Cascadia Associates, LLC

January 18, 2019

Andrew Smith, Site Manager
Department of Ecology
PO Box 47775
Olympia, Washington 98504-7775

Subject: **Pilot Study Results Report**
NuStar Vancouver Annex Facility
5420 NW Fruit Valley Road
Vancouver, Washington
0060-001-004

Dear Mr. Smith:

Enclosed, please find the *Pilot Study Results Report* that has been prepared on behalf of NuStar Terminals Services, Inc. (NuStar) by Cascadia Associates, LLC. (Cascadia). The enclosed report provides a summary of the pilot study implemented in September 2017 that utilized oxygen releasing compound (ORC) and *in-situ* chemical oxidation (ISCO) to remediate petroleum hydrocarbon impacted groundwater at the NuStar Vancouver Annex Facility (the Facility). This report provides a brief overview of the pilot study implementation, summarizes the results of four quarters of post-injection groundwater monitoring, and evaluates the efficacy of using ISCO and/or ORC as final cleanup remedies for the Facility.

If you have any questions or would like to discuss this further, please contact me at (503) 906-6577 (ext. 110).

Sincerely,

Stephanie Bosze Salisbury

Stephanie Bosze Salisbury, L.G.
Senior Associate Geologist

Enclosure
Pilot Study Results Report (electronic via email and 2 hard copies)

cc: Renee Robinson, NuStar Energy, L.P. (electronic deliverable)
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Pilot Study Results Report
NuStar Vancouver Annex Facility
5420 NW Fruit Valley Road
Vancouver, Washington

Prepared for:

NuStar Terminals Operations Partnership, L.P.

Prepared by:

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Project No. 0060-001-004
January 17, 2019

Pilot Study Results Report
NuStar Vancouver Annex Facility
5420 NW Fruit Valley Road
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Prepared for:

NuStar Terminals Operations Partnership, L.P.
Project No. 0060-001-004
January 17, 2019

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1.0 INTRODUCTION

This Pilot Study Results Report (Report) presents the implementation and results of a pilot study at the at the NuStar Terminals Operations Partnership, L.P. (NuStar) Annex Terminal located at 5420 NW Fruit Valley Road, Vancouver, Washington (the Facility). The pilot study was completed in accordance with the Additional Investigation Summary Report and Pilot Study Work Plan (Apex, 2017; [Work Plan]), approved by the Washington Department of Ecology (Ecology) on August 24, 2017, and was conducted to assist in preparation of a Feasibility Study (FS) of remedial technologies for the Facility.

In a September 2016 meeting, Ecology stated that the FS would need to evaluate active remediation to address petroleum hydrocarbons in groundwater near wells MW-5 and MW-6 based on the results from the additional groundwater investigations conducted from 2014 to 2016. As such, NuStar completed a preliminary review of possible remedial technologies and identified injection of oxygen releasing compound and/or *in-situ* chemical oxidation (ISCO) as possible remedial technologies. However, due to the presence of heavier hydrocarbons in the saturated soil and shallow groundwater, it was determined that a pilot test would be prudent to better evaluate the viability of this option prior to completing the FS. In the Work Plan, NuStar proposed the use of RegenOx® (a proprietary ISCO substrate manufactured by Regenesis) and ORCAdvanced (an oxygen releasing formulation also manufactured by Regenesis) for the pilot study.

A description of the site history and previous investigations is presented in the Additional Investigation Summary Report and Pilot Study Work Plan (Apex, 2017). The pilot test was implemented during October and November 2017. The pilot test implementation activities were summarized in the Pilot Study Implementation Memorandum (Pilot Study Memo; Cascadia Associates, LLC [Cascadia], 2018) that was submitted to Ecology on March 13, 2018. The Pilot Study Memo described the pilot study preparatory and implementation activities and summarized the results of the baseline and first-post injection groundwater monitoring events. This results report provides a brief overview of the pilot study implementation, summarizes the results of four quarters of post-injection groundwater monitoring, and evaluates the efficacy of using ISCO and/or oxygen releasing compounds as final cleanup remedies for the Facility.

2.0 BACKGROUND

2.1 SITE LOCATION, DESCRIPTION, AND HISTORY

Location. The Facility address is 5420 NW Fruit Valley Road, Vancouver, Washington 98660 (Latitude: N45º 39.70', Longitude: W122º 41.66'), as shown on Figure 1. The Facility is located on Clark County Tax Lot (TL) No. 147360.

Physical Features. Figure 2 is a Site Plan. The Facility is approximately 31 acres and is roughly rectangular, with dimensions of approximately 800 by 1,800 feet. The Facility is located in a mixed industrial-agricultural area and currently includes a tank farm containing jet fuel and methanol (seven aboveground storage tanks [ASTs] ranging in size from 30,000 to 3,000,000 gallons); a covered truck refueling rack with two ASTs (approximately a 400-gallon AST and a 7,500-gallon AST containing anti-static additive [ASA] and fuel system icing inhibitor [FSII] additive); and several buildings used for equipment storage and offices. A former underground storage tank (UST) associated with a vapor recovery system was also located on the Facility and was removed in 2001. The vapor recovery system and an associated oil/water separator (OWS) remain on-site. The surface of the Facility is comprised of graveled areas and grass fields, with asphalt-paved roads providing access to the fueling areas, ASTs, and office buildings.

Property History. Support Terminals Operating Partnership, L.P. (STOP) purchased the Facility from Cenex Harvest States Cooperative (Cenex) in 2003. NuStar acquired STOP in 2007. The property was developed in 1957 as a truck loading terminal. Records are unclear as to whether the Facility was developed by Cenex. Historically, chemicals and other products stored at the Facility included liquid fertilizers and refined petroleum products such as gasoline, diesel, kerosene, de-natured alcohol, and petroleum product additives. A trans-mix tank is present in the eastern portion of the Facility (Figure 2), and this is typically where waste (such as from tank-bottom cleanouts or the OWS) would be stored prior to off-site disposal or recycling.

2.2 GEOLOGY AND HYDROGEOLOGY

This section presents the understanding of the geology and hydrogeology as discussed in the Remedial Investigation/Remedial Action (RI/RA) Report (Ash Creek, 2010).

2.2.1 Geology

Regional Geology. The regional geology presented herein is based on reports prepared by Pacific Groundwater Group (PGG; 2001) and AMEC (2002a). The vicinity of the Facility is dominated by three primary units: Recent Alluvial deposits, the Pleistocene Alluvial deposits, and the Troutdale Formation. The Recent Alluvial deposits are the upper unit with deposits approximately 55 feet thick and consist of fine-grained silt and sand within the areas investigated near Vancouver Lake. The Pleistocene Alluvial deposits are approximately 95 to 115 feet thick and consist of coarse-grained sand and gravel. The Pleistocene Alluvial deposits originate from alluvial deposits from the Columbia River and deposits from the catastrophic Missoula Floods. The Troutdale Formation underlies the Pleistocene Alluvial deposits and can be greater than 1,000 feet thick. It is made up of cemented sandy gravels and semi-consolidated sands, silts, and clays.

Site Geology. During previous Facility investigations performed by others, soil borings have been installed to depths of up to 72 feet below ground surface (bgs) at the Facility (Ash Creek, 2007). Recent investigations in the western portion of the Facility included installing borings up to depths of 50 feet bgs.

The Recent Alluvial deposits underlying the western portion of the Facility consist of silt and silty clay with some fine sand to depths of approximately 20 to 25 feet bgs. Below 20 to 25 feet bgs, the Recent Alluvial deposits consist of layers of fine- to medium-grained sand to a depth of at least 50 feet bgs. On the eastern portion of the Facility, fine sand or sandy silt with variable layers of sand or silty sand is encountered to a depth of approximately 10 feet bgs. Below 10 feet bgs, the Recent Alluvial deposits in the eastern portion of the Facility consist of layers of fine- to medium-grained sand to a depth of approximately 50 to 60 feet bgs. The Pleistocene Alluvial deposits are encountered below the Recent Alluvial deposits and consist of sand and/or gravel layers of varying thicknesses to at least 72 feet bgs.

2.2.2 Hydrogeology

Regional Hydrogeology. The regional aquifers, Recent Alluvial Aquifer (RAA); Pleistocene Alluvial Aquifer (PAA); and the aquifers of the Troutdale Formation, follow the regional geology discussed above. The regional hydrogeology summarized below is based on reports prepared in support of Clark Public Utilities (CPU) South Lake Wellfield (PGG, 2001; PGG, 2009), and by Ash Creek (2008a and 2008b).

The RAA is unconfined and receives recharge directly from the land surface and/or surface water features. The PAA directly underlies the RAA and is a productive aquifer with high well yields (several thousand gallons per minute [gpm] without significant drawdown). The groundwater flow system is highly influenced by local surface water bodies. The Columbia River, Vancouver Lake, Vancouver Lake Flushing Channel, and Lake River form natural hydrologic boundaries to the groundwater flow system. Tidal influences and seasonal variations in surface water runoff cause dynamic variation in the stage of the Columbia River, and resulting adjustments in the stages of the other three connected surface water bodies. The groundwater flow system is also influenced by tidal and seasonal variations in the surface water bodies. Regionally, it is anticipated that groundwater within the RAA and PAA near the Facility would have a net gradient towards Vancouver Lake and the Columbia River.

Site Hydrogeology. The depth to first encountered groundwater at the Facility ranges from approximately 8 to 32 feet bgs. This zone corresponds to the silt and fine- to medium-grained sand of the RAA (PGG; 2001) and AMEC (2002a). The PAA is encountered at depths ranging from 50 to 70 and is saturated. Groundwater elevations in the tank farm area of the Site are variable and generally range between 8 and 12 feet above mean sea level (MSL), with the highest elevations typically in the spring. In May 2018, groundwater elevations in the tank farm area were particularly high (approximately 18 feet above MSL). Given the limited monitoring history it is uncertain whether the May 2018 elevations were anomalous or are within the typically range of seasonal variability.

Under static conditions, shallow groundwater flow at the Facility is relatively flat with a slight gradient (0.0002 foot per foot [ft/ft]) to the southeast (AMEC, 2002a; SECOR, 2003; Ash Creek, 2009).

3.0 SUMMARY OF SITE INVESTIGATIONS

The below sections summarize historical and recent investigations conducted at the Facility.

3.1 SUMMARY OF HISTORICAL INVESTIGATIONS – 2001 THROUGH 2012

Several investigations have been conducted at the Facility since 2001. The initial investigation assessed the area of a possible fuel release during a UST decommissioning and resulted in further work to define the extent of impacted soil and groundwater (AMEC 2002a, 2002b). In 2003, SECOR conducted a comprehensive Phase II Environmental Site Assessment (ESA) of the Facility as a part of due diligence activities for Cenex during the property transaction to NuStar (SECOR, 2003). From 2007 to 2008, Ash Creek completed several investigations to further characterize the site (Ash Creek, 2007, 2008a, and 2008b). Four monitoring wells were installed in 2004 and were monitored periodically or quarterly during the 2004 to 2012 investigation period. The scope and results of each of these investigations are detailed in the RI/RA Report (Ash Creek, 2010). Table 1 summarizes the depth to groundwater and groundwater elevation data collected during these investigations; Table 2 summarizes the historical groundwater sampling and analysis data; and Table 3 summarizes the historical soil data.

3.2 SUMMARY OF ADDITIONAL INVESTIGATION – 2014 THROUGH 2016

As previously discussed in Section 1.0, Ecology provided NuStar with comments on the Draft FS on October 16, 2013. In the months following receipt, NuStar held several meetings with Ecology to discuss Ecology's comments on the FS, as well as additional comments that were presented to NuStar in a February 4, 2014 meeting. The additional comments included a request for additional groundwater investigation near historical borings SB-8 and SB-9; the locations of these borings are shown on Figure 2. NuStar agreed to the additional investigation, and the preliminary investigation indicated that petroleum hydrocarbons were present in groundwater near historical borings SB-8 and SB-9 at concentrations above MTCA Method A levels. As a result, additional site investigation, well installation, and groundwater monitoring were conducted to evaluate the magnitude and extent of petroleum hydrocarbons in groundwater in the western portion of the terminal. The results of these investigations are detailed in Apex 2015a, 2015b, and 2017. The soil results from these investigations are included on Table 3 and the grab groundwater results are shown on Table 4. Boring and monitoring well locations are shown on Figure 2.

In summary, these investigations included:

- Installing two monitoring wells, MW-5 and MW-6, at the locations of historical borings SB-8 and SB-9, respectively;
- Conducting one year of quarterly groundwater monitoring of existing wells MW-1 through MW-4 and the new wells, MW-5 and MW-6;

- Conducting additional groundwater investigation to define the extent of petroleum hydrocarbons and related constituents in the areas of wells MW-5 and MW-6, including the installation of 12 additional borings (B-1 through B-12) and the collection of two to three depth discrete groundwater samples from each boring using temporary well points;
- Conducting a groundwater investigation to delineate the extent of petroleum hydrocarbons in groundwater to the west of wells MW-5 and MW-6, including the installation of two borings, B-13 and B-14, outside and to the west of the tank farm berms of the Facility;
- Installing four shallow compliance wells, MW-7 through MW-10, to monitor the potential for offsite migration to the north, west, and south; and
- Installing two deeper monitoring wells, MW-5D and MW-8D, adjacent to wells MW-5 and MW-8, respectively, to evaluate potential vertical gradients in groundwater.

Total petroleum hydrocarbons (TPH) and benzene, toluene, ethylbenzene, and xylene (BTEX) concentrations in the groundwater samples from borings B-13 and B-14, and wells MW-7 through MW-10 and MW-8D were below method reporting limits. The results were presented to Ecology in a meeting on September 22, 2016. During the meeting, Ecology supported the conclusion that the compliance well network was acceptable for monitoring purposes.

4.0 2017 PILOT STUDY – IMPLEMENTATION

In the September 2016 meeting, Ecology stated that the FS would need to evaluate active remediation to address the petroleum hydrocarbons in groundwater near wells MW-5 and MW-6 based on the additional groundwater investigations conducted from 2014 to 2016. As such, NuStar indicated that initial evaluations of potential remedial alternatives identified injection of oxygen releasing compound (ORC) and/or ISCO as possible options. However, due to the presence of the heavier hydrocarbons (TPH) in the saturated soil and shallow groundwater, it was determined that a pilot study would be needed to better evaluate the viability of this option. A pilot study work plan was submitted to Ecology in August 2017 (Apex, 2017) and was implemented in October and November 2017. The pilot study implementation activities were detailed in the March 13, 2018 Pilot Study Implementation Memorandum (Cascadia, 2018). A brief summary of the pilot test implementation and initial monitoring activities are provided in the paragraphs below.

4.1 REGENOX® AND ORC-ADVANCED PRODUCT DESCRIPTION

A mixture of RegenOx® and ORCAdvanced was used in the pilot study to evaluate the remediation of residual hydrocarbons in soil and groundwater below the water table at the Facility. RegenOx® is an injectable, two-part ISCO reagent that combines a solid sodium percarbonate based alkaline oxidant (Part A), with a liquid solution of sodium silicates, silica gel, and ferrous sulfate (Part B). RegenOx® produces minimal heat and pressure and is noncorrosive, making it a relatively safe chemical oxidant that is compatible for use in direct contact with underground infrastructure such as utilities, tanks, piping communication lines, etc. In addition to chemical destruction, RegenOx®

produces a significant short-term oxygen footprint that is optimal for establishing aerobic conditions capable of supporting aerobic biodegradation of petroleum hydrocarbons. The ORCAdvanced provides a continuous release of oxygen to the groundwater over a period of up to 12 months to support long-term aerobic biodegradation. ORCAdvanced is a calcium oxy-hydroxide based material that becomes hydrated upon contact with the groundwater, producing a controlled-release of molecular oxygen (17% by weight). Using the combined product model, the RegenOx would provide a more short-term aggressive first approach to mass removal, and the ORCAdvanced would provide a long-term removal of residual mass, particularly in areas of lower hydrocarbon concentrations in groundwater or on the periphery of the plume.

The RegenOx®/ORCAdvanced mixture was injected into 24 borings located within the pilot study area, as shown on Figures 3 and 4. The borings were located on an approximate off-set gridded pattern with 15-foot spacing in general accordance with the pilot study work plan.

4.2 INJECTION PROCESS

The pilot study field activities were performed from October 18 to November 1, 2017. Prior to injection, each borehole was manually cleared (via hand auger) down to 8 feet bgs. Following hand clearance, an injection probe was advanced to a depth of 25 feet bgs using a direct push rig. Because several wells have been installed within or near the pilot study area and lithologic logs of these wells have been prepared, lithologic logs were not prepared for the subsurface injection locations.

RegenOx® and ORCAdvanced were mixed in large totes and injected through the drill stem via air diaphragm pumps on an injection rig. The RegenOx® and ORCAdvanced mix was injected from the bottom depth of the boring up to 15 feet bgs (the approximate depth to groundwater) using one of two types of probe tips:

- A pressure activated probe tip, designed to deliver the injection solution along a localized depth interval (approximately 1 foot); the high pressure required to activate the jet is designed to move the solution out from the injection point into the subsurface as the probe tip is withdrawn in 1-foot intervals.
- A slotted screen injection probe, designed to deliver the injection solution over a 5-foot screened interval. The injection screen consisted of a 5-foot steel rod with rows of injection ports around the circumference of the rod and spaced approximately 3 inches along the length of the screen. The injection screen was withdrawn in 5-foot intervals.

4.3 ISSUES ENCOUNTERED DURING INJECTIONS

Several issues were encountered during the injection activities. These issues were summarized in the Pilot Study memo (Cascadia, 2018), and are reiterated here as they are important factors in considering the efficacy and cost-effectiveness of this remedial technology in the FS.

Daylighting and Slow Injection Rates. Injection rates were significantly slower than anticipated and daylighting of injectant was observed throughout the pilot study. Even with changing the

injection probe from the standard one-foot depth interval to the 5-foot injection screen and injecting the RegenOx®/ORCAdvanced solution at lower pressures, the oxidant solution was still observed at a number of locations in the form of either free-flowing liquid or foaming at the surface. Possible factors contributing to the observed daylighting include: the injection pressure (discussed below), tightness of drill stem connections, and the lithology at the injection boring location. The lithology in the pilot study area is predominantly silt with some fine sand to depths of about 22 feet bgs and the lower permeability of this soil type may have caused the mixture to follow preferential pathways such as along the drill stem casing at times. Additionally, the mixture pumping rate needed to be lowered to accommodate the fluid injections into the lower permeability of the soils. The lowering of the pumping pressure and pumping rates increased the duration of the injection event by approximately 40%.

Injection Pressures. The initial injection locations utilized the pressure activated probe tip to introduce the RegenOx®/ORCAdvanced solution into the subsurface. However, the higher pressures needed to depress the internal spring mechanism in the probe tip resulted in an injection flowrate greater than the subsurface conditions would accept; this resulted in a buildup of pressure and daylighting of the injection material either along the outside of the drill stem or through nearby soil to the surface.

Clogging. The in-line flowmeters used to measure injection flowrate and the total volume pumped at each location had a tendency to clog frequently. ORCAdvanced did not completely dissolve when mixed with water and RegenOx®, resulting in a solution with particles present that would build-up and clog the flowmeters. When this occurred, injection volumes were estimated from the volume of the mixing tanks. To the extent possible the clogging was mitigated by removing and cleaning the flowmeters after each injection was complete.

5.0 GROUNDWATER MONITORING

A pre-pilot study groundwater monitoring event was conducted to collect baseline data, followed by four post injection monitoring events to evaluate the efficacy of the pilot study. Details of the monitoring scope, procedures and analytical program are summarized in the following sections. The analytical results from the pre- and post-injection groundwater monitoring events are summarized in Table 3. Laboratory analytical reports and a data quality review are provided in Appendix A.

5.1 BASELINE GROUNDWATER MONITORING EVENT

Prior to conducting the RegenOx®/ORCAdvanced injections, a groundwater monitoring event was conducted to assess the baseline TPH and petroleum constituent concentrations. Groundwater samples were collected from monitoring well MW-5 on October 23, 2017, and wells MW-6 and MW-5D on October 24, 2017. The samples from the baseline event were submitted to ESC laboratories of Mt. Juliet, Tennessee, for laboratory analysis.

5.2 POST-INJECTION – QUARTERLY GROUNDWATER MONITORING EVENTS

Quarterly pilot study performance monitoring events were conducted on November 30, 2017, February 28, 2018, May 29, 2018, and August 30, 2018. The November 2017 and August 2018 events were conducted by Cascadia and the March and May 2018 events were conducted by Apex Companies, LLC (Apex). During the four performance monitoring events, samples were collected from monitoring wells MW-5, MW-5D, and MW-6 and were submitted to a Washington-accredited laboratory for analysis. The samples collected during November 2017 and February 2018 were analyzed by ESC Laboratories of Mt. Juliet, Tennessee; the samples collected during the May 2018 event were analyzed by Pace Analytical laboratories (Pace) of Minneapolis, Minnesota; and the samples collected during August 2018 were analyzed by Apex Laboratories of Tigard, Oregon.

5.3 GROUNDWATER MONITORING PROCEDURES

During the monitoring events, depth to groundwater measurements were collected from site wells prior to initiating groundwater sampling. During the baseline event, the depth to groundwater was measured in wells MW-5, MW-5D, and MW-6; during the four performance monitoring events, the depth to groundwater was measured in 12 site monitoring wells (MW-1 through 5, MW-5D, MW-6 through MW-8, MW-8D, MW-9, and MW-10).

Following measurement of the depth to groundwater, sampling at each well was initiated. The wells were first purged and then sampled using low-flow techniques. Field parameters including dissolved oxygen (DO) and oxidation-reduction potential (ORP)measurements were collected during the purging process to assist in evaluating the pilot study results. Sampling methods and protocols used are described in Appendix B and field data sheets are provided in Appendix C.

5.4 ANALYTICAL PROGRAM

Groundwater samples collected during the baseline and performance monitoring events were submitted to a Washington State-certified laboratory for gasoline-range total petroleum hydrocarbons (TPHg) using Pacific Northwest Method NW-TPH-Gx, diesel-range total petroleum hydrocarbons (TPHd) and oil-range total petroleum hydrocarbons (TPHo) using Pacific Northwest Method NW-TPH-Dx (with silica gel cleanup), and BTEX using EPA Method 8260B.

6.0 2017 PILOT STUDY – EVALUATION OF RESULTS

Figures 5 through 7 depict total petroleum hydrocarbons in groundwater from wells MW-5, MW-5D, and MW-6 from the October 2017 baseline monitoring event, the first post-injection monitoring event (November 2017) and the fourth post-injection monitoring event (August 2018), respectively. Total petroleum hydrocarbon data for the monitoring events are provided in Table 3, and TPH trend plots for wells MW-5, MW-5D and MW-6 are included in Appendix D.

6.1 DATA EVALUATION APPROACH

Data collected from wells MW-5 and MW-5D are used to evaluate the efficacy of the pilot study injections and data collected from well MW-6 (located outside of the remediation area) are used as a control. Because well MW-6 is located outside of the active remediation area, any changes in hydrocarbon concentration associated with the pilot study injections can be isolated from variability in data associated with season, water level, (non-enhanced) natural attenuation processes, etc. Well MW-5 is screened from 10 to 25 feet bgs and well MW-5D is screened from 35 to 45 feet bgs, so data collected from both wells can be used to evaluate for vertical concentration gradients in the groundwater plume, and to evaluate the vertical extent of the effects of the pilot study injections.

For wells MW-5 and MW-6 trend plots were prepared for diesel range hydrocarbons and gasoline-range hydrocarbons as well as total hydrocarbons (a summation of diesel- and gasoline-range total petroleum hydrocarbons results; expressed as TPHg+TPHd on figures). BTEX concentrations were minimal to non-detect in wells MW-5 and MW-5D, so the data were not used to evaluate the efficacy of the pilot test. Based on the initial data evaluation, the TPHg+TPHd results are considered the most appropriate data for evaluating concentration trends for the following reasons:

1. Because of laboratory ownership changes over the course of the pilot study and some quality control issues identified during the laboratory transition process, three different laboratories were used over the five groundwater monitoring events presented in this report. The carbon ranges used to represent “diesel” or “gasoline” hydrocarbons may vary among laboratories, thus a comparison of TPHg+TPHd results (encompassing a larger carbon chain range) is likely more inclusive and accurate.

2. While gasoline and diesel were the most commonly stored products at the terminal, other products, such as jet fuel, which is a combination of gasoline and kerosene, were also stored at the terminal historically and may comprise a portion of the hydrocarbons in soil and groundwater at the site. While kerosene has an intermediate carbon chain length, relative to gasoline and diesel, there is overlap (in carbon chain length, and therefore weight) among all three types of fuel. Again, with different laboratories reporting slightly different carbon ranges for each fuel type, evaluating data as “total hydrocarbons” is the most accurate method for evaluating changes in concentration, and thus potential loss of mass, in individual monitoring wells between monitoring events. It should be noted that oil range hydrocarbons were not included in the evaluation as they were either not detected or represent a very small fraction of the hydrocarbon mass detected in the samples.

6.2 TREND PLOT EVALUATION – TPH

In well MW-5, the TPHg concentration increased after the baseline event, and generally increased through the August 2018 monitoring event. In the same well, TPHd concentrations also increased for the first three groundwater monitoring events after the baseline event, and then dropped significantly between May and August 2018. When evaluating total hydrocarbons in well MW-5

(expressed as TPHg+TPHd), the concentration was at a monitoring history low during the baseline event, and with the exception of a slight decrease in concentration between the November 2017 and February 2018 monitoring events, continued to increase through August 2018.

As discussed in Section 4.12, in addition to chemical destruction, RegenOx® produces a significant short-term oxygen footprint that is optimal for establishing aerobic conditions capable of supporting aerobic biodegradation of petroleum hydrocarbons. Both the chemical destruction and enhanced aerobic biodegradation reactions typically take place within the first month after injection. The November 2017 groundwater monitoring event was conducted approximately one month after the RegenOx® was injected, at an ideal time for evaluating whether or not the chemical oxidation injections effectively reduced hydrocarbon concentrations in site groundwater. TPHg+TPHd concentrations increased in well MW-5 between the baseline monitoring event and the November 2017 monitoring event, indicating the chemical oxidation injections did not have a measurable effect on hydrocarbon concentrations in groundwater near well MW-5. It is possible that the ground disturbance associated with the injections increased the solubility of the material causing a short-term significant increase in the TPHg+TPHd concentration. In that case, the second post-injection groundwater monitoring event may be a better indicator of how effective the oxidant was. In well MW-5, the concentration of TPHg+TPHd decreased slightly after the second post-injection event before increasing the subsequent two monitoring events. The data may indicate that a small concentration reduction was realized in response to the oxidant (but after the initial concentration surge due to solubilization), followed by an increase in concentration because of the remaining TPH mass in the subsurface.

In addition to total hydrocarbon values, the individual concentrations of TPH-g and TPHd also increased from the baseline monitoring event to the November 2017 monitoring event, further indicating an increase in petroleum hydrocarbons in groundwater after the injections. This may be an indicator that at least some oxidant successfully reached the saturated zone.

As discussed in Section 4.1, the injection of ORCAdvanced provides a continuous release of oxygen to the groundwater over a period of up to 12 months to support long-term aerobic biodegradation. With the exception of a slight dip in total TPH concentration between the November 2017 and February 2018 monitoring events, the concentration of TPH in well MW-5 has been consistently increasing since the ORC Advanced was emplaced in October/November 2017. This suggests that while the ORC Advanced may have been effective in supporting long-term aerobic biodegradation in groundwater around well MW-5D, the injected substrate mass was not sufficient to produce a measurable decrease in total hydrocarbon concentrations. It is also possible that the initial oxidant eradicated the microbes, so that despite the addition of oxygen, the organisms were no longer present for long-term aerobic degradation of hydrocarbons.

As discussed in Section 6.1, this pilot study did not include injections in the vicinity of monitoring well MW-6, so data collected from that well are considered a control for natural fluctuations in groundwater at the terminal. TPHg+TPHd concentrations in groundwater from well MW-6 remained generally consistent between the baseline (October 2017) and November 2017

monitoring events. The concentration of TPHg+TPHd decreased in well MW-6 from November 2017 through May 2018, and then increased rapidly to a monitoring history high by August 2018. The variability in the trend plot for well MW-6 may be more indicative of seasonal fluctuations in the water table, resulting in seasonal increases in dissolved phase petroleum hydrocarbons from seasonably saturated soils. As discussed in Section 2.2.2, water levels in the tank farm area may vary seasonally by as much as 10 feet. While seasonable variability is likely also occurring at well MW-5, the consistently increasing TPHg+TPHd concentrations at well MW-5 suggest the trend is more dominated by the physical solubilization of petroleum hydrocarbons in response to the injections, without the sufficient destruction of aerobic degradation of hydrocarbons in response to the RegenOx®/ORCAdvanced injections.

6.3 DEEPER GROUNDWATER – EVALUATION OF RESULTS FROM MW-5D

TPHg was detected in well MW-5D during the baseline monitoring event and the four subsequent pilot study monitoring events at concentrations below MTCA Method A cleanup levels. TPHd was detected in the baseline, November 2017 and February 2018 monitoring events but not in the May and August 2018 monitoring events; all results were below MTCA Method A cleanup levels. BTEX was not detected in well MW-5D during the baseline and four post-injection monitoring events.

The concentrations of TPHg+TPHd in well MW-5D were too low to see any discernable trends. The data suggest that the pilot study did not have a measurable effect on the concentrations in the deeper monitoring well. Concentrations of petroleum hydrocarbons in well MW-5D will continue to be monitored to confirm that there is no ongoing source to deeper groundwater.

6.4 BTEX RESULTS

While the majority of the petroleum hydrocarbons in groundwater in the vicinity of well MW-5 are gasoline and diesel range hydrocarbons, xylenes were also identified in well MW-5 during the pilot study monitoring events at concentrations exceeding MTCA Method A cleanup levels. A trend plot for xylenes is provide in Appendix D. The concentration of xylenes increased between the October 2017 baseline event and the November 2017 monitoring event, and then varied slightly during the subsequent quarterly pilot study monitoring events. The concentration of xylene did not decrease in response to the initial RegenOx® or during approximately 10 months of additional monitoring in response to the ORC Advanced.

Benzene, toluene and ethylbenzene concentrations were not detected in well MW-5 during the baseline or post-injection monitoring events. The lack of benzene and toluene suggests that the hydrocarbon plume is aged and that the lighter petroleum hydrocarbon constituents have likely long attenuated. BTEX was not detected in well MW-5D during any of the pilot study monitoring events.

7.0 CONCLUSIONS

This pilot study was conducted to evaluate the injection of oxygen releasing compound and/or ISCO products in saturated soil and groundwater, for the potential remediation of petroleum hydrocarbons (TPH) and BTEX at the facility. Based on the results of the pilot study, the following conclusions can be made regarding the effectiveness of *in situ* enhanced bioremediation/ISCO at the site, and the implications for preparation of the FS.

1. There were significant issues associated with physical implementation of the technology in the tank farm area at the Site. Due to the low permeability soils in the injection area, the RegenOx®/ORCAdvanced mixture frequently daylighted both as a free-flowing liquid as well as foaming at the ground surface. While there is no way to determine the volume of injected material lost to daylighting, the loss of injection volume may have been a factor in the lack of concentration reduction observed in the pilot study area. While injection pressures and injection rates were significantly decreased to help prevent the daylighting of material, the decreased injection rates ultimately led to an approximately 40% increase in the total injection time for the project. This generally correlates with a 40% increase in costs for subcontractor labor, oversight labor, and equipment costs. The pilot test provided useful information for preparation of the FS, in that actual injection time needed (and the associated costs) can now be accurately accounted for when comparing the feasibility of chemox/enhanced bioremediation to other potential remedial technologies.

2. Assuming daylighting can be properly managed, the products are considered safe for use at the terminal. RegenOx® is a bicarbonate-based ISCO product and was selected as the appropriate chemical oxidation product for the tank farm area because it is known to be less reactive with metal and other buried infrastructure than other ISCO products on the market. While the material is generally safe for handling, the daylighting of product to the surface may be a safety concern, particularly for a project larger in scope than the pilot study. If pressures and flow rates can be maintained so that there are no releases of chemical oxidation products at the ground surface, RegenOx® may be considered a viable product for limited use at the terminal as described below.

3. Post injection groundwater monitoring indicated that the injections were not effective at reducing concentrations of petroleum hydrocarbons in groundwater. The lack of reduction in concentration of TPH-g, TPHd, and/or total hydrocarbon concentrations in response to the remedial injections may be for multiple reasons. Because the RegenOx® and ORCAdvanced were so difficult to inject into the subsurface, and product was observed to daylight not only at the injection location but also at a distance from the injection location, the ineffectiveness of the injections may be because sufficient volume of product never made it in contact with impacted saturated soils and groundwater. This is true for both the fast-acting RegenOx® as well as the time-released ORCAdvanced product.

The proposed injection volumes were prepared using spreadsheets provided by the RegenOx®/ORCAdvanced vendors and considered factors such as contaminant concentration in pilot study area groundwater, soil type, treatment area, thickness of impacted area, etc. Because site-specific information and analytical data are limited, assumptions were made as to how much injection volume was needed, and safety factors were built in to help accommodate any inaccurate assumptions. It is not clear whether the ineffectiveness of the pilot study was due to the loss of too much oxygen-producing RegenOx®/ORCAdvanced mixture due to daylighting, or if the pilot study design inputs were insufficient to accurately quantify the contaminant mass in the subsurface. While the product vendors stipulate that multiple rounds of injections may be required to fully remediate the impacted groundwater, initial concentration reductions are typically observed after an ISCO application, followed by a rebound in contaminant concentration. Because only a slight decrease in concentration was observed four months after the initial injections followed by steady concentration increases, it is most likely that insufficient product made it into the impacted area.

4. The pilot study provided information for evaluation of chemical oxidation and enhanced bioremediation in the FS. The pilot study was beneficial for identifying physical issues that would have to be overcome for *in situ* injection technologies to be successful at the Facility. In order to potentially overcome product daylighting, the injection pressures and rates would need to be significantly decreased. This would significantly increase the duration of an injection event and make the chemical oxidation and enhanced bioremediation technologies less cost-competitive than other technologies. Because technologies such as ISCO typically require several injection events to fully destroy the hydrocarbon mass in the subsurface, ISCO could quickly become more expensive than other technologies that are generally thought to be more expensive than ISCO and enhanced bioremediation. Furthermore, it is not certain whether injection pressures and rates can be reduced enough to completely eliminate migration along preferential pathways and/or product daylighting. If the material cannot be uniformly injected into the subsurface, then it is not an ideal strategy for remediation of petroleum hydrocarbon contaminants in saturated soil and groundwater at the Facility.

   It should be noted that this technology may be retained as a potential technology for other areas at the Facility. Soil boring information from several investigations in the truck loading rack area indicate that the subsurface soils are more permeable than at the western side of the site. While a pilot study, including the testing of fluid acceptance rates in the treatment zone, would be necessary before chemical oxidation or enhanced bioremediation technologies would be implemented at other portions of the Facility (e.g., truck loading rack area), these technologies will be retained as remedial options for evaluation in the FS.

8.0 REFERENCES

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TABLES

Table 1
Groundwater Elevation Data
NuStar Terminals Operations Partnership, L.P. – Annex Terminal
Vancouver, Washington

Well Number	Date of Measurement	Top of Casing Elevation (feet above MSL)	Screened Interval (feet bgs)	Depth To SPH (feet)	Depth to Groundwater (feet)	SPH Thickness (feet)	Groundwater Elevation (feet)
MW-1	05/14/02	NS	14.5 - 24.5	--	16.00	--	NS
	05/25/07	26.66		--	14.92	--	11.74
	08/24/07	26.66		--	18.67	--	7.99
	11/26/07	26.66		--	17.91	--	8.75
	02/27/08	26.66		--	16.92	--	9.74
	03/30/10	26.66		--	17.09	--	9.57
	09/01/10	26.66		--	19.19	--	7.47
	12/16/14	26.66		--	16.19	--	10.47
	03/25/15	26.66		--	15.25	--	11.41
	06/24/15	26.66		--	18.43	--	8.23
	09/15/15	26.66		--	19.05	--	7.61
	11/30/17	26.72		--	16.16	--	10.56
	02/28/18	26.72		--	15.07	--	11.65
	05/29/18	26.72		--	8.43	--	18.29
	08/30/18	26.72		--	18.37	--	8.35
MW-2	05/14/02	NS	20 - 35	--	27.46	--	NS
	05/25/07	38.21		--	26.46	--	11.75
	08/24/07	38.21		--	30.17	--	8.04
	11/26/07	38.21		--	29.42	--	8.79
	02/27/08	38.21		--	28.50	--	9.71
	03/30/10	38.21		--	28.66	--	9.55
	09/01/10	38.21		--	30.74	--	7.47
	12/16/14	38.21		--	27.77	--	10.44
	03/25/15	38.21		--	26.79	--	11.42
	06/24/15	38.21		--	30.05	--	8.16
	09/15/15	38.21		--	30.65	--	7.56
	11/30/17	38.27		--	27.66	--	10.61
	02/28/18	38.27		--	26.70	--	11.57
	05/29/18	38.27		--	19.96	--	18.31
	08/30/18	38.27		--	29.94	--	8.33

Please refer to notes at end of table.

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Table 1
Groundwater Elevation Data
NuStar Terminals Operations Partnership, L.P. – Annex Terminal
Vancouver, Washington

Well Number	Date of Measurement	Top of Casing Elevation (feet above MSL)	Screened Interval (feet bgs)	Depth To SPH (feet)	Depth to Groundwater (feet)	SPH Thickness (feet)	Groundwater Elevation (feet)
MW-3	05/14/02	NS	24.5 - 34.5	--	28.15	--	NS
	05/25/07	39.11		--	27.17	--	11.94
	08/24/07	39.11		--	31.04	--	8.07
	11/06/07	39.11		--	30.36	--	8.75
	02/27/08	39.11		--	28.71	--	10.40
	03/30/10	39.11		--	29.55	--	9.56
	09/01/10	39.11		--	31.65	--	7.46
	12/16/14	39.11		--	28.54	--	10.57
	03/25/15	39.11		--	27.72	--	11.39
	06/24/15	39.11		--	30.85	--	8.26
	09/15/15	39.11		--	31.52	--	7.59
	11/30/17	39.17		--	28.61	--	10.56
	02/28/18	39.17		--	27.18	--	11.99
	05/29/18	39.17		--	20.91	--	18.26
	08/30/18	39.17		--	30.80	--	8.37
MW-4	05/14/02	NS	20 - 35	--	29.40	--	NS
	05/25/07	40.17		--	28.35	--	11.82
	08/24/07	40.17		--	32.12	--	8.05
	11/06/07	40.17		--	31.40	--	8.77
	02/27/08	40.17		--	30.40	--	9.77
	03/30/10	40.17		--	30.77	--	9.40
	09/01/10	40.17		--	32.62	--	7.55
	12/16/14	40.17		--	29.63	--	10.54
	03/25/15	40.17		--	28.76	--	11.41
	06/24/15	40.17		--	31.92	--	8.25
	09/15/15	40.17		--	32.61	--	7.56
	11/30/17	40.23		--	29.59	--	10.64
	02/28/18	40.23		--	28.60	--	11.63
	05/29/18	40.23		--	21.88	--	18.35
	08/30/18	40.23		--	31.86	--	8.37
MW-5	12/16/14	27.03	10 - 25	--	16.60	--	10.43
	03/25/15	27.03		--	15.37	--	11.66
	06/24/15	27.03		--	18.89	--	8.14
	09/15/15	27.03		--	19.35	--	7.68
	10/23/17	27.03		--	17.82	--	9.21
	11/30/17	27.03		--	16.39	--	10.64
	02/28/18	27.03		--	15.41	--	11.62
	05/29/18	27.03		--	8.68	--	18.35
	08/30/18	27.03		--	18.55	--	8.48

Please refer to notes at end of table.

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Table 1
Groundwater Elevation Data
NuStar Terminals Operations Partnership, L.P. – Annex Terminal
Vancouver, Washington

Well Number	Date of Measurement	Top of Casing Elevation (feet above MSL)	Screened Interval (feet bgs)	Depth To SPH (feet)	Depth to Groundwater (feet)	SPH Thickness (feet)	Groundwater Elevation (feet)
MW-5D	10/24/17	26.71	35 - 45	--	17.50	--	9.21
	11/30/17	26.71		--	16.21	--	10.50
	02/28/18	26.71		--	15.20	--	11.51
	05/29/18	26.71		--	8.37	--	18.34
	08/30/18	26.71		--	18.51	--	8.20
MW-6	12/16/14	27.33	10 - 25	--	16.93	--	10.40
	03/25/15	27.33		--	15.73	--	11.60
	06/24/15	27.33		--	19.34	--	7.99
	09/15/15	27.33		--	19.70	--	7.63
	10/24/17	27.33		--	18.12	--	9.21
	11/30/17	27.33		--	16.71	--	10.62
	02/28/18	27.33		--	15.77	--	11.56
	05/29/18	27.33		--	9.03	--	18.30
	08/30/18	27.33		--	18.99	--	8.34
MW-7	11/30/2017	21.67	10 - 25	--	11.12	--	10.55
	2/28/2018	21.67		--	10.19	--	11.48
	5/29/2018	21.67		--	3.4	--	18.27
	08/30/18	21.67		--	13.26	--	8.41
MW-8	11/30/2017	27.68	10 - 25	--	16.91	--	10.77
	2/28/2017	27.68		--	16.01	--	11.67
	5/29/2018	27.68		--	9.31	--	18.37
	08/30/18	27.68		--	19.22	--	8.46
MW-8D	11/30/2017	27.87	35 - 45	--	17.36	--	10.51
	2/28/2018	27.87		--	16.35	--	11.52
	5/29/2018	27.87		--	9.53	--	18.34
	08/30/18	27.87		--	19.41	--	8.46
MW-9	11/30/2017	29.39	10 - 25	--	18.78	--	10.61
	2/28/2018	29.39		--	17.79	--	11.60
	5/29/2018	29.39		--	11.09	--	18.30
	08/30/18	29.39		--	21.04	--	8.35
MW-10	11/30/2017	28.71	10 - 25	--	18.16	--	10.55
	2/28/2018	28.71		--	17.19	--	11.52
	5/29/2018	28.71		--	10.38	--	18.33
	08/30/18	28.71		--	20.3	--	8.41

Notes:

1. Survey elevations determined by Bluedot Group surveying, November 2017.
2. Reference elevation (i.e., top of casing) relative to NAVD 88, feet above mean sea level.
3. feet above MSL = feet above mean sea level.
4. NS = Not surveyed
5. -- = SPH not measured/observed.
6. bgs = below ground surface.

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Table 2
Analytical Results from Groundwater Monitoring Wells
NuStar Terminals Operations Partnership, L.P. – Annex Terminal
Vancouver, Washington

Well Number	Sample Date	TPHg Gasoline (mg/L)	TPHd Diesel (mg/L)	TPHo Heavy Oil (mg/L)	Benzene (mg/L)	Toluene (mg/L)	Ethylbenzene (mg/L)	Xylenes (mg/L)
MW-1	05/14/02	<0.080	0.455 [5.]	<0.500	<0.0005	<0.0005	<0.0005	<0.001
	05/19/03	--	--	--	<0.001	<0.001	<0.001	<0.002
	05/25/07	<0.080	<0.238	<0.476	<0.0002	<0.0005	<0.0005	<0.001
	08/24/07	<0.1	<0.238	<0.476	<0.001	<0.002	<0.002	<0.006
	11/26/07	<0.080	<0.236	<0.472	<0.001	<0.002	<0.002	<0.006
	02/27/08	<0.080	<0.294	<0.588	<0.0005	<0.0005	<0.0005	<0.001
	03/31/10	<0.250	<0.250	<0.500	<0.0005	<0.0005	<0.0005	<0.0015
	09/01/10	<0.250	<0.250	<0.500	<0.0005	<0.0005	<0.0005	<0.0015
	12/16/14	<0.250	<0.250	<0.500	<0.0005	<0.0005	<0.0005	<0.0005
	03/25/15	<0.250	<0.046	<0.093	<0.0005	<0.0005	<0.0005	<0.001
	06/24/15	<0.250	<0.100	<0.250	<0.0005	<0.0005	<0.0005	<0.001
	09/15/15	<0.250	<0.130	<0.340	<0.0005	<0.0005	0.0015	0.0022
MW-2	05/14/02	**41.4**	<0.250	<0.500	**4.35**	**2.68**	**1.84**	**8.72**
	05/19/03	--	--	--	**0.534**	0.00975	0.194	0.876
	05/25/07	0.439	<0.238	<0.476	**0.071**	0.00114	0.0361	0.0453
	08/24/07	0.102	<0.238	<0.476	<0.001	<0.002	<0.002	<0.006
	11/26/07	<0.080	<0.236	<0.472	<0.001	<0.002	<0.002	<0.006
	02/27/08	0.0817	<0.294	<0.588	0.005	<0.0005	<0.0005	<0.001
	03/31/10	<0.250	<0.250	<0.500	<0.0005	<0.0005	<0.0005	<0.0015
	09/01/10	<0.250	<0.250	<0.500	0.0016	<0.0005	<0.0005	<0.0015
	12/16/14	<0.250	<0.250	<0.500	<0.0005	<0.0005	<0.0005	<0.0005
	03/25/15	<0.250	<0.046	<0.091	<0.0005	<0.0005	<0.0005	<0.001
	06/24/15	<0.250	<0.100	<0.250	<0.0005	<0.0005	<0.0005	<0.001
	09/15/15	<0.250	0.17 D	0.37	<0.0005	<0.0005	<0.0005	<0.001
MW-3	05/14/02	**4.5**	<0.250	<0.500	**0.0419**	0.0096	0.293	0.521
	05/19/03	--	--	--	**0.0908**	0.0097	0.338	0.5382
	05/25/07	0.361	<0.238	<0.476	<0.0005	<0.0005	0.0132	0.0145
	08/24/07	<0.1	<0.238	<0.476	<0.001	<0.002	<0.002	<0.006
	11/26/07	<0.080	<0.236	<0.472	0.0011	<0.002	0.0066	<0.006
	02/27/08	**2.14**	0.387 [6.]	<0.500	<0.0005	<0.0005	0.17	0.17
	2/27/2008 DUP	**1.85**	0.342	<0.485	0.0011	<0.0005	0.19	0.2
	03/31/10	**2.10**	<0.250	<0.500	<0.0005	<0.0005	0.018	0.021
	3/31/2010 DUP	**1.90**	<0.250	<0.500	<0.0015	<0.0015	0.018	0.020
	09/01/10	<0.250	<0.250	<0.500	<0.0005	<0.0005	<0.0005	<0.0015
	9/1/2010 DUP	<0.250	<0.250	<0.500	<0.0005	<0.0005	<0.0005	<0.0015
	12/16/14	<0.250	<0.250	<0.500	<0.0005	<0.0005	<0.0005	<0.0005
	03/25/15	<0.418	<0.046	<0.092	<0.0005	<0.0005	<0.0005	<0.001
	06/24/15	<0.250	0.120	<0.026	<0.0005	<0.0005	<0.0005	<0.001
	09/15/15	<0.250	0.140	<0.250	<0.0008	<0.0008	<0.0008	<0.001

Please refer to notes at end of table.

