - 3.5']	VMP-6 (21.73 ft) [vapor pin]	VMP-1 (40.85 ft) [SI= 3' - 8']	VMP-2 (48.18 ft) [SI= 5' - 10']	VEP-1 (38.92 ft) [SI= 3' - 8']	VEP-2 (43.53 ft) [SI= 4' -9']	VMP-4 (11.03 ft) [vapor pin]	VMP-5 (10.16 ft) [SI= 2.5' - 3.5']	VMP-6 (21.73 ft) [vapor pin]	VMP-1 (40.85 ft) [SI= 3' - 8']	VMP-2 (48.18 ft) [SI= 5' - 10']	VEP-1 (38.92 ft) [SI= 3' - 8']	VEP-2 (43.53 ft) [SI= 4' -9']	VMP-4 (11.03 ft) [vapor pin]	VMP-5 (10.16 ft) [SI= 2.5' - 3.5']	VMP-6 (21.73 ft) [vapor pin]
Flow-Vacuum Condition #1: Blower at 125% Capacity																														
VMP-3	1328					-5.9	81.2			0.0	0.0	0.0	0.0	-0.1	0.0	0.0														
Flow-Vacuum Condition #2L Blower at 70% Capacity																														
VMP-3	1347					-3.16	42.9			--	--	--	--	-0.05	0.00	0.00														
Flow-Vacuum Condition #3: Blower at 95% Capacity																														
VMP-3	1403					-4.08	55.5	16.0	0.00	0.00	0.00	0.00		-0.05	0.00	0.00														

Notes:
SSDS: Sub-Slab Depressurization System
LEL: Lower Explosive Limit %
ft/min - feet/minute

SI = screen interval
acfm = actual cubic feet per minute
scfm = standard cubic feet per minute
F° = Farenheit

%LEL = percent lower explosive limit
inHg = inch of mercury
IWC = inches of water column
ppmv = part per million

Table 4

SSDS Pilot Test Field Monitoring Data - Rotron Blower Extraction from VMP-5

Former Tiger Oil West Nob Hill Boulevard Site

Yakima, WA

SSDS Pilot Test

HALEY ALDRICH

Project No: 0204793-000 Task 04

Test Well: VMP-5 (SI = 2.5' - 3.5')

Date: 2/21/2023

Weather: cold (27° F), windy

Comments: EXTRACTION via ROTRON BLOWER, 7.5 Hp
1st flow condition: at 95% blower capacity; 50.5 Hz
2nd flow condition: at 50% capacity; 37 Hz
3rd flow condition: at 110% capacity; 54 Hz

Field Instrumentation Models & Calibration:

Multi-Gas Meter with PID #1 = MultiRAE Lite
Multi-Gas Meter with PID #2 = N.A.
Digital Manometer = Dwyer Series 477B Handheld Digital Manometer
Pitot Tube = N.A.
Air Velocity Meter = N.A.

Field Instrumentation Basleine Readings & Time:

Multi-Gas Meter with PID #1 =
Multi-Gas Meter with PID #2 =
Digital Manometer =
Pitot Tube =
Air Velocity Meter =

Test Well	Time	Air Velocity	Air Flow Rate	Air Flow Rate	Air Temperature	Vacuum	Vacuum	PID at Test Well	PID/Multi-Gas at Test Well	Vacuum (IWC) at Monitoring Points							
		(ft/min)	(acfm)	(scfm)	(F°)	(inHg)	(IWC)	(ppmv)	%LEL	VMP-1 (44.44 ft) [SI= 3' - 8']	VMP-2 (42.27 ft) [SI= 5' - 10']	VEP-1 (40.03 ft) [SI= 3' - 8']	VEP-2 (39.39 ft) [SI= 4' -9']	VMP-3 (10.16 ft) [vapor pin]	VMP-4 (17.74 ft) [SI= 2.5' - 3.5']	VMP-5 (0.00 ft) [SI= 2.5' - 3.5']	VMP-6 (24.99 ft) [vapor pin]
Flow-Vacuum Condition #1: Blower at 95% Capacity																	
VMP-5	1500			27		-2.26	30.8										
VMP-5	1531			24		-2.36	32.1			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Flow-Vacuum Condition #2: Blower at 50% Capacity																	
VMP-5	1540			16		-1.22	16.6	12.0						0.00	0.00	0.00	0.00
Flow-Vacuum Condition #3: Blower at 110% Capacity																	
VMP-5	1555			32		-2.66	36.8							0.10	0.00		0.00
VMP-5	1606			29		-2.61	35.7	18.0		0.00	0.00	0.00	0.00	0.10	0.00		0.00

Test Well	Time	PID at Monitoring Points (ppmv or ppbv)								PID/Multi-Gas at Monitoring Points %LEL							
		VMP-1 (44.44 ft) [SI= 3' - 8']	VMP-2 (42.27 ft) [SI= 5' - 10']	VEP-1 (40.03 ft) [SI= 3' - 8']	VEP-2 (39.39 ft) [SI= 4' -9']	VMP-3 (10.16 ft) [vapor pin]	VMP-4 (17.74 ft) [SI= 2.5' - 3.5']	VMP-5 (0.00 ft) [SI= 2.5' - 3.5']	VMP-6 (24.99 ft) [vapor pin]	VMP-1 (44.44 ft) [SI= 3' - 8']	VMP-2 (42.27 ft) [SI= 5' - 10']	VEP-1 (40.03 ft) [SI= 3' - 8']	VEP-2 (39.39 ft) [SI= 4' -9']	VMP-3 (10.16 ft) [vapor pin]	VMP-4 (17.74 ft) [SI= 2.5' - 3.5']	VMP-5 (0.00 ft) [SI= 2.5' - 3.5']	VMP-6 (24.99 ft) [vapor pin]
Flow-Vacuum Condition #1: Blower at 95% Capacity																	
VMP-5	1500																
VMP-5	1531																
Flow-Vacuum Condition #2: Blower at 50% Capacity																	
VMP-5	1540																
Flow-Vacuum Condition #3: Blower at 110% Capacity																	
VMP-5	1555																
VMP-5	1606																

Notes:
SSDS: Sub-Slab Depressurization System
LEL: Lower Explosive Limit %
ft/min - feet/minute

SI = screen interval
acfm = actual cubic feet per minute
scfm = standard cubic feet per minute
F° = Farenheit

%LEL = percent lower explosive limit
inHg = inch of mercury
IWC = inches of water column
ppmv = part per million

Table 5

SSDS Pilot Test Field Monitoring Data - Roots Blower Extraction from VEP-1

Former Tiger Oil West Nob Hill Boulevard Site

Yakima, WA

SSDS Pilot Test

Project No: 0204793-000 Task 04

Test Well: VEP-1 (SI = 3' - 8')
Date: 2/22/2023
Weather: cold (25° F), windy, dry
Comments: No detections on PID at nearby VMPs during VEP-1 extraction
EXTRACTION via ROOTS BLOWER, 10 Hp
Dilution valve 100% closed

Field Instrumentation Models & Calibration:
Multi-Gas Meter with PID #1 = MultiRAE Lite
Multi-Gas Meter with PID #2 = N.A.
Digital Manometer = Dwyer Series 477B Handheld Digital Manometer
Pitot Tube = N.A.
Air Velocity Meter = N.A.

Field Instrumentation Baseline Readings & Time:
Multi-Gas Meter with PID #1 =
Multi-Gas Meter with PID #2 =
Digital Manometer =
Pitot Tube =
Air Velocity Meter =

Test Well	Time	Air Velocity	Air Flow Rate	Air Flow Rate	Air Temperature	Vacuum	Vacuum	PID at Test Well	PID/Multi-Gas	Vacuum (IWC) at Monitoring Points							PID at Monitoring Points (ppmv)							PID/Multi-Gas at Monitoring Points %LEL						
		(ft/min)	(acfm)	(scfm)	(F°)	(inHg)	(IWC)	(ppmv)	%LEL	VMP-1 (11.03 ft) [SI= 3' - 8']	VMP-2 (30.72 ft) [SI= 5' - 10']	VEP-2 (21.28 ft) [SI= 4' - 9']	VMP-3 (40.01 ft) [SI= 2.5' - 3.5']	VMP-4 (50.39 ft) [vapor pin]	VMP-5 (41.44 ft) [SI= 2.5' - 3.5']	VMP-6 (18.80 ft) [vapor pin]	VMP-1 (11.03 ft) [SI= 3' - 8']	VMP-2 (30.72 ft) [SI= 5' - 10']	VEP-2 (21.28 ft) [SI= 4' - 9']	VMP-3 (40.01 ft) [SI= 2.5' - 3.5']	VMP-4 (50.39 ft) [vapor pin]	VMP-5 (41.44 ft) [SI= 2.5' - 3.5']	VMP-6 (18.80 ft) [vapor pin]	VMP-1 (11.03 ft) [SI= 3' - 8']	VMP-2 (30.72 ft) [SI= 5' - 10']	VEP-2 (21.28 ft) [SI= 4' - 9']	VMP-3 (40.01 ft) [SI= 2.5' - 3.5']	VMP-4 (50.39 ft) [vapor pin]	VMP-5 (41.44 ft) [SI= 2.5' - 3.5']	VMP-6 (18.80 ft) [vapor pin]
Flow-Vacuum Condition #1																														
VEP-1	1128			50		-6.5	88.3	470	7	0.0																				
VEP-1	1132			55		-5.92	80.5			0.0																				

Notes:
SSDS: Sub-Slab Depressurization System
LEL: Lower Explosive Limit %
ft/min - feet/minute

SI = screen interval
acfm = actual cubic feet per minute
scfm = standard cubic feet per minute
F° = Farenheit

%LEL = percent lower explosive limit
inHg = inch of mercury
IWC = inches of water column
ppmv = part per million

Table 6

SSDS Pilot Test Field Monitoring Data - Roots Blower Extraction from VEP-2

Former Tiger Oil West Nob Hill Boulevard Site

Yakima, WA

SSDS Pilot Test

Project No: 0204793-000 Task 04

Test Well: VEP-2 (SI = 4' - 9')
Date: 2/22/2023
Weather: cold (25° F), windy, dry
Comments: EXTRACTION via ROOTS BLOWER, 10 Hp
Dilution valve 100% closed

Field Instrumentation Models & Calibration:
Multi-Gas Meter with PID #1 = MultiRAE Lite
Multi-Gas Meter with PID #2 = N.A.
Digital Manometer = Dwyer Series 477B Handheld Digital Manometer
Pitot Tube = N.A.
Air Velocity Meter = N.A.

Field Instrumentation Basleine Readings & Time:
Multi-Gas Meter with PID #1 =
Multi-Gas Meter with PID #2 =
Digital Manometer =
Pitot Tube =
Air Velocity Meter =

Test Well	Time	Air Velocity	Air Flow Rate	Air Flow Rate	Air Temperature	Vacuum	Vacuum	PID at Test Well	PID/Multi-Gas at Test Well	Vacuum (IWC) at Monitoring Points							PID at Monitoring Points (ppmv or ppbv)							PID/Multi-Gas at Monitoring Points %LEL						
		(ft/min)	(acfm)	(scfm)	(F°)	(inHg)	(IWC)	(ppmv)	%LEL	VMP-1 (32.07 ft) [SI= 3' - 8']	VMP-2 (9.44 ft) [SI= 5' - 10']	VEP-1 (21.25 ft) [SI= 3' - 8']	VMP-3 (43.53 ft) [SI= 2.5' - 3.5']	VMP-4 (54.51 ft) [vapor pin]	VMP-5 (39.39 ft) [SI= 2.5' - 3.5']	VMP-6 (29.16 ft) [vapor pin]	VMP-1 (32.07 ft) [SI= 3' - 8']	VMP-2 (9.44 ft) [SI= 5' - 10']	VEP-1 (21.25 ft) [SI= 3' - 8']	VMP-3 (43.53 ft) [SI= 2.5' - 3.5']	VMP-4 (54.51 ft) [vapor pin]	VMP-5 (39.39 ft) [SI= 2.5' - 3.5']	VMP-6 (29.16 ft) [vapor pin]	VMP-1 (32.07 ft) [SI= 3' - 8']	VMP-2 (9.44 ft) [SI= 5' - 10']	VEP-1 (21.25 ft) [SI= 3' - 8']	VMP-3 (43.53 ft) [SI= 2.5' - 3.5']	VMP-4 (54.51 ft) [vapor pin]	VMP-5 (39.39 ft) [SI= 2.5' - 3.5']	VMP-6 (29.16 ft) [vapor pin]
Flow-Vacuum Condition #1																														
VEP-2	1233			55		-5.48	74.5	400	9		-0.3																			
VEP-2	1253			55							-0.3	0.0																		

Notes:
SSDS: Sub-Slab Depressurization System
LEL: Lower Explosive Limit %
ft/min - feet/minute
SI = screen interval
acfm = actual cubic feet per minute
scfm = standard cubic feet per minute
F° = Farenheit
%LEL = percent lower explosive limit
inHg = inch of mercury
IWC = inches of water column
ppmv = part per million

Table 7

SSDS Pilot Test Field Monitoring Data - Roots Blower Extraction from VMP-3

Former Tiger Oil West Nob Hill Boulevard Site

Yakima, WA

SSDS Pilot Test

Project No: 0204793-000 Task 04

Test Well: VMP-3 (SI = 2.5' - 3.5')
Date: 2/22/2023
Weather: cold (25° F), windy, dry
Comments: EXTRACTION via ROOTS BLOWER, 10 Hp

<u>Field Instrumentation Models & Calibration:</u>
Multi-Gas Meter with PID #1 = MultiRAE Lite
Multi-Gas Meter with PID #2 = N.A.
Digital Manometer = Dwyer Series 477B Handheld Digital Manometer
Pitot Tube = N.A.
Air Velocity Meter = N.A.

<u>Field Instrumentation Basleine Readings & Time:</u>
Multi-Gas Meter with PID #1 =
Multi-Gas Meter with PID #2 =
Digital Manometer =
Pitot Tube =
Air Velocity Meter =

Test Well	Time	Air Velocity	Air Flow Rate	Air Flow Rate	Air Temperature	Vacuum	Vacuum	PID at Test Well	PID/Multi-Gas at Test Well	Vacuum (IWC) at Monitoring Points						
		(ft/min)	(acfm)	(scfm)	(F°)	(inHg)	(IWC)	(ppmv)	%LEL	VMP-1 (40.85 ft) [SI= 3' - 8']	VMP-2 (48.18 ft) [SI= 5' - 10']	VEP-1 (38.92 ft) [SI= 3' - 8']	VEP-2 (43.53 ft) [SI= 4' -9']	VMP-4 (11.03 ft) [vapor pin]	VMP-5 (10.16 ft) [SI= 2.5' - 3.5']	VMP-6 (21.73 ft) [vapor pin]
Flow-Vacuum Condition #1: Dilution valve 75% Closed																
VMP-3	1019			17		-6.54	88.9							0.0	0.0	0.0
Flow-Vacuum Condition #2: Dilution Valve 100% Closed																
VMP-3	1030			33		-14.2	194.5							-0.1	0.0	0.0
VMP-3	1044					-14.0	189.8							-0.1	0.0	0.0

Test Well	Time	PID at Monitoring Points (ppmv or ppbv)							PID/Multi-Gas at Monitoring Points %LEL						
		VMP-1 (40.85 ft) [SI= 3' - 8']	VMP-2 (48.18 ft) [SI= 5' - 10']	VEP-1 (38.92 ft) [SI= 3' - 8']	VEP-2 (43.53 ft) [SI= 4' -9']	VMP-4 (11.03 ft) [vapor pin]	VMP-5 (10.16 ft) [SI= 2.5' - 3.5']	VMP-6 (21.73 ft) [vapor pin]	VMP-1 (40.85 ft) [SI= 3' - 8']	VMP-2 (48.18 ft) [SI= 5' - 10']	VEP-1 (38.92 ft) [SI= 3' - 8']	VEP-2 (43.53 ft) [SI= 4' -9']	VMP-4 (11.03 ft) [vapor pin]	VMP-5 (10.16 ft) [SI= 2.5' - 3.5']	VMP-6 (21.73 ft) [vapor pin]
VMP-3	1019														
VMP-3	1030														
VMP-3	1044														

Notes:
SSDS: Sub-Slab Depressurization System
LEL: Lower Explosive Limit %
ft/min - feet/minute

SI = screen interval
acfm = actual cubic feet per minute
scfm = standard cubic feet per minute
F° = Farenheit

%LEL = percent lower explosive limit
inHg = inch of mercury
IWC = inches of water column
ppmv = part per million

Table 8

SSDS Pilot Test Field Monitoring Data - Roots Blower Extraction from VMP-5

Former Tiger Oil West Nob Hill Boulevard Site

Yakima, WA

SSDS Pilot Test

Project No: 0204793-000 Task 04

Test Well: VMP-5 (SI = 2.5' - 3.5')
Date: 2/22/2023
Weather: cold (25° F), windy, dry
Comments: EXTRACTION via ROOTS BLOWER, 10 Hp
Dilution valve 100% closed

Field Instrumentation Models & Calibration:
Multi-Gas Meter with PID #1 = MultiRAE Lite
Multi-Gas Meter with PID #2 = N.A.
Digital Manometer = Dwyer Series 477B Handheld Digital Manometer
Pitot Tube = N.A.
Air Velocity Meter = N.A.

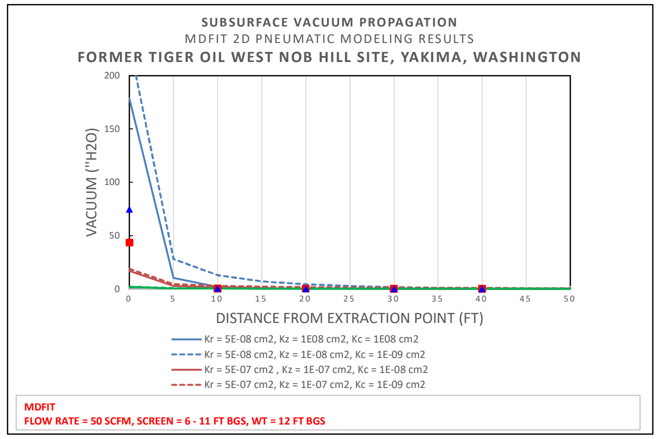
Field Instrumentation Basleine Readings & Time:
Multi-Gas Meter with PID #1 =
Multi-Gas Meter with PID #2 =
Digital Manometer =
Pitot Tube =
Air Velocity Meter =

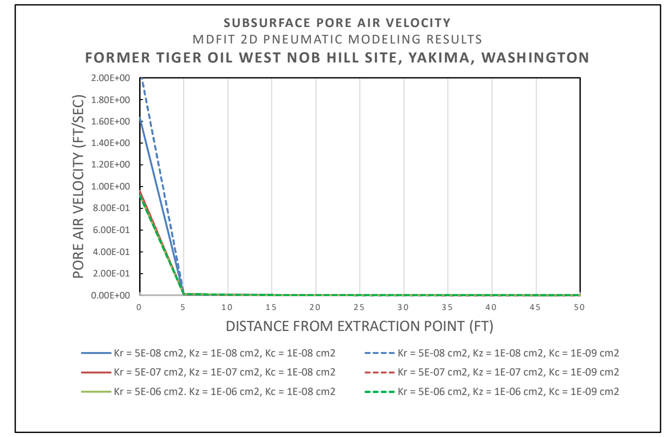
Test Well	Time	Air Velocity	Air Flow Rate	Air Flow Rate	Air Temperature	Vacuum	Vacuum	PID at Test Well	PID/Multi-Gas at Test Well	Vacuum (IWC) at Monitoring Points								PID at Monitoring Points (ppmv or ppbv)								PID/Multi-Gas at Monitoring Points %LEL							
		(ft/min)	(acfm)	(scfm)	(F°)	(inHg)	(IWC)	(ppmv)	%LEL	VMP-1 (44.44 ft) [SI= 3' - 8']	VMP-2 (42.27 ft) [SI= 5' - 10']	VEP-1 (40.03 ft) [SI= 3' - 8']	VEP-2 (39.39 ft) [SI= 4' -9']	VMP-3 (10.16 ft) [vapor pin]	VMP-4 (17.74 ft) [SI= 2.5' - 3.5']	VMP-5 (0.00 ft) [SI= 2.5' - 3.5']	VMP-6 (24.99 ft) [vapor pin]	VMP-1 (44.44 ft) [SI= 3' - 8']	VMP-2 (42.27 ft) [SI= 5' - 10']	VEP-1 (40.03 ft) [SI= 3' - 8']	VEP-2 (39.39 ft) [SI= 4' -9']	VMP-3 (10.16 ft) [vapor pin]	VMP-4 (17.74 ft) [SI= 2.5' - 3.5']	VMP-5 (0.00 ft) [SI= 2.5' - 3.5']	VMP-6 (24.99 ft) [vapor pin]	VMP-1 (44.44 ft) [SI= 3' - 8']	VMP-2 (42.27 ft) [SI= 5' - 10']	VEP-1 (40.03 ft) [SI= 3' - 8']	VEP-2 (39.39 ft) [SI= 4' -9']	VMP-3 (10.16 ft) [vapor pin]	VMP-4 (17.74 ft) [SI= 2.5' - 3.5']	VMP-5 (0.00 ft) [SI= 2.5' - 3.5']	VMP-6 (24.99 ft) [vapor pin]
Flow-Vacuum Condition #1: Dilution Valve 100% Closed																																	
VMP-5	1116					-4.78	65.0																										
VMP-5	1120					-5.31	72.2					0.0		0.1																			

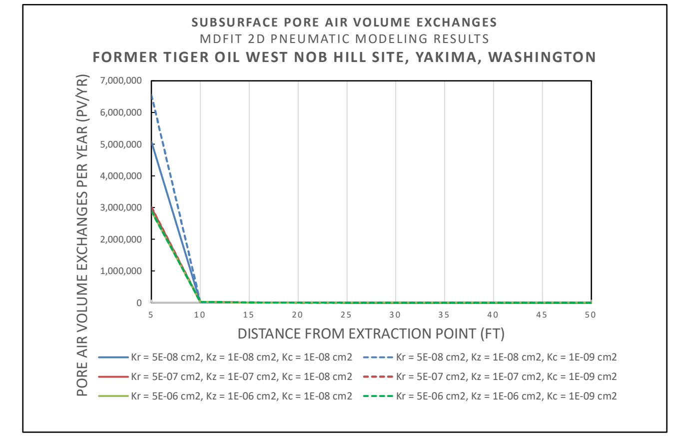
Notes:
SSDS: Sub-Slab Depressurization System
LEL: Lower Explosive Limit %
ft/min - feet/minute
SI = screen interval
acfm = actual cubic feet per minute
scfm = standard cubic feet per minute
F° = Farenheit
%LEL = percent lower explosive limit
inHg = inch of mercury
IWC = inches of water column
ppmv = part per million

