# REMEDIAL INVESTIGATION REPORT

## FINAL – AGENCY REVIEW DRAFT

Alexander Avenue Petroleum Tank Facilities Site
Tacoma, Washington

Ecology Facility Site No. 1377/Cleanup Site No. 743

Prepared for: Port of Tacoma and
Mariana Properties, Inc.

Project No. 130097-01D • December 30, 2016 AGENCY REVIEW DRAFT

Aspect CONSULTING

earth + water

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Aspect Consulting, LLC

**Jeremy Porter, PE**
Senior Associate Remediation Engineer
JPorter@aspectconsulting.com

**Amy Tice, LG**
Project Geologist
atice@aspectconsulting.com

**Steve Germiat, LHG**
Principal Hydrogeologist
sgermiat@aspectconsulting.com

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# Acronyms

| | |
|---|---|
| 500 Property | 500 Alexander Avenue property |
| 605 Property | 605 Alexander Avenue property |
| 709 Property | 709 Alexander Avenue property |
| 900 Property | 900 Alexander Avenue property |
| 1001 Property | 1001 Alexander Avenue property |
| Agreed Order | Agreed Order No. DE 9835 |
| AOC | Administrative Order on Consent |
| ARAR | applicable or relevant and appropriate requirement |
| Aspect | Aspect Consulting, LLC |
| AST | above-ground storage tank |
| ASTM | American Society for Testing and Materials |
| bgs | below ground surface |
| BTEX | benzene, toluene, ethylbenzene, and xylenes |
| CAP | Cleanup Action Plan |
| CFR | Code of Federal Regulations |
| COC | chemicals of concern |
| cPAH | carcinogenic polycyclic aromatic hydrocarbon |
| CVOC | chlorinated volatile organic compound |
| DMMU | Dredge Material Management Unit |
| DNR | Washington Department of Natural Resources |
| Ecology | Washington State Department of Ecology |
| EDB | ethylene dibromide |
| EDC | 1,2-dichloroethane |
| EPA | U.S. Environmental Protection Agency |
| FEH | freshwater equivalent head |
| Fletcher | Fletcher Oil Company |
| FS | Feasibility Study |
| General | General Petroleum Company |
| ID | identification |
| IHS | Indicator Hazardous Substances |

| | |
|---|---|
| LG | licensed geologist |
| LHG | licensed hydrogeologist |
| Lilyblad | Lilyblad Petroleum, Inc. |
| LLC | limited liability company |
| LNAPL | light nonaqueous phase liquid |
| Mariana | Mariana Properties, Inc. |
| Maxwell | Maxwell Petroleum Company |
| mg/kg | milligrams/kilograms |
| mg/L | milligrams per liter |
| MHHW | mean higher high water |
| MLLW | mean lower low water |
| MTCA | Model Toxics Control Act |
| NAPL | non-aqueous phase liquid |
| NAVD | North American Vertical Datum |
| Navy | U.S. Navy |
| No. | number |
| NPDES | National Pollutant Discharge Elimination System |
| NGVD | National Geodetic Vertical Datum |
| OCC | Occidental Chemical Corporation |
| PAH | polycyclic aromatic hydrocarbon |
| PCC | Pacific Coast Container |
| PCE | tetrachloroethylene (perchloroethylene) |
| PE | registered professional engineer |
| Peninsula | Blair-Hylebos Peninsula |
| pH | negative log of the hydrogen ion concentration in solution |
| PID | photoionization detector |
| Pioneer | Pioneer Americas |
| PMI | Port Maritime and Industrial |
| Port | Port of Tacoma |
| PRI | PRI Northwest, Inc. |
| Pyron | Pyron Environmental, Inc. |
| RCW | Revised Code of Washington |
| RI | Remedial Investigation |

| | |
|---|---|
| RI/FS | Remedial Investigation/Feasibility Study |
| SEPA | State Environmental Policy Act |
| Site | Alexander Avenue Petroleum Tank Facilities Site |
| SMA | Sediment Management Area |
| TCE | trichloroethylene |
| TEE | Terrestrial Ecological Evaluation |
| Tesoro | Tesoro Petroleum, Inc. |
| TOC | total organic carbon |
| TOTE | Totem Ocean Trailer Express |
| TPH | total petroleum hydrocarbons |
| µg/L | micrograms per liter |
| United | United Independent Oil Company, Inc. |
| USACE | U.S. Army Corps of Engineers |
| U.S. | United States |
| USAF | U.S. Air Force |
| UST | underground storage tank |
| VI | vapor intrusion |
| VOC | volatile organic compound |
| WAC | Washington Administrative Code |
| WDFW | Washington Department of Fish and Wildlife |

# Executive Summary

The purpose of this Alexander Avenue Petroleum Tank Facilities Site (Site) Remedial Investigation (RI) Report is to present sufficient information to characterize Site conditions attributed to releases of chemicals from the former petroleum storage and distribution facilities located at the Site and to assess area conditions that could affect selection of a remedy. Information collected for the RI will enable preparation of a feasibility study (FS) and select a remedy to address contamination. Aspect Consulting, LLC (Aspect) has prepared this RI Report on behalf of the Port of Tacoma (Port) and Mariana Properties, Inc. (Mariana) and in accordance with the Washington State Department of Ecology (Ecology) Agreed Order No. DE 9835 (Agreed Order).

## Site Description and History

The Site is located at 709, 901, and 1001 Alexander Avenue in Tacoma, Washington (Figure ES-1). Historical Site features are shown on Figure ES-2. Petroleum storage and distribution facilities (tank farms) were formerly located at the 709 Alexander Avenue property (709 property) and the northern portion[1] of the current 901 Alexander Avenue property (901 property). These facilities operated from approximately the 1930s to the 1980s. Following removal of tank farm infrastructure in the 1980s, the 709 property (currently owned by Mariana) has largely been vacant and unused[2], while the 901 property (currently owned by the Port) has been leased by other tenants and most recently used for storage and cargo handling. The 901 property is currently vacant. A liquefied natural gas (LNG) facility is proposed to be constructed in the middle and southern portions of the 901 property.

The 709 property also includes an embankment fill area along the shoreline that was associated with the former Occidental Chemical Corporation (OCC) operations on the parcel to the north (605 Alexander Avenue: 605 property). This fill area is regulated as part of the OCC site and is not considered part of the Site. Sediments east of the 709 and 901 properties are regulated as part of the Commencement Bay/Nearshore Tideflats Superfund Site, and as such are not being addressed as part of this cleanup.

Historical operations at the former tank farm properties have resulted in an area of contaminated soil and groundwater beneath the 709 and 901 properties, the adjacent Alexander Avenue right-of-way, the 605 property, and the 500 Alexander Avenue property (500 property) located across Alexander Avenue to the west. Overlapping the northeast corner of Site impacts is a groundwater plume of elevated pH, metals, and

[1] The northern portion of the 901 property was formerly a distinct tax parcel with the address of 721 Alexander Avenue. Previous investigations and reports have referred to the 721 property address.
[2] The 709 property was briefly used for storage of treated sediments as part of the Hylebos Waterway cleanup.

chlorinated solvents[3] associated with the OCC site. The FS will consider how the presence of commingled contamination may affect Site remedial alternatives and the effect of Site remedial alternatives on potential OCC site remedial actions.

## Site Geology and Hydrogeology

Site soils consist of dredge fill materials (generally fine sands with some silt) overlying native tideflat deltaic deposits that have a slightly higher organic content (wood fibers) compared to the fill unit and consist of gradational clays, silts, and sands. Groundwater is encountered typically 5 to 9 feet below ground surface, with slight seasonal variations (typically 1 to 2 feet) and somewhat more significant tidal variations near the shoreline, particularly in deeper groundwater units. Site impacts are generally confined to two groundwater units identified for the purposes of the RI[4] as follows:

- A 15-foot zone (at depths of approximately 5 to 15 feet), primarily in the dredge fill materials, and at the approximate elevation of the intertidal zone; and
- A 25-foot zone (at depths of approximately 15 to 25 feet) in the upper portion of the native deltaic deposits, at the approximate elevation of the upper portion of the subtidal zone.

Discontinuous layers of low-permeability materials (silts and sandy silts) separate the two intervals, but do not prevent vertical groundwater flow or contaminant transport between the units. Gradients between the units are downward on average but vary during seasonal and tidal cycles.

Groundwater in both units exhibit a north-south-trending divide in approximately the west-central portion of the tank farm properties. Groundwater west of this divide flows generally west, across Alexander Avenue toward the Blair Waterway. Groundwater east of this divide flow generally east, with a slight southerly component, toward the Hylebos Waterway.

## Nature and Extent of Site Contamination

Numerous environmental investigations have been performed at the Site to characterize the nature and extent of contamination, contaminant fate and transport properties, or exposure to people or the ecological environment under the Port's future industrial Site use. Exploration locations are shown on Figure ES-3. For the purposes of this RI Report, chemicals of concern (COCs) include chemicals associated with the Site and chemicals associated with the adjacent OCC site that are comingled with Site contamination. These COCs include chemicals associated with petroleum products, chlorinated solvents, and metals. Beyond the low-level occurrences of chlorinated solvents that have been detected sporadically in soil at the Site, chlorinated solvent and metals exceedances in soil and groundwater are primarily located in the northeastern portion of the Site and on the adjacent 605 property and embankment fill area of the 709 property. The primary

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[3] Low-level occurrences of chlorinated solvents, primarily PCE, have also been detected sporadically in soil at the Site; however, the concentrations detected at the Site are low and not considered risk drivers or to affect the scope of potential Site remedial actions.
[4] Hydrogeologic units are defined consistent with those defined for the adjacent OCC site.

petroleum-associated COCs that were identified as Indicator Hazardous Substances (IHSs) for this RI are as follows:

- Benzene;
- Gasoline-range total petroleum hydrocarbons (TPH); and
- Diesel-range plus heavy-oil-range TPH.

Screening levels for COCs in soil and groundwater were developed based on applicable or relevant and appropriate requirements (ARARs) for the following potential exposure pathways: direct contact (under industrial use), protection of marine surface water for human health and ecological receptors, and protection of vapors. Site groundwater is not considered a current or potential future source of drinking water.

A summary of Site COCs, IHSs, and screening levels is provided in Table ES-1. Occurrences of petroleum product as light non-aqueous phase liquid (LNAPL) and petroleum-associated COCs is described below.

### LNAPL

LNAPL has been observed in several monitoring wells on the western portion of the tank farm properties at a maximum thickness of approximately 1 foot, and extending across the Alexander Avenue right-of-way to the 500 property. Forensic testing of product samples indicates a mixture of weathered gasoline- and middle-distillate diesel-range TPH, with the majority of product in the diesel range. Recoverability testing of LNAPL indicates low recoverability. Low mobility of Site LNAPL is inferred from the product composition and recoverability test results.

### Soil Contamination

High concentrations of benzene, gasoline-range TPH, and diesel- + oil-range TPH are present in soil over much of the former tank farm footprints and the adjacent Alexander Avenue right-of-way. High concentrations of these COCs and field observations of sheen or product in boring logs, even when measurable product is not observed in collocated monitoring wells, imply the presence of LNAPL below residual saturation (i.e., adhered to soil grains and not present as a free-phase accumulation on top of groundwater).

The extent of highly elevated benzene concentrations and gasoline- and diesel- + oil-range TPH above soil screening levels is generally limited to the shallow water table zone (less than 15 feet deep) in the immediate vicinity of the former tank farms. The maximum extent of highly elevated benzene and TPH concentrations is approximated by the extent of diesel- + oil-range TPH in soil in the 5- to 15-foot depth interval, which is shown on Figure ES-4. The extent of modest benzene exceedances in soil extends vertically into the 25-foot zone laterally across part of the 500 property and southeast across the 901 property, consistent with the groundwater plumes in the 15- and 25-foot zones.

### Groundwater Contamination

The extent of gasoline-range TPH and benzene in groundwater exceeding screening levels are similar to those in soil, but extend slightly farther in the directions of groundwater flow (east and west). Similar to soil, gasoline-range TPH exceedances are generally limited to the shallow (15-foot) groundwater zone, but benzene exceedances are present in both the 15- and 25-foot zones. Concentrations of benzene and gasoline-range TPH exceed surface-water protection screening levels at some shoreline wells but are below these screening level in seeps. The extent of benzene in the 15- and 25-foot groundwater zones is shown on Figures ES-5 and ES-6.

The extent of diesel- + oil-range TPH exceedances in Site groundwater depends on whether silica-gel cleanup (SGC) is applied during the laboratory analysis. SGC is a process that removes polar organic compounds, including biodegradation products of petroleum compounds. The extent of diesel- + oil-range TPH exceedances with SGC in groundwater is similar to the extent of exceedances in soil, and generally limited to the former tank farm footprints and immediate vicinity. Without SGC, the extent of diesel- + oil-range TPH exceedances in groundwater extend vertically into the 25-foot zone and laterally east and west to the shorelines of the Blair and Hylebos Waterways, and slightly exceed surface water protection screening levels in two seeps along the Hylebos Waterway. This greater extent of TPH exceedances without SGC is likely due to the ongoing production of polar compounds from biodegradation of TPH, and the higher solubility and subsequently greater mobility of polar compounds.

## Risk Summary and RI Conclusions

Based on the collected data, it is likely that Site contamination is not posing an unacceptable risk to human health or the environment under the current Site use, for the following reasons:

- Concentrations of COCs in groundwater discharging to adjacent waterways (seep samples) are generally below surface water protection-based screening levels. The exception is concentrations of diesel + oil-range TPH (without SGC) that slightly exceeded (less than 2 times) ecological and/or human health-based screening levels in two seep samples. However, as discussed in Section 6, these screening levels are likely highly conservative if applied without SGC.

- Storm drainage lines are higher in elevation than seasonally high water levels, making groundwater infiltration and transport to surface water through storm sewer lines improbable.

- Site buildings are not considered a vapor intrusion (VI) concern. The former Navy Warehouse building on the 901 property is located south of the area of groundwater contamination exceeding VI-based screening levels. The northern warehouse (Port Building 845) on that property occurs within the footprint of groundwater exceeding VI-based screening level. That warehouse is not constructed for occupancy and consists of an uninsulated steel shed above pavement. There are no offices, bathrooms, or other enclosed spaces and no HVAC system to create pressure differential between the air and the subsurface. The building is currently vacant and is planned for being used for storage only. The building would only be occupied by workers when moving materials in or out.

- Access to contaminated soils and groundwater is limited by pavement on the 901 and 500 properties and the City right-of-way, and fences and locked gates restrict access to the 901 and 709 properties. The 709 property is vacant and will likely remain so in the foreseeable future.

Nevertheless, Site contamination exceeds soil and groundwater screening levels over portions of four properties (709, 901, 1001, and 500 properties) and the Alexander Avenue right-of-way. There is a potential for exposure to workers accessing underground utilities, subsurface construction for future development, or to utility workers from contaminants migrating into the sanitary sewer line in Alexander Avenue, which is below the water table. Additional actions may be warranted to comply with MTCA requirements and protect potential exposure pathways in the future. The FS will identify remedial action objectives and potential cleanup standards, develop and evaluate a range of remedial alternatives, and propose a cleanup action for the Site.

## Table ES-1 - Summary of Site COCs, IHSs, and Screening Levels

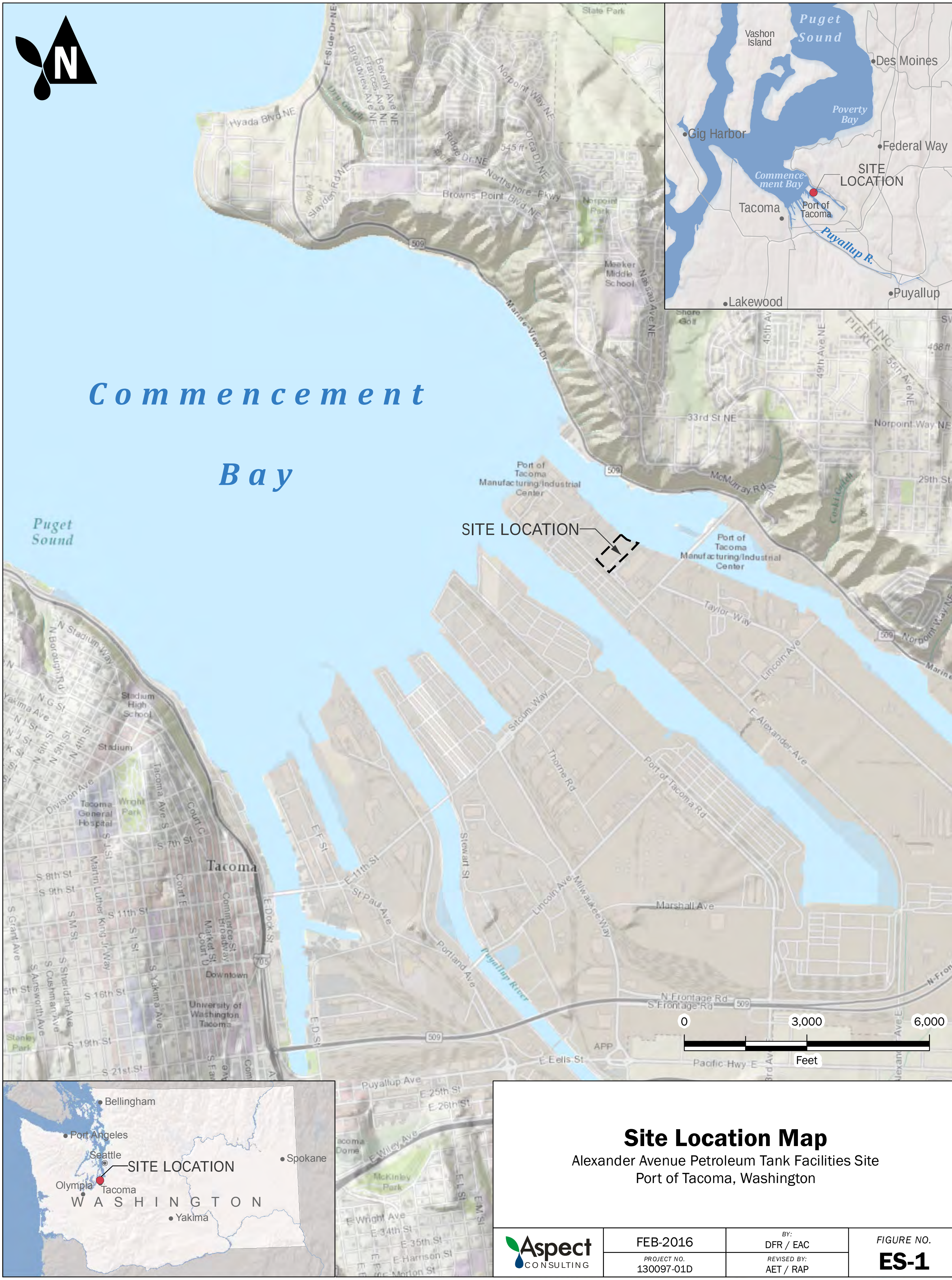
Project No. 130097, Alexander Avenue Petroleum Tank Facilities Site
Tacoma, Washington

| | Soil Screening Levels | | Groundwater Screening Levels | |
|---|---|---|---|---|
| Analyte | Direct Contact Based (mg/kg) | Groundwater Protection Based (mg/kg) | Surface Water Protection Based (ug/L) | Vapor Protection Based (ug/L) |
| **Petroleum Hydrocarbons** | | | | |
| Gasoline Range Hydrocarbons | -- | 30 | 800 | -- |
| Diesel Range Hydrocarbons | -- | 2000 | 500 | -- |
| Oil Range Hydrocarbons | -- | 2000 | 500 | -- |
| Total TPH (D+O Range) | -- | 2000 | 500 | -- |
| Total TPH (G+D+O Range) | -- | -- | 720 | -- |
| **Volatile Organics** | | | | |
| Benzene | 2400 | 0.02 | 58 | 24 |
| Dichloroethene -1,1 | 180000 | -- | 3.2 | 280 |
| Ethylbenzene | 350000 | 0.06 | 130 | 6000 |
| Tetrachloroethene (PCE) | 21000 | 0.005 | 8.9 | 100 |
| Trichloroethene (TCE) | 1800 | 0.005 | 7 | 8.3 |
| Trimethylbenzene -1,2,4 | -- | -- | -- | 63 |
| Vinyl Chloride | 88 | 0.005 | 1.6 | 5.4 |
| Xylenes (total) | 700000 | -- | -- | 970 |
| **Semivolatile Organics: PAHs** | | | | |
| Naphthalene | 70000 | 6.1 | 4700 | 90 |

**Notes:**

-- dashes indicate screening level not established.