Cascadia Associates, LLC

Table 2
Analytical Results from Groundwater Monitoring Wells
NuStar Terminals Operations Partnership, L.P. – Annex Terminal
Vancouver, Washington

Well Number	Sample Date	TPHg Gasoline (mg/L)	TPHd Diesel (mg/L)	TPHo Heavy Oil (mg/L)	Benzene (mg/L)	Toluene (mg/L)	Ethylbenzene (mg/L)	Xylenes (mg/L)
MW-4	05/14/02	<0.080	0.358 [5.]	<0.500	<0.0005	<0.0005	<0.0005	<0.001
	05/19/03	--	--	--	<0.001	<0.001	<0.001	<0.002
	05/25/07	<0.080	<0.238	<0.476	<0.0002	<0.0005	<0.0005	<0.001
	08/24/07	<0.1	<0.238	<0.476	<0.001	<0.002	<0.002	<0.006
	11/26/07	<0.080	<0.236	<0.472	<0.001	<0.002	<0.002	<0.006
	02/27/08	<0.080	<0.248	<0.495	<0.0005	<0.0005	<0.0005	<0.001
	03/31/10	<0.250	<0.250	<0.500	<0.0005	<0.0005	<0.0005	<0.0015
	09/01/10	<0.250	<0.250	<0.500	<0.0005	<0.0005	<0.0005	<0.0015
	12/16/14	<0.250	<0.250	<0.500	<0.0005	<0.0005	<0.0005	<0.0005
	03/25/15	<0.250	0.074	<0.091	<0.0005	<0.0005	<0.0005	<0.001
	06/24/15	<0.250	<0.099	<0.250	<0.0005	<0.0005	<0.0005	<0.001
	09/15/15	<0.250	<0.130	<0.340	<0.0005	<0.0005	<0.0005	<0.001
MW-5	12/16/14	**15**	0.350	<0.500	0.00070	0.00066	0.12	**1.2**
	12/16/2014 DUP	**15**	<0.250	<0.500	0.00088	0.00081	0.18	**1.3**
	03/25/15	**18.1**	<0.045	<0.091	<0.00050	0.00061	0.218	**1.45**
	3/25/2015 DUP	**17.2**	<0.046	<0.092	0.0005	0.00065	0.236	**1.22**
	06/24/15	**15**	0.33 D	<0.250	<0.0012	<0.0012	0.228	**1.51**
	6/24/2015 DUP	**16.8**	**0.560 D**	<0.250	<0.0012	<0.0012	0.232	**1.49**
	09/15/15	**17.3**	**0.82 D**	<0.34	<0.00050	0.00060	0.289	**1.92**
	07/11/16	**19.4**	**0.310**	<0.29	<0.00084	0.00100	0.215	**1.17**
	10/23/17	**7.93 J-**	**1.26**	<0.25	<0.0010	0.00117	0.174	0.99
	11/30/17	**11.3**	**1.63**	<0.25	<0.0250	<0.0250	0.187	**1.21**
	11/30/17 DUP	**10.9**	**1.75**	<0.25	<0.0010	0.00112	0.187	**1.48**
	02/28/18	**9.86**	**1.77**	<0.25	<0.0010	0.00115	0.145	0.877
	05/29/18	**13.2**	**2.20**	<0.25	<0.0010	0.00130	0.271	**1.15**
	08/30/18	**18.6**	**0.819 F-18**	<0.151	<0.00200	<0.0100	0.190	0.936
	8/30/2018 DUP	**20.8**	**0.631 F-18**	<0.151	<0.00200	<0.0100	0.212	**1.06**
MW-5D	10/24/17	0.42	0.147 J	<0.25	<0.0010	<0.0010	0.00138	0.00296 J
	11/30/17	0.41	0.49	<0.25	<0.0010	<0.0010	<0.0010	<0.0030
	02/28/18	0.589	0.249	<0.25	<0.0010	<0.0010	0.00508	0.00204
	05/29/18	0.68	<0.38	<0.38	<0.0010	<0.0010	0.00220	<0.0030
	08/30/18	0.673	<0.0755	<0.151	<0.000200	<0.00100	<0.00050	<0.00150
MW-6	12/16/14	**15**	<0.250	<0.500	**0.47**	0.065	**1.3**	**2.6**
	03/25/15	**13.7**	0.047	<0.092	**0.516**	0.0756	**1.40**	**2.26**
	06/24/15	**17.7**	**1.2 D**	<0.250	**0.423**	0.0582	**1.58**	**1.92**
	09/15/15	**15.1**	**0.54 D**	<0.34	**0.306**	0.0672	**1.23**	**1.92**
	9/15/2015 DUP	**14**	0.44 D	<0.35	**0.328**	0.0684	**1.32**	**2.07**
	07/11/16	**15.5**	0.23	<0.28	**0.358**	0.0616	**1.63**	**1.82**
	10/24/17	**7.73**	**5.07**	0.111 J	**0.194**	0.051	**1.51**	**1.29**
	10/24/17 DUP	**4.19 J**	**8.96 QJ**	**1.19 QJ**	**0.153**	0.046	**1.18**	**1.04**
	11/30/17	**9.42**	**7.44**	**0.69**	**2.223**	0.053	**1.71**	**1.12**
	02/28/18	**7.72**	**3.57**	0.152	**0.256**	0.0423	**1.44**	0.735
	05/29/18	**1.5**	**9.30**	**0.570**	**0.23**	0.0444	**1.38**	0.891
	08/30/18	**20.1**	**1.24 F-18**	<0.151	**0.212**	0.0452	**1.59**	**1.15**

Please refer to notes at end of table.

Cascadia Associates, LLC

Table 2
Analytical Results from Groundwater Monitoring Wells
NuStar Terminals Operations Partnership, L.P. – Annex Terminal
Vancouver, Washington

Well Number	Sample Date	TPHg Gasoline (mg/L)	TPHd Diesel (mg/L)	TPHo Heavy Oil (mg/L)	Benzene (mg/L)	Toluene (mg/L)	Ethylbenzene (mg/L)	Xylenes (mg/L)
MW-7	07/11/16	<0.250	<0.19	<0.29	<0.00050	<0.00050	<0.00050	<0.00015
MW-8	07/11/16	<0.250	<0.19	<0.29	<0.00050	<0.00050	<0.00050	<0.00015
	7/11/16 DUP	<0.250	<0.19	<0.29	<0.00050	<0.00050	<0.00050	<0.00015
MW-9	07/11/16	<0.250	<0.19	<0.29	<0.00050	<0.00050	<0.00050	<0.00015
MW-10	07/11/16	<0.250	<0.19	<0.29	<0.00050	<0.00050	<0.00050	<0.00015
Washington DOE MTCA Method A Cleanup Level		0.8	0.5	0.5	0.005	1	0.7	1

Notes:

1. TPHg = Total petroleum hydrocarbons in gasoline carbon range by NW-TPHgx method.
2. TPHd = Total petroleum hydrocarbons in diesel carbon range by NW-TPHdx method with silica gel cleanup.
3. TPHho = Total petroleum hydrocarbons ion heavy oil carbon range NW-TPHdx method with silica gel cleanup.
4. **Boldface** values represent concentration that exceeds MTCA Method A cleanup level.
5. Analysis completed without silica gel cleanup. Lab detected hydrocarbons with non-petroleum peaks or elution pattern that suggests the presence of biogenic interference.
6. Hydrocarbon pattern most closely resembles a blend of heavy gas-/light diesel-range components.
7. mg/L (ppm) = Milligrams per liter (parts per million).
8. TPHg cleanup level dependent on presence of benzene in groundwater. Cleanup level = 0.800 mg/L if benzene is present and 1.00 mg/L if benzene is not present.
9. Washington DOE MTCA Method A cleanup level = Washington Department of Ecology Model Toxics Control Act Method A cleanup level.
10. < = Not detected at or above the specified laboratory method reporting limit (MRL).
11. bgs = below ground surface
12. -- = Sample not analyzed for constituent.

Quality Assurance/Quality Control Data Qualifiers

J = Reported result is an estimated value.
J- = Reported result is estimated and biased low.
Q = Sample prepared and/or analyzed outside of recommended holding time. Result is considered biased low.
F-18 = Result for Diesel (Diesel Range Organics, C12-C24) is due to overlap from Gasoline or a Gasoline Range product.
D = Laboratory report noted discreet peaks that are not indicative of diesel. The laboratory chemist confirmed the peaks were from non-petroleum organic material.

Table 3
Summary of Soil Analytical Results: TPH and VOCs
NuStar Terminals Operations Partnership, L.P. - Annex Terminal
Vancouver, Washington

				Concentrations in mg/kg (ppm)															
Sample Location	**Sample Date**	**Depth**	**TPH-HCID**	**TPHg**	**TPHd**	**TPHho**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylenes**	**1,2-Dibromo-ethane**	**1,2-Dichloro-ethane**	**Methyl tert-butyl ether (MTBE)**	**Naphthalene**	**1,2,4-Trimethyl-benzene**	**1,3,5-Trimethyl-benzene**	**Isopropyl-benzene**	**n-Propyl-benzene**	**n-Butyl-benzene**	**Chloroform**
Soil Borings																				
GP-2	04/10/02-4/11/02	10-12	--	ND	ND	ND	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GP-3	04/10/02-4/11/02	10-12	--	ND	ND	ND	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GP-5	04/10/02-4/11/02	17-19	--	ND	ND	ND	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GP-7	04/10/02-4/11/02	14-16	--	ND	ND	ND	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GP-8	04/10/02-4/11/02	6-8	--	ND	ND	ND	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GP-9	04/10/02-4/11/02	16-18	--	ND	ND	ND	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GP-12	04/10/02-4/11/02	22-24	--	ND	ND	ND	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GP14	05/09/02	10-12	DET	**3,230**	**19,700**	<1,000	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GP16	05/09/02	10-12	ND	ND	ND	ND	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW2	05/09/02	25-26.5	ND	**314**	<25	<50	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GP26	06/26/02	6-8	--	**5,850**	--	--	<2.5	**9.74**	**91.3**	**825**	<2.5	<2.5	<10	124	891	293	29.7	125	--	--
GP27	06/26/02	10-12	--	**4.96**	--	--	<0.0050	<0.0050	<0.0050	<0.1	<0.05	<0.05	<0.2	<0.5	<0.1	<0.05	<0.2	<0.05	--	--
GP31	06/26/02	22-24	--	<2.5	<25	<50	<0.0050	<0.0050	<0.0050	<0.0050	--	--	--	--	--	--	--	--	--	--
GP32	06/26/02	6.5-8	--	**910**	**2,530**	<50	<5	<5	<5	**16**	--	--	--	--	--	--	--	--	--	--
GP33	06/26/02	8-10	--	**363**	**31,500**	<2,500	<0.500	<0.500	**7.2**	**33.9**	--	--	--	--	--	--	--	--	--	--
GP34	06/26/02	6-8	--	**728**	**13,600**	<1,000	<0.500	<0.500	0.717	**16.9**	--	--	--	--	--	--	--	--	--	--
GP35	06/26/02	8-10	--	10.3	<25	<50	<0.0050	<0.0050	<0.0050	<0.0050	--	--	--	--	--	--	--	--	--	--
SB-2	04/17/03	4	ND	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-2	04/17/03	22	ND	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-4	04/17/03	3	ND	--	<25	<50	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-4	04/17/03	27	ND	--	<25	<50	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-5	04/17/03	11	ND	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-6	04/16/03	3	ND	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-6	04/16/03	16	ND	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-7	04/17/03	12	ND	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-8	04/17/03	8	DET	**1,020**	**7,890**	<1,000	<0.500	<0.500	<0.500	7.45	--	--	--	6.14	31	20.4	<1	3.22	3.54	<0.5
SB-8	04/17/03	16	DET	**369**	**1,440**	<50	<0.500	<0.500	<0.500	<1,000	--	--	--	6.47	1.67	<0.5	1.13	0.837	<2.5	0.539
SB-8R	09/30/14	12	--	<5.0	<5.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-9	04/18/03	12	DET	**504**	**1,890**	<50	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-9	04/18/03	15	DET	**168**	**1,210**	<50	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-9R	09/30/14	12	--	**1,000**	**4,000**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-9R	09/30/14	13.5	--	--	**3,400**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-11	04/16/03	2.5	ND	--	<25	<50	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-11	04/16/03	14	ND	--	<25	<50	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-12	04/22/03	3	ND	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-12	04/18/03	12	ND	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-13	04/22/03	2	ND	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-13	04/22/03	5	ND	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Please refer to notes at end of table.

Cascadia Associates, LLC

Table 3
Summary of Soil Analytical Results: TPH and VOCs
NuStar Terminals Operations Partnership, L.P. - Annex Terminal
Vancouver, Washington

				Concentrations in mg/kg (ppm)															
Sample Location	**Sample Date**	**Depth**	**TPH-HCID**	**TPHg**	**TPHd**	**TPHho**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylenes**	**1,2-Dibromo-ethane**	**1,2-Dichloro-ethane**	**Methyl tert-butyl ether (MTBE)**	**Naphthalene**	**1,2,4-Trimethyl-benzene**	**1,3,5-Trimethyl-benzene**	**Isopropyl-benzene**	**n-Propyl-benzene**	**n-Butyl-benzene**	**Chloroform**
Hand Augers																				
HA-1	04/17/03	3	ND	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
HA-1	04/17/03	6	ND	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
HA-2	04/18/03	2	ND	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
HA-2	04/18/03	5	ND	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
HA-3	04/17/03	2	--	--	--	--	<0.1	<0.1	<0.1	<300	--	--	--	<0.2	<0.1	<0.1	<0.2	<0.1	<0.5	<0.1
HA-3	04/17/03	5.5	--	--	--	--	<0.1	<0.1	<0.1	<300	--	--	--	<0.2	<0.1	<0.1	<0.2	<0.1	<0.5	<0.1
HA-4	04/18/03	2	ND	--	--	--	<0.1	--	--	--	--	--	--	--	--	--	--	--		
HA-4	04/18/03	5	ND	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--		
HA-5	04/18/03	3	DET	**3,320**	**4,780**	<50	<5.0	**10.5**	**48.5**	**500**	--	--	--	76.4	341	109	<10	39.1	<25	6.6
HA-5	04/18/03	5	DET	**2,290**	**10,700**	<250	**6.7**	**216**	**177**	**1,204**	--	--	--	141	576	176	20.8	83.3	34	<5
Washington DOE MTCA Method A cleanup level				100/30[11.]	2,000	2,000	0.03	7	6	9	NA	NA	NA	5	NA	NA	NA	NA	NA	NA
Hand Augers																				
HA-6	04/18/03	2	ND	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
HA-6	04/18/03	5	ND	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
HA-7	04/14/03	6	ND	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
HA-8	04/14/03	6	ND	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Soil Sample from Advancement of Temporary Monitoring Wells																				
PMW-5	04/16/03	8	ND		31	<50	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PMW-5	04/16/03	10	DET	--	146	<50	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PMW-6	04/16/03	3	ND	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PMW-6	04/16/03	12	ND	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PMW-7	04/16/03	3	ND	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PMW-7	04/16/03	16	ND	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Soil Samples from Excavation Confirmation																				
N. Wall	5/20/2002	10	--	--	--	--	<0.100	<0.100	<0.100	<0.2	--	--	<0.1	<0.2	<0.1	<0.1	<0.2	<0.1	<0.5	<0.1
N. Wall	5/20/2002	3	--	--	--	--	<0.100	<0.100	<0.100	<0.2	--	--	<0.1	<0.2	<0.1	<0.1	<0.2	<0.1	<0.5	<0.1
E. Wall	5/21/2002	10	--	--	--	--	<0.100	<0.100	<0.100	<0.2	--	--	<0.1	<0.2	<0.1	<0.1	<0.2	<0.1	<0.5	<0.1
E. Wall	5/21/2002	3	--	--	--	--	<0.100	<0.100	<0.100	<0.2	--	--	<0.1	<0.2	<0.1	<0.1	<0.2	<0.1	<0.5	<0.1
Washington DOE MTCA Method A cleanup level[12.]				100/30[11.]	2,000	2,000	0.03	7	6	9	NA	NA	NA	5	NA	NA	NA	NA	NA	NA

Notes:

1. TPH-HCID = Total petroleum hydrocarbons hydrocarbon identification by NW-TPH-HCID
2. TPHg = Total petroleum hydrocarbons in the gasoline carbon range by NW-TPH-Gx method.
3. TPHd = Total petroleum hydrocarbons in the diesel carbon range by NW-TPH-Dx method with silica gel cleanup.
4. TPHho = Total petroleum hydrocarbons in the heavy oil carbon range by NW-TPH-Dx method with silica gel cleanup.
5. mg/kg (ppm) = Milligrams per kilogram (parts per million).
6. -- = Not analyzed or not available.
7. < = Not detected at or above the specified laboratory method reporting limit (MRL).
8. ND = Not detected; MRL not available.
9. DET = Gasoline-, diesel-, and/or heavy oil-range hydrocarbons was detected using NWTPH-HCID. Follow-up analysis was completed.
10. **Boldface** values represent concentration that exceeds MTCA Method A cleanup level.
11. TPHg cleanup level dependent on presence of benzene in soil. Cleanup level = 30 mg/kg if benzene is present and 100 mg/kg if benzene is not present.
12. Washington DOE MTCA = Washington Department of Ecology Model Toxics Control Act.
13. NA = Cleanup level not available.
14. Grey highlight identifies the 2014 borings installed at the historical (2003) locations of SB-8 and SB-9.

Cascadia Associates, LLC

Table 4
Historical Grab Groundwater Sample Analytical Results: TPH and VOCs
NuStar Terminals Operations Partnership, L.P. - Annex Terminal
Vancouver, Washington

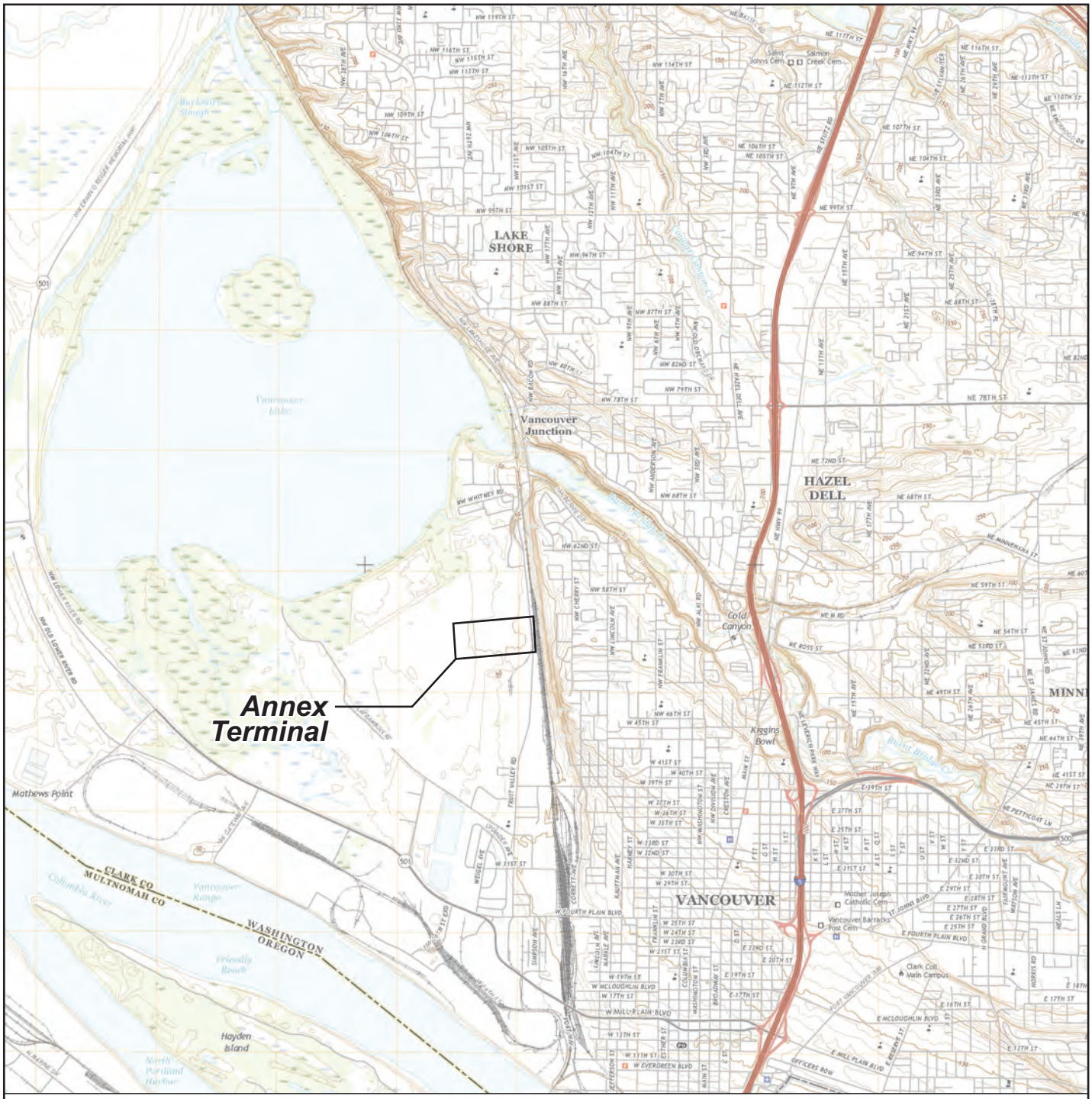
				Concentrations in mg/L (ppm)																
Sample Location	**Sample Date**	**Depth (feet bgs)**	**TPH-HCID**	**TPHg**	**TPHd[16]**	**TPHo[16]**	**Benzene**	**Toluene**	**Ethyl-benzene**	**Xylenes**	**Methyl tert-butyl ether (MTBE)**	**Tert-Amyl Methyl Ether (TAME)**	**Naphthalene**	**1,2,4-Trimethyl benzene**	**1,3,5-Trimethyl benzene**	**Isopropyl-benzene**	**n-Propylbenzene**	**n-Butyl-benzene**	**sec-Butyl-benzene**	**Chloroform**	**Dissolved Lead**
Groundwater Samples from Soil Borings																					
B-1(1)	10/22/2015	21-25	--	**0.483**	**0.51**	<0.28	<0.00050	<0.00050	<0.00050	<0.0010	<0.00050	--	--	--	--	--	--	--	--	--	--
B-1(2)	10/22/2015	26-30	--	<0.250	0.24	0.38	<0.00050	<0.00050	<0.00050	<0.0010	<0.00050	--	--	--	--	--	--	--	--	--	--
B-1(3)	10/22/2015	36-40	--	**0.687**	0.35	<0.24	<0.00050	<0.00050	0.00053	<0.0010	<0.00050	--	--	--	--	--	--	--	--	--	--
B-2(1)	10/23/2015	16-20	--	**4.02**	**0.77**	<0.30	**0.0104**	0.0155	**1.31**	**3.18**	<0.00050	--	--	--	--	--	--	--	--	--	--
B-2(2)	10/23/2015	26-30	--	<0.250	0.2	<0.23	<0.00050	<0.00050	0.0057	0.0108	<0.00050	--	--	--	--	--	--	--	--	--	--
B-2(3)	10/23/2015	36-40	--	**2.37**	**3.5**	<0.28	0.0022	0.0019	0.122	0.184	<0.00050	--	--	--	--	--	--	--	--	--	--
B-3(1)	10/23/2015	16-20	--	**22.3**	**15.9/3.2[16]**	**0.69**/<0.003[16]	**3.94**	0.112	**1.24**	**3.9**	<0.010	--	--	--	--	--	--	--	--	--	--
B-3(2)	10/23/2015	26-30	--	**25.6**	**37.4**	0.46	**3.91**	0.104	**1.23**	**3.52**	<0.010	--	--	--	--	--	--	--	--	--	--
B-4(1)	10/23/2015	16-20	--	**10.3**	**6.2**	<0.300	<0.0012	<0.0012	0.26	**0.321**	<0.0012	--	--	--	--	--	--	--	--	--	--
B-4(2)	10/23/2015	26-30	--	**9.88**	**2.1**	<0.260	0.0012	0.001	0.255	0.214	<0.00050	--	--	--	--	--	--	--	--	--	--
B-5(1)	10/27/2015	16-20	--	**34.7**	**68.4**	**3.8**	<0.025	<0.025	**2.77**	**5.24**	<0.025	--	--	--	--	--	--	--	--	--	--
B-5(2)	10/27/2015	36-40	--	**20.6**	**0.89**	<0.30	<0.0031	0.0097	**0.955**	**1.26**	<0.0031	--	--	--	--	--	--	--	--	--	--
B-6(1)	10/27/2015	19-23	--	**48.6**	**117/67.7[16]**	**0.77/0.62[16]**	<0.0025	0.005	0.0743	0.0245	<0.0025	--	--	--	--	--	--	--	--	--	--
B-6(2)	10/27/2015	51-55	--	<0.250	0.35	0.31	<0.00050		<0.00050	<0.0010	<0.00050	--	--	--	--	--	--	--	--	--	--
B-6(3)	10/27/2015	61-65	--	<0.250	0.35	<0.30	<0.00050	<0.00050	<0.00050	<0.0010	0.0025	--	--	--	--	--	--	--	--	--	--
B-7 (1)	10/28/2015	21-25	--	<0.250	<0.170	<0.260	<0.00050	<0.00050	<0.00050	<0.0010	<0.00050	--	--	--	--	--	--	--	--	--	--
B-7(2)	10/28/2015	26-30	--	<0.250	<0.190	<0.280	<0.00050	<0.00050	<0.00050	<0.0010	<0.00050	--	--	--	--	--	--	--	--	--	--
B-8(1)	10/28/2015	16-20	--	<0.250	<0.190	<0.290	<0.00050	<0.00050	<0.00050	<0.0010	<0.00050	--	--	--	--	--	--	--	--	--	--
B-8(2)	10/28/2015	21-25	--	<0.250	<0.190	<0.290	<0.00050	<0.00050	<0.00050	<0.0010	<0.00050	--	--	--	--	--	--	--	--	--	--
B-9(1)	10/20/2015	16-20	--	**1.63**	0.24	0.28	<0.00050	<0.00050	<0.00050	<0.0010	<0.00050	--	--	--	--	--	--	--	--	--	--
B-9(2)	10/29/2015	36-40	--	**3.03**	0.38	**0.62**	<0.00050	<0.00050	<0.00050	<0.0010	0.0039	--	--	--	--	--	--	--	--	--	--
B-9(3)	10/29/2015	46-50	--	**1.55**	**0.56**	<0.300	<0.00050	<0.00050	<0.00050	<0.0010	0.0048	--	--	--	--	--	--	--	--	--	--
B-10(1)	10/29/2015	16-20	--	**32.7**	**284**	**0.58**	<0.0012	<0.0012	0.377	0.495	<0.0012	--	--	--	--	--	--	--	--	--	--
B-10(2)	10/29/2015	36-40	--	0.421	**2.2**	0.37	<0.00050	<0.00050	0.0022	0.003	<0.00050	--	--	--	--	--	--	--	--	--	--
B-11(1)	10/30/2015	21-25	--	**19.2**	**46.7**	**0.92**	<0.0025	<0.0025	0.455	0.701	<0.0025	--	--	--	--	--	--	--	--	--	--
B-11(2)	10/30/2015	36-40	--	**1.58**	**6.9**	**0.62**	<0.00050	<0.00050	0.0112	0.0187	<0.00050	--	--	--	--	--	--	--	--	--	--
B-11(3)	10/30/2015	41-45	--	<0.250	0.28	0.3	<0.00050	<0.00050	0.00052	<0.0010	<0.00050	--	--	--	--	--	--	--	--	--	--
B-12(1)	10/30/2015	16-20	--	0.265	<0.200	0.36	<0.00050	<0.00050	<0.00050	<0.0010	<0.00050	--	--	--	--	--	--	--	--	--	--
B-12(2)	10/30/2015	36-40	--	<0.250	0.29	<0.260	<0.00050	<0.00050	<0.00050	<0.0010	<0.00050	--	--	--	--	--	--	--	--	--	--
B-12(3)	10/30/2015	41-45	--	<0.250	<0.200	<0.300	<0.00050	<0.00050	<0.00050	<0.0010	0.001	--	--	--	--	--	--	--	--	--	--
B-13 (1)	7/7/2016	15-20	--	<0.250	<0.18	<0.27	<0.00050	<0.00050	<0.00050	<0.0015	--	--	--	--	--	--	--	--	--	--	--
B-13 (2)	7/7/2016	25-30	--	<0.250	<0.18	<0.27	<0.00050	<0.00050	<0.00050	<0.0015	--	--	--	--	--	--	--	--	--	--	--
B-14 (1)	7/7/2016	15-20	--	<0.250	<0.18	<0.27	<0.00050	<0.00050	<0.00050	<0.0015	--	--	--	--	--	--	--	--	--	--	--
B-14 (2)	7/7/2016	25-30	--	<0.250	<0.17	<0.26	<0.00050	<0.00050	<0.00050	<0.0015	--	--	--	--	--	--	--	--	--	--	--
Washington DOE MTCA Method A cleanup level[12.]				0.800[11.]	0.5	0.5	0.005	1	0.7	1	0.02	NA	0.16	NA	NA	NA	NA	NA	NA	NA	0.015

Notes:

1. TPH-HCID = Total petroleum hydrocarbons hydrocarbon identification by method NWTPH-HCID.
2. TPHg = Total petroleum hydrocarbons in the gasoline carbon range by NW-TPH-Gx method.
3. TPHd = Total petroleum hydrocarbons in the diesel carbon range by NW-TPH-Dx method. September 2014 samples were analyzed using silica gel cleanup method.
4. TPHho = Total petroleum hydrocarbons in the heavy oil carbon range by NW-TPH-Dx method.
5. Benzene, toluene, ethylbenzene, and total xylenes (BTEX) analysis per EPA Method 8260B.
6. Volatile organic compounds (VOCs) analysis per EPA Method 8260B.
7. DET = Gasoline-, diesel-, and/or heavy oil-range hydrocarbons was detected using NWTPH-HCID. Follow-up analysis was completed.
8. ND = Not detected; method reporting limit (MRL) not available.
9. < = Not detected at or above the specified laboratory method reporting limit (MRL).
10. mg/L (ppm) = Milligrams per liter (parts per million).
11. TPHg cleanup level dependent on presence of benzene in groundwater. Cleanup level = 0.800 mg/L if benzene is present and 1.00 mg/L if benzene is not present.
12. Washington DOE MTCA = Washington Department of Ecology Model Toxics Control Act.
13. **Boldface** values represent concentration that exceeds MTCA Method A cleanup level.
14. NA = Cleanup level not available.
15. The screened intervals for the October 2015 samples are shown. Sample intake was generally from the centerpoint of each interval - see boring logs for more detail.
16. For TPHd and TPHo, the first value represents with silica gel cleanup and the second without (i.e. 15.9/3.2)

Cascadia Associates, LLC

FIGURES



Note: Base map prepared from USGS 7.5-minute quadrangle of Vancouver, WA, dated 2017 as provided by USGS.gov.

0 4,000 8,000

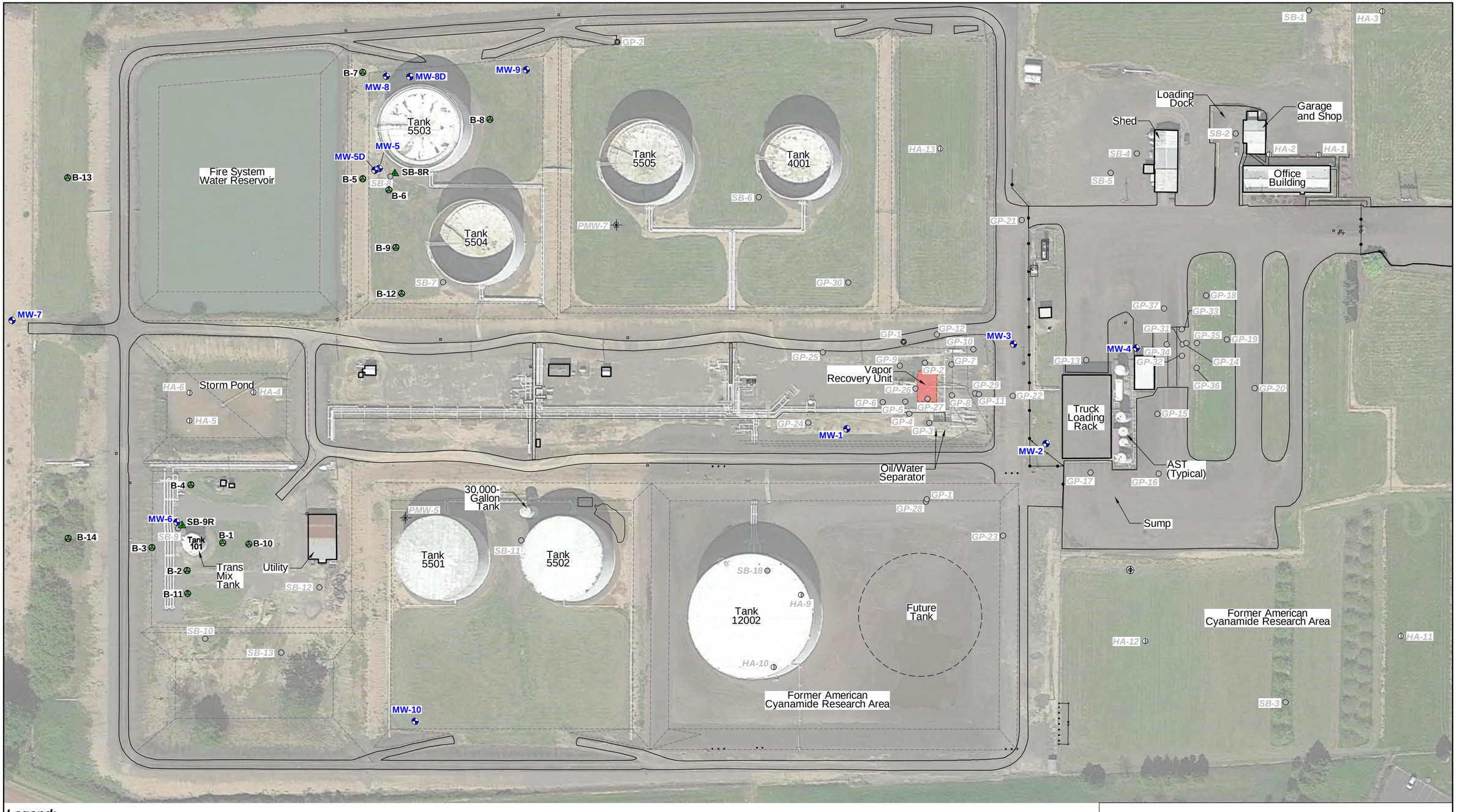
Approximate Scale in Feet

Site Location Map

Pilot Study Summary Report
NuStar Terminals Operations Partnership, L.P.- Annex Terminal
Vancouver, Washington

Cascadia Associates, LLC

Project Number	1569-11	Figure 1
	December 2018	



Legend:

- **B-1** Soil Boring Location (October 2015)
- **SB-8R** Soil Boring Location (September 2014)
- **MW-1** Groundwater Monitoring Well Location (MW-5D and MW-8D are Deep Monitoring Well Locations)
- DP-1 Grab Groundwater Sample Location
- GP-1 Deeper Direct-Push Geoprobe Location
- GP-1 Historical Direct-Push Boring Location (Approximate)
- PMW-5 Historical Temporary Well Location (Approximate)
- HA-1 Historical Hand Auger Location (Approximate)
- Excavation Location (2002)

N

0 100 200

Scale in Feet

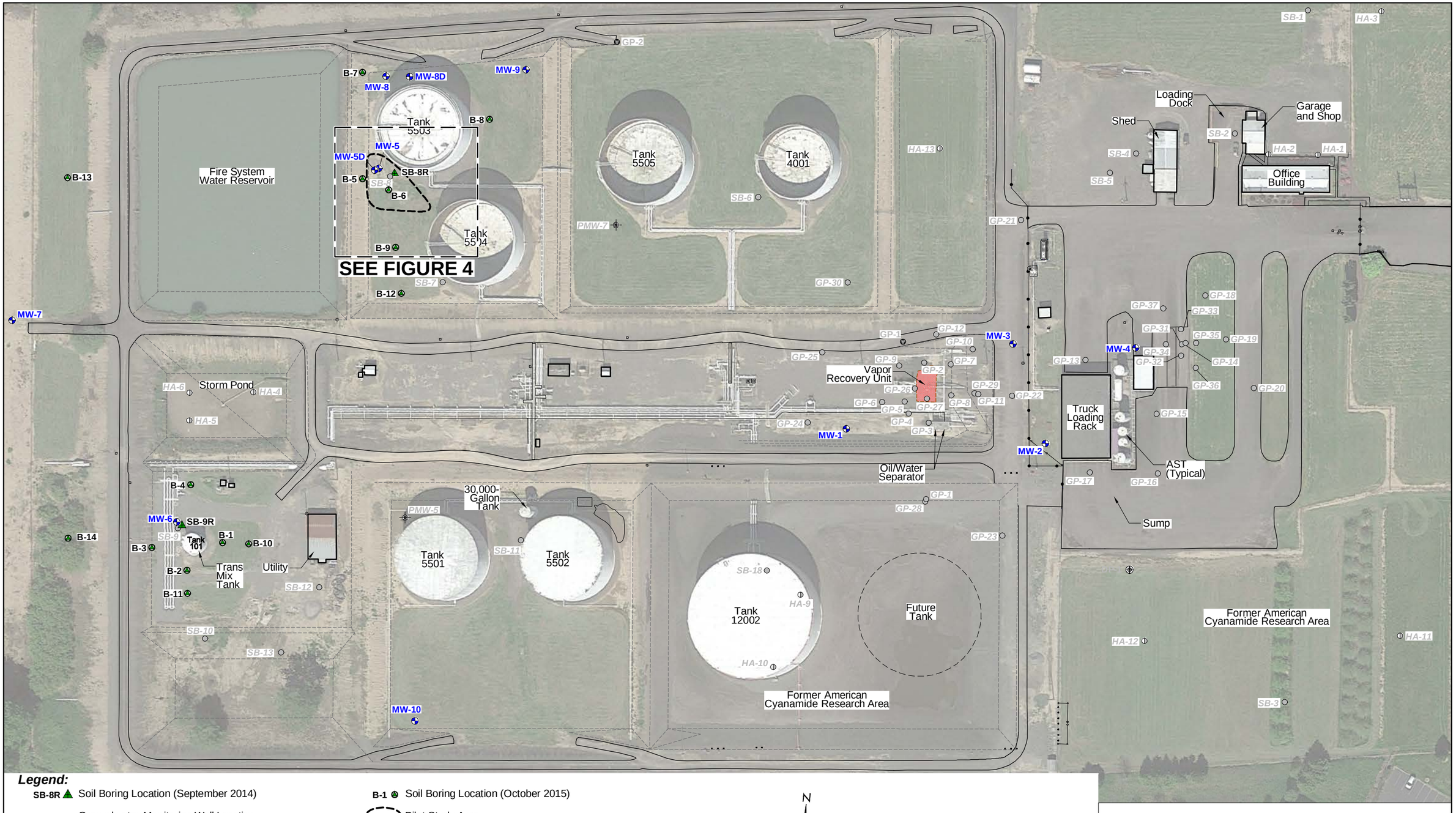
NOTE: Base map completed from a number of sources including but not limited to; Figure VAN1-21-002 provided by NuStar (1/8/2007) and a Monitoring Well Survey by Statewide Land Surveying, Inc (10/30/2007). Locations of roads and containments are approximate. Aerial photograph from Google Earth Pro (4/2015).

Site Plan

Pilot Study Summary Report
NuStar Terminals Operations Partnership, L.P. - Annex Terminal
Vancouver, Washington

Cascadia Associates, LLC

Project Number	1569-11	Figure 2
December 2018		



Legend:

- **SB-8R** Soil Boring Location (September 2014)
- **MW-1** Groundwater Monitoring Well Location (MW-5D and MW-8D are Deep Monitoring Well Locations)
- DP-1 Grab Groundwater Sample Location
- GP-1 Deeper Direct-Push Geoprobe Location
- GP-1 Historical Direct-Push Boring Location (Approximate)
- PMW-5 Historical Temporary Well Location (Approximate)
- HA-1 Historical Hand Auger Location (Approximate)
- **B-1** Soil Boring Location (October 2015)
- Pilot Study Area
- Excavation Location (2002)

N

0 100 200

Scale in Feet

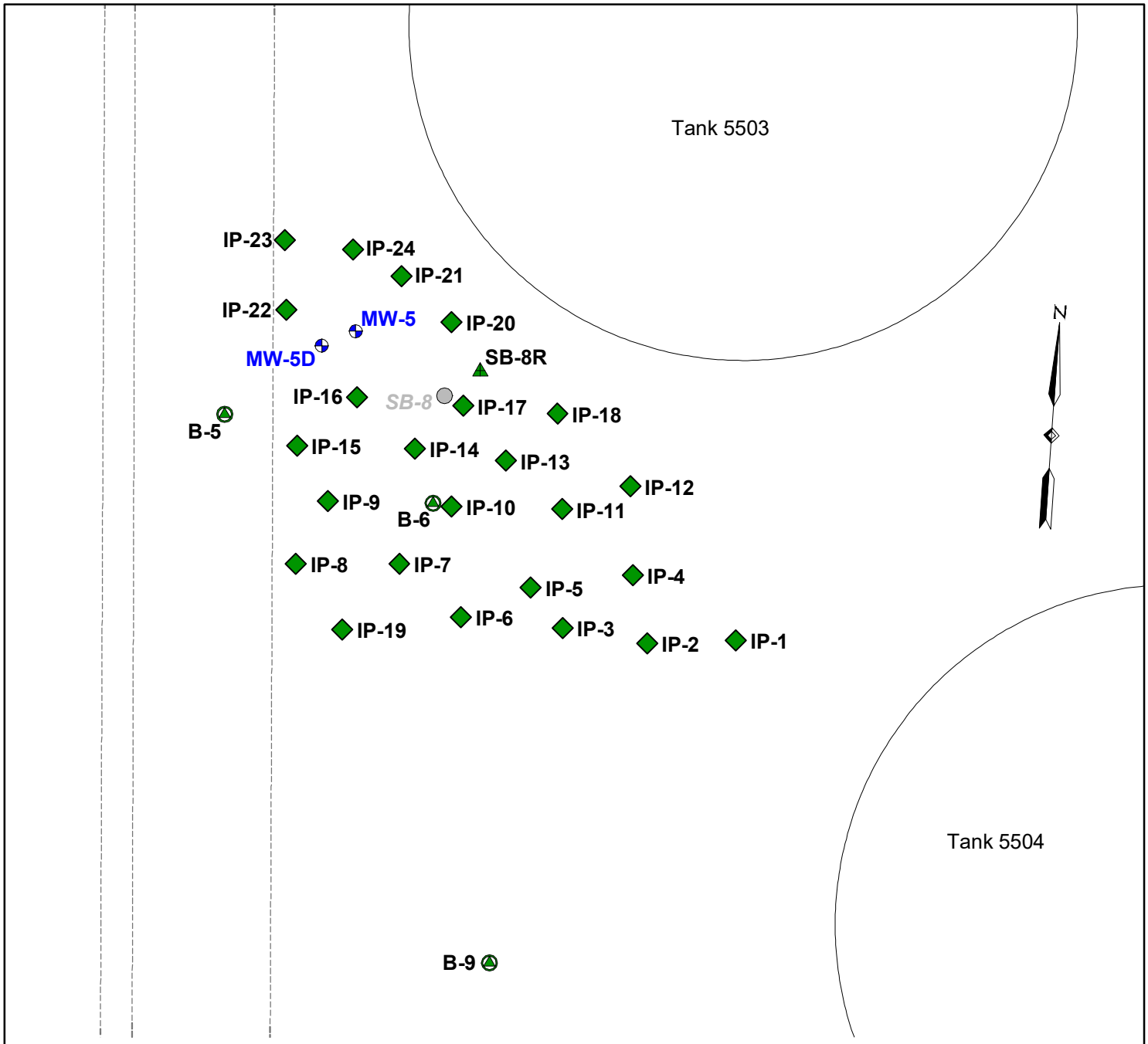
NOTE: Base map completed from a number of sources including but not limited to; Figure VAN1-21-002 provided by NuStar (1/8/2007) and a Monitoring Well Survey by Statewide Land Surveying, Inc (10/30/2007). Locations of roads and containments are approximate. Aerial photograph from Google Earth Pro (4/2015).

Pilot Study Area

Pilot Study Summary Report
NuStar Terminals Operations Partnership, L.P. - Annex Terminal
Vancouver, Washington

Cascadia Associates, LLC

Project Number	1569-11	Figure
	December 2018	3



Legend:

SB-8R Soil Boring Location (September 2014)

MW-5 Groundwater Monitoring Well Location (MW-5D is a Deep Monitoring Well Location)

SB-8 Historical Direct-Push Boring Location (Approximate)

B-6 Soil Boring Location (October 2015)

IP-1 Injection Boring Location

NOTE: Base map completed from a number of sources including but not limited to; Figure VAN1-21-002 provided by NuStar (1/8/2007) and a Monitoring Well Survey by Statewide Land Surveying, Inc (10/30/2007). Locations of roads and containments are approximate.