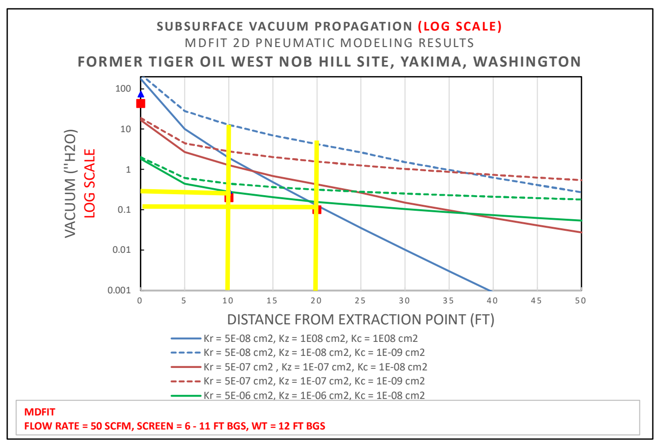
APPENDIX D
ROI Calculations and MDFIT^{TM} Pneumatic Modeling

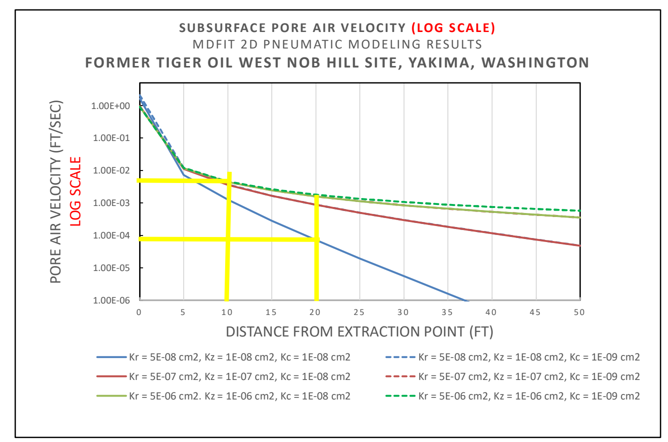
SUBSURFACE PNEUMATIC COMPUTER MODELING RESULT PLOTS
Pilot Scale SSDS Testing ROI Estimation
Former Tiger Oil West Nob Hill Site, Yakima, Washington

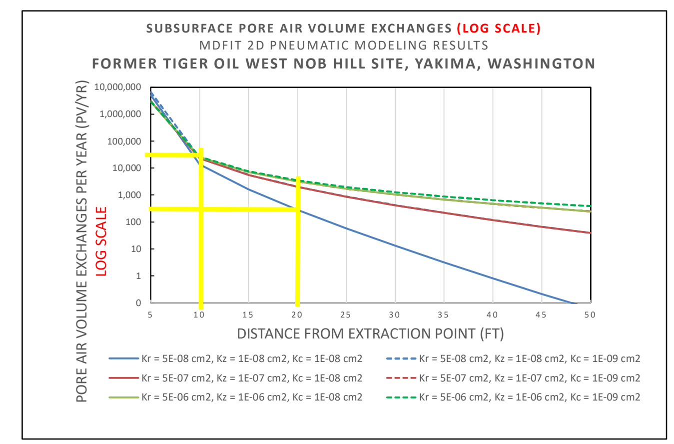






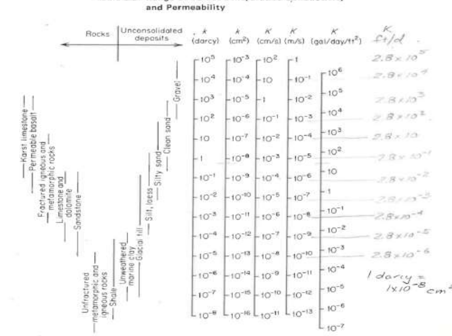






Notes:
Kr = Horizontal Air Intrinsic Permeability (Silty Sand - Sand - Gravel)
Kz = Vertical Air Intrinsic Permeability (Silty Sand - Sand - Gravel)
Kc = Upper (Surface) Confining Layer Air Intrinsic Permeability (Gravel Surface)

The literature permeability values for the silty sand/sandy silt (with sand and gravel layers) target lithology (i.e., 5E-08 to 5E-06 cm2) were taken from the "Groundwater" Handbook by Freeze and Cherry, 1979, Table 2-2, page



29 Physical Properties and Principles / Ch. 2

Table 2.2 Range of Values of Hydraulic Conductivity and Permeability

Rocks	Unconsolidated deposits	k (darcy)	k (cm²)	K (cm/s)	K (m/s)	K (gal/day/ft²)

1 darcy = 1x10⁻⁸ cm²

Table 2.3 Conversion Factors for Permeability and Hydraulic Conductivity Units

	Permeability, k*			Hydraulic conductivity, K		
	cm²	ft²	darcy	m/s	ft/s	U.S. gal/day/ft²
cm²	1	1.08×10^{-3}	1.01×10^{8}	9.80×10^{2}	3.22×10^{3}	1.85×10^{9}
ft²	9.29×10^{2}	1	9.42×10^{10}	9.11×10^{5}	2.99×10^{6}	1.71×10^{12}
darcy	9.87×10^{-9}	1.06×10^{-11}	1	9.66×10^{-6}	3.17×10^{-5}	1.82×10^{1}
m/s	1.02×10^{-3}	1.10×10^{-6}	1.04×10^{5}	1	3.28	2.12×10^{6}
ft/s	3.11×10^{-4}	3.35×10^{-7}	3.15×10^{4}	3.05×10^{-1}	1	6.46×10^{5}
U.S. gal/day/ft²	5.42×10^{-10}	5.83×10^{-13}	5.49×10^{-2}	4.72×10^{-7}	1.55×10^{-6}	1

*To obtain k in ft², multiply k in cm² by 1.08×10^{-3}.

SUBSURFACE PNEUMATIC COMPUTER MODELING RESULTS
Pilot Scale SSDS Testing ROI Estimation
Former Tiger Oil West Nob Hill Site, Yakima, Washington

F = 50 scfm K - 5E-08 cm2 KC = 1E-08 cm2

RADIUS (cm)	RADIUS (ft)	ELEVATIC (ft)	PRESS (atm.)	PRESS (in H20)	VELOCITY (ft/s)	Rotron Actual data
2.54E+00	0	8.50E+00	0.5613	178.5946	1.63E+00	43.3
1.55E+02	5	8.50E+00	0.9754	10.0245	7.36E-03	
3.07E+02	10	8.50E+00	0.9952	1.9527	1.25E-03	0.2
4.60E+02	15	8.50E+00	0.9988	0.4787	2.82E-04	
6.12E+02	20	8.50E+00	0.9997	0.1275	7.19E-05	0.1
7.65E+02	25	8.50E+00	0.9999	0.0355	1.95E-05	
9.17E+02	30	8.50E+00	1	0.0102	5.48E-06	0
1.07E+03	35	8.50E+00	1	0.003	1.58E-06	
1.22E+03	40	8.50E+00	1	0.0009	4.61E-07	0
1.37E+03	45	8.50E+00	1	0.0003	1.37E-07	
1.53E+03	50	8.50E+00	1	0.0001	4.09E-08	
1.68E+03	55	8.50E+00	1	0	1.24E-08	
1.83E+03	60	8.50E+00	1	0	3.76E-09	
1.98E+03	65	8.50E+00	1	0	1.15E-09	
2.14E+03	70	8.50E+00	1	0	3.54E-10	
2.29E+03	75	8.50E+00	1	0	1.09E-10	
2.44E+03	80	8.50E+00	1	0	3.39E-11	
2.59E+03	85	8.50E+00	1	0	1.05E-11	
2.75E+03	90	8.50E+00	1	0	3.29E-12	
2.90E+03	95	8.50E+00	1	0	1.03E-12	

RADIUS CM	RADIUS FT	TIME DAYS	PORE VOL/ YEAR	Roots Actual data
2.54E+00	8.33E-02	0.00E+00	0	74.5
1.55E+02	5.08E+00	7.06E-05	5083263	
3.07E+02	1.01E+01	1.35E-02	13459.04	0.3
4.60E+02	1.51E+01	8.91E-02	1601.34	
6.12E+02	2.01E+01	4.16E-01	278.03	0
7.65E+02	2.51E+01	1.68E+00	57.47	
9.17E+02	3.01E+01	6.32E+00	13.09	0
1.07E+03	3.51E+01	2.27E+01	3.17	
1.22E+03	4.01E+01	7.95E+01	0.8	0
1.37E+03	4.51E+01	2.73E+02	0.21	
1.53E+03	5.01E+01	9.24E+02	0.06	
1.68E+03	5.51E+01	3.10E+03	0.02	
1.83E+03	6.01E+01	1.03E+04	0	
1.98E+03	6.51E+01	3.39E+04	0	
2.14E+03	7.01E+01	1.11E+05	0	
2.29E+03	7.51E+01	3.61E+05	0	
2.44E+03	8.01E+01	1.17E+06	0	
2.59E+03	8.51E+01	3.78E+06	0	
2.75E+03	9.01E+01	1.22E+07	0	
2.90E+03	9.51E+01	3.90E+07	0	

F = 50 scfm K - 5E-07 cm2 KC = 1E-08 cm2

RADIUS (cm)	RADIUS (ft)	ELEVATIC (ft)	PRESS (atm.)	PRESS (in H20)	VELOCITY (ft/s)
2.54E+00	8.33E-02	8.50E+00	0.9587	16.8316	9.55E-01
1.55E+02	5.08E+00	8.50E+00	0.9933	2.7091	1.10E-02
3.07E+02	1.01E+01	8.50E+00	0.9969	1.2585	3.58E-03
4.60E+02	1.51E+01	8.50E+00	0.9983	0.6886	1.64E-03
6.12E+02	2.01E+01	8.50E+00	0.999	0.4232	8.72E-04
7.65E+02	2.51E+01	8.50E+00	0.9994	0.264	4.98E-04
9.17E+02	3.01E+01	8.50E+00	0.9996	0.1507	2.98E-04
1.07E+03	3.51E+01	8.50E+00	0.9998	0.0965	1.84E-04
1.22E+03	4.01E+01	8.50E+00	0.9998	0.0626	1.16E-04
1.37E+03	4.51E+01	8.50E+00	0.9999	0.0411	7.45E-05
1.53E+03	5.01E+01	8.50E+00	0.9999	0.0272	4.84E-05
1.68E+03	5.51E+01	8.50E+00	1	0.0181	3.18E-05
1.83E+03	6.01E+01	8.50E+00	1	0.0121	2.10E-05
1.98E+03	6.51E+01	8.50E+00	1	0.0082	1.40E-05
2.14E+03	7.01E+01	8.50E+00	1	0.0055	9.37E-06
2.29E+03	7.51E+01	8.50E+00	1	0.0037	6.30E-06
2.44E+03	8.01E+01	8.50E+00	1	0.0025	4.25E-06
2.59E+03	8.51E+01	8.50E+00	1	0.0017	2.87E-06
2.75E+03	9.01E+01	8.50E+00	1	0.0012	1.95E-06
2.90E+03	9.51E+01	8.50E+00	1	0.0008	1.32E-06

RADIUS CM	RADIUS FT	TIME DAYS	PORE VOL/ YEAR
2.54E+00	8.33E-02	0.00E+00	0
1.55E+02	5.08E+00	1.20E-04	2997043
3.07E+02	1.01E+01	8.06E-03	22794.54
4.60E+02	1.51E+01	3.02E-02	5459.13
6.12E+02	2.01E+01	7.63E-02	1973.75
7.65E+02	2.51E+01	1.61E-01	860.96
9.17E+02	3.01E+01	3.06E-01	417.29
1.07E+03	3.51E+01	5.46E-01	216.59
1.22E+03	4.01E+01	9.32E-01	118
1.37E+03	4.51E+01	1.54E+00	66.65
1.53E+03	5.01E+01	2.48E+00	38.7
1.68E+03	5.51E+01	3.92E+00	22.96
1.83E+03	6.01E+01	6.11E+00	13.86
1.98E+03	6.51E+01	9.42E+00	8.49
2.14E+03	7.01E+01	1.44E+01	5.26
2.29E+03	7.51E+01	2.18E+01	3.29
2.44E+03	8.01E+01	3.27E+01	2.08
2.59E+03	8.51E+01	4.90E+01	1.32
2.75E+03	9.01E+01	7.30E+01	0.84
2.90E+03	9.51E+01	1.08E+02	0.54

F = 50 scfm K - 5E-06 cm2 KC = 1E-08 cm2

RADIUS (cm)	RADIUS (ft)	ELEVATIC (ft)	PRESS (atm.)	PRESS (in H20)	VELOCITY (ft/s)
2.54E+00	0.1	8.50E+00	0.9955	1.839	9.20E-01
1.55E+02	5.1	8.50E+00	0.9989	0.4428	1.18E-02
3.07E+02	10.1	8.50E+00	0.9993	0.2778	4.43E-03
4.60E+02	15.1	8.50E+00	0.9995	0.2026	2.44E-03
6.12E+02	20.1	8.50E+00	0.9996	0.156	1.59E-03
7.65E+02	25.1	8.50E+00	0.9997	0.1254	1.13E-03
9.17E+02	30.1	8.50E+00	0.9997	0.1031	8.47E-04
1.07E+03	35.1	8.50E+00	0.9998	0.0862	6.60E-04
1.22E+03	40.1	8.50E+00	0.9998	0.073	5.28E-04
1.37E+03	45.1	8.50E+00	0.9998	0.0625	4.30E-04
1.53E+03	50.1	8.50E+00	0.9999	0.0539	3.55E-04
1.68E+03	55.1	8.50E+00	0.9999	0.0469	2.96E-04
1.83E+03	60.1	8.50E+00	0.9999	0.041	2.49E-04
1.98E+03	65.1	8.50E+00	0.9999	0.036	2.11E-04
2.14E+03	70.1	8.50E+00	0.9999	0.0316	1.79E-04
2.29E+03	75.1	8.50E+00	0.9999	0.0275	1.53E-04
2.44E+03	80.1	8.50E+00	0.9999	0.0237	1.31E-04
2.59E+03	85.1	8.50E+00	1	0.0198	1.13E-04
2.75E+03	90.1	8.50E+00	1	0.0162	9.71E-05
2.90E+03	95.1	8.50E+00	1	0.0141	8.38E-05

RADIUS CM	RADIUS FT	TIME DAYS	PORE VOL/ YEAR
2.54E+00	8.33E-02	0.00E+00	0
1.55E+02	5.08E+00	1.24E-04	2889778
3.07E+02	1.01E+01	7.28E-03	25302.65
4.60E+02	1.51E+01	2.41E-02	7176.33
6.12E+02	2.01E+01	5.29E-02	3160.23
7.65E+02	2.51E+01	9.55E-02	1706.54
9.17E+02	3.01E+01	1.54E-01	1035.41
1.07E+03	3.51E+01	2.31E-01	677.62
1.22E+03	4.01E+01	3.28E-01	467.46
1.37E+03	4.51E+01	4.49E-01	335.07
1.53E+03	5.01E+01	5.97E-01	247.16
1.68E+03	5.51E+01	7.74E-01	186.4
1.83E+03	6.01E+01	9.87E-01	143.06
1.98E+03	6.51E+01	1.24E+00	111.35
2.14E+03	7.01E+01	1.54E+00	87.69
2.29E+03	7.51E+01	1.88E+00	69.74
2.44E+03	8.01E+01	2.29E+00	55.92
2.59E+03	8.51E+01	2.77E+00	45.17
2.75E+03	9.01E+01	3.32E+00	36.71
2.90E+03	9.51E+01	3.96E+00	30

F = 50 scfm K - 5E-08 cm2 KC = 1E-09 cm2

RADIUS (cm)	RADIUS (ft)	ELEVATIC (ft)	PRESS (atm.)	PRESS (in H20)	VELOCITY (ft/s)
2.54E+00	0	8.50E+00	0.4361	229.5608	2.10E+00
1.55E+02	5	8.50E+00	0.9313	27.9612	1.17E-02
3.07E+02	10	8.50E+00	0.9686	12.7657	3.68E-03
4.60E+02	15	8.50E+00	0.983	6.9396	1.67E-03
6.12E+02	20	8.50E+00	0.9896	4.2523	8.80E-04
7.65E+02	25	8.50E+00	0.9935	2.6479	5.01E-04
9.17E+02	30	8.50E+00	0.9963	1.5093	2.99E-04
1.07E+03	35	8.50E+00	0.9976	0.9655	1.84E-04
1.22E+03	40	8.50E+00	0.9985	0.6266	1.16E-04
1.37E+03	45	8.50E+00	0.999	0.411	7.46E-05
1.53E+03	50	8.50E+00	0.9993	0.2719	4.85E-05
1.68E+03	55	8.50E+00	0.9996	0.1811	3.18E-05
1.83E+03	60	8.50E+00	0.9997	0.1212	2.10E-05
1.98E+03	65	8.50E+00	0.9998	0.0815	1.40E-05
2.14E+03	70	8.50E+00	0.9999	0.055	9.37E-06
2.29E+03	75	8.50E+00	0.9999	0.0372	6.30E-06
2.44E+03	80	8.50E+00	0.9999	0.0252	4.25E-06
2.59E+03	85	8.50E+00	1	0.0171	2.87E-06
2.75E+03	90	8.50E+00	1	0.0117	1.95E-06
2.90E+03	95	8.50E+00	1	0.008	1.32E-06

RADIUS CM	RADIUS FT	TIME DAYS	PORE VOL/ YEAR
2.54E+00	8.33E-02	0.00E+00	0
1.55E+02	5.08E+00	5.48E-05	6549526
3.07E+02	1.01E+01	7.56E-03	24103.27
4.60E+02	1.51E+01	2.92E-02	5595.16
6.12E+02	2.01E+01	7.46E-02	2000.4
7.65E+02	2.51E+01	1.58E-01	868.02
9.17E+02	3.01E+01	3.03E-01	419.35
1.07E+03	3.51E+01	5.43E-01	217.22
1.22E+03	4.01E+01	9.28E-01	118.22
1.37E+03	4.51E+01	1.53E+00	66.73
1.53E+03	5.01E+01	2.48E+00	38.73
1.68E+03	5.51E+01	3.92E+00	22.97
1.83E+03	6.01E+01	6.11E+00	13.87
1.98E+03	6.51E+01	9.41E+00	8.49
2.14E+03	7.01E+01	1.44E+01	5.26
2.29E+03	7.51E+01	2.17E+01	3.29
2.44E+03	8.01E+01	3.27E+01	2.08
2.59E+03	8.51E+01	4.90E+01	1.32
2.75E+03	9.01E+01	7.30E+01	0.84
2.90E+03	9.51E+01	1.08E+02	0.54

F = 50 scfm K - 5E-07 cm2 KC = 1E-09 cm2

RADIUS (cm)	RADIUS (ft)	ELEVATIC (ft)	PRESS (atm.)	PRESS (in H20)	VELOCITY (ft/s)
2.54E+00	8.33E-02	8.50E+00	0.9539	18.7815	9.60E-01
1.55E+02	5.08E+00	8.50E+00	0.9891	4.4499	1.19E-02
3.07E+02	1.01E+01	8.50E+00	0.9932	2.7862	4.45E-03
4.60E+02	1.51E+01	8.50E+00	0.995	2.0307	2.45E-03
6.12E+02	2.01E+01	8.50E+00	0.9962	1.5623	1.59E-03
7.65E+02	2.51E+01	8.50E+00	0.9969	1.2555	1.13E-03
9.17E+02	3.01E+01	8.50E+00	0.9975	1.0324	8.49E-04
1.07E+03	3.51E+01	8.50E+00	0.9979	0.8631	6.62E-04
1.22E+03	4.01E+01	8.50E+00	0.9982	0.7308	5.29E-04
1.37E+03	4.51E+01	8.50E+00	0.9985	0.6253	4.31E-04
1.53E+03	5.01E+01	8.50E+00	0.9987	0.5397	3.56E-04
1.68E+03	5.51E+01	8.50E+00	0.9988	0.4694	2.96E-04
1.83E+03	6.01E+01	8.50E+00	0.999	0.4106	2.49E-04
1.98E+03	6.51E+01	8.50E+00	0.9991	0.3602	2.11E-04
2.14E+03	7.01E+01	8.50E+00	0.9992	0.3159	1.79E-04
2.29E+03	7.51E+01	8.50E+00	0.9993	0.2754	1.53E-04
2.44E+03	8.01E+01	8.50E+00	0.9994	0.2365	1.31E-04
2.59E+03	8.51E+01	8.50E+00	0.9995	0.1975	1.13E-04
2.75E+03	9.01E+01	8.50E+00	0.9996	0.1617	9.71E-05
2.90E+03	9.51E+01	8.50E+00	0.9997	0.1409	8.39E-05

RADIUS CM	RADIUS FT	TIME DAYS	PORE VOL/ YEAR
2.54E+00	8.33E-02	0.00E+00	0
1.55E+02	5.08E+00	1.19E-04	3014633
3.07E+02	1.01E+01	7.21E-03	25528.53
4.60E+02	1.51E+01	2.40E-02	7216.54
6.12E+02	2.01E+01	5.26E-02	3173.19
7.65E+02	2.51E+01	9.51E-02	1711.97
9.17E+02	3.01E+01	1.54E-01	1038.07
1.07E+03	3.51E+01	2.30E-01	679.06
1.22E+03	4.01E+01	3.27E-01	468.29
1.37E+03	4.51E+01	4.48E-01	335.57
1.53E+03	5.01E+01	5.95E-01	247.48
1.68E+03	5.51E+01	7.73E-01	186.61
1.83E+03	6.01E+01	9.85E-01	143.2
1.98E+03	6.51E+01	1.24E+00	111.45
2.14E+03	7.01E+01	1.53E+00	87.76
2.29E+03	7.51E+01	1.88E+00	69.78
2.44E+03	8.01E+01	2.29E+00	55.95
2.59E+03	8.51E+01	2.76E+00	45.19
2.75E+03	9.01E+01	3.32E+00	36.73
2.90E+03	9.51E+01	3.95E+00	30.01