Indicator Hazardous Substances (IHSs)

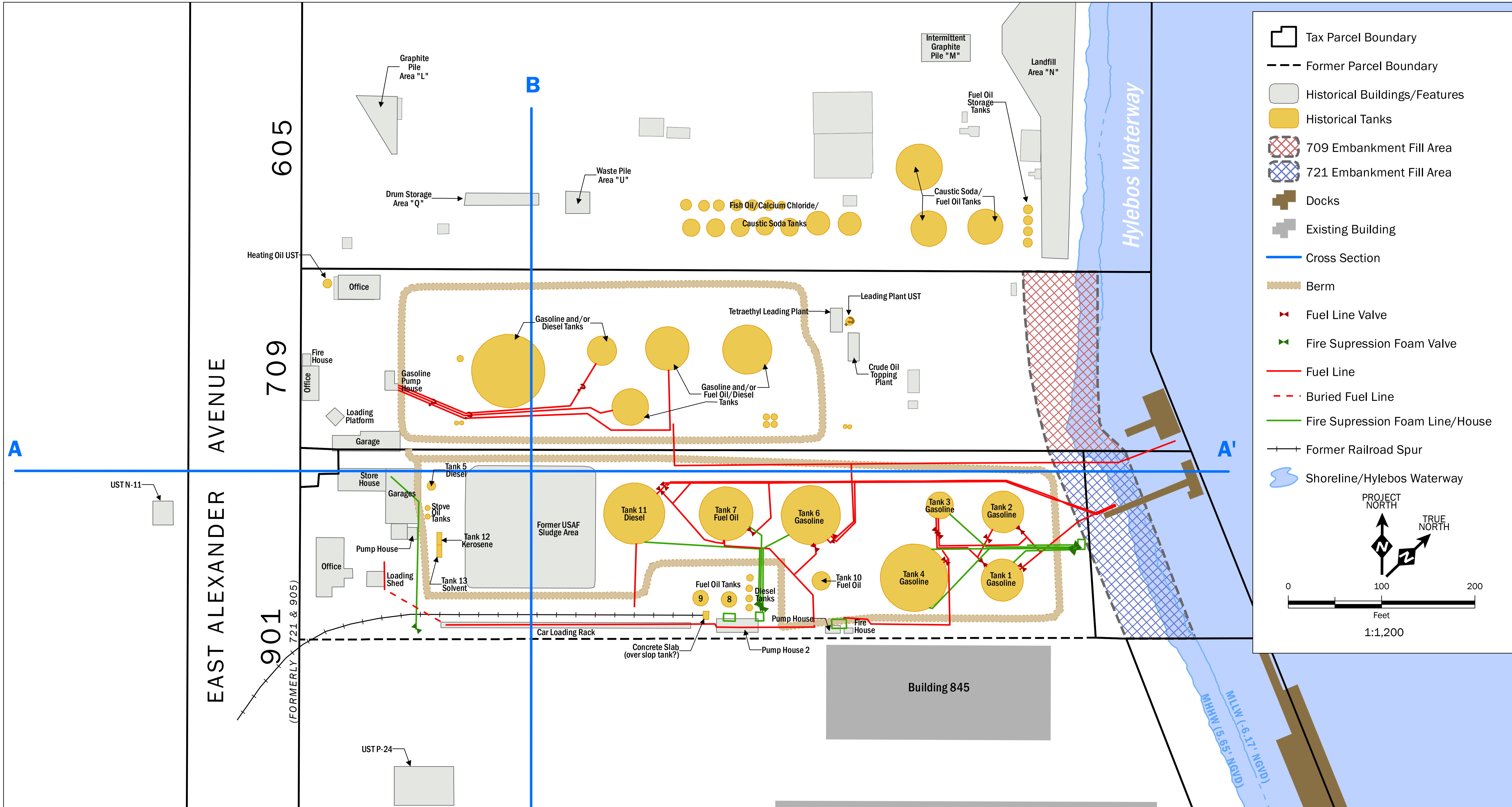



# Site Location Map

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

| | | | |
|---|---|---|---|
| Aspect CONSULTING | FEB-2016 | BY: DFR / EAC | FIGURE NO. |
| | PROJECT NO. 130097-01D | REVISED BY: AET / RAP | ES-1 |

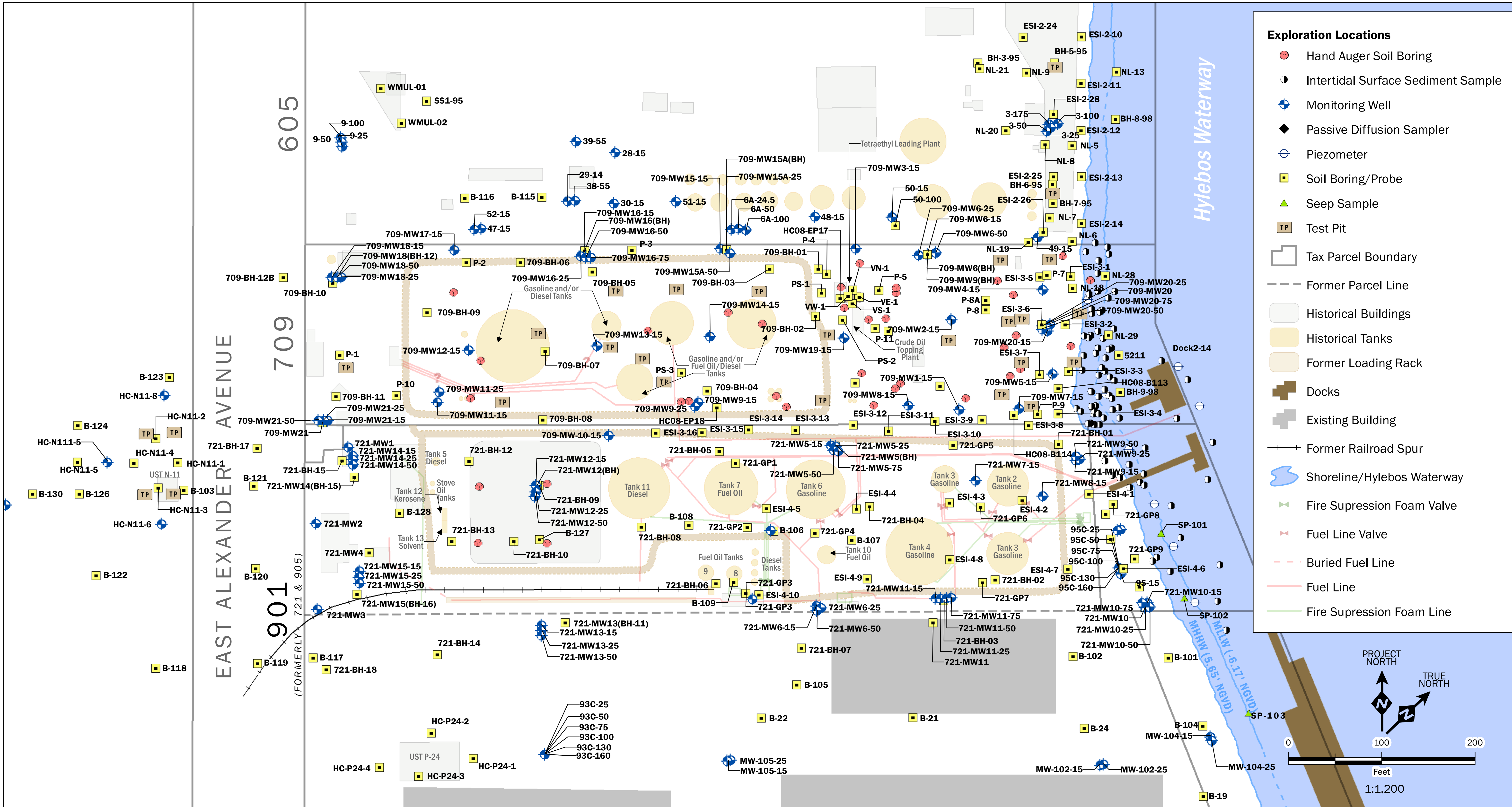
GIS Path: T:\projects_8\Port_of_Tacoma\AlexanderAve_130097\Delivered\RemedialInvestigationReport\Executive Summary\ES-1 Site Vicinity.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 2/24/2016 || User: rbobich || Print Date: 3/31/2016




## Historical Features

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

| | | | |
|---|---|---|---|
| Aspect CONSULTING | MAR-2016 | BY: PPW / DFR | FIGURE NO. |
| | PROJECT NO. 130097-01B | REVISED BY: EAC / RAP / AET | ES-2 |

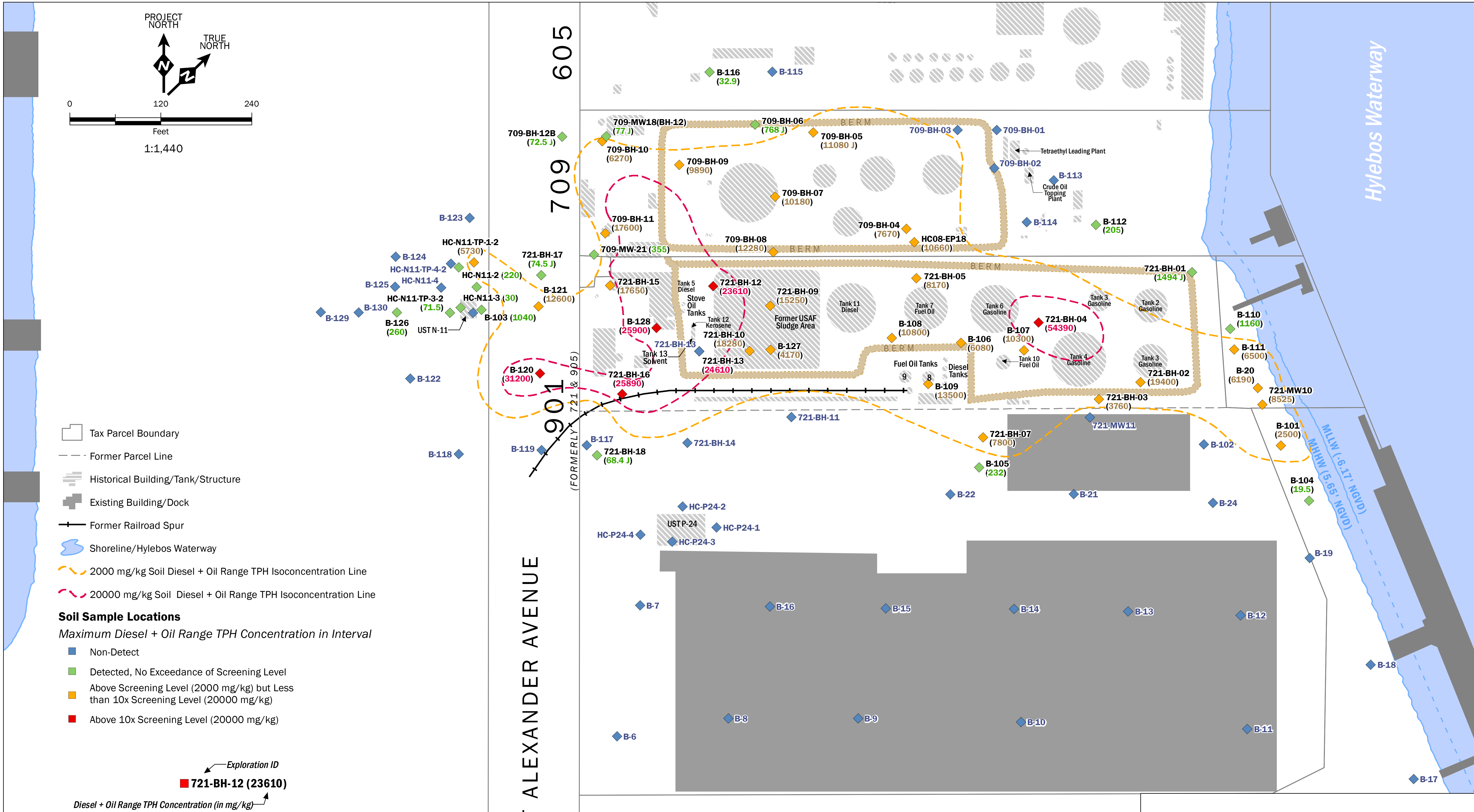



# Exploration Locations

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING

| | | | |
|---|---|---|---|
| OCT-2016 | BY: PPW / DFR | FIGURE NO. |
| PROJECT NO. 130097-01D | REVISED BY: EAH / RAP | ES-3 |




Notes:
•Diesel and Oil Range TPH concentrations are summed in accordance with Ecology Implementation Memorandum #4 (Ecology, 2004)
•For samples where either diesel or oil range TPH was not detected, ½ the detection limit was used to calculate the sum. Concentrations were not summed when both diesel and oil range TPH were not detected.

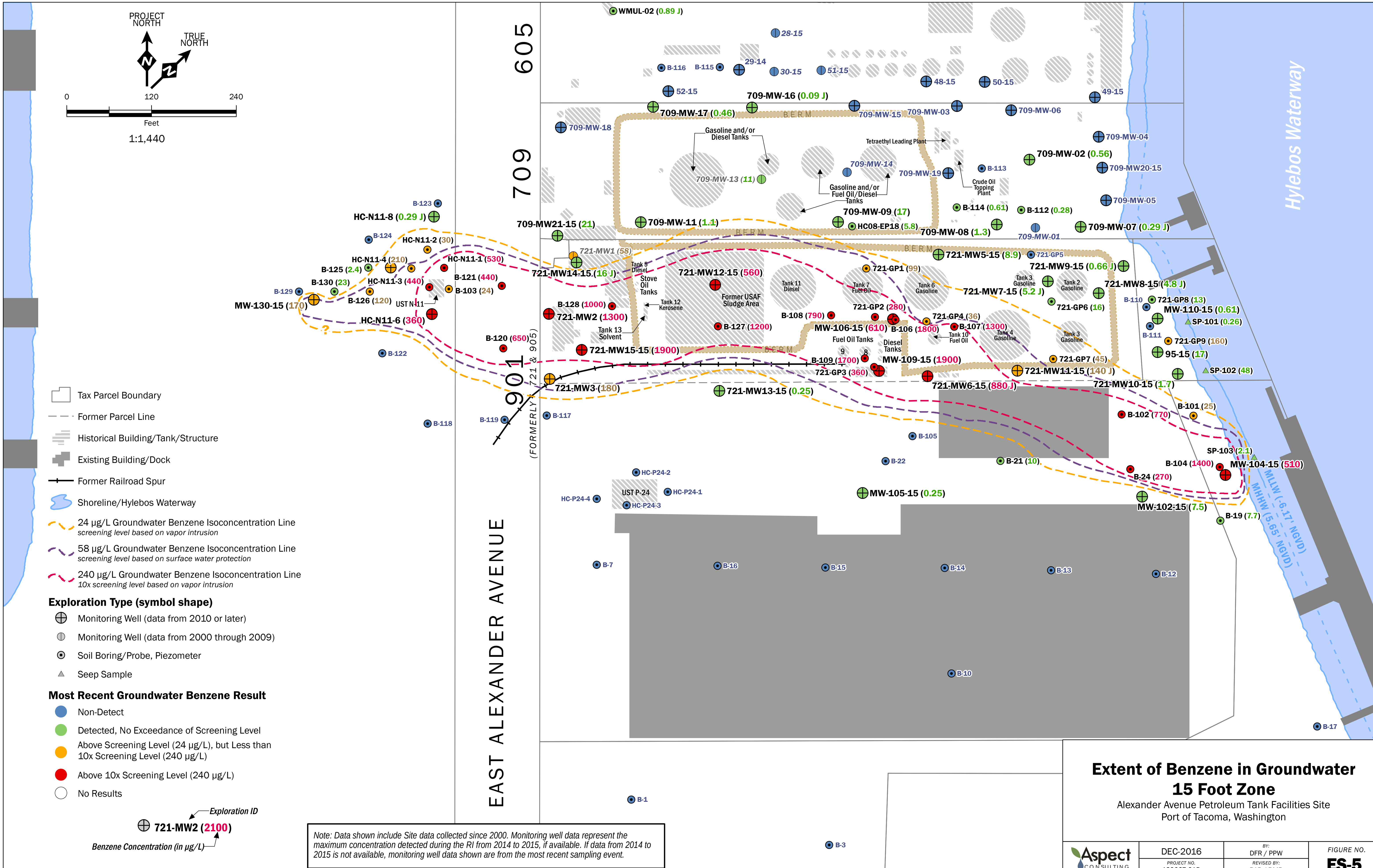
*Note: Displayed concentrations represent the maximum detected at each exploration location in the indicated depth interval. Only data collected since 2000 are displayed. Screening level 2000 mg/kg is based on MTCA Method A for industrial land use.*

# Extent of Diesel + Oil Range TPH in Soil Saturated Zone (5 – 15' bgs)

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

| | | | |
|---|---|---|---|
| Aspect CONSULTING | MAR-2016 | BY: DFR / PPW | FIGURE NO. |
| | PROJECT NO. 130097-01D | REVISED BY: EAC / RAP | ES-4 |

GIS Path: T:\projects_8\Port_of_Tacoma\AlexanderAve_130097\Delivered\RemedialInvestigationReport\Executive Summary\ES-4 Soil Diesel and Oil Range TPH 5-15.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 3/31/2016 || User: dbobich || Print Date: 3/31/2016

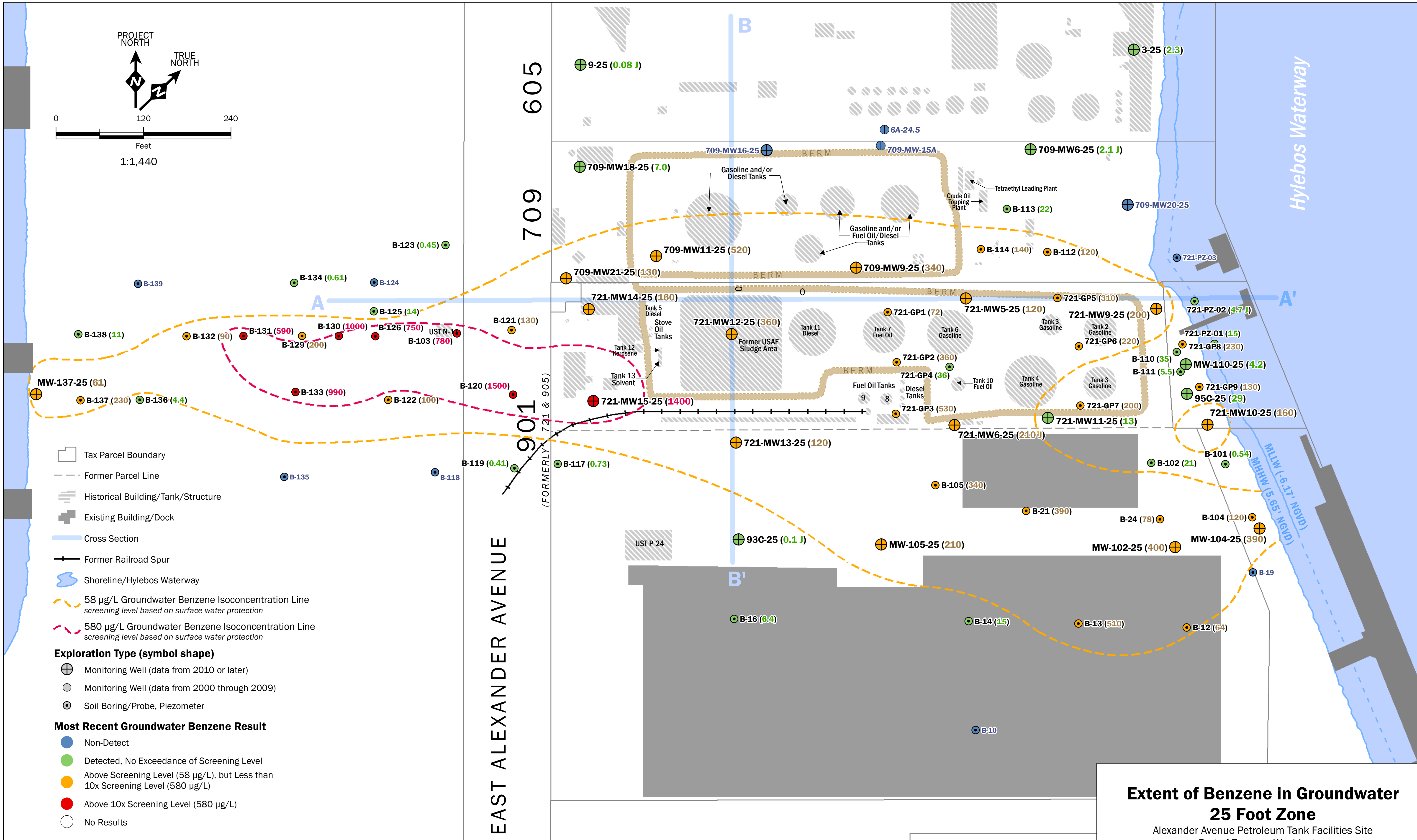



Note: Data shown include Site data collected since 2000. Monitoring well data represent the maximum concentration detected during the RI from 2014 to 2015, if available. If data from 2014 to 2015 is not available, monitoring well data shown are from the most recent sampling event.

## Extent of Benzene in Groundwater 15 Foot Zone

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

| Aspect Consulting | DEC-2016 | BY: DFR / PPW | FIGURE NO. |
|---|---|---|---|
| | PROJECT NO. 130097-01D | REVISED BY: RAP / RMB | ES-5 |




*Note: Data shown include Site data collected since 2000. Monitoring well data represent the maximum concentration detected during the RI from 2014 to 2015, if available. If data from 2014 to 2015 is not available, monitoring well data shown are from the most recent sampling event.*

# Extent of Benzene in Groundwater 25 Foot Zone

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

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| | | | |
|---|---|---|---|
| DEC-2016 | BY: DFR / PPW | FIGURE NO. | |
| PROJECT NO. 130097-01B | REVISED BY: RAP / RMB | ES-6 | |

GIS Path: T:\projects_8\Port_of_Tacoma\AlexanderAve_130097\Delivered\RemedialInvestigationReport\6.4-4 GW Benzene 25.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 12/27/2016 || User: rpepin || Print Date: 12/27/2016

# 1 Introduction

This Remedial Investigation (RI) Report describes environmental conditions at the Alexander Avenue Petroleum Tank Facilities Site (Site) located at 709, 901, and 1001 Alexander Avenue in Tacoma, Washington (Figure 1.1). This RI Report has been prepared to meet the requirements of Agreed Order No. DE 9835 (Agreed Order) between the Washington State Department of Ecology (Ecology), Mariana Properties, Inc. (Mariana), and the Port of Tacoma (Port), executed on October 3, 2013. The Agreed Order includes the following primary work scope elements:

- An RI and Feasibility Study (FS) Work Plan (RI/FS Work Plan);
- Field investigations and data gathering as identified in the RI/FS Work Plan;
- RI Report;
- FS Report; and
- Draft Cleanup Action Plan (dCAP).