0 20 40

Scale in Feet

Pilot Study Injection Layout

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Vancouver, Washington

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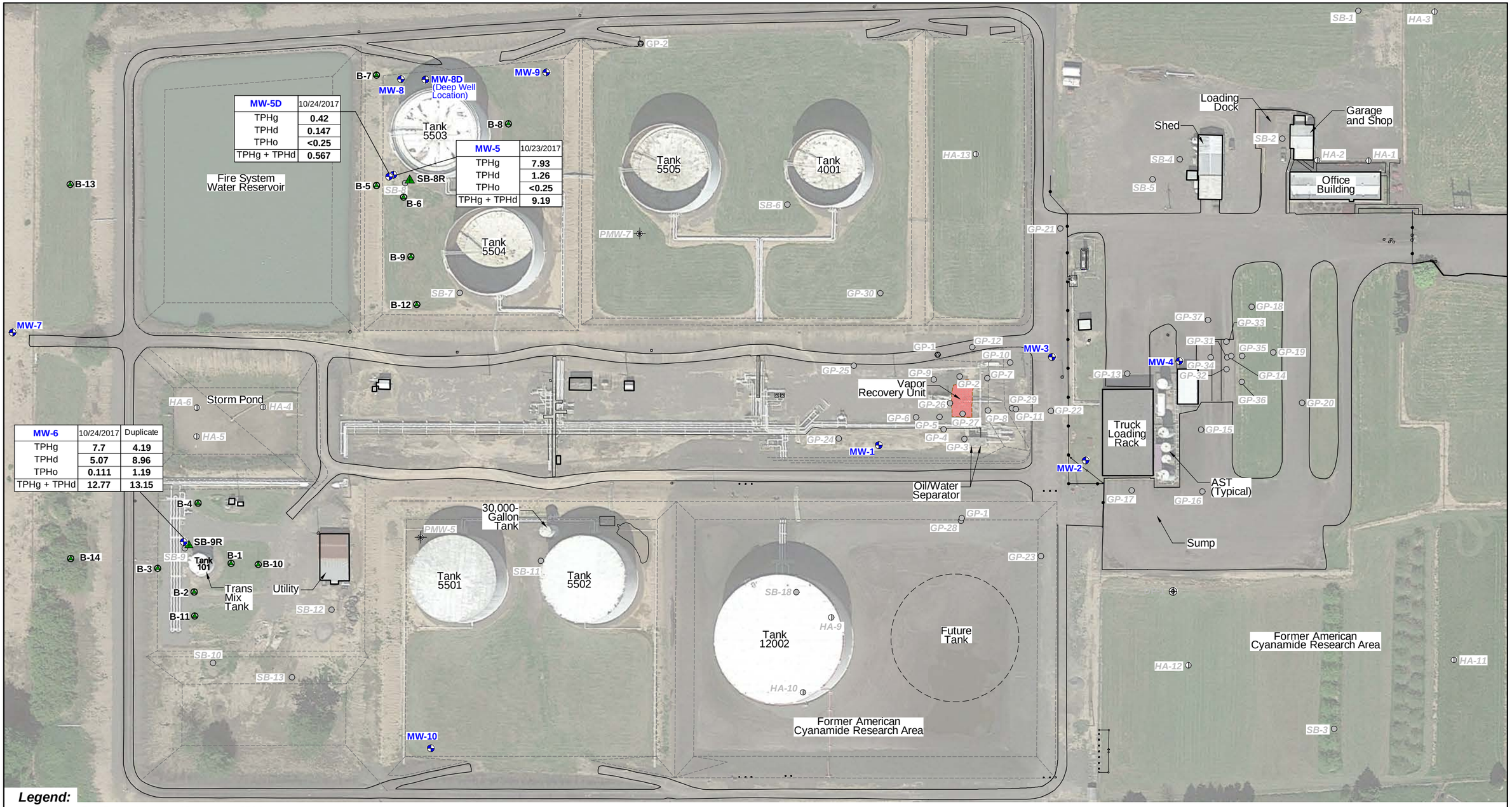
Project Number	1569-11	Figure
December 2018		4



Legend:

- **SB-8R** Soil Boring Location (September 2014)
- **MW-1** Groundwater Monitoring Well Location (MW-5D and MW-8D are Deep Monitoring Well Locations)
- **DP-1** Grab Groundwater Sample Location
- **GP-1** Deeper Direct-Push Geoprobe Location
- ***GP-1*** Historical Direct-Push Boring Location (Approximate)
- ***PMW-5*** Historical Temporary Well Location (Approximate)
- ***HA-1*** Historical Hand Auger Location (Approximate)
- **B-1** Soil Boring Location (October 2015)

MW-6	10/24/2017	Duplicate
TPHg	7.7	4.19
TPHd	5.07	8.96
TPHo	0.111	1.19
TPHg + TPHd	12.77	13.15

Date Sampled and Duplicate (If taken)

Concentration in mg/L

Analyte Sampled

Abbreviations	
TPHg	Total Petroleum Hydrocarbons Gasoline-Range
TPHd	Total Petroleum Hydrocarbons Diesel-Range
TPHo	Total Petroleum Hydrocarbons Heavy Oil-Range

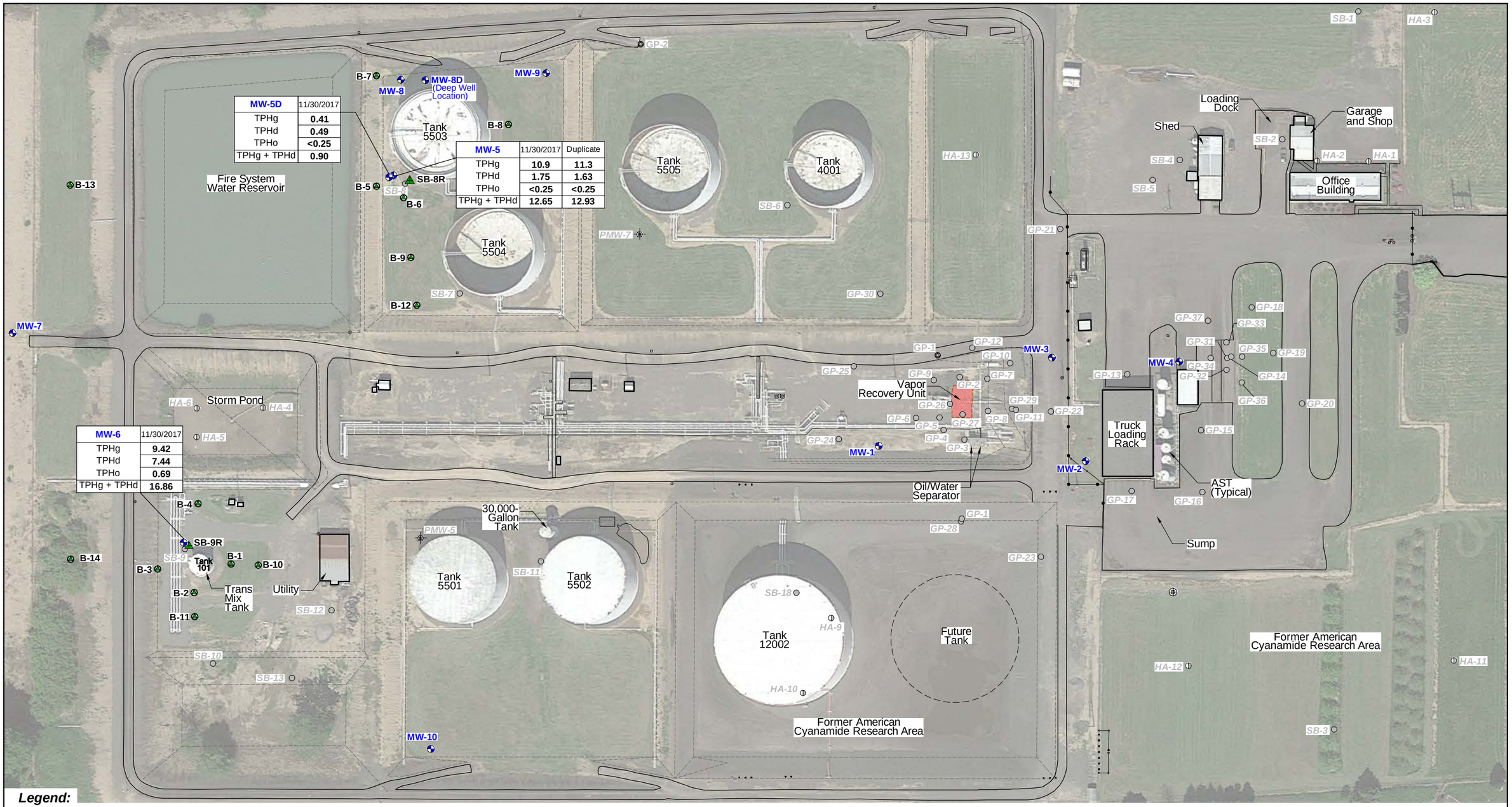
NOTE: Base map completed from a number of sources including but not limited to; Figure VAN1-21-002 provided by NuStar (1/8/2007) and a Monitoring Well Survey by Statewide Land Surveying, Inc (10/30/2007). Locations of roads and containments are approximate. Aerial photograph from Google Earth Pro (4/2015).

Total Petroleum Hydrocarbons in Groundwater (Pre-Injection) - October 2017

Pilot Study Summary Report
NuStar Terminals Operations Partnership, L.P. - Annex Terminal
Vancouver, Washington

Cascadia Associates, LLC

Project Number	1569-11	Figure
December 2018		5



Legend:

- **SB-8R** Soil Boring Location (September 2014)
- **MW-1** Groundwater Monitoring Well Location (MW-5D and MW-8D are Deep Monitoring Well Locations)
- DP-1 Grab Groundwater Sample Location
- GP-1 Deeper Direct-Push Geoprobe Location
- *GP-1* Historical Direct-Push Boring Location (Approximate)
- *PMW-5* Historical Temporary Well Location (Approximate)
- *HA-1* Historical Hand Auger Location (Approximate)
- **B-1** Soil Boring Location (October 2015)

MW-5	11/30/2017	Duplicate
TPHg	10.9	11.3
TPHd	1.75	1.63
TPHo	<0.25	<0.25
TPHg + TPHd	12.65	12.93

Date Sampled and Duplicate (If taken)

Concentration in mg/L

Analyte Sampled

Abbreviations	
TPHg	Total Petroleum Hydrocarbons Gasoline-Range
TPHd	Total Petroleum Hydrocarbons Diesel-Range
TPHo	Total Petroleum Hydrocarbons Heavy Oil-Range

N

0 100 200

Scale in Feet

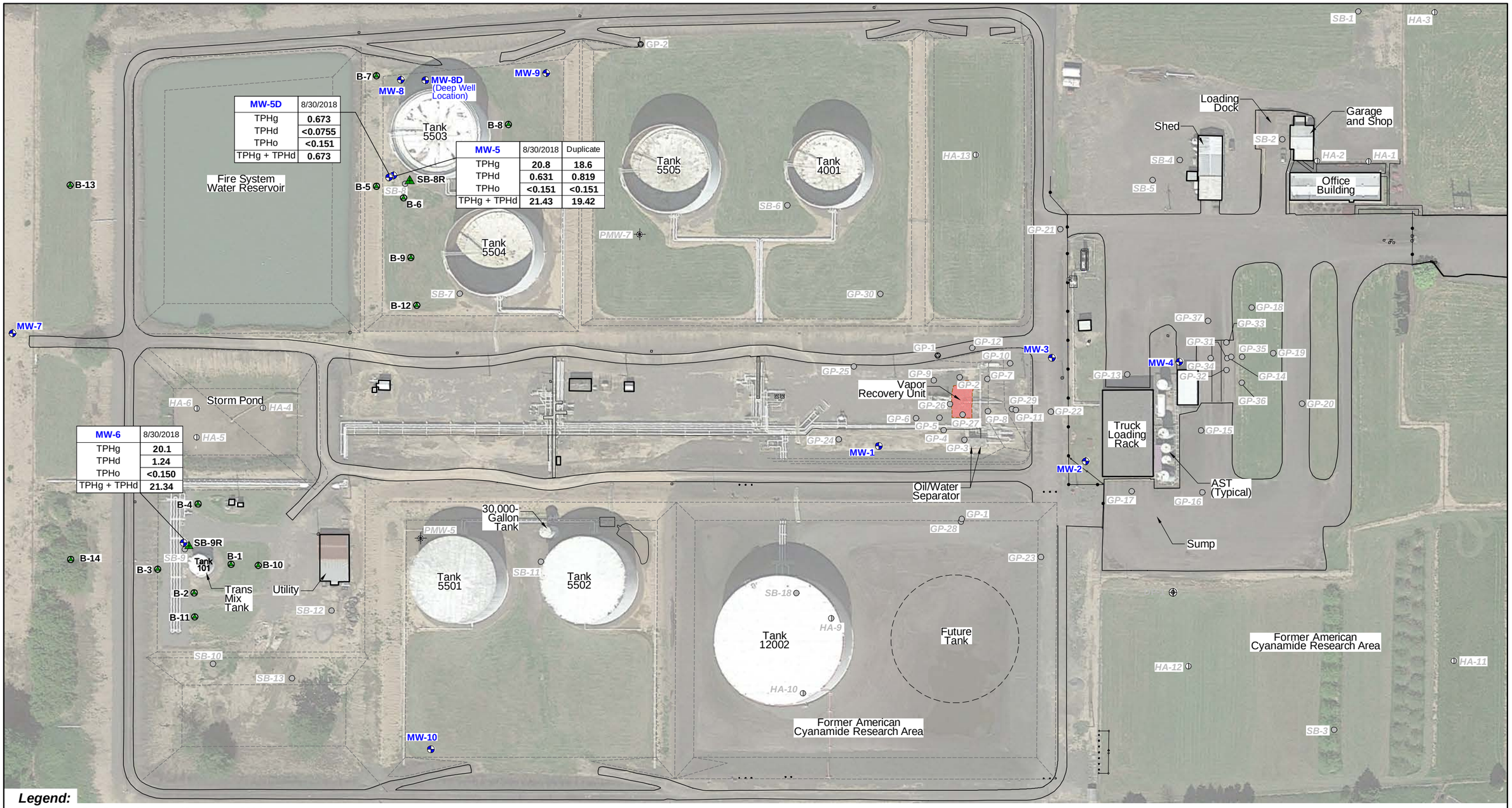
NOTE: Base map completed from a number of sources including but not limited to; Figure VAN1-21-002 provided by NuStar (1/8/2007) and a Monitoring Well Survey by Statewide Land Surveying, Inc (10/30/2007). Locations of roads and containments are approximate. Aerial photograph from Google Earth Pro (4/2015).

Total Petroleum Hydrocarbons in Groundwater First Post-Injection Monitoring Event - November 2017

Pilot Study Summary Report
NuStar Terminals Operations Partnership, L.P. - Annex Terminal
Vancouver, Washington

Cascadia Associates, LLC

Project Number	1569-11	Figure
December 2018		6



NOTE: Base map completed from a number of sources including but not limited to; Figure VAN1-21-002 provided by NuStar (1/8/2007) and a Monitoring Well Survey by Statewide Land Surveying, Inc (10/30/2007). Locations of roads and containments are approximate. Aerial photograph from Google Earth Pro (4/2015).

Total Petroleum Hydrocarbons in Groundwater Fourth Post-Injection Monitoring Event - August 2018

Pilot Study Summary Report
NuStar Terminals Operations Partnership, L.P. - Annex Terminal
Vancouver, Washington

Cascadia Associates, LLC

Project Number	1569-11	Figure
December 2018		7

APPENDIX A

LABORATORY REPORTS AND

DATA QUALITY REVIEW

1.0 INTRODUCTION

This attachment documents the results of a quality assurance/quality control (QA/QC) review of the analytical data for the groundwater samples collected as part of the pilot study implementation and subsequent monitoring at the NuStar Terminals Operations Partnership (NuStar) Annex Terminal in Vancouver, Washington (the Facility). Groundwater sample analyses were performed by an accredited environmental laboratory; laboratories used during the pilot study are listed in the table below. Copies of the laboratory reports are included in this attachment.

Report	Sampling Date	Event	Laboratory
L946549	10/24/2017	Baseline Monitoring	ESC – Mt. Juliet, TN
L948749	10/28/17	Baseline Monitoring	ESC
L954460	11/30/2017	First Post-Injection Monitoring	ESC
L974072	2/28/2018	Second Post-Injection Monitoring	ESC
10433756	5/29/18	Third Post-Injection Monitoring	Pace Analytical – Minneapolis, MN
A8H0297	8/30/18	Fourth Post-Injection Monitoring	Apex Laboratories, Tigard, OR

2.0 DATA VALIDATION

The QA review included examination and validation of the laboratory data packages for the following:

- Analytical preparation and quantitation methods
- Analytical method holding times
- Sample handling
- Chain of custody handling
- Detection and reporting limits
- Method blank detections
- Laboratory control samples, matrix spikes and surrogates to assess laboratory accuracy
- Laboratory control sample duplicates and matrix spike duplicates to assess laboratory precision
- Field duplicates to assess sampling and laboratory precision

The QA/QC review did not include a review of raw data.

2.1 DATA QUALIFIERS

Any data that is found to have possible bias or error was qualified and flagged. The flags used in the data table are below.

J	Result is an estimated value.
F-18	Result for Diesel (Diesel Range Organics, C12-C24) is due to overlap from gasoline or a gasoline-range product.
Q	Sample prepared and/or analyzed outside of recommended holding time. Result is considered biased low.

3.0 ANALYTICAL METHODS

Groundwater sample analyses included the following.

- Gasoline-range petroleum hydrocarbons (TPHg) by Method NWTPH-Gx;
- Diesel-range petroleum hydrocarbons (TPHd) and oil-range petroleum hydrocarbons (TPHo) by Method NWTPH-Dx with silica gel cleanup; and
- Benzene, toluene, ethylbenzene, and xylenes (collectively BTEX) by U.S. Environmental Protection Agency (EPA) Method 8260B.

4.0 QUALITY ASSURANCE OBJECTIONS AND REVIEW

The general QA objectives for this project were to develop and implement procedures for obtaining, evaluating, and confirming the usability of data of a specified quality for monitoring groundwater quality trends at the Facility. To collect such information, analytical data must have an appropriate degree of accuracy and reproducibility, samples collected must be representative of actual field conditions, and samples must be collected and analyzed using unbroken COC procedures.

Reporting limits and analytical results for the samples were compared to Washington Department of Ecology MTCA Method A Cleanup Levels for each parameter. Precision, accuracy, representativeness, completeness, and comparability parameters used to indicate data quality are defined below.

4.1 HOLDING TIMES AND SAMPLE RECEIPT

The holding time is the minimum amount of time the sample can be stored before analytes start to degrade and are not representative of initial sampling concentrations. Holding times are defined by analytical methods. The groundwater samples included in this QA/QC review were analyzed within the method recommended holding time, except for analysis of diesel range hydrocarbons in the duplicate sample collected from well MW-6 during the baseline sampling event. When the lab began sample preparation, a test of pH showed that the MW-6 DUP sample pH was greater than two. While the sample was prepared and analyzed within standard 14-day hold time, the hold time for

the NWTPH-Dx analysis with a pH greater than two is seven days. The diesel- and residual-range results were subsequently flagged as out-of-hold. Below is a table outlining sample holding times based on sampling preservation and matrix.

Method	Matrix	Analyte	Preservative	Hold Time
EPA 8260B	Water	Volatile Organic Compounds	Hydrochloric Acid (HCl) to pH<2; No headspace; Glass	14 days
NWTPH-Gx	Water	Gasoline Range Organics	Hydrochloric Acid (HCl) to pH<2; No headspace; Glass	14 days
NWTPH-Dx	Water	Diesel Range Organics	Hydrochloric Acid (HCl) to pH<2; Amber glass container	14 days

Samples were received on ice below 4^0C by the analytical laboratory. Sampling containers arrived intact and unbroken to the laboratories. Groundwater samples to be analyzed for VOCs were received without headspace in VOA sampling containers. All chain-of-custodies were appropriately relinquished by the Cascadia Associates sampler and received by the intentional environmental laboratory. There were no major discrepancies found between the bottles and the chain of custodies received.

4.2 REPORTING LIMITS

Reporting limits are the lowest concentration an instrument is capable of accurately detecting an analyte. They are determined by the laboratory and are based on instrumentation capabilities, the matrix of field samples, sample preparation procedures and suggested reporting limits by the EPA or the Washington Department of Ecology. In some cases, the reporting limits may be raised due to high concentrations of analytes or matrix interferences. Detection limits were generally consistent with industry standards and regulatory standards. Reporting limits for individual samples varied based on the magnitude of the chemical impact.

4.3 METHOD BLANKS

A method- or laboratory-blank is a QC sample prepared by the laboratory from an analyte-free matrix and analyzed in an analytical batch along with environmental and other QC samples. It is used to assess laboratory contamination or background interferences. Some analytes were detected in the laboratory method blanks for the groundwater analyses, as follows.

- For gasoline range organics in batch WG1049399, report L954460, TPH-g was detected in the method blank between the method detection limit (MDL) and the reported detection limit (RDL) but the concentration was less than one half the reporting limit. Sample data were accepted and not flagged.

4.4 ACCURACY

Accuracy compares the accepted reference concentration of an analyte to the concentration determined analytically. Accuracy is measured as a percent recovery. This recovery must be within

a certain range or control limit for the data in an analytical batch to be considered acceptable. The analytical laboratory provides quality control samples and surrogates to help determine the accuracy and acceptability of the data reported. These quality control samples and surrogates are discussed below.

4.4.1 Laboratory Control Samples

Laboratory control samples (LCS) and laboratory control duplicate samples (LCSD) were analyzed by the laboratory to assess the accuracy of the analytical methods. A minimum of one set of LCS and LCSD was analyzed per analytical batch. The LCS and LCSD are prepared from an analyte-free matrix that is spiked with known levels of compounds of concern. The concentrations are measured and compared to the known spiked levels. This comparison is expressed as percent recovery. The percent recoveries for LCS and LCSD quality control samples were within method control limits.

4.4.2 Matrix Spikes

A matrix spike QC sample is used to assess the performance of the analytical method by determining potential matrix interferences. Matrix spike (MS) and matrix spike duplicate (MSD) analyses are performed on one environmental sample per analytical batch. A matrix spike sample uses an environmental sample that is spiked with known concentrations of analytes of interest. The matrix spike is then prepared and analyzed with the same analytical procedures as environmental samples in the analytical batch. The resulting concentration of the matrix spike is then compared to the known or true values plus the non-spiked environmental sample concentration. This comparison is expressed as a percent recovery. The percent recoveries for MS and MSD quality control samples were within method control limits, with one exception:

The RPD between the MS and MSD for total petrol hydrocarbons – gasoline range, was slightly above control limits for sample batch 10433756. Because the analyses were performed on a non-project sample, and the associated LCS/LCSD percent recovery for the sample batch was within acceptable limits, no data are flagged.

4.4.3 Surrogates

Surrogates are organic compounds that are similar in chemical composition to the analytes of interest but are not likely to be found in the environment. They are spiked at a known concentration into environmental and batch QC samples prior to sample preparation and analysis. Surrogate recoveries for environmental samples are used to evaluate matrix interference, sample preparation efficiency and analysis performance on a sample-specific basis. Surrogate recoveries were within control limits.

4.5 PRECISION

Precision is measured by how close values of duplicate analyses are to each other. These duplicate analyses are prepared from separate aliquots of the same sample and are analyzed at the same (or

similar) time. Precision in the field ensures that samples taken are representative of field concentrations; this is demonstrated by field duplicates. Analytical precision is the ability of the laboratory to reproduce results that are similar to each other; this is measured through duplicate analysis of environmental and batch QC samples. Precision is estimated by the relative percent difference (RPD) between the original analysis and the duplicate analysis.

4.5.1 Laboratory Control Sample Duplicates

The analytical batch LCS concentration of an analyte is compared to the LCSD concentration of the same analyte. The RPD is calculated from these two concentrations; which must be below a certain percentage to be considered acceptable. The RPD values for the laboratory control samples of the same batch were within the method control limits.

4.5.2 Matrix Spikes

Like the LCS/LCSD, the MS/MSD analyte concentrations are also compared to each other and expressed as an RPD. The RPD values for analytical batch MS/MSD were within the control limit.

4.5.3 Field Duplicate

A field duplicate is a second field sample collected from a selected sample location. Field duplicate samples serve as a check on laboratory precision, sampling quality, as well as potential variability of the sample matrix. The field duplicate is analyzed and compared to the original sample to assess precision. This comparison can be expressed by the RPD between the original and duplicate samples. Application of RPD values is appropriate when the analyte result is five times greater than the reporting limit. Laboratory precision decreases as the analytical result approaches the reporting limit. Some results did exceed the 30 percent control limit but were less than 5 times the reporting limit. Data was accepted and not flagged in the data table, except for the following.

- For sample MW-6 from the baseline sampling event (reports L946549 and L948749), the RPD for TPH-g, TPH-d, and TPH-o between the primary and duplicate sample collected from exceeded the 30 percent control limit. The discrepancy appears to be due to matrix interference with the samples and not the result of laboratory quality control issues. The detected concentrations were more than 5 times the reporting limit. The reported concentrations for TPH-g, TPH-d, and TPH-o in the sample from well MW-6 were J flagged as estimated values.

5.0 CONCLUSION

The overall QA objectives have been met and the data are of adequate quality for use in this project.

ANALYTICAL REPORT

January 29, 2018

Cascadia Associates- Portland, OR

Sample Delivery Group:	L946549
Samples Received:	10/26/2017
Project Number:	0060-001-001
Description:	Nustar - Vannex Pilot Study
Site:	VANCOUVER, WA
Report To:	Ian Maguire 6915 SW Macadam Ave Ste. 250 Portland, OR 97219

Entire Report Reviewed By:

Brian Ford

Technical Service Representative

Results relate only to the items tested or calibrated and are reported as rounded values. This test report shall not be reproduced, except in full, without written approval of the laboratory. Where applicable, sampling conducted by ESC is performed per guidance provided in laboratory standard operating procedures: 060302, 060303, and 060304.

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MW-5 L946549-01 GW

Collected by: Ian Maguire | Collected date/time: 10/23/17 13:00 | Received date/time: 10/26/17 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Volatile Organic Compounds (GC) by Method NWTPHGX	WG1036093	1	10/27/17 10:29	10/27/17 10:29	LRL
Volatile Organic Compounds (GC/MS) by Method 8260C	WG1036371	1	10/27/17 16:20	10/27/17 16:20	BMB
Volatile Organic Compounds (GC/MS) by Method 8260C	WG1036371	25	11/02/17 02:51	11/02/17 02:51	ACG
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1036830	1	10/30/17 05:29	10/30/17 15:01	LM

MW-5D L946549-02 GW

Collected by: Ian Maguire | Collected date/time: 10/24/17 09:45 | Received date/time: 10/26/17 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Volatile Organic Compounds (GC) by Method NWTPHGX	WG1036093	1	10/27/17 10:51	10/27/17 10:51	LRL
Volatile Organic Compounds (GC/MS) by Method 8260C	WG1036371	1	10/27/17 16:41	10/27/17 16:41	BMB
Volatile Organic Compounds (GC/MS) by Method 8260C	WG1036371	1	11/02/17 03:11	11/02/17 03:11	ACG
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1036830	1	10/30/17 05:29	10/30/17 15:18	LM

MW-6 L946549-03 GW

Collected by: Ian Maguire | Collected date/time: 10/24/17 11:35 | Received date/time: 10/26/17 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Volatile Organic Compounds (GC) by Method NWTPHGX	WG1036093	1	10/27/17 11:13	10/27/17 11:13	LRL
Volatile Organic Compounds (GC/MS) by Method 8260C	WG1036371	1	10/27/17 17:01	10/27/17 17:01	BMB
Volatile Organic Compounds (GC/MS) by Method 8260C	WG1036371	50	11/02/17 03:31	11/02/17 03:31	ACG
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1036830	1	10/30/17 05:29	10/30/17 15:36	LM
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1036830	5	10/30/17 05:29	10/31/17 19:22	LM

HA-1 L946549-04 Solid

Collected by: Ian Maguire | Collected date/time: 10/24/17 15:30 | Received date/time: 10/26/17 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Total Solids by Method 2540 G-2011	WG1037601	1	11/01/17 11:06	11/01/17 11:19	KDW
Volatile Organic Compounds (GC) by Method NWTPHGX	WG1036385	500	10/24/17 15:30	10/27/17 15:57	LRL
Volatile Organic Compounds (GC/MS) by Method 8260C	WG1036716	1	10/24/17 15:30	11/02/17 11:38	ACG
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1037950	1	11/02/17 07:36	11/03/17 21:12	DMG
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1037950	5	11/02/17 07:36	11/03/17 22:03	DMG

HA-1 L946549-05 GW

Collected by: Ian Maguire | Collected date/time: 10/24/17 15:30 | Received date/time: 10/26/17 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Preparation by Method 1312	WG1037226	1	10/31/17 08:01	10/31/17 08:01	TM
Preparation by Method 1312	WG1037796	1	11/01/17 11:45	11/01/17 11:45	KK
Volatile Organic Compounds (GC) by Method 8021B/NWTPHGX	WG1038336	1	11/02/17 14:40	11/02/17 14:40	JHH
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1037937	1	11/01/17 22:37	11/02/17 20:49	CLG

All sample aliquots were received at the correct temperature, in the proper containers, with the appropriate preservatives, and within method specified holding times, unless qualified or notated within the report. Where applicable, all MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All radiochemical sample results for solids are reported on a dry weight basis with the exception of tritium, carbon-14 and radon, unless wet weight was requested by the client. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.

Brian Ford
Technical Service Representative

Volatile Organic Compounds (GC) by Method 8021B/NWTPHGX

Analyte	Result ug/l	Qualifier	MDL ug/l	RDL ug/l	Dilution	Analysis date / time	Batch
Gasoline Range Organics-NWTPH	7930		31.6	100	1	10/27/2017 10:29	WG1036093
(S) a,a,a-Trifluorotoluene(FID)	*67.5*	J2		*77.0-122*		*10/27/2017 10:29*	WG1036093

Sample Narrative:

L946549-01 WG1036093: Surrogate failure due to sample matrix.

Volatile Organic Compounds (GC/MS) by Method 8260C

Analyte	Result ug/l	Qualifier	MDL ug/l	RDL ug/l	Dilution	Analysis date / time	Batch
Benzene	U		0.331	1.00	1	10/27/2017 16:20	WG1036371
Toluene	1.17		0.412	1.00	1	10/27/2017 16:20	WG1036371
Ethylbenzene	174		9.60	25.0	25	11/02/2017 02:51	WG1036371
Total Xylenes	988		26.5	75.0	25	11/02/2017 02:51	WG1036371
(S) Toluene-d8	*100*			*80.0-120*		*10/27/2017 16:20*	WG1036371
(S) Toluene-d8	*109*			*80.0-120*		*11/02/2017 02:51*	WG1036371
(S) Dibromofluoromethane	*92.2*			*76.0-123*		*10/27/2017 16:20*	WG1036371
(S) Dibromofluoromethane	*99.1*			*76.0-123*		*11/02/2017 02:51*	WG1036371
(S) a,a,a-Trifluorotoluene	*99.7*			*80.0-120*		*10/27/2017 16:20*	WG1036371
(S) a,a,a-Trifluorotoluene	*110*			*80.0-120*		*11/02/2017 02:51*	WG1036371
(S) 4-Bromofluorobenzene	*90.7*			*80.0-120*		*11/02/2017 02:51*	WG1036371
(S) 4-Bromofluorobenzene	*95.7*			*80.0-120*		*10/27/2017 16:20*	WG1036371

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT

Analyte	Result ug/l	Qualifier	MDL ug/l	RDL ug/l	Dilution	Analysis date / time	Batch
Diesel Range Organics (DRO)	1260		66.0	200	1	10/30/2017 15:01	WG1036830
Residual Range Organics (RRO)	U		82.5	250	1	10/30/2017 15:01	WG1036830
(S) o-Terphenyl	*85.7*			*52.0-156*		*10/30/2017 15:01*	WG1036830

Volatile Organic Compounds (GC) by Method 8021B/NWTPHGX

Analyte	Result ug/l	Qualifier	MDL ug/l	RDL ug/l	Dilution	Analysis date / time	Batch
Gasoline Range Organics-NWTPH	422		31.6	100	1	10/27/2017 10:51	WG1036093
(S) a,a,a-Trifluorotoluene(FID)	*98.9*			*77.0-122*		*10/27/2017 10:51*	WG1036093

Volatile Organic Compounds (GC/MS) by Method 8260C

Analyte	Result ug/l	Qualifier	MDL ug/l	RDL ug/l	Dilution	Analysis date / time	Batch
Benzene	U		0.331	1.00	1	10/27/2017 16:41	WG1036371
Toluene	U		0.412	1.00	1	10/27/2017 16:41	WG1036371
Ethylbenzene	1.38		0.384	1.00	1	11/02/2017 03:11	WG1036371
Total Xylenes	2.96	J	1.06	3.00	1	11/02/2017 03:11	WG1036371
(S) Toluene-d8	*108*			*80.0-120*		*11/02/2017 03:11*	WG1036371
(S) Toluene-d8	*106*			*80.0-120*		*10/27/2017 16:41*	WG1036371
(S) Dibromofluoromethane	*93.3*			*76.0-123*		*10/27/2017 16:41*	WG1036371
(S) Dibromofluoromethane	*98.5*			*76.0-123*		*11/02/2017 03:11*	WG1036371
(S) a,a,a-Trifluorotoluene	*104*			*80.0-120*		*10/27/2017 16:41*	WG1036371
(S) a,a,a-Trifluorotoluene	*110*			*80.0-120*		*11/02/2017 03:11*	WG1036371
(S) 4-Bromofluorobenzene	*95.2*			*80.0-120*		*10/27/2017 16:41*	WG1036371
(S) 4-Bromofluorobenzene	*90.3*			*80.0-120*		*11/02/2017 03:11*	WG1036371

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT

Analyte	Result ug/l	Qualifier	MDL ug/l	RDL ug/l	Dilution	Analysis date / time	Batch
Diesel Range Organics (DRO)	147	J	66.0	200	1	10/30/2017 15:18	WG1036830
Residual Range Organics (RRO)	U		82.5	250	1	10/30/2017 15:18	WG1036830
(S) o-Terphenyl	*87.5*			*52.0-156*		*10/30/2017 15:18*	WG1036830

Volatile Organic Compounds (GC) by Method 8021B/NWTPHGX

Analyte	Result ug/l	Qualifier	MDL ug/l	RDL ug/l	Dilution	Analysis date / time	Batch
Gasoline Range Organics-NWTPH	7730		31.6	100	1	10/27/2017 11:13	WG1036093
(S) a,a,a-Trifluorotoluene(FID)	*82.2*			*77.0-122*		*10/27/2017 11:13*	WG1036093

Volatile Organic Compounds (GC/MS) by Method 8260C

Analyte	Result ug/l	Qualifier	MDL ug/l	RDL ug/l	Dilution	Analysis date / time	Batch
Benzene	194		16.6	50.0	50	11/02/2017 03:31	WG1036371
Toluene	51.2		0.412	1.00	1	10/27/2017 17:01	WG1036371
Ethylbenzene	1510		19.2	50.0	50	11/02/2017 03:31	WG1036371
Total Xylenes	1290		53.0	150	50	11/02/2017 03:31	WG1036371
(S) Toluene-d8	*105*			*80.0-120*		*11/02/2017 03:31*	WG1036371
(S) Toluene-d8	*102*			*80.0-120*		*10/27/2017 17:01*	WG1036371
(S) Dibromofluoromethane	*101*			*76.0-123*		*11/02/2017 03:31*	WG1036371
(S) Dibromofluoromethane	*90.2*			*76.0-123*		*10/27/2017 17:01*	WG1036371
(S) a,a,a-Trifluorotoluene	*104*			*80.0-120*		*10/27/2017 17:01*	WG1036371
(S) a,a,a-Trifluorotoluene	*115*			*80.0-120*		*11/02/2017 03:31*	WG1036371
(S) 4-Bromofluorobenzene	*86.0*			*80.0-120*		*11/02/2017 03:31*	WG1036371
(S) 4-Bromofluorobenzene	*97.5*			*80.0-120*		*10/27/2017 17:01*	WG1036371

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT

Analyte	Result ug/l	Qualifier	MDL ug/l	RDL ug/l	Dilution	Analysis date / time	Batch
Diesel Range Organics (DRO)	5070		330	1000	5	10/31/2017 19:22	WG1036830
Residual Range Organics (RRO)	111	J	82.5	250	1	10/30/2017 15:36	WG1036830
(S) o-Terphenyl	*94.7*			*52.0-156*		*10/30/2017 15:36*	WG1036830
(S) o-Terphenyl	*95.5*			*52.0-156*		*10/31/2017 19:22*	WG1036830

Total Solids by Method 2540 G-2011

Analyte	Result	Qualifier	Dilution	Analysis	Batch
	%			date / time	
Total Solids	70.8		1	11/01/2017 11:19	WG1037601

Volatile Organic Compounds (GC) by Method NWTPHGX

Analyte	Result (dry)	Qualifier	MDL (dry)	RDL (dry)	Dilution	Analysis	Batch
	mg/kg		mg/kg	mg/kg		date / time	
Gasoline Range Organics-NWTPH	1890		24.0	70.6	500	10/27/2017 15:57	WG1036385
(S) a,a,a-Trifluorotoluene(FID)	*93.6*			*77.0-120*		*10/27/2017 15:57*	WG1036385

Volatile Organic Compounds (GC/MS) by Method 8260C

Analyte	Result (dry)	Qualifier	MDL (dry)	RDL (dry)	Dilution	Analysis	Batch
	mg/kg		mg/kg	mg/kg		date / time	
Benzene	U		0.00183	0.00353	1	11/02/2017 11:38	WG1036716
Toluene	0.0128		0.00374	0.00706	1	11/02/2017 11:38	WG1036716
Ethylbenzene	0.0105		0.00182	0.00353	1	11/02/2017 11:38	WG1036716
Total Xylenes	0.0334		0.00176	0.0106	1	11/02/2017 11:38	WG1036716
(S) Toluene-d8	*109*			*80.0-120*		*11/02/2017 11:38*	WG1036716
(S) Dibromofluoromethane	*101*			*74.0-131*		*11/02/2017 11:38*	WG1036716
(S) a,a,a-Trifluorotoluene	*96.0*			*80.0-120*		*11/02/2017 11:38*	WG1036716
(S) 4-Bromofluorobenzene	*161*	J1		*64.0-132*		*11/02/2017 11:38*	WG1036716

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT

Analyte	Result (dry)	Qualifier	MDL (dry)	RDL (dry)	Dilution	Analysis	Batch
	mg/kg		mg/kg	mg/kg		date / time	
Diesel Range Organics (DRO)	427		9.32	28.2	5	11/03/2017 22:03	WG1037950
Residual Range Organics (RRO)	U		4.66	14.1	1	11/03/2017 21:12	WG1037950
(S) o-Terphenyl	*61.8*			*18.0-148*		*11/03/2017 21:12*	WG1037950
(S) o-Terphenyl	*72.0*			*18.0-148*		*11/03/2017 22:03*	WG1037950

Preparation by Method 1312

Analyte	Result	Qualifier	Prep date / time	Batch
SPLP Extraction	-		10/31/2017 8:01:58 AM	WG1037226
SPLP ZHE Extraction	-		11/1/2017 11:45:56 AM	WG1037796
Fluid	2		10/31/2017 8:01:58 AM	WG1037226
Initial pH	4.81		10/31/2017 8:01:58 AM	WG1037226
Final pH	4.74		10/31/2017 8:01:58 AM	WG1037226

Volatile Organic Compounds (GC) by Method 8021B/NWTPHGX

Analyte	Result ug/l	Qualifier	MDL ug/l	RDL ug/l	Dilution	Analysis date / time	Batch
Gasoline Range Organics-NWTPH	562		31.6	100	1	11/02/2017 14:40	WG1038336
Benzene	0.601	B	0.190	0.500	1	11/02/2017 14:40	WG1038336
Toluene	1.86	B	0.412	1.00	1	11/02/2017 14:40	WG1038336
Ethylbenzene	57.8		0.160	0.500	1	11/02/2017 14:40	WG1038336
Total Xylene	10.4		0.510	1.50	1	11/02/2017 14:40	WG1038336
(S) a,a,a-Trifluorotoluene(PID)	*102*			*80.0-121*		*11/02/2017 14:40*	WG1038336
(S) a,a,a-Trifluorotoluene(FID)	*94.7*			*77.0-122*		*11/02/2017 14:40*	WG1038336

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT

Analyte	Result ug/l	Qualifier	MDL ug/l	RDL ug/l	Dilution	Analysis date / time	Batch
Diesel Range Organics (DRO)	1620		66.0	200	1	11/02/2017 20:49	WG1037937
Residual Range Organics (RRO)	152	J	82.5	250	1	11/02/2017 20:49	WG1037937
(S) o-Terphenyl	*67.1*			*52.0-156*		*11/02/2017 20:49*	WG1037937

Method Blank (MB)

(MB) R3262355-1 11/01/17 11:19

Analyte	MB Result %	MB Qualifier	MB MDL %	MB RDL %
Total Solids	0.0007			

L946549-04 Original Sample (OS) • Duplicate (DUP)

(OS) L946549-04 11/01/17 11:19 • (DUP) R3262355-3 11/01/17 11:19

Analyte	Original Result %	DUP Result %	Dilution	DUP RPD %	DUP Qualifier	DUP RPD Limits %
Total Solids	70.8	70.5	1	0		5

Laboratory Control Sample (LCS)

(LCS) R3262355-2 11/01/17 11:19

Analyte	Spike Amount %	LCS Result %	LCS Rec. %	Rec. Limits %	LCS Qualifier
Total Solids	50.0	50.0	100	85-115	

Method Blank (MB)

(MB) R3262620-3 11/02/17 14:18

Analyte	MB Result ug/l	MB Qualifier	MB MDL ug/l	MB RDL ug/l
Gasoline Range Organics-NWTPH	U		31.6	100
Benzene	0.313	J	0.190	0.500
Toluene	0.461	J	0.412	1.00
Ethylbenzene	U		0.160	0.500
Total Xylene	U		0.510	1.50
(S) a,a,a-Trifluorotoluene(PID)	*103*			*80.0-121*
(S) a,a,a-Trifluorotoluene(FID)	*93.8*			*77.0-122*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3262620-1 11/02/17 10:02 • (LCSD) R3262620-2 11/02/17 10:24

Analyte	Spike Amount ug/l	LCS Result ug/l	LCSD Result ug/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Gasoline Range Organics-NWTPH	5500	4240	3960	77.0	72.0	72.0-134			6.80	20
(S) a,a,a-Trifluorotoluene(FID)				*108*	*107*	*77.0-122*				

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3262620-6 11/03/17 03:52 • (LCSD) R3262620-7 11/03/17 04:51

Analyte	Spike Amount ug/l	LCS Result ug/l	LCSD Result ug/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Benzene	50.0	48.6	47.4	97.3	94.9	71.0-121			2.48	20
Toluene	50.0	53.0	51.2	106	102	72.0-120			3.30	20
Ethylbenzene	50.0	53.4	51.9	107	104	75.0-122			2.74	20
Total Xylene	150	154	147	103	98.0	74.0-124			4.78	20
(S) a,a,a-Trifluorotoluene(PID)				*102*	*101*	*80.0-121*				
(S) a,a,a-Trifluorotoluene(FID)				*94.8*	*93.8*	*77.0-122*				

L946549-05 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L946549-05 11/02/17 14:40 • (MS) R3262620-4 11/02/17 16:25 • (MSD) R3262620-5 11/02/17 16:47

Analyte	Spike Amount ug/l	Original Result ug/l	MS Result ug/l	MSD Result ug/l	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Gasoline Range Organics-NWTPH	5500	562	5410	5490	88.1	89.7	1	23.0-159			1.61	20
(S) a,a,a-Trifluorotoluene(FID)					*107*	*107*		*77.0-122*				

Method Blank (MB)

(MB) R3261836-3 10/27/17 03:28

Analyte	MB Result ug/l	MB Qualifier	MB MDL ug/l	MB RDL ug/l
Gasoline Range Organics-NWTPH	U		31.6	100
(S) a,a,a-Trifluorotoluene(FID)	*100*			*77.0-122*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3261836-1 10/27/17 02:21 • (LCSD) R3261836-2 10/27/17 02:43

Analyte	Spike Amount ug/l	LCS Result ug/l	LCSD Result ug/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Gasoline Range Organics-NWTPH	5500	5800	5820	105	106	72.0-134			0.310	20
(S) a,a,a-Trifluorotoluene(FID)				*102*	*102*	*77.0-122*				

L946549-03 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L946549-03 10/27/17 11:13 • (MS) R3261836-4 10/27/17 11:35 • (MSD) R3261836-5 10/27/17 11:57

Analyte	Spike Amount ug/l	Original Result ug/l	MS Result ug/l	MSD Result ug/l	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Gasoline Range Organics-NWTPH	5500	7730	10900	11100	57.4	61.6	1	23.0-159		E	2.10	20
(S) a,a,a-Trifluorotoluene(FID)					*97.6*	*96.6*		*77.0-122*				

Method Blank (MB)

(MB) R3261308-3 10/27/17 12:20

Analyte	MB Result mg/kg	MB Qualifier	MB MDL mg/kg	MB RDL mg/kg
Gasoline Range Organics-NWTPH	U		0.0339	0.100
(S) a,a,a-Trifluorotoluene(FID)	*93.9*			*77.0-120*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3261308-1 10/27/17 10:29 • (LCSD) R3261308-2 10/27/17 10:53

Analyte	Spike Amount mg/kg	LCS Result mg/kg	LCSD Result mg/kg	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Gasoline Range Organics-NWTPH	5.50	6.47	6.35	118	115	70.0-133			1.81	20
(S) a,a,a-Trifluorotoluene(FID)				*100*	*101*	*77.0-120*				

L946549-04 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L946549-04 10/27/17 15:57 • (MS) R3261308-4 10/27/17 20:20 • (MSD) R3261308-5 10/27/17 20:44

Analyte	Spike Amount (dry) mg/kg	Original Result (dry) mg/kg	MS Result (dry) mg/kg	MSD Result (dry) mg/kg	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Gasoline Range Organics-NWTPH	7.76	1890	6260	5740	112	99.0	500	10.0-146			8.70	30
(S) a,a,a-Trifluorotoluene(FID)					*97.9*	*98.0*		*77.0-120*				

Method Blank (MB)

(MB) R3262256-2 10/27/17 15:39

Analyte	MB Result ug/l	MB Qualifier	MB MDL ug/l	MB RDL ug/l
Benzene	U		0.331	1.00
Ethylbenzene	U		0.384	1.00
Toluene	U		0.412	1.00
Xylenes, Total	U		1.06	3.00
(S) Toluene-d8	*111*			*80.0-120*
(S) Dibromofluoromethane	*94.4*			*76.0-123*
(S) 4-Bromofluorobenzene	*98.2*			*80.0-120*
(S) a,a,a-Trifluorotoluene	*106*			*80.0-120*

Laboratory Control Sample (LCS)

(LCS) R3262256-1 10/27/17 14:38

Analyte	Spike Amount ug/l	LCS Result ug/l	LCS Rec. %	Rec. Limits %	LCS Qualifier
Benzene	25.0	21.5	86.1	69.0-123	
Ethylbenzene	25.0	24.9	99.6	77.0-120	
Toluene	25.0	24.6	98.5	77.0-120	
Xylenes, Total	75.0	74.3	99.1	77.0-120	
(S) Toluene-d8			*103*	*80.0-120*	
(S) Dibromofluoromethane			*92.7*	*76.0-123*	
(S) 4-Bromofluorobenzene			*97.4*	*80.0-120*	
(S) a,a,a-Trifluorotoluene			*104*	*80.0-120*	

Method Blank (MB)

(MB) R3262116-3 11/01/17 11:07

Analyte	MB Result mg/kg	MB Qualifier	MB MDL mg/kg	MB RDL mg/kg
Benzene	U		0.00130	0.00250
Ethylbenzene	U		0.00129	0.00250
Toluene	U		0.00265	0.00500
Xylenes, Total	U		0.00125	0.00750
(S) Toluene-d8	*104*			*80.0-120*
(S) Dibromofluoromethane	*95.2*			*74.0-131*
(S) a,a,a-Trifluorotoluene	*100*			*80.0-120*
(S) 4-Bromofluorobenzene	*99.6*			*64.0-132*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3262116-1 11/01/17 09:52 • (LCSD) R3262116-2 11/01/17 10:11

Analyte	Spike Amount mg/kg	LCS Result mg/kg	LCSD Result mg/kg	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Benzene	0.625	0.613	0.587	98.1	93.9	72.6-120			4.39	20
Ethylbenzene	0.625	0.596	0.614	95.3	98.2	78.6-124			3.05	20
Toluene	0.625	0.586	0.608	93.8	97.3	76.7-116			3.62	20
Xylenes, Total	1.88	1.83	1.88	97.5	100	78.1-123			2.86	20
(S) Toluene-d8				*102*	*106*	*80.0-120*				
(S) Dibromofluoromethane				*105*	*98.0*	*74.0-131*				
(S) a,a,a-Trifluorotoluene				*102*	*102*	*80.0-120*				
(S) 4-Bromofluorobenzene				*98.7*	*98.4*	*64.0-132*				

L946651-04 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L946651-04 11/01/17 15:45 • (MS) R3262116-4 11/01/17 18:52 • (MSD) R3262116-5 11/01/17 19:11

Analyte	Spike Amount (dry) mg/kg	Original Result (dry) mg/kg	MS Result (dry) mg/kg	MSD Result (dry) mg/kg	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Benzene	0.759	ND	0.397	0.544	52.3	71.6	1	47.8-131		J3	31.1	22.8
Ethylbenzene	0.759	ND	0.440	0.575	58.0	75.8	1	44.8-135			26.5	26.9
Toluene	0.759	ND	0.442	0.574	58.2	75.6	1	47.8-127		J3	26.0	24.3
Xylenes, Total	2.28	ND	1.37	1.74	59.9	76.3	1	42.7-135			24.0	26.6
(S) Toluene-d8					*105*	*106*		*80.0-120*				
(S) Dibromofluoromethane					*92.1*	*92.6*		*74.0-131*				
(S) a,a,a-Trifluorotoluene					*104*	*103*		*80.0-120*				
(S) 4-Bromofluorobenzene					*101*	*101*		*64.0-132*				

Method Blank (MB)

(MB) R3261738-1 10/30/17 13:33

Analyte	MB Result	MB Qualifier	MB MDL	MB RDL
	ug/l		ug/l	ug/l
Diesel Range Organics (DRO)	U		66.7	200
Residual Range Organics (RRO)	U		83.3	250
(S) o-Terphenyl	*87.5*			*52.0-156*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3261738-2 10/30/17 13:51 • (LCSD) R3261738-3 10/30/17 14:08

Analyte	Spike Amount	LCS Result	LCSD Result	LCS Rec.	LCSD Rec.	Rec. Limits	LCS Qualifier	LCSD Qualifier	RPD	RPD Limits
	ug/l	ug/l	ug/l	%	%	%			%	%
Diesel Range Organics (DRO)	750	775	849	103	113	50.0-150			9.10	20
Residual Range Organics (RRO)	750	706	847	94.2	113	50.0-150			18.1	20
(S) o-Terphenyl				*84.9*	*90.7*	*52.0-156*				

Method Blank (MB)

(MB) R3263425-1 11/02/17 17:53

Analyte	MB Result ug/l	MB Qualifier	MB MDL ug/l	MB RDL ug/l
Diesel Range Organics (DRO)	U		66.7	200
Residual Range Organics (RRO)	U		83.3	250
(S) o-Terphenyl	*81.4*			*52.0-156*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3263425-2 11/02/17 18:09 • (LCSD) R3263425-3 11/02/17 18:25

Analyte	Spike Amount ug/l	LCS Result ug/l	LCSD Result ug/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Diesel Range Organics (DRO)	750	733	705	97.8	94.0	50.0-150			3.91	20
Residual Range Organics (RRO)	750	785	777	105	104	50.0-150			1.03	20
(S) o-Terphenyl				*81.6*	*82.6*	*52.0-156*				

Method Blank (MB)

(MB) R3262687-1 11/02/17 17:35

Analyte	MB Result mg/kg	MB Qualifier	MB MDL mg/kg	MB RDL mg/kg
Diesel Range Organics (DRO)	U		1.33	4.00
Residual Range Organics (RRO)	U		3.33	10.0
(S) o-Terphenyl	*51.6*			*18.0-148*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3262687-2 11/02/17 17:52 • (LCSD) R3262687-3 11/02/17 18:09

Analyte	Spike Amount mg/kg	LCS Result mg/kg	LCSD Result mg/kg	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Diesel Range Organics (DRO)	30.0	19.1	20.5	63.5	68.4	50.0-150			7.40	20
Residual Range Organics (RRO)	30.0	17.3	17.8	57.7	59.2	50.0-150			2.61	20
(S) o-Terphenyl				*66.5*	*72.5*	*18.0-148*				

L946611-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L946611-01 11/03/17 20:21 • (MS) R3262971-1 11/03/17 20:38 • (MSD) R3262971-2 11/03/17 20:55

Analyte	Spike Amount (dry) mg/kg	Original Result (dry) mg/kg	MS Result (dry) mg/kg	MSD Result (dry) mg/kg	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Diesel Range Organics (DRO)	38.0	3.93	18.5	26.3	38.4	58.7	1	50.0-150	J6	J3	34.5	20
Residual Range Organics (RRO)	38.0	51.2	60.1	79.5	23.5	74.3	1	50.0-150	J6	J3	27.7	20
(S) o-Terphenyl					*39.3*	*50.3*		*18.0-148*				

Guide to Reading and Understanding Your Laboratory Report

The information below is designed to better explain the various terms used in your report of analytical results from the Laboratory. This is not intended as a comprehensive explanation, and if you have additional questions please contact your project representative.