F = 50 scfm K - 5E-06 cm2 KC = 1E-09 cm2

RADIUS (cm)	RADIUS (ft)	ELEVATIC (ft)	PRESS (atm.)	PRESS (in H20)	VELOCITY (ft/s)
2.54E+00	8.33E-02	8.50E+00	0.9951	2.0113	9.20E-01
1.55E+02	5.08E+00	8.50E+00	0.9985	0.6126	1.19E-02
3.07E+02	1.01E+01	8.50E+00	0.9989	0.4441	4.59E-03
4.60E+02	1.51E+01	8.50E+00	0.9991	0.365	2.63E-03
6.12E+02	2.01E+01	8.50E+00	0.9992	0.3135	1.79E-03
7.65E+02	2.51E+01	8.50E+00	0.9993	0.278	1.34E-03
9.17E+02	3.01E+01	8.50E+00	0.9994	0.2505	1.07E-03
1.07E+03	3.51E+01	8.50E+00	0.9994	0.2281	8.84E-04
1.22E+03	4.01E+01	8.50E+00	0.9995	0.2094	7.53E-04
1.37E+03	4.51E+01	8.50E+00	0.9995	0.1933	6.53E-04
1.53E+03	5.01E+01	8.50E+00	0.9996	0.1792	5.75E-04
1.68E+03	5.51E+01	8.50E+00	0.9996	0.1668	5.12E-04
1.83E+03	6.01E+01	8.50E+00	0.9996	0.1557	4.60E-04
1.98E+03	6.51E+01	8.50E+00	0.9996	0.1456	4.17E-04
2.14E+03	7.01E+01	8.50E+00	0.9997	0.1365	3.79E-04
2.29E+03	7.51E+01	8.50E+00	0.9997	0.1282	3.47E-04
2.44E+03	8.01E+01	8.50E+00	0.9997	0.1207	3.18E-04
2.59E+03	8.51E+01	8.50E+00	0.9997	0.1137	2.93E-04
2.75E+03	9.01E+01	8.50E+00	0.9997	0.1073	2.71E-04
2.90E+03	9.51E+01	8.50E+00	0.9998	0.1014	2.51E-04

RADIUS CM	RADIUS FT	TIME DAYS	PORE VOL/ YEAR
2.54E+00	8.33E-02	0.00E+00	0
1.55E+02	5.08E+00	1.24E-04	2891395
3.07E+02	1.01E+01	7.15E-03	25767.27
4.60E+02	1.51E+01	2.32E-02	7549.88
6.12E+02	2.01E+01	4.94E-02	3471.04
7.65E+02	2.51E+01	8.63E-02	1971.15
9.17E+02	3.01E+01	1.34E-01	1264.25
1.07E+03	3.51E+01	1.94E-01	877.73
1.22E+03	4.01E+01	2.64E-01	643.9
1.37E+03	4.51E+01	3.47E-01	491.61
1.53E+03	5.01E+01	4.41E-01	386.74
1.68E+03	5.51E+01	5.47E-01	311.36
1.83E+03	6.01E+01	6.66E-01	255.31
1.98E+03	6.51E+01	7.98E-01	212.48
2.14E+03	7.01E+01	9.44E-01	179.04
2.29E+03	7.51E+01	1.10E+00	152.44
2.44E+03	8.01E+01	1.28E+00	130.95
2.59E+03	8.51E+01	1.47E+00	113.36
2.75E+03	9.01E+01	1.67E+00	98.8
2.90E+03	9.51E+01	1.89E+00	86.63

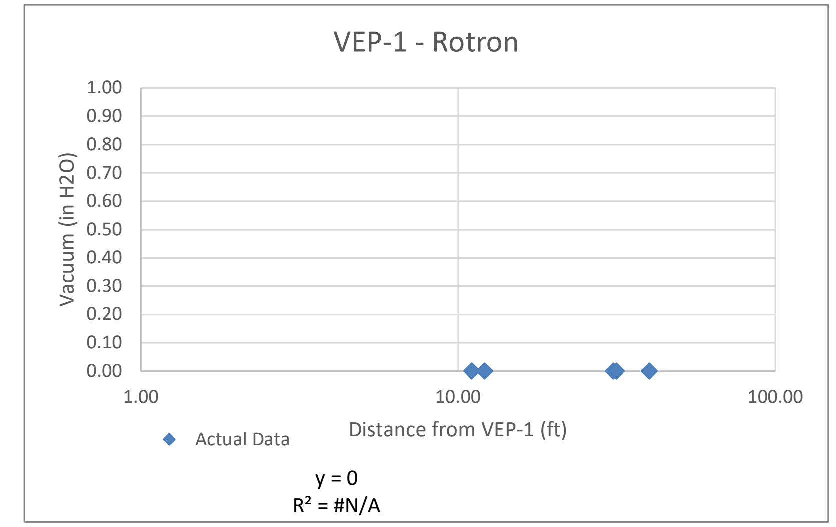
APPENDIX D

Linear Regression Model
Data Sets, Plots, and Equations

Rotron blower test

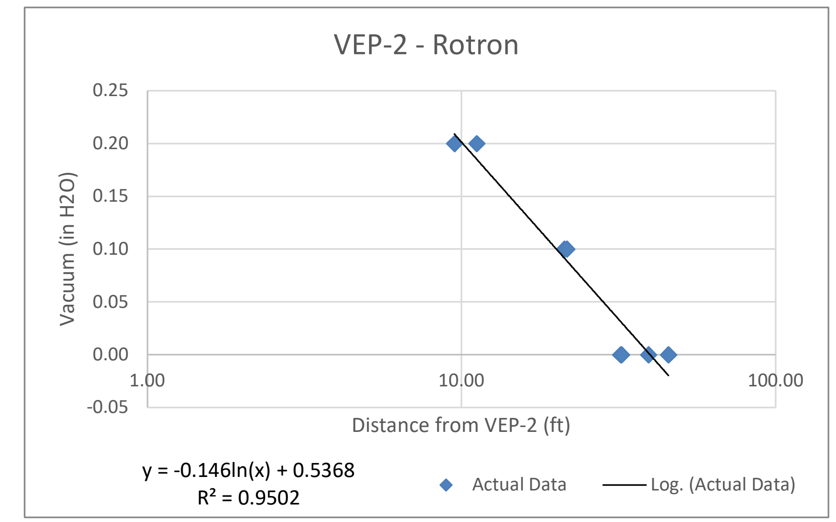
Well ID		Well Head Vacuum	Upper Screen interval	Lower Screen interval
VEP-1		68.00	3	8
Probe ID		**Final vacuum**	**Horizontal distance**	**Distance to screen**
VMP-1	3	0.00	11.03	11.03
	8	0.00	11.03	12.11
VMP-2	5	0.00	30.72	30.79
	10	0.00	30.72	31.51
VMP-3	2.5	0.00	40.01	40.01
	3.5	0.00	40.01	40.01
VMP-5	2.5	0.00	41.44	41.44
	3.5	0.00	41.44	41.44
VEP-2	4	0.00	21.28	21.30
	9	0.00	21.28	22.11

Y = mLnx+b = Equation of a Line
From graph:
Y = 0.1000 inWC (1% of well head vacuum selected as minimum vacuum rating)
m = 0
b = 0
x = ROI = #DIV/0! feet



Well ID		Well Head Vacuum	Upper Screen interval	Lower Screen interval
VEP-2		43.30	4	9
Probe ID		**Final vacuum**	**Horizontal distance**	**Distance to screen**
VMP-1	3	0.00	32.07	32.09
	8	0.00	32.07	32.32
VMP-2	5	0.20	9.44	9.49
	10	0.20	9.44	11.19
VEP-1	3	0.10	21.25	21.27
	8	0.10	21.25	21.62
VMP-3	2.5	0.00	45.53	45.55
	3.5	0.00	45.53	45.53
VMP-5	2.5	0.00	39.39	39.42
	3.5	0.00	39.39	39.39

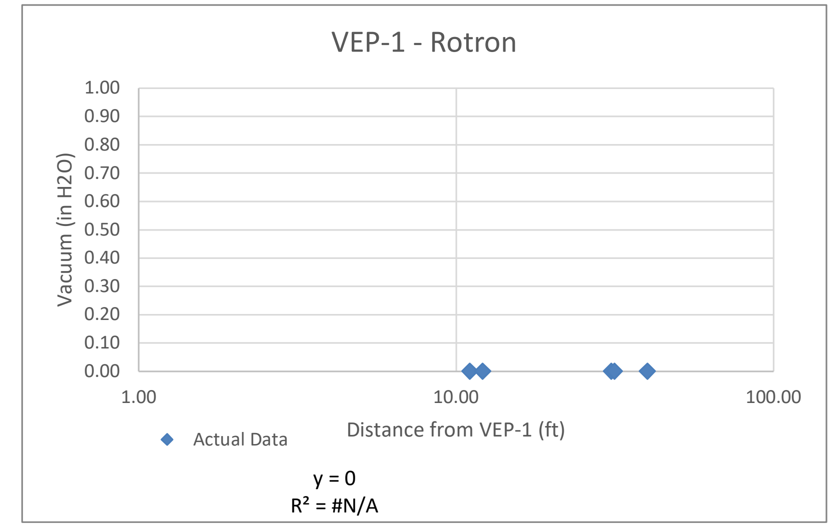
Y = mLnx+b = Equation of a Line
From graph:
Y = 0.1000 inWC (1% of well head vacuum selected as minimum vacuum rating)
m = -0.146
b = 0.5368
x = ROI = 20 feet



Roots blower test

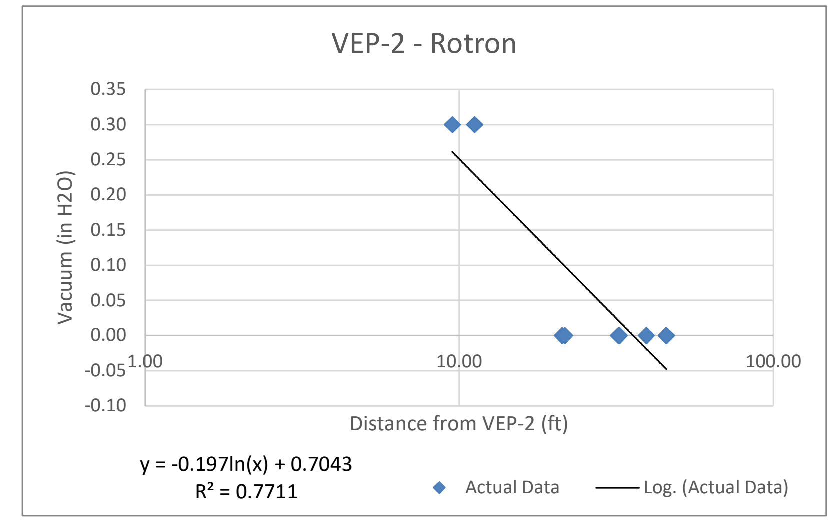
Well ID		Well Head Vacuum	Upper Screen interval	Lower Screen interval
VEP-1		88.30	3	8
Probe ID		**Final vacuum**	**Horizontal distance**	**Distance to screen**
VMP-1	3	0.00	11.03	11.03
	8	0.00	11.03	12.11
VMP-2	5	0.00	30.72	30.79
	10	0.00	30.72	31.51
VMP-3	2.5	0.00	40.01	40.01
	3.5	0.00	40.01	40.01
VMP-5	2.5	0.00	41.44	41.44
	3.5	0.00	41.44	41.44
VEP-2	4	0.00	21.28	21.30
	9	0.00	21.28	22.11

Y = mLnx+b = Equation of a Line
From graph:
Y = 0.1000 inWC (1% of well head vacuum selected as minimum vacuum rating)
m = 0
b = 0
x = ROI = #DIV/0! feet



Well ID		Well Head Vacuum	Upper Screen interval	Lower Screen interval
VEP-2		74.50	4	9
Probe ID		**Final vacuum**	**Horizontal distance**	**Distance to screen**
VMP-1	3	0.00	32.07	32.09
	8	0.00	32.07	32.32
VMP-2	5	0.30	9.44	9.49
	10	0.30	9.44	11.19
VEP-1	3	0.00	21.25	21.27
	8	0.00	21.25	21.62
VMP-3	2.5	0.00	45.53	45.55
	3.5	0.00	45.53	45.53
VMP-5	2.5	0.00	39.39	39.42
	3.5	0.00	39.39	39.39

Y = mLnx+b = Equation of a Line
From graph:
Y = 0.1000 inWC (1% of well head vacuum selected as minimum vacuum rating)
m = -0.197
b = 0.7043
x = ROI = 21 feet



APPENDIX D

ROI CALCULATIONS AND SUBSURFACE PNEUMATIC COMPUTER MODELING

APPROACH, PROCEDURES, AND RESULTS

Pilot Scale SSDS Testing ROI Estimation

Former Tiger Oil West Nob Hill Site, Yakima, Washington

Approach

- The February 2023 SSDS pilot test data was used as input to a linear regression model and subsurface pneumatic computer model (MDFIT) to determine design parameters (i.e., vapor extraction well radius of influence [ROI], subsurface vacuum distribution, subsurface pore air/vapor volume exchanges per year [PV Per Year], and subsurface pore air/vapor velocity distribution, etc.) for the full-scale SSDS system.

Objectives

- Predict air flow rate and vacuum/pressure distribution in the subsurface
- Predict the system's performance under varying subsurface conditions
- Determine system design and operational parameters
- Estimate the vapor extraction well ROI and other design parameters for the full-scale SSDS system

Inputs

- February 2023 SSDS pilot testing data
- MDFIT computer modeling inputs
- Linear regression model inputs
- Other MDFIT Model Inputs:
    - Vapor extraction air flow rate = 50 scfm
    - Well diameter = 2 inches
    - Well screen interval = 6 – 11 ft bgs
    - Water table = 12 ft bgs
    - Soil porosity = 0.35 (assumed)
- Subsurface air flow field simulation depth = 8.5 feet bgs (selected)

MDFIT Modeling Step 1 Procedures and Outputs: Air Intrinsic Permeability Estimation

- Air intrinsic permeability, K
- Kr = Horizontal air intrinsic permeability
- Kz = Vertical air intrinsic permeability

APPENDIX D

- Model estimated Kr and Kz values: Kr = Kz:

	6.65E-08 cm2
	8.85E-08 cm2
	1.07E-07 cm2
	8.85E-08 cm2
	8.85E-08 cm2
Average Kr value:	**8.78E-08 cm2**

- The model estimated average Kr value was also compared with the literature permeability values for the silty sand/sandy silt (with sand and gravel layers) target lithology (i.e., Kr = horizontal air intrinsic permeability range = 5E-08 to 5E-06 cm2 - "Groundwater" Handbook by Freeze and Cherry, 1979, Table 2-2, page 29.). The model estimated average Kr value matched closely with the lower range of the literature permeability values.

- **Selected permeability values for design simulation runs:**

  Kr = Horizontal air intrinsic permeability range = 5E-08 to 5E-06 cm2
  Kz = Vertical air intrinsic permeability range = 1E-08 to 1E-06 cm2; assumed to be slightly lower than Kr (assumed)
  Kc = Air intrinsic permeability of the upper surface confining layer (gravel surface), range = 1E-09 cm2 to 1E-08 cm2 (assumed)

MDFIT Modeling Step 2 Procedures and Outputs: Design Simulation Runs and Outputs

- Radius of Influence (ROI)
- Pore air volume exchanges (PV)
- Design air flow rates
- Vacuum/pressure propagation in the subsurface
- A minimum subsurface vacuum/pressure distribution criterion of 0.1 inches of water (in. H_2O) from the vapor extraction point was selected as the design basis.

- **Estimated ROI range = 10 to 20 feet**

- **Observed ROI from the February 2023 SSDS Pilot Testing Results**

  Based on the subsurface vacuum propagation response measurements taken during pilot testing, a conservative ROI of 9.44 feet (rounded to 10 feet) was observed where at least the selected threshold vacuum response of 0.1 inH2O was achieved. Therefore, this conservative ROI of 10 feet was selected for the design of the full-scale vapor intrusion mitigation system for the Site.

APPENDIX D

- **Subsurface pore air velocity distribution, Vi @ an ROI range of 10 to 20 feet =**
  4.43E-03 ft/sec (10 feet ROI)
  7.19E-05 ft/sec (20 feet ROI)

- **Estimated subsurface pore air volume exchanges per year, *PV*/year @ @ an ROI range of 10 to 20 feet =**
  25,302 PV/year (10 feet ROI)
  278 PV/year (20 feet ROI)

<u>**Linear Regression Model Step Procedures**</u>

- Step 1: - Create a semi-log Distance Vacuum plot based on observed vacuum at monitoring points and distances from extraction well
- Step 2: Format a trendline to the plot data
- Step 3: Select a minimum threshold subsurface vacuum/pressure distribution criterion (0.1 inches of water [in. H_20])
- Step 4: Use the equation of the trendline in combination with the minimum threshold vacuum to estimate the extraction point radius of influence (ROI)

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          Welcom to FSS program
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   ----- Simulated Scenario -----    1


Simulating information:

Depth to the top of screen (ft)          =          .6000E+01

Depth to the bottom of screen (ft)       =          .1100E+02

Depth to the groundwater table (ft)      =          .1200E+02

Depth to the simulated elevation(ft)     =          .8500E+01

Radius of the simulating well (in. )     =          .1000E+01

Temperature of the soil ( C )            =          .2500E+02

Flow rate of pumping/injection well( cfm )=         .5000E+02

Soil porosity( Dimensionless )           =          .3500E+00

Peameability for R direction ( cm**2 )   =          .5000E-07

Peameability for Z direction ( cm**2 )   =          .1000E-07

Peameability  Kc/Bc                      =          .1000E-08


 Aquifer geological structure properties
```

1: Aquifer is anisotropic.
2: There is a upper confining unit.

************************ OUTPUT ********************************

RADIUS (cm)	RADIUS (ft)	ELEVATION (ft)	PRESS (atm.)	PRESS (in H20)	VELOCITY (ft/s)
.254E+01	.833E-01	.850E+01	.5613	178.5946	.1631E+01
.155E+03	.508E+01	.850E+01	.9754	10.0245	.7357E-02
.307E+03	.101E+02	.850E+01	.9952	1.9527	.1250E-02
.460E+03	.151E+02	.850E+01	.9988	.4787	.2822E-03
.612E+03	.201E+02	.850E+01	.9997	.1275	.7192E-04
.765E+03	.251E+02	.850E+01	.9999	.0355	.1950E-04
.917E+03	.301E+02	.850E+01	1.0000	.0102	.5480E-05
.107E+04	.351E+02	.850E+01	1.0000	.0030	.1577E-05
.122E+04	.401E+02	.850E+01	1.0000	.0009	.4614E-06
.137E+04	.451E+02	.850E+01	1.0000	.0003	.1367E-06
.153E+04	.501E+02	.850E+01	1.0000	.0001	.4094E-07
.168E+04	.551E+02	.850E+01	1.0000	.0000	.1236E-07
.183E+04	.601E+02	.850E+01	1.0000	.0000	.3759E-08
.198E+04	.651E+02	.850E+01	1.0000	.0000	.1150E-08
.214E+04	.701E+02	.850E+01	1.0000	.0000	.3535E-09
.229E+04	.751E+02	.850E+01	1.0000	.0000	.1092E-09
.244E+04	.801E+02	.850E+01	1.0000	.0000	.3385E-10
.259E+04	.851E+02	.850E+01	1.0000	.0000	.1053E-10
.275E+04	.901E+02	.850E+01	1.0000	.0000	.3286E-11
.290E+04	.951E+02	.850E+01	1.0000	.0000	.1028E-11

---------- Simulation finished ----------

----- Simulated Scenario ----- 1

************************ OUTPUT ********************************

RADIUS CM	RADIUS FT	TIME DAYS	PORE VOL/ YEAR
.254E+01	.833E-01	.000000E+00	.00
.155E+03	.508E+01	.706272E-04	5083263.00
.307E+03	.101E+02	.135182E-01	13459.04
.460E+03	.151E+02	.890764E-01	1601.34
.612E+03	.201E+02	.415917E+00	278.03
.765E+03	.251E+02	.168197E+01	57.47
.917E+03	.301E+02	.631570E+01	13.09
.107E+04	.351E+02	.227178E+02	3.17
.122E+04	.401E+02	.795079E+02	.80
.137E+04	.451E+02	.273025E+03	.21
.153E+04	.501E+02	.924430E+03	.06
.168E+04	.551E+02	.309577E+04	.02
.183E+04	.601E+02	.102753E+05	.00
.198E+04	.651E+02	.338540E+05	.00
.214E+04	.701E+02	.110843E+06	.00
.229E+04	.751E+02	.360979E+06	.00
.244E+04	.801E+02	.117014E+07	.00
.259E+04	.851E+02	.377784E+07	.00
.275E+04	.901E+02	.121537E+08	.00
.290E+04	.951E+02	.389781E+08	.00

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----- Simulated Scenario -----   1

Simulating information:

Depth to the top of screen (ft)	=	.6000E+01
Depth to the bottom of screen (ft)	=	.1100E+02
Depth to the groundwater table (ft)	=	.1200E+02
Depth to the simulated elevation(ft)	=	.8500E+01
Radius of the simulating well (in.)	=	.1000E+01
Temperature of the soil (C)	=	.2500E+02
Flow rate of pumping/injection well(cfm)	=	.5000E+02
Soil porosity(Dimensionless)	=	.3500E+00
Peameability for R direction (cm**2)	=	.5000E-05
Peameability for Z direction (cm**2)	=	.1000E-05
Peameability Kc/Bc	=	.1000E-08

Aquifer geological structure properties

1: Aquifer is anisotropic.
2: There is a upper confining unit.

************************ OUTPUT ********************************

RADIUS (cm)	RADIUS (ft)	ELEVATION (ft)	PRESS (atm.)	PRESS (in H20)	VELOCITY (ft/s)
.254E+01	.833E-01	.850E+01	.9955	1.8390	.9199E+00
.155E+03	.508E+01	.850E+01	.9989	.4428	.1175E-01
.307E+03	.101E+02	.850E+01	.9993	.2778	.4426E-02
.460E+03	.151E+02	.850E+01	.9995	.2026	.2438E-02
.612E+03	.201E+02	.850E+01	.9996	.1560	.1587E-02
.765E+03	.251E+02	.850E+01	.9997	.1254	.1128E-02
.917E+03	.301E+02	.850E+01	.9997	.1031	.8473E-03
.107E+04	.351E+02	.850E+01	.9998	.0862	.6603E-03
.122E+04	.401E+02	.850E+01	.9998	.0730	.5280E-03
.137E+04	.451E+02	.850E+01	.9998	.0625	.4300E-03
.153E+04	.501E+02	.850E+01	.9999	.0539	.3550E-03
.168E+04	.551E+02	.850E+01	.9999	.0469	.2961E-03
.183E+04	.601E+02	.850E+01	.9999	.0410	.2490E-03
.198E+04	.651E+02	.850E+01	.9999	.0360	.2106E-03
.214E+04	.701E+02	.850E+01	.9999	.0316	.1791E-03
.229E+04	.751E+02	.850E+01	.9999	.0275	.1530E-03
.244E+04	.801E+02	.850E+01	.9999	.0237	.1311E-03
.259E+04	.851E+02	.850E+01	1.0000	.0198	.1127E-03
.275E+04	.901E+02	.850E+01	1.0000	.0162	.9708E-04
.290E+04	.951E+02	.850E+01	1.0000	.0141	.8384E-04

---------- Simulation finished ----------

----- Simulated Scenario ----- 1

************************ OUTPUT ********************************

RADIUS CM	RADIUS FT	TIME DAYS	PORE VOL/ YEAR
.254E+01	.833E-01	.000000E+00	.00
.155E+03	.508E+01	.124237E-03	2889778.00
.307E+03	.101E+02	.727731E-02	25302.65
.460E+03	.151E+02	.241375E-01	7176.33
.612E+03	.201E+02	.528922E-01	3160.23
.765E+03	.251E+02	.955268E-01	1706.54
.917E+03	.301E+02	.154117E+00	1035.41
.107E+04	.351E+02	.230885E+00	677.62
.122E+04	.401E+02	.328284E+00	467.46
.137E+04	.451E+02	.449098E+00	335.07
.153E+04	.501E+02	.596527E+00	247.16
.168E+04	.551E+02	.774270E+00	186.40
.183E+04	.601E+02	.986594E+00	143.06
.198E+04	.651E+02	.123841E+01	111.35
.214E+04	.701E+02	.153536E+01	87.69
.229E+04	.751E+02	.188390E+01	69.74
.244E+04	.801E+02	.229141E+01	55.92
.259E+04	.851E+02	.276630E+01	45.17
.275E+04	.901E+02	.331815E+01	36.71
.290E+04	.951E+02	.395788E+01	30.00

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   ----- Simulated Scenario -----    1


Simulating information:

Depth to the top of screen (ft)           =           .6000E+01

Depth to the bottom of screen (ft)        =           .1100E+02

Depth to the groundwater table (ft)       =           .1200E+02

Depth to the simulated elevation(ft)      =           .8500E+01

Radius of the simulating well (in. )      =           .1000E+01

Temperature of the soil ( C )             =           .2500E+02

Flow rate of pumping/injection well( cfm )=           .5000E+02

Soil porosity( Dimensionless )            =           .3500E+00

Peameability for R direction ( cm**2 )    =           .5000E-06

Peameability for Z direction ( cm**2 )    =           .1000E-06

Peameability  Kc/Bc                       =           .1000E-08



 Aquifer geological structure properties
```