The purpose of this RI is to evaluate the nature and extent of hazardous substances in environmental media at the Site. The information gathered in the RI will be used in the Feasibility Study (FS) to develop and evaluate potential remedial alternatives and select a preferred cleanup action. After the FS is approved, the Ecology-selected cleanup action will be described in the dCAP.

The Site is generally located between Alexander Avenue and the Hylebos Waterway on the northern side of the Blair-Hylebos Peninsula. The Site includes a portion of 709 Alexander Avenue (Pierce County Parcels 2275200510 and 2275200520), and portions of 901 and 1001 Alexander Avenue (Pierce County Parcels 5000350021 and 2275200502, respectively). Portions of 901 and 1001 Alexander Avenue were historically combined and previously known as 721 Alexander Avenue. In this report, the former 709 and 721 Alexander Avenue properties are individually referred to as the 709 property and the northern portion of the 901 property (Figure 1.2).

In accordance with the Agreed Order, the Site is defined more specifically as the extent of contamination caused by the release of hazardous substances originating from activities associated with historic petroleum storage and processing facilities that were operated at the noted properties, and the Site is not limited by property boundaries. The areal extent of contamination from the adjoining Occidental Chemical Corporation (OCC) Site overlaps with this Site. Investigation and cleanup of the OCC Site is being conducted under an existing Administrative Order on Consent (AOC) for the Occidental Site, as amended by OCC, Ecology, and the U.S. Environmental Protection Agency (EPA). One of the objectives of this RI is to assess the relationship between contaminants originating at the Site and contaminants originating from the OCC Site. This information will be used to develop remedial alternatives for this Site which will be compatible with Occidental Site response actions.

The cleanup area does not include intertidal/subtidal areas in the Hylebos Waterway because they are part of the larger Commencement Bay/ Nearshore Tideflats (CBNT) Superfund Site. Sediments were investigated as part of this RI and, although TPH was identified, sediment quality was determined not be a threat to aquatic life based on bioassays. TPH-related compounds related to the former tank facilities were not identified in sediments above CBNT Sediment Quality Objectives (SQOs). The CBNT Superfund Site is further discussed in Section 2.3.3.

The RI has been conducted in accordance with RCW 70.105D.050(1) and the Washington State Model Toxics Control Act Cleanup Regulation (MTCA), Chapter 173-340 of the Washington Administrative Code (WAC). Specific objectives of the Site RI are to:

- Obtain sufficient data to describe the physical setting and physical properties of Site soil, groundwater, sediments, and soil vapor (air);
- Determine the nature and extent of contamination in Site soil, groundwater, and, where applicable, sediment and soil vapor (air);
- Characterize the fate and transport of identified contaminants, including how contaminants migrate between media (e.g., soil leaching to groundwater, groundwater discharge to sediments and then surface water, and volatilization from soil or groundwater to air);
- Identify potential areas where contaminant plumes from different sources and/or properties may “commingle” in Site soil, groundwater, and, where applicable, sediment and soil vapor (subsurface air); and
- Use the information collected to assess potential risk to human health and the environment under current and anticipated future land use; and
- Report the methods and findings of the RI to Ecology and project stakeholders, including the local community.

The primary stakeholders for the AO work are the United States Environmental Protection Agency (EPA), through their jurisdiction for the Hylebos Waterway problem area of the Commencement Bay Nearshore/Tideflats Superfund site and the associated adjacent OCC Site; the Tacoma-based Citizens for a Healthy Bay; and the Puyallup Tribe (the Mouth of Hylebos Waterway is within the Puyallup Tribe usual and accustomed (U&A) fishing and gathering area). Other public agencies that have or may have interest and/or jurisdiction over the tank farm properties include: the United States Army Corps of Engineers (USACE), the Washington Department of Fish and Wildlife (WDFW), and the Washington Department of Natural Resources (DNR). The public involvement activities are described in greater detail within Ecology’s Public Participation Plan for the Site, which is Exhibit G to the Agreed Order.

## 1.1 Report Organization

This RI includes nine sections and multiple appendices. The main text is organized as follows:

- Section 1 – The **Introduction** presents regulatory status of the Site and information regarding the objectives and approaches for the RI;

- Section 2 – The **Site History and Background** section describes the Site location, ownership, zoning, operational history, and environmental setting;
- Section 3 – The **Environmental Setting** section describes the Site physical conditions including topography and surface drainage, geology and hydrogeology, ecological environment (terrestrial and aquatic), cultural resources, land use, and existing infrastructure;
- Section 4 – A **Summary of Completed Investigations** describes the purpose and scope of each investigation conducted at the Site;
- Section 5 – **ARARs and Screening Levels** are identified for the purposes of comparing chemical concentrations and identifying potential exposure pathways;
- Section 6 – The **Nature and Extent of Contamination** describes the distribution of chemicals in environmental media within the Study Area;
- Section 7 – The **Conceptual Site Model** synthesizes the collective information to describe sources of contamination and the mechanisms of contaminant fate and transport, and evaluate potential exposure pathways resulting from Chemical of Concern (COC) occurrences;
- Section 8 – **Conclusions** of the RI are summarized and recommendations for future actions are provided; and
- **References** cited are provided at the end of the main report text.

This RI includes multiple appendices to support the analyses and discussions in the main body of the text. These appendices include:

- Appendix A – Boring Logs;
- Appendix B – Data Tables for Site data used in this RI, grouped by analyte group and sampling interval;
- Appendix C—Selected Historical Documents;
- Appendix D—Figures Depicting Extent of OCC-related Metals and Elevated pH in Groundwater. Includes figures of arsenic, copper, nickel, lead, pH >8.5 in the 15-foot and 25-foot aquifer zones;
- Appendix E - Data Usability with Lab and Data Validation Reports on CD;
- Appendix F – Simplified Terrestrial Ecological Evaluation Form for Site;
- Appendix G – Estimates of Contaminant Mass; and
- Appendix H - LNAPL Recoverability Testing Memo.

# 2 Site History and Background

## 2.1 Site Location and Zoning

The Site is located in an industrial-port area on the northern side of the Blair-Hylebos Peninsula (Peninsula), approximately 2.5 miles northeast of downtown Tacoma, Washington (Figure 1.1). The Site includes portions of four existing, contiguous tax parcels that total approximately 9 acres of land (Figure 1.2). The Site includes portions of the 709 property (Pierce County Parcels 2275200510 and 2275200520), and portions of 901 and 1001 Alexander Avenue (Pierce County Parcels 5000350021 and 2275200502, respectively), including that portion of 901 and 1001 Alexander Avenue that was historically referred to as 721 Alexander Avenue.

The entire Blair-Hylebos Peninsula, including the Site and adjacent properties, is zoned Port Maritime and Industrial (PMI). Zoning in the vicinity of the Site is consistent with the MTCA definition (WAC 173-340-200) of industrial property:

- "Industrial properties" means properties that are or have been characterized by, or are to be committed to, traditional industrial uses such as processing or manufacturing of materials, marine terminal and transportation areas and facilities, fabrication, assembly, treatment, or distribution of manufactured products, or storage of bulk materials, that are either:
  - Zoned for industrial use by a city or county conducting land use planning under chapter 36.70A RCW (Growth Management Act); or
  - For counties not planning under chapter 36.70A RCW (Growth Management Act) and the cities within them, zoned for industrial use and adjacent to properties currently used or designated for industrial purposes.

Ecology's Facilities/Sites Database includes the following cleanup-related listings within the subject properties:

- Site Name: Alexander Avenue Petroleum Tank Facilities (the subject of this RI)
  Facility/Site ID: 1377
  Facility Address: 721 Alexander Avenue

- Site Name: Glenn Springs Holdings, Inc./ PRI Northwest, Inc. (subject of Enforcement Order 95TC-S242 from Ecology to PRI Northwest, Occidental Chemical Corporation, and F. O. Fletcher, Inc.).
  Facility/Site ID: 1246
  Facility Address: 709 Alexander Avenue

  The Glenn Springs Holdings/ PRI Northwest site was originally identified because of embankment fill along the shoreline of the 709 property. The embankment fill is now recognized as part of the OCC Site, not the Alexander Avenue Petroleum Tank Facilities Site. Further required action under Enforcement Order 95TC-S242 has been held in abeyance due to the OCC AOC and it is expected that the area will eventually be included in the OCC Site administrative order and cleanup.

- Site Name: Naval Reserve Center Tacoma
  Facility/Site ID: 93581722
  Facility Address: 1001 Alexander Avenue

  The 1001 property where the Naval Reserve Center is located, is a large irregularly shaped parcel. A portion of this parcel runs along the shoreline edge of the 901 property and was formerly part of the tank facility property. However, the area and issues that caused the Naval Reserve Center listing are not close to the subject site. This property underwent an investigation and remediation related to the 1993 removal of six USTs, during which 166 tons of petroleum-impacted soil were removed and disposed of offsite. The site was entered into the VCP and an NFA has been tentatively approved by Ecology pending upload of data to EIM and completion of a terrestrial ecological evaluation.

### *2.1.1 Current and Future Land Use*

#### 2.1.1.1 709 Alexander Avenue Parcel

As mentioned above, the 709 property is vacant and zoned for industrial use. The property contains a dilapidated dock that is not currently in use, and there are no plans for its future use. The property is primarily unpaved and covered with sparse vegetation, with the exception of a graveled roadway and small asphalt pad. The planned future use of this property is to remain vacant in the foreseeable future. Vacant property also provides OCC with remedial design flexibility related to the anticipated cleanup of the OCC Site contaminants, including the embankment fill area located in the eastern portion of the property.

#### 2.1.1.2 901 Alexander Avenue Parcel

The fully paved 901 property is currently zoned for industrial use and is leased by the Port of Tacoma as a storage and staging yard for shipping containers and truck trailers. The property contains a dilapidated dock to the north that is not in use, and there are no plans for its future use. The property also contains a stable, functioning dock south of the dilapidated dock that is not in use and is not planned for future use. The planned future use is maritime industrial, consistent with the current industrial use. In particular, a proposed liquefied natural gas (LNG) storage and distribution facility is planned for this property. The main plant facilities are planned to be constructed on the south portion of the 901 property, outside the footprint of the contaminant plume. A large warehouse exists on the property and is currently referred to as “Port Building 50” (Figure 2.2), but will be demolished for the LNG facility. The existing asphalt-on-grade warehouse (building 845) located within the plume footprint will be used during LNG facility construction for storage of construction materials. After the plant is constructed the building will be used by the tenant for long term storage. The preliminary layout of the proposed LNG facility structures on the northern portion of the 901 property is shown on Figure 2.1.

## 2.2 Properties History and Ownership

The development history of the 709 and 901 properties (collectively, the tank farm properties) and surrounding properties, and specific information regarding historical operations, facilities, and features, is described in several previous environmental reports including the *Data Summary Report - 709 and 721 Alexander Avenue* (CRA, 2012b and 2013a) and *Final Report, 721 East Alexander* (GeoEngineers, 2010a). In addition to previous environmental investigation reports, a variety of historical information was reviewed during the preparation of this RI, including: Sanborn maps, aerial photographs (orthographic and oblique), facility diagrams, demolition records, property ownership records, and utility maps. Selected historical documents are provided in Appendix C. Site history, as documented in these records and reports, is summarized below. The locations of key historical features, including former tanks, piping, process areas, and loading areas, are shown on Figure 2.2.

All subsequent references to cardinal directions in this RI Report are based on "project north" which is oriented along the long axis of the Hylebos Peninsula. Project north is located approximately 45 degrees west of true north, as shown on each figure, starting with Figure 2.2.

This section summarizes the history of property ownership and operations for the properties included in the Site, organized by current site address. Adjacent properties are discussed in Section 2.3.

### 2.2.1 Development History of Blair-Hylebos Peninsula

The Hylebos Peninsula was created in the 1920s by the placement of approximately 16 to 20 feet of fill dredged from nearby waterways. The dredged fill material was placed directly onto the native tideflat deposits, and the nearby waterways were widened and deepened to support maritime industrial activities. During and after World War Two (in the 1940s and 1950s), nearly all of the Blair- Hylebos Peninsula surrounding the subject properties and the former OCC facility was used by instrumentalities of the United States for the purpose of ship construction, maintenance, and dismantling associated with the United States' war effort and the post-war activities at the Naval Station Tacoma, and subsequent activities related to the U.S. Naval and Marine Reserve Center.

### 2.2.2 Ownership/Operational History of the 709 Property

#### 2.2.2.1 709 Tank Farm (Originally Fletcher Oil)

The 709 property was originally owned by Norton and Mary Clapp, who sold the property to the Fletcher Oil Company (Fletcher). Fletcher developed and operated the property as a fuel storage and distribution facility between 1938 and 1978. The distribution facility had five large above-ground storage tanks (ASTs) and several smaller ASTs, with a total maximum capacity of 1.9 million gallons. Historical records indicate that Fletcher distributed gasoline and diesel fuel, which was delivered to the Site by barge and was trucked off site. Tesoro Petroleum, Inc. (Tesoro) and the United Independent Oil Company, Inc. (United) leased portions of the property during the 1970s.

PRI Northwest, Inc. (PRI) began to lease the 709 property from Fletcher in 1979, and purchased it in 1981. PRI stored and distributed unleaded gasoline, leaded gasoline, diesel fuel, and fuel alcohol. A tetraethyl leading plant for blending lead into gasoline and a crude oil distillation plant were added to the property in the late 1970s. The tetraethyl leading plant and the crude oil distillation plant were operational through the early 1980s. The crude oil distillation infrastructure was removed from the property in 1985. The ASTs, a lead waste underground storage tank (UST), and associated soils were removed from the property in 1989. The remaining tanks and structures at the property were removed in 1996.

The 709 property was purchased by OCC Tacoma, a subsidiary of OCC, in 1997, and transferred to Mariana in 2001. The property remains vacant and secured by a chain-link fence. The property was used from November 2002 through February 2003 to temporarily store treated sediments removed by OCC from the Hylebos Waterway (Area 5106 Removal Action) under EPA oversight (EPA, 2002). Dredged sediments were stored and treated on the adjacent 605 Alexander Avenue property then stockpiled on the 709 Alexander Avenue property prior to being loaded onto barges for final disposal in a nearby confined disposal facility.

#### 2.2.2.2 Embankment Fill

A portion of the 709 property along the shoreline was filled with industrial materials including wastes and debris from the adjacent OCC facility, and likely other sources (see Figure 2.2 "Embankment Fill Area"). The dates of this fill is uncertain but it is believed that this fill is generally contiguous with the "N" landfill area on the 605 property. This fill area is listed as facility-site number 1246 in Ecology's cleanup site database.

### *2.2.3 Ownership/Operational History of the 901 Property*

#### 2.2.3.1 901 Tank Farm (Originally Maxwell Petroleum)

The northern portion of the 901 property (former 721 property) was developed as a fuel storage and distribution facility by Maxwell Petroleum Company (Maxwell) in the 1930s. Maxwell owned and operated the Site through the 1930s into the early 1940s. The Maxwell facility initially contained eight large ASTs within an earthen berm for storage of gasoline, diesel fuel, and fuel oil. Several small ASTs were located within the bermed area for the storage of kerosene, solvents, and stove oils. In addition, a number of small ASTs for storage of fuel oil were located outside of the bermed area.

Throughout the 1940s and 1950s, fill was added to the shoreline to form its present day embankment (CRA, 2012b). The source of this fill is unknown, but boring logs indicate that this fill is not the same composition as the embankment fill on the 709 property. Boring logs from the 901 property indicate that this fill material is composed of sand and gravel mixtures and is present to a depth of approximately 4 feet below ground surface (bgs). Characteristic material from the 709 property embankment fill such as bricks, fibrous material, and graphite anodes is not noted in the 901 property boring logs.

In the early 1940s, General Petroleum Company (General) began operating on and leasing the former 721 property from Maxwell, and eventually purchased it in 1951. General sold its property to the U.S. Air Force (USAF) later in 1951. The USAF continued to use the property as a fuel storage and distribution facility throughout the 1950s and into the 1960s. The USAF transferred 0.71 acres of the property (including the shoreline and dock) to the U.S. Navy (Navy) in 1965 (present-day Pierce County tax parcel 2275200532 – see Figure 1.2). In 1966, the USAF sold the remainder of the former 721 property to the Port who leased the property as a petroleum storage facility until 1983.

In 1970, the Port began to lease several ASTs on the former 721 property to Fletcher, who owned the adjacent 709 property at the time (as discussed above). The Port also leased one of the large on-site tanks to Lilyblad Petroleum, Inc. (Lilyblad) from the 1970s into the early 1980s. Records indicate that Lilyblad's lease was for diesel fuel storage but also stored aliphatic solvents in a small tank located in the western portion of the property (CRA, 2012b).

PRI took over Fletcher's lease on the former 721 property in 1979 when they entered a lease-purchase agreement on the 709 property. The ASTs, buildings, and associated infrastructure were removed from the property in 1983 when the property was paved. Since 1983, the Port has leased the property to multiple organizations for above-ground commercial storage (primarily trucks and shipping containers).

#### 2.2.3.2 Warehouses

The southern portion of the 901 property was formerly the 905 Alexander Avenue property (former 905 property). The limited historical records available for this property indicate that it has been under Port ownership since at least the early 1940s, and was leased to the Navy from 1942 to 1953 (GeoEngineers, 2010b). Historical records indicate that the Navy operated a large warehouse on the property. The warehouse still exists on the property (Port Building 50), but is planned to be removed as part of the LNG facility construction. A smaller warehouse, Port Building 845, is located north of Port Building 50. Port Building 845 is metal frame and roof building that is non-insulated and unheated. It has historically been used for material storage but does not include offices and is not regularly occupied by workers. It is currently empty, and is planned to be used for storage in the future.

The entire 901 property is currently owned by the Port and most recently leased to Totem Ocean Trailer Express (TOTE) as a shipping container storage, with future plans to be leased to Puget Sound Energy (PSE) for a LNG storage and distribution facility. An abandoned UST (P-24) reportedly used for leaded gasoline storage is located in the northwestern portion (Figure 2.2). Further discussion of the P-24 UST is presented in Section 4.1.

## 2.3 Surrounding Properties

### *2.3.1 605 Alexander Avenue Property*

North of the 709 property are three tax parcels located at 605 Alexander Avenue and previously owned by OCC, now owned by Mariana (the 605 property). A predecessor of OCC began operations on the property in 1929 and acquired additional adjacent parcels over time. Other owners and/or operators of all or a portion of the property have included Hooker-Detrex Corporation, the United States Navy, Todd Shipyards, and the Defense Plant Corporation. OCC or its predecessors operated a chemical manufacturing facility on the 605 property until 1997. The plant originally produced chlor-alkali products such as chlorine, sodium hydroxide, hydrochloric acid, and calcium chloride. Later, PCE and TCE were produced in the northeast portion of the property from 1947 to 1973 (Ecology, 2010). In 1997, the 605 property and all associated chemical manufacturing infrastructure was purchased by Pioneer Americas (Pioneer). Pioneer continued to produce chlor-alkali products on the property until 2002. Mariana, a subsidiary of Glenn Springs Holdings Inc., an affiliate of OCC, purchased the property from Pioneer in 2005, and all manufacturing infrastructure was removed from the property between 2006 and 2008. Investigation and cleanup of the OCC Site, which includes the 605 property and adjacent properties impacted by releases from the former OCC facility and other sources (including portions of the tank farm properties), is being conducted under an AOC between OCC and the EPA and Ecology (EPA, 2005).

### 2.3.2 500 Alexander Avenue Property

On the west side of Alexander Avenue is the 500 Alexander Avenue (500 property). The 500 property is owned by the Port and currently leased to TOTE as a shipping container terminal. This property was formerly part of a larger U.S. Naval Station in the 1940s and 1950s. An 8,000 gallon UST (N-11) reportedly used for fuel oil storage appears on historical drawings near the eastern edge of the property. A test pit investigation in 2012 (Hart Crowser, 2012a) and a ground-penetrating radar survey conducted as part of this RI (see Section 4) did not identify a UST remaining in this area.

### 2.3.3 Hylebos Waterway

The eastern portions of the 709 and 901 properties include intertidal and subtidal portions of the Hylebos Waterway (Figure 1.2). The remainder of the Hylebos Waterway offshore east of the tank farm properties is owned by the Port. The area of the Hylebos Waterway adjacent to the tank farm properties is part of the Mouth of the Hylebos Waterway, one of several “Problem Areas” within the larger CBNT Superfund Site. Portions of the 701 and 901 properties below ordinary high water are part of Segment 5 of the Mouth of the Hylebos Waterway Problem Area. Ecology has determined that the lands below ordinary high water that are part of the CBNT Superfund Site will not be addressed under the Agreed Order governing this cleanup site (see Section 1).

Within Segment 5, the intertidal and subtidal embankments of the Waterway adjacent to the tank farm properties have not been disturbed as a result of dredging associated with the OCC AOC. However, dredging of the Hylebos shipping channel (-36 to -41 feet NGVD) east of the embankments adjacent to the Site has been completed and includes Sediment Management Areas (SMAs) 512, 522b, 522c and Dredge Material Management Units (DMMUs) C-14 and C-15 (CRA, 2014a). These areas are shown on Figure 2.3. The intertidal and subtidal embankments adjacent to the former Navy Warehouse have been designated as a Natural Recovery Area SMA 534. The intertidal and subtidal embankments adjacent to the former 721 property were not designated for remedial action under the Segment 5 cleanup.

