MEMORANDUM

DATE: March 3, 2020

TO: John Mefford, Washington State Department of Ecology

FROM: Angie Goodwin and Mike Ehlebracht, Hart Crowser

RE: **Soil Vapor Monitoring Results Summary**
Ken's Auto Wash
Project Number: **7168-10**
Site Name: **Ken's Auto Wash II**
Site Address: **1013 E. University Way, Ellensburg**
Facility/Site ID No.: **3892**
Cleanup Site ID No.: **5208**
Agreed Order No.: **DE 10350**

This memorandum presents the findings of Hart Crowser's recent soil gas sampling of oxygen, carbon dioxide, and methane to provide another line of evidence that an active biodegradation zone is present beneath the Ken's Auto Wash site (Site) located at 1013 East University Way in Ellensburg, Washington. Soil gas monitoring was conducted in general accordance with the Soil Vapor Monitoring Work Plan (Work Plan) submitted to the Washington State Department of Ecology (Ecology) on November 21, 2019.

Vapor Sampling from Existing Wells

Soil vapor monitoring was attempted on December 26, 2019; however, site conditions were difficult due to the snow and cold and some of the wells were not accessible. Therefore, another sampling event was conducted at the Site on January 8, 2020. The weather in Ellensburg on this date was partly cloudy with temperatures ranging from 30 to 40 degrees F. Hart Crowser's field representative was Jolie Higgins, senior staff environmental engineer who is experienced at monitoring soil vapor in landfill gas wells. Monitoring of oxygen, carbon dioxide, and methane soil vapor was conducted in existing monitoring wells located near the former dispenser area, former underground storage tank area, and Site building (Figure 1). The Work Plan identified wells MW-2, MW-3, MW-4R, MW-5, and MW-14 for monitoring. However, well MW-14 could not be sampled due to a damaged surface monument.

Soil vapor monitoring was completed from the interval of unsaturated well screen for methane, carbon dioxide, and oxygen (percent by volume) using a GEM2000 gas analyzer. Vapor monitoring was generally completed using the following procedure:

- The depth to water (DTW) was recorded from each monitoring well and documented in the field notebook.

- New disposable polyethylene tubing for each monitoring well was measured and cut based on the depth of groundwater below ground surface (bgs) recorded and the depth to the screen bgs listed by monitoring well, shown in Table 1. The tubing within the monitoring well was measured and cut to sit between the top of the screen depth and the groundwater level.

- A Vapour Sampling EcoPlug™ well cap (pictured below) was placed at the top of the monitoring well casing with the tubing attached and placed above the measured groundwater level. This specialized well plug uses a stainless-steel valve which allowed extraction of the trapped headspace vapors while preventing the loss of well gasses to the atmosphere. The sample port adapter allowed for monitoring soil vapor without removing the cap from the well.

- Tubing was added to the top of the well cap and attached to the GEM2000 gas analyzer.

- Air within the tubing was purged using the gas analyzer at a rate of approximately 500 cc/min. Methane (C H4), carbon dioxide (CO2), and oxygen (O2) concentrations in percent by volume were documented during purging and after the gas readings stabilized. Results are shown in the table below.

- In order to evaluate if more aggressive purging would alter observed gas readings, well MW-2 was initially purged using the gas analyzer for 25 minutes and was then purged for an additional 30 minutes using a peristaltic pump attached to the well cap.

A summary of well purging and gas monitoring results are provided below.

Sample ID	Comments/Notes	Soil Vapor Field Screening Results in Percent
MW-2	Start of screen is 5 feet bgs. Length of unsaturated screen is 2.3 feet. No tubing attached initially. 5-feet of tubing attached at 12:15.	DTW: 7.3’ C H4 | CO2 | O2 11:03 0.2 0.1 20.7 11:26 0.1 0.1 20.5 12:15 Started purging with peristaltic pump 12:30 0.1 0.1 20.5 12:45 0.1 0.1 20.5
MW-3	Start of screen is 5 feet bgs. Length of unsaturated screen is 2.8 feet. 6-feet of tubing attached.	DTW: 7.8’ C H4 | CO2 | O2 11:40 0.0 0.0 20.8 11:50 0.0 0.0 20.6 12:00 0.0 0.0 20.5 12:10 0.0 0.0 20.5 *maintained at the same levels for next thirty minutes while using another gas meter to sample other wells*
MW-4R	Start of screen is 5.5 feet bgs. Length of unsaturated screen is 1.5 feet. 5-feet of tubing attached.	DTW: 7.0’ C H4 | CO2 | O2 16:10 0.2 0.2 20.4 16:13 0.2 0.2 20.4 16:16 0.1 0.1 20.3 16:20 0.2 0.1 20.4
MW-5	Start of screen is 4.33 feet bgs. Length of unsaturated screen is 3.97 feet.	DTW: 8.3’ C H4 | CO2 | O2 15:52 0.2 0.2 20.1 15:54 0.2 0.2 20.1