1: Aquifer is anisotropic.
2: There is a upper confining unit.

************************ OUTPUT ********************************

RADIUS (cm)	RADIUS (ft)	ELEVATION (ft)	PRESS (atm.)	PRESS (in H20)	VELOCITY (ft/s)
.254E+01	.833E-01	.850E+01	.9587	16.8316	.9552E+00
.155E+03	.508E+01	.850E+01	.9933	2.7091	.1100E-01
.307E+03	.101E+02	.850E+01	.9969	1.2585	.3580E-02
.460E+03	.151E+02	.850E+01	.9983	.6886	.1642E-02
.612E+03	.201E+02	.850E+01	.9990	.4232	.8715E-03
.765E+03	.251E+02	.850E+01	.9994	.2640	.4981E-03
.917E+03	.301E+02	.850E+01	.9996	.1507	.2980E-03
.107E+04	.351E+02	.850E+01	.9998	.0965	.1839E-03
.122E+04	.401E+02	.850E+01	.9998	.0626	.1161E-03
.137E+04	.451E+02	.850E+01	.9999	.0411	.7449E-04
.153E+04	.501E+02	.850E+01	.9999	.0272	.4842E-04
.168E+04	.551E+02	.850E+01	1.0000	.0181	.3179E-04
.183E+04	.601E+02	.850E+01	1.0000	.0121	.2104E-04
.198E+04	.651E+02	.850E+01	1.0000	.0082	.1401E-04
.214E+04	.701E+02	.850E+01	1.0000	.0055	.9372E-05
.229E+04	.751E+02	.850E+01	1.0000	.0037	.6298E-05
.244E+04	.801E+02	.850E+01	1.0000	.0025	.4246E-05
.259E+04	.851E+02	.850E+01	1.0000	.0017	.2871E-05
.275E+04	.901E+02	.850E+01	1.0000	.0012	.1946E-05
.290E+04	.951E+02	.850E+01	1.0000	.0008	.1322E-05

---------- Simulation finished ----------

----- Simulated Scenario ----- 1

************************ OUTPUT ********************************

RADIUS CM	RADIUS FT	TIME DAYS	PORE VOL/ YEAR
.254E+01	.833E-01	.000000E+00	.00
.155E+03	.508E+01	.119790E-03	2997043.00
.307E+03	.101E+02	.805992E-02	22794.54
.460E+03	.151E+02	.302236E-01	5459.13
.612E+03	.201E+02	.762635E-01	1973.75
.765E+03	.251E+02	.160770E+00	860.96
.917E+03	.301E+02	.306149E+00	417.29
.107E+04	.351E+02	.546321E+00	216.59
.122E+04	.401E+02	.932155E+00	118.00
.137E+04	.451E+02	.153952E+01	66.65
.153E+04	.501E+02	.248114E+01	38.70
.168E+04	.551E+02	.392399E+01	22.96
.183E+04	.601E+02	.611488E+01	13.86
.198E+04	.651E+02	.941779E+01	8.49
.214E+04	.701E+02	.143686E+02	5.26
.229E+04	.751E+02	.217547E+02	3.29
.244E+04	.801E+02	.327321E+02	2.08
.259E+04	.851E+02	.489945E+02	1.32
.275E+04	.901E+02	.730215E+02	.84
.290E+04	.951E+02	.108438E+03	.54

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   ----- Simulated Scenario -----    1


Simulating information:

Depth to the top of screen (ft)           =           .6000E+01

Depth to the bottom of screen (ft)        =           .1100E+02

Depth to the groundwater table (ft)       =           .1200E+02

Depth to the simulated elevation(ft)      =           .8500E+01

Radius of the simulating well (in. )      =           .1000E+01

Temperature of the soil ( C )             =           .2500E+02

Flow rate of pumping/injection well( cfm )=           .5000E+02

Soil porosity( Dimensionless )            =           .3500E+00

Peameability for R direction ( cm**2 )    =           .5000E-07

Peameability for Z direction ( cm**2 )    =           .1000E-07

Peameability  Kc/Bc                       =           .1000E-09


 Aquifer geological structure properties
```

1: Aquifer is anisotropic.
2: There is a upper confining unit.

************************ OUTPUT ********************************

RADIUS (cm)	RADIUS (ft)	ELEVATION (ft)	PRESS (atm.)	PRESS (in H20)	VELOCITY (ft/s)
.254E+01	.833E-01	.850E+01	.4361	229.5608	.2100E+01
.155E+03	.508E+01	.850E+01	.9313	27.9612	.1173E-01
.307E+03	.101E+02	.850E+01	.9686	12.7657	.3684E-02
.460E+03	.151E+02	.850E+01	.9830	6.9396	.1668E-02
.612E+03	.201E+02	.850E+01	.9896	4.2523	.8797E-03
.765E+03	.251E+02	.850E+01	.9935	2.6479	.5011E-03
.917E+03	.301E+02	.850E+01	.9963	1.5093	.2990E-03
.107E+04	.351E+02	.850E+01	.9976	.9655	.1843E-03
.122E+04	.401E+02	.850E+01	.9985	.6266	.1162E-03
.137E+04	.451E+02	.850E+01	.9990	.4110	.7456E-04
.153E+04	.501E+02	.850E+01	.9993	.2719	.4845E-04
.168E+04	.551E+02	.850E+01	.9996	.1811	.3180E-04
.183E+04	.601E+02	.850E+01	.9997	.1212	.2104E-04
.198E+04	.651E+02	.850E+01	.9998	.0815	.1401E-04
.214E+04	.701E+02	.850E+01	.9999	.0550	.9373E-05
.229E+04	.751E+02	.850E+01	.9999	.0372	.6298E-05
.244E+04	.801E+02	.850E+01	.9999	.0252	.4246E-05
.259E+04	.851E+02	.850E+01	1.0000	.0171	.2871E-05
.275E+04	.901E+02	.850E+01	1.0000	.0117	.1946E-05
.290E+04	.951E+02	.850E+01	1.0000	.0080	.1322E-05

---------- Simulation finished ----------

----- Simulated Scenario -----   1

************************ OUTPUT ********************************

RADIUS CM	RADIUS FT	TIME DAYS	PORE VOL/ YEAR
.254E+01	.833E-01	.000000E+00	.00
.155E+03	.508E+01	.548156E-04	6549526.00
.307E+03	.101E+02	.756383E-02	24103.27
.460E+03	.151E+02	.291887E-01	5595.16
.612E+03	.201E+02	.746153E-01	2000.40
.765E+03	.251E+02	.158436E+00	868.02
.917E+03	.301E+02	.303099E+00	419.35
.107E+04	.351E+02	.542580E+00	217.22
.122E+04	.401E+02	.927702E+00	118.22
.137E+04	.451E+02	.153434E+01	66.73
.153E+04	.501E+02	.247521E+01	38.73
.168E+04	.551E+02	.391732E+01	22.97
.183E+04	.601E+02	.610744E+01	13.87
.198E+04	.651E+02	.940958E+01	8.49
.214E+04	.701E+02	.143596E+02	5.26
.229E+04	.751E+02	.217450E+02	3.29
.244E+04	.801E+02	.327216E+02	2.08
.259E+04	.851E+02	.489832E+02	1.32
.275E+04	.901E+02	.730094E+02	.84
.290E+04	.951E+02	.108425E+03	.54

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   ----- Simulated Scenario -----    1



Simulating information:

Depth to the top of screen (ft)          =          .6000E+01

Depth to the bottom of screen (ft)       =          .1100E+02

Depth to the groundwater table (ft)      =          .1200E+02

Depth to the simulated elevation(ft)     =          .8500E+01

Radius of the simulating well (in. )     =          .1000E+01

Temperature of the soil ( C )            =          .2500E+02

Flow rate of pumping/injection well( cfm )=          .5000E+02

Soil porosity( Dimensionless )           =          .3500E+00

Peameability for R direction ( cm**2 )   =          .5000E-05

Peameability for Z direction ( cm**2 )   =          .1000E-05

Peameability  Kc/Bc                      =          .1000E-09



 Aquifer geological structure properties
```

1: Aquifer is anisotropic.
2: There is a upper confining unit.

************************ OUTPUT ********************************

RADIUS (cm)	RADIUS (ft)	ELEVATION (ft)	PRESS (atm.)	PRESS (in H20)	VELOCITY (ft/s)
.254E+01	.833E-01	.850E+01	.9951	2.0113	.9203E+00
.155E+03	.508E+01	.850E+01	.9985	.6126	.1188E-01
.307E+03	.101E+02	.850E+01	.9989	.4441	.4593E-02
.460E+03	.151E+02	.850E+01	.9991	.3650	.2629E-02
.612E+03	.201E+02	.850E+01	.9992	.3135	.1792E-02
.765E+03	.251E+02	.850E+01	.9993	.2780	.1343E-02
.917E+03	.301E+02	.850E+01	.9994	.2505	.1069E-02
.107E+04	.351E+02	.850E+01	.9994	.2281	.8844E-03
.122E+04	.401E+02	.850E+01	.9995	.2094	.7525E-03
.137E+04	.451E+02	.850E+01	.9995	.1933	.6531E-03
.153E+04	.501E+02	.850E+01	.9996	.1792	.5753E-03
.168E+04	.551E+02	.850E+01	.9996	.1668	.5124E-03
.183E+04	.601E+02	.850E+01	.9996	.1557	.4604E-03
.198E+04	.651E+02	.850E+01	.9996	.1456	.4166E-03
.214E+04	.701E+02	.850E+01	.9997	.1365	.3792E-03
.229E+04	.751E+02	.850E+01	.9997	.1282	.3467E-03
.244E+04	.801E+02	.850E+01	.9997	.1207	.3184E-03
.259E+04	.851E+02	.850E+01	.9997	.1137	.2933E-03
.275E+04	.901E+02	.850E+01	.9997	.1073	.2711E-03
.290E+04	.951E+02	.850E+01	.9998	.1014	.2513E-03

---------- Simulation finished ----------

----- Simulated Scenario ----- 1

************************ OUTPUT ********************************

RADIUS CM	RADIUS FT	TIME DAYS	PORE VOL/ YEAR
.254E+01	.833E-01	.000000E+00	.00
.155E+03	.508E+01	.124167E-03	2891395.00
.307E+03	.101E+02	.714826E-02	25767.27
.460E+03	.151E+02	.231743E-01	7549.88
.612E+03	.201E+02	.493542E-01	3471.04
.765E+03	.251E+02	.862653E-01	1971.15
.917E+03	.301E+02	.134250E+00	1264.25
.107E+04	.351E+02	.193515E+00	877.73
.122E+04	.401E+02	.264226E+00	643.90
.137E+04	.451E+02	.346569E+00	491.61
.153E+04	.501E+02	.440791E+00	386.74
.168E+04	.551E+02	.547201E+00	311.36
.183E+04	.601E+02	.666174E+00	255.31
.198E+04	.651E+02	.798141E+00	212.48
.214E+04	.701E+02	.943587E+00	179.04
.229E+04	.751E+02	.110304E+01	152.44
.244E+04	.801E+02	.127707E+01	130.95
.259E+04	.851E+02	.146628E+01	113.36
.275E+04	.901E+02	.167132E+01	98.80
.290E+04	.951E+02	.189288E+01	86.63

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      Welcom to FSS program
 ____________________________________
               VAPEX
 ------------------------------------




   ----- Simulated Scenario -----    1


Simulating information:

Depth to the top of screen (ft)          =           .6000E+01

Depth to the bottom of screen (ft)       =           .1100E+02

Depth to the groundwater table (ft)      =           .1200E+02

Depth to the simulated elevation(ft)     =           .8500E+01

Radius of the simulating well (in. )     =           .1000E+01

Temperature of the soil ( C )            =           .2500E+02

Flow rate of pumping/injection well( cfm )=          .5000E+02

Soil porosity( Dimensionless )           =           .3500E+00

Peameability for R direction ( cm**2 )   =           .5000E-06

Peameability for Z direction ( cm**2 )   =           .1000E-06

Peameability  Kc/Bc                      =           .1000E-09



 Aquifer geological structure properties
```

1: Aquifer is anisotropic.
2: There is a upper confining unit.

************************ OUTPUT ********************************

RADIUS (cm)	RADIUS (ft)	ELEVATION (ft)	PRESS (atm.)	PRESS (in H20)	VELOCITY (ft/s)
.254E+01	.833E-01	.850E+01	.9539	18.7815	.9600E+00
.155E+03	.508E+01	.850E+01	.9891	4.4499	.1187E-01
.307E+03	.101E+02	.850E+01	.9932	2.7862	.4454E-02
.460E+03	.151E+02	.850E+01	.9950	2.0307	.2449E-02
.612E+03	.201E+02	.850E+01	.9962	1.5623	.1592E-02
.765E+03	.251E+02	.850E+01	.9969	1.2555	.1131E-02
.917E+03	.301E+02	.850E+01	.9975	1.0324	.8493E-03
.107E+04	.351E+02	.850E+01	.9979	.8631	.6616E-03
.122E+04	.401E+02	.850E+01	.9982	.7308	.5288E-03
.137E+04	.451E+02	.850E+01	.9985	.6253	.4306E-03
.153E+04	.501E+02	.850E+01	.9987	.5397	.3555E-03
.168E+04	.551E+02	.850E+01	.9988	.4694	.2964E-03
.183E+04	.601E+02	.850E+01	.9990	.4106	.2492E-03
.198E+04	.651E+02	.850E+01	.9991	.3602	.2108E-03
.214E+04	.701E+02	.850E+01	.9992	.3159	.1792E-03
.229E+04	.751E+02	.850E+01	.9993	.2754	.1530E-03
.244E+04	.801E+02	.850E+01	.9994	.2365	.1311E-03
.259E+04	.851E+02	.850E+01	.9995	.1975	.1127E-03
.275E+04	.901E+02	.850E+01	.9996	.1617	.9711E-04
.290E+04	.951E+02	.850E+01	.9997	.1409	.8387E-04

---------- Simulation finished ----------

----- Simulated Scenario ----- 1

************************ OUTPUT ********************************

RADIUS CM	RADIUS FT	TIME DAYS	PORE VOL/ YEAR
.254E+01	.833E-01	.000000E+00	.00
.155E+03	.508E+01	.119091E-03	3014633.00
.307E+03	.101E+02	.720887E-02	25528.53
.460E+03	.151E+02	.239751E-01	7216.54
.612E+03	.201E+02	.526124E-01	3173.19
.765E+03	.251E+02	.951116E-01	1711.97
.917E+03	.301E+02	.153552E+00	1038.07
.107E+04	.351E+02	.230157E+00	679.06
.122E+04	.401E+02	.327382E+00	468.29
.137E+04	.451E+02	.448014E+00	335.57
.153E+04	.501E+02	.595252E+00	247.48
.168E+04	.551E+02	.772796E+00	186.61
.183E+04	.601E+02	.984912E+00	143.20
.198E+04	.651E+02	.123651E+01	111.45
.214E+04	.701E+02	.153324E+01	87.76
.229E+04	.751E+02	.188155E+01	69.78
.244E+04	.801E+02	.228883E+01	55.95
.259E+04	.851E+02	.276348E+01	45.19
.275E+04	.901E+02	.331512E+01	36.73
.290E+04	.951E+02	.395463E+01	30.01

SCENARIO ------ 1

```
KR=KZ=    .6655E-07 SUM OF SQUARED ERRORS=    .5365E-04
KR=KZ=    .5839E-07 SUM OF SQUARED ERRORS=    .1985E-05
KR=KZ=    .5928E-07 SUM OF SQUARED ERRORS=    .1604E-08
```

```
   SCENARIO ------     1


KR=KZ=    .8858E-07 SUM OF SQUARED ERRORS=    .1156E-04
KR=KZ=    .8339E-07 SUM OF SQUARED ERRORS=    .1112E-07
KR=KZ=    .8422E-07 SUM OF SQUARED ERRORS=    .6148E-09


   SCENARIO ------     2


KR=KZ=    .1072E-06 SUM OF SQUARED ERRORS=    .1451E-04
KR=KZ=    .9310E-07 SUM OF SQUARED ERRORS=    .4075E-08
KR=KZ=    .9423E-07 SUM OF SQUARED ERRORS=    .1682E-08


   SCENARIO ------     3


KR=KZ=    .8858E-07 SUM OF SQUARED ERRORS=    .1532E-04
KR=KZ=    .8173E-07 SUM OF SQUARED ERRORS=    .4209E-06
KR=KZ=    .8230E-07 SUM OF SQUARED ERRORS=    .7813E-08