Abbreviations and Definitions

(dry)	Results are reported based on the dry weight of the sample. [this will only be present on a dry report basis for soils].
MDL	Method Detection Limit.
MDL (dry)	Method Detection Limit.
RDL	Reported Detection Limit.
RDL (dry)	Reported Detection Limit.
Rec.	Recovery.
RPD	Relative Percent Difference.
SDG	Sample Delivery Group.
(S)	Surrogate (Surrogate Standard) - Analytes added to every blank, sample, Laboratory Control Sample/Duplicate and Matrix Spike/Duplicate; used to evaluate analytical efficiency by measuring recovery. Surrogates are not expected to be detected in all environmental media.
U	Not detected at the Reporting Limit (or MDL where applicable).
Analyte	The name of the particular compound or analysis performed. Some Analyses and Methods will have multiple analytes reported.
Dilution	If the sample matrix contains an interfering material, or if concentrations of analytes in the sample are higher than the highest limit of concentration that the laboratory can accurately report, the sample may be diluted for analysis. If a value different than 1 is used in this field, the result reported has already been corrected for this factor.
Limits	These are the target % recovery ranges or % difference value that the laboratory has historically determined as normal for the method and analyte being reported. Successful QC Sample analysis will target all analytes recovered or duplicated within these ranges.
Original Sample	The non-spiked sample in the prep batch used to determine the Relative Percent Difference (RPD) from a quality control sample. The Original Sample may not be included within the reported SDG.
Qualifier	This column provides a letter and/or number designation that corresponds to additional information concerning the result reported. If a Qualifier is present, a definition per Qualifier is provided within the Glossary and Definitions page and potentially a discussion of possible implications of the Qualifier in the Case Narrative if applicable.
Result	The actual analytical final result (corrected for any sample specific characteristics) reported for your sample. If there was no measurable result returned for a specific analyte, the result in this column may state “ND” (Not Detected) or “BDL” (Below Detectable Levels). The information in the results column should always be accompanied by either an MDL (Method Detection Limit) or RDL (Reporting Detection Limit) that defines the lowest value that the laboratory could detect or report for this analyte.
Case Narrative (Cn)	A brief discussion about the included sample results, including a discussion of any non-conformances to protocol observed either at sample receipt by the laboratory from the field or during the analytical process. If present, there will be a section in the Case Narrative to discuss the meaning of any data qualifiers used in the report.
Quality Control Summary (Qc)	This section of the report includes the results of the laboratory quality control analyses required by procedure or analytical methods to assist in evaluating the validity of the results reported for your samples. These analyses are not being performed on your samples typically, but on laboratory generated material.
Sample Chain of Custody (Sc)	This is the document created in the field when your samples were initially collected. This is used to verify the time and date of collection, the person collecting the samples, and the analyses that the laboratory is requested to perform. This chain of custody also documents all persons (excluding commercial shippers) that have had control or possession of the samples from the time of collection until delivery to the laboratory for analysis.
Sample Results (Sr)	This section of your report will provide the results of all testing performed on your samples. These results are provided by sample ID and are separated by the analyses performed on each sample. The header line of each analysis section for each sample will provide the name and method number for the analysis reported.
Sample Summary (Ss)	This section of the Analytical Report defines the specific analyses performed for each sample ID, including the dates and times of preparation and/or analysis.

Qualifier	Description
B	The same analyte is found in the associated blank.
E	The analyte concentration exceeds the upper limit of the calibration range of the instrument established by the initial calibration (ICAL).
J	The identification of the analyte is acceptable; the reported value is an estimate.
J1	Surrogate recovery limits have been exceeded; values are outside upper control limits.
J2	Surrogate recovery limits have been exceeded; values are outside lower control limits.
J3	The associated batch QC was outside the established quality control range for precision.
J6	The sample matrix interfered with the ability to make any accurate determination; spike value is low.

ESC Lab Sciences is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our one location design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be YOUR LAB OF CHOICE.
* Not all certifications held by the laboratory are applicable to the results reported in the attached report.

State Accreditations

Alabama	40660	Nevada	TN-03-2002-34
Alaska	UST-080	New Hampshire	2975
Arizona	AZ0612	New Jersey–NELAP	TN002
Arkansas	88-0469	New Mexico	TN00003
California	01157CA	New York	11742
Colorado	TN00003	North Carolina	Env375
Connecticut	PH-0197	North Carolina [1]	DW21704
Florida	E87487	North Carolina [2]	41
Georgia	NELAP	North Dakota	R-140
Georgia [1]	923	Ohio–VAP	CL0069
Idaho	TN00003	Oklahoma	9915
Illinois	200008	Oregon	TN200002
Indiana	C-TN-01	Pennsylvania	68-02979
Iowa	364	Rhode Island	221
Kansas	E-10277	South Carolina	84004
Kentucky [1]	90010	South Dakota	n/a
Kentucky [2]	16	Tennessee [1 4]	2006
Louisiana	AI30792	Texas	T 104704245-07-TX
Maine	TN0002	Texas [5]	LAB0152
Maryland	324	Utah	6157585858
Massachusetts	M-TN003	Vermont	VT2006
Michigan	9958	Virginia	109
Minnesota	047-999-395	Washington	C1915
Mississippi	TN00003	West Virginia	233
Missouri	340	Wisconsin	9980939910
Montana	CERT0086	Wyoming	A2LA
Nebraska	NE-OS-15-05		

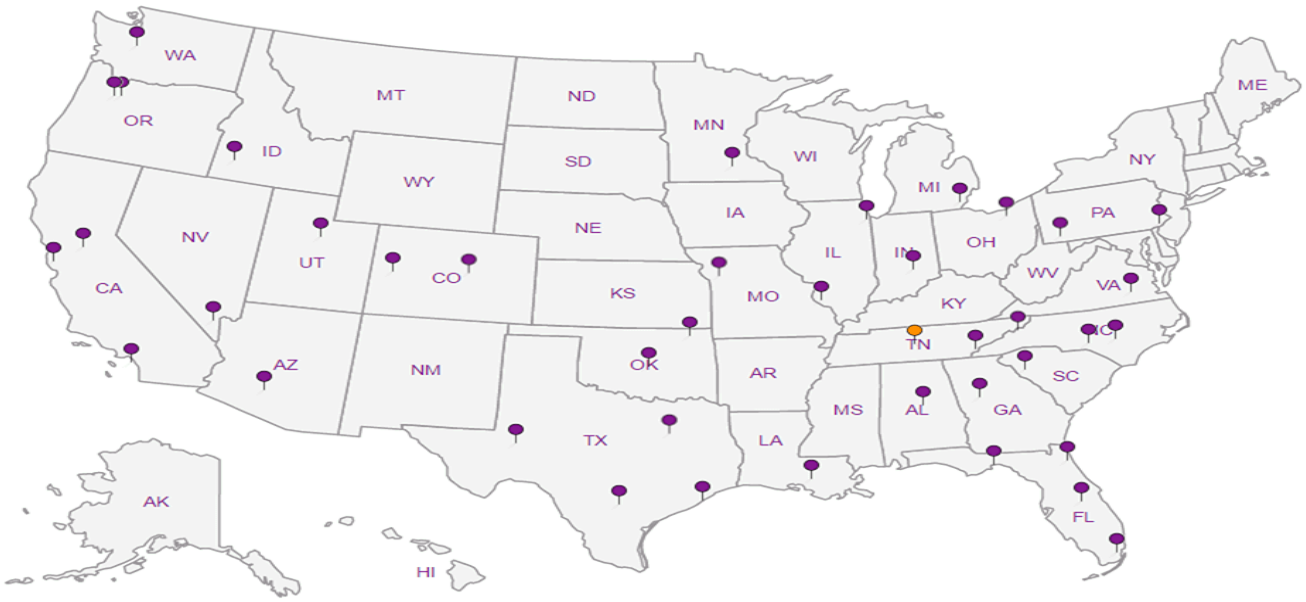
Third Party Federal Accreditations

A2LA – ISO 17025	1461.01	AIHA-LAP,LLC	100789
A2LA – ISO 17025 [5]	1461.02	DOD	1461.01
Canada	1461.01	USDA	S-67674
EPA–Crypto	TN00003		

[1] Drinking Water [2] Underground Storage Tanks [3] Aquatic Toxicity [4] Chemical/Microbiological [5] Mold n/a Accreditation not applicable

Our Locations

ESC Lab Sciences has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. ESC Lab Sciences performs all testing at our central laboratory.



Cascadia Associates- Portland, OR

6915 SW Macadam Ave
Ste. 250
Portland, OR 97219

Billing Information:
Accounts Payable- Chris Breemer
6915 SW Macadam Ave
Ste. 250
Portland, OR 97219

Pres Chk

Report to: Ian Maguire

Email To: imaguire@cascadiaassociates.com

Project Description: Nustar- Vannex Pilot Study

City/State Collected: Vancouver, WA

Phone: 503-906-6577
Fax:

Client Project # 0060-001-001

Lab Project # CASASCTOR-NUVANCOUVE

Collected by (print): Ian Maguire

Site/Facility ID # VANCOUVER, WA

P.O. # ~~0060-001-001~~

Collected by (signature): Ian Maguire
Immediately Packed on Ice N ___ Y X

Rush? (Lab MUST Be Notified)
___ Same Day ___ Five Day
___ Next Day ___ 5 Day (Rad Only)
___ Two Day ___ 10 Day (Rad Only)
___ Three Day

Date Results Needed

Quote #

Sample ID	Comp/Grab	Matrix *	Depth	Date	Time	No. of Cntrs	NWTPHDXLVI (w/ SGT) 40mlAmb-HCl-BT	NWTPHGX 40mlAmb HCl	V8260BTEXC 40mlAmb-HCl	NWTPH-GX	NWTPH-DX	BTEX (8260)	SPLP *			Remarks	Sample # (lab only)
MW-5	Grab	GW	NA	10/23/17	1300	8	X	X	X								-01
MW-5D	Grab	GW	NA	10/24/17	945	8	X	X	X								-02
MW-6	Grab	GW	NA	10/24/17	1135	8	X	X	X								-03
MW-6 DUP	Grab	GW	NA	10/24/17	1135	8	H	H	H								
~~———~~		~~GW~~															
HA-1	Grab	Soil	6'	10/24/17	1530	8				X	X	X	X				-04/05

Analysis / Container / Preservative

Chain of Custody Page ___ of ___

ESC LAB SCIENCES
12065 Lebanon Rd
Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
Fax: 615-758-5859

L# L946549

Table E124

Acctnum: CASASCTOR
Template: T128931
Prelogin: P622609
TSR: 110 - Brian Ford
PB:
Shipped Via:

* Matrix:
SS - Soil AIR - Air F - Filter
GW - Groundwater B - Bioassay
WW - WasteWater
DW - Drinking Water
OT - Other

Remarks: * Contact Ian for specific metals.

pH ___ Temp ___
Flow ___ Other ___

Samples returned via:
__ UPS _/ FedEx __ Courier __ ___

Tracking # 7400 1463 3873

Sample Receipt Checklist
COC Seal Present/Intact: NP Y N
COC Signed/Accurate: Y N
Bottles arrive intact: Y N
Correct bottles used: Y N
Sufficient volume sent: Y N
If Applicable
VOA Zero Headspace: Y N
Preservation Correct/Checked: Y N

Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)
[signature]	10/25/17	1205	[signature] ESCLon
[signature] ESCLon	10/25/17	1230	
			Received for lab by: (Signature) [signature] 860

Trip Blank Received: Yes / No
HCL / MeoH
TBR

Temp: 0.4 °C Bottles Received: 40

Date: 10/26/17 Time: 8:45

If preservation required by Login: Date/Time

10-145

Condition: NCF / OK

ANALYTICAL REPORT

November 14, 2017

Cascadia Associates- Portland, OR

Sample Delivery Group:	L948749
Samples Received:	10/28/2017
Project Number:	0060-001-001
Description:	Nustar - Vannex Pilot Study
Site:	VANCOUVER, WA
Report To:	Ian Maguire 6915 SW Macadam Ave Ste. 250 Portland, OR 97219

Entire Report Reviewed By:

Brian Ford

Technical Service Representative

Results relate only to the items tested or calibrated and are reported as rounded values. This test report shall not be reproduced, except in full, without written approval of the laboratory. Where applicable, sampling conducted by ESC is performed per guidance provided in laboratory standard operating procedures: 060302, 060303, and 060304.

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MW-6 DUP L948749-01 GW

Collected by	Collected date/time	Received date/time
Ian Maguire	10/24/17 11:35	10/28/17 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Volatile Organic Compounds (GC) by Method NWTPHGX	WG1040147	1	11/07/17 19:15	11/07/17 19:15	BMB
Volatile Organic Compounds (GC/MS) by Method 8260C	WG1039917	1	11/07/17 14:00	11/07/17 14:00	ACG
Volatile Organic Compounds (GC/MS) by Method 8260C	WG1039917	50	11/07/17 15:19	11/07/17 15:19	ACG
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1039652	1	11/07/17 17:09	11/08/17 14:39	LM
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1039652	5	11/07/17 17:09	11/08/17 19:47	LM

All sample aliquots were received at the correct temperature, in the proper containers, with the appropriate preservatives, and within method specified holding times. All MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All radiochemical sample results for solids are reported on a dry weight basis with the exception of tritium, carbon-14 and radon, unless wet weight was requested by the client. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.

Brian Ford
Technical Service Representative

Volatile Organic Compounds (GC) by Method NWTPHGX

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Gasoline Range Organics-NWTPH	4190		31.6	100	1	11/07/2017 19:15	WG1040147
(S) a,a,a-Trifluorotoluene(FID)	*82.2*			*77.0-122*		*11/07/2017 19:15*	WG1040147

Volatile Organic Compounds (GC/MS) by Method 8260C

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Benzene	153		16.6	50.0	50	11/07/2017 15:19	WG1039917
Toluene	46.2		0.412	1.00	1	11/07/2017 14:00	WG1039917
Ethylbenzene	1180		19.2	50.0	50	11/07/2017 15:19	WG1039917
Total Xylenes	1040		53.0	150	50	11/07/2017 15:19	WG1039917
(S) Toluene-d8	*102*			*80.0-120*		*11/07/2017 14:00*	WG1039917
(S) Toluene-d8	*111*			*80.0-120*		*11/07/2017 15:19*	WG1039917
(S) Dibromofluoromethane	*103*			*76.0-123*		*11/07/2017 15:19*	WG1039917
(S) Dibromofluoromethane	*105*			*76.0-123*		*11/07/2017 14:00*	WG1039917
(S) a,a,a-Trifluorotoluene	*101*			*80.0-120*		*11/07/2017 14:00*	WG1039917
(S) a,a,a-Trifluorotoluene	*107*			*80.0-120*		*11/07/2017 15:19*	WG1039917
(S) 4-Bromofluorobenzene	*96.3*			*80.0-120*		*11/07/2017 15:19*	WG1039917
(S) 4-Bromofluorobenzene	*91.1*			*80.0-120*		*11/07/2017 14:00*	WG1039917

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Diesel Range Organics (DRO)	8960	Q	330	1000	5	11/08/2017 19:47	WG1039652
Residual Range Organics (RRO)	1190	Q	82.5	250	1	11/08/2017 14:39	WG1039652
(S) o-Terphenyl	*71.0*			*52.0-156*		*11/08/2017 19:47*	WG1039652
(S) o-Terphenyl	*112*			*52.0-156*		*11/08/2017 14:39*	WG1039652

Method Blank (MB)

(MB) R3263837-3 11/07/17 17:37

Analyte	MB Result ug/l	MB Qualifier	MB MDL ug/l	MB RDL ug/l
Gasoline Range Organics-NWTPH	U		31.6	100
(S) a,a,a-Trifluorotoluene(FID)	*95.9*			*77.0-122*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3263837-1 11/07/17 16:30 • (LCSD) R3263837-2 11/07/17 16:52

Analyte	Spike Amount ug/l	LCS Result ug/l	LCSD Result ug/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Gasoline Range Organics-NWTPH	5500	4370	4300	79.5	78.2	72.0-134			1.61	20
(S) a,a,a-Trifluorotoluene(FID)				*97.7*	*102*	*77.0-122*				

L948847-14 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L948847-14 11/08/17 11:56 • (MS) R3263837-4 11/08/17 12:18 • (MSD) R3263837-5 11/08/17 12:41

Analyte	Spike Amount ug/l	Original Result ug/l	MS Result ug/l	MSD Result ug/l	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Gasoline Range Organics-NWTPH	5500	U	2090	2010	38.1	36.6	1	23.0-159			3.97	20
(S) a,a,a-Trifluorotoluene(FID)					*97.1*	*96.6*		*77.0-122*				

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

Method Blank (MB)

(MB) R3263749-3 11/07/17 10:29

Analyte	MB Result	MB Qualifier	MB MDL	MB RDL
	ug/l		ug/l	ug/l
Benzene	U		0.331	1.00
Ethylbenzene	U		0.384	1.00
Toluene	U		0.412	1.00
Xylenes, Total	U		1.06	3.00
(S) Toluene-d8	*108*			*80.0-120*
(S) Dibromofluoromethane	*100*			*76.0-123*
(S) a,a,a-Trifluorotoluene	*111*			*80.0-120*
(S) 4-Bromofluorobenzene	*99.7*			*80.0-120*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3263749-1 11/07/17 09:30 • (LCSD) R3263749-2 11/07/17 09:49

Analyte	Spike Amount	LCS Result	LCSD Result	LCS Rec.	LCSD Rec.	Rec. Limits	LCS Qualifier	LCSD Qualifier	RPD	RPD Limits
	ug/l	ug/l	ug/l	%	%	%			%	%
Benzene	25.0	23.9	24.4	95.4	97.5	69.0-123			2.16	20
Ethylbenzene	25.0	25.1	25.2	101	101	77.0-120			0.100	20
Toluene	25.0	23.1	23.4	92.4	93.6	77.0-120			1.20	20
Xylenes, Total	75.0	79.9	78.3	107	104	77.0-120			2.02	20
(S) Toluene-d8				*104*	*104*	*80.0-120*				
(S) Dibromofluoromethane				*106*	*105*	*76.0-123*				
(S) a,a,a-Trifluorotoluene				*110*	*107*	*80.0-120*				
(S) 4-Bromofluorobenzene				*96.2*	*99.7*	*80.0-120*				

Method Blank (MB)

(MB) R3264068-1 11/08/17 11:08

Analyte	MB Result	MB Qualifier	MB MDL	MB RDL
	ug/l		ug/l	ug/l
Diesel Range Organics (DRO)	U		66.7	200
Residual Range Organics (RRO)	U		83.3	250
(S) o-Terphenyl	*73.6*			*52.0-156*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3264068-2 11/08/17 11:24 • (LCSD) R3264068-3 11/08/17 11:40

Analyte	Spike Amount	LCS Result	LCSD Result	LCS Rec.	LCSD Rec.	Rec. Limits	LCS Qualifier	LCSD Qualifier	RPD	RPD Limits
	ug/l	ug/l	ug/l	%	%	%			%	%
Diesel Range Organics (DRO)	750	796	811	106	108	50.0-150			1.90	20
Residual Range Organics (RRO)	750	757	762	101	102	50.0-150			0.570	20
(S) o-Terphenyl				*76.6*	*74.1*	*52.0-156*				

Guide to Reading and Understanding Your Laboratory Report

The information below is designed to better explain the various terms used in your report of analytical results from the Laboratory. This is not intended as a comprehensive explanation, and if you have additional questions please contact your project representative.

Abbreviations and Definitions

MDL	Method Detection Limit.
RDL	Reported Detection Limit.
Rec.	Recovery.
RPD	Relative Percent Difference.
SDG	Sample Delivery Group.
(S)	Surrogate (Surrogate Standard) - Analytes added to every blank, sample, Laboratory Control Sample/Duplicate and Matrix Spike/Duplicate; used to evaluate analytical efficiency by measuring recovery. Surrogates are not expected to be detected in all environmental media.
U	Not detected at the Reporting Limit (or MDL where applicable).
Analyte	The name of the particular compound or analysis performed. Some Analyses and Methods will have multiple analytes reported.
Dilution	If the sample matrix contains an interfering material, or if concentrations of analytes in the sample are higher than the highest limit of concentration that the laboratory can accurately report, the sample may be diluted for analysis. If a value different than 1 is used in this field, the result reported has already been corrected for this factor.
Limits	These are the target % recovery ranges or % difference value that the laboratory has historically determined as normal for the method and analyte being reported. Successful QC Sample analysis will target all analytes recovered or duplicated within these ranges.
Original Sample	The non-spiked sample in the prep batch used to determine the Relative Percent Difference (RPD) from a quality control sample. The Original Sample may not be included within the reported SDG.
Qualifier	This column provides a letter and/or number designation that corresponds to additional information concerning the result reported. If a Qualifier is present, a definition per Qualifier is provided within the Glossary and Definitions page and potentially a discussion of possible implications of the Qualifier in the Case Narrative if applicable.
Result	The actual analytical final result (corrected for any sample specific characteristics) reported for your sample. If there was no measurable result returned for a specific analyte, the result in this column may state “ND” (Not Detected) or “BDL” (Below Detectable Levels). The information in the results column should always be accompanied by either an MDL (Method Detection Limit) or RDL (Reporting Detection Limit) that defines the lowest value that the laboratory could detect or report for this analyte.
Case Narrative (Cn)	A brief discussion about the included sample results, including a discussion of any non-conformances to protocol observed either at sample receipt by the laboratory from the field or during the analytical process. If present, there will be a section in the Case Narrative to discuss the meaning of any data qualifiers used in the report.
Quality Control Summary (Qc)	This section of the report includes the results of the laboratory quality control analyses required by procedure or analytical methods to assist in evaluating the validity of the results reported for your samples. These analyses are not being performed on your samples typically, but on laboratory generated material.
Sample Chain of Custody (Sc)	This is the document created in the field when your samples were initially collected. This is used to verify the time and date of collection, the person collecting the samples, and the analyses that the laboratory is requested to perform. This chain of custody also documents all persons (excluding commercial shippers) that have had control or possession of the samples from the time of collection until delivery to the laboratory for analysis.
Sample Results (Sr)	This section of your report will provide the results of all testing performed on your samples. These results are provided by sample ID and are separated by the analyses performed on each sample. The header line of each analysis section for each sample will provide the name and method number for the analysis reported.
Sample Summary (Ss)	This section of the Analytical Report defines the specific analyses performed for each sample ID, including the dates and times of preparation and/or analysis.

Qualifier	Description
Q	Sample was prepared and/or analyzed past recommended holding time. Concentrations should be considered minimum values.

ESC Lab Sciences is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our "one location" design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be **YOUR LAB OF CHOICE.**
***** Not all certifications held by the laboratory are applicable to the results reported in the attached report.

State Accreditations

Alabama	40660	Nevada	TN-03-2002-34
Alaska	UST-080	New Hampshire	2975
Arizona	AZ0612	New Jersey–NELAP	TN002
Arkansas	88-0469	New Mexico	TN00003
California	01157CA	New York	11742
Colorado	TN00003	North Carolina	Env375
Conneticut	PH-0197	North Carolina [1]	DW21704
Florida	E87487	North Carolina [2]	41
Georgia	NELAP	North Dakota	R-140
Georgia [1]	923	Ohio–VAP	CL0069
Idaho	TN00003	Oklahoma	9915
Illinois	200008	Oregon	TN200002
Indiana	C-TN-01	Pennsylvania	68-02979
Iowa	364	Rhode Island	221
Kansas	E-10277	South Carolina	84004
Kentucky [1]	90010	South Dakota	n/a
Kentucky [2]	16	Tennessee [1 4]	2006
Louisiana	AI30792	Texas	T 104704245-07-TX
Maine	TN0002	Texas [5]	LAB0152
Maryland	324	Utah	6157585858
Massachusetts	M-TN003	Vermont	VT2006
Michigan	9958	Virginia	109
Minnesota	047-999-395	Washington	C1915
Mississippi	TN00003	West Virginia	233
Missouri	340	Wisconsin	9980939910
Montana	CERT0086	Wyoming	A2LA
Nebraska	NE-OS-15-05		

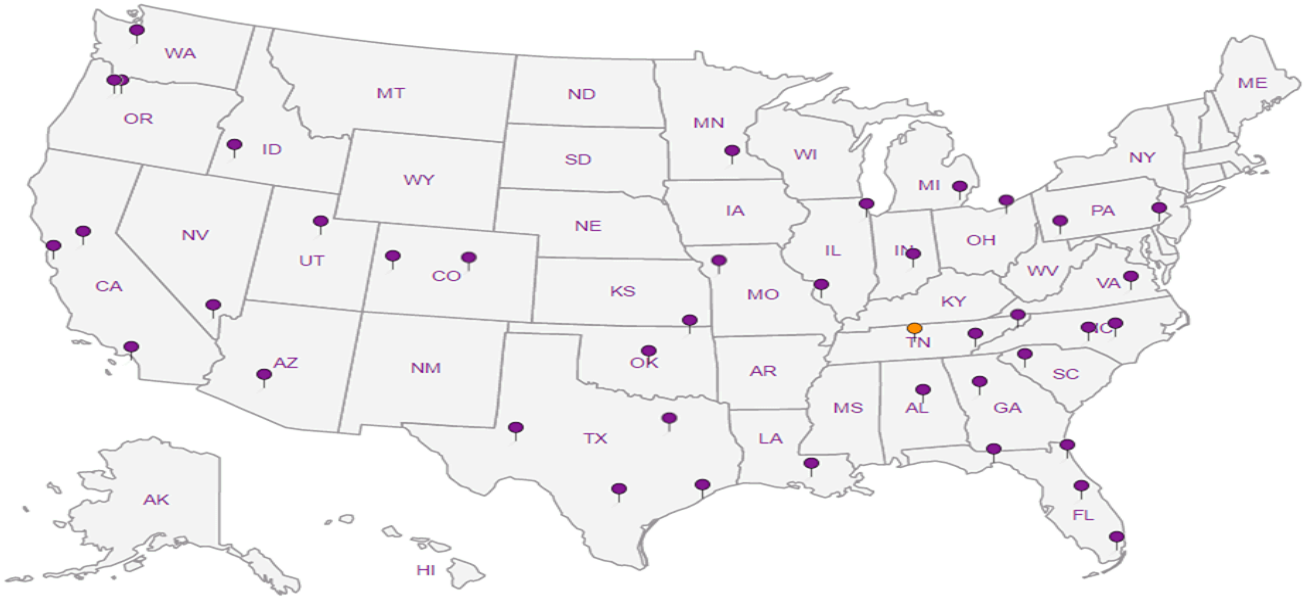
Third Party & Federal Accreditations

A2LA – ISO 17025	1461.01	AIHA-LAP,LLC	100789
A2LA – ISO 17025 [5]	1461.02	DOD	1461.01
Canada	1461.01	USDA	S-67674
EPA–Crypto	TN00003		

[1] Drinking Water [2] Underground Storage Tanks [3] Aquatic Toxicity [4] Chemical/Microbiological [5] Mold [n/a] Accreditation not applicable

Our Locations

ESC Lab Sciences has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. **ESC Lab Sciences performs all testing at our central laboratory.**



Chain of Custody Page __ of __

ESC LAB SCIENCES

12065 Lebanon Rd, Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
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Cascadia Associates- Portland, OR

6915 SW Macadam Ave
Ste. 250
Portland, OR 97219

Billing information:
Accounts Payable- Chris Breemer
6915 SW Macadam Ave
Ste. 250
Portland, OR 97219

Email To: imaguire@cascadiaassociates.com

Report to: Ian Maguire

Project Description: Nustar- Vannex Pilot Study

City/State Collected: Vancouver, WA

Phone: 503-906-6577
Fax:

Client Project #: 0060-001-001

Lab Project #: CASASCTOR-NUVANCOUVE

Collected by (print): Ian Maguire

Site/Facility ID #: VANCOUVER, WA

P.O. #: ~~0060-001-001~~

Collected by (signature): [signature]

Rush? (Lab MUST Be Notified)
___ Same Day ___ Five Day
___ Next Day ___ 5 Day (Rad Only)
___ Two Day ___ 10 Day (Rad Only)
___ Three Day

Quote #

Date Results Needed

Immediately Packed on Ice N ___ Y X

L# ~~1946549~~

Table: E124 — 1948749 (N 11/7/17)

Acctnum: CASASCTOR
Template: T128931
Prelogin: P622609
TSR: 110 - Brian Ford
PB:
Shipped Via:

Analysis / Container / Preservative

Sample ID	Comp/Grab	Matrix *	Depth	Date	Time	No. of Cntrs	NWTPHDXLVI (w/ SGT) 40mlAmb-HCl-BT	NWTPHGX 40mlAmb HCl	V8260BTEXC 40mlAmb-HCl	NWTPH-Gx	NWTPH-Dx	BTEX (8260B)	SPLP *	Remarks	Sample # (lab only)
MW-5	Grab	GW	NA	10/23/17	1300	8	X	X	X						~~-01~~
MW-5D	Grab	GW	NA	10/24/17	945	8	X	X	X						~~-02~~
MW-6	Grab	GW	NA	10/24/17	1135	8	X	X	X						~~-03~~
MW-6 DUP	Grab	GW	NA	10/24/17	1135	8	H	H	H						-01
		~~GW~~													~~-04/-05~~
HA-1	Grab	Soil	6'	10/24/17	1530	8				X	X	X	X		

* Matrix:
SS - Soil AIR - Air F - Filter
GW - Groundwater B - Bioassay
WW - WasteWater
DW - Drinking Water
OT - Other ______

Remarks: * Contact Ian for specific metals.

pH ______ Temp ______
Flow ______ Other ______

Sample Receipt Checklist
COC Seal Present/Intact: NP Y N
COC Signed/Accurate: Y N
Bottles arrive intact: Y N
Correct bottles used: Y N
Sufficient volume sent: Y N
If Applicable
VOA Zero Headspace: Y N
Preservation Correct/Checked: Y N

Samples returned via: ___ UPS X FedEx ___ Courier ______

Tracking # 7480 1463 3873

Trip Blank Received: Yes / No
HCL / MeoH
TBR

Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)
[signature]	10/25/17	1205	[signature] ESCPon
[signature] ESCPon	10/25/17	1230	Received by: (Signature)
Relinquished by: (Signature)	Date:	Time:	Received for lab by: (Signature) [signature] 860

Temp: 6.4 °C ... Bottles Received: 40

Date: 10/26/17 Time: 8:45

10-145

If preservation required by Login: Date/Time

Condition: NCF / OK

Andy Vann

From: Brian Ford
Sent: Monday, November 06, 2017 3:03 PM
To: Login; Brian Ford
Subject: L946549 *CASASCTOR* log off hold

Please log MW-6 DUP off hold label 10-145 for NWTPHGX, V8260BTEXC, and NWTPHDXLVI. Log as R5 due 11/13.

Thanks,

Brian Ford
Technical Service Representative
ESC Lab Sciences-a subsidiary of Pace Analytical
12065 Lebanon Road | Mt. Juliet, TN 37122
615.773.9772
bford@esclabsciences.com | www.esclabsciences.com

ANALYTICAL REPORT

December 12, 2017

Cascadia Associates- Portland, OR

Sample Delivery Group:	L954460
Samples Received:	12/01/2017
Project Number:	006-001-001
Description:	Vannex GWM
Site:	VANCOUVER, WA
Report To:	Ian Maguire 6915 SW Macadam Ave Ste. 250 Portland, OR 97219

Entire Report Reviewed By:

Brian Ford

Technical Service Representative

Results relate only to the items tested or calibrated and are reported as rounded values. This test report shall not be reproduced, except in full, without written approval of the laboratory. Where applicable, sampling conducted by ESC is performed per guidance provided in laboratory standard operating procedures: 060302, 060303, and 060304.

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MW-6 L954460-01 GW

Collected by: Joel Mattecheck | Collected date/time: 11/30/17 11:45 | Received date/time: 12/01/17 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Volatile Organic Compounds (GC) by Method NWTPHGX	WG1049399	10	12/06/17 12:22	12/06/17 12:22	DWR
Volatile Organic Compounds (GC/MS) by Method 8260C	WG1048800	50	12/03/17 02:12	12/03/17 02:12	BMB
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1049374	1	12/06/17 22:35	12/07/17 21:02	LM
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1049374	5	12/06/17 22:35	12/11/17 14:12	LM

MW-5 L954460-02 GW

Collected by: Joel Mattecheck | Collected date/time: 11/30/17 10:55 | Received date/time: 12/01/17 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Volatile Organic Compounds (GC) by Method NWTPHGX	WG1049399	10	12/06/17 12:46	12/06/17 12:46	DWR
Volatile Organic Compounds (GC/MS) by Method 8260C	WG1048800	25	12/03/17 02:28	12/03/17 02:28	BMB
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1049374	1	12/06/17 22:35	12/07/17 21:18	LM

MW-5D L954460-03 GW

Collected by: Joel Mattecheck | Collected date/time: 11/30/17 10:10 | Received date/time: 12/01/17 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Volatile Organic Compounds (GC) by Method NWTPHGX	WG1049399	1	12/04/17 23:06	12/04/17 23:06	LRL
Volatile Organic Compounds (GC/MS) by Method 8260C	WG1048800	1	12/03/17 02:45	12/03/17 02:45	BMB
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1049374	1	12/06/17 22:35	12/07/17 21:34	LM

MW-5 DUP L954460-04 GW

Collected by: Joel Mattecheck | Collected date/time: 11/30/17 10:55 | Received date/time: 12/01/17 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Volatile Organic Compounds (GC) by Method NWTPHGX	WG1049399	1	12/04/17 23:30	12/04/17 23:30	LRL
Volatile Organic Compounds (GC/MS) by Method 8260C	WG1048800	1	12/03/17 03:02	12/03/17 03:02	BMB
Volatile Organic Compounds (GC/MS) by Method 8260C	WG1048800	25	12/05/17 23:14	12/05/17 23:14	LRL
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1049374	1	12/06/17 22:35	12/07/17 21:50	LM

All sample aliquots were received at the correct temperature, in the proper containers, with the appropriate preservatives, and within method specified holding times, unless qualified or notated within the report. All MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All radiochemical sample results for solids are reported on a dry weight basis with the exception of tritium, carbon-14 and radon, unless wet weight was requested by the client. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.

Brian Ford
Technical Service Representative

Volatile Organic Compounds (GC) by Method NWTPHGX

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Gasoline Range Organics-NWTPH	9420		316	1000	10	12/06/2017 12:22	WG1049399
(S) a,a,a-Trifluorotoluene(FID)	*95.6*			*77.0-122*		*12/06/2017 12:22*	WG1049399

Volatile Organic Compounds (GC/MS) by Method 8260C

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Benzene	223		16.6	50.0	50	12/03/2017 02:12	WG1048800
Toluene	53.1		20.6	50.0	50	12/03/2017 02:12	WG1048800
Ethylbenzene	1710		19.2	50.0	50	12/03/2017 02:12	WG1048800
Total Xylenes	1120		53.0	150	50	12/03/2017 02:12	WG1048800
(S) Toluene-d8	*107*			*80.0-120*		*12/03/2017 02:12*	WG1048800
(S) Dibromofluoromethane	*88.9*			*76.0-123*		*12/03/2017 02:12*	WG1048800
(S) a,a,a-Trifluorotoluene	*105*			*80.0-120*		*12/03/2017 02:12*	WG1048800
(S) 4-Bromofluorobenzene	*97.3*			*80.0-120*		*12/03/2017 02:12*	WG1048800

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Diesel Range Organics (DRO)	7440		330	1000	5	12/11/2017 14:12	WG1049374
Residual Range Organics (RRO)	686		82.5	250	1	12/07/2017 21:02	WG1049374
(S) o-Terphenyl	*120*			*52.0-156*		*12/07/2017 21:02*	WG1049374
(S) o-Terphenyl	*103*			*52.0-156*		*12/11/2017 14:12*	WG1049374

Volatile Organic Compounds (GC) by Method NWTPHGX

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Gasoline Range Organics-NWTPH	11300		316	1000	10	12/06/2017 12:46	WG1049399
(S) a,a,a-Trifluorotoluene(FID)	*95.0*			*77.0-122*		*12/06/2017 12:46*	WG1049399

Volatile Organic Compounds (GC/MS) by Method 8260C

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Benzene	U		8.28	25.0	25	12/03/2017 02:28	WG1048800
Toluene	U		10.3	25.0	25	12/03/2017 02:28	WG1048800
Ethylbenzene	187		9.60	25.0	25	12/03/2017 02:28	WG1048800
Total Xylenes	1210		26.5	75.0	25	12/03/2017 02:28	WG1048800
(S) Toluene-d8	*106*			*80.0-120*		*12/03/2017 02:28*	WG1048800
(S) Dibromofluoromethane	*87.9*			*76.0-123*		*12/03/2017 02:28*	WG1048800
(S) a,a,a-Trifluorotoluene	*105*			*80.0-120*		*12/03/2017 02:28*	WG1048800
(S) 4-Bromofluorobenzene	*97.0*			*80.0-120*		*12/03/2017 02:28*	WG1048800

Sample Narrative:

L954460-02 WG1048800: Target and non-target analytes too high to re-analyze at a lower dilution.

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Diesel Range Organics (DRO)	1630		66.0	200	1	12/07/2017 21:18	WG1049374
Residual Range Organics (RRO)	U		82.5	250	1	12/07/2017 21:18	WG1049374
(S) o-Terphenyl	*91.4*			*52.0-156*		*12/07/2017 21:18*	WG1049374

Volatile Organic Compounds (GC) by Method NWTPHGX

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Gasoline Range Organics-NWTPH	411		31.6	100	1	12/04/2017 23:06	WG1049399
(S) a,a,a-Trifluorotoluene(FID)	*104*			*77.0-122*		*12/04/2017 23:06*	WG1049399

Volatile Organic Compounds (GC/MS) by Method 8260C

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Benzene	U		0.331	1.00	1	12/03/2017 02:45	WG1048800
Toluene	U		0.412	1.00	1	12/03/2017 02:45	WG1048800
Ethylbenzene	U		0.384	1.00	1	12/03/2017 02:45	WG1048800
Total Xylenes	U		1.06	3.00	1	12/03/2017 02:45	WG1048800
(S) Toluene-d8	*105*			*80.0-120*		*12/03/2017 02:45*	WG1048800
(S) Dibromofluoromethane	*88.9*			*76.0-123*		*12/03/2017 02:45*	WG1048800
(S) a,a,a-Trifluorotoluene	*105*			*80.0-120*		*12/03/2017 02:45*	WG1048800
(S) 4-Bromofluorobenzene	*98.5*			*80.0-120*		*12/03/2017 02:45*	WG1048800

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Diesel Range Organics (DRO)	494		66.0	200	1	12/07/2017 21:34	WG1049374
Residual Range Organics (RRO)	U		82.5	250	1	12/07/2017 21:34	WG1049374
(S) o-Terphenyl	*84.9*			*52.0-156*		*12/07/2017 21:34*	WG1049374

Volatile Organic Compounds (GC) by Method NWTPHGX

Analyte	Result ug/l	Qualifier	MDL ug/l	RDL ug/l	Dilution	Analysis date / time	Batch
Gasoline Range Organics-NWTPH	10900		31.6	100	1	12/04/2017 23:30	WG1049399
(S) a,a,a-Trifluorotoluene(FID)	*101*			*77.0-122*		*12/04/2017 23:30*	WG1049399

Volatile Organic Compounds (GC/MS) by Method 8260C

Analyte	Result ug/l	Qualifier	MDL ug/l	RDL ug/l	Dilution	Analysis date / time	Batch
Benzene	U		0.331	1.00	1	12/03/2017 03:02	WG1048800
Toluene	1.12		0.412	1.00	1	12/03/2017 03:02	WG1048800
Ethylbenzene	187		0.384	1.00	1	12/03/2017 03:02	WG1048800
Total Xylenes	1480		26.5	75.0	25	12/05/2017 23:14	WG1048800
(S) Toluene-d8	*100*			*80.0-120*		*12/05/2017 23:14*	WG1048800
(S) Toluene-d8	*99.2*			*80.0-120*		*12/03/2017 03:02*	WG1048800
(S) Dibromofluoromethane	*87.7*			*76.0-123*		*12/03/2017 03:02*	WG1048800
(S) Dibromofluoromethane	*96.1*			*76.0-123*		*12/05/2017 23:14*	WG1048800
(S) a,a,a-Trifluorotoluene	*103*			*80.0-120*		*12/05/2017 23:14*	WG1048800
(S) a,a,a-Trifluorotoluene	*109*			*80.0-120*		*12/03/2017 03:02*	WG1048800
(S) 4-Bromofluorobenzene	*93.9*			*80.0-120*		*12/03/2017 03:02*	WG1048800
(S) 4-Bromofluorobenzene	*99.0*			*80.0-120*		*12/05/2017 23:14*	WG1048800

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT

Analyte	Result ug/l	Qualifier	MDL ug/l	RDL ug/l	Dilution	Analysis date / time	Batch
Diesel Range Organics (DRO)	1750		66.0	200	1	12/07/2017 21:50	WG1049374
Residual Range Organics (RRO)	U		82.5	250	1	12/07/2017 21:50	WG1049374
(S) o-Terphenyl	*85.5*			*52.0-156*		*12/07/2017 21:50*	WG1049374

Method Blank (MB)

(MB) R3270407-3 12/04/17 11:11

Analyte	MB Result ug/l	MB Qualifier	MB MDL ug/l	MB RDL ug/l
Gasoline Range Organics-NWTPH	33.1	J	31.6	100
(S) a,a,a-Trifluorotoluene(FID)	*102*			*77.0-122*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3270407-1 12/04/17 09:59 • (LCSD) R3270407-2 12/04/17 10:23

Analyte	Spike Amount ug/l	LCS Result ug/l	LCSD Result ug/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Gasoline Range Organics-NWTPH	5500	5720	5870	104	107	72.0-134			2.58	20
(S) a,a,a-Trifluorotoluene(FID)				*108*	*108*	*77.0-122*				

L954576-05 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L954576-05 12/05/17 03:02 • (MS) R3270407-4 12/05/17 03:26 • (MSD) R3270407-5 12/05/17 03:50

Analyte	Spike Amount ug/l	Original Result ug/l	MS Result ug/l	MSD Result ug/l	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Gasoline Range Organics-NWTPH	5500	ND	2590	2670	46.3	47.9	1	23.0-159			3.15	20
(S) a,a,a-Trifluorotoluene(FID)					*101*	*101*		*77.0-122*				

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

Method Blank (MB)

(MB) R3270555-2 12/03/17 01:39

Analyte	MB Result ug/l	MB Qualifier	MB MDL ug/l	MB RDL ug/l
Benzene	U		0.331	1.00
Ethylbenzene	U		0.384	1.00
Toluene	U		0.412	1.00
Xylenes, Total	U		1.06	3.00
(S) Toluene-d8	*106*			*80.0-120*
(S) Dibromofluoromethane	*89.7*			*76.0-123*
(S) a,a,a-Trifluorotoluene	*105*			*80.0-120*
(S) 4-Bromofluorobenzene	*98.2*			*80.0-120*

Laboratory Control Sample (LCS)

(LCS) R3270555-1 12/03/17 01:05

Analyte	Spike Amount ug/l	LCS Result ug/l	LCS Rec. %	Rec. Limits %	LCS Qualifier
Benzene	25.0	23.4	93.5	69.0-123	
Ethylbenzene	25.0	25.8	103	77.0-120	
Toluene	25.0	25.1	100	77.0-120	
Xylenes, Total	75.0	77.0	103	77.0-120	
(S) Toluene-d8			*105*	*80.0-120*	
(S) Dibromofluoromethane			*88.4*	*76.0-123*	
(S) a,a,a-Trifluorotoluene			*105*	*80.0-120*	
(S) 4-Bromofluorobenzene			*99.7*	*80.0-120*	

Method Blank (MB)

(MB) R3271729-1 12/07/17 18:21

Analyte	MB Result ug/l	MB Qualifier	MB MDL ug/l	MB RDL ug/l
Diesel Range Organics (DRO)	U		66.7	200
Residual Range Organics (RRO)	U		83.3	250
(S) o-Terphenyl	*77.2*			*52.0-156*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3271729-2 12/07/17 18:36 • (LCSD) R3271729-3 12/07/17 18:52

Analyte	Spike Amount ug/l	LCS Result ug/l	LCSD Result ug/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Diesel Range Organics (DRO)	750	719	697	95.9	93.0	50.0-150			3.05	20
Residual Range Organics (RRO)	750	633	614	84.4	81.9	50.0-150			3.00	20
(S) o-Terphenyl				*73.4*	*72.2*	*52.0-156*				

L954618-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L954618-01 12/07/17 22:06 • (MS) R3271729-4 12/07/17 22:22 • (MSD) R3271729-5 12/07/17 22:38

Analyte	Spike Amount ug/l	Original Result ug/l	MS Result ug/l	MSD Result ug/l	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Diesel Range Organics (DRO)	750	ND	619	622	74.2	74.5	1	50.0-150			0.418	20
Residual Range Organics (RRO)	750	ND	526	536	63.5	64.8	1	50.0-150			1.94	20
(S) o-Terphenyl					*63.3*	*61.8*		*52.0-156*				

Guide to Reading and Understanding Your Laboratory Report

The information below is designed to better explain the various terms used in your report of analytical results from the Laboratory. This is not intended as a comprehensive explanation, and if you have additional questions please contact your project representative.