Sample ID	Comments/Notes	Soil Vapor Field Screening Results in Percent
MW-5 cont.	5-feet of tubing attached.	C H4 | CO2 | O2 15:57 0.2 0.2 20.1 16:01 0.2 0.2 20.1 16:04 0.2 0.2 20.1
MW-14	Not Sampled	Well monument is damaged and HC rep was not able to pull off protective lid.

Discussion of Soil Gas Monitoring Results

Results of soil gas monitoring conducted at the Site provides another line of evidence that an active biodegradation zone is present. Elevated oxygen concentrations and low methane concentrations in subsurface soil gas are indicative of an aerobic environment. Soil gas oxygen levels were slightly below atmospheric levels in all four wells sampled. Methane was detected at very low levels and was not present at levels indicative of an anaerobic (oxygen-deficient) environment. As noted in the United States Environmental Protection Agency's (EPA) document "Evaluation of Empirical Data to Support Soil Vapor Intrusion Screening Criteria for Petroleum Hydrocarbon Compounds" dated January 2013, biodegradation of petroleum vapors is relatively rapid when oxygen is present and typically limits the concentration and extent of subsurface petroleum vapor migration.

These results are consistent with the conceptual site model presented in Hart Crowser's Site Characterization Report (dated September 24, 2019) which indicated that weathered residual petroleum hydrocarbons do not appear to pose a significant risk to existing or future buildings via the vapor intrusion pathway. A more detailed discussion of the soil gas monitoring results is provided below.

Oxygen Levels in Soil Gas

Measured oxygen concentrations in soil gas samples collected from the four monitoring wells were slightly below the typical atmospheric level (approximately 21%). The highest oxygen level was detected in well MW-3 located upgradient (north) of the petroleum-impacted area. Slightly lower measured oxygen levels in the three wells located near or within the petroleum-impacted area is consistent with oxygen serving as an electron acceptor during aerobic degradation of the residual hydrocarbons. The consumption of oxygen (oxygen demand) within the petroleum-impacted area is partially offset by continued diffusion of atmospheric oxygen particularly through unpaved granular soils located on the western portion of the Site. Oxygen demand within the Site vadose zone appears to be limited based on

the lack of light nonaqueous phase liquid (NAPL), organic soils, or significant accumulations of reactive minerals (e.g. minerals containing ferrous iron).

Although future redevelopment will likely result in placement of less permeable surfaces on the western portion of the Site, we anticipate that the vadose zone beneath the Site will remain aerobic. Well MW-3 is surrounded by less permeable surfaces (buildings, pavement, etc.) but contains relatively high oxygen levels in soil vapor. Pavement and other hard surfaces may limit but do not prevent air diffusion particularly through cracks and other preferred pathways. Infiltration of oxygenated rainwater into the shallow perched water-bearing unit provides an additional source of oxygen to the Site subsurface.

Carbon Dioxide Levels in Soil Gas

Measured carbon dioxide concentrations in soil gas samples collected from the three monitoring wells located in or near the petroleum-impacted area exceed the typical atmospheric level (approximately 0.04%). Carbon dioxide was not detected in upgradient well MW-3 but was detected in the other three wells at levels of 0.1% to 0.2%. Slightly higher measured carbon dioxide levels in the three wells located near or within the petroleum-impacted area is consistent with carbon dioxide being produced during aerobic degradation of the residual hydrocarbons.