   SCENARIO ------     4
```

```
KR=KZ=     .8858E-07 SUM OF SQUARED ERRORS=    .9722E-04
KR=KZ=     .7694E-07 SUM OF SQUARED ERRORS=    .4071E-06
KR=KZ=     .7795E-07 SUM OF SQUARED ERRORS=    .2884E-08
```

APPENDIX D

<u>MDFIT Modeling Step 1 Simulation Runs</u>
<u>Air Intrinsic Permeability (K) Estimation</u>
<u>Model Output Files</u>

(Modeling simulation runs/output files are attached for reference.)

HALEY ALDRICH

APPENDIX D

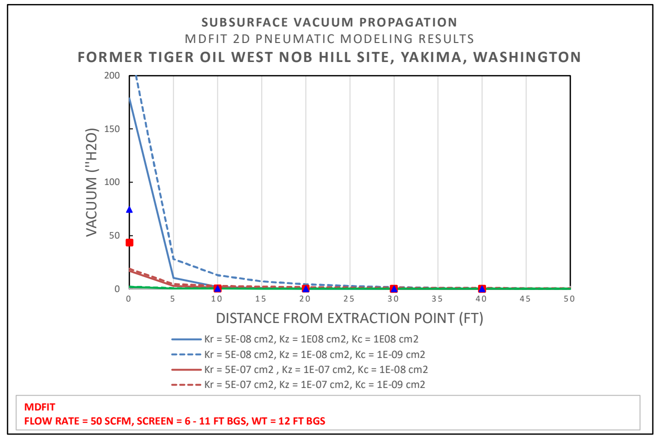
MDFIT Modeling Simulation Runs Summary Table and Plots
MDFIT Modeling Step 2 Simulation Runs and Outputs

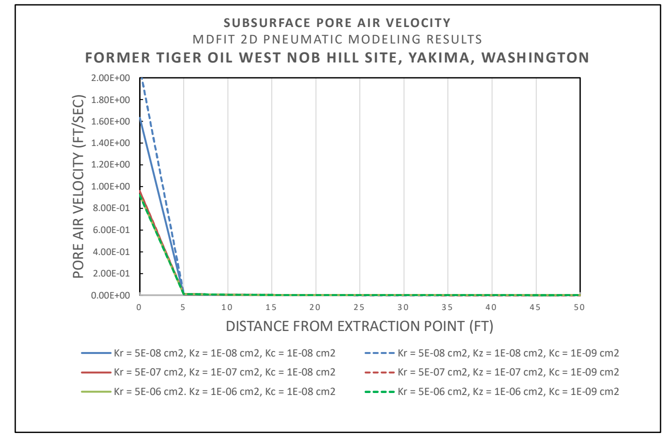
1. **Subsurface vacuum/pressure distribution (ROI)**
2. **Subsurface pore air velocity distribution**
3. **Estimated pore air volume exchanges per year (PV/Year)**

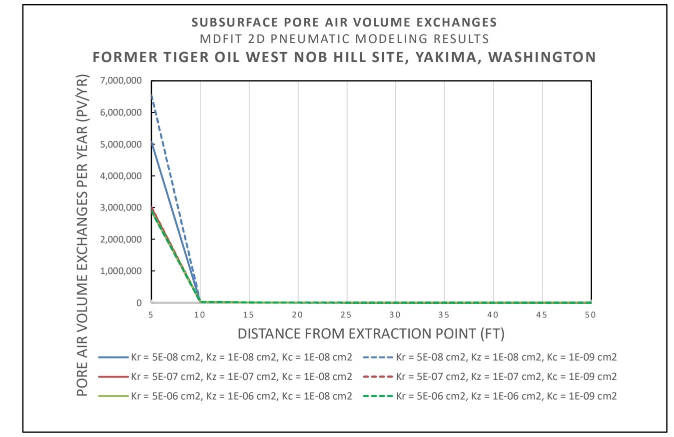
(Results are provided in the attached summary tables, plots, and model output files.)

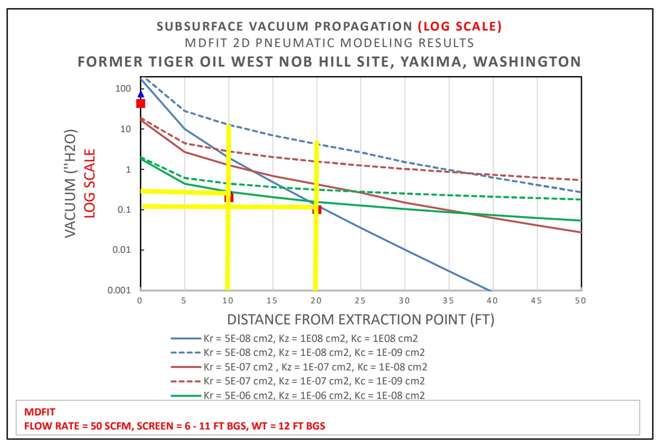
HALEY ALDRICH

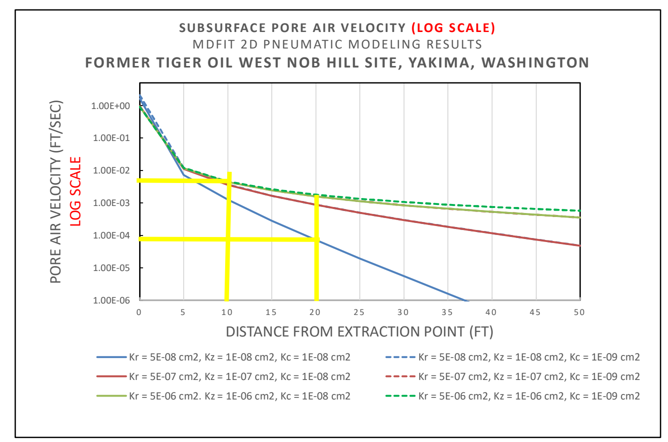
SUBSURFACE PNEUMATIC COMPUTER MODELING RESULT PLOTS
Pilot Scale SSDS Testing ROI Estimation
Former Tiger Oil West Nob Hill Site, Yakima, Washington

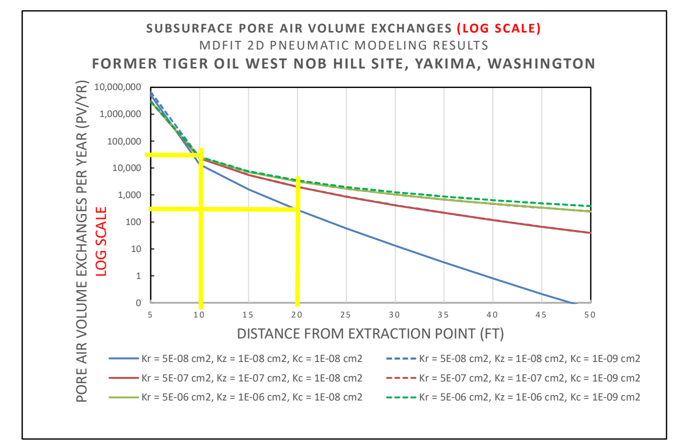








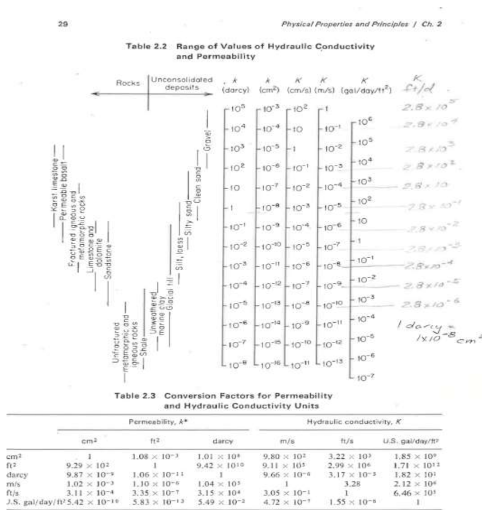




Notes:

Kr = Horizontal Air Intrinsic Permeability (Silty Sand - Sand - Gravel)
Kz = Vertical Air Intrinsic Permeability (Silty Sand - Sand - Gravel)
Kc = Upper (Surface) Confining Layer Air Intrinsic Permeability (Gravel Surface)

The literature permeability values for the silty sand/sandy silt (with sand and gravel layers) target lithology (i.e., 5E-08 to 5E-06 cm2) were taken from the "Groundwater" Handbook by Freeze and Cherry, 1979, Table 2-2, page



29 *Physical Properties and Principles / Ch. 2*

Table 2.2 Range of Values of Hydraulic Conductivity and Permeability

Table 2.3 Conversion Factors for Permeability and Hydraulic Conductivity Units

	Permeability, k*			Hydraulic conductivity, K		
	cm²	ft²	darcy	m/s	ft/s	U.S. gal/day/ft²
cm²	1	1.08×10^{-3}	1.01×10^{8}	9.80×10^{2}	3.22×10^{3}	1.85×10^{9}
ft²	9.29×10^{2}	1	9.42×10^{10}	9.11×10^{5}	2.99×10^{6}	1.71×10^{12}
darcy	9.87×10^{-9}	1.06×10^{-11}	1	9.66×10^{-6}	3.17×10^{-5}	1.82×10^{1}
m/s	1.02×10^{-3}	1.10×10^{-6}	1.04×10^{5}	1	3.28	2.12×10^{6}
ft/s	3.11×10^{-4}	3.35×10^{-7}	3.15×10^{4}	3.05×10^{-1}	1	6.46×10^{5}
U.S. gal/day/ft²	5.42×10^{-10}	5.83×10^{-13}	5.49×10^{-2}	4.72×10^{-7}	1.55×10^{-6}	1

*To obtain k in ft², multiply k in cm² by 1.08×10^{-3}.

SUBSURFACE PNEUMATIC COMPUTER MODELING RESULTS
Pilot Scale SSDS Testing ROI Estimation
Former Tiger Oil West Nob Hill Site, Yakima, Washington

F = 50 scfm K - 5E-08 cm2 KC = 1E-08 cm2

RADIUS (cm)	RADIUS (ft)	ELEVATIC (ft)	PRESS (atm.)	PRESS (in H20)	VELOCITY (ft/s)	Rotron Actual data	RADIUS CM	RADIUS FT	TIME DAYS	PORE VOL/ YEAR	Roots Actual data
2.54E+00	0	8.50E+00	0.5613	178.5946	1.63E+00	43.3	2.54E+00	8.33E-02	0.00E+00	0	74.5
1.55E+02	5	8.50E+00	0.9754	10.0245	7.36E-03		1.55E+02	5.08E+00	7.06E-05	5083263	
3.07E+02	10	8.50E+00	0.9952	1.9527	1.25E-03	0.2	3.07E+02	1.01E+01	1.35E-02	13459.04	0.3
4.60E+02	15	8.50E+00	0.9988	0.4787	2.82E-04		4.60E+02	1.51E+01	8.91E-02	1601.34	
6.12E+02	20	8.50E+00	0.9997	0.1275	7.19E-05	0.1	6.12E+02	2.01E+01	4.16E-01	278.03	0
7.65E+02	25	8.50E+00	0.9999	0.0355	1.95E-05		7.65E+02	2.51E+01	1.68E+00	57.47	
9.17E+02	30	8.50E+00	1	0.0102	5.48E-06	0	9.17E+02	3.01E+01	6.32E+00	13.09	0
1.07E+03	35	8.50E+00	1	0.003	1.58E-06		1.07E+03	3.51E+01	2.27E+01	3.17	
1.22E+03	40	8.50E+00	1	0.0009	4.61E-07	0	1.22E+03	4.01E+01	7.95E+01	0.8	0
1.37E+03	45	8.50E+00	1	0.0003	1.37E-07		1.37E+03	4.51E+01	2.73E+02	0.21	
1.53E+03	50	8.50E+00	1	0.0001	4.09E-08		1.53E+03	5.01E+01	9.24E+02	0.06	
1.68E+03	55	8.50E+00	1	0	1.24E-08		1.68E+03	5.51E+01	3.10E+03	0.02	
1.83E+03	60	8.50E+00	1	0	3.76E-09		1.83E+03	6.01E+01	1.03E+04	0	
1.98E+03	65	8.50E+00	1	0	1.15E-09		1.98E+03	6.51E+01	3.39E+04	0	
2.14E+03	70	8.50E+00	1	0	3.54E-10		2.14E+03	7.01E+01	1.11E+05	0	
2.29E+03	75	8.50E+00	1	0	1.09E-10		2.29E+03	7.51E+01	3.61E+05	0	
2.44E+03	80	8.50E+00	1	0	3.39E-11		2.44E+03	8.01E+01	1.17E+06	0	
2.59E+03	85	8.50E+00	1	0	1.05E-11		2.59E+03	8.51E+01	3.78E+06	0	
2.75E+03	90	8.50E+00	1	0	3.29E-12		2.75E+03	9.01E+01	1.22E+07	0	
2.90E+03	95	8.50E+00	1	0	1.03E-12		2.90E+03	9.51E+01	3.90E+07	0	

F = 50 scfm K - 5E-07 cm2 KC = 1E-08 cm2

RADIUS (cm)	RADIUS (ft)	ELEVATIC (ft)	PRESS (atm.)	PRESS (in H20)	VELOCITY (ft/s)	RADIUS CM	RADIUS FT	TIME DAYS	PORE VOL/ YEAR
2.54E+00	8.33E-02	8.50E+00	0.9587	16.8316	9.55E-01	2.54E+00	8.33E-02	0.00E+00	0
1.55E+02	5.08E+00	8.50E+00	0.9933	2.7091	1.10E-02	1.55E+02	5.08E+00	1.20E-04	2997043
3.07E+02	1.01E+01	8.50E+00	0.9969	1.2585	3.58E-03	3.07E+02	1.01E+01	8.06E-03	22794.54
4.60E+02	1.51E+01	8.50E+00	0.9983	0.6886	1.64E-03	4.60E+02	1.51E+01	3.02E-02	5459.13
6.12E+02	2.01E+01	8.50E+00	0.999	0.4232	8.72E-04	6.12E+02	2.01E+01	7.63E-02	1973.75
7.65E+02	2.51E+01	8.50E+00	0.9994	0.264	4.98E-04	7.65E+02	2.51E+01	1.61E-01	860.96
9.17E+02	3.01E+01	8.50E+00	0.9996	0.1507	2.98E-04	9.17E+02	3.01E+01	3.06E-01	417.29
1.07E+03	3.51E+01	8.50E+00	0.9998	0.0965	1.84E-04	1.07E+03	3.51E+01	5.46E-01	216.59
1.22E+03	4.01E+01	8.50E+00	0.9998	0.0626	1.16E-04	1.22E+03	4.01E+01	9.32E-01	118
1.37E+03	4.51E+01	8.50E+00	0.9999	0.0411	7.45E-05	1.37E+03	4.51E+01	1.54E+00	66.65
1.53E+03	5.01E+01	8.50E+00	0.9999	0.0272	4.84E-05	1.53E+03	5.01E+01	2.48E+00	38.7
1.68E+03	5.51E+01	8.50E+00	1	0.0181	3.18E-05	1.68E+03	5.51E+01	3.92E+00	22.96
1.83E+03	6.01E+01	8.50E+00	1	0.0121	2.10E-05	1.83E+03	6.01E+01	6.11E+00	13.86
1.98E+03	6.51E+01	8.50E+00	1	0.0082	1.40E-05	1.98E+03	6.51E+01	9.42E+00	8.49
2.14E+03	7.01E+01	8.50E+00	1	0.0055	9.37E-06	2.14E+03	7.01E+01	1.44E+01	5.26
2.29E+03	7.51E+01	8.50E+00	1	0.0037	6.30E-06	2.29E+03	7.51E+01	2.18E+01	3.29
2.44E+03	8.01E+01	8.50E+00	1	0.0025	4.25E-06	2.44E+03	8.01E+01	3.27E+01	2.08
2.59E+03	8.51E+01	8.50E+00	1	0.0017	2.87E-06	2.59E+03	8.51E+01	4.90E+01	1.32
2.75E+03	9.01E+01	8.50E+00	1	0.0012	1.95E-06	2.75E+03	9.01E+01	7.30E+01	0.84
2.90E+03	9.51E+01	8.50E+00	1	0.0008	1.32E-06	2.90E+03	9.51E+01	1.08E+02	0.54

F = 50 scfm K - 5E-06 cm2 KC = 1E-08 cm2

RADIUS (cm)	RADIUS (ft)	ELEVATIC (ft)	PRESS (atm.)	PRESS (in H20)	VELOCITY (ft/s)	RADIUS CM	RADIUS FT	TIME DAYS	PORE VOL/ YEAR
2.54E+00	0.1	8.50E+00	0.9955	1.839	9.20E-01	2.54E+00	8.33E-02	0.00E+00	0
1.55E+02	5.1	8.50E+00	0.9989	0.4428	1.18E-02	1.55E+02	5.08E+00	1.24E-04	2889778
3.07E+02	10.1	8.50E+00	0.9993	0.2778	4.43E-03	3.07E+02	1.01E+01	7.28E-03	25302.65
4.60E+02	15.1	8.50E+00	0.9995	0.2026	2.44E-03	4.60E+02	1.51E+01	2.41E-02	7176.33
6.12E+02	20.1	8.50E+00	0.9996	0.156	1.59E-03	6.12E+02	2.01E+01	5.29E-02	3160.23
7.65E+02	25.1	8.50E+00	0.9997	0.1254	1.13E-03	7.65E+02	2.51E+01	9.55E-02	1706.54
9.17E+02	30.1	8.50E+00	0.9997	0.1031	8.47E-04	9.17E+02	3.01E+01	1.54E-01	1035.41
1.07E+03	35.1	8.50E+00	0.9998	0.0862	6.60E-04	1.07E+03	3.51E+01	2.31E-01	677.62
1.22E+03	40.1	8.50E+00	0.9998	0.073	5.28E-04	1.22E+03	4.01E+01	3.28E-01	467.46
1.37E+03	45.1	8.50E+00	0.9998	0.0625	4.30E-04	1.37E+03	4.51E+01	4.49E-01	335.07
1.53E+03	50.1	8.50E+00	0.9999	0.0539	3.55E-04	1.53E+03	5.01E+01	5.97E-01	247.16
1.68E+03	55.1	8.50E+00	0.9999	0.0469	2.96E-04	1.68E+03	5.51E+01	7.74E-01	186.4
1.83E+03	60.1	8.50E+00	0.9999	0.041	2.49E-04	1.83E+03	6.01E+01	9.87E-01	143.06
1.98E+03	65.1	8.50E+00	0.9999	0.036	2.11E-04	1.98E+03	6.51E+01	1.24E+00	111.35
2.14E+03	70.1	8.50E+00	0.9999	0.0316	1.79E-04	2.14E+03	7.01E+01	1.54E+00	87.69
2.29E+03	75.1	8.50E+00	0.9999	0.0275	1.53E-04	2.29E+03	7.51E+01	1.88E+00	69.74
2.44E+03	80.1	8.50E+00	0.9999	0.0237	1.31E-04	2.44E+03	8.01E+01	2.29E+00	55.92
2.59E+03	85.1	8.50E+00	1	0.0198	1.13E-04	2.59E+03	8.51E+01	2.77E+00	45.17
2.75E+03	90.1	8.50E+00	1	0.0162	9.71E-05	2.75E+03	9.01E+01	3.32E+00	36.71
2.90E+03	95.1	8.50E+00	1	0.0141	8.38E-05	2.90E+03	9.51E+01	3.96E+00	30

F = 50 scfm K - 5E-08 cm2 KC = 1E-09 cm2

RADIUS (cm)	RADIUS (ft)	ELEVATIC (ft)	PRESS (atm.)	PRESS (in H20)	VELOCITY (ft/s)	RADIUS CM	RADIUS FT	TIME DAYS	PORE VOL/ YEAR
2.54E+00	0	8.50E+00	0.4361	229.5608	2.10E+00	2.54E+00	8.33E-02	0.00E+00	0
1.55E+02	5	8.50E+00	0.9313	27.9612	1.17E-02	1.55E+02	5.08E+00	5.48E-05	6549526
3.07E+02	10	8.50E+00	0.9686	12.7657	3.68E-03	3.07E+02	1.01E+01	7.56E-03	24103.27
4.60E+02	15	8.50E+00	0.983	6.9396	1.67E-03	4.60E+02	1.51E+01	2.92E-02	5595.16
6.12E+02	20	8.50E+00	0.9896	4.2523	8.80E-04	6.12E+02	2.01E+01	7.46E-02	2000.4
7.65E+02	25	8.50E+00	0.9935	2.6479	5.01E-04	7.65E+02	2.51E+01	1.58E-01	868.02
9.17E+02	30	8.50E+00	0.9963	1.5093	2.99E-04	9.17E+02	3.01E+01	3.03E-01	419.35
1.07E+03	35	8.50E+00	0.9976	0.9655	1.84E-04	1.07E+03	3.51E+01	5.43E-01	217.22
1.22E+03	40	8.50E+00	0.9985	0.6266	1.16E-04	1.22E+03	4.01E+01	9.28E-01	118.22
1.37E+03	45	8.50E+00	0.999	0.411	7.46E-05	1.37E+03	4.51E+01	1.53E+00	66.73
1.53E+03	50	8.50E+00	0.9993	0.2719	4.85E-05	1.53E+03	5.01E+01	2.48E+00	38.73
1.68E+03	55	8.50E+00	0.9996	0.1811	3.18E-05	1.68E+03	5.51E+01	3.92E+00	22.97
1.83E+03	60	8.50E+00	0.9997	0.1212	2.10E-05	1.83E+03	6.01E+01	6.11E+00	13.87
1.98E+03	65	8.50E+00	0.9998	0.0815	1.40E-05	1.98E+03	6.51E+01	9.41E+00	8.49
2.14E+03	70	8.50E+00	0.9999	0.055	9.37E-06	2.14E+03	7.01E+01	1.44E+01	5.26
2.29E+03	75	8.50E+00	0.9999	0.0372	6.30E-06	2.29E+03	7.51E+01	2.17E+01	3.29
2.44E+03	80	8.50E+00	0.9999	0.0252	4.25E-06	2.44E+03	8.01E+01	3.27E+01	2.08
2.59E+03	85	8.50E+00	1	0.0171	2.87E-06	2.59E+03	8.51E+01	4.90E+01	1.32
2.75E+03	90	8.50E+00	1	0.0117	1.95E-06	2.75E+03	9.01E+01	7.30E+01	0.84
2.90E+03	95	8.50E+00	1	0.008	1.32E-06	2.90E+03	9.51E+01	1.08E+02	0.54

F = 50 scfm K - 5E-07 cm2 KC = 1E-09 cm2

RADIUS (cm)	RADIUS (ft)	ELEVATIC (ft)	PRESS (atm.)	PRESS (in H20)	VELOCITY (ft/s)	RADIUS CM	RADIUS FT	TIME DAYS	PORE VOL/ YEAR
2.54E+00	8.33E-02	8.50E+00	0.9539	18.7815	9.60E-01	2.54E+00	8.33E-02	0.00E+00	0
1.55E+02	5.08E+00	8.50E+00	0.9891	4.4499	1.19E-02	1.55E+02	5.08E+00	1.19E-04	3014633
3.07E+02	1.01E+01	8.50E+00	0.9932	2.7862	4.45E-03	3.07E+02	1.01E+01	7.21E-03	25528.53
4.60E+02	1.51E+01	8.50E+00	0.995	2.0307	2.45E-03	4.60E+02	1.51E+01	2.40E-02	7216.54
6.12E+02	2.01E+01	8.50E+00	0.9962	1.5623	1.59E-03	6.12E+02	2.01E+01	5.26E-02	3173.19
7.65E+02	2.51E+01	8.50E+00	0.9969	1.2555	1.13E-03	7.65E+02	2.51E+01	9.51E-02	1711.97
9.17E+02	3.01E+01	8.50E+00	0.9975	1.0324	8.49E-04	9.17E+02	3.01E+01	1.54E-01	1038.07
1.07E+03	3.51E+01	8.50E+00	0.9979	0.8631	6.62E-04	1.07E+03	3.51E+01	2.30E-01	679.06
1.22E+03	4.01E+01	8.50E+00	0.9982	0.7308	5.29E-04	1.22E+03	4.01E+01	3.27E-01	468.29
1.37E+03	4.51E+01	8.50E+00	0.9985	0.6253	4.31E-04	1.37E+03	4.51E+01	4.48E-01	335.57
1.53E+03	5.01E+01	8.50E+00	0.9987	0.5397	3.56E-04	1.53E+03	5.01E+01	5.95E-01	247.48
1.68E+03	5.51E+01	8.50E+00	0.9988	0.4694	2.96E-04	1.68E+03	5.51E+01	7.73E-01	186.61
1.83E+03	6.01E+01	8.50E+00	0.999	0.4106	2.49E-04	1.83E+03	6.01E+01	9.85E-01	143.2
1.98E+03	6.51E+01	8.50E+00	0.9991	0.3602	2.11E-04	1.98E+03	6.51E+01	1.24E+00	111.45
2.14E+03	7.01E+01	8.50E+00	0.9992	0.3159	1.79E-04	2.14E+03	7.01E+01	1.53E+00	87.76
2.29E+03	7.51E+01	8.50E+00	0.9993	0.2754	1.53E-04	2.29E+03	7.51E+01	1.88E+00	69.78
2.44E+03	8.01E+01	8.50E+00	0.9994	0.2365	1.31E-04	2.44E+03	8.01E+01	2.29E+00	55.95
2.59E+03	8.51E+01	8.50E+00	0.9995	0.1975	1.13E-04	2.59E+03	8.51E+01	2.76E+00	45.19
2.75E+03	9.01E+01	8.50E+00	0.9996	0.1617	9.71E-05	2.75E+03	9.01E+01	3.32E+00	36.73
2.90E+03	9.51E+01	8.50E+00	0.9997	0.1409	8.39E-05	2.90E+03	9.51E+01	3.95E+00	30.01

F = 50 scfm K - 5E-06 cm2 KC = 1E-09 cm2

RADIUS (cm)	RADIUS (ft)	ELEVATIC (ft)	PRESS (atm.)	PRESS (in H20)	VELOCITY (ft/s)	RADIUS CM	RADIUS FT	TIME DAYS	PORE VOL/ YEAR
2.54E+00	8.33E-02	8.50E+00	0.9951	2.0113	9.20E-01	2.54E+00	8.33E-02	0.00E+00	0
1.55E+02	5.08E+00	8.50E+00	0.9985	0.6126	1.19E-02	1.55E+02	5.08E+00	1.24E-04	2891395
3.07E+02	1.01E+01	8.50E+00	0.9989	0.4441	4.59E-03	3.07E+02	1.01E+01	7.15E-03	25767.27
4.60E+02	1.51E+01	8.50E+00	0.9991	0.365	2.63E-03	4.60E+02	1.51E+01	2.32E-02	7549.88
6.12E+02	2.01E+01	8.50E+00	0.9992	0.3135	1.79E-03	6.12E+02	2.01E+01	4.94E-02	3471.04
7.65E+02	2.51E+01	8.50E+00	0.9993	0.278	1.34E-03	7.65E+02	2.51E+01	8.63E-02	1971.15
9.17E+02	3.01E+01	8.50E+00	0.9994	0.2505	1.07E-03	9.17E+02	3.01E+01	1.34E-01	1264.25
1.07E+03	3.51E+01	8.50E+00	0.9994	0.2281	8.84E-04	1.07E+03	3.51E+01	1.94E-01	877.73
1.22E+03	4.01E+01	8.50E+00	0.9995	0.2094	7.53E-04	1.22E+03	4.01E+01	2.64E-01	643.9
1.37E+03	4.51E+01	8.50E+00	0.9995	0.1933	6.53E-04	1.37E+03	4.51E+01	3.47E-01	491.61
1.53E+03	5.01E+01	8.50E+00	0.9996	0.1792	5.75E-04	1.53E+03	5.01E+01	4.41E-01	386.74
1.68E+03	5.51E+01	8.50E+00	0.9996	0.1668	5.12E-04	1.68E+03	5.51E+01	5.47E-01	311.36
1.83E+03	6.01E+01	8.50E+00	0.9996	0.1557	4.60E-04	1.83E+03	6.01E+01	6.66E-01	255.31
1.98E+03	6.51E+01	8.50E+00	0.9996	0.1456	4.17E-04	1.98E+03	6.51E+01	7.98E-01	212.48
2.14E+03	7.01E+01	8.50E+00	0.9997	0.1365	3.79E-04	2.14E+03	7.01E+01	9.44E-01	179.04
2.29E+03	7.51E+01	8.50E+00	0.9997	0.1282	3.47E-04	2.29E+03	7.51E+01	1.10E+00	152.44
2.44E+03	8.01E+01	8.50E+00	0.9997	0.1207	3.18E-04	2.44E+03	8.01E+01	1.28E+00	130.95
2.59E+03	8.51E+01	8.50E+00	0.9997	0.1137	2.93E-04	2.59E+03	8.51E+01	1.47E+00	113.36
2.75E+03	9.01E+01	8.50E+00	0.9997	0.1073	2.71E-04	2.75E+03	9.01E+01	1.67E+00	98.8
2.90E+03	9.51E+01	8.50E+00	0.9998	0.1014	2.51E-04	2.90E+03	9.51E+01	1.89E+00	86.63

APPENDIX E
Laboratory Analytical Report

H&P Mobile Geochemistry Inc.

09 March 2023

Yen-Vy Van
Haley & Aldrich - Washington
3131 Elliott Ave., Suite 600
Seattle, WA 98121

H&P Project: HAL022823-10
Client Project: Former Tiger Oil /0204793-000 Task 04

Dear Yen-Vy Van:

Enclosed is the analytical report for the above referenced project. The data herein applies to samples as received by H&P Mobile Geochemistry, Inc. on 28-Feb-23 which were analyzed in accordance with the attached Chain of Custody record(s).