Abbreviations and Definitions

MDL	Method Detection Limit.
RDL	Reported Detection Limit.
Rec.	Recovery.
RPD	Relative Percent Difference.
SDG	Sample Delivery Group.
(S)	Surrogate (Surrogate Standard) - Analytes added to every blank, sample, Laboratory Control Sample/Duplicate and Matrix Spike/Duplicate; used to evaluate analytical efficiency by measuring recovery. Surrogates are not expected to be detected in all environmental media.
U	Not detected at the Reporting Limit (or MDL where applicable).
Analyte	The name of the particular compound or analysis performed. Some Analyses and Methods will have multiple analytes reported.
Dilution	If the sample matrix contains an interfering material, or if concentrations of analytes in the sample are higher than the highest limit of concentration that the laboratory can accurately report, the sample may be diluted for analysis. If a value different than 1 is used in this field, the result reported has already been corrected for this factor.
Limits	These are the target % recovery ranges or % difference value that the laboratory has historically determined as normal for the method and analyte being reported. Successful QC Sample analysis will target all analytes recovered or duplicated within these ranges.
Original Sample	The non-spiked sample in the prep batch used to determine the Relative Percent Difference (RPD) from a quality control sample. The Original Sample may not be included within the reported SDG.
Qualifier	This column provides a letter and/or number designation that corresponds to additional information concerning the result reported. If a Qualifier is present, a definition per Qualifier is provided within the Glossary and Definitions page and potentially a discussion of possible implications of the Qualifier in the Case Narrative if applicable.
Result	The actual analytical final result (corrected for any sample specific characteristics) reported for your sample. If there was no measurable result returned for a specific analyte, the result in this column may state “ND” (Not Detected) or “BDL” (Below Detectable Levels). The information in the results column should always be accompanied by either an MDL (Method Detection Limit) or RDL (Reporting Detection Limit) that defines the lowest value that the laboratory could detect or report for this analyte.
Case Narrative (Cn)	A brief discussion about the included sample results, including a discussion of any non-conformances to protocol observed either at sample receipt by the laboratory from the field or during the analytical process. If present, there will be a section in the Case Narrative to discuss the meaning of any data qualifiers used in the report.
Quality Control Summary (Qc)	This section of the report includes the results of the laboratory quality control analyses required by procedure or analytical methods to assist in evaluating the validity of the results reported for your samples. These analyses are not being performed on your samples typically, but on laboratory generated material.
Sample Chain of Custody (Sc)	This is the document created in the field when your samples were initially collected. This is used to verify the time and date of collection, the person collecting the samples, and the analyses that the laboratory is requested to perform. This chain of custody also documents all persons (excluding commercial shippers) that have had control or possession of the samples from the time of collection until delivery to the laboratory for analysis.
Sample Results (Sr)	This section of your report will provide the results of all testing performed on your samples. These results are provided by sample ID and are separated by the analyses performed on each sample. The header line of each analysis section for each sample will provide the name and method number for the analysis reported.
Sample Summary (Ss)	This section of the Analytical Report defines the specific analyses performed for each sample ID, including the dates and times of preparation and/or analysis.

Qualifier	Description
J	The identification of the analyte is acceptable; the reported value is an estimate.

ESC Lab Sciences is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our "one location" design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be **YOUR LAB OF CHOICE.**
***** Not all certifications held by the laboratory are applicable to the results reported in the attached report.

State Accreditations

Alabama	40660	Nevada	TN-03-2002-34
Alaska	UST-080	New Hampshire	2975
Arizona	AZ0612	New Jersey–NELAP	TN002
Arkansas	88-0469	New Mexico	TN00003
California	01157CA	New York	11742
Colorado	TN00003	North Carolina	Env375
Conneticut	PH-0197	North Carolina [1]	DW21704
Florida	E87487	North Carolina [2]	41
Georgia	NELAP	North Dakota	R-140
Georgia [1]	923	Ohio–VAP	CL0069
Idaho	TN00003	Oklahoma	9915
Illinois	200008	Oregon	TN200002
Indiana	C-TN-01	Pennsylvania	68-02979
Iowa	364	Rhode Island	221
Kansas	E-10277	South Carolina	84004
Kentucky [1]	90010	South Dakota	n/a
Kentucky [2]	16	Tennessee [1 4]	2006
Louisiana	AI30792	Texas	T 104704245-07-TX
Maine	TN0002	Texas [5]	LAB0152
Maryland	324	Utah	6157585858
Massachusetts	M-TN003	Vermont	VT2006
Michigan	9958	Virginia	109
Minnesota	047-999-395	Washington	C1915
Mississippi	TN00003	West Virginia	233
Missouri	340	Wisconsin	9980939910
Montana	CERT0086	Wyoming	A2LA
Nebraska	NE-OS-15-05		

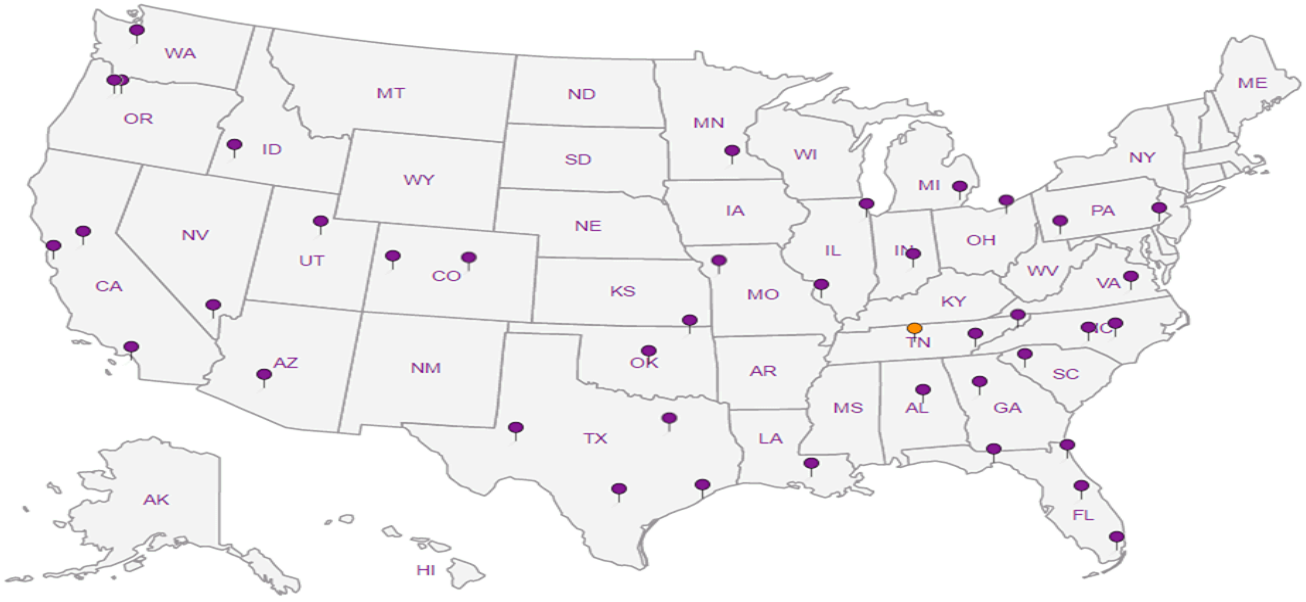
Third Party & Federal Accreditations

A2LA – ISO 17025	1461.01	AIHA-LAP,LLC	100789
A2LA – ISO 17025 [5]	1461.02	DOD	1461.01
Canada	1461.01	USDA	S-67674
EPA–Crypto	TN00003		

[1] Drinking Water [2] Underground Storage Tanks [3] Aquatic Toxicity [4] Chemical/Microbiological [5] Mold [n/a] Accreditation not applicable

Our Locations

ESC Lab Sciences has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. **ESC Lab Sciences performs all testing at our central laboratory.**



Cascadia Associates- Portland, OR

6915 SW Macadam Ave
Ste. 250
Portland, OR 97219

Billing Information:
Accounts Payable- Chris Breemer
6915 SW Macadam Ave
Ste. 250
Portland, OR 97219

Email To: imaguire@cascadiaassociates.com

Report to: Ian Maguire

Project Description: Vannex Comm

City/State Collected: Vancouver WA

Phone: 503-906-6577
Fax:

Client Project # 006-001-001

Lab Project # CASASCTOR-NUVANCOUVE

Collected by (print): Joel Mattecheck

Site/Facility ID # VANCOUVER, WA

P.O. # 006-001-001

Collected by (signature):

Quote #

Immediately Packed on Ice N ___ Y X

Rush? (Lab MUST Be Notified)
___ Same Day ___ Five Day
___ Next Day ___ 5 Day (Rad Only)
___ Two Day ___ 10 Day (Rad Only)
___ Three Day X Standard

Date Results Needed

Sample ID	Comp/Grab	Matrix *	Depth	Date	Time	No. of Cntrs	NWTPHDXLVI w/ SG; 40mlAmb-HCl-BT	NWTPHGX 40mlAmb HCl	BTEX (8260B)
MW-6	Grab	GW	—	11/30/17	1145	8	X	X	X
MW-5	Grab	GW	—	11/30/17	1055	8	X	X	X
MW-50	Grab	GW	—	11/30/17	1010	8	X	X	X
MW-5 Dup	Grab	GW	—	11/30/17	1055	8	X	X	X
		GW							

Analysis / Container / Preservative

Chain of Custody Page ___ of ___

ESC LAB SCIENCES
a subsidiary of Accutest

12065 Lebanon Rd
Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
Fax: 615-758-5859

L# L954460

B086

Acctnum: CASASCTOR
Template: T130154
Prelogin: P627256
TSR: 110 - Brian Ford
PB:
Shipped Via:

Remarks	Sample # (lab only)
	-01
	-02
	-03
	-04

* Matrix:
SS - Soil AIR - Air F - Filter
GW - Groundwater B - Bioassay
WW - WasteWater
DW - Drinking Water
OT - Other

Remarks: email results to Ian Maguire

Samples returned via: ___ UPS X FedEx ___ Courier

Tracking # 746614664251

pH ___ Temp ___
Flow ___ Other ___

Trip Blank Received: Yes / No
HCl / MeoH
TBR

Temp: 0.3 °C Bottles Received: 32

If preservation required by Login: Date/Time

Hold:

Condition: NCF / OK

Sample Receipt Checklist
COC Seal Present/Intact: NP Y N
COC Signed/Accurate: Y N
Bottles arrive intact: Y N
Correct bottles used: Y N
Sufficient volume sent: Y N
If Applicable
VOA Zero Headspace: Y N
Preservation Correct/Checked: Y N

Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)
	11/30/17	1530	
Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)
Relinquished by: (Signature)	Date:	Time:	Received for lab by: (Signature)
			535

Date: 12/01/17 Time: 0345

Apex Laboratories, LLC

12232 S.W. Garden Place
Tigard, OR 97223
503-718-2323
EPA ID: OR01039

Tuesday, September 11, 2018

Stephanie Salisbury
Cascadia Associates
6915 SW Macadam, Suite 250
Portland, OR 97219

RE: A8H0927 - Nustar Vannex - 0060-001-001

Thank you for using Apex Laboratories. We greatly appreciate your business and strive to provide the highest quality services to the environmental industry.

Enclosed are the results of analyses for work order A8H0927, which was received by the laboratory on 8/31/2018 at 1:41:00PM.

If you have any questions concerning this report or the services we offer, please feel free to contact me by email at: ldomenighini@apex-labs.com, or by phone at 503-718-2323.

Please note: All samples will be disposed of within 30 days of final reporting, unless prior arrangements have been made.

This Final Report is the official version of the data results for this sample submission, unless superseded by a subsequent, labeled amended report.

All other deliverables derived from this data, including Electronic Data Deliverables (EDDs), CLP-like forms, client requested summary sheets, and all other products are considered secondary to this report.

Apex Laboratories

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Lisa Domenighini, Client Services Manager

Apex Laboratories, LLC

12232 S.W. Garden Place
Tigard, OR 97223
503-718-2323
EPA ID: OR01039

Cascadia Associates	Project: **Nustar Vannex**	
6915 SW Macadam, Suite 250	Project Number: **0060-001-001**	**Report ID:**
Portland, OR 97219	Project Manager: **Stephanie Salisbury**	**A8H0927 - 09 11 18 0747**

ANALYTICAL REPORT FOR SAMPLES

SAMPLE INFORMATION

Client Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
MW-5	A8H0927-01	Water	08/30/18 10:45	08/31/18 13:41
MW-5D	A8H0927-02	Water	08/30/18 11:50	08/31/18 13:41
MW-6	A8H0927-03	Water	08/30/18 12:35	08/31/18 13:41
MW-5 DUP	A8H0927-04	Water	08/30/18 10:45	08/31/18 13:41
Trip Blank #1859	A8H0927-05	Water	08/30/18 00:00	08/31/18 13:41

Apex Laboratories

Lisa A Domenighini

Lisa Domenighini, Client Services Manager

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Cascadia Associates	Project: **Nustar Vannex**	
6915 SW Macadam, Suite 250	Project Number: **0060-001-001**	**Report ID:**
Portland, OR 97219	Project Manager: **Stephanie Salisbury**	**A8H0927 - 09 11 18 0747**

ANALYTICAL SAMPLE RESULTS

Diesel and/or Oil Hydrocarbons by NWTPH-Dx with Silica Gel Column Cleanup

Analyte	Sample Result	Detection Limit	Reporting Limit	Units	Dilution	Date Analyzed	Method Ref.	Notes
MW-5 (A8H0927-01)				**Matrix: Water**		**Batch: 8090441**		
Diesel	**0.819**	---	0.0755	mg/L	1	09/05/18	NWTPH-Dx/SGC	**F-18**
Oil	ND	---	0.151	mg/L	1	09/05/18	NWTPH-Dx/SGC	
Surrogate: o-Terphenyl (Surr)		*Recovery: 78 %*		*Limits: 50-150 %*	*1*	*09/05/18*	*NWTPH-Dx/SGC*	
MW-5D (A8H0927-02)				**Matrix: Water**		**Batch: 8090441**		
Diesel	ND	---	0.0755	mg/L	1	09/05/18	NWTPH-Dx/SGC	
Oil	ND	---	0.151	mg/L	1	09/05/18	NWTPH-Dx/SGC	
Surrogate: o-Terphenyl (Surr)		*Recovery: 85 %*		*Limits: 50-150 %*	*1*	*09/05/18*	*NWTPH-Dx/SGC*	
MW-6 (A8H0927-03)				**Matrix: Water**		**Batch: 8090441**		
Diesel	**1.24**	---	0.0748	mg/L	1	09/05/18	NWTPH-Dx/SGC	**F-18**
Oil	ND	---	0.150	mg/L	1	09/05/18	NWTPH-Dx/SGC	
Surrogate: o-Terphenyl (Surr)		*Recovery: 76 %*		*Limits: 50-150 %*	*1*	*09/05/18*	*NWTPH-Dx/SGC*	
MW-5 DUP (A8H0927-04)				**Matrix: Water**		**Batch: 8090441**		
Diesel	**0.631**	---	0.0755	mg/L	1	09/05/18	NWTPH-Dx/SGC	**F-18**
Oil	ND	---	0.151	mg/L	1	09/05/18	NWTPH-Dx/SGC	
Surrogate: o-Terphenyl (Surr)		*Recovery: 64 %*		*Limits: 50-150 %*	*1*	*09/05/18*	*NWTPH-Dx/SGC*	

Apex Laboratories

Lisa A Domenighini

Lisa Domenighini, Client Services Manager

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12232 S.W. Garden Place
Tigard, OR 97223
503-718-2323
EPA ID: OR01039

Cascadia Associates	Project: **Nustar Vannex**	
6915 SW Macadam, Suite 250	Project Number: **0060-001-001**	**Report ID:**
Portland, OR 97219	Project Manager: **Stephanie Salisbury**	**A8H0927 - 09 11 18 0747**

ANALYTICAL SAMPLE RESULTS

Gasoline Range Hydrocarbons (Benzene through Naphthalene) by NWTPH-Gx

Analyte	Sample Result	Detection Limit	Reporting Limit	Units	Dilution	Date Analyzed	Method Ref.	Notes
MW-5 (A8H0927-01RE1)				**Matrix: Water**			**Batch: 8090448**	
Gasoline Range Organics	**18.6**	---	1.00	mg/L	10	09/05/18	NWTPH-Gx (MS)	
Surrogate: 4-Bromofluorobenzene (Sur)		*Recovery: 100 %*	*Limits: 50-150 %*		*1*	*09/05/18*	*NWTPH-Gx (MS)*	
1,4-Difluorobenzene (Sur)			*99 %*	*50-150 %*	*1*	*09/05/18*	*NWTPH-Gx (MS)*	
MW-5D (A8H0927-02)				**Matrix: Water**			**Batch: 8090370**	
Gasoline Range Organics	**0.673**	---	0.100	mg/L	1	09/04/18	NWTPH-Gx (MS)	
Surrogate: 4-Bromofluorobenzene (Sur)		*Recovery: 96 %*	*Limits: 50-150 %*		*1*	*09/04/18*	*NWTPH-Gx (MS)*	
1,4-Difluorobenzene (Sur)			*104 %*	*50-150 %*	*1*	*09/04/18*	*NWTPH-Gx (MS)*	
MW-6 (A8H0927-03RE1)				**Matrix: Water**			**Batch: 8090427**	
Gasoline Range Organics	**20.1**	---	1.00	mg/L	10	09/05/18	NWTPH-Gx (MS)	
Surrogate: 4-Bromofluorobenzene (Sur)		*Recovery: 97 %*	*Limits: 50-150 %*		*1*	*09/05/18*	*NWTPH-Gx (MS)*	
1,4-Difluorobenzene (Sur)			*106 %*	*50-150 %*	*1*	*09/05/18*	*NWTPH-Gx (MS)*	
MW-5 DUP (A8H0927-04RE1)				**Matrix: Water**			**Batch: 8090448**	
Gasoline Range Organics	**20.8**	---	1.00	mg/L	10	09/05/18	NWTPH-Gx (MS)	
Surrogate: 4-Bromofluorobenzene (Sur)		*Recovery: 99 %*	*Limits: 50-150 %*		*1*	*09/05/18*	*NWTPH-Gx (MS)*	
1,4-Difluorobenzene (Sur)			*98 %*	*50-150 %*	*1*	*09/05/18*	*NWTPH-Gx (MS)*	

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Lisa Domenighini, Client Services Manager

Apex Laboratories, LLC

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503-718-2323
EPA ID: OR01039

Cascadia Associates	Project: **Nustar Vannex**	
6915 SW Macadam, Suite 250	Project Number: **0060-001-001**	**Report ID:**
Portland, OR 97219	Project Manager: **Stephanie Salisbury**	**A8H0927 - 09 11 18 0747**

ANALYTICAL SAMPLE RESULTS

BTEX Compounds by EPA 8260C

Analyte	Sample Result	Detection Limit	Reporting Limit	Units	Dilution	Date Analyzed	Method Ref.	Notes
MW-5 (A8H0927-01RE1)				**Matrix: Water**		**Batch: 8090448**		
Benzene	ND	---	2.00	ug/L	10	09/05/18	EPA 8260C	
Toluene	ND	---	10.0	ug/L	10	09/05/18	EPA 8260C	
Ethylbenzene	**190**	---	5.00	ug/L	10	09/05/18	EPA 8260C	
Xylenes, total	**936**	---	15.0	ug/L	10	09/05/18	EPA 8260C	
Surrogate: 1,4-Difluorobenzene (Surr)		*Recovery:*	*99 %*	*Limits: 80-120 %*	*1*	*09/05/18*	*EPA 8260C*	
Toluene-d8 (Surr)			*98 %*	*80-120 %*	*1*	*09/05/18*	*EPA 8260C*	
4-Bromofluorobenzene (Surr)			*100 %*	*80-120 %*	*1*	*09/05/18*	*EPA 8260C*	
MW-5D (A8H0927-02)				**Matrix: Water**		**Batch: 8090370**		
Benzene	ND	---	0.200	ug/L	1	09/04/18	EPA 8260C	
Toluene	ND	---	1.00	ug/L	1	09/04/18	EPA 8260C	
Ethylbenzene	ND	---	0.500	ug/L	1	09/04/18	EPA 8260C	
Xylenes, total	ND	---	1.50	ug/L	1	09/04/18	EPA 8260C	
Surrogate: 1,4-Difluorobenzene (Surr)		*Recovery:*	*103 %*	*Limits: 80-120 %*	*1*	*09/04/18*	*EPA 8260C*	
Toluene-d8 (Surr)			*97 %*	*80-120 %*	*1*	*09/04/18*	*EPA 8260C*	
4-Bromofluorobenzene (Surr)			*98 %*	*80-120 %*	*1*	*09/04/18*	*EPA 8260C*	
MW-6 (A8H0927-03RE1)				**Matrix: Water**		**Batch: 8090427**		
Benzene	**212**	---	2.00	ug/L	10	09/05/18	EPA 8260C	
Toluene	**45.2**	---	10.0	ug/L	10	09/05/18	EPA 8260C	
Ethylbenzene	**1590**	---	5.00	ug/L	10	09/05/18	EPA 8260C	
Xylenes, total	**1150**	---	15.0	ug/L	10	09/05/18	EPA 8260C	
Surrogate: 1,4-Difluorobenzene (Surr)		*Recovery:*	*105 %*	*Limits: 80-120 %*	*1*	*09/05/18*	*EPA 8260C*	
Toluene-d8 (Surr)			*98 %*	*80-120 %*	*1*	*09/05/18*	*EPA 8260C*	
4-Bromofluorobenzene (Surr)			*99 %*	*80-120 %*	*1*	*09/05/18*	*EPA 8260C*	
MW-5 DUP (A8H0927-04RE1)				**Matrix: Water**		**Batch: 8090448**		
Benzene	ND	---	2.00	ug/L	10	09/05/18	EPA 8260C	
Toluene	ND	---	10.0	ug/L	10	09/05/18	EPA 8260C	
Ethylbenzene	**212**	---	5.00	ug/L	10	09/05/18	EPA 8260C	
Xylenes, total	**1060**	---	15.0	ug/L	10	09/05/18	EPA 8260C	
Surrogate: 1,4-Difluorobenzene (Surr)		*Recovery:*	*98 %*	*Limits: 80-120 %*	*1*	*09/05/18*	*EPA 8260C*	
Toluene-d8 (Surr)			*99 %*	*80-120 %*	*1*	*09/05/18*	*EPA 8260C*	
4-Bromofluorobenzene (Surr)			*99 %*	*80-120 %*	*1*	*09/05/18*	*EPA 8260C*	
Trip Blank #1859 (A8H0927-05)				**Matrix: Water**		**Batch: 8090370**		
Benzene	ND	---	0.200	ug/L	1	09/04/18	EPA 8260C	

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Cascadia Associates	Project: **Nustar Vannex**	
6915 SW Macadam, Suite 250	Project Number: **0060-001-001**	**Report ID:**
Portland, OR 97219	Project Manager: **Stephanie Salisbury**	**A8H0927 - 09 11 18 0747**

ANALYTICAL SAMPLE RESULTS

BTEX Compounds by EPA 8260C

Analyte	Sample Result	Detection Limit	Reporting Limit	Units	Dilution	Date Analyzed	Method Ref.	Notes
Trip Blank #1859 (A8H0927-05)				**Matrix: Water**		**Batch: 8090370**		
Toluene	ND	---	1.00	ug/L	1	09/04/18	EPA 8260C	
Ethylbenzene	ND	---	0.500	ug/L	1	09/04/18	EPA 8260C	
Xylenes, total	ND	---	1.50	ug/L	1	09/04/18	EPA 8260C	
Surrogate: 1,4-Difluorobenzene (Surr)		*Recovery: 101 %*		*Limits: 80-120 %*	*1*	*09/04/18*	*EPA 8260C*	
Toluene-d8 (Surr)			*97 %*	*80-120 %*	*1*	*09/04/18*	*EPA 8260C*	
4-Bromofluorobenzene (Surr)			*101 %*	*80-120 %*	*1*	*09/04/18*	*EPA 8260C*	

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6915 SW Macadam, Suite 250	Project Number: **0060-001-001**	**Report ID:**
Portland, OR 97219	Project Manager: **Stephanie Salisbury**	**A8H0927 - 09 11 18 0747**

QUALITY CONTROL (QC) SAMPLE RESULTS

Diesel and/or Oil Hydrocarbons by NWTPH-Dx with Silica Gel Column Cleanup

Analyte	Result	Detection Limit	Reporting Limit	Units	Dilution	Spike Amount	Source Result	% REC	% REC Limits	RPD	RPD Limit	Notes
Batch 8090441 - EPA 3510C (Fuels/Acid Ext.) w/Silica Gel												**Water**
Blank (8090441-BLK1)			Prepared: 09/05/18 11:14		Analyzed: 09/05/18 20:41							
NWTPH-Dx/SGC												
Diesel	ND	---	0.0727	mg/L	1	---	---	---	---	---	---	
Oil	ND	---	0.145	mg/L	1	---	---	---	---	---	---	
Surr: o-Terphenyl (Surr)			*Recovery: 106 %*		*Limits: 50-150 %*			*Dilution: 1x*				
LCS (8090441-BS1)			Prepared: 09/05/18 11:14		Analyzed: 09/05/18 21:02							
NWTPH-Dx/SGC												
Diesel	0.433	---	0.0800	mg/L	1	0.500	---	87	52-120%	---	---	
Surr: o-Terphenyl (Surr)			*Recovery: 100 %*		*Limits: 50-150 %*			*Dilution: 1x*				
LCS Dup (8090441-BSD1)			Prepared: 09/05/18 11:14		Analyzed: 09/05/18 21:23							**Q-19**
NWTPH-Dx/SGC												
Diesel	0.451	---	0.0800	mg/L	1	0.500	---	90	52-120%	4	20%	
Surr: o-Terphenyl (Surr)			*Recovery: 100 %*		*Limits: 50-150 %*			*Dilution: 1x*				

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QUALITY CONTROL (QC) SAMPLE RESULTS

Gasoline Range Hydrocarbons (Benzene through Naphthalene) by NWTPH-Gx

Analyte	Result	Detection Limit	Reporting Limit	Units	Dilution	Spike Amount	Source Result	% REC	% REC Limits	RPD	RPD Limit	Notes
Batch 8090370 - EPA 5030B									Water			
Blank (8090370-BLK1)		Prepared: 09/04/18 09:10		Analyzed: 09/04/18 13:16								
NWTPH-Gx (MS)												
Gasoline Range Organics	ND	---	0.100	mg/L	1	---	---	---	---	---	---	
Surr: 4-Bromofluorobenzene (Sur)		*Recovery: 92 %*		*Limits: 50-150 %*			*Dilution: 1x*					
1,4-Difluorobenzene (Sur)		*103 %*		*50-150 %*			*"*					
LCS (8090370-BS2)		Prepared: 09/04/18 09:10		Analyzed: 09/04/18 10:03								
NWTPH-Gx (MS)												
Gasoline Range Organics	0.517	---	0.100	mg/L	1	0.500	---	103	80-120%	---	---	
Surr: 4-Bromofluorobenzene (Sur)		*Recovery: 97 %*		*Limits: 50-150 %*			*Dilution: 1x*					
1,4-Difluorobenzene (Sur)		*104 %*		*50-150 %*			*"*					
Duplicate (8090370-DUP1)		Prepared: 09/04/18 11:36		Analyzed: 09/04/18 18:12								
QC Source Sample: MW-5 (A8H0927-01)												
NWTPH-Gx (MS)												
Gasoline Range Organics	**20.0**	---	5.00	mg/L	50	---	20.0	---	---	0.04	30%	
Surr: 4-Bromofluorobenzene (Sur)		*Recovery: 94 %*		*Limits: 50-150 %*			*Dilution: 1x*					
1,4-Difluorobenzene (Sur)		*103 %*		*50-150 %*			*"*					

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QUALITY CONTROL (QC) SAMPLE RESULTS

Gasoline Range Hydrocarbons (Benzene through Naphthalene) by NWTPH-Gx

Analyte	Result	Detection Limit	Reporting Limit	Units	Dilution	Spike Amount	Source Result	% REC	% REC Limits	RPD	RPD Limit	Notes
Batch 8090427 - EPA 5030B									Water			
Blank (8090427-BLK1)		Prepared: 09/05/18 10:06		Analyzed: 09/05/18 11:56								
NWTPH-Gx (MS)												
Gasoline Range Organics	ND	---	0.100	mg/L	1	---	---	---	---	---	---	
Surr: 4-Bromofluorobenzene (Sur)		*Recovery: 92 %*		*Limits: 50-150 %*			*Dilution: 1x*					
1,4-Difluorobenzene (Sur)		*103 %*		*50-150 %*			*"*					
LCS (8090427-BS2)		Prepared: 09/05/18 10:06		Analyzed: 09/05/18 11:30								
NWTPH-Gx (MS)												
Gasoline Range Organics	0.482	---	0.100	mg/L	1	0.500	---	96	80-120%	---	---	
Surr: 4-Bromofluorobenzene (Sur)		*Recovery: 95 %*		*Limits: 50-150 %*			*Dilution: 1x*					
1,4-Difluorobenzene (Sur)		*104 %*		*50-150 %*			*"*					

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QUALITY CONTROL (QC) SAMPLE RESULTS

Gasoline Range Hydrocarbons (Benzene through Naphthalene) by NWTPH-Gx

Analyte	Result	Detection Limit	Reporting Limit	Units	Dilution	Spike Amount	Source Result	% REC	% REC Limits	RPD	RPD Limit	Notes
Batch 8090448 - EPA 5030B									Water			
Blank (8090448-BLK1)		Prepared: 09/05/18 12:00		Analyzed: 09/05/18 14:55								
NWTPH-Gx (MS)												
Gasoline Range Organics	ND	---	0.100	mg/L	1	---	---	---	---	---	---	
Surr: 4-Bromofluorobenzene (Sur)		*Recovery: 94 %*		*Limits: 50-150 %*			*Dilution: 1x*					
1,4-Difluorobenzene (Sur)		*96 %*		*50-150 %*			*"*					
LCS (8090448-BS2)		Prepared: 09/05/18 12:00		Analyzed: 09/05/18 14:26								
NWTPH-Gx (MS)												
Gasoline Range Organics	0.477	---	0.100	mg/L	1	0.500	---	95	80-120%	---	---	
Surr: 4-Bromofluorobenzene (Sur)		*Recovery: 96 %*		*Limits: 50-150 %*			*Dilution: 1x*					
1,4-Difluorobenzene (Sur)		*97 %*		*50-150 %*			*"*					

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QUALITY CONTROL (QC) SAMPLE RESULTS

BTEX Compounds by EPA 8260C

Analyte	Result	Detection Limit	Reporting Limit	Units	Dilution	Spike Amount	Source Result	% REC	% REC Limits	RPD	RPD Limit	Notes
Batch 8090370 - EPA 5030B												**Water**
Blank (8090370-BLK1)		Prepared: 09/04/18 09:10 Analyzed: 09/04/18 13:16										
EPA 8260C												
Benzene	ND	---	0.200	ug/L	1	---	---	---	---	---	---	
Toluene	ND	---	1.00	ug/L	1	---	---	---	---	---	---	
Ethylbenzene	ND	---	0.500	ug/L	1	---	---	---	---	---	---	
Xylenes, total	ND	---	1.50	ug/L	1	---	---	---	---	---	---	
Surr: 1,4-Difluorobenzene (Surr)		*Recovery: 101 %*		*Limits: 80-120 %*			*Dilution: 1x*					
Toluene-d8 (Surr)		*99 %*		*80-120 %*			*"*					
4-Bromofluorobenzene (Surr)		*98 %*		*80-120 %*			*"*					
LCS (8090370-BS3)		Prepared: 09/04/18 09:10 Analyzed: 09/04/18 10:57										
EPA 8260C												
Benzene	20.6	---	0.200	ug/L	1	20.0	---	103	80-120%	---	---	
Toluene	19.4	---	1.00	ug/L	1	20.0	---	97	80-120%	---	---	
Ethylbenzene	20.1	---	0.500	ug/L	1	20.0	---	101	80-120%	---	---	
Xylenes, total	66.4	---	1.50	ug/L	1	60.0	---	111	80-120%	---	---	
Surr: 1,4-Difluorobenzene (Surr)		*Recovery: 103 %*		*Limits: 80-120 %*			*Dilution: 1x*					
Toluene-d8 (Surr)		*99 %*		*80-120 %*			*"*					
4-Bromofluorobenzene (Surr)		*100 %*		*80-120 %*			*"*					
Duplicate (8090370-DUP1)		Prepared: 09/04/18 11:36 Analyzed: 09/04/18 18:12										
QC Source Sample: MW-5 (A8H0927-01)												
EPA 8260C												
Benzene	ND	---	10.0	ug/L	50	---	ND	---	---	---	30%	
Toluene	ND	---	50.0	ug/L	50	---	ND	---	---	---	30%	
Ethylbenzene	**203**	---	25.0	ug/L	50	---	210	---	---	3	30%	
Xylenes, total	**1110**	---	75.0	ug/L	50	---	1110	---	---	0.2	30%	
Surr: 1,4-Difluorobenzene (Surr)		*Recovery: 101 %*		*Limits: 80-120 %*			*Dilution: 1x*					
Toluene-d8 (Surr)		*97 %*		*80-120 %*			*"*					
4-Bromofluorobenzene (Surr)		*96 %*		*80-120 %*			*"*					

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QUALITY CONTROL (QC) SAMPLE RESULTS

BTEX Compounds by EPA 8260C

Analyte	Result	Detection Limit	Reporting Limit	Units	Dilution	Spike Amount	Source Result	% REC	% REC Limits	RPD	RPD Limit	Notes
Batch 8090427 - EPA 5030B							**Water**					
Blank (8090427-BLK1)		Prepared: 09/05/18 10:06		Analyzed: 09/05/18 11:56								
EPA 8260C												
Benzene	ND	---	0.200	ug/L	1	---	---	---	---	---	---	
Toluene	ND	---	1.00	ug/L	1	---	---	---	---	---	---	
Ethylbenzene	ND	---	0.500	ug/L	1	---	---	---	---	---	---	
Xylenes, total	ND	---	1.50	ug/L	1	---	---	---	---	---	---	
Surr: 1,4-Difluorobenzene (Surr)		*Recovery: 101 %*		*Limits: 80-120 %*			*Dilution: 1x*					
Toluene-d8 (Surr)		*98 %*		*80-120 %*			*"*					
4-Bromofluorobenzene (Surr)		*101 %*		*80-120 %*			*"*					
LCS (8090427-BS1)		Prepared: 09/05/18 10:06		Analyzed: 09/05/18 11:03								
EPA 8260C												
Benzene	20.1	---	0.200	ug/L	1	20.0	---	101	80-120%	---	---	
Toluene	19.5	---	1.00	ug/L	1	20.0	---	97	80-120%	---	---	
Ethylbenzene	20.3	---	0.500	ug/L	1	20.0	---	101	80-120%	---	---	
Xylenes, total	66.0	---	1.50	ug/L	1	60.0	---	110	80-120%	---	---	
Surr: 1,4-Difluorobenzene (Surr)		*Recovery: 101 %*		*Limits: 80-120 %*			*Dilution: 1x*					
Toluene-d8 (Surr)		*98 %*		*80-120 %*			*"*					
4-Bromofluorobenzene (Surr)		*98 %*		*80-120 %*			*"*					

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QUALITY CONTROL (QC) SAMPLE RESULTS

BTEX Compounds by EPA 8260C

Analyte	Result	Detection Limit	Reporting Limit	Units	Dilution	Spike Amount	Source Result	% REC	% REC Limits	RPD	RPD Limit	Notes
Batch 8090448 - EPA 5030B									Water			
Blank (8090448-BLK1)		Prepared: 09/05/18 12:00		Analyzed: 09/05/18 14:55								
EPA 8260C												
Benzene	ND	---	0.200	ug/L	1	---	---	---	---	---	---	
Toluene	ND	---	1.00	ug/L	1	---	---	---	---	---	---	
Ethylbenzene	ND	---	0.500	ug/L	1	---	---	---	---	---	---	
Xylenes, total	ND	---	1.50	ug/L	1	---	---	---	---	---	---	
Surr: 1,4-Difluorobenzene (Surr)		*Recovery:*	*96 %*	*Limits:*	*80-120 %*		*Dilution:*	*1x*				
Toluene-d8 (Surr)			*99 %*		*80-120 %*			*"*				
4-Bromofluorobenzene (Surr)			*101 %*		*80-120 %*			*"*				
LCS (8090448-BS1)		Prepared: 09/05/18 12:00		Analyzed: 09/05/18 13:57								
EPA 8260C												
Benzene	18.7	---	0.200	ug/L	1	20.0	---	94	80-120%	---	---	
Toluene	18.2	---	1.00	ug/L	1	20.0	---	91	80-120%	---	---	
Ethylbenzene	18.8	---	0.500	ug/L	1	20.0	---	94	80-120%	---	---	
Xylenes, total	56.5	---	1.50	ug/L	1	60.0	---	94	80-120%	---	---	
Surr: 1,4-Difluorobenzene (Surr)		*Recovery:*	*100 %*	*Limits:*	*80-120 %*		*Dilution:*	*1x*				
Toluene-d8 (Surr)			*100 %*		*80-120 %*			*"*				
4-Bromofluorobenzene (Surr)			*102 %*		*80-120 %*			*"*				

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SAMPLE PREPARATION INFORMATION

Diesel and/or Oil Hydrocarbons by NWTPH-Dx with Silica Gel Column Cleanup

Prep: EPA 3510C (Fuels/Acid Ext.) w/Silica Gel

Lab Number	Matrix	Method	Sampled	Prepared	Sample Initial/Final	Default Initial/Final	RL Prep Factor
Batch: 8090441							
A8H0927-01	Water	NWTPH-Dx/SGC	08/30/18 10:45	09/05/18 11:14			0.94
A8H0927-02	Water	NWTPH-Dx/SGC	08/30/18 11:50	09/05/18 11:14			0.94
A8H0927-03	Water	NWTPH-Dx/SGC	08/30/18 12:35	09/05/18 11:14			0.94
A8H0927-04	Water	NWTPH-Dx/SGC	08/30/18 10:45	09/05/18 11:14			0.94

Gasoline Range Hydrocarbons (Benzene through Naphthalene) by NWTPH-Gx

Prep: EPA 5030B

Lab Number	Matrix	Method	Sampled	Prepared	Sample Initial/Final	Default Initial/Final	RL Prep Factor
Batch: 8090370							
A8H0927-02	Water	NWTPH-Gx (MS)	08/30/18 11:50	09/04/18 11:36	5mL/5mL	5mL/5mL	1.00
Batch: 8090427							
A8H0927-03RE1	Water	NWTPH-Gx (MS)	08/30/18 12:35	09/05/18 11:27	5mL/5mL	5mL/5mL	1.00
Batch: 8090448							
A8H0927-01RE1	Water	NWTPH-Gx (MS)	08/30/18 10:45	09/05/18 14:13	5mL/5mL	5mL/5mL	1.00
A8H0927-04RE1	Water	NWTPH-Gx (MS)	08/30/18 10:45	09/05/18 14:13	5mL/5mL	5mL/5mL	1.00

BTEX Compounds by EPA 8260C

Prep: EPA 5030B

Lab Number	Matrix	Method	Sampled	Prepared	Sample Initial/Final	Default Initial/Final	RL Prep Factor
Batch: 8090370							
A8H0927-02	Water	EPA 8260C	08/30/18 11:50	09/04/18 11:36	5mL/5mL	5mL/5mL	1.00
A8H0927-05	Water	EPA 8260C	08/30/18 00:00	09/04/18 11:36	5mL/5mL	5mL/5mL	1.00
Batch: 8090427							
A8H0927-03RE1	Water	EPA 8260C	08/30/18 12:35	09/05/18 11:27	5mL/5mL	5mL/5mL	1.00
Batch: 8090448							
A8H0927-01RE1	Water	EPA 8260C	08/30/18 10:45	09/05/18 14:13	5mL/5mL	5mL/5mL	1.00
A8H0927-04RE1	Water	EPA 8260C	08/30/18 10:45	09/05/18 14:13	5mL/5mL	5mL/5mL	1.00

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Lisa Domenighini, Client Services Manager

Apex Laboratories, LLC

12232 S.W. Garden Place
Tigard, OR 97223
503-718-2323
EPA ID: OR01039

Cascadia Associates	Project: **Nustar Vannex**	
6915 SW Macadam, Suite 250	Project Number: **0060-001-001**	**Report ID:**
Portland, OR 97219	Project Manager: **Stephanie Salisbury**	**A8H0927 - 09 11 18 0747**

QUALIFIER DEFINITIONS

Client Sample and Quality Control (QC) Sample Qualifier Definitions:

Apex Laboratories

F-18	Result for Diesel (Diesel Range Organics, C12-C24) is due to overlap from Gasoline or a Gasoline Range product.
Q-19	Blank Spike Duplicate (BSD) sample analyzed in place of Matrix Spike/Duplicate samples due to limited sample amount available for analysis.

Apex Laboratories

Lisa A Domenighini

Lisa Domenighini, Client Services Manager

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REPORTING NOTES AND CONVENTIONS:

Abbreviations:

DET Analyte DETECTED at or above the detection or reporting limit.

ND Analyte NOT DETECTED at or above the detection or reporting limit.

NR Result Not Reported

RPD Relative Percent Difference

Detection Limits: Limit of Detection (LOD)

Limits of Detection (LODs) are normally set at a level of one half the validated Limit of Quantitation (LOQ).
If no value is listed ('-----'), then the data has not been evaluated below the Reporting Limit.

Reporting Limits: Limit of Quantitation (LOQ)

Validated Limits of Quantitation (LOQs) are reported as the Reporting Limits for all analyses where the LOQ, MRL, PQL or CRL are requested. The LOQ represents a level at or above the low point of the calibration curve, that has been validated according to Apex Laboratories' comprehensive LOQ policies and procedures.

Reporting Conventions:

Basis: Results for soil samples are generally reported on a 100% dry weight basis.
The Result Basis is listed following the units as " dry", " wet", or " " (blank) designation.

" dry" Sample results and Reporting Limits are reported on a dry weight basis. (i.e. "ug/kg dry")
See Percent Solids section for details of dry weight analysis.

" wet" Sample results and Reporting Limits for this analysis are normally dry weight corrected, but have not been modified in this case.

" " Results without 'wet' or 'dry' designation are not normally dry weight corrected. These results are considered 'As Received'.

QC Source:

In cases where there is insufficient sample provided for Sample Duplicates and/or Matrix Spikes, a Lab Control Sample Duplicate (LCS Dup) may be analyzed to demonstrate accuracy and precision of the extraction batch.

Non-Client Batch QC Samples (Duplicates and Matrix Spike/Duplicates) are not included in this report. Please request a Full QC report if this data is required.

Miscellaneous Notes:

" --- " QC results are not applicable. For example, % Recoveries for Blanks and Duplicates, % RPD for Blanks, Blank Spikes and Matrix Spikes, etc.

" *** " Used to indicate a possible discrepancy with the Sample and Sample Duplicate results when the %RPD is not available. In this case, either the Sample or the Sample Duplicate has a reportable result for this analyte, while the other is Non Detect (ND).

Blanks:

Standard practice is to evaluate the results from Blank QC Samples down to a level equal to ½ the Reporting Limit (RL).
-For Blank hits falling between ½ the RL and the RL (J flagged hits), the associated sample and QC data will receive a 'B-02' qualifier.
-For Blank hits above the RL, the associated sample and QC data will receive a 'B' qualifier, per Apex Laboratories' Blank Policy.
For further details, please request a copy of this document.

Apex Laboratories

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REPORTING NOTES AND CONVENTIONS (Cont.):

Blanks (Cont.):

Sample results flagged with a 'B' or 'B-02' qualifier are potentially biased high if the blank results are less than ten times the level found in the blank for inorganic analyses, or less than five times the level found in the blank for organic analyses.

'B' and 'B-02' qualifications are only applied to sample results detected above the Reporting Level.

Preparation Notes:

Mixed Matrix Samples:

Water Samples:

Water samples containing significant amounts of sediment are decanted or separated prior to extraction, and only the water portion analyzed, unless otherwise directed by the client.

Soil and Sediment Samples:

Soil and Sediment samples containing significant amounts of water are decanted prior to extraction, and only the solid portion analyzed, unless otherwise directed by the client.

Sampling and Preservation Notes:

Certain regulatory programs, such as National Pollutant Discharge Elimination System (NPDES), require that activities such as sample filtration (for dissolved metals, orthophosphate, hexavalent chromium, etc.) and testing of short hold analytes (pH, Dissolved Oxygen, etc.) be performed in the field (on-site) within a short time window. In addition, sample matrix spikes are required for some analyses, and sufficient volume must be provided, and billable site specific QC requested, if this is required. All regulatory permits should be reviewed to ensure that these requirements are being met.

Data users should be aware of which regulations pertain to the samples they submit for testing. If related sample collection activities are not approved for a particular regulatory program, results should be considered estimates. Apex Laboratories will qualify these analytes according to the most stringent requirements, however results for samples that are for non-regulatory purposes may be acceptable.

Samples that have been filtered and preserved at Apex Laboratories per client request are listed in the preparation section of the report with the date and time of filtration listed.

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LABORATORY ACCREDITATION INFORMATION

TNI Certification ID: OR100062 (Primary Accreditation) - EPA ID: OR01039

All methods and analytes reported from work performed at Apex Laboratories are included on Apex Laboratories' ORELAP Scope of Certification, with the exception of any analyte(s) listed below:

Apex Laboratories

Matrix	Analysis	TNI_ID	Analyte	TNI_ID	Accreditation

All reported analytes are included in Apex Laboratories' current ORELAP scope.

Secondary Accreditations

Apex Laboratories also maintains reciprocal accreditation with non-TNI states (Washington DOE), as well as other state specific accreditations not listed here.

Subcontract Laboratory Accreditations

Subcontracted data falls outside of Apex Laboratories' Scope of Accreditation.
Please see the Subcontract Laboratory report for full details, or contact your Project Manager for more information.

Field Testing Parameters

Results for Field Tested data are provded by the client or sampler, and fall outside of Apex Laboratories' Scope of Accreditation.