The intertidal area adjacent to the embankment fill area of the 709 property is recognized as part of the OCC Site, not the Alexander Avenue Petroleum Tank Facilities Site, unless contamination in this area is determined to be caused by the release of hazardous substances originating from activities associated with historic petroleum storage and processing facilities that were operated at the 709 or 901 properties. Further action under Enforcement Order 95TC-S242 has been held in abeyance due to the OCC AOC and it is expected that the area will eventually be included in the OCC Site cleanup.

## 2.4 Property Access and Easements

Presently, access at the 709 and 901 properties is limited by chain-link fencing and gates. The 709 property is fenced on all sides, and the 901 property is fenced on the west, north, and east sides. Access to the western portion of the Site on the 500 property is also limited by chain-link fencing and gates.

Two docks in the Hylebos Waterway on the 709 property and northern portion of the 901 property are partially intact, but are currently inactive. A third dock is located west of the former Navy warehouse and is used intermittently by the Navy.

The 605 and 901 properties were each historically served by stub railroad lines which connected to the spur railroad line along the western side of Alexander Avenue. The rail lines serving the northern portion of the 901 property were removed in 1983. The stub rail line serving the 605 property was terminated in 2006; a small portion of the line still remains in the southwest corner of the 605 property. The rail line serving the southern portion of the 901 property is still intact and serves the southern warehouse on the property.

Between the 709 and 901 properties and the 500 property is the Alexander Avenue right-of-way owned by the City of Tacoma. The right-of-way contains Alexander Avenue, a two-lane/two-way street, and a railroad right-of-way also operated by the City of Tacoma (Tacoma Rail).

# 3 Environmental Setting

## 3.1 Upland Topography and Surface Drainage

The Site is generally flat with an average ground surface elevation of 12 feet relative to the National Geodetic Vertical Datum of 1929 (NGVD). The mean lower low water (MLLW) vertical datum in the Port of Tacoma is 6.17 feet lower than the NGVD vertical datum (MLLW = NGVD + 6.17 feet). The embankment along the eastern upland portion of the tank farm properties abruptly drops off into the Hylebos Waterway, and is covered primarily with concrete rubble and riprap.

The following table summarizes the relationships between the NGVD, North American Vertical Datum of 1988 (NAVD), and the MLLW vertical datum at the site. Tidal datums are from NOAA Station 9446484, located 0.9 miles west of the Site.

**Table 3.1. Vertical Datum Relationships**

| | Abbreviation | MLLW Feet | NAVD Feet | NGVD Feet |
|---|---|---|---|---|
| Mean Higher High Water & Ordinary High Water | MHHW & OHW | 11.82 | 9.15 | 5.66 |
| Mean High Water | MHW | 10.95 | 8.28 | 4.80 |
| Mean Tide Level | MTL | 6.90 | 4.23 | 0.74 |
| Mean Sea Level | MSL | 6.87 | 4.19 | 0.71 |
| National Geodetic Vertical Datum | NGVD | 6.16 | 3.48 | 0.00 |
| Mean Low Water | MLW | 2.85 | 0.18 | -3.31 |
| North American Vertical Datum | NAVD | 2.67 | 0.00 | -3.48 |
| Mean Lower Low Water | MLLW | 0.00 | -2.67 | -6.16 |

Limited stormwater runoff occurs at the tank farm properties. The 709 property is generally unpaved; continuous water level monitoring data during a storm event indicates that precipitation readily infiltrates into the soil (CRA, 2013a). The 901 property is paved, and stormwater is conveyed via catch basins to three outfalls to the Hylebos Waterway (Figure 3.1).

## 3.2 Geology and Hydrogeology

### *3.2.1 Geology*

The Site is located within the Puget Sound Lowland, an area characterized by heterogeneous glacial and interglacial soil deposits. The geology of the Site and the Blair-Hylebos Peninsula is well described in the *Data Summary Report - 709 and 721 Alexander Avenue* (CRA, 2012b), and is summarized below.

Two Site geologic cross sections have been prepared from existing boring logs, with section locations shown on Figure 2.2. Cross section A-A’ (Figure 3.2-2) presents an east-west transect. Cross Section B-B’ (Figure 3.2-3) presents a north-south transect.

The general geologic setting of the property is the Tacoma Tideflats, which is composed of dredged fill material above a thick sequence of stratified deltaic deposits that ultimately overlie Vashon glacial deposits (Hart Crowser, 1974).

The upper 16 to 20 feet of the Site is primarily composed of dredge fill placed during the 1920s. The fill material is generally fine-grained sand with trace silt. The fill was historically dredged to deepen the adjacent waterways (e.g., Blair, Hylebos, etc.) and create the current upland; therefore, the fill and underlying native materials may appear similar unless the fill also contains debris.

Below the upper fill unit lies native tideflat deposits overlying native deltaic deposits. The tideflat deposits are found in the majority of the explorations across the Site and include a clayey unit which varies from approximately 0.5 feet to 3 feet thick. The native tideflat deposits have a slightly higher organic content (wood fibers) compared to the fill unit. The native deltaic deposits are found below the tideflat deposits to a depth of 180 to 220 feet bgs. The deltaic deposits consist of gradational clays, silts, and sands. Glacial deposits are found below the deltaic deposits. Nearby production water well logs indicate that these glacial deposits can extend to a depth of at least 800 feet.

### *3.2.2 Hydrogeology*

Regional information indicates the presence of multiple hydrostratigraphic units within the combined fill and underlying deltaic deposits. Distinct depth zones for water-bearing units beneath the Site have been previously described and classified for the OCC Site as follows (CRA, 2012a):

- **15-foot Zone –** is the uppermost unconfined (water table) water-bearing unit, which occurs between the water table and the native tideflats deposit. The water table generally occurs in the elevation range of 2 to 6 feet NGVD (5 to 9 feet bgs). The native tideflat deposits represent a leaky aquitard unit and are present at approximately -5 feet NGVD. The 15-foot zone is at the approximate same elevation as the intertidal zone near the Hylebos waterway. During lower low tide stages, generally diffuse, low-volume seepage is visible on the intertidal beach at the base of this zone, just above the native tideflat deposits, at approximately -5 feet NGVD. The seepage discharge from the 15-foot zone was sampled multiple times as part of this RI.

- **25-foot Zone –**This zone includes the native tideflat deposits (approximately -5 to -10 feet NGVD), and the uppermost sandy deltaic deposits beneath the native tideflat deposits, to the top of a deeper silt-clay layer at approximately -20 feet NGVD. Monitoring wells in this zone are generally screened from -10 to -20 feet NGVD. The 25-foot zone generally includes elevations within the subtidal zone near the Hylebos waterway, though the uppermost 2 to 3 feet of the 25-foot zone can be intertidal during periods of tidal extremes. This zone includes piezometer sampling locations.

- **50-foot Zone –** includes native sandy deltaic deposits located below a deeper silt/clay confining unit present at -20 to -25 feet NGVD 29. The silt/clay confining unit ranges in thickness between 9.5 and 25 feet and is present in all 50-foot zone monitoring well logs within the 709 and 901 properties. The 50-foot zone generally extends from -30 to -40 feet NGVD 29.

This existing nomenclature will be used throughout the Site RI/FS process. Additional depth zones below the 50-foot zone have been previously defined for the OCC Site, but the available data indicate that they do not contain petroleum-related constituents of concern related to the Site.

Local groundwater flow in the 15-, 25-, and 50-foot zones across the Blair-Hylebos Peninsula is generally semi-radial, flowing towards the nearest waterway from a groundwater divide within the middle of the long axis of the peninsula. Both the Blair and Hylebos Waterways are deep enough to intercept lateral discharge from the 25 and 50-foot zones. Groundwater divides should exist in the 25 and 50 foot zones near the centerline of the peninsula, but the exact location of the divides may vary based on infiltration at the ground surface, lithology at different zones, and tidal fluctuations. Groundwater levels at the Site fluctuate seasonally in response to precipitation patterns and are tidally influenced.

A significant amount of continuous water level data was collected from the water-bearing zones during the 2012 Comprehensive Site Investigation (CRA, 2013a). This work was performed for the Occidental Chemical Site. Groundwater elevation contour maps are presented from this dataset for the 15-foot and 25-foot zones (Figures 3.2-4 and 3.2-5, respectively). The water levels shown represent the average freshwater equivalent heads (FEHs) calculated by the Serfes (1991) method and using data from a groundwater monitoring event during the operation of a groundwater extraction and treatment system on the 605 property to the north. This “pumping” condition is representative of current Site conditions because the groundwater extraction system has been operating almost continuously since the mid-1990s. However, the groundwater elevation contours and thus inferred groundwater flow directions across the Site are very similar during periods of pumping and periods without pumping (CRA, 2013a). The effect of the 605 property groundwater extraction system is minimal at the Site because the nearest extraction well is located approximately 850 feet north of the 605/709 property boundary.

Groundwater elevation data collected during the RI is tabulated in Appendix B and was consistent with data collected in previous investigations. In particular, the location of the 15-foot zone groundwater divide was compared to the previous dataset because the 2012 dataset did not include any monitoring wells located west of Alexander Avenue. The groundwater divide observed during October 2014 using the manual groundwater elevation measurements is shown on Figure 3.2-6, and appears to be consistent with the 2012 CRA data. The groundwater divide is oriented parallel to the Hylebos peninsula and located approximately 250 to 350 feet east of the Alexander Avenue centerline. It should be noted that the 2012 CRA dataset is comprised of tidally averaged pressure transducer data while the 2014 dataset consists of manual (one-time) water level measurements. Comparison of these two different data types in the vicinity of the groundwater divide is valid because the groundwater divide is located more than 500 feet from the Hylebos Waterway, and the 15-foot zone experiences minimal tidal fluctuations compared to the 25-foot zone.

Based on the site-specific data, groundwater in the 15-foot zone flows eastward toward the Hylebos Waterway on approximately the eastern half of the Site, and flows westward to the Blair Waterway on approximately the western half of the Site. The average location of the groundwater divide is shown on Figure 3.2-4, but the location of the divide on the Site fluctuates seasonally based on infiltration during precipitation events. The water table in the 15-foot zone exhibits 2 to 3 feet of seasonal variation and up to 0.5 feet of tidal variation (CRA, 2013a).

Groundwater in the 25-foot zone flows eastward towards the Hylebos peninsula on approximately the eastern 600 feet of the Site, and flows westward towards the Blair peninsula on the western 200 feet of the Site. The average location of the groundwater divide is shown on Figure 3.2-5. The groundwater divide for the 25-foot zone is located slightly west of the groundwater divide for the 15-foot zone (Figure 3.2-4). The exact location of the divide varies slightly due to tidal fluctuations. FEH elevations in the 25-foot zone exhibit approximately 1 foot of seasonal fluctuation, but may exhibit up to 10 feet of tidal response depending on proximity to the waterway(s).

Horizontal hydraulic gradients (Serfes-average FEHs) in the 15-foot zone range from 0.001 to 0.003 ft/ft; and horizontal hydraulic gradients in the 25-foot zone range from 0.003 to 0.007 ft/ft. These average gradients incorporate tidal fluctuations and corresponding short-term groundwater flow reversals, and are therefore the most appropriate values for representing contaminant transport at the Site.

Based on the Site-specific data, vertical hydraulic gradients between the 15-foot and 25-foot zones are generally downwards across most of the Site, but short-term cyclic upward gradients may occur near the Hylebos Waterway shoreline at high tidal stages. Vertical gradients between the 25-foot and 50-foot zones are close to neutral, except near the Hylebos Waterway shoreline where the gradient is overall slightly upward. Time-series vertical gradients between the 15-foot and 25-foot zones, and between the 25-foot and 50-foot zones, during a 4-month monitoring period in 2012 are illustrated for a transect of monitoring wells distributed from west to east across the Site, as follows:

- The 709-MW21 well cluster (Figure 3.2-7) located just east of Alexander Avenue;
- The 721-MW5 well cluster located 270 feet west of the Hylebos Waterway shoreline (Figure 3.2-8); and
- The 721-MW12 well cluster (Figure 3.2-9) located 250 feet east of Alexander Avenue and 600 feet west of the Hylebos Waterway;
- The 721-MW9 well cluster located 40 feet from the Hylebos Waterway shoreline (Figure 3.2-10).

As expected, the more inland locations show less tidal response and have a stronger downward gradient (indicating a groundwater recharge area), while locations closer to the shoreline exhibit more tidal fluctuations and more upward vertical gradients (indicating a regional groundwater discharge area). In the 15-foot zone, tidal fluctuations have been observed within 200 feet of the Hylebos Waterway. In the 25-foot and 50-foot zones, tidal fluctuations have been observed at all wells on the Site.

CRA (2014b) reports ranges of horizontal hydraulic conductivities derived from numerous slug tests conducted across the Site. The reported hydraulic conductivities for the 15-foot zone range from 0.3 to 30 ft/day ($1 \times 10^{-4}$ to $1 \times 10^{-2}$ cm/sec), and hydraulic conductivities for the 25-foot zone range from 0.03 to 30 ft/day ($1 \times 10^{-5}$ to $1 \times 10^{-2}$ cm/sec).

### 3.2.3 Groundwater Velocity Estimates

Using the ranges of hydraulic parameters outlined above, ranges of horizontal groundwater seepage velocities for the 15-foot and 25-foot zones are calculated applying Darcy's Law of the form: $v = K * I / n_e$, where:

- v = seepage velocity (feet/year);
- K = hydraulic conductivity (feet/year);
- I = tidally averaged horizontal gradient (feet/foot); and
- ne = effective porosity (dimensionless).

Low and high estimates for seepage velocity are calculated using the low and high estimates, respectively, for hydraulic conductivity and hydraulic gradient, with the high and low estimates, respectively, for effective porosity in each water-bearing zone. In addition, an average-case velocity is calculated applying the midpoint value for the ranges of hydraulic conductivity[5] and hydraulic gradient with a best estimate value for effective porosity. Effective porosity was assumed to be 25% for the average case, and vary between 0.20 and 0.35 for both zones, based on literature values. Table 3-2 below shows the input values and resulting estimated groundwater seepage velocities for the average case and the high and low velocity cases, for both the 15-foot and 25-foot zones.

The 25-foot zone has a wider range of reported hydraulic conductivities (on the low end) but somewhat higher hydraulic gradients. Accordingly, a broader range of seepage velocities is estimated for the 25-foot zone than the 15-foot zone, but the average-case estimate is approximately the same for both zones (0.02 ft/day, or 7 to 8 feet/year).

**Table 3-2 - Groundwater Seepage Velocity Estimates for 15-foot and 25-foot Zones**

| Water-Bearing Zone | Sensitivity Category | Hydraulic Conductivity (cm/sec) | Hydraulic Conductivity (ft/day) | Hydraulic Gradient (ft/ft) | Effective Porosity (-) | Groundwater Seepage Velocity[1] (ft/day) | Groundwater Seepage Velocity[1] (ft/year) |
|---|---|---|---|---|---|---|---|
| 15-foot Zone | average case | 1E-03 | 3 | 0.002 | 25% | 0.02 | 8 |
| | high velocity | 1E-02 | 30 | 0.003 | 20% | 0.5 | 160 |
| | low velocity | 1E-04 | 0.3 | 0.001 | 35% | 0.001 | 0.3 |
| 25-foot Zone | average case | 3E-04 | 0.9 | 0.005 | 25% | 0.02 | 7 |
| | high velocity | 1E-02 | 30 | 0.007 | 20% | 1.1 | 380 |
| | low velocity | 1E-05 | 0.03 | 0.003 | 35% | 0.0003 | 0.09 |

Notes:
1) Seepage velocity estimated through Darcy's Law of the form: Velocity = (Hydraulic Conductivity * Hydraulic Gradient)/ Effective Porosity.
2) Average case applies the median value (log-transformed) of the reported hydraulic conductivity.

[5] In logarithmic space since the K range spans multiple orders of magnitude.

# 3.3 Climate and Ecological Setting

## *3.3.1 Climate*

Climate at the tank farm properties is characterized by mild maritime temperatures year round and significant precipitation during winter months. Average annual precipitation is 39 inches, with over half of that precipitation occurring from November to February. Average winter temperatures range from the daytime high temperatures in the upper 40s (degrees Fahrenheit) to nighttime lows in the mid-30s. Average summer temperatures range from daytime highs in the low 70s to nighttime lows in the mid-50s.

## *3.3.2 Terrestrial Ecological Setting*

The fenced, predominately paved nature of the Site limits any significant terrestrial ecological habitat. While there may be occasional terrestrial wildlife present on the Site, vegetation in unpaved portions of the Site is extremely sparse, which is consistent with the urban industrial environment. Several hybrid poplar trees are present on the 709 property; these trees were planted by Mariana in the late 2000s.

### Exclusion from Terrestrial Ecological Evaluation

This Site qualifies for conducting a Simplified Terrestrial Ecological Evaluation (TEE) in accordance with MTCA (WAC 173-340-7492(2)). The Simplified TEE found no further evaluation was required using the Exposure Analysis (WAC 173-340-7492(2)(a)), which states “land use at the site and surrounding area make substantial wildlife exposure unlikely.” The Exposure Analysis is provided in Appendix F. The current and planned future land use is industrial.

As a component of the Site FS, the need for institutional controls such as environmental covenants regarding maintenance of pavement, and/or structures to provide a long-term effective physical barrier to residual contaminated soil will be evaluated.

## *3.3.3 Aquatic Ecological Setting (Hylebos Waterway)*

The properties are located adjacent to the Hylebos Waterway, a shipping inlet which empties into Commencement Bay of the Puget Sound. The Hylebos Waterway is tidally influenced by the Puget Sound.

The depth of the Hylebos Waterway is a result of the same dredging operations that were used to elevate the Peninsula in the 1930s. Segment 5 (north of the 11$^{th}$ Street Bridge) of the Mouth of the Hylebos Waterway area was most recently dredged in 2003 as part of the Commencement Bay/Nearshore Tideflats Superfund Site cleanup. Post-dredging surveys of the Hylebos Waterway indicate that the navigational channel (approximately 200 feet wide) generally extends to an elevation of approximately -41 feet NGVD (-35 feet MLLW).

The shoreline and aquatic area at the tank farm properties includes both intertidal and subtidal habitats. The upper portion of the bank slopes steeply (approximately 2H:1V) and is generally riprapped from the top of the bank to approximately elevation 0 feet MLLW (Pacific International Engineering 1999). The riprapped areas contain localized pockets of sandy and gravelly sediment. The substrate along the bank below the riprap consists of mixed fines. These habitats currently support feeding and refuge functions for juvenile salmonids, flatfish, waterfowl, crab, and other species.

## 3.4 Cultural Resources

No historical cultural resources have been identified at the Site, and a recent peninsula-wide study indicates that no cultural resources are known to exist on the Hylebos peninsula north of East 11th Street (CRC, 2009). This northern portion of the Hylebos peninsula was subtidal prior to the placement of dredged sands during the 1920s as described in Section 3.2.1.

## 3.5 Existing Infrastructure

Site utilities and a recent aerial photograph showing Site features are depicted on Figure 3.1. A brief description of existing infrastructure is provided below.

### *3.5.1 Structures*

Two warehouses and three docks (see Section 2.4) are located on the 709 and 901 properties. The two northerly docks, which were used for offloading petroleum products to the Site, are constructed of creosote-treated timbers and are only partially intact. The southern dock is intact and is constructed of creosote-treated timbers. The warehouses are not regularly occupied by workers. The northern warehouse has historically been intermittently used for repackaging of bulk dry goods using heavy machinery. As part of the planned LNG facility, PSE is intending to use this warehouse for long term storage. The southern warehouse is not currently used and is slated to be demolished for construction of the LNG facility described in Section 2.1.1.2.

No structures are located within the Site on the 500 property or adjacent to the Site to the north or south.

### *3.5.2 Utilities*

#### Power

Electrical service exists on each of the properties associated with the Site. Known above-ground lines, below-ground lines, and light poles are shown on Figure 3.1.

#### Water Supply

The Site properties are served by the City of Tacoma municipal water supply via underground lines which originate from a water main located along the central portion of Alexander Avenue (Figure 3.1). On the 901 property, water lines serve the warehouse buildings.

#### Sanitary Sewer

No sanitary sewer lines are currently mapped on the tank farm properties, although an abandoned sanitary sewer line is known to exist in the northwest corner of the 709 property near the former office building (Ec). The sanitary sewer line serving the northern portion of the Hylebos Peninsula runs along the eastern portion of the Alexander Avenue right-of-way, to the west of the Site. Within the north-south limits of the Site, the minimum invert elevation of the pipe is about 2.75 ft (NGVD29), which falls below the seasonal high groundwater elevations within the 15-foot groundwater zone.

Petroleum sheen was discovered in this sewer line in 1984, which resulted in the initial environmental investigations at the 709 and 901 properties. The sewer line investigations are further described in Section 6.2. Record drawings of the sanitary sewer construction details are included in Appendix C.

#### Stormwater

There are no operational stormwater conveyance utilities on the 709 Alexander Avenue property. The property is generally not paved and the frequent low-intensity precipitation infiltrates into the soil.

Stormwater catch basins and conveyance pipes are present on the 901 property. Invert elevations of storm conveyance pipes and catch basins on the property are shown on Figure 3.2-2 and are above seasonal high groundwater elevations. Storm drains discharge into the Hylebos Waterway at three outfalls (Figure 3.1). Based on the elevation of stormwater outfalls (slightly below Mean High High Water), the outfalls and conveyance piping close to the shoreline may be temporarily submerged during high tides.

Stormwater catch basins and conveyance pipes are present in Alexander Avenue at depths shallower than seasonal high groundwater levels (Figure 3.2-2). Storm drains in Alexander Avenue discharge into the Blair Waterway at an outfall on the southern end of the 500 property.