The results for all sample analyses and required QA/QC analyses are presented in the following sections and summarized in the documents:

- Sample Summary
- Case Narrative (if applicable)
- Sample Results
- Quality Control Summary
- Notes and Definitions / Appendix
- Chain of Custody
- Sampling Logs (if applicable)

Unless otherwise noted, I certify that all analyses were performed and reviewed in compliance with our Quality Systems Manual and Standard Operating Procedures. This report shall not be reproduced, except in full, without the written approval of H&P Mobile Geochemistry, Inc.

We at H&P Mobile Geochemistry, Inc. sincerely appreciate the opportunity to provide analytical services to you on this project. If you have any questions or concerns regarding this analytical report, please contact me at your convenience at 760-804-9678.

Sincerely,

Lisa Eminhizer
Laboratory Director

H&P Mobile Geochemistry, Inc. is certified under the California ELAP and the National Environmental Laboratory Accreditation Conference (NELAC) for the fields of proficiency and analytes listed on those certificates. H& P is approved as an Environmental Testing Laboratory in accordance with the DoD-ELAP Program and ISO/IEC 17025:2005 programs for the fields of proficiency and analytes included in the certification process and to the extent offered by the accreditation agency . Unless otherwise noted, accreditation certificate numbers, expiration of certificates, and scope of accreditation can be found at: www.handpmg.com/about/certifications. Fields of services and analytes contained in this report that are not listed on the certificates should be considered uncertified or unavailable for certification.

H&P Mobile
Geochemistry Inc.

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Carlsbad, CA 92010
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Haley & Aldrich - Washington 3131 Elliott Ave., Suite 600 Seattle, WA 98121	Project: HAL022823-10 Project Number: Former Tiger Oil /0204793-000 Task 04 Project Manager: Yen-Vy Van	Reported: 09-Mar-23 09:26

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
VEP2 Flow 1	E303001-01	Vapor	22-Feb-23	28-Feb-23
VEP1 Flow 1	E303001-02	Vapor	22-Feb-23	28-Feb-23
Effluent VEP1	E303001-03	Vapor	22-Feb-23	28-Feb-23
VEP2 Flow 2	E303001-04	Vapor	22-Feb-23	28-Feb-23
Static VEP1	E303001-05	Vapor	22-Feb-23	28-Feb-23

Due to elevated concentrations, samples VEP2 Flow 1, VEP1 Flow 1 and VEP2 Flow 2 were analyzed by H&P 8260SV rather than EPA Method TO-15. The following EPA Method TO-15 analytes are not reported by H&P 8260SV:
Dichlorotetrafluoroethane
4-Ehtyltoluene

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DETECTIONS SUMMARY

Sample ID: **VEP2 Flow 1** Laboratory ID: **E303001-01**

Analyte	Result	Reporting Limit	Units	Method	Notes
TPHv (C5 - C12)	**1000000**	200000	ug/m3	H&P 8260SV	

Sample ID: **VEP1 Flow 1** Laboratory ID: **E303001-02**

Analyte	Result	Reporting Limit	Units	Method	Notes
TPHv (C5 - C12)	**1700000**	200000	ug/m3	H&P 8260SV	

Sample ID: **Effluent VEP1** Laboratory ID: **E303001-03**

Analyte	Result	Reporting Limit	Units	Method	Notes
Chloromethane	**1.5**	0.8	ug/m3	EPA TO-15	
Trichlorofluoromethane (F11)	**6.1**	2.3	ug/m3	EPA TO-15	
2-Butanone (MEK)	**19**	2.4	ug/m3	EPA TO-15	
Benzene	**1.7**	0.6	ug/m3	EPA TO-15	
Toluene	**29**	3.1	ug/m3	EPA TO-15	
Ethylbenzene	**3.1**	1.8	ug/m3	EPA TO-15	
m,p-Xylene	**17**	1.8	ug/m3	EPA TO-15	
o-Xylene	**5.1**	1.8	ug/m3	EPA TO-15	
1,2,4-Trimethylbenzene	**3.0**	2.0	ug/m3	EPA TO-15	
1,3-Dichlorobenzene	**21**	2.4	ug/m3	EPA TO-15	
TPHv (C5 - C12)	**640**	100	ug/m3	EPA TO-15	

Sample ID: **VEP2 Flow 2** Laboratory ID: **E303001-04**

Analyte	Result	Reporting Limit	Units	Method	Notes
Toluene	**11000**	6900	ug/m3	H&P 8260SV	
m,p-Xylene	**8900**	3400	ug/m3	H&P 8260SV	
TPHv (C5 - C12)	**2500000**	200000	ug/m3	H&P 8260SV	

Sample ID: **Static VEP1** Laboratory ID: **E303001-05**

Analyte	Result	Reporting Limit	Units	Method	Notes
2-Butanone (MEK)	**1900**	48	ug/m3	EPA TO-15	
Benzene	**22**	13	ug/m3	EPA TO-15	
4-Methyl-2-pentanone (MIBK)	**140**	66	ug/m3	EPA TO-15	
Toluene	**830**	61	ug/m3	EPA TO-15	
Ethylbenzene	**170**	35	ug/m3	EPA TO-15	

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Sample ID: **Static VEP1** Laboratory ID: **E303001-05**

Analyte	Result	Reporting Limit	Units	Method	Notes
m,p-Xylene	**570**	35	ug/m3	EPA TO-15	
o-Xylene	**84**	35	ug/m3	EPA TO-15	
1,2,4-Trimethylbenzene	**41**	40	ug/m3	EPA TO-15	
TPHv (C5 - C12)	**170000**	2000	ug/m3	EPA TO-15	

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Volatile Organic Compounds by EPA TO-15

H&P Mobile Geochemistry, Inc.

Analyte	Result	Reporting Limit	Units	Dilution Factor	Batch	Prepared	Analyzed	Method	Notes
Effluent VEP1 (E303001-03) Vapor Sampled: 22-Feb-23 Received: 28-Feb-23									
Dichlorodifluoromethane (F12)	ND	4.0	ug/m3	1	EC30715	07-Mar-23	08-Mar-23	EPA TO-15	
Chloromethane	**1.5**	0.8	"	"	"	"	"	"	
Dichlorotetrafluoroethane (F114)	ND	2.8	"	"	"	"	"	"	
Vinyl chloride	ND	0.5	"	"	"	"	"	"	
Bromomethane	ND	1.6	"	"	"	"	"	"	
Chloroethane	ND	1.1	"	"	"	"	"	"	
Trichlorofluoromethane (F11)	**6.1**	2.3	"	"	"	"	"	"	
1,1-Dichloroethene	ND	1.6	"	"	"	"	"	"	
Tertiary-butyl alcohol (TBA)	ND	6.1	"	"	"	"	"	"	
1,1,2-Trichlorotrifluoroethane (F113)	ND	3.1	"	"	"	"	"	"	
Methylene chloride (Dichloromethane)	ND	1.4	"	"	"	"	"	"	
Carbon disulfide	ND	1.3	"	"	"	"	"	"	
trans-1,2-Dichloroethene	ND	1.6	"	"	"	"	"	"	
Methyl tertiary-butyl ether (MTBE)	ND	2.9	"	"	"	"	"	"	
1,1-Dichloroethane	ND	1.6	"	"	"	"	"	"	
2-Butanone (MEK)	**19**	2.4	"	"	"	"	"	"	
cis-1,2-Dichloroethene	ND	1.6	"	"	"	"	"	"	
Diisopropyl ether (DIPE)	ND	3.4	"	"	"	"	"	"	
Chloroform	ND	1.0	"	"	"	"	"	"	
Ethyl tert-butyl ether (ETBE)	ND	3.4	"	"	"	"	"	"	
1,1,1-Trichloroethane	ND	2.2	"	"	"	"	"	"	
1,2-Dichloroethane (EDC)	ND	1.6	"	"	"	"	"	"	
Benzene	**1.7**	0.6	"	"	"	"	"	"	
Carbon tetrachloride	ND	1.3	"	"	"	"	"	"	
Tertiary-amyl methyl ether (TAME)	ND	3.4	"	"	"	"	"	"	
Trichloroethene	ND	2.2	"	"	"	"	"	"	
1,2-Dichloropropane	ND	1.9	"	"	"	"	"	"	
Bromodichloromethane	ND	2.7	"	"	"	"	"	"	
cis-1,3-Dichloropropene	ND	1.8	"	"	"	"	"	"	
4-Methyl-2-pentanone (MIBK)	ND	3.3	"	"	"	"	"	"	
trans-1,3-Dichloropropene	ND	1.8	"	"	"	"	"	"	
Toluene	**29**	3.1	"	"	"	"	"	"	
1,1,2-Trichloroethane	ND	2.2	"	"	"	"	"	"	
2-Hexanone (MBK)	ND	3.3	"	"	"	"	"	"	
Dibromochloromethane	ND	3.5	"	"	"	"	"	"	
Tetrachloroethene	ND	2.8	"	"	"	"	"	"	
1,2-Dibromoethane (EDB)	ND	3.1	"	"	"	"	"	"	
1,1,1,2-Tetrachloroethane	ND	2.8	"	"	"	"	"	"	

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Haley & Aldrich - Washington 3131 Elliott Ave., Suite 600 Seattle, WA 98121	Project: HAL022823-10 Project Number: Former Tiger Oil /0204793-000 Task 04 Project Manager: Yen-Vy Van	Reported: 09-Mar-23 09:26

Volatile Organic Compounds by EPA TO-15

H&P Mobile Geochemistry, Inc.

Analyte	Result	Reporting Limit	Units	Dilution Factor	Batch	Prepared	Analyzed	Method	Notes
Effluent VEP1 (E303001-03) Vapor Sampled: 22-Feb-23 Received: 28-Feb-23									
Chlorobenzene	ND	1.9	ug/m3	1	EC30715	07-Mar-23	08-Mar-23	EPA TO-15	
Ethylbenzene	**3.1**	1.8	"	"	"	"	"	"	
m,p-Xylene	**17**	1.8	"	"	"	"	"	"	
Styrene	ND	1.7	"	"	"	"	"	"	
o-Xylene	**5.1**	1.8	"	"	"	"	"	"	
Bromoform	ND	4.2	"	"	"	"	"	"	
1,1,2,2-Tetrachloroethane	ND	2.8	"	"	"	"	"	"	
4-Ethyltoluene	ND	2.0	"	"	"	"	"	"	
1,3,5-Trimethylbenzene	ND	2.0	"	"	"	"	"	"	
1,2,4-Trimethylbenzene	**3.0**	2.0	"	"	"	"	"	"	
1,3-Dichlorobenzene	**21**	2.4	"	"	"	"	"	"	
1,4-Dichlorobenzene	ND	2.4	"	"	"	"	"	"	
1,2-Dichlorobenzene	ND	2.4	"	"	"	"	"	"	
Naphthalene	ND	2.1	"	"	"	"	"	"	
1,2,4-Trichlorobenzene	ND	7.5	"	"	"	"	"	"	
Hexachlorobutadiene	ND	11	"	"	"	"	"	"	
Surrogate: 1,2-Dichloroethane-d4		*117 %*	*76-134*		*"*	*"*	*"*	*"*	
Surrogate: Toluene-d8		*102 %*	*78-125*		*"*	*"*	*"*	*"*	
Surrogate: 4-Bromofluorobenzene		*91.7 %*	*77-127*		*"*	*"*	*"*	*"*	
Static VEP1 (E303001-05) Vapor Sampled: 22-Feb-23 Received: 28-Feb-23									
Dichlorodifluoromethane (F12)	ND	80	ug/m3	20	EC30715	07-Mar-23	08-Mar-23	EPA TO-15	
Chloromethane	ND	17	"	"	"	"	"	"	
Dichlorotetrafluoroethane (F114)	ND	56	"	"	"	"	"	"	
Vinyl chloride	ND	10	"	"	"	"	"	"	
Bromomethane	ND	32	"	"	"	"	"	"	
Chloroethane	ND	21	"	"	"	"	"	"	
Trichlorofluoromethane (F11)	ND	45	"	"	"	"	"	"	
1,1-Dichloroethene	ND	32	"	"	"	"	"	"	
Tertiary-butyl alcohol (TBA)	ND	120	"	"	"	"	"	"	
1,1,2-Trichlorotrifluoroethane (F113)	ND	62	"	"	"	"	"	"	
Methylene chloride (Dichloromethane)	ND	28	"	"	"	"	"	"	
Carbon disulfide	ND	25	"	"	"	"	"	"	
trans-1,2-Dichloroethene	ND	32	"	"	"	"	"	"	
Methyl tertiary-butyl ether (MTBE)	ND	58	"	"	"	"	"	"	
1,1-Dichloroethane	ND	33	"	"	"	"	"	"	
2-Butanone (MEK)	**1900**	48	"	"	"	"	"	"	

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Volatile Organic Compounds by EPA TO-15

H&P Mobile Geochemistry, Inc.

Analyte	Result	Reporting Limit	Units	Dilution Factor	Batch	Prepared	Analyzed	Method	Notes
Static VEP1 (E303001-05) Vapor Sampled: 22-Feb-23 Received: 28-Feb-23									
cis-1,2-Dichloroethene	ND	32	ug/m3	20	EC30715	07-Mar-23	08-Mar-23	EPA TO-15	
Diisopropyl ether (DIPE)	ND	68	"	"	"	"	"	"	
Chloroform	ND	20	"	"	"	"	"	"	
Ethyl tert-butyl ether (ETBE)	ND	68	"	"	"	"	"	"	
1,1,1-Trichloroethane	ND	44	"	"	"	"	"	"	
1,2-Dichloroethane (EDC)	ND	33	"	"	"	"	"	"	
Benzene	**22**	13	"	"	"	"	"	"	
Carbon tetrachloride	ND	26	"	"	"	"	"	"	
Tertiary-amyl methyl ether (TAME)	ND	68	"	"	"	"	"	"	
Trichloroethene	ND	44	"	"	"	"	"	"	
1,2-Dichloropropane	ND	37	"	"	"	"	"	"	
Bromodichloromethane	ND	54	"	"	"	"	"	"	
cis-1,3-Dichloropropene	ND	37	"	"	"	"	"	"	
4-Methyl-2-pentanone (MIBK)	**140**	66	"	"	"	"	"	"	
trans-1,3-Dichloropropene	ND	37	"	"	"	"	"	"	
Toluene	**830**	61	"	"	"	"	"	"	
1,1,2-Trichloroethane	ND	44	"	"	"	"	"	"	
2-Hexanone (MBK)	ND	66	"	"	"	"	"	"	
Dibromochloromethane	ND	69	"	"	"	"	"	"	
Tetrachloroethene	ND	55	"	"	"	"	"	"	
1,2-Dibromoethane (EDB)	ND	62	"	"	"	"	"	"	
1,1,1,2-Tetrachloroethane	ND	56	"	"	"	"	"	"	
Chlorobenzene	ND	37	"	"	"	"	"	"	
Ethylbenzene	**170**	35	"	"	"	"	"	"	
m,p-Xylene	**570**	35	"	"	"	"	"	"	
Styrene	ND	35	"	"	"	"	"	"	
o-Xylene	**84**	35	"	"	"	"	"	"	
Bromoform	ND	84	"	"	"	"	"	"	
1,1,2,2-Tetrachloroethane	ND	56	"	"	"	"	"	"	
4-Ethyltoluene	ND	40	"	"	"	"	"	"	
1,3,5-Trimethylbenzene	ND	40	"	"	"	"	"	"	
1,2,4-Trimethylbenzene	**41**	40	"	"	"	"	"	"	
1,3-Dichlorobenzene	ND	49	"	"	"	"	"	"	
1,4-Dichlorobenzene	ND	49	"	"	"	"	"	"	
1,2-Dichlorobenzene	ND	49	"	"	"	"	"	"	
Naphthalene	ND	42	"	"	"	"	"	"	
1,2,4-Trichlorobenzene	ND	150	"	"	"	"	"	"	
Hexachlorobutadiene	ND	210	"	"	"	"	"	"	

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Volatile Organic Compounds by EPA TO-15

H&P Mobile Geochemistry, Inc.

Analyte	Result	Reporting Limit	Units	Dilution Factor	Batch	Prepared	Analyzed	Method	Notes
Static VEP1 (E303001-05) Vapor Sampled: 22-Feb-23 Received: 28-Feb-23									
Surrogate: 1,2-Dichloroethane-d4		*114 %*	*76-134*		*EC30715*	*07-Mar-23*	*08-Mar-23*	*EPA TO-15*	
Surrogate: Toluene-d8		*95.3 %*	*78-125*		*"*	*"*	*"*	*"*	
Surrogate: 4-Bromofluorobenzene		*90.3 %*	*77-127*		*"*	*"*	*"*	*"*	

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Haley & Aldrich - Washington	Project:	HAL022823-10	
3131 Elliott Ave., Suite 600	Project Number:	Former Tiger Oil /0204793-000 Task 04	Reported:
Seattle, WA 98121	Project Manager:	Yen-Vy Van	09-Mar-23 09:26

Volatile Organic Compounds by H&P 8260SV

H&P Mobile Geochemistry, Inc.

Analyte	Result	Reporting Limit	Units	Dilution Factor	Batch	Prepared	Analyzed	Method	Notes
VEP2 Flow 1 (E303001-01) Vapor Sampled: 22-Feb-23 Received: 28-Feb-23									**R-05**
2-Butanone (MEK)	ND	10000	ug/m3	0.2	EC30714	06-Mar-23	06-Mar-23	H&P 8260SV	
2-Hexanone (MBK)	ND	10000	"	"	"	"	"	"	
4-Methyl-2-pentanone (MIBK)	ND	10000	"	"	"	"	"	"	
Dichlorodifluoromethane (F12)	ND	2000	"	"	"	"	"	"	
Chloromethane	ND	2000	"	"	"	"	"	"	
Vinyl chloride	ND	200	"	"	"	"	"	"	
Bromomethane	ND	2000	"	"	"	"	"	"	
Chloroethane	ND	2000	"	"	"	"	"	"	
Trichlorofluoromethane (F11)	ND	2000	"	"	"	"	"	"	
1,1-Dichloroethene	ND	2000	"	"	"	"	"	"	
1,1,2 Trichlorotrifluoroethane (F113)	ND	2000	"	"	"	"	"	"	
Carbon disulfide	ND	2000	"	"	"	"	"	"	
Methylene chloride (Dichloromethane)	ND	2000	"	"	"	"	"	"	
Methyl tertiary-butyl ether (MTBE)	ND	2000	"	"	"	"	"	"	
trans-1,2-Dichloroethene	ND	2000	"	"	"	"	"	"	
Diisopropyl ether (DIPE)	ND	4000	"	"	"	"	"	"	
1,1-Dichloroethane	ND	2000	"	"	"	"	"	"	
Ethyl tert-butyl ether (ETBE)	ND	4000	"	"	"	"	"	"	
cis-1,2-Dichloroethene	ND	2000	"	"	"	"	"	"	
Chloroform	ND	400	"	"	"	"	"	"	
1,1,1-Trichloroethane	ND	2000	"	"	"	"	"	"	
Carbon tetrachloride	ND	400	"	"	"	"	"	"	
1,2-Dichloroethane (EDC)	ND	400	"	"	"	"	"	"	
Tertiary-amyl methyl ether (TAME)	ND	4000	"	"	"	"	"	"	
Benzene	ND	400	"	"	"	"	"	"	
Trichloroethene	ND	400	"	"	"	"	"	"	
1,2-Dichloropropane	ND	2000	"	"	"	"	"	"	
Bromodichloromethane	ND	2000	"	"	"	"	"	"	
cis-1,3-Dichloropropene	ND	2000	"	"	"	"	"	"	
Toluene	ND	4000	"	"	"	"	"	"	
trans-1,3-Dichloropropene	ND	2000	"	"	"	"	"	"	
1,1,2-Trichloroethane	ND	2000	"	"	"	"	"	"	
1,2-Dibromoethane (EDB)	ND	2000	"	"	"	"	"	"	
Tetrachloroethene	ND	400	"	"	"	"	"	"	
Dibromochloromethane	ND	2000	"	"	"	"	"	"	
Chlorobenzene	ND	400	"	"	"	"	"	"	
Ethylbenzene	ND	2000	"	"	"	"	"	"	
1,1,1,2-Tetrachloroethane	ND	2000	"	"	"	"	"	"	

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3131 Elliott Ave., Suite 600	Project Number: Former Tiger Oil /0204793-000 Task 04	Reported:
Seattle, WA 98121	Project Manager: Yen-Vy Van	09-Mar-23 09:26

Volatile Organic Compounds by H&P 8260SV

H&P Mobile Geochemistry, Inc.

Analyte	Result	Reporting Limit	Units	Dilution Factor	Batch	Prepared	Analyzed	Method	Notes
VEP2 Flow 1 (E303001-01) Vapor Sampled: 22-Feb-23 Received: 28-Feb-23									**R-05**