Apex Laboratories

Lisa Domenighini, Client Services Manager

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Cascadia Associates	Project: **Nustar Vannex**	
6915 SW Macadam, Suite 250	Project Number: **0060-001-001**	**Report ID:**
Portland, OR 97219	Project Manager: **Stephanie Salisbury**	**A8H0927 - 09 11 18 0747**

APEX LABS

CHAIN OF CUSTODY Lab # A8H0927 COC 1 of 1

12232 S.W. Garden Place, Tigard, OR 97223 Ph: 503-718-2323 Fax: 503-718-0333

Company: Cascadia Associates | Project Mgr: Stephanie Salisbury | Project Name: Nustar Vannex | PO# | Project # 0060-001-001

Address: 6915 SW Macadam Avenue, Ste 250 | Phone: 503 956 6515 | Fax: | Email: sbsalisbury@cascadia associates.com

Sampled by: Joel Mattecheck

Site Location: OR (WA) Other:

ANALYSIS REQUEST

	SAMPLE ID	LAB ID #	DATE	TIME	MATRIX	# OF CONTAINERS	NWTPH-HCID	NWTPH-Dx w/ Silica 5	NWTPH-Gx	8260 VOCs Full List	8260 RBDM VOCs	8260 HVOCs	8260 BTEX VOCs	8270 SVOC	8270 SIM PAHs	8082 PCBs	600 TTO	RCRA Metals (8)	TCLP Metals (8)	Al, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Hg, Mg, Mn, Mo, Ni, K, Se, Ag, Na, Tl, V, Zn TOTAL DISS TCLP	1200- COLS	1200-Z	BTEX
1	MW-5		8/30	1045	GW	5		X	X														X
2	MW-5D		8/30	1150	GW	5		X	X														X
3	MW-6		8/30	1235	GW	5		X	X														X
4																							
5																							
6																							
7																							
8																							
9																							
10																							

Normal Turn Around Time (TAT) = 10 Business Days (YES) NO

TAT Requested (circle): 1 Day 2 Day 3 Day 4 DAY 5 DAY Other: ______

SPECIAL INSTRUCTIONS: Dx w/ Silica gel cleanup

SAMPLES ARE HELD FOR 30 DAYS

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
Signature: [signature] Date: 8/31/18	Signature: [signature] Date: 8/31/18	Signature: Date:	Signature: Date:
Printed Name: Joel Mattecheck Time: 1341	Printed Name: Charles Heffron Time: 1341	Printed Name: Time:	Printed Name: Time:
Company: Cascadia	Company: Apex Labs	Company:	Company:

Apex Laboratories, LLC

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Cascadia Associates	Project: **Nustar Vannex**	
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Portland, OR 97219	Project Manager: **Stephanie Salisbury**	**A8H0927 - 09 11 18 0747**

APEX LABS COOLER RECEIPT FORM

Client: Cascadia Assoc. Element WO#: A8H0927

Project/Project #: Nustar Vannex #0060-001-001

Delivery info:

Date/Time Received: 8/31/18 @ 1341 By: CFH

Delivered by: Apex X Client ___ ESS ___ FedEx ___ UPS ___ Swift ___ Senvoy ___ SDS ___ Other ___

Cooler Inspection Inspected by: AHL : 8/31/18 @ 1635

Chain of Custody Included? Yes X No ___ Custody Seals? Yes ___ No X

Signed/Dated by Client? Yes X No ___

Signed/Dated by Apex? Yes X No ___

	Cooler #1	Cooler #2	Cooler #3	Cooler #4	Cooler #5	Cooler #6	Cooler #7
Temperature (deg. C)	0.3						
Received on Ice? (Y/N)	Y						
Temp. Blanks? (Y/N)	Y						
Ice Type: (Gel/Real/Other)	Real						
Condition:	Melted						

Cooler out of temp? (Y/(N)) Possible reason why: ___

If some coolers are in temp and some out, were green dot applied to out of temperature samples? Yes/No/(NA)

Samples Inspection: Inspected by: TG : 8/31/18 @ 17:35

All Samples Intact? Yes X No ___ Comments: ~~Sa~~ TG 8/31/18

Bottle Labels/COCs agree? Yes ___ No X Comments: Sample MW-5 Dup

Date reading 8/30 wl T of 10:45 not listed on CoC

Containers/Volumes Received Appropriate for Analysis? Yes X No ___ Comments:

Do VOA Vials have Visible Headspace? Yes ___ No ___ NA X

Comments ___

Water Samples: pH Checked and Appropriate (except VOAs): Yes ~~X~~ No ___ NA ___

Comments: ___

Additional Information: Trip blank #1859 not on CoC

Labeled by: TG Witness: AHL Cooler Inspected by: TG See Project Contact Form: (Y)

Apex Laboratories

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Lisa A Domenighini

Lisa Domenighini, Client Services Manager

ANALYTICAL REPORT

March 09, 2018

APEX Companies - Portland, OR

Sample Delivery Group:	L974072
Samples Received:	03/01/2018
Project Number:	1569-12
Description:	Nustar - Vancouver Annex
Site:	VANCOUVER, WA
Report To:	Megan Masterson 3015 SW First Avenue Portland, OR 97201-4707

Entire Report Reviewed By:

Brian Ford

Technical Service Representative

Results relate only to the items tested or calibrated and are reported as rounded values. This test report shall not be reproduced, except in full, without written approval of the laboratory. Where applicable, sampling conducted by ESC is performed per guidance provided in laboratory standard operating procedures: 060302, 060303, and 060304.

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MW-5 L974072-01 GW

Collected by: M. Masterson
Collected date/time: 02/28/18 11:50
Received date/time: 03/01/18 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Volatile Organic Compounds (GC) by Method NWTPHGX	WG1080467	1	03/04/18 23:22	03/04/18 23:22	ACG
Volatile Organic Compounds (GC/MS) by Method 8260C	WG1079893	1	03/02/18 20:42	03/02/18 20:42	JAH
Volatile Organic Compounds (GC/MS) by Method 8260C	WG1079893	25	03/04/18 15:59	03/04/18 15:59	JAH
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1080793	1	03/06/18 08:51	03/06/18 15:22	LM

MW-5D L974072-02 GW

Collected by: M. Masterson
Collected date/time: 02/28/18 11:25
Received date/time: 03/01/18 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Volatile Organic Compounds (GC) by Method NWTPHGX	WG1080467	1	03/04/18 23:46	03/04/18 23:46	ACG
Volatile Organic Compounds (GC/MS) by Method 8260C	WG1079893	1	03/02/18 21:01	03/02/18 21:01	JAH
Volatile Organic Compounds (GC/MS) by Method 8260C	WG1079893	1	03/04/18 16:18	03/04/18 16:18	JAH
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1080793	1	03/06/18 08:51	03/06/18 15:38	LM

MW-6 L974072-03 GW

Collected by: M. Masterson
Collected date/time: 02/28/18 10:40
Received date/time: 03/01/18 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Volatile Organic Compounds (GC) by Method NWTPHGX	WG1080467	1	03/05/18 00:10	03/05/18 00:10	ACG
Volatile Organic Compounds (GC/MS) by Method 8260C	WG1079893	20	03/04/18 16:37	03/04/18 16:37	JAH
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1080793	1	03/06/18 08:51	03/06/18 15:54	LM

All sample aliquots were received at the correct temperature, in the proper containers, with the appropriate preservatives, and within method specified holding times, unless qualified or notated within the report. Where applicable, all MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All radiochemical sample results for solids are reported on a dry weight basis with the exception of tritium, carbon-14 and radon, unless wet weight was requested by the client. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.

Brian Ford
Technical Service Representative

Volatile Organic Compounds (GC) by Method NWTPHGX

Analyte	Result ug/l	Qualifier	MDL ug/l	RDL ug/l	Dilution	Analysis date / time	Batch
Gasoline Range Organics-NWTPH	9860		31.6	100	1	03/04/2018 23:22	WG1080467
(S) a,a,a-Trifluorotoluene(FID)	*99.8*			*77.0-122*		*03/04/2018 23:22*	WG1080467

Volatile Organic Compounds (GC/MS) by Method 8260C

Analyte	Result ug/l	Qualifier	MDL ug/l	RDL ug/l	Dilution	Analysis date / time	Batch
Benzene	U		0.331	1.00	1	03/02/2018 20:42	WG1079893
Toluene	1.15		0.412	1.00	1	03/02/2018 20:42	WG1079893
Ethylbenzene	145		0.384	1.00	1	03/02/2018 20:42	WG1079893
Total Xylenes	877		26.5	75.0	25	03/04/2018 15:59	WG1079893
(S) Toluene-d8	*94.5*			*80.0-120*		*03/02/2018 20:42*	WG1079893
(S) Toluene-d8	*104*			*80.0-120*		*03/04/2018 15:59*	WG1079893
(S) Dibromofluoromethane	*105*			*76.0-123*		*03/04/2018 15:59*	WG1079893
(S) Dibromofluoromethane	*104*			*76.0-123*		*03/02/2018 20:42*	WG1079893
(S) a,a,a-Trifluorotoluene	*94.3*			*80.0-120*		*03/04/2018 15:59*	WG1079893
(S) a,a,a-Trifluorotoluene	*96.1*			*80.0-120*		*03/02/2018 20:42*	WG1079893
(S) 4-Bromofluorobenzene	*106*			*80.0-120*		*03/04/2018 15:59*	WG1079893
(S) 4-Bromofluorobenzene	*107*			*80.0-120*		*03/02/2018 20:42*	WG1079893

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT

Analyte	Result ug/l	Qualifier	MDL ug/l	RDL ug/l	Dilution	Analysis date / time	Batch
Diesel Range Organics (DRO)	1770		66.0	200	1	03/06/2018 15:22	WG1080793
Residual Range Organics (RRO)	U		82.5	250	1	03/06/2018 15:22	WG1080793
(S) o-Terphenyl	*106*			*52.0-156*		*03/06/2018 15:22*	WG1080793

Volatile Organic Compounds (GC) by Method NWTPHGX

Analyte	Result ug/l	Qualifier	MDL ug/l	RDL ug/l	Dilution	Analysis date / time	Batch
Gasoline Range Organics-NWTPH	589		31.6	100	1	03/04/2018 23:46	WG1080467
(S) a,a,a-Trifluorotoluene(FID)	*104*			*77.0-122*		*03/04/2018 23:46*	WG1080467

Volatile Organic Compounds (GC/MS) by Method 8260C

Analyte	Result ug/l	Qualifier	MDL ug/l	RDL ug/l	Dilution	Analysis date / time	Batch
Benzene	U		0.331	1.00	1	03/02/2018 21:01	WG1079893
Toluene	U		0.412	1.00	1	03/02/2018 21:01	WG1079893
Ethylbenzene	5.08		0.384	1.00	1	03/02/2018 21:01	WG1079893
Total Xylenes	2.04	J	1.06	3.00	1	03/04/2018 16:18	WG1079893
(S) Toluene-d8	*101*			*80.0-120*		*03/02/2018 21:01*	WG1079893
(S) Toluene-d8	*105*			*80.0-120*		*03/04/2018 16:18*	WG1079893
(S) Dibromofluoromethane	*104*			*76.0-123*		*03/04/2018 16:18*	WG1079893
(S) Dibromofluoromethane	*106*			*76.0-123*		*03/02/2018 21:01*	WG1079893
(S) a,a,a-Trifluorotoluene	*97.9*			*80.0-120*		*03/04/2018 16:18*	WG1079893
(S) a,a,a-Trifluorotoluene	*95.3*			*80.0-120*		*03/02/2018 21:01*	WG1079893
(S) 4-Bromofluorobenzene	*108*			*80.0-120*		*03/04/2018 16:18*	WG1079893
(S) 4-Bromofluorobenzene	*102*			*80.0-120*		*03/02/2018 21:01*	WG1079893

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT

Analyte	Result ug/l	Qualifier	MDL ug/l	RDL ug/l	Dilution	Analysis date / time	Batch
Diesel Range Organics (DRO)	249		66.0	200	1	03/06/2018 15:38	WG1080793
Residual Range Organics (RRO)	U		82.5	250	1	03/06/2018 15:38	WG1080793
(S) o-Terphenyl	*110*			*52.0-156*		*03/06/2018 15:38*	WG1080793

Volatile Organic Compounds (GC) by Method NWTPHGX

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Gasoline Range Organics-NWTPH	7720		31.6	100	1	03/05/2018 00:10	WG1080467
(S) a,a,a-Trifluorotoluene(FID)	*112*			*77.0-122*		*03/05/2018 00:10*	WG1080467

Volatile Organic Compounds (GC/MS) by Method 8260C

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Benzene	256		6.62	20.0	20	03/04/2018 16:37	WG1079893
Toluene	42.3		8.24	20.0	20	03/04/2018 16:37	WG1079893
Ethylbenzene	1440		7.68	20.0	20	03/04/2018 16:37	WG1079893
Total Xylenes	735		21.2	60.0	20	03/04/2018 16:37	WG1079893
(S) Toluene-d8	*106*			*80.0-120*		*03/04/2018 16:37*	WG1079893
(S) Dibromofluoromethane	*105*			*76.0-123*		*03/04/2018 16:37*	WG1079893
(S) a,a,a-Trifluorotoluene	*96.3*			*80.0-120*		*03/04/2018 16:37*	WG1079893
(S) 4-Bromofluorobenzene	*106*			*80.0-120*		*03/04/2018 16:37*	WG1079893

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Diesel Range Organics (DRO)	3570		66.0	200	1	03/06/2018 15:54	WG1080793
Residual Range Organics (RRO)	152	J	82.5	250	1	03/06/2018 15:54	WG1080793
(S) o-Terphenyl	*117*			*52.0-156*		*03/06/2018 15:54*	WG1080793

Method Blank (MB)

(MB) R3290564-3 03/04/18 22:13

Analyte	MB Result ug/l	MB Qualifier	MB MDL ug/l	MB RDL ug/l
Gasoline Range Organics-NWTPH	U		31.6	100
(S) a,a,a-Trifluorotoluene(FID)	*104*			*77.0-122*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3290564-1 03/04/18 21:00 • (LCSD) R3290564-2 03/04/18 21:25

Analyte	Spike Amount ug/l	LCS Result ug/l	LCSD Result ug/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Gasoline Range Organics-NWTPH	5500	5090	5090	92.5	92.5	72.0-134			0.000591	20
(S) a,a,a-Trifluorotoluene(FID)				*110*	*111*	*77.0-122*				

L974541-03 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L974541-03 03/05/18 06:37 • (MS) R3290564-4 03/05/18 07:02 • (MSD) R3290564-5 03/05/18 07:26

Analyte	Spike Amount ug/l	Original Result ug/l	MS Result ug/l	MSD Result ug/l	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Gasoline Range Organics-NWTPH	5500	U	3550	3530	64.5	64.2	1	23.0-159			0.597	20
(S) a,a,a-Trifluorotoluene(FID)					*104*	*104*		*77.0-122*				

Method Blank (MB)

(MB) R3290325-2 03/02/18 16:12

Analyte	MB Result ug/l	MB Qualifier	MB MDL ug/l	MB RDL ug/l
Benzene	U		0.331	1.00
Ethylbenzene	U		0.384	1.00
Toluene	U		0.412	1.00
Xylenes, Total	U		1.06	3.00
(S) Toluene-d8	*107*			*80.0-120*
(S) Dibromofluoromethane	*103*			*76.0-123*
(S) a,a,a-Trifluorotoluene	*96.8*			*80.0-120*
(S) 4-Bromofluorobenzene	*102*			*80.0-120*

Laboratory Control Sample (LCS)

(LCS) R3290325-1 03/02/18 15:13

Analyte	Spike Amount ug/l	LCS Result ug/l	LCS Rec. %	Rec. Limits %	LCS Qualifier
Benzene	25.0	25.1	100	69.0-123	
Ethylbenzene	25.0	25.9	104	77.0-120	
Toluene	25.0	24.8	99.4	77.0-120	
Xylenes, Total	75.0	76.6	102	77.0-120	
(S) Toluene-d8			*103*	*80.0-120*	
(S) Dibromofluoromethane			*102*	*76.0-123*	
(S) a,a,a-Trifluorotoluene			*95.7*	*80.0-120*	
(S) 4-Bromofluorobenzene			*104*	*80.0-120*	

Method Blank (MB)

(MB) R3290888-1 03/06/18 13:14

Analyte	MB Result ug/l	MB Qualifier	MB MDL ug/l	MB RDL ug/l
Diesel Range Organics (DRO)	U		66.7	200
Residual Range Organics (RRO)	U		83.3	250
(S) o-Terphenyl	*92.3*			*52.0-156*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3290888-2 03/06/18 13:30 • (LCSD) R3290888-3 03/06/18 13:46

Analyte	Spike Amount ug/l	LCS Result ug/l	LCSD Result ug/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Diesel Range Organics (DRO)	750	998	942	133	126	50.0-150			5.84	20
Residual Range Organics (RRO)	750	919	884	123	118	50.0-150			3.90	20
(S) o-Terphenyl				*110*	*122*	*52.0-156*				

Guide to Reading and Understanding Your Laboratory Report

The information below is designed to better explain the various terms used in your report of analytical results from the Laboratory. This is not intended as a comprehensive explanation, and if you have additional questions please contact your project representative.

Abbreviations and Definitions

MDL	Method Detection Limit.
RDL	Reported Detection Limit.
Rec.	Recovery.
RPD	Relative Percent Difference.
SDG	Sample Delivery Group.
(S)	Surrogate (Surrogate Standard) - Analytes added to every blank, sample, Laboratory Control Sample/Duplicate and Matrix Spike/Duplicate; used to evaluate analytical efficiency by measuring recovery. Surrogates are not expected to be detected in all environmental media.
U	Not detected at the Reporting Limit (or MDL where applicable).
Analyte	The name of the particular compound or analysis performed. Some Analyses and Methods will have multiple analytes reported.
Dilution	If the sample matrix contains an interfering material, or if concentrations of analytes in the sample are higher than the highest limit of concentration that the laboratory can accurately report, the sample may be diluted for analysis. If a value different than 1 is used in this field, the result reported has already been corrected for this factor.
Limits	These are the target % recovery ranges or % difference value that the laboratory has historically determined as normal for the method and analyte being reported. Successful QC Sample analysis will target all analytes recovered or duplicated within these ranges.
Original Sample	The non-spiked sample in the prep batch used to determine the Relative Percent Difference (RPD) from a quality control sample. The Original Sample may not be included within the reported SDG.
Qualifier	This column provides a letter and/or number designation that corresponds to additional information concerning the result reported. If a Qualifier is present, a definition per Qualifier is provided within the Glossary and Definitions page and potentially a discussion of possible implications of the Qualifier in the Case Narrative if applicable.
Result	The actual analytical final result (corrected for any sample specific characteristics) reported for your sample. If there was no measurable result returned for a specific analyte, the result in this column may state “ND” (Not Detected) or “BDL” (Below Detectable Levels). The information in the results column should always be accompanied by either an MDL (Method Detection Limit) or RDL (Reporting Detection Limit) that defines the lowest value that the laboratory could detect or report for this analyte.
Case Narrative (Cn)	A brief discussion about the included sample results, including a discussion of any non-conformances to protocol observed either at sample receipt by the laboratory from the field or during the analytical process. If present, there will be a section in the Case Narrative to discuss the meaning of any data qualifiers used in the report.
Quality Control Summary (Qc)	This section of the report includes the results of the laboratory quality control analyses required by procedure or analytical methods to assist in evaluating the validity of the results reported for your samples. These analyses are not being performed on your samples typically, but on laboratory generated material.
Sample Chain of Custody (Sc)	This is the document created in the field when your samples were initially collected. This is used to verify the time and date of collection, the person collecting the samples, and the analyses that the laboratory is requested to perform. This chain of custody also documents all persons (excluding commercial shippers) that have had control or possession of the samples from the time of collection until delivery to the laboratory for analysis.
Sample Results (Sr)	This section of your report will provide the results of all testing performed on your samples. These results are provided by sample ID and are separated by the analyses performed on each sample. The header line of each analysis section for each sample will provide the name and method number for the analysis reported.
Sample Summary (Ss)	This section of the Analytical Report defines the specific analyses performed for each sample ID, including the dates and times of preparation and/or analysis.

Qualifier	Description
J	The identification of the analyte is acceptable; the reported value is an estimate.

ESC Lab Sciences is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our one location design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be YOUR LAB OF CHOICE.
* Not all certifications held by the laboratory are applicable to the results reported in the attached report.
* Accreditation is only applicable to the test methods specified on each scope of accreditation held by ESC Lab Sciences.

State Accreditations

Alabama	40660	Nebraska	NE-OS-15-05
Alaska	17-026	Nevada	TN-03-2002-34
Arizona	AZ0612	New Hampshire	2975
Arkansas	88-0469	New Jersey–NELAP	TN002
California	2932	New Mexico [1]	n/a
Colorado	TN00003	New York	11742
Connecticut	PH-0197	North Carolina	Env375
Florida	E87487	North Carolina [1]	DW21704
Georgia	NELAP	North Carolina [3]	41
Georgia [1]	923	North Dakota	R-140
Idaho	TN00003	Ohio–VAP	CL0069
Illinois	200008	Oklahoma	9915
Indiana	C-TN-01	Oregon	TN200002
Iowa	364	Pennsylvania	68-02979
Kansas	E-10277	Rhode Island	LAO00356
Kentucky [1 6]	90010	South Carolina	84004
Kentucky [2]	16	South Dakota	n/a
Louisiana	AI30792	Tennessee [1 4]	2006
Louisiana [1]	LA180010	Texas	T 104704245-17-14
Maine	TN0002	Texas [5]	LAB0152
Maryland	324	Utah	TN00003
Massachusetts	M-TN003	Vermont	VT2006
Michigan	9958	Virginia	460132
Minnesota	047-999-395	Washington	C847
Mississippi	TN00003	West Virginia	233
Missouri	340	Wisconsin	9980939910
Montana	CERT0086	Wyoming	A2LA

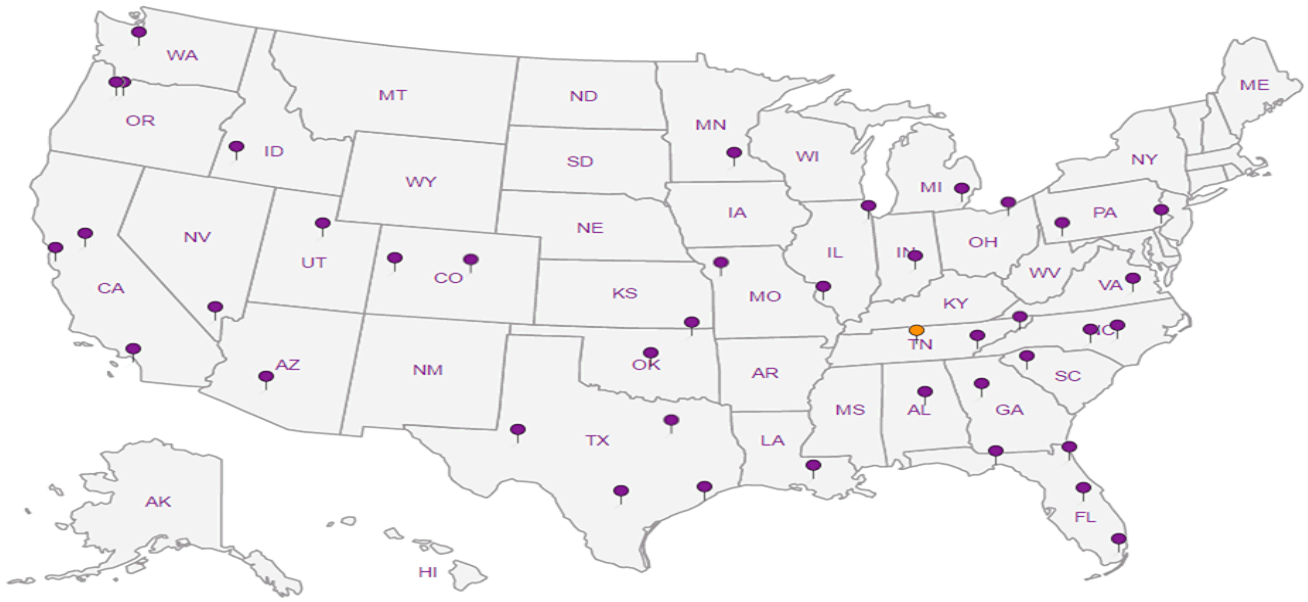
Third Party Federal Accreditations

A2LA – ISO 17025	1461.01	AIHA-LAP,LLC EMLAP	100789
A2LA – ISO 17025 [5]	1461.02	DOD	1461.01
Canada	1461.01	USDA	P330-15-00234
EPA–Crypto	TN00003		

[1] Drinking Water [2] Underground Storage Tanks [3] Aquatic Toxicity [4] Chemical/Microbiological [5] Mold [6] Wastewater n/a Accreditation not applicable

Our Locations

ESC Lab Sciences has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. ESC Lab Sciences performs all testing at our central laboratory.



APEX Companies - Portland, OR

3015 SW First Avenue
Portland, OR 97201-4707

Billing Information:
Accounts Payable
3015 SW First Ave.
Portland, OR 97201-4707

Pres Chk

Report to: Megan Masterson

Email To: megan.masterson@apexcos.com SSALISBURY@APEXCOS.COM

Project Description: Nustar - Vancouver Annex

City/State Collected: OR VANCOUVER WA

Phone: 503-924-4704
Fax: 503-943-6357

Client Project # 1569-12

Lab Project # ASHCREPOR-NUVANCOUVE

Collected by (print): M. MASTERSON

Site/Facility ID # VANCOUVER, WA

P.O. #

Collected by (signature):

Immediately Packed on Ice N ___ Y ✓

Rush? (Lab MUST Be Notified)
___ Same Day ___ Five Day
___ Next Day ___ 5 Day (Rad Only)
___ Two Day ___ 10 Day (Rad Only)
___ Three Day STANDARD

Quote #

Date Results Needed

Sample ID	Comp/Grab	Matrix *	Depth	Date	Time	No. of Cntrs	NWTPHDXLVI w/ SGT 40mlAmb-HCl-BT	NWTPHGX 40mlAmb HCl	V8260BTEXC 40mlAmb-HCl							Remarks	Sample # (lab only)
MW-5		GW		2-28-18	1150	8	X	X	X								-01
MW-5D		GW		2-28-18	1125	8	X	X	X								02
MW-6		GW		2-28-18	1040	8	X	X	X								03
		GW															

Analysis / Container / Preservative

Chain of Custody Page ___ of ___

ESC LAB SCIENCES
a subsidiary of Accutest

12065 Lebanon Rd
Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
Fax: 615-758-5859

L# L994072
G174

Acctnum: ASHCREPOR
Template: T133159
Prelogin: P640529
TSR: 110 - Brian Ford
PB:
Shipped Via:

* Matrix:
SS - Soil AIR - Air F - Filter
GW - Groundwater B - Bioassay
WW - WasteWater
DW - Drinking Water
OT - Other_____

Remarks: Please email results to: SSALISBURY@APEXCOS.COM STANDARD TAT

pH _____ Temp _____
Flow _____ Other _____

Samples returned via: __ UPS __ FedEx __ Courier _____

Tracking # 4196 3255 6166

Sample Receipt Checklist
COC Seal Present/Intact: NP Y N
COC Signed/Accurate: Y N
Bottles arrive intact: Y N
Correct bottles used: Y N
Sufficient volume sent: Y N
If Applicable
VOA Zero Headspace: Y N
Preservation Correct/Checked: Y N

Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Trip Blank Received: Yes / No HCl / MeoH TBR
MH	2/28/18	1400		
Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Temp: 2.1 °C Bottles Received: 24
Relinquished by: (Signature)	Date:	Time:	Received for lab by: (Signature) B. Sle 962	Date: 03.01.18 Time: 845

If preservation required by Login: Date/Time

Hold:

Condition: NCF (OK)

Pace Analytical Services, LLC
1700 Elm Street - Suite 200
Minneapolis, MN 55414
(612)607-1700

June 11, 2018

Stephanie Bosze-Salisbury
Apex Companies, LLC
3015 SW First Avenue
Portland, OR 97201

RE: Project: 1569-12 NuStar Vancouver Annex
Pace Project No.: 10433756

Dear Stephanie Bosze-Salisbury:
Enclosed are the analytical results for sample(s) received by the laboratory on June 02, 2018. The results relate only to the samples included in this report. Results reported herein conform to the most current, applicable TNI/NELAC standards and the laboratory's Quality Assurance Manual, where applicable, unless otherwise noted in the body of the report.

The samples were received outside of required temperature range. Analysis was completed upon client approval.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Annika Asp
annika.asp@pacelabs.com
(612)607-1700
Project Manager

Enclosures

Pace Analytical Services, LLC
1700 Elm Street - Suite 200
Minneapolis, MN 55414
(612)607-1700

CERTIFICATIONS

Project: 1569-12 NuStar Vancouver Annex
Pace Project No.: 10433756

Minnesota Certification IDs

1700 Elm Street SE, Suite 200, Minneapolis, MN 55414-2485
A2LA Certification #: 2926.01
Alabama Certification #: 40770
Alaska Contaminated Sites Certification #: 17-009
Alaska DW Certification #: MN00064
Arizona Certification #: AZ0014
Arkansas Certification #: 88-0680
California Certification #: 2929
CNMI Saipan Certification #:MP0003
Colorado Certification #: MN00064
Connecticut Certification #: PH-0256
EPA Region 8+Wyoming DW Certification #: via MN 027-053-137
Florida Certification #: E87605
Georgia Certification #: 959
Guam EPA Certification #: MN00064
Hawaii Certification #: MN00064
Idaho Certification #: MN00064
Illinois Certification #: 200011
Indiana Certification #: C-MN-01
Iowa Certification #: 368
Kansas Certification #: E-10167
Kentucky DW Certification #: 90062
Kentucky WW Certification #: 90062
Louisiana DEQ Certification #: 03086
Louisiana DW Certification #: MN00064
Maine Certification #: MN00064
Maryland Certification #: 322
Massachusetts Certification #: M-MN064
Michigan Certification #: 9909
Minnesota Certification #: 027-053-137
Mississippi Certification #: MN00064
Montana Certification #: CERT0092
Nebraska Certification #: NE-OS-18-06
Nevada Certification #: MN00064
New Hampshire Certification #: 2081
New Jersey Certification #: MN002
New York Certification #: 11647
North Carolina DW Certification #: 27700
North Carolina WW Certification #: 530
North Dakota Certification #: R-036
Ohio DW Certification #: 41244
Ohio VAP Certification #: CL101
Oklahoma Certification #: 9507
Oregon NwTPH Certification #: MN300001
Oregon Secondary Certification #: MN200001
Pennsylvania Certification #: 68-00563
Puerto Rico Certification #: MN00064
South Carolina Certification #:74003001
Tennessee Certification #: TN02818
Texas Certification #: T104704192
Utah Certification #: MN00064
Virginia Certification #: 460163
Washington Certification #: C486
West Virginia DW Certification #: 9952 C
West Virginia DEP Certification #: 382
Wisconsin Certification #: 999407970

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Minneapolis, MN 55414
(612)607-1700

SAMPLE SUMMARY

Project: 1569-12 NuStar Vancouver Annex
Pace Project No.: 10433756

Lab ID	Sample ID	Matrix	Date Collected	Date Received
10433756001	**MW-5**	Water	05/29/18 11:04	06/02/18 09:15
10433756002	**MW-5D**	Water	05/29/18 11:30	06/02/18 09:15
10433756003	**MW-6**	Water	05/29/18 10:25	06/02/18 09:15
10433756004	**Trip Blank**	Water	05/29/18 00:00	06/02/18 09:15

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SAMPLE ANALYTE COUNT

Project: 1569-12 NuStar Vancouver Annex
Pace Project No.: 10433756

Lab ID	Sample ID	Method	Analysts	Analytes Reported	Laboratory
10433756001	**MW-5**	NWTPH-Dx	EC2	4	PASI-M
		NWTPH-Gx	AJR	2	PASI-M
		EPA 8260B	DS2, MJD	7	PASI-M
10433756002	**MW-5D**	NWTPH-Dx	EC2	4	PASI-M
		NWTPH-Gx	AJR	2	PASI-M
		EPA 8260B	DS2	7	PASI-M
10433756003	**MW-6**	NWTPH-Dx	EC2	4	PASI-M
		NWTPH-Gx	AJR	2	PASI-M
		EPA 8260B	DS2, MJD	7	PASI-M
10433756004	**Trip Blank**	NWTPH-Gx	AJR	2	PASI-M
		EPA 8260B	MJD	7	PASI-M

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PROJECT NARRATIVE

Project: 1569-12 NuStar Vancouver Annex
Pace Project No.: 10433756

Method: **NWTPH-Dx**
Description: NWTPH-Dx GCS Silica Gel LV
Client: Apex Companies, LLC_Davis
Date: June 11, 2018

General Information:
3 samples were analyzed for NWTPH-Dx. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Sample Preparation:
The samples were prepared in accordance with EPA Mod. 3510C with any exceptions noted below.

Initial Calibrations (including MS Tune as applicable):
All criteria were within method requirements with any exceptions noted below.

Continuing Calibration:
All criteria were within method requirements with any exceptions noted below.

Surrogates:
All surrogates were within QC limits with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

Duplicate Sample:
All duplicate sample results were within method acceptance criteria with any exceptions noted below.

Additional Comments:

Pace Analytical Services, LLC
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Minneapolis, MN 55414
(612)607-1700

PROJECT NARRATIVE

Project: 1569-12 NuStar Vancouver Annex
Pace Project No.: 10433756

Method: **NWTPH-Gx**
Description: NWTPH-Gx GCV
Client: Apex Companies, LLC_Davis
Date: June 11, 2018

General Information:
4 samples were analyzed for NWTPH-Gx. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Initial Calibrations (including MS Tune as applicable):
All criteria were within method requirements with any exceptions noted below.

Continuing Calibration:
All criteria were within method requirements with any exceptions noted below.

Surrogates:
All surrogates were within QC limits with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

QC Batch: 542721

A matrix spike and/or matrix spike duplicate (MS/MSD) were performed on the following sample(s): 10433667002

R1: RPD value was outside control limits.

- MSD (Lab ID: 2952497)
  - TPH as Gas

Duplicate Sample:
All duplicate sample results were within method acceptance criteria with any exceptions noted below.

Additional Comments:

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Minneapolis, MN 55414
(612)607-1700

PROJECT NARRATIVE

Project: 1569-12 NuStar Vancouver Annex
Pace Project No.: 10433756

Method: **EPA 8260B**
Description: 8260B MSV UST
Client: Apex Companies, LLC_Davis
Date: June 11, 2018

General Information:
4 samples were analyzed for EPA 8260B. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Initial Calibrations (including MS Tune as applicable):
All criteria were within method requirements with any exceptions noted below.

Continuing Calibration:
All criteria were within method requirements with any exceptions noted below.

Internal Standards:
All internal standards were within QC limits with any exceptions noted below.

Surrogates:
All surrogates were within QC limits with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

Additional Comments:

This data package has been reviewed for quality and completeness and is approved for release.

Pace Analytical Services, LLC
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Minneapolis, MN 55414
(612)607-1700

ANALYTICAL RESULTS

Project: 1569-12 NuStar Vancouver Annex
Pace Project No.: 10433756

Sample: MW-5 **Lab ID: 10433756001** Collected: 05/29/18 11:04 Received: 06/02/18 09:15 Matrix: Water

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
NWTPH-Dx GCS Silica Gel LV	Analytical Method: NWTPH-Dx Preparation Method: EPA Mod. 3510C							
Diesel Fuel Range SG	**2.2**	mg/L	0.38	1	06/05/18 15:24	06/07/18 13:10	68334-30-5	
Motor Oil Range SG	ND	mg/L	0.38	1	06/05/18 15:24	06/07/18 13:10	64742-65-0	
Surrogates								
o-Terphenyl (S)	81	%.	50-150	1	06/05/18 15:24	06/07/18 13:10	84-15-1	
n-Triacontane (S)	94	%.	50-150	1	06/05/18 15:24	06/07/18 13:10	638-68-6	
NWTPH-Gx GCV	Analytical Method: NWTPH-Gx							
TPH as Gas	**13200**	ug/L	1000	10		06/09/18 00:51		
Surrogates								
a,a,a-Trifluorotoluene (S)	95	%.	50-150	10		06/09/18 00:51	98-08-8	
8260B MSV UST	Analytical Method: EPA 8260B							
Benzene	ND	ug/L	1.0	1		06/07/18 00:37	71-43-2	
Ethylbenzene	**271**	ug/L	20.0	20		06/08/18 01:26	100-41-4	
Toluene	**1.3**	ug/L	1.0	1		06/07/18 00:37	108-88-3	
Xylene (Total)	**1150**	ug/L	60.0	20		06/08/18 01:26	1330-20-7	
Surrogates								
1,2-Dichloroethane-d4 (S)	104	%.	75-125	1		06/07/18 00:37	17060-07-0	
Toluene-d8 (S)	97	%.	75-125	1		06/07/18 00:37	2037-26-5	
4-Bromofluorobenzene (S)	97	%.	75-125	1		06/07/18 00:37	460-00-4	

Sample: MW-5D **Lab ID: 10433756002** Collected: 05/29/18 11:30 Received: 06/02/18 09:15 Matrix: Water

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
NWTPH-Dx GCS Silica Gel LV	Analytical Method: NWTPH-Dx Preparation Method: EPA Mod. 3510C							
Diesel Fuel Range SG	ND	mg/L	0.38	1	06/05/18 15:24	06/07/18 13:32	68334-30-5	
Motor Oil Range SG	ND	mg/L	0.38	1	06/05/18 15:24	06/07/18 13:32	64742-65-0	
Surrogates								
o-Terphenyl (S)	72	%.	50-150	1	06/05/18 15:24	06/07/18 13:32	84-15-1	
n-Triacontane (S)	80	%.	50-150	1	06/05/18 15:24	06/07/18 13:32	638-68-6	
NWTPH-Gx GCV	Analytical Method: NWTPH-Gx							
TPH as Gas	**680**	ug/L	100	1		06/06/18 20:49		
Surrogates								
a,a,a-Trifluorotoluene (S)	92	%.	50-150	1		06/06/18 20:49	98-08-8	
8260B MSV UST	Analytical Method: EPA 8260B							
Benzene	ND	ug/L	1.0	1		06/07/18 20:10	71-43-2	
Ethylbenzene	**2.2**	ug/L	1.0	1		06/07/18 20:10	100-41-4	
Toluene	ND	ug/L	1.0	1		06/07/18 20:10	108-88-3	
Xylene (Total)	ND	ug/L	3.0	1		06/07/18 20:10	1330-20-7	
Surrogates								
1,2-Dichloroethane-d4 (S)	102	%.	75-125	1		06/07/18 20:10	17060-07-0	
Toluene-d8 (S)	93	%.	75-125	1		06/07/18 20:10	2037-26-5	
4-Bromofluorobenzene (S)	99	%.	75-125	1		06/07/18 20:10	460-00-4	

REPORT OF LABORATORY ANALYSIS

Pace Analytical Services, LLC
1700 Elm Street - Suite 200
Minneapolis, MN 55414
(612)607-1700

ANALYTICAL RESULTS

Project: 1569-12 NuStar Vancouver Annex
Pace Project No.: 10433756

Sample: MW-6 **Lab ID: 10433756003** Collected: 05/29/18 10:25 Received: 06/02/18 09:15 Matrix: Water

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
NWTPH-Dx GCS Silica Gel LV	Analytical Method: NWTPH-Dx Preparation Method: EPA Mod. 3510C							
Diesel Fuel Range SG	**9.3**	mg/L	0.39	1	06/05/18 15:24	06/07/18 13:43	68334-30-5	
Motor Oil Range SG	**0.57**	mg/L	0.39	1	06/05/18 15:24	06/07/18 13:43	64742-65-0	
Surrogates								
o-Terphenyl (S)	78	%.	50-150	1	06/05/18 15:24	06/07/18 13:43	84-15-1	
n-Triacontane (S)	83	%.	50-150	1	06/05/18 15:24	06/07/18 13:43	638-68-6	
NWTPH-Gx GCV	Analytical Method: NWTPH-Gx							
TPH as Gas	**1500**	ug/L	100	1		06/09/18 01:25		
Surrogates								
a,a,a-Trifluorotoluene (S)	88	%.	50-150	1		06/09/18 01:25	98-08-8	
8260B MSV UST	Analytical Method: EPA 8260B							
Benzene	**230**	ug/L	20.0	20		06/08/18 01:43	71-43-2	
Ethylbenzene	**1380**	ug/L	20.0	20		06/08/18 01:43	100-41-4	
Toluene	**44.4**	ug/L	1.0	1		06/07/18 01:12	108-88-3	
Xylene (Total)	**891**	ug/L	60.0	20		06/08/18 01:43	1330-20-7	
Surrogates								
1,2-Dichloroethane-d4 (S)	100	%.	75-125	1		06/07/18 01:12	17060-07-0	
Toluene-d8 (S)	96	%.	75-125	1		06/07/18 01:12	2037-26-5	
4-Bromofluorobenzene (S)	99	%.	75-125	1		06/07/18 01:12	460-00-4	

Sample: Trip Blank **Lab ID: 10433756004** Collected: 05/29/18 00:00 Received: 06/02/18 09:15 Matrix: Water

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
NWTPH-Gx GCV	Analytical Method: NWTPH-Gx							
TPH as Gas	ND	ug/L	100	1		06/06/18 23:54		HS
Surrogates								
a,a,a-Trifluorotoluene (S)	94	%.	50-150	1		06/06/18 23:54	98-08-8	
8260B MSV UST	Analytical Method: EPA 8260B							
Benzene	ND	ug/L	1.0	1		06/06/18 19:57	71-43-2	
Ethylbenzene	ND	ug/L	1.0	1		06/06/18 19:57	100-41-4	
Toluene	ND	ug/L	1.0	1		06/06/18 19:57	108-88-3	
Xylene (Total)	ND	ug/L	3.0	1		06/06/18 19:57	1330-20-7	
Surrogates								
1,2-Dichloroethane-d4 (S)	101	%.	75-125	1		06/06/18 19:57	17060-07-0	
Toluene-d8 (S)	94	%.	75-125	1		06/06/18 19:57	2037-26-5	
4-Bromofluorobenzene (S)	99	%.	75-125	1		06/06/18 19:57	460-00-4	

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QUALITY CONTROL DATA

Project: 1569-12 NuStar Vancouver Annex
Pace Project No.: 10433756

QC Batch: 542721 Analysis Method: NWTPH-Gx
QC Batch Method: NWTPH-Gx Analysis Description: NWTPH-Gx Water
Associated Lab Samples: 10433756002, 10433756004

METHOD BLANK: 2951205 Matrix: Water
Associated Lab Samples: 10433756002, 10433756004

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
TPH as Gas	ug/L	ND	100	06/06/18 17:42	
a,a,a-Trifluorotoluene (S)	%.	90	50-150	06/06/18 17:42	

METHOD BLANK: 2951206 Matrix: Water
Associated Lab Samples: 10433756002, 10433756004

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
TPH as Gas	ug/L	ND	100	06/06/18 17:59	
a,a,a-Trifluorotoluene (S)	%.	95	50-150	06/06/18 17:59	

LABORATORY CONTROL SAMPLE & LCSD: 2951207 2951208

Parameter	Units	Spike Conc.	LCS Result	LCSD Result	LCS % Rec	LCSD % Rec	% Rec Limits	RPD	Max RPD	Qualifiers
TPH as Gas	ug/L	1000	1010	1050	101	105	41-137	4	20	
a,a,a-Trifluorotoluene (S)	%.				99	99	50-150			

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2952496 2952497

Parameter	Units	10433667002 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
TPH as Gas	ug/L	ND	1000	1000	708	1010	70	100	30-145	35	30	R1
a,a,a-Trifluorotoluene (S)	%.						99	100	50-150			

SAMPLE DUPLICATE: 2952498

Parameter	Units	10433667003 Result	Dup Result	RPD	Max RPD	Qualifiers
TPH as Gas	ug/L	ND	ND		30	
a,a,a-Trifluorotoluene (S)	%.	84	83	1		

SAMPLE DUPLICATE: 2952499

Parameter	Units	10433926005 Result	Dup Result	RPD	Max RPD	Qualifiers
TPH as Gas	ug/L	<15.0	ND		30	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

REPORT OF LABORATORY ANALYSIS

Pace Analytical Services, LLC
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QUALITY CONTROL DATA

Project: 1569-12 NuStar Vancouver Annex
Pace Project No.: 10433756

SAMPLE DUPLICATE: 2952499

Parameter	Units	10433926005 Result	Dup Result	RPD	Max RPD	Qualifiers
a,a,a-Trifluorotoluene (S)	%.	89	81	9		

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REPORT OF LABORATORY ANALYSIS

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QUALITY CONTROL DATA

Project: 1569-12 NuStar Vancouver Annex
Pace Project No.: 10433756

QC Batch: 543445 Analysis Method: NWTPH-Gx
QC Batch Method: NWTPH-Gx Analysis Description: NWTPH-Gx Water
Associated Lab Samples: 10433756001, 10433756003

METHOD BLANK: 2954934 Matrix: Water
Associated Lab Samples: 10433756001, 10433756003

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
TPH as Gas	ug/L	ND	100	06/08/18 22:03	
a,a,a-Trifluorotoluene (S)	%.	90	50-150	06/08/18 22:03	

LABORATORY CONTROL SAMPLE & LCSD: 2954935 2954936

Parameter	Units	Spike Conc.	LCS Result	LCSD Result	LCS % Rec	LCSD % Rec	% Rec Limits	RPD	Max RPD	Qualifiers
TPH as Gas	ug/L	1000	992	1010	99	101	41-137	2	20	
a,a,a-Trifluorotoluene (S)	%.				96	99	50-150			

SAMPLE DUPLICATE: 2955393

Parameter	Units	10433756001 Result	Dup Result	RPD	Max RPD	Qualifiers
TPH as Gas	ug/L	13200	13700	4	30	
a,a,a-Trifluorotoluene (S)	%.	95	96	1		

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REPORT OF LABORATORY ANALYSIS

Pace Analytical Services, LLC
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QUALITY CONTROL DATA

Project: 1569-12 NuStar Vancouver Annex
Pace Project No.: 10433756

QC Batch: 542950 Analysis Method: EPA 8260B
QC Batch Method: EPA 8260B Analysis Description: 8260B MSV UST-WATER
Associated Lab Samples: 10433756001, 10433756003, 10433756004

METHOD BLANK: 2952202 Matrix: Water
Associated Lab Samples: 10433756001, 10433756003, 10433756004

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Benzene	ug/L	ND	1.0	06/06/18 19:22	
Ethylbenzene	ug/L	ND	1.0	06/06/18 19:22	
Toluene	ug/L	ND	1.0	06/06/18 19:22	
Xylene (Total)	ug/L	ND	3.0	06/06/18 19:22	
1,2-Dichloroethane-d4 (S)	%.	103	75-125	06/06/18 19:22	
4-Bromofluorobenzene (S)	%.	99	75-125	06/06/18 19:22	
Toluene-d8 (S)	%.	93	75-125	06/06/18 19:22	

LABORATORY CONTROL SAMPLE: 2952203

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Benzene	ug/L	20	23.9	120	75-126	
Ethylbenzene	ug/L	20	22.2	111	75-125	
Toluene	ug/L	20	21.1	106	74-125	
Xylene (Total)	ug/L	60	64.6	108	75-125	
1,2-Dichloroethane-d4 (S)	%.			101	75-125	
4-Bromofluorobenzene (S)	%.			100	75-125	
Toluene-d8 (S)	%.			95	75-125	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2952216 2952217

Parameter	Units	10433739012 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Benzene	ug/L	1630	200	200	1900	1900	137	136	62-140	0	30	
Ethylbenzene	ug/L	765	200	200	986	981	111	108	75-131	1	30	
Toluene	ug/L	60.5	200	200	264	262	102	101	68-132	0	30	
Xylene (Total)	ug/L	971	600	600	1630	1620	110	108	69-135	1	30	
1,2-Dichloroethane-d4 (S)	%.						100	99	75-125			
4-Bromofluorobenzene (S)	%.						99	99	75-125			
Toluene-d8 (S)	%.						95	95	75-125			

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REPORT OF LABORATORY ANALYSIS

Pace Analytical Services, LLC
1700 Elm Street - Suite 200
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(612)607-1700

QUALITY CONTROL DATA

Project: 1569-12 NuStar Vancouver Annex
Pace Project No.: 10433756

QC Batch: 543144 Analysis Method: EPA 8260B
QC Batch Method: EPA 8260B Analysis Description: 8260B MSV UST-WATER
Associated Lab Samples: 10433756002

METHOD BLANK: 2953229 Matrix: Water
Associated Lab Samples: 10433756002

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Benzene	ug/L	ND	1.0	06/07/18 19:00	
Ethylbenzene	ug/L	ND	1.0	06/07/18 19:00	
Toluene	ug/L	ND	1.0	06/07/18 19:00	
Xylene (Total)	ug/L	ND	3.0	06/07/18 19:00	
1,2-Dichloroethane-d4 (S)	%.	99	75-125	06/07/18 19:00	
4-Bromofluorobenzene (S)	%.	100	75-125	06/07/18 19:00	
Toluene-d8 (S)	%.	93	75-125	06/07/18 19:00	

LABORATORY CONTROL SAMPLE: 2953230

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Benzene	ug/L	20	23.4	117	75-126	
Ethylbenzene	ug/L	20	20.6	103	75-125	
Toluene	ug/L	20	19.3	96	74-125	
Xylene (Total)	ug/L	60	60.7	101	75-125	
1,2-Dichloroethane-d4 (S)	%.			98	75-125	
4-Bromofluorobenzene (S)	%.			96	75-125	
Toluene-d8 (S)	%.			93	75-125	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2953231 2953232

Parameter	Units	10433739011 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Benzene	ug/L	90.8	200	200	338	341	124	125	62-140	1	30	
Ethylbenzene	ug/L	483	200	200	720	709	118	113	75-131	1	30	
Toluene	ug/L	ND	200	200	212	210	104	103	68-132	1	30	
Xylene (Total)	ug/L	1220	600	600	1940	1910	120	115	69-135	2	30	
1,2-Dichloroethane-d4 (S)	%.						98	99	75-125			
4-Bromofluorobenzene (S)	%.						96	96	75-125			
Toluene-d8 (S)	%.						92	93	75-125			

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REPORT OF LABORATORY ANALYSIS

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1700 Elm Street - Suite 200
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(612)607-1700

QUALITY CONTROL DATA

Project: 1569-12 NuStar Vancouver Annex
Pace Project No.: 10433756

QC Batch: 542660 Analysis Method: NWTPH-Dx
QC Batch Method: EPA Mod. 3510C Analysis Description: NWTPH-Dx GCS LV SG
Associated Lab Samples: 10433756001, 10433756002, 10433756003

METHOD BLANK: 2950839 Matrix: Water
Associated Lab Samples: 10433756001, 10433756002, 10433756003

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Diesel Fuel Range SG	mg/L	ND	0.40	06/07/18 12:37	
Motor Oil Range SG	mg/L	ND	0.40	06/07/18 12:37	
n-Triacontane (S)	%.	88	50-150	06/07/18 12:37	
o-Terphenyl (S)	%.	75	50-150	06/07/18 12:37	

LABORATORY CONTROL SAMPLE & LCSD: 2950840 2950841

Parameter	Units	Spike Conc.	LCS Result	LCSD Result	LCS % Rec	LCSD % Rec	% Rec Limits	RPD	Max RPD	Qualifiers
Diesel Fuel Range SG	mg/L	2	1.8	1.8	90	91	50-150	1	20	
Motor Oil Range SG	mg/L	2	1.9	1.9	93	93	50-150	0	20	
n-Triacontane (S)	%.				93	95	50-150			
o-Terphenyl (S)	%.				82	83	50-150			

SAMPLE DUPLICATE: 2950842

Parameter	Units	10433756001 Result	Dup Result	RPD	Max RPD	Qualifiers
Diesel Fuel Range SG	mg/L	2.2	2.2	2	30	
Motor Oil Range SG	mg/L	ND	.089J		30	
n-Triacontane (S)	%.	94	89	7		
o-Terphenyl (S)	%.	81	73	12		

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REPORT OF LABORATORY ANALYSIS

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1700 Elm Street - Suite 200
Minneapolis, MN 55414
(612)607-1700

QUALIFIERS

Project: 1569-12 NuStar Vancouver Annex
Pace Project No.: 10433756

DEFINITIONS

DF - Dilution Factor, if reported, represents the factor applied to the reported data due to dilution of the sample aliquot.