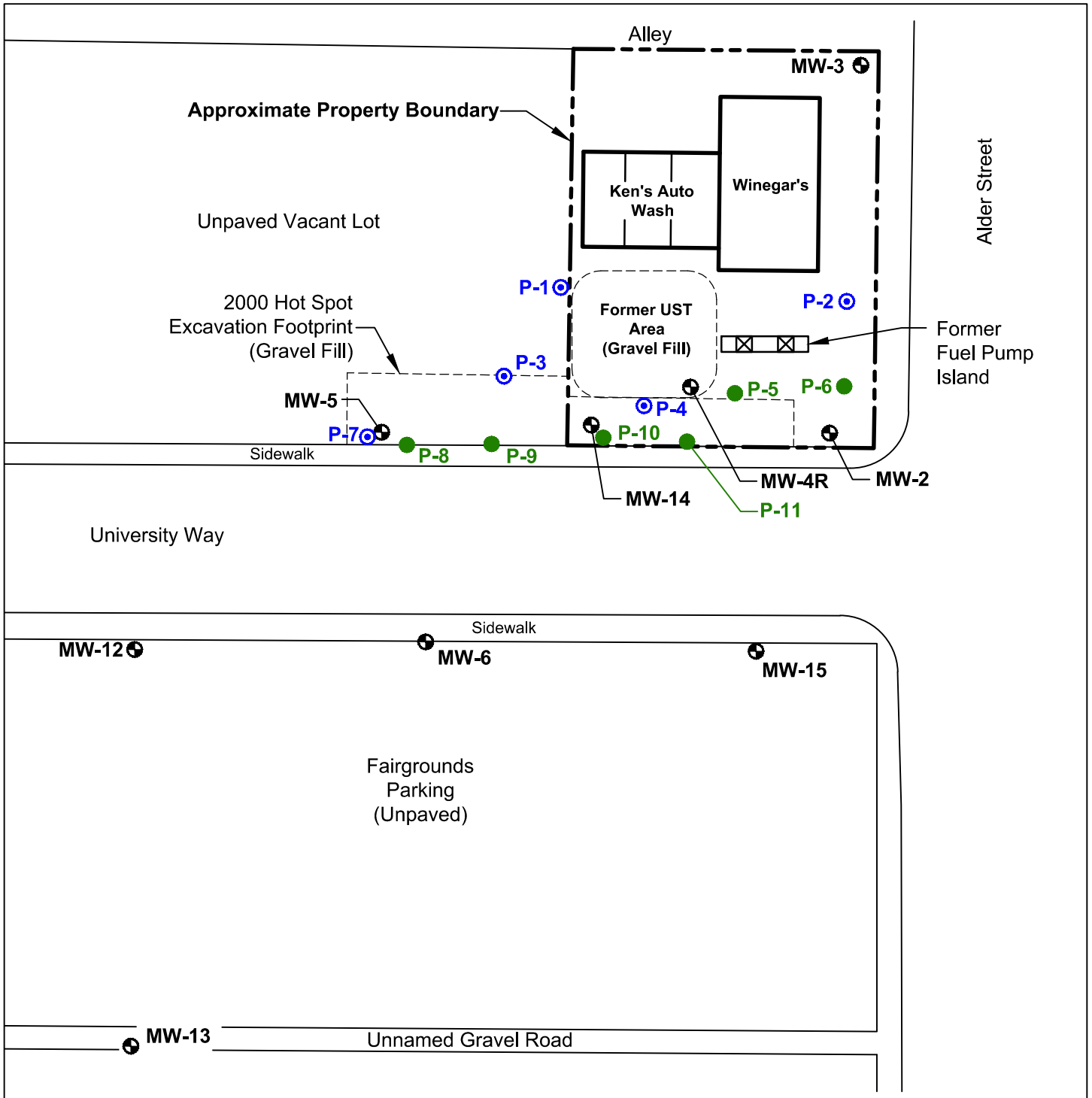
Methane Levels in Soil Gas

Methane was not detected in the upgradient well MW-3 but was encountered in soil gas samples collected from the other three monitoring wells at concentrations which exceed the typical atmospheric level (approximately 0.0002%). However, methane concentrations in the three wells located near or within the petroleum-impacted area are well below the lower explosive limit of 5% and are not indicative of anaerobic conditions.

Conclusions

Findings of our recent sampling for oxygen, carbon dioxide, and methane in soil gas provides another line of evidence that an active biodegradation zone is present beneath the Site. Elevated oxygen concentrations and low methane concentrations in subsurface soil gas are indicative of an aerobic environment. These results are consistent with the conceptual site model which indicated that weathered residual petroleum hydrocarbons do not appear to pose a significant risk to existing or future buildings via the vapor intrusion pathway.

Attachments:
Figure 1 – Site and Exploration Plan



Note: Base map prepared from drawing provided by Sage Earth Sciences titled "Proposed Addtional Monitoring Well and ORC Injections Locations," dated January 1998.

0 50 100
Scale in Feet

P-5 2019 Push Probe

P-1 2019 Push Probe and Temporary Soil Vapor Well

MW-6 Hart Crowser Monitoring Well

N

Ken's Auto Wash
Ellensburg, Washington

Site and Exploration Plan

7168-10 03/20

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Figure 1

EDF 03/2/20 716810-029 (SPlan).dwg