m,p-Xylene	ND	2000	ug/m3	0.2	EC30714	06-Mar-23	06-Mar-23	H&P 8260SV	
o-Xylene	ND	2000	"	"	"	"	"	"	
Styrene	ND	2000	"	"	"	"	"	"	
Bromoform	ND	2000	"	"	"	"	"	"	
1,1,2,2-Tetrachloroethane	ND	2000	"	"	"	"	"	"	
1,3,5-Trimethylbenzene	ND	2000	"	"	"	"	"	"	
1,2,4-Trimethylbenzene	ND	2000	"	"	"	"	"	"	
1,3-Dichlorobenzene	ND	2000	"	"	"	"	"	"	
1,4-Dichlorobenzene	ND	2000	"	"	"	"	"	"	
1,2-Dichlorobenzene	ND	2000	"	"	"	"	"	"	
1,2,4-Trichlorobenzene	ND	2000	"	"	"	"	"	"	
Hexachlorobutadiene	ND	2000	"	"	"	"	"	"	
Naphthalene	ND	400	"	"	"	"	"	"	
Tertiary-butyl alcohol (TBA)	ND	20000	"	"	"	"	"	"	
Surrogate: Dibromofluoromethane		*83.3 %*	*75-125*		*"*	*"*	*"*	*"*	
Surrogate: Toluene-d8		*92.0 %*	*75-125*		*"*	*"*	*"*	*"*	
Surrogate: 4-Bromofluorobenzene		*83.2 %*	*75-125*		*"*	*"*	*"*	*"*	
VEP1 Flow 1 (E303001-02) Vapor Sampled: 22-Feb-23 Received: 28-Feb-23									**R-05**
2-Butanone (MEK)	ND	10000	ug/m3	0.2	EC30714	06-Mar-23	06-Mar-23	H&P 8260SV	
2-Hexanone (MBK)	ND	10000	"	"	"	"	"	"	
4-Methyl-2-pentanone (MIBK)	ND	10000	"	"	"	"	"	"	
Dichlorodifluoromethane (F12)	ND	2000	"	"	"	"	"	"	
Chloromethane	ND	2000	"	"	"	"	"	"	
Vinyl chloride	ND	200	"	"	"	"	"	"	
Bromomethane	ND	2000	"	"	"	"	"	"	
Chloroethane	ND	2000	"	"	"	"	"	"	
Trichlorofluoromethane (F11)	ND	2000	"	"	"	"	"	"	
1,1-Dichloroethene	ND	2000	"	"	"	"	"	"	
1,1,2 Trichlorotrifluoroethane (F113)	ND	2000	"	"	"	"	"	"	
Carbon disulfide	ND	2000	"	"	"	"	"	"	
Methylene chloride (Dichloromethane)	ND	2000	"	"	"	"	"	"	
Methyl tertiary-butyl ether (MTBE)	ND	2000	"	"	"	"	"	"	
trans-1,2-Dichloroethene	ND	2000	"	"	"	"	"	"	
Diisopropyl ether (DIPE)	ND	4000	"	"	"	"	"	"	
1,1-Dichloroethane	ND	2000	"	"	"	"	"	"	
Ethyl tert-butyl ether (ETBE)	ND	4000	"	"	"	"	"	"	

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Volatile Organic Compounds by H&P 8260SV

H&P Mobile Geochemistry, Inc.

Analyte	Result	Reporting Limit	Units	Dilution Factor	Batch	Prepared	Analyzed	Method	Notes
VEP1 Flow 1 (E303001-02) Vapor Sampled: 22-Feb-23 Received: 28-Feb-23									**R-05**
cis-1,2-Dichloroethene	ND	2000	ug/m3	0.2	EC30714	06-Mar-23	06-Mar-23	H&P 8260SV	
Chloroform	ND	400	"	"	"	"	"	"	
1,1,1-Trichloroethane	ND	2000	"	"	"	"	"	"	
Carbon tetrachloride	ND	400	"	"	"	"	"	"	
1,2-Dichloroethane (EDC)	ND	400	"	"	"	"	"	"	
Tertiary-amyl methyl ether (TAME)	ND	4000	"	"	"	"	"	"	
Benzene	ND	400	"	"	"	"	"	"	
Trichloroethene	ND	400	"	"	"	"	"	"	
1,2-Dichloropropane	ND	2000	"	"	"	"	"	"	
Bromodichloromethane	ND	2000	"	"	"	"	"	"	
cis-1,3-Dichloropropene	ND	2000	"	"	"	"	"	"	
Toluene	ND	4000	"	"	"	"	"	"	
trans-1,3-Dichloropropene	ND	2000	"	"	"	"	"	"	
1,1,2-Trichloroethane	ND	2000	"	"	"	"	"	"	
1,2-Dibromoethane (EDB)	ND	2000	"	"	"	"	"	"	
Tetrachloroethene	ND	400	"	"	"	"	"	"	
Dibromochloromethane	ND	2000	"	"	"	"	"	"	
Chlorobenzene	ND	400	"	"	"	"	"	"	
Ethylbenzene	ND	2000	"	"	"	"	"	"	
1,1,1,2-Tetrachloroethane	ND	2000	"	"	"	"	"	"	
m,p-Xylene	ND	2000	"	"	"	"	"	"	
o-Xylene	ND	2000	"	"	"	"	"	"	
Styrene	ND	2000	"	"	"	"	"	"	
Bromoform	ND	2000	"	"	"	"	"	"	
1,1,2,2-Tetrachloroethane	ND	2000	"	"	"	"	"	"	
1,3,5-Trimethylbenzene	ND	2000	"	"	"	"	"	"	
1,2,4-Trimethylbenzene	ND	2000	"	"	"	"	"	"	
1,3-Dichlorobenzene	ND	2000	"	"	"	"	"	"	
1,4-Dichlorobenzene	ND	2000	"	"	"	"	"	"	
1,2-Dichlorobenzene	ND	2000	"	"	"	"	"	"	
1,2,4-Trichlorobenzene	ND	2000	"	"	"	"	"	"	
Hexachlorobutadiene	ND	2000	"	"	"	"	"	"	
Naphthalene	ND	400	"	"	"	"	"	"	
Tertiary-butyl alcohol (TBA)	ND	20000	"	"	"	"	"	"	
Surrogate: Dibromofluoromethane		*81.4 %*	*75-125*		"	"	"	"	
Surrogate: Toluene-d8		*95.5 %*	*75-125*		"	"	"	"	
Surrogate: 4-Bromofluorobenzene		*86.0 %*	*75-125*		"	"	"	"	

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Volatile Organic Compounds by H&P 8260SV

H&P Mobile Geochemistry, Inc.

Analyte	Result	Reporting Limit	Units	Dilution Factor	Batch	Prepared	Analyzed	Method	Notes
VEP2 Flow 2 (E303001-04) Vapor Sampled: 22-Feb-23 Received: 28-Feb-23									
2-Butanone (MEK)	ND	17000	ug/m3	0.344	EC30714	06-Mar-23	06-Mar-23	H&P 8260SV	
2-Hexanone (MBK)	ND	17000	"	"	"	"	"	"	
4-Methyl-2-pentanone (MIBK)	ND	17000	"	"	"	"	"	"	
Dichlorodifluoromethane (F12)	ND	3400	"	"	"	"	"	"	
Chloromethane	ND	3400	"	"	"	"	"	"	
Vinyl chloride	ND	340	"	"	"	"	"	"	
Bromomethane	ND	3400	"	"	"	"	"	"	
Chloroethane	ND	3400	"	"	"	"	"	"	
Trichlorofluoromethane (F11)	ND	3400	"	"	"	"	"	"	
1,1-Dichloroethene	ND	3400	"	"	"	"	"	"	
1,1,2 Trichlorotrifluoroethane (F113)	ND	3400	"	"	"	"	"	"	
Carbon disulfide	ND	3400	"	"	"	"	"	"	
Methylene chloride (Dichloromethane)	ND	3400	"	"	"	"	"	"	
Methyl tertiary-butyl ether (MTBE)	ND	3400	"	"	"	"	"	"	
trans-1,2-Dichloroethene	ND	3400	"	"	"	"	"	"	
Diisopropyl ether (DIPE)	ND	6900	"	"	"	"	"	"	
1,1-Dichloroethane	ND	3400	"	"	"	"	"	"	
Ethyl tert-butyl ether (ETBE)	ND	6900	"	"	"	"	"	"	
cis-1,2-Dichloroethene	ND	3400	"	"	"	"	"	"	
Chloroform	ND	690	"	"	"	"	"	"	
1,1,1-Trichloroethane	ND	3400	"	"	"	"	"	"	
Carbon tetrachloride	ND	690	"	"	"	"	"	"	
1,2-Dichloroethane (EDC)	ND	690	"	"	"	"	"	"	
Tertiary-amyl methyl ether (TAME)	ND	6900	"	"	"	"	"	"	
Benzene	ND	690	"	"	"	"	"	"	
Trichloroethene	ND	690	"	"	"	"	"	"	
1,2-Dichloropropane	ND	3400	"	"	"	"	"	"	
Bromodichloromethane	ND	3400	"	"	"	"	"	"	
cis-1,3-Dichloropropene	ND	3400	"	"	"	"	"	"	
Toluene	**11000**	6900	"	"	"	"	"	"	
trans-1,3-Dichloropropene	ND	3400	"	"	"	"	"	"	
1,1,2-Trichloroethane	ND	3400	"	"	"	"	"	"	
1,2-Dibromoethane (EDB)	ND	3400	"	"	"	"	"	"	
Tetrachloroethene	ND	690	"	"	"	"	"	"	
Dibromochloromethane	ND	3400	"	"	"	"	"	"	
Chlorobenzene	ND	690	"	"	"	"	"	"	
Ethylbenzene	ND	3400	"	"	"	"	"	"	
1,1,1,2-Tetrachloroethane	ND	3400	"	"	"	"	"	"	

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Volatile Organic Compounds by H&P 8260SV

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Analyte	Result	Reporting Limit	Units	Dilution Factor	Batch	Prepared	Analyzed	Method	Notes
VEP2 Flow 2 (E303001-04) Vapor Sampled: 22-Feb-23 Received: 28-Feb-23									
m,p-Xylene	**8900**	3400	ug/m3	0.344	EC30714	06-Mar-23	06-Mar-23	H&P 8260SV	
o-Xylene	ND	3400	"	"	"	"	"	"	
Styrene	ND	3400	"	"	"	"	"	"	
Bromoform	ND	3400	"	"	"	"	"	"	
1,1,2,2-Tetrachloroethane	ND	3400	"	"	"	"	"	"	
1,3,5-Trimethylbenzene	ND	3400	"	"	"	"	"	"	
1,2,4-Trimethylbenzene	ND	3400	"	"	"	"	"	"	
1,3-Dichlorobenzene	ND	3400	"	"	"	"	"	"	
1,4-Dichlorobenzene	ND	3400	"	"	"	"	"	"	
1,2-Dichlorobenzene	ND	3400	"	"	"	"	"	"	
1,2,4-Trichlorobenzene	ND	3400	"	"	"	"	"	"	
Hexachlorobutadiene	ND	3400	"	"	"	"	"	"	
Naphthalene	ND	690	"	"	"	"	"	"	
Tertiary-butyl alcohol (TBA)	ND	34000	"	"	"	"	"	"	
Surrogate: Dibromofluoromethane		*81.5 %*		*75-125*	"	"	"	"	
Surrogate: Toluene-d8		*94.9 %*		*75-125*	"	"	"	"	
Surrogate: 4-Bromofluorobenzene		*85.8 %*		*75-125*	"	"	"	"	

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Haley & Aldrich - Washington 3131 Elliott Ave., Suite 600 Seattle, WA 98121	Project: HAL022823-10 Project Number: Former Tiger Oil /0204793-000 Task 04 Project Manager: Yen-Vy Van	Reported: 09-Mar-23 09:26

Petroleum Hydrocarbon Analysis by EPA TO-15

H&P Mobile Geochemistry, Inc.

Analyte	Result	Reporting Limit	Units	Dilution Factor	Batch	Prepared	Analyzed	Method	Notes
Effluent VEP1 (E303001-03) Vapor Sampled: 22-Feb-23 Received: 28-Feb-23									
TPHv (C5 - C12)	**640**	100	ug/m3	1	EC30715	07-Mar-23	08-Mar-23	EPA TO-15	
Static VEP1 (E303001-05) Vapor Sampled: 22-Feb-23 Received: 28-Feb-23									
TPHv (C5 - C12)	**170000**	2000	ug/m3	20	EC30715	07-Mar-23	08-Mar-23	EPA TO-15	

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Petroleum Hydrocarbon Analysis by H&P 8260SV

H&P Mobile Geochemistry, Inc.

Analyte	Result	Reporting Limit	Units	Dilution Factor	Batch	Prepared	Analyzed	Method	Notes
VEP2 Flow 1 (E303001-01) Vapor Sampled: 22-Feb-23 Received: 28-Feb-23									
TPHv (C5 - C12)	**1000000**	200000	ug/m3	0.2	EC30714	06-Mar-23	06-Mar-23	H&P 8260SV	
VEP1 Flow 1 (E303001-02) Vapor Sampled: 22-Feb-23 Received: 28-Feb-23									
TPHv (C5 - C12)	**1700000**	200000	ug/m3	0.2	EC30714	06-Mar-23	06-Mar-23	H&P 8260SV	
VEP2 Flow 2 (E303001-04) Vapor Sampled: 22-Feb-23 Received: 28-Feb-23									
TPHv (C5 - C12)	**2500000**	200000	ug/m3	0.344	EC30714	06-Mar-23	06-Mar-23	H&P 8260SV	

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Volatile Organic Compounds by EPA TO-15 - Quality Control
H&P Mobile Geochemistry, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch EC30715 - TO-15										
Blank (EC30715-BLK1)				Prepared & Analyzed: 07-Mar-23						
Dichlorodifluoromethane (F12)	ND	4.0	ug/m3							
Chloromethane	ND	0.8	"							
Dichlorotetrafluoroethane (F114)	ND	2.8	"							
Vinyl chloride	ND	0.5	"							
Bromomethane	ND	1.6	"							
Chloroethane	ND	1.1	"							
Trichlorofluoromethane (F11)	ND	2.3	"							
1,1-Dichloroethene	ND	1.6	"							
Tertiary-butyl alcohol (TBA)	ND	6.1	"							
1,1,2-Trichlorotrifluoroethane (F113)	ND	3.1	"							
Methylene chloride (Dichloromethane)	ND	1.4	"							
Carbon disulfide	ND	1.3	"							
trans-1,2-Dichloroethene	ND	1.6	"							
Methyl tertiary-butyl ether (MTBE)	ND	2.9	"							
1,1-Dichloroethane	ND	1.6	"							
2-Butanone (MEK)	ND	2.4	"							
cis-1,2-Dichloroethene	ND	1.6	"							
Diisopropyl ether (DIPE)	ND	3.4	"							
Chloroform	ND	1.0	"							
Ethyl tert-butyl ether (ETBE)	ND	3.4	"							
1,1,1-Trichloroethane	ND	2.2	"							
1,2-Dichloroethane (EDC)	ND	1.6	"							
Benzene	ND	0.6	"							
Carbon tetrachloride	ND	1.3	"							
Tertiary-amyl methyl ether (TAME)	ND	3.4	"							
Trichloroethene	ND	2.2	"							
1,2-Dichloropropane	ND	1.9	"							
Bromodichloromethane	ND	2.7	"							
cis-1,3-Dichloropropene	ND	1.8	"							
4-Methyl-2-pentanone (MIBK)	ND	3.3	"							
trans-1,3-Dichloropropene	ND	1.8	"							
Toluene	ND	3.1	"							
1,1,2-Trichloroethane	ND	2.2	"							
2-Hexanone (MBK)	ND	3.3	"							

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Haley & Aldrich - Washington	Project: HAL022823-10	
3131 Elliott Ave., Suite 600	Project Number: Former Tiger Oil /0204793-000 Task 04	Reported:
Seattle, WA 98121	Project Manager: Yen-Vy Van	09-Mar-23 09:26

Volatile Organic Compounds by EPA TO-15 - Quality Control
H&P Mobile Geochemistry, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch EC30715 - TO-15										
Blank (EC30715-BLK1)				Prepared & Analyzed: 07-Mar-23						
Dibromochloromethane	ND	3.5	ug/m3							
Tetrachloroethene	ND	2.8	"							
1,2-Dibromoethane (EDB)	ND	3.1	"							
1,1,1,2-Tetrachloroethane	ND	2.8	"							
Chlorobenzene	ND	1.9	"							
Ethylbenzene	ND	1.8	"							
m,p-Xylene	ND	1.8	"							
Styrene	ND	1.7	"							
o-Xylene	ND	1.8	"							
Bromoform	ND	4.2	"							
1,1,2,2-Tetrachloroethane	ND	2.8	"							
4-Ethyltoluene	ND	2.0	"							
1,3,5-Trimethylbenzene	ND	2.0	"							
1,2,4-Trimethylbenzene	ND	2.0	"							
1,3-Dichlorobenzene	ND	2.4	"							
1,4-Dichlorobenzene	ND	2.4	"							
1,2-Dichlorobenzene	ND	2.4	"							
Naphthalene	270	2.1	"							
1,2,4-Trichlorobenzene	ND	7.5	"							
Hexachlorobutadiene	ND	11	"							
Surrogate: 1,2-Dichloroethane-d4	*237*		*"*	*214*		*111*	*76-134*			
Surrogate: Toluene-d8	*229*		*"*	*208*		*110*	*78-125*			
Surrogate: 4-Bromofluorobenzene	*338*		*"*	*363*		*93.2*	*77-127*			
LCS (EC30715-BS1)				Prepared & Analyzed: 07-Mar-23						
Dichlorodifluoromethane (F12)	120	4.0	ug/m3	101		118	59-128			
Vinyl chloride	61	0.5	"	52.0		118	64-127			
Chloroethane	63	1.1	"	53.6		117	63-127			
Trichlorofluoromethane (F11)	130	2.3	"	113		115	62-126			
1,1-Dichloroethene	82	1.6	"	80.8		102	61-133			
1,1,2-Trichlorotrifluoroethane (F113)	160	3.1	"	155		101	66-126			
Methylene chloride (Dichloromethane)	82	1.4	"	70.8		115	62-115			
trans-1,2-Dichloroethene	88	1.6	"	80.8		109	67-124			

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Volatile Organic Compounds by EPA TO-15 - Quality Control
H&P Mobile Geochemistry, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch EC30715 - TO-15										
LCS (EC30715-BS1)				Prepared & Analyzed: 07-Mar-23						
1,1-Dichloroethane	89	1.6	ug/m3	82.4		107	68-126			
cis-1,2-Dichloroethene	85	1.6	"	80.0		106	70-121			
Chloroform	100	1.0	"	99.2		105	68-123			
1,1,1-Trichloroethane	120	2.2	"	111		105	68-125			
1,2-Dichloroethane (EDC)	90	1.6	"	82.4		109	65-128			
Benzene	64	0.6	"	64.8		98.0	69-119			
Carbon tetrachloride	130	1.3	"	128		101	68-132			
Trichloroethene	110	2.2	"	110		98.3	71-123			
Toluene	72	3.1	"	76.8		94.3	66-119			
1,1,2-Trichloroethane	100	2.2	"	111		93.1	73-119			
Tetrachloroethene	110	2.8	"	138		80.5	66-124			
1,1,1,2-Tetrachloroethane	130	2.8	"	140		92.2	67-129			
Ethylbenzene	66	1.8	"	88.4		74.3	70-124			
m,p-Xylene	67	1.8	"	88.4		75.4	61-134			
o-Xylene	66	1.8	"	88.4		74.2	67-125			
1,1,2,2-Tetrachloroethane	100	2.8	"	140		73.2	65-127			
Surrogate: 1,2-Dichloroethane-d4	*244*		"	*214*		*114*	*76-134*			
Surrogate: Toluene-d8	*219*		"	*208*		*106*	*78-125*			
Surrogate: 4-Bromofluorobenzene	*347*		"	*363*		*95.7*	*77-127*			
LCS Dup (EC30715-BSD1)				Prepared & Analyzed: 07-Mar-23						
Dichlorodifluoromethane (F12)	120	4.0	ug/m3	101		118	59-128	0.632	25	
Vinyl chloride	61	0.5	"	52.0		118	64-127	0.212	25	
Chloroethane	62	1.1	"	53.6		116	63-127	1.24	25	
Trichlorofluoromethane (F11)	130	2.3	"	113		114	62-126	0.740	25	
1,1-Dichloroethene	81	1.6	"	80.8		101	61-133	1.23	25	
1,1,2-Trichlorotrifluoroethane (F113)	160	3.1	"	155		103	66-126	1.17	25	
Methylene chloride (Dichloromethane)	67	1.4	"	70.8		94.4	62-115	19.8	25	
trans-1,2-Dichloroethene	85	1.6	"	80.8		105	67-124	3.45	25	
1,1-Dichloroethane	84	1.6	"	82.4		101	68-126	5.77	25	
cis-1,2-Dichloroethene	83	1.6	"	80.0		103	70-121	2.98	25	
Chloroform	100	1.0	"	99.2		103	68-123	1.58	25	
1,1,1-Trichloroethane	110	2.2	"	111		101	68-125	3.43	25	

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Volatile Organic Compounds by EPA TO-15 - Quality Control