ND - Not Detected at or above adjusted reporting limit.

TNTC - Too Numerous To Count

J - Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.

MDL - Adjusted Method Detection Limit.

PQL - Practical Quantitation Limit.

RL - Reporting Limit.

S - Surrogate

1,2-Diphenylhydrazine decomposes to and cannot be separated from Azobenzene using Method 8270. The result for each analyte is a combined concentration.

Consistent with EPA guidelines, unrounded data are displayed and have been used to calculate % recovery and RPD values.

LCS(D) - Laboratory Control Sample (Duplicate)

MS(D) - Matrix Spike (Duplicate)

DUP - Sample Duplicate

RPD - Relative Percent Difference

NC - Not Calculable.

SG - Silica Gel - Clean-Up

U - Indicates the compound was analyzed for, but not detected.

N-Nitrosodiphenylamine decomposes and cannot be separated from Diphenylamine using Method 8270. The result reported for each analyte is a combined concentration.

Pace Analytical is TNI accredited. Contact your Pace PM for the current list of accredited analytes.

TNI - The NELAC Institute.

LABORATORIES

PASI-M	Pace Analytical Services - Minneapolis

ANALYTE QUALIFIERS

HS	Results are from sample aliquot taken from VOA vial with headspace (air bubble greater than 6 mm diameter).
R1	RPD value was outside control limits.

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QUALITY CONTROL DATA CROSS REFERENCE TABLE

Project: 1569-12 NuStar Vancouver Annex
Pace Project No.: 10433756

Lab ID	Sample ID	QC Batch Method	QC Batch	Analytical Method	Analytical Batch
10433756001	**MW-5**	EPA Mod. 3510C	542660	NWTPH-Dx	543230
10433756002	**MW-5D**	EPA Mod. 3510C	542660	NWTPH-Dx	543230
10433756003	**MW-6**	EPA Mod. 3510C	542660	NWTPH-Dx	543230
10433756001	**MW-5**	NWTPH-Gx	543445		
10433756002	**MW-5D**	NWTPH-Gx	542721		
10433756003	**MW-6**	NWTPH-Gx	543445		
10433756004	**Trip Blank**	NWTPH-Gx	542721		
10433756001	**MW-5**	EPA 8260B	542950		
10433756002	**MW-5D**	EPA 8260B	543144		
10433756003	**MW-6**	EPA 8260B	542950		
10433756004	**Trip Blank**	EPA 8260B	542950		

APEX

CHAIN OF CUSTODY RECORD

WO# : 10433756

10433756

Client Name: Apex Companies, LLC
Address: 3015 SW First Ave
City/State/Zip: Portland, OR 97201
Telep

Project Manager: Stephanie Bosze Salisbury 503-924-4704 x1925
Analytic

Project Name: NuStar Vacouver Annex GWM
Report To: Ssalisbury@Apexcos.com

Project Number: 1569-12
Page: 1 of 1

Sampler Name: M. Masterson

Sample ID / Description	Date Sampled	Time Sampled	No. of Containers Shipped	Grab	Composite	Field Filtered	Preservative: Ice	HNO_3 (Red Label)	HCl (Blue Label)	NaOH (Orange Label)	H_2SO_4 Plastic (Yellow Label)	H_2SO_4 Glass(Yellow Label)	None (Black Label)	Other (Specify)	Matrix: Groundwater	Wastewater	Drinking Water	Sludge	Soil	Other (specify):	Analyze For: TPH-diesel and heavy oil -NWTPG-Dx with silica gel clea	NWTPH-Gx	BTEX by 8260B	RUSH TAT (Pre-Schedule)	Standard TAT	Fax Results	Send QC with report
MW-5	5/29/18	1104	8	X			X		X						X						X	X	X		X		
MW-5D	5/29/18	1130	8	X			X		X						X						X	X	X		X		
MW-6	5/29/18	1025	8	X			X		X						X						X	X	X		X		
Trip Blank			4																								
HK 6/2/18																											

Special Instructions: TPH-Dx samples include Silica Gel Cleanup

Method of Shipment: FexEx

Laboratory Comments:
Temperature Upon Receipt:
VOCs Free of Headspace? Y N

Relinquished by: Name/Company	Date	Time	Received by: Name/Company	Date	Time
Megan Masterson / Apex Companies	6/1/2018	1500	Pace	6/2/18	915
Relinquished by: Name/Company	Date	Time	Received by: Name/Company	Date	Time
Relinquished by: Name/Company	Date	Time	Received by: Name/Company	Date	Time
Relinquished by: Name/Company	Date	Time	Received by: Name/Company	Date	Time

T=9.8

Pace Analytical	Document Name: **Sample Condition Upon Receipt Form**	Document Revised: 02May2018 Page 1 of 2
	Document No.: **F-MN-L-213-rev.23**	Issuing Authority: Pace Minnesota Quality Office

Sample Condition Upon Receipt

Client Name: Apex

Project #: WO#: 10433756

PM: AKO Due Date: 06/05/18

CLIENT: Apex_Davis

Courier: ☑ Fed Ex ☐ UPS ☐ USPS ☐ Client ☐ Commercial ☐ Pace ☐ SpeeDee ☐ Other:

Tracking Number: 7475 9833 1832

Custody Seal on Cooler/Box Present? ☐ Yes ☑ No **Seals Intact?** ☐ Yes ☑ No

Optional: Proj. Due Date: Proj. Name:

Packing Material: ☑ Bubble Wrap ☑ Bubble Bags ☐ None ☐ Other: **Temp Blank?** ☑ Yes ☐ No

Thermometer Used: ☐ G87A9170600254 ☑ G87A9155100842 **Type of Ice:** ☑ Wet ☐ Blue ☐ None ☐ Dry ☐ Melted

Cooler Temp Read (°C): 9.3 **Cooler Temp Corrected (°C):** 9.8 **Biological Tissue Frozen?** ☐ Yes ☐ No ☑ N/A

Temp should be above freezing to 6°C **Correction Factor:** True **Date and Initials of Person Examining Contents:** HF 6/2/18

USDA Regulated Soil (☑ N/A, water sample)

Did samples originate in a quarantine zone within the United States: AL, AR, CA, FL, GA, ID, LA. MS, NC, NM, NY, OK, OR, SC, TN, TX or VA (check maps)? ☐ Yes ☐ No

Did samples originate from a foreign source (internationally, including Hawaii and Puerto Rico)? ☐ Yes ☐ No

If Yes to either question, fill out a Regulated Soil Checklist (F-MN-Q-338) and include with SCUR/COC paperwork.

				COMMENTS:
Chain of Custody Present?	☑ Yes	☐ No		1.
Chain of Custody Filled Out?	☑ Yes	☐ No		2.
Chain of Custody Relinquished?	☑ Yes	☐ No		3.
Sampler Name and/or Signature on COC?	☐ Yes	☑ No	☐ N/A	4.
Samples Arrived within Hold Time?	☑ Yes	☐ No		5.
Short Hold Time Analysis (<72 hr)?	☐ Yes	☑ No		6.
Rush Turn Around Time Requested?	☐ Yes	☑ No		7.
Sufficient Volume?	☑ Yes	☐ No		8.
Correct Containers Used?	☑ Yes	☐ No		9.
-Pace Containers Used?	☑ Yes	☐ No		
Containers Intact?	☑ Yes	☐ No		10.
Filtered Volume Received for Dissolved Tests?	☐ Yes	☐ No	☑ N/A	11. Note if sediment is visible in the dissolved container
Is sufficient information available to reconcile the samples to the COC? Matrix: WT	☑ Yes	☐ No		12.
All containers needing acid/base preservation have been checked?	☐ Yes	☐ No	☑ N/A	13. ☐ HNO_3 ☐ H_2SO_4 ☐ NaOH Positive for Res. Chlorine? Y N
All containers needing preservation are found to be in compliance with EPA recommendation? (HNO_3, H_2SO_4, <2pH, NaOH >9 Sulfide, NaOH>12 Cyanide)	☐ Yes	☐ No	☑ N/A	Sample #
Exceptions: VOA, Coliform, TOC/DOC Oil and Grease, DRO/8015 (water) and Dioxin/PFAS	☑ Yes	☐ No	☐ N/A	Initial when completed: Lot # of added preservative:
Headspace in VOA Vials (>6mm)?	☑ Yes	☐ No	☐ N/A	14. 4/4 Trip Blanks have >6mm headspace
Trip Blank Present?	☑ Yes	☐ No	☐ N/A	15.
Trip Blank Custody Seals Present?	☑ Yes	☐ No	☐ N/A	
Pace Trip Blank Lot # (if purchased): 160158, 158227				

CLIENT NOTIFICATION/RESOLUTION **Field Data Required?** ☐ Yes ☐ No

Person Contacted: Megan Masterson Date/Time: 6/4/18

Comments/Resolution: Client was notified that samples were received out of recommended temperature and headspace greater than 6 mm was present in 4 of 4 trip blanks. Client confirmed the sample was collected in Washington and was from a non-potable water source.

Project Manager Review: Anne Osp **Date:** 6/4/18

Note: Whenever there is a discrepancy affecting North Carolina compliance samples, a copy of this form will be sent to the North Carolina DEHNR Certification Office (i.e out of hold, incorrect preservative, out of temp, incorrect containers).

APPENDIX B

SAMPLING METHODS AND PROTOCOLS

1. PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) describes the methods for observing and sampling from push-probes (i.e., GeoProbe™, AMS PowerProbe™, or similar). Subsurface soil cores may be obtained using this system for purposes of determining subsurface soil conditions and for obtaining soil samples for physical and/or chemical evaluation. Grab groundwater samples may be collected using temporary well screens. Soil vapor samples may be obtained using temporary well points. Shallow (less than 50 feet), small-diameter (2-inch max) pre-packed wells may also be installed using push-probe equipment. This procedure is applicable during all Cascadia Associates, LLC (Cascadia) push-probe activities.

2. EQUIPMENT AND MATERIALS

The following materials are necessary for this procedure:

- Traffic cones, tools, keys, and buckets/drums
- Water quality meter with calibration solutions (record daily calibration/calibration check in field notes)
- Sampling equipment (water level probe, pumps, tubing) and laboratory-supplied sample containers
- Field documentation materials
- Decontamination materials
- Personal protective equipment (as required by project Health and Safety Plan)

3. METHODOLOGY

Coring Procedure (Conducted by Drilling Subcontractor):

The sampling procedure includes driving a 2-inch outside-diameter, 5-foot-long, push-probe soil sampler to the desired depth using a combination of hydraulic pressure and mechanical hammer blows. When the sampling depth is reached, the pin attaching the sampler's tip is released (if a tip is used), which allows the tip to slide inside the sampler (Macro-Core Sampler with removable plastic liner). The sampler is driven the length of the sampler to collect a soil core, which is then withdrawn from the exploration. When the sampler is retrieved from the borehole the drive head/cutting shoe is detached and the liner is removed and the liner is cut open to expose the recovered soil core. Soil cores are collected continuously to the full depth of the exploration unless otherwise specified in a project-specific sampling and analysis plan (SAP). Verify that the subcontractor decontaminates the sampling device prior to its initial use and following collection of each soil sample.

Logging and Soil Sample Collection:

Remove the soil core from the sampler for field screening, description, and placement into sample jars. Soil samples will be collected for field screening and possible chemical analysis on two foot intervals unless otherwise specified in a project-specific SAP. The sampling interval will be determined in the field based on recovery, soil variability, and evidence of contamination.

Complete field screening as specified in the applicable SOP. Soil samples should be collected using different procedures for volatile on non-volatile analyses, as follows.

- Volatile Analyses. Sampling for volatile organics analysis (VOA) is different than other routine physical or chemical testing because of the potential loss of volatiles during sampling. To limit volatile loss, the soil sample must be obtained as quickly and as directly as possible. If a VOA sample is to collected as part of a multiple analyte sample, the VOA sample portion will be obtained first. The VOA sample should be obtained from a discrete portion of the entire collected sample and should not be composited or homogenized. Sample bottles should be filled to capacity, with no headspace.
- Other Analyses. Soil samples for non-volatile analyses will be thoroughly homogenized in a stainless-steel bowl prior to bottling. Sample homogenizing is accomplished by manually mixing the entire soil sample in the stainless-steel bowl with a clean sampling tool until a uniform mixture is achieved. The sample jar should be filled completely.

Grab Groundwater Sample Collection:

Collect grab groundwater samples using a sampling attachment with a 4 to 5-foot-long temporary screen (specify to drillers whether to use decontaminated stainless steel or disposable PVC. Also, specify whether a filter pack is necessary based on field observations). Obtain samples using a peristaltic pump unless otherwise specified in the SAP with new tubing for each boring. Record field parameters (e.g., temperature, conductivity, and pH) prior to sampling.

Backfilling the Excavation (Conducted by Drilling Subcontractor):

After sampling activities are completed, abandon each exploration in accordance with Oregon Water Resources Department (OWRD) regulations and procedures (or other regulatory authority if work is completed outside of the State of Oregon. The abandonment procedure typically consists of filling the exploration with granular bentonite and hydrating the bentonite with water. Match the surface completion to the surrounding materials.

1. PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) provides instructions for standard field screening. Field screening results are used to aid in the selection of soil samples for chemical analysis. This procedure is applicable during all Cascadia Associates, LLC (Cascadia) soil sampling operations.

Standard field screening techniques include the use of a photoionization detector (PID) to assess for volatile organic compounds (VOCs) and for the presence of separate-phase petroleum hydrocarbons using a sheen test. These methods will not detect all potential contaminants, so selection of screening techniques shall be based on an understanding of the site history. The PID is not compound or concentration-specific, but it can provide a qualitative indication of the presence of VOCs. PID measurements are affected by other field parameters such as temperature and soil moisture. Other field screening methods, such as screening for dense non-aqueous phase liquid (DNAPL) using dye or UV light, are not considered "standard" and will be detailed in the site-specific sampling and analysis plan (SAP).

2. EQUIPMENT AND MATERIALS

The following materials are necessary for this procedure:

- PID with calibration gas (record daily calibration/calibration check in field notes);
- Plastic resealable bags (for PID measurement); and
- Glass jars or stainless steel bowls (for sheen testing).

3. METHODOLOGY

Each soil sample will be field screened for VOCs using a PID and for the presence of separate-phase petroleum hydrocarbons using a sheen test.

PID lamps come in multiple sizes, typically 9.8, 10.6, and 11.7 electron volts (eV). The eV rating for the lamp must be greater than the ionization potential (in eV) of a compound for the PID to detect the compound. For petroleum hydrocarbons, a lamp of at least 9.8 eV should be used. For typical chlorinated alkenes (dichloroethene, trichloroethene, tetrachloroethene, or vinyl chloride), a lamp of at least 10.6 eV should be used. The compatibility of the lamp size with the site constituents should be verified prior to the field event and will be detailed in the site-specific SAP.

PID Calibration Procedure: The PID used on-site should be calibrated daily or more frequently if needed. Calibration of the PID should be documented in field notes. Calibrations procedures should be conducted per the manufacturer's instructions.

PID Screening Procedure:

- Place a representative portion (approximately one ounce) of freshly exposed, uncompacted soil into a clean resealable plastic bag.
- Seal the bag and break up the soil to expose vapors from the soil matrix.
- Allow the bag to sit to reach ambient temperature. Note: Ambient temperature and

weather conditions/humidity should be recorded in field notes. Changes in ambient temperature and weather during the field work should also be recorded, as temperature and humidity can affect PID readings.

- Carefully insert the intake port of the PID into the plastic bag.
- Record the PID measurement in the field notes or boring logs.

Sheen Test Procedure:

- Following the PID screen, place approximately one ounce of freshly exposed, uncompacted soil into a clean glass jar or stainless steel bowl.
- Add enough water to cover the sample.
- Observe the water surface for signs of discoloration/sheen and characterize based on the descriptions below.

No Sheen (NS)	No visible sheen on the water surface
Biogenic Film (BF)	Dull, platy/blocky or foamy film.
Slight Sheen (SS)	Light sheen with irregular spread, not rapid. May have small spots of color/iridescence. Majority of water surface not covered by sheen.
Moderate Sheen (MS)	Medium to heavy coverage, some color/iridescence, spread is irregular to flowing. Sheen covering a large portion of water surface.
Heavy Sheen (HS)	Heavy sheen coverage with color/iridescence, spread is rapid, entire water surface covered with sheen. Separate-phase hydrocarbons may be evident during sheen test.

1. PURPOSE AND SCOPE

The objective of this standard operating procedure (SOP) is to define the methods and requirements for collection of groundwater samples from monitoring wells applying low flow protocols. Low flow sampling is a technique for collecting samples that does not require the removal of large volumes of water and therefore does not overly agitate the water, suspend particles, or potentially aspirate VOCs. Typical flow rates for low flow sampling should range from 0.1 L/min to 0.5 L/min depending on site characteristics. The groundwater monitoring activities will consist of measuring water levels, purging and sampling groundwater, and measuring groundwater field parameters. This procedure is applicable during all Cascadia Associates, LLC low flow groundwater sampling activities.

2. EQUIPMENT AND MATERIALS

The following materials are necessary for this procedure:

- Traffic cones, tools, keys, and buckets/drums;
- Water quality meter with calibration solutions (record daily calibration/calibration check in field notes);
- Sampling equipment (water level indicator, pump, tubing);
- Laboratory-supplied sample containers (Consult the project-specific sampling and analysis plan (SAP) for sampling requirements);
- Field documentation materials;
- Decontamination materials; and
- Personal protective equipment (consult the site-specific Health and Safety Plan).

3. METHODOLOGY

Water Levels:

Water levels in the wells will be measured and recorded for the purpose of determining groundwater elevations and gradient. The wells will be opened and the water level allowed to equilibrate before the measurements are taken. Measurements of the depth to water will be made to the nearest 0.01 foot using an electronic water level indicator.

Purging:

Purge using low-flow sampling equipment (e.g., peristaltic or bladder pump) at a rate no greater than the recharge rate of the groundwater to prevent water table drawdown. Unless specified otherwise in the project-specific SAP the sample tubing/pump will be lowered to the middle of the screened interval. Groundwater field parameters (pH, electrical conductivity, and temperature) will be measured using a water quality meter and flow cell connected to the discharge tubing of the sample pump to assess the effectiveness of purging. Purging will be considered complete when the water quality parameters (i.e., pH, temperature, and specific conductance) stabilize within 10 percent for three consecutive 3-minute intervals. Consult the

project-specific SAP for additional parameters and stabilization criteria. Purge water will be placed in Department of Transportation (DOT) approved drums.

Sample Collection:

After the purging of each well is complete, collect groundwater samples for chemical analyses using the same pump used for the well purging.

Low Yield Sampling Procedure:

If a well pumps dry during purging discontinue measurement of water quality parameters. Collect groundwater samples once the water level recovers to 90 percent of the pre-purge water column. Contact project manager in the event of slow recharge conditions. Always collect samples for VOC analysis as soon after recharge as possible.

APPENDIX C

FIELD SAMPLING DATA SHEETS

APEX

3015 SW First Avenue
Portland, Oregon 97201-4707
(503) 924-4704 Phone
(503) 943-6357 Fax

PROJECT NUMBER 1569-12
FIELD REPORT NUMBER
PAGE 1 OF 1
DATE 2/28/2018

PROJECT	Vancouver Annex GWM	ARRIVAL TIME	0800
LOCATION	Vancouver, Washington	DEPARTURE TIME	1225
CLIENT	NuStar	WEATHER	Rainy / Lt. Wind
PURPOSE OF OBSERVATIONS	Gauge monitoring wells, collect samples from wells MW-5, MW-5D, and MW-6		
APEX REPRESENTATIVE	M. Masterson	APEX PROJECT MANAGER	S. Salisbury
CONTRACTOR	NA	PERMIT NO.	--
CONTRACTOR REP.	NA	H&S REVIEW	Yes

0800	Arrived on-site, checked-in with Site Manager (Karen), site safety training, issued work permit.
0830	HASP review / tailgate form
0835	Began removing well caps from monitoring wells to allow pressure to equalize prior to gauging
0915	Finished removing caps, began gauging wells
1005	Finished gauging wells, mobilize to MW-6, calibrate YSI
1025	Start sampling wells
1205	Finished sampling wells MW-5, MW-5D, and MW-6
1210	Gave IDW to Karen, Karen disposed of IDW in their oil-water separator
1225	Checked out with Karen, left site

BY

APEX REPRESENTATIVE

REVIEWED BY

APEX PROJECT MANAGER

WELL GAGING DATA SHEET

APEX

		Job Number:	1569-12
Client:	NuStar	Date:	2/28/19
Project:	VAN ANNEX GWM	Sampler:	mm
Weather:	RAINY	Time In/Out:	

WATER LEVEL DATA

Well I.D.	Time	Depth to Free Product (feet)	Depth to Water (feet)	Depth to Well Bottom (feet)	Product Thickness (feet)	Water Column Height (feet)	Notes/Other Remarks
MW-1	0959		15.07				bolts dound thread
MW-2	0948		26.70				1 bolt missing 1/2
MW-3	0955		27.18				
MW-4	0952		28.60				
MW-5	0934		15.41				
MW-5D	0932		15.20				
MW-6	1005		15.77				
MW-7	0927		16.19				
MW-8	0936		16.01				
MW-8D	0938		16.35				
MW-9	0942		17.79				
MW-10	0920	—	17.19				

WELL MONITORING DATA SHEET

APEX

Well I.D.	MW-5	Job Number:	1569-12
Client:	NuStar	Date:	2/28/18
Project:	VAN ANNEX GWM	Sampler:	MM
Weather:	RAINY / WINDY	Time In/Out:	

WELL DATA

Well Depth:	–	Well Diameter:	2"	Water Height	–
Depth to Water:	15.42	Screened Interval:	–	x Multiplier	–
Water Column Length:	–	Depth to Free Product:	–	x Casing Volumes	–
Purge Volume:	–	Free Product Thickness:	–	= Purge Volume	–
Water Height Multipliers (gal)	1-inch = 0.041	2-inch = 0.162	4-inch = 0.653	1 gallon = 3.785 liters	

PURGING DATA

Purge Method:	PERRI	Pump Intake Depth:	MS	Comments	
Sampling Method:	LF	Tubing Type:	HDPE		

Time	Volume Purged (liters)	Cumulative Volume Purged (liters)	DTW (btc)	Purge Rate (L/min)	pH	Temp (°C)	Cond (µS/cm)	DO (ppm)	ORP (mV)	Turbidity (NTUs)	Clarity/Color Other Remarks
					+/-0.1	+/-0.5° C	+/-5%	+/- 0.5 ppm	+/-20mV	+/-10%	<-- Stabilization Criteria
1137			15.93	0.1	6.98	11.7	356.1	1.11	-40.5	–	C
1140			16.22	0.1	6.86	11.9	363.5	0.29	-60.0	–	C
1143			16.50	0.1	6.85	12.0	365.3	0.20	-65.4	–	C
1146			16.79	0.1	6.87	12.0	370.8	0.34	-69.2	–	C

Clarity: VC = very cloudy, Cl = Cloudy, SC = slightly cloudy, AC = almost clear, C = clear

SAMPLING DATA

Sample ID:	MW-5	Sampling Flow Rate	0.1	Analytical Laboratory:	PACE
Sample Time:	1150	Final Depth to Water:	16.60	Did Well Dewater?	N

# Containers/Type	Preservative	Analysis/Method	Field Filtered	Filter Size	MS/MSD	Duplicate ID
2x 40ml	HCl	DRO RRO	yes (no)			
3x 40ml	HCl	GRO	yes (no)			
3x 40ml	HCl	BTEX	yes (no)			
			yes no			
			yes no			
			yes no			

COMMENTS

WELL MONITORING DATA SHEET

APEX

Well I.D.	MW-5D	Job Number:	1569-12
Client:	NuStar	Date:	2/28/18
Project:	VAN ANNEX GWM	Sampler:	MM
Weather:	RAINY	Time In/Out:	

WELL DATA

Well Depth:	–	Well Diameter:	2"	Water Height	–
Depth to Water:	15.25	Screened Interval:	–	x Multiplier	–
Water Column Length:	–	Depth to Free Product:	–	x Casing Volumes	–
Purge Volume:	–	Free Product Thickness:	–	= Purge Volume	–
Water Height Multipliers (gal)	1-inch = 0.041	2-inch = 0.162	4-inch = 0.653	1 gallon = 3.785 liters	–

PURGING DATA

Purge Method:	PORRI	Pump Intake Depth:	MS	Comments	
Sampling Method:	LF	Tubing Type:	HDPE		

Time	Volume Purged (liters)	Cumulative Volume Purged (liters)	DTW (btc)	Purge Rate (L/min)	pH	Temp (°C)	Cond (µS/cm)	DO (ppm)	ORP (mV)	Turbidity (NTUs)	Clarity/Color Other Remarks
					+/-0.1	+/-0.5° C	+/-5%	+/- 0.5 ppm	+/-20mV	+/-10%	<-- Stabilization Criteria
1104			15.25	0.1	7.44	10.8	309.2	1.62	-46.4	–	AC
1107			15.25	0.1	7.40	11.3	319.5	1.72	-75.1	–	AC
1110			15.25	0.1	7.32	11.5	344.3	1.56	-77.2	–	AC
1113			15.25	0.1	7.27	11.3	375.9	1.45	-77.8	–	AC
1116			15.25	0.1	7.18	11.4	488.9 / 480.7	1.28	-69.8	–	AC
1119			15.25	0.1	7.13	11.4	492.7	1.27	-51.3	–	AC
1122			15.25	0.1	7.11	11.3	496.1	1.23	-49.9	–	C

Clarity: VC = very cloudy, Cl = Cloudy, SC = slightly cloudy, AC = almost clear, C = clear

SAMPLING DATA

Sample ID:	MW-5D	Sampling Flow Rate	0.1	Analytical Laboratory:	PACE
Sample Time:	1125	Final Depth to Water:	15.25	Did Well Dewater?	N

# Containers/Type	Preservative	Analysis/Method	Field Filtered	Filter Size	MS/MSD	Duplicate ID
2 x 40 ml	HCl	DRO, RRO	yes (no)			
3 x 40 ml	HCl	GRO	yes (no)			
3 x 40 ml	HCl	BTEX	yes (no)			
			yes no			
			yes no			
			yes no			

COMMENTS

WELL MONITORING DATA SHEET

APEX

Well I.D.	MW-6	Job Number:	1569-12
Client:	Nustar	Date:	2/28/18
Project:	VAN ANNEX GW SM	Sampler:	MM
Weather:	RAIN	Time In/Out:	

WELL DATA

Well Depth:	-	Well Diameter:	2"	Water Height	-
Depth to Water:	15.77	Screened Interval:	-	x Multiplier	-
Water Column Length:	-	Depth to Free Product:	-	x Casing Volumes	-
Purge Volume:	-	Free Product Thickness:	-	= Purge Volume	-
Water Height Multipliers (gal)	1-inch = 0.041	2-inch = 0.162	4-inch = 0.653	1 gallon = 3.785 liters	-

PURGING DATA

Purge Method:	PERI	Pump Intake Depth:	MS	Comments	
Sampling Method:	LF	Tubing Type:	HDPE		

Time	Volume Purged (liters)	Cumulative Volume Purged (liters)	DTW (btc)	Purge Rate (L/min)	pH	Temp (°C)	Cond (µS/cm)	DO (ppm)	ORP (mV)	Turbidity (NTUs)	Clarity/Color Other Remarks
					+/-0.1	+/-0.5° C	+/-5%	+/- 0.5 ppm	+/-20mV	+/-10%	<-- Stabilization Criteria
1025			16.56	0.1	6.59	10.4	802	0.66	-56.2	-	C
1028			16.69	0.1	6.69	10.7	821	0.98	-75.0	-	C
1031			16.80	0.1	6.69	10.7	822	1.05	-80.2	-	C
1034				0.1	6.69	10.8	823	1.21	-84.0	-	C

Clarity: VC = very cloudy, Cl = Cloudy, SC = slightly cloudy, AC = almost clear, C = clear

SAMPLING DATA

Sample ID:	MW-6	Sampling Flow Rate	0.1	Analytical Laboratory:	PACE
Sample Time:	~~1043~~ 1040	Final Depth to Water:	16.44	Did Well Dewater?	N

# Containers/Type	Preservative	Analysis/Method	Field Filtered	Filter Size	MS/MSD	Duplicate ID
2 x 40 mL	HCl	TPH-~~GRO~~ DRO	yes (no)			
3 x 40 mL	HCl	TPH GRO	yes (no)			
3 x 40	HCl	BTEX	yes (no)			
			yes no			
			yes no			
			yes no			

COMMENTS

APEX

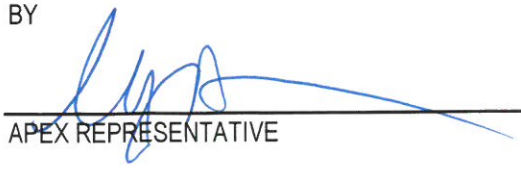
3015 SW First Avenue
Portland, Oregon 97201-4707
(503) 924-4704 Phone
(503) 943-6357 Fax

PROJECT NUMBER 1569-12
FIELD REPORT NUMBER
PAGE 1 OF 1
DATE 5/29/2018

PROJECT	Vancouver Annex GWM	ARRIVAL TIME	0755
LOCATION	Vancouver, WA	DEPARTURE TIME	1200
CLIENT	NuStar	WEATHER	Fair/ Overcast
PURPOSE OF OBSERVATIONS	Gauge monitoring wells, collect samples from wells MW-5, MW-5D, and MW-6		
APEX REPRESENTATIVE	M. Masterson	APEX PROJECT MANAGER	S. Salisbury
CONTRACTOR	NA	PERMIT NO.	--
CONTRACTOR REP.	NA	H&S REVIEW	Yes

0755	Arrived on-site/ checked in with Site Manager (Karen) / Signed in / Issued Permit / HASP Review
0805	Removed well caps from monitoring wells to allow pressure to equalize prior to gauging
0850	Gauged monitoring wells to nearest 0.01 foot
0940	Finished gauging / calibrate YSI / Set up on well for sampling
1000	Sampled wells using low flow techniques with a Peristaltic Pump per Apes SOPs
1145	Finished sampling wells / gave purge water to Karen (NuStar) who disposed of the IDW in the on-site OWS
1200	Signed out / left site.

BY



APEX REPRESENTATIVE

REVIEWED BY

APEX PROJECT MANAGER

WELL GAGING DATA SHEET

APEX

		Job Number:	1569-12
Client:	NuStar	Date:	5/29/18
Project:	UAN ANNEX GW	Sampler:	MMASTERSON
Weather:	FAIR	Time In/Out:	

WATER LEVEL DATA

Well I.D.	Time	Depth to Free Product (feet)	Depth to Water (feet)	Depth to Well Bottom (feet)	Product Thickness (feet)	Water Column Height (feet)	Notes/Other Remarks
MW-1	0935		8.43				
MW-2	0927		19.96				
MW-3	0932		20.91				
MW-4	0924		21.88				
MW-5D	0907		8.37				
MW-5	0910		8.68				RAISED MONUMENT
MW-6	0940		9.03				
MW-7	0908		3.40				
MW-8	0913		9.31				
MW-8D	0915		9.53				
MW-9	0919		11.09				
MW-10	0855		10.38				

WELL MONITORING DATA SHEET

APEX

Well I.D.	MW-5	Job Number:	1569-12
Client:	Nustar	Date:	5-29-18
Project:	VAN ANNEX GUAM	Sampler:	MM
Weather:	OVERCAST	Time In/Out:	

WELL DATA

Well Depth:	–	Well Diameter:	2"	Water Height	–
Depth to Water:	8.65	Screened Interval:	–	x Multiplier	–
Water Column Length:	–	Depth to Free Product:	–	x Casing Volumes	–
Purge Volume:	–	Free Product Thickness:	–	= Purge Volume	–

Water Height Multipliers (gal): 1-inch = 0.041 | 2-inch = 0.162 | 4-inch = 0.653 | 1 gallon = 3.785 liters

PURGING DATA

Purge Method:	PERRL	Pump Intake Depth:	MS
Sampling Method:	LF	Tubing Type:	HDPE

Comments:

Time	Volume Purged (liters)	Cumulative Volume Purged (liters)	DTW (btc)	Purge Rate (L/min)	pH	Temp (°C)	Cond (µS/cm)	DO (ppm)	ORP (mV)	Turbidity (NTUs)	Clarity/Color Other Remarks
					+/-0.1	+/-0.5° C	+/-5%	+/- 0.5 ppm	+/-20mV	+/-10%	<-- Stabilization Criteria
1044			9.15	0.15	7.64	14.45	431	4.67	-38.5	–	SC
1047			9.24	0.15	7.65	14.39	433	3.58	-76.1	–	AC
1050			9.37	0.15	7.66	14.50	434	2.12	-81.3	–	AC
1053			9.51	0.15	7.72	14.34	432	1.73	-87.2	–	AC
1056			9.67	0.15	7.82	14.46	433	1.55	-93.8	–	AC
1059			9.82	0.15	7.81	14.15	429	1.44	-92.3	–	AC

Clarity: VC = very cloudy, Cl = Cloudy, SC = slightly cloudy, AC = almost clear, C = clear

SAMPLING DATA

Sample ID:	MW-5	Sampling Flow Rate	0.15	Analytical Laboratory:	PACE
Sample Time:	1104	Final Depth to Water:	9.44	Did Well Dewater?	N

# Containers/Type	Preservative	Analysis/Method	Field Filtered	Filter Size	MS/MSD	Duplicate ID
3x40 ml	HCl	BTEX	yes (no)			
3x40 ml	HCl	TPH-Gx	yes (no)			
2x250 ml Amber	HCl	TPH-Dx	yes (no)			
			yes no			
			yes no			
			yes no			

COMMENTS

WELL MONITORING DATA SHEET

APEX

Well I.D.	MW-5D	Job Number:	1569-12
Client:	NuStar	Date:	5-29-18
Project:	VAN ANNEX GWM	Sampler:	
Weather:	OVERCAST	Time In/Out:	

WELL DATA

Well Depth:	-	Well Diameter:	2"	Water Height	-
Depth to Water:	8.38	Screened Interval:	-	x Multiplier	-
Water Column Length:	-	Depth to Free Product:	-	x Casing Volumes	-
Purge Volume:	-	Free Product Thickness:	-	= Purge Volume	-
Water Height Multipliers (gal)	1-inch = 0.041	2-inch = 0.162	4-inch = 0.653	1 gallon = 3.785 liters	

PURGING DATA

Purge Method:	PERI	Pump Intake Depth:	MS	Comments	
Sampling Method:	LF	Tubing Type:	HDPE		

Time	Volume Purged (liters)	Cumulative Volume Purged (liters)	DTW (btc)	Purge Rate (L/min)	pH	Temp (°C)	Cond (µS/cm)	DO (ppm)	ORP (mV)	Turbidity (NTUs)	Clarity/Color Other Remarks
					+/-0.1	+/-0.5° C	+/-5%	+/- 0.5 ppm	+/-20mV	+/-10%	<-- Stabilization Criteria
1114			8.41	0.2	7.94	14.05	355	7.21	-1.7	-	SC
1117			8.42	0.2	7.90	13.93	358	1.74	-13.7	-	SC
1120			8.42	0.2	7.91	13.86	356	1.38	-16.8	-	SC
1123			8.42	0.2	7.90	13.84	355	1.22	-18.9	-	SC
1126			8.42	0.2	7.92	13.85	356	1.14	-21.3	-	AC

Clarity: VC = very cloudy, Cl = Cloudy, SC = slightly cloudy, AC = almost clear, C = clear

SAMPLING DATA

Sample ID:	MW-5D	Sampling Flow Rate	0.2	Analytical Laboratory:	PACE
Sample Time:	1130	Final Depth to Water:	8.42	Did Well Dewater?	N

# Containers/Type	Preservative	Analysis/Method	Field Filtered	Filter Size	MS/MSD	Duplicate ID
3x40ml	HCl	BTEX	yes (no)			
3x40ml	HCl	TPH-Gx	yes (no)			
2x250ml Amber	HCl	TPH-Dx	yes (no)			
			yes no			
			yes no			
			yes no			

COMMENTS

WELL MONITORING DATA SHEET

APEX

Well I.D.	MW-6	Job Number:	1569-12
Client:	NuStar	Date:	5/29/10
Project:	VAN ANNEX GWM	Sampler:	M. MASTERSON
Weather:	FAIR/OVERCAST	Time In/Out:	

WELL DATA

Well Depth:	-	Well Diameter:	2"	Water Height	-
Depth to Water:	9.00	Screened Interval:	-	x Multiplier	-
Water Column Length:	-	Depth to Free Product:	-	x Casing Volumes	-
Purge Volume:	-	Free Product Thickness:	-	= Purge Volume	-
Water Height Multipliers (gal)	1-inch = 0.041	2-inch = 0.162	4-inch = 0.653	1 gallon = 3.785 liters	

PURGING DATA

Purge Method:	PERI	Pump Intake Depth:	MS	Comments	
Sampling Method:	LF	Tubing Type:	HDPE		

Time	Volume Purged (liters)	Cumulative Volume Purged (liters)	DTW (btc)	Purge Rate (L/min)	pH	Temp (°C)	Cond (µS/cm)	DO (ppm)	ORP (mV)	Turbidity (NTUs)	Clarity/Color Other Remarks
					+/-0.1	+/-0.5° C	+/-5%	+/- 0.5 ppm	+/-20mV	+/-10%	<-- Stabilization Criteria
1003			9.72	0.2	8.55	14.00	811	8.68	-12.9	-	~~AC~~ SC
1006			9.85	0.2	8.01	13.86	712	5.02	-69.0	-	SC
1009			9.97	0.2	7.94	13.84	708	4.92	-85.1	-	SC
1012			10.03	0.2	7.91	13.78	708	4.00	-89.4	-	SC
1015			10.12	0.2	7.89	13.87	710	2.89	-96.1	-	SC
1018			10.15	0.2	7.88	13.76	705	2.75	-99.1	-	~~SC~~ AC
1021			10.21	0.2	7.87	13.72	703	2.61	-101.3	-	AC

Clarity: VC = very cloudy, Cl = Cloudy, SC = slightly cloudy, AC = almost clear, C = clear

SAMPLING DATA

Sample ID:	MW-6	Sampling Flow Rate	0.2	Analytical Laboratory:	PACE
Sample Time:	1025	Final Depth to Water:	9.39	Did Well Dewater?	N

# Containers/Type	Preservative	Analysis/Method	Field Filtered	Filter Size	MS/MSD	Duplicate ID
3 x 40ml	HCl	BTEX	yes (no)			
3 x 40 ml	HCl	TPH-Gx	yes (no)			
2 x 250ml	Amber HCl	TPH-Dx	yes (no)			
			yes no			
			yes no			
			yes no			

COMMENTS

Project:
Client:
Sampler:

Date:
Permit:

Well ID:	Time:	DTP:	DTW:	Product Thickness:	Notes:
MW-4	0850		31.86		
MW-2	0900		29.94		
MW-3	0910		30.80		
MW-1	0915		18.37		
MW-6	0920		18.99		
MW-10	0925		20.30		
MW-7	0930		13.26		
MW-9	0940		21.04		
MW-8D	0950		19.41		
MW-8	1000		19.22		
MW-5	1010		18.55		
MW-5D	1020		18.51		

MW-5, MW-5D, MW-6

Vannex

11-30-17

	time	GW depth	total depth
MW-2	8:45	27.66	
MW-4	8:50	29.59	
MW-3	9:01	28.61	
MW-1	9:04	16.16	
MW-6	9:09	16.71	
MW-7	9:11	11.12	
MW-10	9:14	28.16	
MW-9	9:19	18.78	
MW-8D	9:20	17.36	
MW-8	9:22	16.91	
MW-5D	9:24	16.21	45'
MW-5	9:25	16.39	

MW-1

WELL GAGING DATA SHEET

Cascadia Associates, LLC

Well ID:	MW-5D	Job Number:	006-001-001
Client:	NUSTAR	Date:	11-30-2017
Project:	VANNEX	Sampler:	A. Spencer / Joel Mathews
Weather:	CLOUDY, RAINING	Time In/Out:	9:40

WELL DATA

Monument Type:	(Flush-mount)/Stick-up	Well Diameter:	2"	Depth to Free Product:	/
	Other:	Well Depth:	45	Free Product Thickness:	/
Monument Condition:		Depth to Water:	16.21	Water Column Length:	~20'
Well Cap Lock Present:	(Yes) No	Screened Interval:	35-45	Purge Volume:	
Comments:					

Purge Volume = (Water Height) X (Multiplier) X (# Casing Volumes)

Water height multipliers (gal):	1-inch well = 0.041	2-inch = 0.162	4-inch = 0.653	1 gal = 3.785 liters

PURGING DATA

Purge Method:	peristaltic	Pump Intake Depth:	mid-screen
Sampling Method:	low flow	Tubing Material & Type:	LDPE NEW / DEDICATED

Time	Volume Purged (liters)	Cumulative Volume Purged (liters)	DTW (btc)	Purge Rate (L/min)	pH	Temp (°C)	Cond (µS/cm)	DO (ppm)	ORP (mV)	Clarity/Color Other Remarks
					+/-0.1	+/-0.5 °C	+/-5%	+/-0.5 ppm	+/-20 mV	
09:50			16.22	0.3	6.46	12.12	512	4.4	109.2	clear
09:53			16.24		6.51	12.06	516	3.40	97.1	
09:56			16.24		6.55	12.19	534	1.94	84.8	
09:59			16.24		6.56	11.70	532	1.00	79.0	
10:02			16.24		6.57	12.06	534	0.80	73.3	
10:10			16.24							

PURGING DATA

Sample ID: MW-5D		Sampling Flow Rate:	0.3 L/min		Analytical Laboratory:		ESC
Sample Time: 10:10		Final Depth to Water:	16.24		Did Well Dewater:		NO
No. of Containers/Type	Preservative	Analysis/Method	Field Filtered	Filter Size	MS/MSD	Duplicate ID	
8 VOAs	HCL						

NOTES/ADDITIONAL COMMENTS

WELL GAGING DATA SHEET

Cascadia Associates, LLC

Well ID:	MW-5	Job Number:	006-001-001
Client:	NUSTAR	Date:	11-30-2017
Project:	VANNEX	Sampler:	Spencer / Mathelier
Weather:	RAINY	Time In/Out:	10:27

WELL DATA

Monument Type:	(Flush-mount)/Stick-up	Well Diameter:	2"	Depth to Free Product:	
	Other:	Well Depth: (?)	25'	Free Product Thickness:	
Monument Condition:	Good	Depth to Water:	17.14	Water Column Length:	
Well Cap Lock Present:	(Yes) No	Screened Interval:		Purge Volume:	

Comments:

Purge Volume = (Water Height) X (Multiplier) X (# Casing Volumes)

Water height multipliers (gal):	1-inch well = 0.041	2-inch = 0.162	4-inch = 0.653	1 gal = 3.785 liters

PURGING DATA

Purge Method:		Pump Intake Depth:	
Sampling Method:		Tubing Material & Type:	NEW / DEDICATED

Time	Volume Purged (liters)	Cumulative Volume Purged (liters)	DTW (btc)	Purge Rate (L/min)	pH	Temp (°C)	Cond (µS/cm)	DO (ppm)	ORP (mV)	Clarity/Color Other Remarks
					+/-0.1	+/-0.5 °C	+/-5%	+/-0.5 ppm	+/-20 mV	
10:27			17.14	0.2	9.8	12.40	393	7.3	36.1	Clear
10:30					8.8	12.39	382	8.0	30.4	
10:35			17.81		10.7	12.50	384	7.7	28.8	
10:38			17.85		8.7	12.38	395	7.4	24.6	
10:42			17.91		6.5	12.16	396	7.1	24.5	
10:45			17.98		10.6	12.10	403	7.1	23.2	

PURGING DATA

Sample ID:	MW-5	Sampling Flow Rate:	0.2		Analytical Laboratory:	ESC
Sample Time:	10:55	Final Depth to Water:	17.98		Did Well Dewater:	No

No. of Containers/Type	Preservative	Analysis/Method	Field Filtered	Filter Size	MS/MSD	Duplicate ID	
16	HCL						
8 -							
8 - Dup							

NOTES/ADDITIONAL COMMENTS

WELL GAGING DATA SHEET

Cascadia Associates, LLC

Well ID:	MW-6	Job Number:	006-001-001
Client:	NuStar	Date:	11/30/17
Project:	VANNEX	Sampler:	SPENCER/MaHelcheck
Weather:	RAINY	Time In/Out:	11:15

WELL DATA

Monument Type:	Flush-mount/Stick-up	Well Diameter:	2"	Depth to Free Product:	
	Other:	Well Depth:	25	Free Product Thickness:	
Monument Condition:	Good	Depth to Water:		Water Column Length:	
Well Cap Lock Present:	Yes No	Screened Interval:	15-25	Purge Volume:	

Comments:

Purge Volume = (Water Height) X (Multiplier) X (# Casing Volumes)

Water height multipliers (gal):	1-inch well = 0.041	2-inch = 0.162	4-inch = 0.653	1 gal = 3.785 liters

PURGING DATA

Purge Method:		Pump Intake Depth:	
Sampling Method:		Tubing Material & Type:	NEW / DEDICATED

Time	Volume Purged (liters)	Cumulative Volume Purged (liters)	DTW (btc)	Purge Rate (L/min)	pH (not working)	Temp (°C)	Cond (µS/cm)	DO (ppm)	ORP (mV)	Clarity/Color Other Remarks
					+/-0.1	+/-0.5 °C	+/-5%	+/-0.5 ppm	+/-20 mV	
11:20			17.70	0.2	∅	12.38	741	0.98	40.3	clear
11:23			18.00	0.2	/	12.30	755	0.84	23.0	
11:26			18.40			12.63	755	0.48	20.2	
11:29			18.75			12.74	768	0.46	36.0	
11:33			19.01			12.69	766	0.50	41.2	