#### Product Pipelines

Most of the pipelines (including pipelines for petroleum transfer and for fire suppression foam) associated with the former tank farms were above ground and were removed in conjunction with demolition of above-ground structures and tanks. It is unknown if underground pipeline segments remain in place on the tank farm properties.

#### Natural Gas

A subsurface natural gas line is present in the shallow subsurface within the eastern portion of the Alexander Avenue right-of-way (to the west of the tank farm properties) as mapped on Figure 3.1. There are no natural gas connections to the tank farm properties; however, there is a mapped natural gas connection to the 605 property at the southwest property corner.

#### Hydrogen

A subsurface hydrogen line is reportedly present in the shallow subsurface within the eastern portion of the Alexander Avenue right-of-way (to the west of the Site) as mapped in Figure 3.1. The line connects to the northwest portion of the 709 property where it terminates shortly after crossing the property boundary. The historical use and current status of this utility are not known.

## 3.6 Potential Sources of Contamination

The primary potential contaminant sources for the Site based on historical records are described below.

### *3.6.1 709 Property Tank Farm*

As discussed above (Section 2.2.2), the 709 property was operated by multiple entities and used for petroleum storage, processing, and distribution for over 50 years between the 1930s and the 1980s. Potential contaminant sources associated with historical operations include:

- The loading dock in the Hylebos Waterway, where petroleum was offloaded and distributed via barge;
- A total of 14 ASTs reportedly containing diesel, gasoline, heating and fuel oil, located within a bermed containment area;
- An above-ground product pipeline (running mostly on the northern portion of the 901 property) connected the storage tank area to the 709 property dock. Conveyance pipelines also ran between the ASTs within the bermed area, and a gasoline pump house was located outside the west end of the bermed area (Figure 2.2);
- A tetraethyl leading plant and crude oil topping plant, which PRI operated from approximately the late 1970s to 1983;
- Probable use of unknown solvents and other materials for various purposes, including cleaning of tanks and equipment; and
- Two USTs, one containing heating oil for the office on the property's northwest corner and one used to collect waste material from the tetraethyl leading facility; these USTs were removed in 1989.

Documented spills associated with the 709 property include (CRA, 2012b):

- A 1979 gasoline spill (69 gallons);
- Spills during 1981 from leaking valves (gasoline, diesel, and/or fuel oil); and
- A 1981 spill of diesel (300 gallons).

### *3.6.2 901 Property Tank Farm*

Similar to the 709 property, the 901 property tank farm was operated by multiple entities for petroleum storage, processing, and distribution between the late 1930s and early 1980s. Potential contaminant sources associated with historical operations include:

- The loading dock in the Hylebos Waterway, where petroleum was offloaded and distributed via barge;
- Product pipelines including: pipelines that connected the bermed storage tank areas to the 709 and 901 property docks, pipelines that connected the northern 901 dock to the 901 bermed area, a product pipeline than ran north-south between the 709 and 901 bermed areas, product pipelines that ran between the ASTs within the 901 bermed area, and distribution facilities located to the West and the South of the bermed area (Figure 2.2);
- A total of 13 ASTs reportedly containing diesel, gasoline, fuel oil, stove oil, kerosene, and an unidentified "solvent", located within a bermed containment area. Just south of the bermed area, six smaller ASTs reportedly contained diesel and fuel oil for a portion of the operating period;
- A rail loading rack, two petroleum pump houses, and a loading shed located outside the bermed area;

- Probable use of unknown solvents and other materials for various purposes, including cleaning of tanks and equipment; and
- A sludge pit reportedly used by the USAF on the western portion of the property.

Fill was also reportedly added near the property shoreline in the 1940s and 1950s.

Documented spills associated with the 901 property include (CRA, 2012b):

- A 1981 spill of Safety-Kleen aliphatic solvent associated with Lilyblad. (unknown volume and location).

### 3.6.3 Other Potential Area Sources

Potential sources of contamination located to the north associated with historical operations at the former OCC plant on the 605 property include:

- Releases of chlorinated solvents and sodium hydroxide (caustic);
- Petroleum bulk storage in nine ASTs on the east end of the property (oil and fuel oil); and
- The Landfill N area on the southeast portion of the property, which includes various former OCC plant process wastes including corrosive compounds, chlorinated organic compounds, and lead.
- In addition, along the 709 property shoreline is an area where fill material containing corrosive compounds, chlorinated organic compounds, and inorganic lead. The embankment fill is part of the OCC Site, not this Site. It is possible that petroleum-related contaminants from this Site are commingled with this part of the OCC site. The estimated extent of embankment fill materials based on boring and test pit logs is shown on Figure 2.2.

Potential sources of contamination located to the west associated with historical operations at the former US Naval Station on the 500 property include:

- A fuel oil UST (N-11) formerly located along the east side of this property[6].

Potential sources of contamination located to the south associated with historical operations at the former US Naval Station on the 901 property include:

- UST P-24, located at the northwest corner of the 901 property large warehouse and abandoned in place.

[6] The tank is believed to have been removed based on a ground penetrating radar (GPR) survey during the RI field investigation.

# 4 Summary of Environmental Investigations

This section describes the environmental investigations and cleanup actions that have been conducted at the properties. Information gathered during these investigations are used in this RI to characterize environmental conditions. Locations of explorations conducted during pre-RI and RI investigations are shown on Figure 4.1.

## 4.1 Pre-RI Investigations

A total of 15 separate environmental investigations were completed at the Site prior to this RI, starting in 1989 and ending with sampling completed during OCC's 2012 Comprehensive Supplemental Investigation (CSI) (CRA, 2012a). Figure 4.1 depicts explorations from the prior investigations. Fourteen of these investigations are summarized by property in the *Data Summary Report - 709 and 721 Alexander Avenue* (CRA, 2012b) and also the *Final Report - 721 East Alexander Avenue and Adjacent Properties Data Summary* (GeoEngineers, 2010a).

The CSI, undertaken by OCC, included the following:

- Soil sampling at 34 new soil boring locations, including 15 on the 709 property and 19 on the 901 property;
- Installation and sampling of 38 new groundwater monitoring wells, including 14 on the 709 property (one in the 15-foot zone, six in the 25-foot zone, five in the 50-foot zone, and two in the 75-foot zone), and 24 on the 901 property (six in the 15-foot zone, seven in the 25-foot zone, seven in the 50-foot zone, and four in the 75-foot zone);
- Sampling of 44 existing groundwater monitoring wells;
- Continuous water-level monitoring of water levels at 25 monitoring wells for a period of 4 months (September 2012 to December 2012); and
- Continuous water level monitoring of water levels at eight monitoring wells for a period of 1 year (December 2011 to December 2012).

Piezometer installation and sampling was completed in 1998 and 2004, and is described in the Site Characterization Report – Groundwater and Sediment Remediation (CRA, 2014b). Additionally, UST investigations at UST N-11 on the 500 property and at UST P-24 on the 901 property were conducted in 2010 under the Port's UST program (Hart Crowser, 2012a and 2012b). Both investigations generated relevant soil and groundwater data that are included in this RI.

## 4.2 Previous Cleanup Actions

No cleanup actions have been completed on the Site with the exception of two separate UST removals on the 709 property.

The leading plant waste UST (Figure 2.2) was removed in 1989 and four soil samples were collected from the sidewalls of the excavation. The sidewall samples were analyzed for total petroleum hydrocarbons (TPH) and extraction procedure toxicity (EPtox) lead, and those data are included in the Site database used to generate this report. An additional analytical sample was collected of the soil that was excavated and hauled off site; however, this sample is not included in the Site database.

The heating oil UST located adjacent to the 709 property office building (Figure 2.2) was removed when the property was decommissioned in 1996. No soil samples were collected from the UST removal. However, subsequent soil and groundwater sampling (soil boring 709-BH-10 and monitoring well cluster 709-MW18) was completed immediately adjacent to the former UST location as part of OCC's CSI (CRA, 2013a).

## 4.3 RI Investigations

Based on historical data, data gaps were identified where insufficient information was available to characterize the nature and extent of petroleum-related contamination, contaminant fate and transport properties, or exposure to people or the ecological environment under the Port's future industrial Site use. The *RI/FS Work Plan* (Aspect 2014a), prepared to meet requirements of the Agreed Order, described the data gaps and the investigations planned to address them. Work completed as part of the RI included:

- **Direct-push soil and groundwater sampling**, to fill data gaps regarding the extent of TPH, benzene, toluene, ethylbenzene, and xylenes (BTEX), chlorinated volatile organic compound (CVOCs), and lead in soil and groundwater exceeding preliminary screening levels, and determine the organic carbon content of fill and native soils;
- **Groundwater well installation and monitoring,** to delineate current plume boundaries and fill data gaps regarding long-term trends in groundwater quality;
- **LNAPL monitoring and recovery testing,** to fill data gaps regarding the current extent of LNAPL and LNAPL recoverability;
- **Surface sediment sampling,** to fill data gaps regarding the potential for sediment impacts from historical petroleum releases at the Site docks and through groundwater discharge; and
- **Seep sampling**, to fill data gaps regarding TPH and BTEX concentrations in groundwater discharging to the Hylebos Waterway.

The majority of this work was conducted between July and October 2014, and the data presented in the *RI Data Memo and Groundwater Monitoring Plan* (hereafter referred to as the RI Data Memo; Aspect, 2015a), which was submitted to and discussed with Ecology. Exploration locations are shown on Figure 4.1 and 4.2.

Concurrent with this RI, Puget Sound Energy conducted soil and groundwater sampling on the 901 property as part of due diligence for a proposed LNG Plant (see Section 2.1.1.2), as described in the *Soil and Groundwater Data Summary – Limited Environmental Site Assessment Memorandum* (GeoEngineers, 2014). That data was incorporated into the Site database.

The *RI/FS Work Plan* contemplated several potential contingency investigations including: 1) additional groundwater and seep monitoring to characterize seasonal variability in groundwater conditions; 2) sediment porewater sampling; and 3) subsurface sediment core sampling. Additional groundwater and seep monitoring was conducted between January and December 2015 in accordance with the schedule provided in the *RI Data Memo* (Aspect, 2015a). As agreed to by Ecology, contingent sediment porewater and subsurface sediment investigations were not conducted because 1) surface sediment samples that contained petroleum hydrocarbons did not fail bioassay tests, thereby confirming that sediments are not toxic for the benthic pathway; and 2) sediments in Hylebos Waterway are addressed under the federal Commencement Bay Nearshore/Tideflats Superfund site. Because of these factors, Ecology determined that sediments will not be addressed under this cleanup effort (see Section 2.3.3).

A summary of specific work completed for the RI is provided below.

### 4.3.1 Direct-Push Soil and Groundwater Sampling

Soil samples were collected from direct push borings B-101 through B-128 as described in the Work Plan (Aspect, 2014a) with several revisions and additions. Revised boring locations B-103 and B-104, and additional boring locations B-129 and B-130 were described in a *Proposed Remedial Investigation Work* memorandum (Aspect, 2014b). Soil samples from borings were analyzed for gasoline- and diesel-range TPH, VOCs, lead, and total organic carbon. Groundwater grab samples from borings were analyzed for gasoline-range TPH, lead, and VOCs. Borings B-131 to B-139 were subsequently completed in two separate phases as step out borings from screening level exceedances detected at B-130. Boring locations are shown on Figure 4.2, and boring logs are provided in Appendix A. Borings B-1 through B-26 completed by GeoEngineers for the PSE Tacoma LNG project were also used as part of this RI. These logs are also included in Appendix A. Samples from the PSE investigation were analyzed for gasoline- and diesel-range TPH, VOCs, metals, and SVOCs; data is included in Appendix B.

### 4.3.2 Groundwater Monitoring

Groundwater samples were collected from new monitoring wells, and existing monitoring wells and analyzed for gasoline- and diesel-range TPH, VOCs, lead, and natural attenuation parameters[7]. The majority of groundwater samples were collected from the 15- and 25-foot zones. A few existing wells in the 50-foot zone were also included based on historical data. To characterize the extent of LNAPL, LNAPL presence and thickness were monitored at all wells sampled during the monitoring program and at a subset of wells where groundwater samples were not analyzed but in areas of potential LNAPL occurrence. New monitoring wells were named with a '-15' suffix if installed in the 15-foot zone and a '-25' suffix if installed in the 25-foot zone.

Groundwater monitoring was conducted as described in the *RI/FS Work Plan* (Aspect, 2014a) with several revisions. Revised monitoring well locations MW-102-15, MW-102-25, MW-105-15, MW-105-25, and MW-109-15 (formerly MW-107-15 proposed in the Work Plan**)** were described in a *Proposed Remedial Investigation Work* memorandum (Aspect, 2014b). Monitoring wells MW-104-15, MW-104-25, MW-130-15, and MW-137-25 were subsequently installed pending results from temporary groundwater samples collected at soil boring B-104 and step out borings B-129 and B-137.

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[7] Natural attenuation parameters include dissolved iron and manganese, sulfate, nitrate, nitrite, alkalinity, and dissolved gases (methane, ethane, ethene).

As per the *RI/FS Work Plan*, a subset of wells was selected to provide data for seasonal and long-term concentration trend analysis based on the results of the first round of groundwater sampling (in October 2014). The proposed sampling locations were described in the *RI Data Memo and Groundwater Monitoring Plan* (Aspect, 2015a) and revised in April 2015 per Ecology's request to run all samples for NWTPH-Dx analyses with and without silica gel cleanup. Sampling methods were consistent with the initial October 2014 sampling event and with the procedures described in the Sampling and Analysis Plan provided as Appendix A of the *RI/FS Work Plan*.

Based on data collected through August 2015, additional data needs were identified to complete the RI and FS. The proposed additional sampling was outlined in *RI/FS Work Plan Addendum No. 1* (Aspect, 2015b), and includes quarterly groundwater monitoring and LNAPL gauging from a subset[8] of wells to better evaluate long-term trends in groundwater conditions. This sampling plan was revised in December 2015 to include three additional wells to be sampled and analyzed for NWTPH-Dx with and without silica gel cleanup, to better define the extent of diesel-range TPH in groundwater. The first round of that quarterly sampling was completed in December 2015 and that data is included in this RI. Data from subsequent quarters (February, May, and August 2016) will be included in the FS.

### *4.3.3 LNAPL Characterization*

Initial LNAPL gauging was conducted in October 2014 at monitoring wells in areas that were known or suspected to contain LNAPL. Three wells of sufficient product thickness (>0.10') were chosen for LNAPL recoverability testing: 721-MW2, 721-MW4, and 721-MW-15-15. Testing was performed in accordance with the ASTM E2856-13 *Standard Guide for Estimation of LNAPL Transmissivity* (2013). Testing was performed October 27-29, 2014. Results are summarized in Appendix H and discussed in Section 6.2.

Additional LNAPL gauging was conducted during quarterly groundwater monitoring events as outlined in the *RI/FS Work Plan* (Aspect, 2014a), *RI Data Memo* (Aspect, 2015a) and the *RI/FS Work Plan Addendum No. 1* (Aspect, 2015b).

### *4.3.4 Sediment Sampling*

Hylebos Waterway sediment samples were collected from locations SS-101 through SS-112, with two additional samples (SS-BKGRD-1 and SS-BKGRD-2) collected as background samples, as described in the *RI/FS Work Plan* (Aspect, 2014a). Sediment samples were analyzed for gasoline- and diesel-range TPH, VOCs, PAHs, and TOC. Based on the TPH data from 14 sediment samples collected in July 2014 (Figure 4.2), samples SS-101, SS-103, SS-106, SS-111, and SS-112 were submitted for confirmatory biological testing.

### *4.3.5 Seep Sampling*

Intertidal seep samples were collected from SP-101 and SP-102 locations at lower low tide conditions in July 2014 and August 2014 respectively, as described in the *RI/FS Work Plan* (Aspect, 2014a). Seep samples were analyzed for gasoline- and diesel-range TPH and VOCs. Seep elevations fall within the 15-foot groundwater zone. Seep samples were collected from these locations again in May 2015, along with an additional location,

[8]Wells outside the area of historical LNAPL occurrences are inspected for evidence of LNAPL, but are only gauged if indicators are observed during sampling.

SP-103 (Figure 4.2), which was added based on the interpreted benzene plume extent in the 15-foot zone (Aspect, 2015b).

## 4.4 Data Summary and Usability

As described in Section 1, the Site is defined "by the extent of contamination caused by the release of hazardous substances originating from activities associated with historic petroleum storage and processing facilities that were operated at the noted properties". The Site database contains data collected during the investigations described above on the 709, 901, and 500 properties and the adjacent Alexander Avenue right-of-way. The Site database also includes data from the OCC Site on the 605 property less than 230 feet north of the 709 property boundary.

Because petroleum releases from historical petroleum handling operations likely occurred decades ago, and petroleum hydrocarbons can degrade substantially over time, this RI uses the most recent data available as most representative of current Site conditions. Only data collected since 2000 were included in the database for evaluating and describing contaminant nature and extent in Section 6, as earlier data have generally been superseded by newer data. In addition:

- For monitoring wells with multiple sampling events after 2000, the following hierarchy was used in mapping data and determining the extent of contamination:
  - The maximum detected concentration during the RI investigation (2014 and 2015), if available; or
  - The most recent detected concentration, if no data from 2014 or 2015 were available. Groundwater data from 2009 or earlier, when mapped, are differentiated by symbol on the figures in Section 6.
- Groundwater data from soil borings were included in the database but were only plotted on nature-and-extent figures if no groundwater well was installed and sampled at the same location. Groundwater data from wells were deemed to supersede groundwater data from borings in the same area if available. Data figures differentiate groundwater data from soil borings by symbol since these are considered of lower quality than groundwater data from monitoring wells. Groundwater data for diesel- and oil-range TPH collected at soil borings were not plotted because this analysis is subject to strong bias from turbidity.
- Groundwater data for metals at several locations collected by Puget Sound Energy was identified as potentially biased high based on field observations or laboratory methods (GeoEngineers, 2014). These data were not used in the RI.

Data tables are included in Appendix B. These include the following:

- Soil data collected during the RI and from historical investigations, from the 0- to 30-foot depth interval and at depths greater than 30 feet;
- Groundwater data collected during the RI and from historical investigations, from the 15-foot, 25-foot, and 50-foot zones; and

- Seep data collected during the RI and from historical investigations.
- Sediment data collected during the RI and from historical investigations.

Level III data validation was conducted for data collected during the RI investigations. Validation reports are included in Appendix E. The overall assessment of the validation reports indicated the data are acceptable for use as qualified in the reports.

# 5 ARARs and Screening Levels

Many state and federal environmental laws may apply to cleanup actions at the Site. A number of these laws identify chemical concentrations in environmental media that are determined to be protective of human health and the environment under specified exposure conditions (i.e., cleanup levels). In this section, we identify potentially applicable environmental regulations and cleanup levels so as to establish chemical-specific screening levels for a particular media and exposure pathway. In Section 6, chemical concentrations detected in the Site media are compared to the screening levels to determine chemicals of concern (COCs). Preliminary cleanup levels for Site COCs will be developed in the FS and finalized by Ecology in the dCAP.

## 5.1 Potential Applicable Regulatory Requirements

The following provides a summary of potentially applicable or relevant and appropriate requirements (ARARs) based on state and federal laws for identifying screening levels (i.e., chemical-specific ARARs) for Site soil, groundwater, and air. Sediment ARARs are not identified because Ecology has determined that sediments will not be included in the cleanup actions for this Site (see Section 1).

### *5.1.1 Potentially Applicable Federal Requirements*

The **Clean Water Act** (CWA) (33 USC Section 1251 *et seq*.) requires the establishment of guidelines and standards to control the direct or indirect discharge of pollutants to waters of the United States. Section 304 of the CWA (33 USC 1314) requires the EPA to publish Water Quality Criteria, which are developed for the protection of human health and aquatic life. Federal water quality criteria are published as they are developed, and many of them are included in the *Quality Criteria for Water* (EPA 440/5-86-001, May 1, 1986 (51 FR 43665), commonly known as the "Gold Book". Publications of additional criteria established since the Gold Book was printed are announced in the Federal Register. Federal water quality criteria are used by states, including Washington, to set water quality standards for surface water. These standards are adopted by the state under the Washington Water Pollution Control Act (see Section 5.1.2).

In 1992, EPA promulgated the National Toxics Rule (NTR) at 40 Code of Federal Regulations (CFR) 131.36, establishing chemical-specific numeric criteria for 14 states and territories, including Washington, that were not in compliance with CWA 303(c)(2)(B). The federal human health criteria in the NTR remain applicable to Washington's waters and are incorporated into the screening level development.

Because the Hylebos Waterway is considered non-potable, potentially applicable Water Quality Standards for protection of human health are based on consumption of organisms only.

### *5.1.2 Potentially Applicable State and Local Requirements*

**Washington Model Toxics Control Act** (MTCA; Chapter 70.105D RCW). This Act authorized Ecology to adopt cleanup standards for remedial actions at sites where hazardous substances are present. The processes for identifying, investigating, and cleaning up these sites are defined and cleanup standards are set for groundwater, soil, surface water, and air in Chapter 173-340 WAC.

MTCA procedures employ a risk-based evaluation of potential human health and environmental exposures to site COCs. To establish cleanup standards, it is necessary to determine both the cleanup level as well as the point of compliance where the cleanup level applies. For a given COC detected in soil, groundwater, surface water, and/or air, cleanup levels must be at least as stringent as established state or federal standards or other laws (i.e., ARARs) developed for human health and environmental protection. Not all COCs have state or federal standards. If a state or federal standard is available, that ARAR is evaluated to ensure that it is protective under MTCA. If the ARAR is not protective (excess cancer risk exceeding 1 in 100,000, or hazard quotient exceeding 1), the cleanup level is adjusted to a lower value to ensure its protectiveness.