H&P Mobile Geochemistry, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch EC30715 - TO-15										
LCS Dup (EC30715-BSD1)				Prepared & Analyzed: 07-Mar-23						
1,2-Dichloroethane (EDC)	88	1.6	ug/m3	82.4		106	65-128	2.45	25	
Benzene	63	0.6	"	64.8		97.1	69-119	0.973	25	
Carbon tetrachloride	130	1.3	"	128		99.6	68-132	1.49	25	
Trichloroethene	100	2.2	"	110		94.2	71-123	4.18	25	
Toluene	70	3.1	"	76.8		90.6	66-119	3.98	25	
1,1,2-Trichloroethane	100	2.2	"	111		90.3	73-119	3.03	25	
Tetrachloroethene	110	2.8	"	138		79.4	66-124	1.44	25	
1,1,1,2-Tetrachloroethane	130	2.8	"	140		92.8	67-129	0.592	25	
Ethylbenzene	67	1.8	"	88.4		75.6	70-124	1.73	25	
m,p-Xylene	68	1.8	"	88.4		77.2	61-134	2.35	25	
o-Xylene	67	1.8	"	88.4		76.0	67-125	2.45	25	
1,1,2,2-Tetrachloroethane	100	2.8	"	140		75.0	65-127	2.35	25	
Surrogate: 1,2-Dichloroethane-d4	*243*		*"*	*214*		*114*	*76-134*			
Surrogate: Toluene-d8	*218*		*"*	*208*		*105*	*78-125*			
Surrogate: 4-Bromofluorobenzene	*351*		*"*	*363*		*96.7*	*77-127*			

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Volatile Organic Compounds by H&P 8260SV - Quality Control

H&P Mobile Geochemistry, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch EC30714 - EPA 5030										
Blank (EC30714-BLK1)				Prepared & Analyzed: 06-Mar-23						
2-Butanone (MEK)	ND	2500	ug/m3							
2-Hexanone (MBK)	ND	2500	"							
4-Methyl-2-pentanone (MIBK)	ND	2500	"							
Dichlorodifluoromethane (F12)	ND	500	"							
Chloromethane	ND	500	"							
Vinyl chloride	ND	50	"							
Bromomethane	ND	500	"							
Chloroethane	ND	500	"							
Trichlorofluoromethane (F11)	ND	500	"							
1,1-Dichloroethene	ND	500	"							
1,1,2 Trichlorotrifluoroethane (F113)	ND	500	"							
Carbon disulfide	ND	500	"							
Methylene chloride (Dichloromethane)	ND	500	"							
Methyl tertiary-butyl ether (MTBE)	ND	500	"							
trans-1,2-Dichloroethene	ND	500	"							
Diisopropyl ether (DIPE)	ND	1000	"							
1,1-Dichloroethane	ND	500	"							
Ethyl tert-butyl ether (ETBE)	ND	1000	"							
cis-1,2-Dichloroethene	ND	500	"							
Chloroform	ND	100	"							
1,1,1-Trichloroethane	ND	500	"							
Carbon tetrachloride	ND	100	"							
1,2-Dichloroethane (EDC)	ND	100	"							
Tertiary-amyl methyl ether (TAME)	ND	1000	"							
Benzene	ND	100	"							
Trichloroethene	ND	100	"							
1,2-Dichloropropane	ND	500	"							
Bromodichloromethane	ND	500	"							
cis-1,3-Dichloropropene	ND	500	"							
Toluene	ND	1000	"							
trans-1,3-Dichloropropene	ND	500	"							
1,1,2-Trichloroethane	ND	500	"							
1,2-Dibromoethane (EDB)	ND	500	"							
Tetrachloroethene	ND	100	"							

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Volatile Organic Compounds by H&P 8260SV - Quality Control
H&P Mobile Geochemistry, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch EC30714 - EPA 5030										
Blank (EC30714-BLK1)				Prepared & Analyzed: 06-Mar-23						
Dibromochloromethane	ND	500	ug/m3							
Chlorobenzene	ND	100	"							
Ethylbenzene	ND	500	"							
1,1,1,2-Tetrachloroethane	ND	500	"							
m,p-Xylene	ND	500	"							
o-Xylene	ND	500	"							
Styrene	ND	500	"							
Bromoform	ND	500	"							
1,1,2,2-Tetrachloroethane	ND	500	"							
1,3,5-Trimethylbenzene	ND	500	"							
1,2,4-Trimethylbenzene	ND	500	"							
1,3-Dichlorobenzene	ND	500	"							
1,4-Dichlorobenzene	ND	500	"							
1,2-Dichlorobenzene	ND	500	"							
1,2,4-Trichlorobenzene	ND	500	"							
Hexachlorobutadiene	ND	500	"							
Naphthalene	ND	100	"							
Tertiary-butyl alcohol (TBA)	ND	5000	"							
Surrogate: Dibromofluoromethane	*2130*		*"*	*2500*		*85.1*	*75-125*			
Surrogate: Toluene-d8	*2250*		*"*	*2500*		*89.9*	*75-125*			
Surrogate: 4-Bromofluorobenzene	*2150*		*"*	*2500*		*86.0*	*75-125*			
LCS (EC30714-BS1)				Prepared & Analyzed: 06-Mar-23						
Dichlorodifluoromethane (F12)	3500	500	ug/m3	5000		70.9	70-130			
Vinyl chloride	4100	50	"	5000		82.8	70-130			
Chloroethane	3400	500	"	5000		68.2	70-130			QL-1L
Trichlorofluoromethane (F11)	4700	500	"	5000		93.0	70-130			
1,1-Dichloroethene	4400	500	"	5000		87.4	70-130			
1,1,2 Trichlorotrifluoroethane (F113)	4600	500	"	5000		93.0	70-130			
Methylene chloride (Dichloromethane)	4000	500	"	5000		80.6	70-130			
trans-1,2-Dichloroethene	4500	500	"	5000		89.1	70-130			
1,1-Dichloroethane	4300	500	"	5000		85.2	70-130			
cis-1,2-Dichloroethene	4300	500	"	5000		85.2	70-130			

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Haley & Aldrich - Washington	Project:	HAL022823-10	
3131 Elliott Ave., Suite 600	Project Number:	Former Tiger Oil /0204793-000 Task 04	Reported:
Seattle, WA 98121	Project Manager:	Yen-Vy Van	09-Mar-23 09:26

Volatile Organic Compounds by H&P 8260SV - Quality Control
H&P Mobile Geochemistry, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch EC30714 - EPA 5030										
LCS (EC30714-BS1)				Prepared & Analyzed: 06-Mar-23						
Chloroform	4000	100	ug/m3	5000		80.0	70-130			
1,1,1-Trichloroethane	4000	500	"	5000		81.0	70-130			
Carbon tetrachloride	4300	100	"	5000		85.3	70-130			
1,2-Dichloroethane (EDC)	3700	100	"	5000		73.4	70-130			
Benzene	4300	100	"	5000		85.9	70-130			
Trichloroethene	4200	100	"	5000		83.8	70-130			
Toluene	4300	1000	"	5000		86.0	70-130			
1,1,2-Trichloroethane	3600	500	"	5000		71.4	70-130			
Tetrachloroethene	5000	100	"	5000		99.9	70-130			
Ethylbenzene	4800	500	"	5000		96.8	70-130			
1,1,1,2-Tetrachloroethane	4300	500	"	5000		85.7	70-130			
m,p-Xylene	9400	500	"	10000		94.0	70-130			
o-Xylene	4500	500	"	5000		90.1	70-130			
1,1,2,2-Tetrachloroethane	3100	500	"	5000		62.0	70-130			QL-1L
Surrogate: Dibromofluoromethane	*2120*		*"*	*2500*		*84.7*	*75-125*			
Surrogate: Toluene-d8	*2320*		*"*	*2500*		*92.8*	*75-125*			
Surrogate: 4-Bromofluorobenzene	*2240*		*"*	*2500*		*89.7*	*75-125*			

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3131 Elliott Ave., Suite 600	Project Number: Former Tiger Oil /0204793-000 Task 04	Reported:
Seattle, WA 98121	Project Manager: Yen-Vy Van	09-Mar-23 09:26

Petroleum Hydrocarbon Analysis by EPA TO-15 - Quality Control

H&P Mobile Geochemistry, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch EC30715 - TO-15										
Blank (EC30715-BLK1)				Prepared & Analyzed: 07-Mar-23						
TPHv (C5 - C12)	ND	100	ug/m3							

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Haley & Aldrich - Washington 3131 Elliott Ave., Suite 600 Seattle, WA 98121	Project: HAL022823-10 Project Number: Former Tiger Oil /0204793-000 Task 04 Project Manager: Yen-Vy Van	Reported: 09-Mar-23 09:26

Petroleum Hydrocarbon Analysis by H&P 8260SV - Quality Control

H&P Mobile Geochemistry, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch EC30714 - EPA 5030										
Blank (EC30714-BLK1)				Prepared & Analyzed: 06-Mar-23						
TPHv (C5 - C12)	ND	200000	ug/m3							

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Haley & Aldrich - Washington	Project:	HAL022823-10	
3131 Elliott Ave., Suite 600	Project Number:	Former Tiger Oil /0204793-000 Task 04	Reported:
Seattle, WA 98121	Project Manager:	Yen-Vy Van	09-Mar-23 09:26

Notes and Definitions

R-05	The sample was diluted due to the presence of high level(s) of non-target analyte(s) resulting in elevated reporting limits.
QL-1L	The LCS and/or LCSD recoveries fell below the established control specifications for this analyte. Any result for this compound is qualified and should be considered biased low.
LCC	Leak Check Compound
ND	Analyte NOT DETECTED at or above the reporting limit
MDL	Method Detection Limit
%REC	Percent Recovery
RPD	Relative Percent Difference

All soil results are reported in wet weight.

Appendix

H&P Mobile Geochemistry, Inc. is approved as an Environmental Testing Laboratory and Mobile Laboratory in accordance with the DoD-ELAP Program and ISO/IEC 17025:2005 programs through PJLA, accreditation number 69070 for EPA Method TO-15, EPA Method 8260B and H&P 8260SV.

H&P is approved by the State of California as an Environmental Laboratory and Mobile Laboratory in conformance with the Environmental Laboratory Accreditation Program (ELAP) for the category of Volatile and Semi-Volatile Organic Chemistry of Hazardous Waste, certification numbers 2740, 2741, 2743 & 2745.

H&P is approved by the State of Louisiana Department of Environmental Quality under the National Environmental Laboratory Accreditation Conference (NELAC) certification number 04138

The complete list of stationary and mobile laboratory certifications along with the fields of testing (FOTs) and analyte lists are available at www.handpmg.com/about/certifications.

H&P Mobile Geochemistry, Inc.
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VAPOR / AIR Chain of Custody

DATE: 2/22/23
Page 1 of 1

Lab Client and Project Information
Former Tiger Oil 0204793-000 Task 04

Lab Client/Consultant: HALEY & ALDRICH	Project Name / #: Former Tiger Oil 0204793-000 Task 04
Lab Client Project Manager: Y. VAN	Project Location: Yakima, WA (Yakima, WA)
Lab Client Address: ~~301 Elliott Ave Suite 600~~ 3131 Elliott Ave., Suite 600	Report E-Mail(s): yvan@haleyaldrich.com (YVan@haleyaldrich.com); ouppal@haleyaldrich.com (OUppal@haleyaldrich.com)
Lab Client City, State, Zip: Seattle, WA 98121	
Phone Number: 253-320-5378	

Sample Receipt (Lab Use Only)

Date Rec'd: 2/28	Control #: 230077.01
H&P Project #: ~~H&A~~ HAL 022823-10	
Lab Work Order #: E303001	
Sample Intact: [X] Yes [ ] No [ ] See Notes Below	
Receipt Gauge ID: 61210	Temp: RT
Outside Lab:	
Receipt Notes/Tracking #: 1293TT6187 5109 7359	
Lab PM Initials: SN	

Reporting Requirements
[X] Standard Report [ ] Level III [ ] Level IV
[X] Excel EDD [ ] Other EDD: ______
[ ] CA Geotracker Global ID: ______

Turnaround Time
[X] Standard (7 days for preliminary report, 10 days for final report)
[ ] Rush (specify): ______

Sampler Information
Sampler(s): Y. Van ; O. Uppal
Signature: [signature]
Date: 2/22/23

Additional Instructions to Laboratory: VOC List Attached SN 3/01/23

(*) Analyzed by H&P 8260SV YSE 3/8/23

* Preferred VOC units (please choose one): [ ] µg/L [X] µg/m³ [ ] ppbv [ ] ppmv

SAMPLE NAME	FIELD POINT NAME (if applicable)	DATE mm/dd/yy	TIME 24hr clock	SAMPLE TYPE Indoor Air (IA), Ambient Air (AA), Subslab (SS), Soil Vapor (SV)	CONTAINER SIZE & TYPE 400mL/1L/6L Summa, Tedlar, Tube, etc.	CONTAINER ID (###)	Lab use only: Receipt Vac	VOCs Standard Full List [ ] 8260SV [X] TO-15	VOCs Short List / Project List [ ] 8260SV [ ] TO-15	Oxygenates [ ] 8260SV [X] TO-15	Naphthalene [ ] 8260SV [X] TO-15	TPHv as Gas [ ] 8260SVm [X] TO-15m	Aromatic/Aliphatic Fractions [ ] 8260SVm [ ] TO-15m	Leak Check Compound [ ] DFA [ ] IPA [ ] He	Methane by EPA 8015m	Fixed Gases by ASTM D1945 [ ] CO2 [ ] O2 [ ] N2
VEP2 Flow 1	VEP2 Flow 1 (*)	02/22/23	1302	SV	1L	598	-5.05	X		X	X	X				
VEP1 Flow 1	VEP1 Flow 1 (*)	02/22/23	1336	SV	1L	576	-5.68	X		X	X	X				
Effluent @ VEP1 Extraction	Effluent VEP1	02/22/23	1358	SV	1L	581	-0.06	X		X	X	X				
VEP2 Flow 2 ~~(Rotron blower)~~ (*)		02/22/23	1241	SV	1L	587	-12.99	X		X	X	X				
Static @ VEP1 ~~(blower shut off)~~		02/22/23	1437	SV	1L	590	-0.33	X		X	X	X				
Static VEP1																

Approved/Relinquished by:	Company:	Date:	Time:	Received by:	Company:	Date:	Time:
Yen Vy Van	H & A	2/22/23	1410	[signature]	H&P	2/28/23	1040

*Approval constitutes as authorization to proceed with analysis and acceptance of conditions on back

H&P Mobile Geochemistry Inc.

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EPA Method TO-15 (1-Liter Summa Canister)

Analyte	*CAS #*	*1-Liter RL/LOQ Vapor (µg/m³)*	*1-Liter RL/LOQ Vapor (ppbv)*
Dichlorodifluoromethane (F12)	75-71-8	4.0	0.8
Chloromethane	74-87-3	0.8	0.4
Dichlorotetrafluoroethane (F114)	76-14-2	2.8	0.4
Vinyl chloride	75-01-4	0.5	0.2
Bromomethane	74-83-9	1.6	0.4
Chloroethane	75-00-3	1.1	0.4
Trichlorofluoromethane (F11)	75-69-4	2.3	0.4
1,1-Dichloroethene	75-35-4	1.6	0.4
Methylene chloride (Dichloromethane)	75-09-2	1.4	0.4
1,1,2-Trichlorotrifluoroethane (F113)	76-13-1	3.1	0.4
Carbon disulfide	75-15-0	1.3	0.4
trans-1,2-Dichloroethene	156-60-5	1.6	0.4
1,1-Dichloroethane	75-34-3	1.6	0.4
2-Butanone (MEK)	78-93-3	2.4	0.8
cis-1,2-Dichloroethene	156-59-2	1.6	0.4
Chloroform	67-66-3	1.0	0.2
1,2-Dichloroethane (EDC)	107-06-2	1.6	0.4
1,1,1-Trichloroethane	71-55-6	2.2	0.4
Benzene	71-43-2	0.6	0.2
Carbon tetrachloride	56-23-5	1.3	0.2
1,2-Dichloropropane	78-87-5	1.9	0.4
Bromodichloromethane	75-27-4	2.7	0.4
Trichloroethene	79-01-6	2.2	0.4
cis-1,3-Dichloropropene	10061-01-5	1.8	0.4
4-Methyl-2-pentanone (MIBK)	108-10-1	3.3	0.8
trans-1,3-Dichloropropene	10061-02-6	1.8	0.4
1,1,2-Trichloroethane	79-00-5	2.2	0.4
Toluene	108-88-3	3.1	0.8
2-Hexanone (MBK)	591-78-6	3.3	0.8
Dibromochloromethane	124-48-1	3.5	0.4
1,2-Dibromoethane (EDB)	106-93-4	3.1	0.4
Tetrachloroethene	127-18-4	2.8	0.4
1,1,1,2-Tetrachloroethane	630-20-6	2.8	0.4
Chlorobenzene	108-90-7	1.9	0.4
Ethylbenzene	100-41-4	1.8	0.4
m,p-Xylene	179601-23-1	1.8	0.4
Bromoform	75-25-2	4.2	0.4
Styrene	100-42-5	1.7	0.4
1,1,2,2-Tetrachloroethane	79-34-5	2.8	0.4
o-Xylene	95-47-6	1.8	0.4
4-Ethyltoluene	622-96-8	2.0	0.4
1,3,5-Trimethylbenzene	108-67-8	2.0	0.4
1,2,4-Trimethylbenzene	95-63-6	2.0	0.4
1,3-Dichlorobenzene	541-73-1	2.4	0.4
1,4-Dichlorobenzene	106-46-7	2.4	0.4
1,2-Dichlorobenzene	95-50-1	2.4	0.4
1,2,4-Trichlorobenzene	120-82-1	7.5	1.0
Hexachlorobutadiene	87-68-3	10.7	1.0

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Analyte	*CAS #*	*1-Liter RL/LOQ Vapor (µg/m³)*	*1-Liter RL/LOQ Vapor (ppbv)*
Additional Compounds			
Naphthalene	91-20-3	2.1	0.4
Oxygenates			
Tertiary-butyl alcohol (TBA)	75-65-0	6.1	2.0
Methyl tertiary-butyl ether (MTBE)	1634-04-4	2.9	0.8
Diisopropyl ether (DIPE)	108-20-3	3.4	0.8
Ethyl tertiary-butyl ether (ETBE)	637-92-3	3.4	0.8
Tertiary-amyl methyl ether (TAME)	994-05-8	3.4	0.8
TPH gas			
TPH gas (C5-C12)		100	