PURGING DATA

Sample ID: MW-6		Sampling Flow Rate:	0.2		Analytical Laboratory:	ESC
Sample Time: 11:45		Final Depth to Water:			Did Well Dewater:	

No. of Containers/Type	Preservative	Analysis/Method	Field Filtered	Filter Size	MS/MSD	Duplicate ID
8	HCL					

NOTES/ADDITIONAL COMMENTS

Cascadia Associates- Portland, OR

6915 SW Macadam Ave
Ste. 250
Portland OR 97219

Billing Information:
Accounts Payable- Chris Breemer
6915 SW Macadam Ave
Ste. 250
Portland, OR 97219

Pres Chk

Report to: Ian Maguire

Email To: imaguire@cascadiaassociates.com

Project Description: Vannex Comm

City/State Collected: Vancouver WA

Phone: 503-906-6577
Fax:

Client Project # 006-001-001

Lab Project # CASASCTOR-NUVANCOUVE

Collected by (print): Joel Mattecheck

Site/Facility ID # VANCOUVER, WA

P.O. # 006-001-001

Collected by (signature):

Rush? (Lab MUST Be Notified)
___ Same Day ___ Five Day
___ Next Day ___ 5 Day (Rad Only)
___ Two Day ___ 10 Day (Rad Only)
___ Three Day X Standard

Quote #

Date Results Needed

Immediately Packed on Ice N ___ Y X

Sample ID	Comp/Grab	Matrix *	Depth	Date	Time	No. of Cntrs	NWTPHDXLVI w/ SGT 40mlAmb-HCl-BT	NWTPHGX 40mlAmb HCl	~~VOC~~ BTEX (8260B) ~~HCl~~								
MW-6	Grab	GW	—	11/30/17	1145	8	X	X	X								
MW-5	Grab	GW	—	11/30/17	~~1055~~	8	X	X	X								
MW-50	Grab	GW	—	11/30/17	1010	8	X	X	X								
MW-5 Dup	Grab	GW	—	11/30/17	1055	8	X	X	X								
		GW															

Analysis / Container / Preservative

Chain of Custody Page ___ of ___

ESC

12065 Lebanon Rd
Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
Fax: 615-758-5859

L #

Table #

Acctnum: CASASCTOR
Template: T130154
Prelogin: P627256
TSR: 110 - Brian Ford
PB:

Shipped Via:

Remarks | Sample # (lab only)

* Matrix:
SS - Soil AIR - Air F - Filter
GW - Groundwater B - Bioassay
WW - WasteWater
DW - Drinking Water
OT - Other_____

Remarks:
email results to Ian Maguire

pH _____ Temp _____
Flow _____ Other _____

Samples returned via:
__ UPS __ FedEx __ Courier _____

Tracking #

Sample Receipt Checklist
COC Seal Present/Intact: __NP __Y __N
COC Signed/Accurate: __Y __N
Bottles arrive intact: __Y __N
Correct bottles used: __Y __N
Sufficient volume sent: __Y __N
If Applicable
VOA Zero Headspace: __Y __N
Preservation Correct/Checked: __Y __N

Relinquished by : (Signature)	Date:	Time:	Received by: (Signature)	Trip Blank Received: Yes / No HCL / MeoH TBR	If preservation required by Login: Date/Time
	11/30/17	1530			
Relinquished by : (Signature)	Date:	Time:	Received by: (Signature)	Temp: °C Bottles Received:	
Relinquished by : (Signature)	Date:	Time:	Received for lab by: (Signature)	Date: Time:	Hold: Condition: NCF / OK

WELL MONITORING DATA SHEET

Cascadia Associates, LLC

Well ID:	MW-5	Job Number:	
Client:	Nustar Vancex	Date:	8/30/18
Project:	GWM	Sampler:	JM
Weather:	Overcast	Time In/Out:	1030

WELL DATA

Monument Type:	Flush-mount/Stick-up	Well Diameter:	2"	Depth to Free Product:	—
	Other:	Well Depth:	—	Free Product Thickness:	—
Monument Condition:		Depth to Water:	18.55	Water Column Length:	—
Well Cap Lock Present:	Yes No	Screened Interval:	—	Purge Volume:	—

Comments:

Purge Volume = (Water Height) X (Multiplier) X (# Casing Volumes)

Water height multipliers (gal): 1-inch well = 0.041 | 2-inch = 0.162 | 4-inch = 0.653 | 1 gal = 3.785 liters

PURGING DATA

Purge Method:	P. Pump	Pump Intake Depth:	MS
Sampling Method:	LF	Tubing Material & Type:	LDPE (NEW) / DEDICATED

Time	Volume Purged (liters)	Cumulative Volume Purged (liters)	~~DTW~~ (btc)	~~Purge~~ Rate (L/min)	pH	Temp (°C)	Cond (µS/cm)	DO (ppm)	ORP (mV)	Clarity/Color Other Remarks
					+/-0.1	+/-0.5 °C	+/-5%	+/-0.5 ppm	+/-20 mV	
1030	—	—	0.20	18.55	6.45	16.24	426	2.23	-82.0	S. Cl
1033	—	—		18.57	6.40	16.38	426	1.83	-85.3	
1036	—	—		18.64	6.60	16.70	428	1.50	-92.5	
1039	—	—		18.71	6.63	16.48	425	1.33	-99.6	
1042	—	—		18.74	6.64	16.45	424	1.25	-100.6	

PURGING DATA

Sample ID:	MW-5	Sampling Flow Rate:	0.30			Analytical Laboratory:	Apex
Sample Time:	1045	Final Depth to Water:	18.76			Did Well Dewater:	No
No. of Containers/Type	Preservative	Analysis/Method	Field Filtered	Filter Size	MS/MSD	Duplicate ID	
3 x 40 ml	HCl	6x/BTEX				X	MW-5 Dup
2 x 1 L	HCl	Dx				X	b
		~~BTEX~~					

NOTES/ADDITIONAL COMMENTS

MW-5 Dup @ 1045

WELL MONITORING DATA SHEET

Cascadia Associates, LLC

Well ID:	MW-5D	Job Number:	
Client:	Nuster	Date:	5/30/18
Project:	Vannex	Sampler:	JM
Weather:	Overcast	Time In/Out:	1130

WELL DATA

Monument Type:	(Flush-mount)/Stick-up	Well Diameter:	2"	Depth to Free Product:	—
	Other:	Well Depth:	—	Free Product Thickness:	—
Monument Condition:		Depth to Water:		Water Column Length:	—
Well Cap Lock Present:	(Yes) No	Screened Interval:	—	Purge Volume:	—

Comments:

Purge Volume = (Water Height) X (Multiplier) X (# Casing Volumes)

Water height multipliers (gal):	1-inch well = 0.041	2-inch = 0.162	4-inch = 0.653	1 gal = 3.785 liters

PURGING DATA

Purge Method:	P. Pump	Pump Intake Depth:	NS
Sampling Method:	LF	Tubing Material & Type:	LDPE (NEW) / DEDICATED

Time	Volume Purged (liters)	Cumulative Volume Purged (liters)	DTW (btc)	Purge Rate (L/min)	pH	Temp (°C)	Cond (µS/cm)	DO (ppm)	ORP (mV)	Clarity/Color Other Remarks
					+/-0.1	+/-0.5 °C	+/-5%	+/-0.5 ppm	+/-20 mV	
1130	—	—	18.50	0.30	7.09	17.33	467	3.00	10.0	Clear
1133	—	—	18.56	↓	6.50	17.02	473	3.40	-27.0	Clear
1136	—	—	18.62		6.62	16.23	464	2.30	-25.2	Clear
1139	—	—	18.65		6.60	15.94	444	1.16	-32.0	Clear
1142	—	—	18.67		6.61	15.93	447	1.13	-31.6	Clear
1145	—	—	18.71		6.60	15.94	450	1.14	-33.8	Clear

PURGING DATA

Sample ID:	MW-5D	Sampling Flow Rate:	0.30	Analytical Laboratory:	APEX
Sample Time:	1150	Final Depth to Water:	18.76	Did Well Dewater:	No

No. of Containers/Type	Preservative	Analysis/Method	Field Filtered	Filter Size	MS/MSD	Duplicate ID	
3 x 40mL	HCl	BTEX/VOCs					
2 x 1L	HCl	DX					

NOTES/ADDITIONAL COMMENTS

WELL MONITORING DATA SHEET

Cascadia Associates, LLC

Well ID:	MW-6	Job Number:	
Client:	Nustar	Date:	8/30/18
Project:	Vannes	Sampler:	JM
Weather:	Overcast	Time In/Out:	1226

WELL DATA

Monument Type:	Flush-mount/Stick-up	Well Diameter:	2"	Depth to Free Product:	—
	Other:	Well Depth:	—	Free Product Thickness:	—
Monument Condition:		Depth to Water:	19.00	Water Column Length:	—
Well Cap Lock Present:	Yes No	Screened Interval:	—	Purge Volume:	—

Comments:

Purge Volume = (Water Height) X (Multiplier) X (# Casing Volumes)

Water height multipliers (gal): 1-inch well = 0.041 | 2-inch = 0.162 | 4-inch = 0.653 | 1 gal = 3.785 liters

PURGING DATA

Purge Method:	P. Pump	Pump Intake Depth:	MS
Sampling Method:	LF	Tubing Material & Type:	LDPE

NEW / DEDICATED

Time	Volume Purged (liters)	Cumulative Volume Purged (liters)	DTW (btc)	Purge Rate (L/min)	pH	Temp (°C)	Cond (µS/cm)	DO (ppm)	ORP (mV)	Clarity/Color Other Remarks
					+/-0.1	+/-0.5 °C	+/-5%	+/-0.5 ppm	+/-20 mV	
1220	—	—	19.00	0.30	6.49	16.46	859	4.26	-91.1	clear
1223	—	—	19.10		6.16	16.42	865	1.80	-81.0	
1226	—	—	19.15		6.13	16.16	858	1.53	-81.4	
1229	—	—	19.16		6.13	16.00	860	1.40	-80.2	
1232	—	—	19.21		6.15	16.00	857	1.29	-79.6	

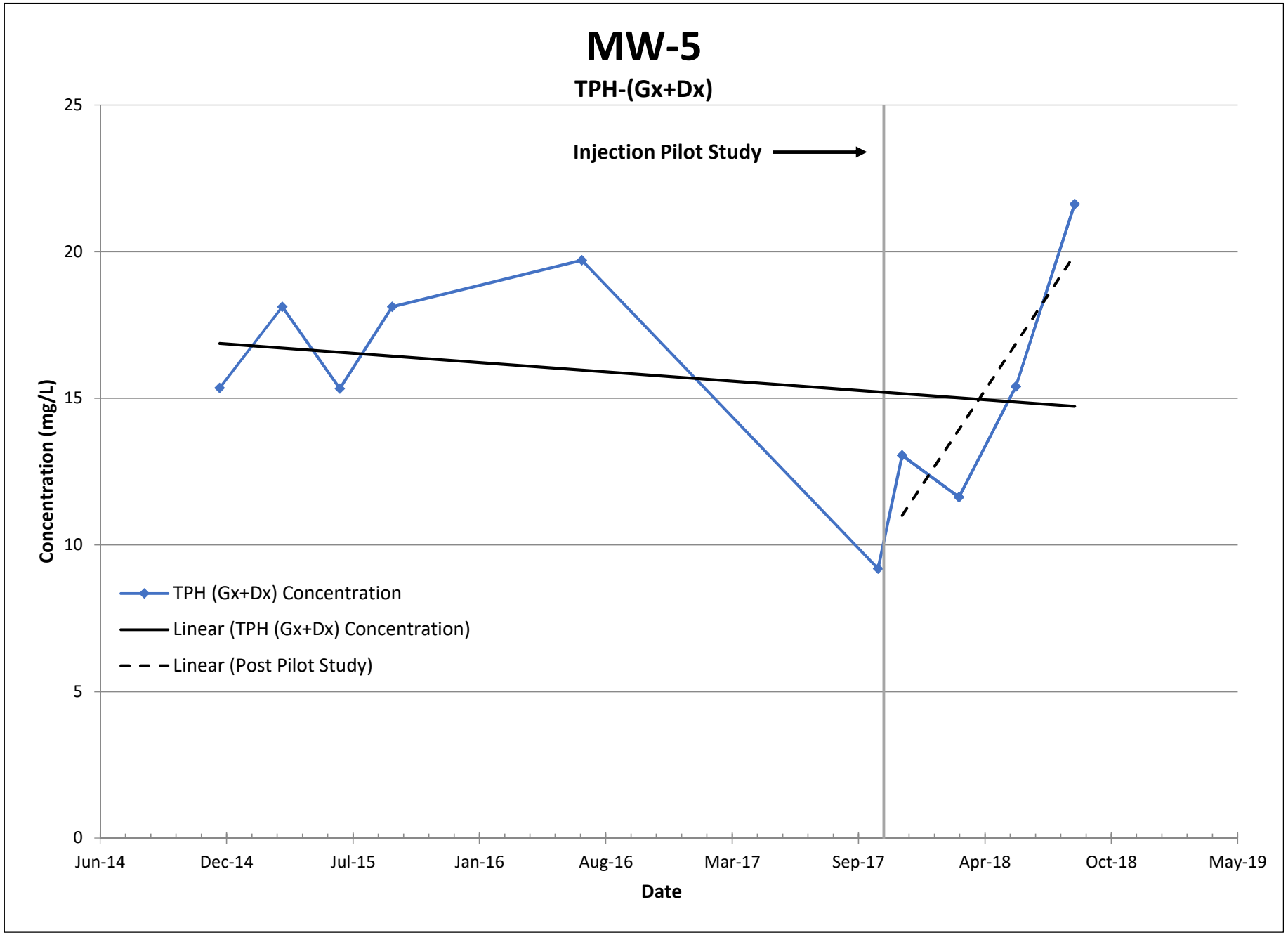
PURGING DATA

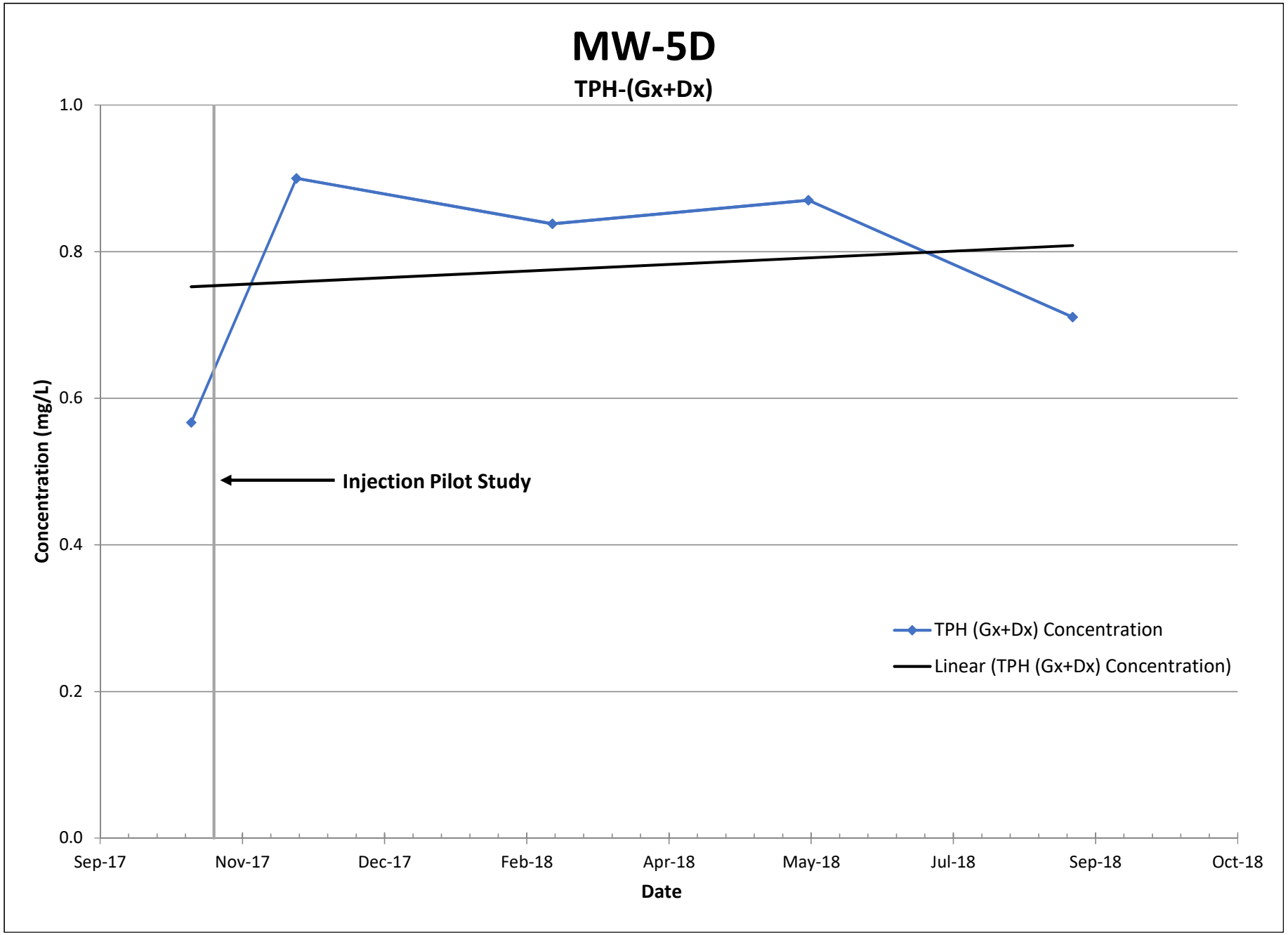
Sample ID:	MW-6	Sampling Flow Rate:	0.30			Analytical Laboratory:	Apex
Sample Time:	1235	Final Depth to Water:	19.20			Did Well Dewater:	No
No. of Containers/Type	Preservative	Analysis/Method	Field Filtered	Filter Size	MS/MSD	Duplicate ID	
3x 40 ml	HCl	BTEX/Gx					
2x 1L	HCl	Dx					

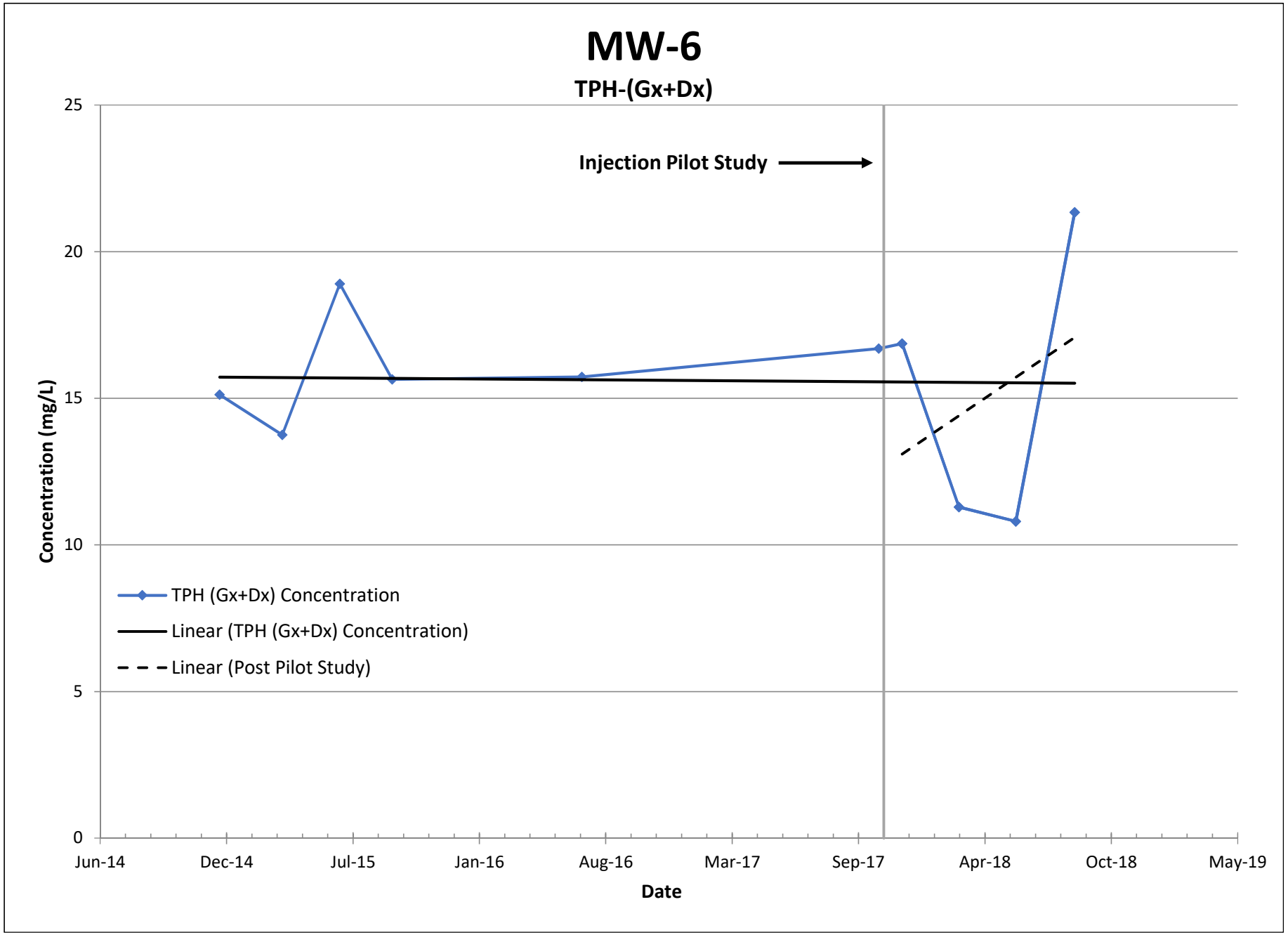
NOTES/ADDITIONAL COMMENTS

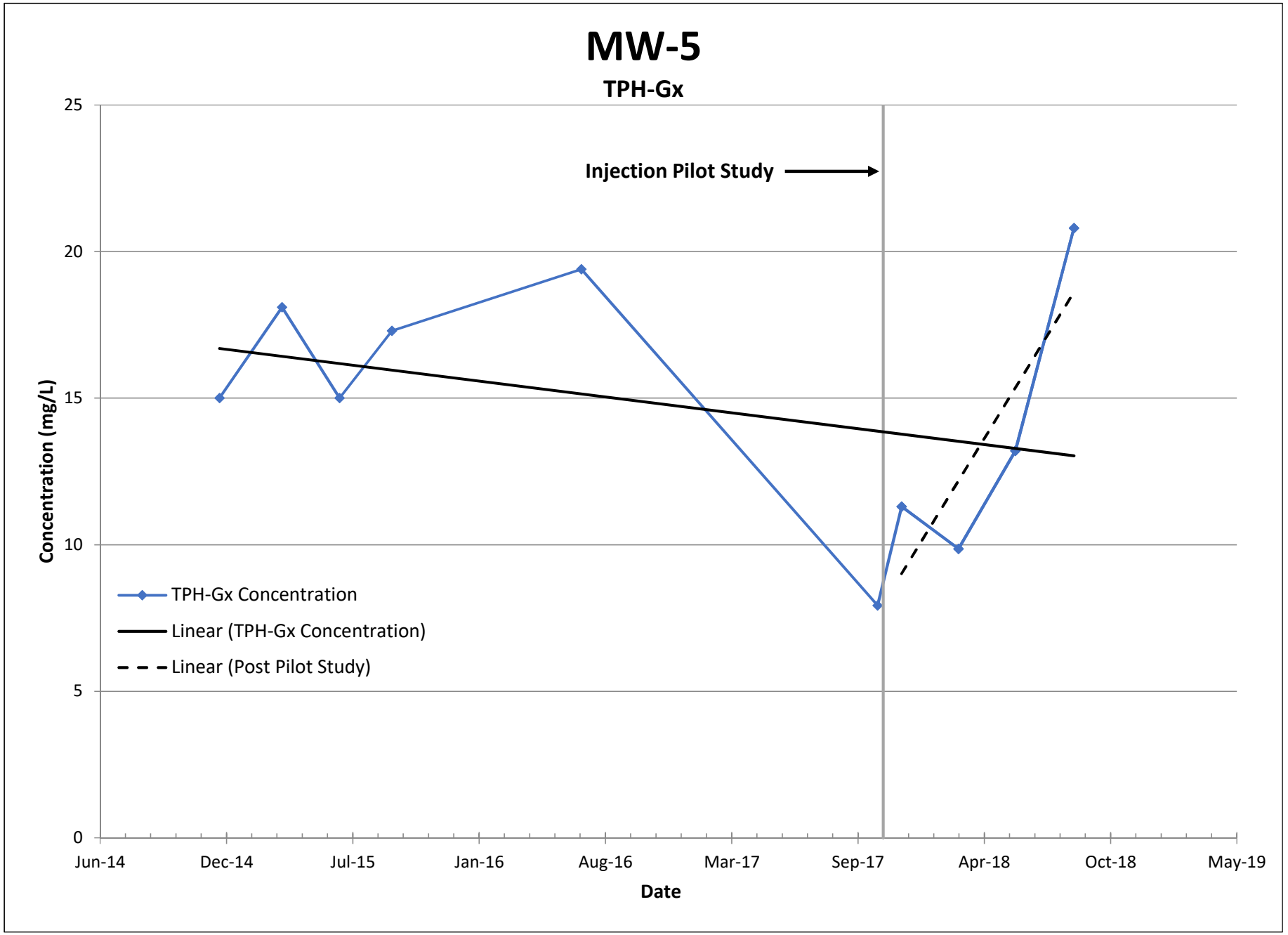
APPENDIX D

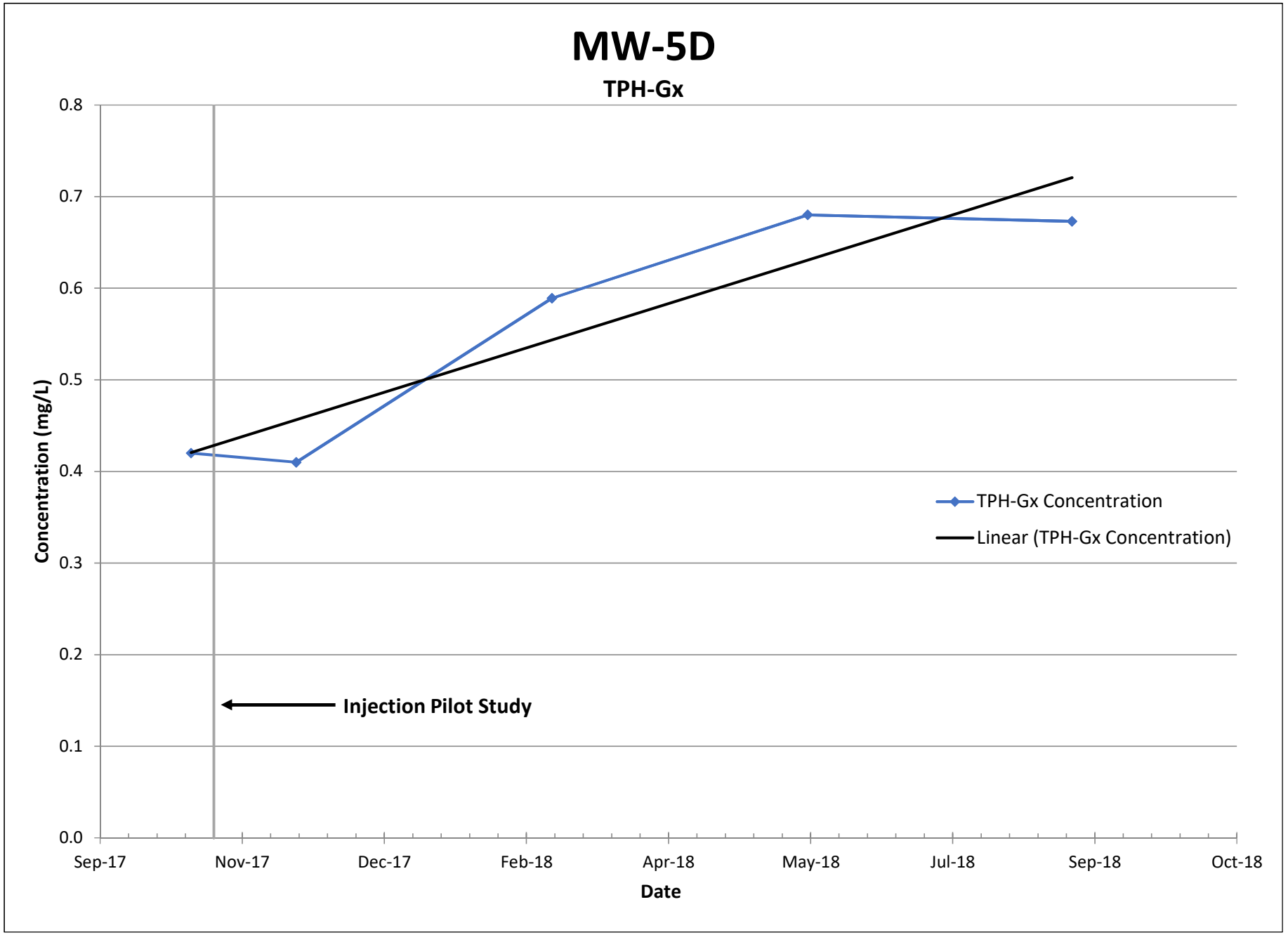
TOTAL PETROLEUM HYDROCARBON TREND PLOTS

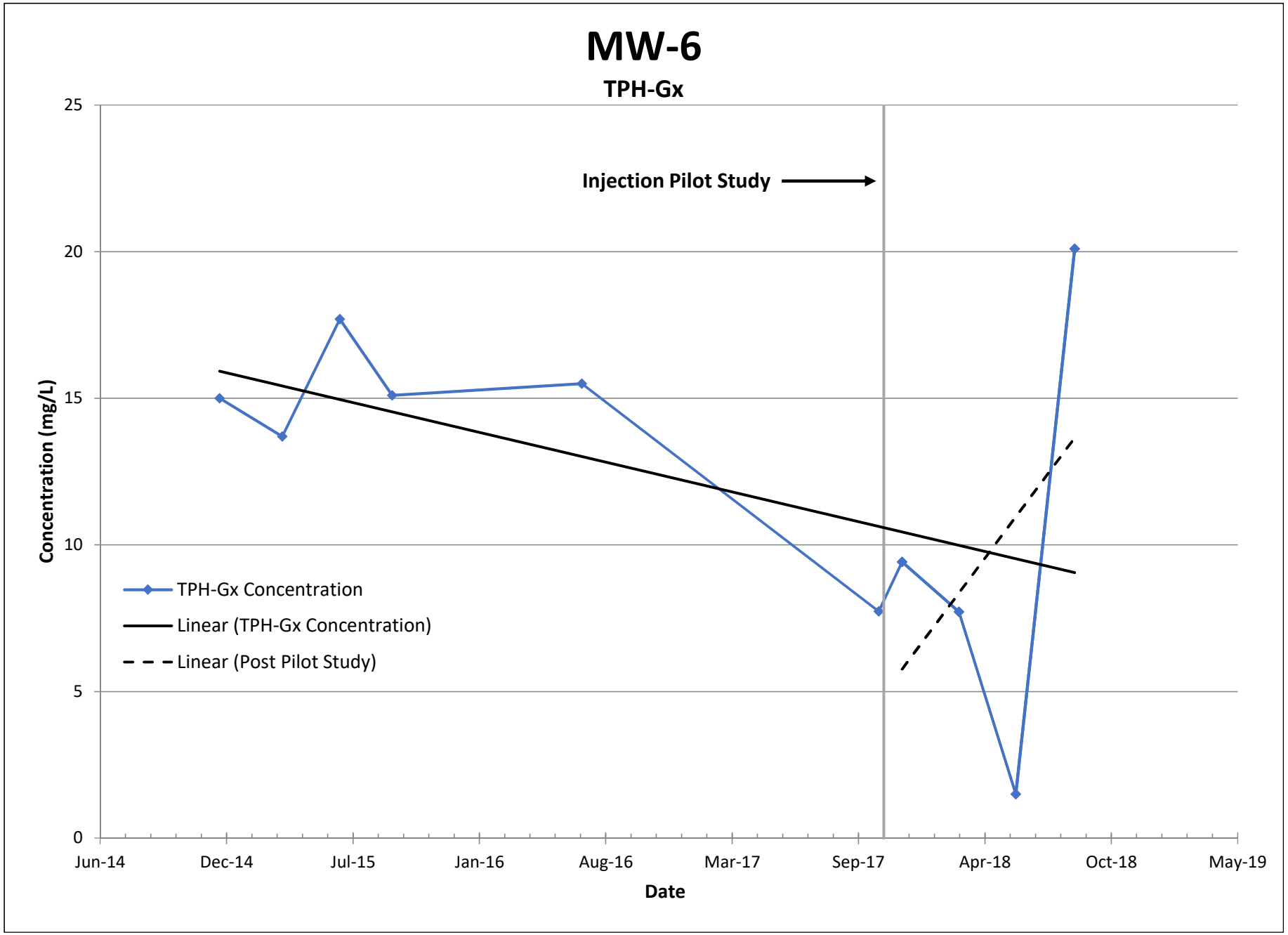

MW-5
TPH-(Gx+Dx)
Injection Pilot Study
Concentration (mg/L)
25
20
15
10
5
0
Jun-14
Dec-14
Jul-15
Jan-16
Aug-16
Mar-17
Sep-17
Apr-18
Oct-18
May-19
Date
TPH (Gx+Dx) Concentration
Linear (TPH (Gx+Dx) Concentration)
Linear (Post Pilot Study)

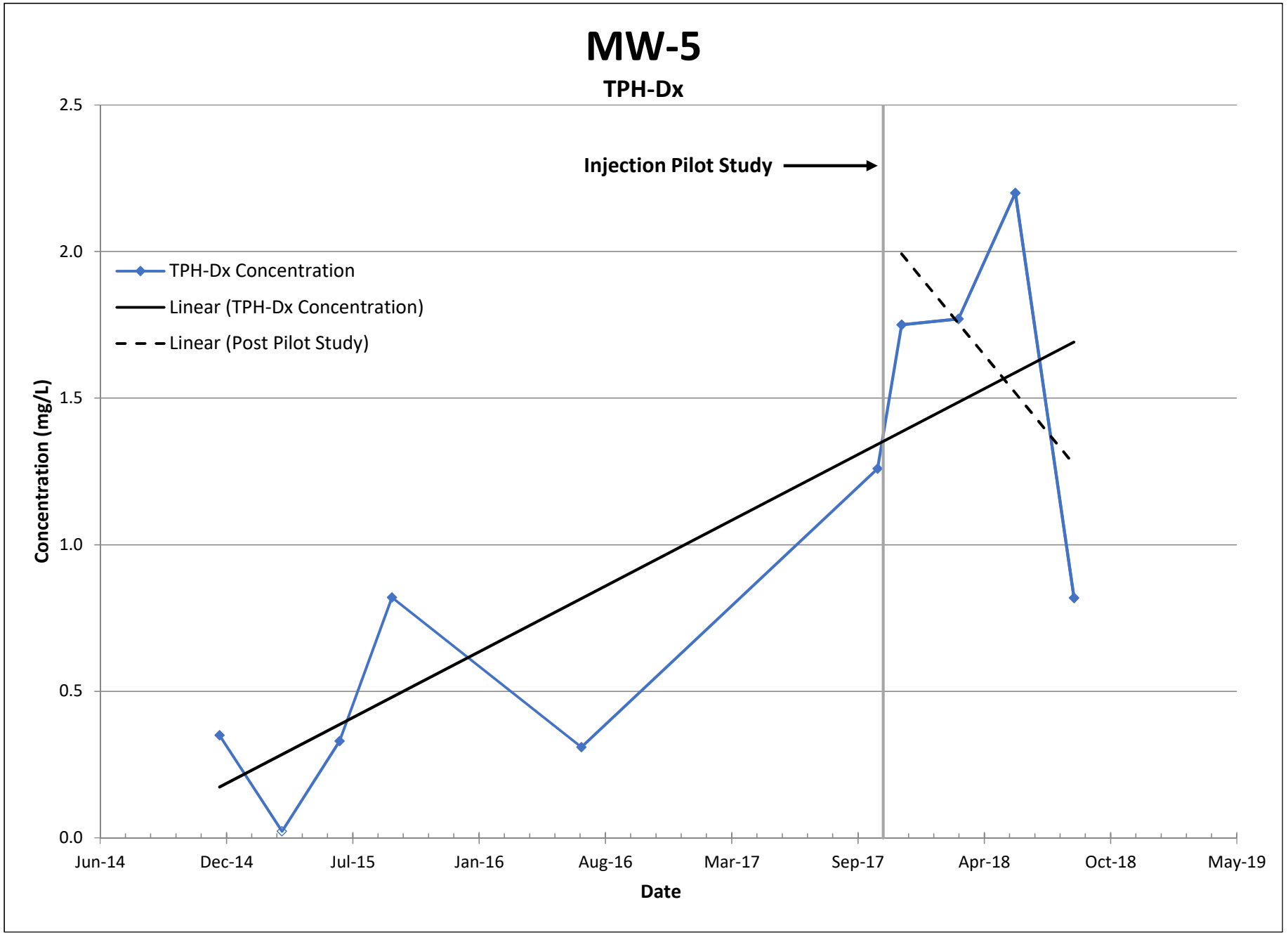

MW-5D
TPH-(Gx+Dx)
1.0
0.8
0.6
0.4
0.2
0.0
Concentration (mg/L)
Injection Pilot Study
TPH (Gx+Dx) Concentration
Linear (TPH (Gx+Dx) Concentration)
Sep-17
Nov-17
Dec-17
Feb-18
Apr-18
May-18
Jul-18
Sep-18
Oct-18
Date

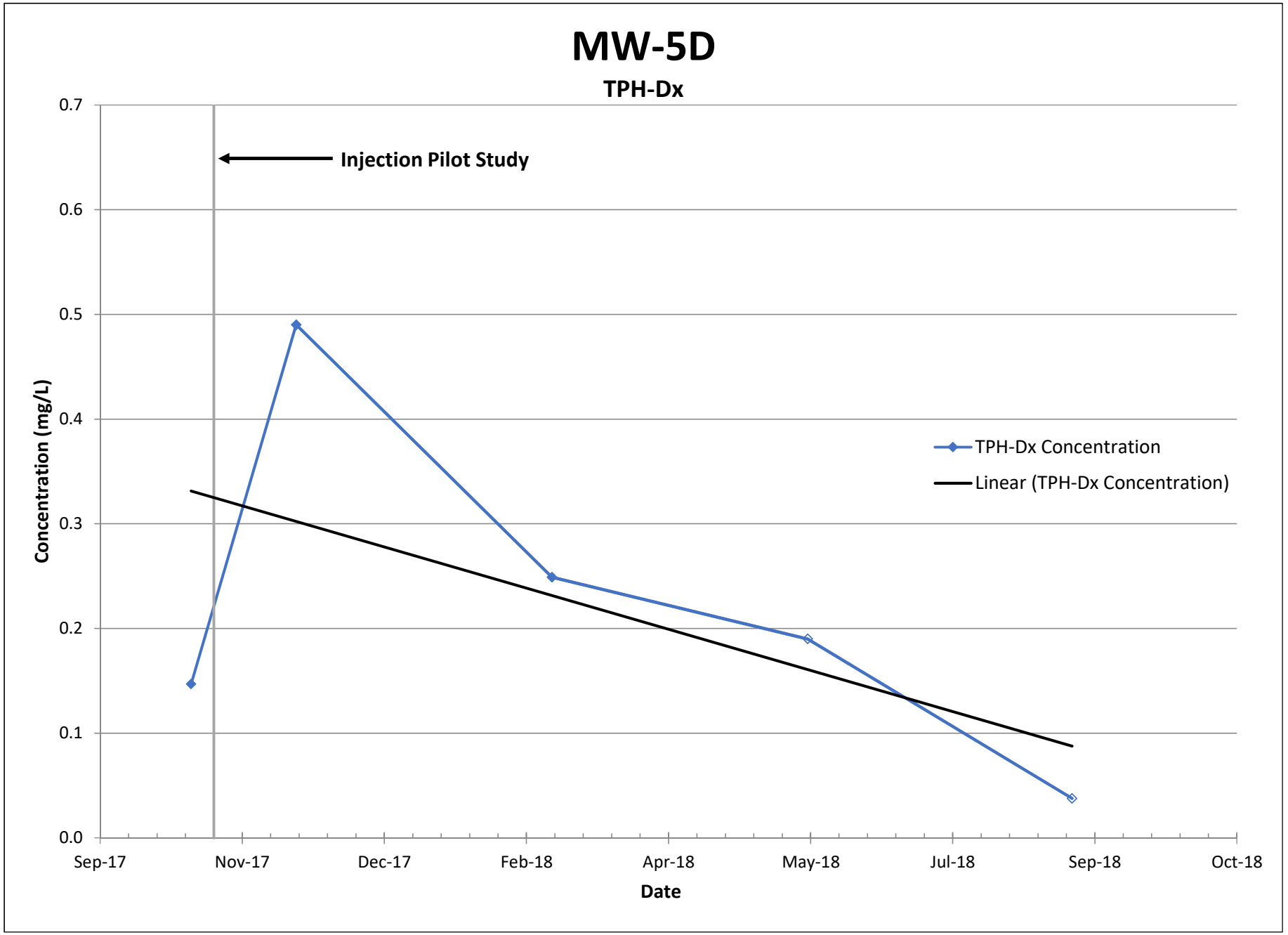

MW-6
TPH-(Gx+Dx)
Injection Pilot Study
Concentration (mg/L)
25
20
15
10
5
0
TPH (Gx+Dx) Concentration
Linear (TPH (Gx+Dx) Concentration)
Linear (Post Pilot Study)
Jun-14
Dec-14
Jul-15
Jan-16
Aug-16
Mar-17
Sep-17
Apr-18
Oct-18
May-19
Date

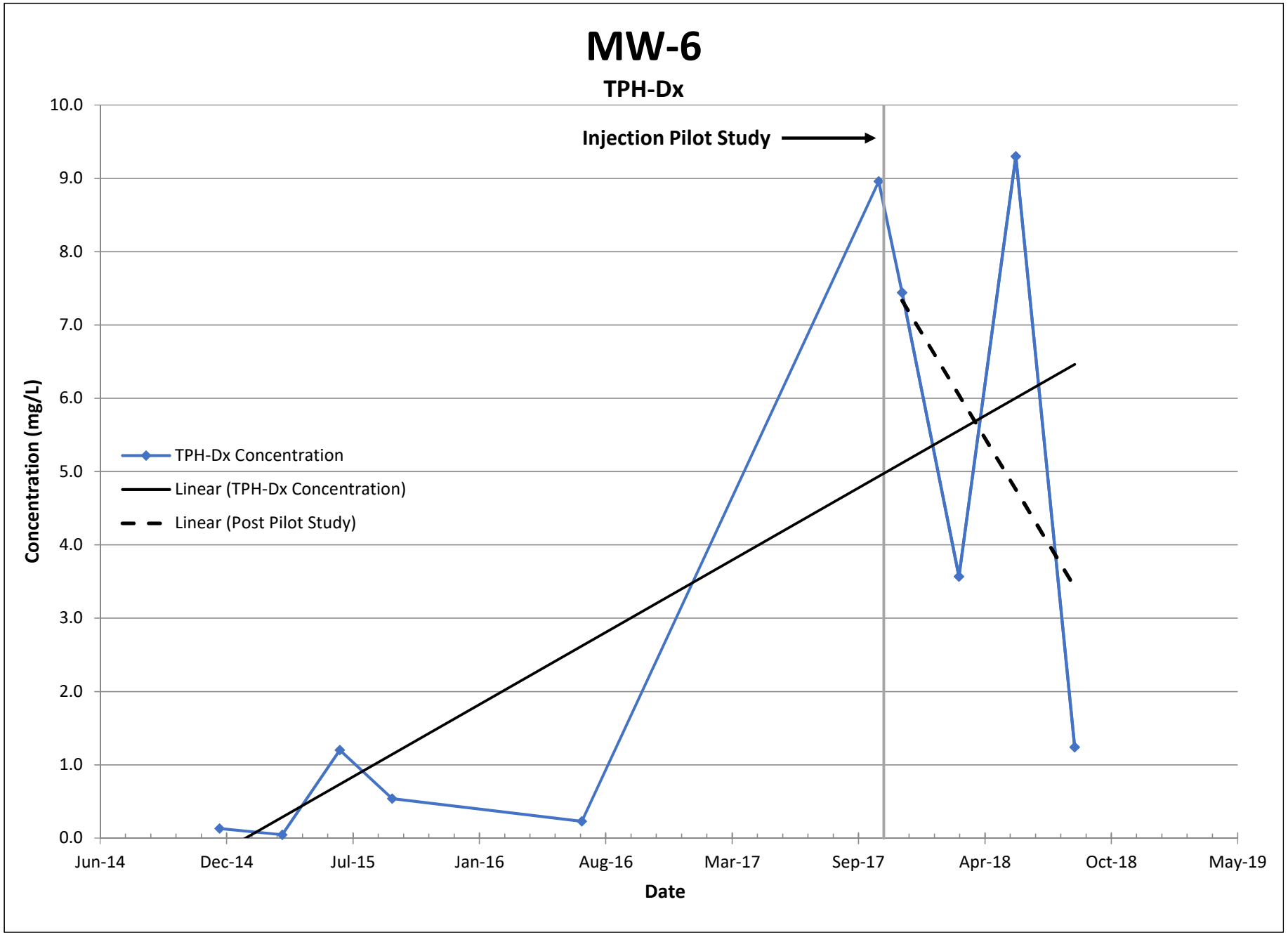

MW-5
TPH-Gx
Injection Pilot Study
Concentration (mg/L)
25
20
15
10
5
0
TPH-Gx Concentration
Linear (TPH-Gx Concentration)
Linear (Post Pilot Study)
Jun-14
Dec-14
Jul-15
Jan-16
Aug-16
Mar-17
Sep-17
Apr-18
Oct-18
May-19
Date


MW-5D
TPH-Gx
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Concentration (mg/L)
TPH-Gx Concentration
Linear (TPH-Gx Concentration)
Injection Pilot Study
Sep-17
Nov-17
Dec-17
Feb-18
Apr-18
May-18
Jul-18
Sep-18
Oct-18
Date


MW-6
TPH-Gx
Injection Pilot Study
Concentration (mg/L)
25
20
15
10
5
0
Jun-14
Dec-14
Jul-15
Jan-16
Aug-16
Mar-17
Sep-17
Apr-18
Oct-18
May-19
Date
TPH-Gx Concentration
Linear (TPH-Gx Concentration)
Linear (Post Pilot Study)


MW-5
TPH-Dx
Injection Pilot Study
TPH-Dx Concentration
Linear (TPH-Dx Concentration)
Linear (Post Pilot Study)
Concentration (mg/L)
2.5
2.0
1.5
1.0
0.5
0.0
Jun-14
Dec-14
Jul-15
Jan-16
Aug-16
Mar-17
Sep-17
Apr-18
Oct-18
May-19
Date


MW-5D
TPH-Dx
Injection Pilot Study
Concentration (mg/L)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Sep-17
Nov-17
Dec-17
Feb-18
Apr-18
May-18
Jul-18
Sep-18
Oct-18
Date
TPH-Dx Concentration
Linear (TPH-Dx Concentration)


MW-6
TPH-Dx
Injection Pilot Study
Concentration (mg/L)
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
TPH-Dx Concentration
Linear (TPH-Dx Concentration)
Linear (Post Pilot Study)
Jun-14
Dec-14
Jul-15
Jan-16
Aug-16
Mar-17
Sep-17
Apr-18
Oct-18
May-19
Date


Cascadia
Associates, LLC