The cleanup level for one media must also be protective of the beneficial uses of other affected media via cross-media transport. For example, since Site groundwater eventually discharges into the Hylebos Waterway, site-specific MTCA groundwater cleanup levels need to consider the protection of surface water. The procedures for developing cleanup levels for groundwater, surface water, soil, and air are outlined in the MTCA Cleanup Regulation Sections 173-340-720, -730, -740, and -750 WAC, respectively. Included in these sections are the specific rules for evaluating cross-media protectiveness.

**Washington Water Pollution Control Act** (Chapter 90.48 RCW; Chapter 173-201A WAC). This Act provides for the protection of surface water and groundwater quality. Chapter 173-201A WAC establishes water quality standards for surface waters of the state. As with the CWA, this RI considers marine surface water standards to be potentially applicable because of the potential for discharge of COCs to a marine surface water body (the Hylebos Waterway). Water quality criteria for protection of human health are currently undergoing revision and will potentially change in the future.

## 5.2 Potential Exposure Pathways

Ecology has agreed that the Site qualifies as an industrial property under MTCA. Under the current and future industrial land use of the Site, the following exposure pathways and receptors were identified for purposes of establishing screening levels:

- Marine benthic and aquatic organisms in the Hylebos Waterway, if groundwater contaminants migrate and discharge to the marine sediment and surface water;
- Fisherpersons consuming benthic and/or aquatic organisms which could be impacted if groundwater contaminants migrate and discharge to the marine sediment and surface water;
- Occasional industrial Site workers who could be exposed to contaminated soil and/or groundwater or could inhale volatilized contaminants from unsaturated soils or groundwater during construction, maintenance, and/or utility work; and
- On-site office and warehouse workers that could be exposed to contaminants in indoor air if groundwater or soil contaminants volatilize and migrate into indoor work areas via vapor intrusion (VI).

- On-site and off-site utility workers could be exposed to contaminants via infiltration of vapors and petroleum into sanitary sewer lines.

Human consumption of Site groundwater is not a complete exposure pathway because Site groundwater is considered non-potable in accordance with MTCA (WAC 173-340-720(2)) for the following reasons:

> (2)(a) Groundwater in the two shallow water-bearing zones of interest at the Site does not serve as a current source of drinking water. The Site is located within the City of Tacoma municipal water service area, providing a reliable source of potable water supply, and this will continue for future Site redevelopment. Drinking water supply wells do not exist at the Site.
>
> (2)(c) It is unlikely that hazardous substances will be transported from the contaminated groundwater to groundwater that is a current or potential future source of drinking water at concentration which exceed groundwater quality criteria published in chapter 173-200 WAC. Groundwater in the two shallow water-bearing zones of interest at the Site discharges directly into the marine waters of the Hylebos and Blair Waterways, and there are no water wells on the Site or between the Site and those surface waters; groundwater in these water-bearing zones will not flow laterally inland towards a current or potential future source of drinking water, because the inland aquifer is hydraulically upgradient of the shallow water-bearing zones. Similarly, contaminated groundwater in the shallow units will not migrate into any deeper regional freshwater aquifer that is a current or potential future source of drinking water, because regional groundwater flow adjacent to Commencement Bay is upward from deep regional aquifers into shallow zones (CRA 2013).
>
> (2)(d) There is an extremely low probability that the groundwater will be used for drinking water supply because of the Site's proximity to surface water that is not suitable as a domestic water supply. Reasons for this include:
>
>> (i) There are known or projected points of entry of groundwater in the water-bearing zones of interest into the surface water;
>>
>> (ii) The surface water is not classified as a suitable domestic water supply source under chapter 173-201A WAC. The Hylebos Waterway (and Blair Waterway) are marine surface water bodies and do not classify as a suitable domestic water supply under Chapter 173-201A WAC; and
>>
>> (iii) The groundwater in the shallow water-bearing zones is sufficiently hydraulically connected to the surface water that the groundwater is not practicable to use as a drinking water source; the hydraulic connection is well established by tidal monitoring studies across the Site and well-established hydrogeologic interpretations for the Hylebos-Blair peninsula as a whole. It is not practical to use Site groundwater for potable water supply due to the potential for drawing saline water into the water-bearing zone (salt water intrusion). Therefore, it is not practicable to use as a drinking water source.

Lastly, the Site properties are subject to restrictive covenants restricting land use, including prohibition against groundwater extraction, supply, or use for drinking or other human consumption or domestic use of any kind[9].

The non-potability of Site groundwater is consistent with Ecology's determination that groundwater at the adjacent OCC site is non-potable (Ecology 2015).

As described in Section 3.3.2, this Site qualifies for conducting a Simplified Terrestrial Ecological Evaluation (TEE) in accordance with MTCA (WAC 173-340-7492(2)), which found that "land use at the site and surrounding area make substantial wildlife exposure unlikely."

## 5.3 Screening Levels

This section describes how screening levels are established for each medium. Preliminary screening levels were developed in the *RI/FS Work Plan* (Aspect, 2014a). Screening levels were updated in the *RI Data Memo* (Aspect 2015a) and are further updated in this RI Report based on initial data findings, exposure pathway evaluations, and updated toxicity information used by Ecology.

Identification of screening levels was conducted as follows:

- Preliminary COCs were identified in the *RI/FS Work Plan* by considering chemicals associated with past Site operations and chemicals detected during previous environmental investigations. Chemicals not associated with past operations and which were detected in few or no samples were not identified as preliminary COCs.

- Preliminary screening levels were identified in the *RI/FS Work Plan* based on potential exposure pathways and associated potential cleanup levels for soil, groundwater, surface water, and sediment based on ARARs.

- Data was collected during the RI field investigations to further define the nature and extent of preliminary COCs at the Site.

- In Section 6 of this RI Report, Site data is compared relative to preliminary screening levels to evaluate if a potential exposure pathway is complete or likely to be complete in the future. Screening levels based on incomplete pathways are eliminated.

- Screening levels are identified as the lowest potentially applicable screening level for each medium and location[10] so that they are protective of all complete exposure pathways.

[9] Quit Claim Deed (Corrected) recorded on April 28, 1997 (Pierce County Auditor Recording No. 9704280734); Restrictive Covenant recorded on May 5, 2003 (Pierce County Auditor Recording No. 200305050452).

[10] Different cleanup levels may apply to different areas of a particular medium. For example, screening levels for shallow groundwater consider the vapor intrusion pathway, while deeper groundwater does not.

- Final COCs are identified based on chemicals detected above screening levels for each medium based on the RI data set.

Screening levels and the information used to develop them are provided in Tables 5-1 through 5-4, as follows:

- Table 5-1 summarizes key chemical parameters used in screening level calculations;
- Table 5-2 summarizes CBNT Hylebos Waterway Sediment Quality Objectives (SQOs). SQOs were used to provide a comparison of sediment data collected during the RI and to develop groundwater screening levels protective of sediment in the *RI/FS Work Plan*;
- Table 5-3 summarizes groundwater screening levels; and
- Table 5-4 summarizes soil screening levels.

Further evaluation of the applicability of particular screening levels based on site-specific data is provided in Section 6. Screening levels that are determined not to apply based on empirical data as described in Section 6 are shown in Table 5-2 and Table 5-3 in grey italics.

## 5.4 Points of Compliance

The point of compliance is that location where the final cleanup levels for each medium are applied. Final Site cleanup levels and points of compliance will be developed as part of the FS. Potential points of compliance for each medium are outlined below.

### *5.4.1 Groundwater Point of Compliance*

Under MTCA, the standard point of compliance for groundwater cleanup levels is throughout Site groundwater, regardless of whether groundwater is potable or not (WAC 173-340-720(8)(b)). If it is not practicable to meet groundwater cleanup levels throughout the Site, Ecology may approve a conditional point of compliance for groundwater, in accordance with WAC 173-340-720(8)(c) and (d).

For volatile groundwater contaminants that can pose a risk via VI, protectiveness is achieved by meeting VI-based groundwater screening levels (Ecology, 2009) throughout the upper water bearing zone of the Site. Therefore, for groundwater screening levels based on VI protection, the Site point of compliance is throughout the 15-ft groundwater zone.

Because the Site groundwater's highest beneficial use is discharge to marine water, protecting that beneficial use is dependent on meeting marine water criteria at the points where groundwater discharges to the Hylebos or Blair Waterways. Therefore, a groundwater conditional point of compliance within the sediment bioactive zone (upper 10 centimeters), or in intertidal seeps, would achieve protection of the marine environment (both sediment and surface water). For the purposes of this RI, the MTCA standard point of compliance is assumed, and data across the Site are compared against groundwater screening levels protective of the marine environment. The FS may consider a conditional point of compliance under one or more alternatives if it demonstrates that it is not practicable to achieve surface water-based screening levels across the Site.

### 5.4.2 Soil Point of Compliance

In accordance with MTCA, the point of compliance for direct contact with soil extends to 15 feet below grade, based on a reasonable maximum depth of excavation and assumed placement of excavated soils at the surface where contact occurs. Therefore, for soil screening levels based on direct contact, the soil point of compliance is to a depth of 15 feet. Different soil screening levels based on groundwater protection apply for unsaturated soil versus saturated soil, so the points of compliance are different for each: unsaturated screening levels apply to depths above the water table, and saturated screening levels apply to depths below the water table.

# 6 Nature and Extent of Contamination

As described in Section 4.4, soil and groundwater data collected since 2000 are used in this RI Report to describe the nature and extent of contamination. This section describes the following:

- Section 6.1 evaluates which of the screening levels identified in Section 5 are potentially applicable to the Site, and identifies COCs and indicator hazardous substances (IHSs) based on comparison of Site data to those screening levels.
- Section 6.2 describes the nature and extent of Non-Aqueous Phase Liquids (NAPLs).
- Section 6.3 describes the nature and extent of COCs in soil.
- Section 6.4 describes the nature and extent of COCs in groundwater.
- Section 6.5 describes the nature and extent of COCs in sediment; this information is presented to assist in evaluation of cross-media transport of COCs.

For the purposes of this discussion, data from shoreline seeps (representing discharge of upland groundwater) is discussed as part of the groundwater data in Section 6.4.

## 6.1 Screening Levels and Chemicals of Concern

Identification of COCs and screening levels is an iterative process as described in Section 5. This section identifies the COCs and potentially applicable screening levels for each medium based on data collected to date. This section also identifies IHSs in accordance with WAC 173-340-703.

For the purposes of this RI Report, COCs include chemicals associated with the Site and chemicals associated with the adjacent OCC Site that have migrated onto the Site and are comingled with Site contamination. The FS will generally target Site COCs for cleanup under the assumption that OCC-related COCs will be addressed as part of the OCC site. However, the FS will include an evaluation of the effect that OCC-related COCs will have on potential Site cleanup actions and the effect Site actions may have on OCC-related COCs.

Chemicals excluded based on historical data included potential gasoline additives such as methyl tert-butyl ether (MTBE), ethylene dichloride (EDC), and ethylene dibromide (EDB). PCBs were not identified as preliminary COCs for the Site based on the low frequency and magnitude of detection in historical data (as discussed in the *Work Plan*).

As explained in Section 4.4, some previously collected data, as well as data generated during this RI effort, were included in the database and analysis of contaminant nature and extent discussed in this section.

### *6.1.1 Sediment Quality Objectives*

Although Ecology has determined that sediments will not be addressed as part of this cleanup action, sediment data collected during the RI are compared to CBNT Hylebos

Waterway SQOs and SMS toxicity criteria. SQOs are also considered in calculation of soil and groundwater screening levels that are based on cross-media transport (described below). Sediment data were also evaluated for petroleum. While there are not SQOs or other ARARs for petroleum mixtures, the sediment samples were analyzed for TPH to determine if Site sources might have affected sediments. Sediments with elevated TPH were then subjected to bioassays and compared to state standards for toxicity. SQOs are summarized in Table 5-2. A statistical summary of chemicals detected in Site sediments is provided in Table 6-1.

### *6.1.2 Groundwater COCs and Screening Levels*

As described in Section 5, Site groundwater is not considered a current or potential future use of drinking water. Groundwater screening levels therefore consider the following pathways:

- Discharge to marine surface water (ecological and human health exposures). This exposure pathway was considered for each groundwater zone, including seeps; and

- Vapor intrusion (human health exposure). This pathway was considered for shallow groundwater (15-foot zone) only and was not considered for seeps.

ARARs and associated potential screening levels are summarized in Table 5-3. In addition to ARARs, the following sources were also used to develop potential screening levels:

- MTCA Method B and C surface water cleanup levels (human health). As in the *RI/FS Work Plan*, these were not used for identifying screening levels if other ARARs are 'sufficiently protective' as per MTCA (WAC 173-340-730(3)(b) and (4)(b)); and

- Groundwater screening levels for vapor intrusion (human health), calculated as described in Ecology's draft vapor intrusion guidance (Ecology, 2009) and using current air cleanup levels.

In the *RI/FS Work Plan*, a groundwater screening level was also calculated for all potential COCs with sediment screening levels based on the groundwater-to-sediment pathway as an initial screening tool. Based on collected sediment data, the only site-related COCs detected in sediment above SQOs were not detected in groundwater[11]; therefore, this pathway was determined to be incomplete. Therefore, a groundwater-to-sediment screening level was not applied for the RI.

[11] Of the chemicals detected in both sediment and groundwater, there were two exceedances of the PCE SQO (detected in two historical composite samples), three exceedances of the lead SQO, and one exceedance of the copper SQO. These were in an area located adjacent to the 709 embankment fill area. This area is not considered part of the Site. There were also two exceedances of the fluoranthene SQO and two exceedances of the pyrene SQO in sediment, but neither of these compounds were detected in groundwater above the groundwater-to-sediment pathway screening level identified in the *RI/FS Work Plan*. Therefore, the groundwater-to-sediment screening level was not carried forward to the RI.

None of the ARARs or above-calculated values provide screening levels for petroleum hydrocarbon mixtures (gasoline, diesel, oil). For the petroleum mixtures, groundwater screening levels were identified as follows:

- Human Health: MTCA Method A cleanup levels, in accordance with WAC 173-340-720 and WAC 173-340-730.

- Ecological: No Observed Effect Levels (NOEL) for petroleum mixtures (EPA Ecotox database: http://cfpub.epa.gov/ecotox/report.cfm.) A level of 720 ug/L total TPH (gasoline + diesel + oil ranges) was recommended by Ecology based on values in the Ecotox database. The total TPH concentrations are calculated in the data tables and discussed in the text but separate figures of total TPH distribution compared to the screening level were not prepared for this RI Report.

#### 6.1.2.1 Use of the Silica Gel Cleanup for Groundwater Analysis of TPH

TPH is defined in MTCA (see 173-340-200 WAC) as a fraction of crude oil or refinery product of crude oil, as quantified by analytical methods such as NWTPH-Gx, NWTPH-Dx, VPH, or EPH. Analytical methods for measuring diesel- + oil-range TPH concentrations can include a preliminary step called ‘silica gel cleanup’ (SGC). SGC is an optional element of the NWTPH-Dx method, to be used in cases where samples contain significant amounts of naturally occurring non-petroleum organics such as leaf litter, bark or peat that may cause biogenic interferences. SGC is a required element of the EPH method, which is a more specific method of quantifying petroleum hydrocarbons. The purpose of SGC is to remove organic compounds that are not petroleum hydrocarbons prior to quantification. Non-petroleum hydrocarbons that may be quantified by TPH analytical methods without the SGC step include natural organics (e.g., humic acids) and polar organic compounds such as organic acids, alcohols, and ketones that can result from biodegradation of petroleum hydrocarbons. Recent studies (Zemo 2013; Mohler 2013) indicate that polar compounds that have been identified as biodegradation products of TPH at petroleum sites have substantially lower human health and ecological toxicity than petroleum hydrocarbon mixtures, based on the general toxicity of polar compound classes. In particular, the studies have concluded (Zemo 2014):

- **Human Health.** The vast majority of polar organic compounds removed by SGC (primarily alcohols, organic acids, and ketones) have low human health toxicity; and

- **Ecological.** The presence of polar organic compounds resulting from petroleum biodegradation does not increase the aquatic toxicity of the groundwater.

Up through October 2014, Site data typically included use of SGC in measuring petroleum concentrations by method NWTPH-Dx. In January 2015, Ecology directed the groundwater monitoring program to include NWTPH-Dx analysis without the use of SGC. Groundwater samples collected from January through December 2015 were analyzed by NWTPH-Dx using both SGC and non-SGC for comparative purposes. Groundwater TPH concentrations quantified without use of SGC were substantially higher at many Site wells.

Comparison of the chromatograms for groundwater samples run via SGC and non-SGC methods show that the non-SGC data do not match the diesel standard but have a shift in peaks towards a carbon range heavier than standard diesel-range TPH, which is indicative of the polar degradation compounds that take longer to elute on the gas chromatograph (Zemo, 2014). In December 2015, three groundwater samples were analyzed by EPA Method 8270 with and without SGC and a GC/MS library scan was conducted to tentatively identify compounds that may be removed by SGC. The lab report and a tabular summary of compounds detected, and their potential source based on literature, is provided in Appendix E. This analysis tentatively indicated the presence of several likely polar biodegradation products of petroleum hydrocarbons, including a ketone, a phenol, and organic acids. It also identified several potential petroleum hydrocarbons including alkylated cyclohexanes, cyclopentane, and two alkylated benzenes. According to the lab, the non-polar petroleum hydrocarbons should not be removed by SGC and they may have been misidentified; the 'Qualifier' rating (scale of 1 to 100) for these identifications ranged between 50 and 73 (only qualifier ratings greater than 50 were reported).

It is likely that comparing the non-SGC TPH data to groundwater TPH cleanup levels is conservative.

As described above, recent studies indicate that these polar degradation products may have generally low toxicity to human health and aquatic life. Of all the compounds detected, the only one with human health toxicity in Ecology's CLARC database or EPA's IRIS database is 2,6-methylphenol, and the detected concentration is well below potential cleanup levels for that compound. Furthermore, the non-hydrocarbon polar metabolites are also not expected to pose a human health concern through ingestion of marine aquatic organisms or pose a concern to higher-trophic-level aquatic organisms because of the low potential for bioaccumulation. A substance's bioaccumulation potential is generally correlated to the octanol-water partition coefficient, $K_{ow}$, and some researchers have stated that only substances with log $K_{ow}$ greater than 5 are considered potentially bioaccumulative (Gobas, 2001). $K_{ow}$s for polar degradation products of petroleum hydrocarbons are much lower than the parent compound. For instance, for a representative diesel-range alkane, dodecane, the log $K_{ow}$ is 6.1 (EPA, 2015). Metabolic degradation products include dodecanol, dodecandioic acid, and dodecanone (Whyte et al, 1998), which have log $K_{ow}$s ranging from 3.17 to 4.70, or between 25 and 850 times less bioaccumulative than the parent compound. $K_{ow}$s for polar compounds detected in the library scan and for their likely parent compounds are summarized in Appendix E. As compounds are further metabolized and broken down, degradation products will be shorter chained and have correspondingly lower $K_{ow}$s. Therefore, cleanup levels for petroleum hydrocarbon mixtures that are protective of human health via the surface water pathway will be overly conservative if applied to concentrations that include polar degradation products.

Ecology has indicated that, based on current Ecology policy, non-SGC TPH data should be used in determining the extent of contamination. For the purposes of the RI, both SGC and non-SGC data have been compared to screening levels and are included in the discussion of contaminant occurrences.

#### 6.1.2.2 Summary of Groundwater Screening Levels and COCs

Groundwater screening levels were identified as the lowest applicable groundwater screening level for each potential exposure pathway. Different screening levels were identified for some volatile constituents in shallow versus deep groundwater because of no vapor intrusion pathway from the deeper groundwater zones.

A statistical summary of chemicals detected in Site groundwater is provided in Table 6-2 (15-foot zone), Table 6-3 (25-foot zone), and Table 6-4 (deeper than 25-foot zone). A statistical summary of chemicals detected in seeps is provided in Table 6-5.

Several chemicals detected above screening levels were not retained as COCs, as follows:

- Chloroform only exceeded in one location during one sample event. That exceedance was located at well 28-15, which is on the adjacent OCC Property, north (upgradient) of the Site. Therefore, this chemical has not been retained as a COC in groundwater.
- Acrylonitrile and bis-2ethyl-hexyl phthalate was not retained as a COC in groundwater due to low frequency and magnitude of exceedances.
- Exceedances of heavy metals (including arsenic, copper, lead[12], nickel, and zinc) in groundwater are correlated to the 709 embankment fill area and the elevated pH plume associated with the OCC site (see Appendix D), and are not deemed to be associated with the Site. These chemicals were not retained as COCs in groundwater.
- cPAHs slightly exceeded screening levels in 2 samples, located on the eastern portion of the 709 Property[13]. Because of the small magnitude of exceedance, the low mobility of these compounds, and the long distance from the wells to surface water, cPAHs are not considered to be a potential migration risk to surface water and were not retained as COCs.

All other chemicals detected above screening levels[14] are retained as COCs in groundwater for the RI (Table 6-8).

### 6.1.3 Soil COCs and Screening Levels

Based on aa simplified Terrestrial Ecological Evaluation (see Section 3), MTCA criteria for terrestrial ecological receptors are not incorporated. Soil screening levels therefore consider the following pathways:

- Direct contact (human health) under industrial land use; and
- Protection of groundwater for both human health and ecological receptors. As described above, groundwater cleanup levels consider marine surface water and vapor intrusion receptors.

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[12] The RI included testing for lead and a contingency to test for organic lead due to the potential for leaded gasoline as a contaminant source. However, no exceedances for lead in soil were identified outside of the 709 embankment fill area.

[13] Maps of cPAH occurrences in groundwater were provided in the *Work Plan.*

MTCA soil cleanup levels for these pathways are presented in Table 5-4[15]. Also included in Table 5-4 are potential modifying factors (natural background concentrations and practical quantitation limits). Soil screening levels were identified based on the lowest potentially applicable soil screening level for each pathway, adjusted if appropriate based on the modifying factors.

Groundwater-protection-based soil screening levels were not applied for chemicals which were not detected in Site groundwater above groundwater screening levels, specifically chloroform, ethylene dichloride, methylene chloride, trans 1,2-dichloroethene, 1,1,2,2-tetrachloroethane, toluene, xylenes, acenaphthene, anthracene, fluoranthene, fluorene, phenanthrene, and pyrene. In addition, as previously described in the *RI Data Memo* (Aspect, 2015a), three chemicals (1,1-dichloroethene, lead and carcinogenic polycyclic aromatic hydrocarbon (cPAHs)) had minor exceedances in groundwater, but the soil-to-groundwater screening level was not applied because the limited magnitude of exceedance and location of exceedances do not indicate that migration to surface water is a potential concern[16].

A statistical summary of chemicals detected in Site soil is provided in Table 6-6 (depths 0 to 30 feet) and Table 6-7 (depths greater than 30 feet). Of the chemicals detected above soil screening levels, several were not retained as COCs, as follows:

- Three SVOCs not associated with petroleum that are associated with the OCC site (hexachlorobutadiene, hexachlorobenzene, pentachlorophenol) have only been detected above screening levels at samples located in the embankment fill area of the 709 Property, which is associated with the OCC site and not within the footprint of the former petroleum storage facilities.

- Lead has also only been detected in soil above screening levels at samples located in the embankment fill area of the 709 Property (see the *Work Plan* Figures 6-6-13, 6-6-14, and 6-6-15).

- Bis-2-ethyl-hexyl phthalate was not retained as a COC in soil due to low frequency and magnitude of exceedances.

All other chemicals detected above soil screening levels are retained as COCs in soil for this RI/FS (Table 6-8).

### 6.1.4 Identification of Indicator Hazardous Substances

As described above, statistical summaries of chemical occurrences are provided in Tables 6-2 through 6-5 for groundwater and Tables 6-6 and 6-7 for soil. IHSs were identified based on the frequency and magnitude of exceedance of COCs in each medium. IHSs are chemicals that are used in this RI Report to illustrate the extent of contamination and to define the scope of remedial actions. Based on comparison of existing data to potential cleanup levels, the following are identified as IHSs at the Site:

[15] Table 5-4 does not include soil concentrations for protection of groundwater for TPH Eco-risk pathway.

[16] Lead and cPAHs do not present a potential VI concern and do not have VI-based groundwater screening levels. 1,1-Dichloroethene has not been detected above VI-based groundwater screening levels.

- Benzene;
- Gasoline-range TPH;
- Diesel-range plus heavy-oil-range TPH;
- CVOCs, including PCE, TCE, and vinyl chloride (groundwater only).

Other chemicals were only sporadically detected or are correlated to IHSs but cover a smaller footprint and have a lower exceedance of screening levels, as follows:

- 1,1-dichloroethene is a breakdown product associated with the IHSs PCE and TCE; and
- Ethylbenzene, 1,2,4-trimethylbenzene, xylenes, and naphthalene are associated with gasoline-range TPH, and have smaller exceedances and extent than benzene.

A summary of Site COCs, IHSs, and screening levels is provided in Table 6-8.

The following sections describe the current understanding of LNAPL and IHS occurrences in Site soil and groundwater.

## 6.2 Occurrence of Light Nonaqueous Phase Liquid (LNAPL)

In 1987, "oil" was reportedly observed in the sanitary sewer line Manhole 30 (currently named Manhole 6773134) located near the southwest corner of the 709 property (Figure 3.1). At that time, the City of Tacoma's videotaping of the sewer line did not identify the origin of the oil. In 1991, City of Tacoma videotaped the sewer line again, which identified oil infiltrating into the sewer line at a joint located 120 feet south of Manhole 30. A 1995 sample of the petroleum in the sewer line identified the petroleum to be weathered diesel.

In 1995, LNAPL accumulations (approximately 1 foot) were observed in Site monitoring wells 721-MW-2 and 721-MW-4 located adjacent to the office and loading shed on the west end of the 901 property. LNAPL was not identified in nearby wells 721-MW-1 and 721-MW-3 at that time. The LNAPL was sampled for specific gravity and petroleum hydrocarbon identification analyses, which identified a mixture of predominantly diesel-range hydrocarbons (62 to 65 percent of the mixture in the C12 to C24 carbon range) with a lower proportion of gasoline-range hydrocarbons (35 to 28 percent of the mixture in the C7 to C12 range); heavy oil-range hydrocarbons were negligible in the mixture (0 percent in the C24 to C34 range) (AGI, 1995).

In 2008, a trace accumulation of LNAPL (0.05 foot) was measured in well 721-MW-2, but LNAPL was not identified in adjacent wells 721-MW-1 and 721-MW-3 (monitoring well 721-MW-4 was not located). Analyses performed on the LNAPL sample included petroleum hydrocarbon identification, density, viscosity, surface tension air/water, interfacial tension NAPL/water, and surface tension air/NAPL (GeoEngineers, 2008). Based on capillary gas chromatography analysis and physical property testing of the LNAPL sample, Torkelson Geochemistry Inc. (2008) provided the following interpretation: "The MW2-0802150 Product sample appears to be a mixture of an extremely weathered middle distillate such as diesel fuel or fuel oil and smaller amount of a lighter material perhaps an extremely weathered gasoline. …the age of the middle distillate portion of MW2-080215-Product is estimated at be at least 19 +/- 2 years. The results of the physical property analyses are consistent with a product that is dominantly weathered middle distillate."

RI investigations included evaluation of soil cores for potential LNAPL indicators, such as heavy sheen or product droplets, and measurement of LNAPL presence and thicknesses in monitoring wells. Potential LNAPL indicators were observed at a number of soil borings and correlated with high detected concentrations of TPH (Figure 6.2-1). These indicators were generally observed near the top of the water table (i.e., the 'smear zone'), where floating product is spread up and down with rising and falling water levels. The smear zone appears to be on average approximately 2 feet thick based on the depth range of very high photoionization detector (PID) concentrations and product observations and most borings (see Table H-1, Appendix H). LNAPL indicators were observed at depths less than 13 feet. Free-phase LNAPL in wells was measured within a much smaller area than LNAPL indicators, suggesting that product is below residual saturation at many locations.

LNAPL measurements at wells are summarized in Appendix H, and product thicknesses measured in October 2014 are illustrated on Figure 6.2-2. Measurable LNAPL was detected at several wells on the western portion of the 709 and 901 properties in the 15-foot zone and may extend across part of the Alexander Avenue right-of-way, based on historical observations of product in the sanitary sewer (see Section 3.5.2) and one measurement of LNAPL at well HC-N11-6 in December 2015. The chemistry of collocated soil and groundwater samples from these locations suggests a mixture of weathered gasoline and diesel products with a generally higher proportion of diesel, the same interpretation as indicated by Torkelson (2008). LNAPL has not been observed in measureable quantities in the 25-foot zone.

LNAPL recovery testing was conducted in October 2014 at wells containing significant product thicknesses. Testing results and interpretation were reported in the LNAPL Recoverability Testing Memo (Aspect, 2014c), which is included in Appendix H. Results indicated that Site LNAPL has low recoverability and is thus inferred to have low mobility.

## 6.3 Soil Quality

This section describes the extent of IHSs in soil (including gasoline-range TPH, benzene, diesel + oil-range TPH, PCE, and TCE) relative to soil screening levels. The magnitude and extent of exceedances for other Site COCs associated with petroleum products – including toluene, ethylbenzene, xylenes, naphthalene, and other non-carcinogenic PAHs – is smaller than for the IHSs. Similarly, the magnitude and extent in soil of Site COCs associated with chlorinated solvents other than PCE and TCE (e.g., vinyl chloride) is smaller than for the IHSs.

IHS occurrences are discussed in the 0 to 5-foot depth interval (the approximate extent of the unsaturated zone, soil above the seasonal high water table), in the upper portion of the saturated zone (depths of 5 to 15 feet, generally corresponding to the 15-foot zone for groundwater), and deeper in the saturated zone (depths of 15 to 30 feet, generally corresponding to the 25-foot zone for groundwater).

### *6.3.1 Gasoline-Range TPH and Benzene in Soil*

Gasoline-range TPH and benzene occurrences are discussed together because they are generally collocated, and the source of benzene at the Site is assumed to be spilled gasoline product. As expected for petroleum-related contaminants, gasoline-range TPH and benzene are predominantly concentrated in the shallow soils at or near the water table.

Occurrences of gasoline-range TPH in soil are illustrated on Figures 6.3-1 (0- to 5-foot depth), 6.3-2 (5- to 15-foot depth) and 6.3-3 (15- to 30-foot depth). These occurrences are compared to the screening level of 30 mg/kg, which is the MTCA Method A value for gasoline when benzene is present, and is based on protection of drinking water. Although drinking water is not a potential exposure pathway at this Site, under MTCA this value is assumed to also be protective of surface water (human health) and vapor intrusion. Although a Site-specific screening level for the direct contact pathway was not developed, Ecology guidance (Ecology, 2015) has identified a default value of 1,500 mg/kg for total TPH that can be assumed to be protective of direct contact under unrestricted use when gasoline is present; an equivalent screening level under industrial use would be much higher. Therefore, the 30 mg/kg screening level is assumed to also be protective of the direct contact pathway.

Occurrences of benzene are illustrated on Figures 6.3-4 (0- to 5-foot depth), 6.3-5 (5- to 15-foot depth) and 6.3-6 (15- to 30-foot depth). These occurrences are compared to the groundwater protection-based screening level of 0.02 mg/kg (for groundwater-to-vapor pathway). No soil samples exceeded the 2,390 mg/kg direct contact-based screening level for benzene. The groundwater protection-based screening level is based on the lower of the surface water or vapor intrusion protection-based groundwater screening level and is therefore protective of both pathways.

Occurrences of gasoline-range TPH and benzene in unsaturated zone and saturated zone soils are described below.

#### 6.3.1.1 Unsaturated Zone Soils

In unsaturated zone soil, the highest concentrations of gasoline-range TPH (up to 5,100 mg/kg) occur on the northern portion of the 901 property within the former bermed fuel tank area and former USAF sludge area (Figure 6.3-1). The highest benzene concentration detected in unsaturated zone soil (11 mg/kg at B-127 and 4.3 mg/kg at B-108) also occurs in this area (Figure 6.3-1).

Other areas with unsaturated zone gasoline-range TPH concentrations exceeding 300 mg/kg (10 times the 30 mg/kg screening level) are as follows:

- In Alexander Avenue west of the boundary between the 709 and 901 properties (boring 721-BH-17);
- The northern portion of the bermed area of the 709 property (borings 709-BH-06 and 709-BH-05)

- On the southeast side of tank 4 (gasoline) in the northeastern portion of the 901 property (boring 721-BH-03).

The interpreted spatial extent of gasoline-range TPH in unsaturated zone soil exceeding the 30 mg/kg screening level encompasses the high concentration areas described above; the data indicate relatively sharp declines in concentrations away from the high-concentration source areas.

The extent of benzene exceedances in unsaturated soil is comparable to the extent of gasoline-range TPH, but benzene exceedances do not extend as far to the east (no benzene exceedance at boring 721-BH-03).

#### 6.3.1.2 Saturated Zone Soils

In the saturated zone, gasoline-range TPH and benzene exceedances are more spatially extensive than in unsaturated zone soil, which is consistent with groundwater transport of petroleum compounds away from the source areas. As depicted on Figures 6.3-2 and 6.3-5, gasoline-range TPH and benzene exceedances were detected across the western portion of the 709 property, the northern portion of the 901 property up to the edge of the Hylebos Waterway, and east (downgradient) of the former location of UST N-11 west of Alexander Avenue.

Relative to the unsaturated zone soil data, gasoline-range TPH and benzene concentrations in saturated soil tend to show a more gradual decline with distance away from the higher-concentration areas—that is, gasoline-range TPH concentrations greater than 30 mg/kg in saturated zone soil encompasses a relatively larger area than concentrations in unsaturated zone soil exceeding 300 mg/kg.

The vast majority of gasoline-range TPH exceedances in soil have been detected in the upper 15 feet. High concentrations of benzene are generally limited to the upper 15 feet, but modest exceedances of the benzene screening level in soil extend deeper than 15 feet, consistent with the extent of benzene in groundwater (see Section 6.4). No exceedances of gasoline-range TPH or benzene have been detected in soil samples collected at depths greater than 30 feet (Table 6-7).

### *6.3.2 Diesel-Range and Oil-Range TPH in Soil*

For purposes of this RI Report, concentrations of diesel-range and oil-range TPH are summed to calculate and present a single TPH value for each sample in accordance with Ecology's 2004 Technical Memorandum #4 (Ecology, 2004). Previous petroleum forensic work has identified middle distillate diesel products and no heavier diesel or oil-range TPH products.

Occurrences of diesel- + oil-range TPH are illustrated on Figures 6.3-7 (0- to 5-foot depth), 6.3-8 (5- to 15-foot depth) and 6.3-9 (15- to 30-foot depth). These occurrences are compared to the screening level of 2,000 mg/kg, which is the MTCA Method A value for diesel, and is based on accumulation of free product. Although empirical data suggest the residual saturation of Site LNAPL is much higher than the screening level, this screening level is assumed to also be protective of surface water (human health) and vapor intrusion[17]. Similar as described for gasoline-range TPH, this screening value is also assumed to be protective of the direct contact pathway. Although use of the 2,000 mg/kg

[17] MTCA identifies a threshold of 10,000 mg/kg diesel-range TPH as a trigger for evaluating the vapor pathway.

screening level for diesel- + oil-range TPH is likely conservative, it is assumed to not significantly affect the FS.

#### 6.3.2.1 Unsaturated Zone Soils

In unsaturated zone soil, the spatial extent of diesel- + oil-range TPH concentrations exceeding the 2,000 mg/kg screening level (Figure 6.3-7) is similar to the extent of gasoline-range TPH exceedances. Diesel- + oil-range TPH exceedances in unsaturated soil occur at boring 721-BH17 in Alexander Avenue, in the former USAF sludge area on the 901 property, and in the vicinity of former kerosene, solvent, diesel, and fuel oil tanks on the 709 and 901 properties. The highest concentration (31,300 mg/kg) was detected at boring 721-BH-08 located on the south side of tank 11 (diesel).

#### 6.3.2.2 Saturated Zone Soils

In saturated soil, diesel- + oil-range TPH exceedances are more spatially extensive than in unsaturated zone soil (Figure 6.3-8). The saturated soil samples generally have higher diesel- + oil-range TPH soil concentrations than gasoline-range TPH soil concentrations, although there are exceptions (e.g., 709-BH-06). The diesel- + oil-range TPH soil exceedances are limited to the 15-foot zone (no exceedances in soil samples collected from 15- to 30-foot depth zone (Figure 6.3-9).

Similar to gasoline-range TPH exceedances, the diesel + oil-range TPH exceedances in saturated soil (5- to 15-foot depth interval) are detected across the former tank farm footprints, in the Alexander Avenue right-of-way, and near the former location of UST N-11 west of Alexander Avenue. Diesel- + oil-range TPH concentration exceeding 20,000 mg/kg (10 times the screening level) were detected in the 5- to 15-foot depth interval within a contiguous area in the northwest corner of the 901 property and southwest portion of the 709 property, similar to the area of free-phase LNAPL observations. One sample exceeding 20,000 mg/kg was also detected on the northeastern portion of the 901 property (at boring 721-BH-04).

No diesel- + oil-range TPH soil exceedances are detected in the 15- to 30-foot depth interval (Figure 6.3-9).

### *6.3.3 Chlorinated VOCs in Soil*

PCE and TCE occurrences are discussed together because they are generally collocated. TCE is a degradation product (aka 'daughter product') of PCE[18]. Historical data indicated these compounds in soil at the Site exceeding screening levels, and additional data was collected during the RI to help assess whether occurrences originated from activities associated with historic petroleum storage and processing facilities that were operated on the 709 and 901 properties[19] or from off-Site sources.

Occurrences of PCE in soil are illustrated on Figures 6.3-10 (0- to 5-foot depth), 6.3-11 (5- to 15-foot depth) and 6.3-12 (15- to 30-foot depth). These occurrences are compared to the groundwater protection-based screening level of 0.005 mg/kg (for protection of

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[18] Other daughter products of PCE and TCE include cis-DCE and vinyl chloride; however, those compounds were detected very infrequently in soil at the Site.

[19] Per Agreed Order DE 9835, this Site is defined by "the extent of contamination caused by release of hazardous substances originating from activities associated with historic petroleum storage and processing facilities that were operated at the noted properties."

human health for fish consumption, adjusted to PQL); no PCE occurrences exceed the direct contact based screening level of 21,000 mg/kg. The groundwater protection-based screening level is based on the lower of the surface water or vapor protection-based groundwater screening level and is therefore protective of both pathways.

Occurrences of TCE in soil are illustrated on Figures 6.3-13 (0- to 5-foot depth), 6.3-14 (5- to 15-foot depth), and 6.3-15 (15- to 30-foot depth). These occurrences are compared to the groundwater protection-based screening level of 0.005 mg/kg (for protection of human health for fish consumption, adjusted to PQL); no TCE occurrences exceed the direct contact based screening level of 1,750 mg/kg. The groundwater protection-based screening level is based on the lower of the surface water or vapor protection-based groundwater screening level and is therefore protective of both pathways.

Occurrences of PCE and TCE in unsaturated zone and saturated zone soils are described below.

#### 6.3.3.1 Unsaturated Zone Soils

Concentrations of PCE (up to 12 mg/kg) and TCE (up to 0.68 mg/kg) were detected in unsaturated soils within the embankment fill. In unsaturated soil outside of the embankment fill, there are scattered low PCE exceedances (less than 0.03 mg/kg) on the 709 and 901 properties and one TCE exceedance on the 709 property (Figures 6.3-10 and 6.3-13). The unsaturated soil data do not suggest any substantial surface releases of CVOCs on the 709 or 901 properties outside of the embankment fill.

#### 6.3.3.2 Saturated Zone Soils

Within the 5- to 15-foot depth interval of saturated soil, the highest PCE concentrations were detected in the western portion of the 901 property (up to 0.17 mg/kg) in the area of the former Solvent Tank 13. Scattered low-level PCE exceedances also occur in single borings near the northern and southern boundaries of the 709 property (0.024 mg/kg at 709-BH-03, 0.008 mg/kg at 709-BH-01, and 0.01 mg/kg at B-114, respectively) (Figure 6.3-11). PCE exceedances also occur in embankment fill soils. No TCE soil exceedances are detected in the 5- to 15-foot depth interval outside of the embankment fill (Figure 6.3-14).

Within the 15- to 30-foot depth interval of saturated soil outside of the embankment fill, low-level PCE soil exceedances occur from the north-central portion of the 709 property (up to 0.065 mg/kg at 709-BH-01) to the northeastern portion of the 901 property (up to 0.062 mg/kg at 721-MW-8). A low-level TCE exceedance likewise occurs at the 721-MW-8 location (0.14 mg/kg) (Figure 6.3-15). These exceedances are low-level and are consistent with the groundwater plume, not a local shallow source. The low-level exceedances of PCE observed in the 5- to 15-foot zone within the western portion of the 901 property do not extend into the deeper zone (Figure 6.3-11).

## 6.4 Groundwater Quality

This section describes the extent of IHSs in groundwater (including gasoline-range TPH, benzene, diesel + oil-range TPH, PCE, TCE, and VC) relative to groundwater screening levels. This section also describes the extent of an elevated pH and metals plume associated with the OCC site that is commingled with Site contamination.

Similar to soil occurrences, the magnitude and extent in groundwater of exceedances for other Site COCs associated with petroleum products – including toluene, ethylbenzene, xylenes, naphthalene, and other non-carcinogenic PAHs – is smaller than for the IHSs.

IHS occurrences are discussed in the upper portion of the saturated zone (depths of 5 to 15 feet, generally corresponding to the 15-foot zone for groundwater), and deeper in the saturated zone (depths of 15 to 30 feet, generally corresponding to the 25-foot zone for groundwater).

### 6.4.1 Gasoline-Range TPH and Benzene in Groundwater

Occurrences of gasoline-range TPH are illustrated on Figures 6.4-1 (15-foot zone) and 6.4-2 (25-foot zone). These occurrences are compared to the screening level of 800 µg/L, which is the MTCA Method A value and is based on protecting drinking water. Although drinking water is not a potential exposure pathway at this Site, under MTCA (WAC 173-340-730(3)(b)(iii)(C)) this value is assumed to also be protective of surface water (human health/fish consumption pathway) and vapor intrusion. The extent of gasoline-range TPH in groundwater is also approximately the extent of total TPH (gasoline + diesel + oil) with SGC exceeding the eco-risk screening level of 720 µg/L[20].

Occurrences of benzene are illustrated on Figure 6.4-3 (15-foot zone), Figure 6.4-4 (25-foot zone), and Figure 6.4-5 (50-foot zone). For the 15-foot zone, these occurrences are compared to the vapor-intrusion screening level of 24 µg/L and the surface water protection screening level of 58 µg/L. For the 25-foot and 50-foot zones, where the vapor intrusion pathway is not complete, these occurrences are compared to only the surface water protection screening level.

Occurrences of gasoline-range TPH and benzene in groundwater are described below.

#### 6.4.1.1 15-Foot Zone

In the shallowest water-bearing zone (15-foot zone), the spatial distribution of gasoline-range TPH and benzene concentrations in groundwater that exceed screening levels generally matches the distribution of those constituents in soil — with gasoline-range TPH covering the western portion of the 709 property, and gasoline-range TPH and benzene covering the northern portion of the 901 property, and into the UST N-11 area west of Alexander Avenue (Figures 6.4-1 and 6.4-3). At the westernmost monitoring well (MW-130-15), the concentrations of gasoline-range TPH (2,500 µg/L) and benzene (170 µg/L) exceed screening levels; the western boundary of gasoline-range TPH and benzene is estimated based on the low concentrations at boring B-129 further west of the well and the general lack of field observations in this depth interval (these borings were field screened in the 15-foot zone but were only sampled in the 25-foot zone) at other borings advanced further west on the 500 property (refer to boring locations shown on Figure 4.1 and boring logs in Appendix A).

In seep samples along the Hylebos Waterway (SP-101, SP-102, and SP-103), which represent groundwater discharge from the 15-foot groundwater zone, gasoline-range TPH

[20] The extent of total TPH exceeding the eco-risk screening level without SGC is approximately the extent of diesel+ oil TPH without SGC, as described in Section 6.4.2.

and benzene concentrations were below the surface water screening levels (Figures 6.4-1 and 6.4-3).

#### 6.4.1.2 25-Foot Zone

In the deeper water-bearing zone (25-foot zone), two wells, 709-MW21-25 and 721-MW15-25 in the southwest corner of the 709 property and the western side of the 901 property respectively, had a detected exceedance for gasoline-range TPH (Figure 6.4-2). The groundwater sample from boring B-111 also had a detected exceedance for gasoline-range TPH, but samples collected from well MW-110-25, which is located proximate to B-111, did not produce the same results.

Benzene exceedances are more extensive, extending across the southern half of the 709 property, the northern half of the 901 property, and extending west of Alexander Avenue, across the 500 property to the Blair Waterway shoreline (Figure 6.4-4). Groundwater benzene exceedances extend to the upland shoreline monitoring wells along the Hylebos Waterway, but no exceedances were detected during one-time sampling of the three piezometers installed in the intertidal zone on the east side of the properties and screened in the elevation interval of the 25-foot zone (721-PZ-01, 721-PZ-02, and 721-PZ-03). Benzene was not detected in the intertidal well 721-PZ-03 on the east end of the 709 property. Benzene was detected in the intertidal wells on the east end of the 901 property, but at concentrations (15 and 4.7 μg/L at 721-PZ-01 and 721-PZ-02, respectively) below the 58 μg/L surface water protection screening level (Figure 6.4-4).

#### 6.4.1.3 50-Foot Zone

Groundwater samples collected at depths below 30 feet exceed the 58 μg/L screening level for benzene at only two locations (Figure 6.4-5). One of those is at monitoring well 721-MW13-50, at a maximum concentration of 120 μg/L. The other was from a groundwater grab sample collected from a soil boring; subsequent monitoring well installation and sampling in the area of that grab sample did not indicate a benzene exceedance. Benzene has not been detected above its screening level at any other wells from the 50-foot zone. Gasoline-range TPH has not been detected at the wells from the 50-foot zone.

Figures 6.4-6A and 6.4-6B depict the vertical distribution of benzene in groundwater along cross sections A-A’ and B-B’ (cross section locations shown on Figure 6.4-4). Intertidal well 721-PZ-02 is depicted on cross section A-A’ (Figure 6.4-6A). Cross Section A-A’ also depicts the deeper sample data, which demonstrate vertical bounding of benzene exceedances within the 25-foot zone. Cross Section B-B’ (Figure 6.4-6B) shows the area near 721-MW-13 where elevated benzene was detected in the 50-foot zone.

### *6.4.2 Diesel-Range and Oil-Range TPH in Groundwater*

For purposes of this RI Report, concentrations of diesel-range and oil-range TPH are summed to calculate and present a single TPH value for each sample in accordance with Ecology’s 2004 Technical Memorandum #4 (Ecology, 2004). In essentially all samples analyzed with SGC, oil-range TPH is not detected or, when detected, the concentration is a relatively small fraction of the reported diesel-range TPH concentration (the December 2015 sample from well 709-MW-11-15 is the one exception). Included in the site database are TPH summations assuming a concentration of 0 when non-detect (ND=0) and assuming a concentration of ½ the detection limit when non-detect (ND=1/2U). In some cases, adding ½ the detection limits cause exceedances of screening levels for the

ND=1/2U scenario. Data figures referenced in this section use the ND=0 summation. Occurrences of diesel- + oil-range TPH in groundwater with SGC are illustrated on Figures 6.4-7 (15-foot zone) and 6.4-8 (25-foot zone). Occurrences of diesel- + oil-range TPH in groundwater without SGC are illustrated on Figures 6.4-9 (15-foot zone) and 6.4-10 (25-foot zone). Because data collected prior to January 2015 included use of SGC for this analysis, the dataset with SGC is more complete.

Diesel- + oil-range TPH concentrations are compared to the screening level of 500 μg/L, which is the MTCA Method A value and is based on protecting drinking water. Although drinking water is not a potential exposure pathway at this Site, under MTCA the MTCA Method A value is assumed to also be protective of surface water (human health) (WAC 173-340-730(3)(iii)(C)). The extent of diesel- + oil-range TPH without SGC is approximately the same as the extent of total TPH (gasoline + diesel + oil) exceeding the eco-risk screening level of 720 μg/L.

Occurrences of diesel + oil-range TPH in groundwater, using data with and without SGC, are described below.

#### 6.4.2.1 15-Foot Zone

**With Silica Gel Cleanup.** Within the 15-foot zone, diesel + oil-range TPH exceedances in groundwater occur across the former tank farm areas (up to 7,250 ug/l at well 721-MW15-15); however, detected concentrations in shoreline wells are all below the screening level (Figure 6.4-7) and no concentrations were detected in seeps (Figure 6.4-7). Total TPH concentrations in seeps were also below the eco-risk screening level of 720 μg/L. Diesel + oil-range TPH exceedances extend west from the 901 and 709 properties to the 500 property in the UST N-11 area, and are bounded to the west by well MW-130-15.

**Without Silica Gel Cleanup.** Diesel + oil-range TPH concentrations in groundwater without SGC are much higher (up to 30,000 μg/L at 709-MW-17) and extend over a greater area, including in shoreline wells (Figure 6.4-9). Concentrations slightly exceeding the screening level were detected in seeps SP-102 (520 μg/L) and SP-103 (750 μg/L) (Figure 6.6-5). Total TPH at SP-103 also exceeds the 720 μg/L eco-risk screening level. The extent of diesel- + oil-range TPH (no SGC) above the screening level is not bounded in the 15-foot zone on the 500 property to the west or southwest.

#### 6.4.2.2 25-Foot Zone

**With Silica Gel Cleanup.** No groundwater exceedances of diesel + oil-range TPH with SGC were identified in the 25-foot zone (Figure 6.4-8).

**Without Silica Gel Cleanup.** Diesel + oil-range TPH concentrations in groundwater without SGC exceed screening levels over a large area that includes the former tank farm areas and extending south to the Navy Warehouse. The area of exceedances includes shoreline wells along both the Hylebos Waterway (to a maximum concentration of 9,500 μg/L at well MW-104-25: Figure 6.4-10) and the Blair Waterway (at a concentration of 1,180 μg/L at well MW-137-25). The extent of diesel- + oil-range TPH (no SGC) above the screening level extends across the Hylebos peninsula and is not bounded in several areas to the north or south. The estimated extent shown on Figure 6.4-10 is based on the low or non-detect concentrations at well 93C-25 to the south, 709-MW-6-25 to the north, and the well-characterized groundwater flow characteristics that establish generally easterly and westerly flow directions at the Site (see Section 3.2.2).

## 6.4.3 Chlorinated VOCs in Groundwater

Chlorinated VOC IHSs include PCE, TCE, and VC. Occurrences of PCE are illustrated on Figure 6.4-11 (15-foot zone) and Figure 6.4-12 (25-foot zone). For the 15-foot zone, these occurrences are compared to the vapor protection screening level of 100 µg/L and the surface water protection screening level of 8.9 µg/L. For the 25-foot zone, where the vapor intrusion pathway is not complete, these occurrences are compared to only the surface water protection screening level.

Occurrences of TCE are illustrated on Figure 6.4-13 (15-foot zone) and Figure 6.4-14 (25-foot zone). For the 15-foot zone, these occurrences are compared to the vapor protection screening level of 8.3 µg/L and the surface water protection screening level of 7 µg/L. For the 25-foot zone, where the vapor intrusion pathway is not complete, these occurrences are compared to only the surface water protection screening level.

Occurrences of VC are illustrated on Figure 6.4-15 (15-foot zone) and Figure 6.4-16 (25-foot zone). For the 15-foot zone, these occurrences are compared to the vapor protection screening level of 5.4 µg/L and the surface water protection screening level of 1.6 µg/L. For the 25-foot zone, where the vapor intrusion pathway is not complete, these occurrences are compared to only the surface water protection screening level.

Occurrences of PCE, TCE, and VC in groundwater are described below.

### 6.4.3.1 15-Foot Zone

PCE concentrations exceeding screening levels occur in 15-foot-zone groundwater on the far southeast portion of the 605 property, the eastern portion of the 709 property, and the northeast corner of the 901 property (Figure 6.4-11). The highest concentrations observed were located on the east of the 709 and 901 properties near the 709/901 property line (120 µg/L at well 709-MW-1 and 80 µg/L at soil boring 721-GP5). On the 709 property, groundwater PCE concentrations exceeding the 8.9 µg/L surface water protection screening level occur at shoreline wells throughout the embankment fill, but concentrations were below screening levels at the downgradient intertidal seep samples. On the 901 property, PCE concentrations are below screening levels at shoreline wells and in seep samples. Only one location has a PCE detection exceeding the 100 µg/L vapor protection screening level (120 µg/L at 709-MW-01; Figure 6.4-11).

TCE concentrations exceeding screening levels occur along the western to middle portion of the 605/709 property boundary, extend southeast across the 709 property, and continue onto the northeast portion of the 901 property (Figure 6.4-13). The highest concentrations of TCE were identified in the southeast portion of the 709 property (maximum concentration of 35 µg/L at well 709-MW-01) and in the northeast portion of the 901 property (maximum concentration of 96 µg/L at historical soil boring 721-GP6[21]). Two shoreline locations had a TCE detection exceeding the 7 µg/L surface water protection screening level: 8.9 µg/L at 709-MW20-15 and 56 µg/L at 721-GP8, but TCE was not detected in any of the intertidal seep samples. Detected TCE concentrations

[21] The data from soil boring 721-GP6 was not used in determining isoconcentration contours shown on Figure 6.4-13 because more recent data from nearby monitoring well 721-MW7-15 was considered more representative of current conditions.

exceed the 8.3 µg/L vapor protection screening level across broad areas of the 709 and northern 901 properties (Figure 6.4-13).

Figure 6.4-15 depicts the groundwater VC data for the 15-foot zone, which indicates exceedances in the northeastern portion of the 901 property and a small portion of the southernmost 709 property. The vapor-based and surface water-based screening levels for VC are comparable (5.4 vs 1.6 µg/L), therefore the distribution of exceedances for each are similar. Along the shoreline, VC exceedances of the 1.6 µg/L surface water screening level were detected at 721-GP8 (29 µg/L) on the 901 property, and at the NL-28 and 721-PZ-03 locations (3.2 and 5.5 µg/L, respectively) on the 709 property. VC was not detected in any of the intertidal seep samples.

#### 6.4.3.2 25-Foot Zone

In the 25-foot zone groundwater, PCE and TCE groundwater exceedances of their surface water screening levels are limited to the southern portion of the 605 property and the east-central portion of the 709 property; no PCE or TCE exceedances are detected in the shoreline locations on any of the properties (Figures 6.4-12 and 6.4-14).

VC exceedances of the 1.6 µg/L surface water screening level in the 25-foot zone occur across much of the 709 property, and extending west across Alexander Avenue into the northeastern portion of the 500 property; the only exceedances detected on the 901 property were in the northwest and northeast corners (Figure 6.4-16). The highest detected VC concentrations occurred at shoreline well 709-MW20-25 (95 µg/L) located within the footprint of the embankment fill on the 709 property and at 709-MW18-25 (68 µg/L) located in the northwest corner of the 709 property. Offshore of the embankment fill on the 709 property, VC exceeded the screening level in one subtidal porewater sample (5.6 µg/L at NL-28). No exceedances were detected at the piezometer sample locations on the 709 and 901 properties.

### *6.4.4 Extent of pH and Metals in Groundwater*

Elevated pH and metals other than lead have primarily been detected in deeper groundwater (50-foot or deeper zones), and in shallow groundwater (15- or 25-foot zone) in the north/northeastern portion of the 709/901 properties. Figures depicting the extent of high pH (>8.5) and metals exceeding screening levels at the Site in shallow groundwater are shown in Appendix D.

Exceedances of metals are spatially correlated with high pH and appear to be associated with former caustic storage tanks on the southern portion of the 605 property, north of 709-MW-15. pH affects the mobility of metals in groundwater but generally does not have a significant direct effect on the mobility of hydrophobic organic compounds such as petroleum hydrocarbons or chlorinated solvents. Petroleum plumes can affect mobility of metals due to altered oxidation/reduction conditions; however, in this case, the exceedances of metals are correlated with high pH associated with the OCC site and not the Site TPH plume.

## 6.5 Sediment Quality

Sediment sampling was conducted as part of the RI program as described in Section 4. Ecology subsequently determined that sediments will not be included in cleanup actions at this Site as discussed in Section 4.3. However, the collected sediment data are presented here and compared to CBNT SQOs for reference.

Twelve surface sediment samples were collected at subtidal stations offshore of the 709 and 901 properties. In addition, because of the potential for area-wide background occurrences of potential Site COCs, including petroleum and PAHs, two 'background' samples were collected – one sample south of the Site, offshore of the 901 property[22] (Figure 6.5-1), and one farther south of the Site near the 11th Street Bridge.

Sediment samples SS-101, SS-106, and SS-111 exceeded the SQOs for fluoranthene and pyrene. Samples SS-106 and SS-111 exceeded the SQO for total high molecular weight PAHs (HPAHs). All three of these samples with exceedances of individual SQOs were submitted for confirmatory biological testing (bioassay) in accordance with state Sediment Management Standards protocols (Chapter 173-204 WAC). Samples SS-103 and SS-112 were also submitted for bioassay testing based on detected concentrations of high molecular weight PAHs (HPAHs) and TPH.

All five sediment samples submitted for bioassays passed by overall determination and by each specific biological test, including the three samples discussed above with exceedances of individual SQOs. The summary of the bioassay evaluation is provided in Table 6-9. below, and the full report is provided in Appendix E.

**Table 6-9 – Summary of Bioassay Evaluation**

| Treatment | Sediment Quality Standards | | | Cleanup Screening Levels | | | Overal Determination |
|---|---|---|---|---|---|---|---|
| | Amphipod | Polychaete | Larval | Amphipod | Polychaete | Larval | |
| SS-101 | Pass | Pass | Pass | Pass | Pass | Pass | Pass |
| SS-103 | Pass | Pass | Pass | Pass | Pass | Pass | Pass |
| SS-106 | Pass | Pass | Pass | Pass | Pass | Pass | Pass |
| SS-111 | Pass | Pass | Pass | Pass | Pass | Pass | Pass |
| SS-112 | Pass | Pass | Pass | Pass | Pass | Pass | Pass |

The occurrence of Site IHSs in sediment adjacent to the Site, based on historical investigations and data collected during the RI, is summarized below.

### *6.5.1 Gasoline-Range TPH and Benzene in Sediment*

Gasoline-range TPH has not been detected in sediment samples adjacent to the Site Figure 6.5-1). Low concentrations of benzene (up to a maximum of 0.057 mg/kg, at SS-110: Figure 6.5-2) were detected in several nearshore sediment samples. Benzene was not detected in sediment adjacent to the historical docks.

[22] The 901 property 'background' sample (SS-BKGRD-1) may not represent background conditions due to its proximity to the discharge point for the groundwater plume.

### *6.5.2 Diesel + Oil-Range TPH in Sediment*

Diesel- + oil-range TPH was detected in all sediment samples, up to a maximum of 1,250 mg/kg at SS-111 (Figure 6.5-3). Samples containing the highest TPH concentrations were submitted for bioassay testing and passed, as described above.

### *6.5.3 Chlorinated VOCs in Sediment*

A PCE concentration of 0.084 mg/kg was detected prior to the RI in historical composite sample A-2 of five subtidal sediment subsamples collected in 1997 from the 709 property shoreline adjacent to the embankment fill, slightly exceeding the 0.057 mg/kg SQO; however, this area is part of the adjacent OCC site and not considered part of the Site. PCE concentrations in adjacent discrete sediment samples were below the SQO. All sediment samples collected adjacent to the 901 property, including those collected during the RI, were below PCE and TCE SQOs (Figures 6.5-4 and 6.5-5).

## 6.6 Contaminant Mass Estimates

Based on the collective data, the estimated mass of petroleum-related contaminants (including gasoline-range TPH, diesel- + oil-range TPH, and benzene) was calculated using a Thiessen Polygon method as described in Appendix G. Contaminant mass in soil was calculated based on detected concentrations and the mass in LNAPL was based on product measurements and LNAPL modeling tools. For purposes of this analysis, the dissolved mass in groundwater was assumed negligible compared to the total mass of contaminants in soil and LNAPL. Details of the mass estimate calculations, including maps of Thiessen polygons and calculated average concentrations for depth intervals of 0 to 5 feet, 5 to 15 feet, and 15 to 30 feet, are provided in Appendix G.

Based on this analysis, the total estimated mass of contaminants is 315,000 pounds of gasoline-range TPH, 1.6 million pounds of diesel- + oil-range TPH, and 800 pounds of benzene. The majority of contaminant mass is located in the 5 to 15-foot depth interval (which includes the petroleum ‘smear’ zone).

# 7 Conceptual Site Model

This conceptual site model describes sources of contaminants, and the potential migration pathways and environmental media where the contaminant sources are suspected or confirmed to be found. The conceptual site model also describes the environmental receptors and exposure pathways by which the receptors could be exposed to contaminants.

## 7.1 Sources of Contamination

Potential contaminant sources and source areas at the Site, including former operation and storage areas and reported spills, were identified in Section 3.6. Based on the collected data, multiple releases during petroleum storage, processing, and distribution activities on the 709 and northern portion of the 901 property have resulted in substantial petroleum contamination (primarily a mixture of gasoline- and diesel-range TPH and associated hydrocarbon constituents) of the underlying soil and groundwater. Releases of chlorinated solvents on the OCC site appear to be the primary source of CVOCs at the Site although there does appear to be less significant contributions from Site activities. The identified IHS for the Site are benzene, gasoline-range TPH, diesel-range TPH, and the CVOCs PCE, TCE, and vinyl chloride.

## 7.2 Distribution of IHS in Site Media

### *7.2.1 Petroleum Hydrocarbons Distribution*

Under current conditions, measurable thicknesses of LNAPL are present primarily along the northwestern portion of the 901 property. Soil containing concentrations of gasoline-range TPH with benzene exceeding screening levels occurs across a broad portion of the 709 and 901 properties, and extends west across Alexander Avenue into the 500 property. The highest soil concentrations and greatest lateral extent of these compounds occur within the saturated portion of the 15-foot zone. Soil exceedances of gasoline-range TPH occur throughout the 709 and northern 901 properties, but benzene exceedances are largely limited to the northern portion of the 901 property (former 721 property). The lateral extent of diesel- + oil-range TPH concentrations in soil exceeding screening levels is similar to that for gasoline-range TPH.

The soil screening levels for TPH and benzene are based on groundwater protection, applying conservative MTCA-default assumptions regarding LNAPL mobility and contaminant attenuation and assuming a standard point of compliance for groundwater. The soil concentrations of the toxic components in the Site TPH mixtures (e.g., benzene and cPAHs) do not pose a direct contact risk for the Site’s industrial use because they are below industrial cleanup standards. For TPH mixtures containing gasoline, Ecology (2015) guidance for applying model remedies identifies a 1,500 mg/kg soil screening level for unrestricted direct contact, but no corresponding soil screening level for industrial direct contact. MTCA Method C (industrial direct contact) soil cleanup levels for benzene and cPAHs (benzo(a)pyrene) are both 130 times higher than the respective Method B (unrestricted direct contact) soil cleanup levels due to differences in the reasonable maximum exposure assumptions. Although a Site-specific TPH screening level(s) for the direct contact pathway has not been developed, the Site soil concentrations of gasoline-range TPH (up to 9,700 mg/kg) and diesel- + oil-range TPH (up to 54,000 mg/kg) may be protective of industrial direct contact. Notwithstanding a potential calculated Method C direct contact value, the soil concentration must still be protective of dissolved components in groundwater, and must not be above residual saturation concentrations.

For groundwater within the 15-foot zone, the extents of gasoline-range TPH and benzene exceedances are similar to their extents in saturated soil: encompassing a broad portion of the 709 property and northern portion of 901 property (TPH exceedances occur farther north than do benzene exceedances), and extending west into the 505 property. To the west, the groundwater gasoline-range TPH and benzene exceedances are laterally bound more than 300 feet from the Blair Waterway. To the east, exceedances are detected in upland wells along the Hylebos Waterway shoreline on the 901 property, but not in any of the shoreline seeps representing groundwater discharge.

There is a substantial difference in the interpreted extents of diesel- + oil-range TPH in 15-foot-zone groundwater based on interpreting data with SGC versus without SGC. Using data without SGC, which includes non-petroleum polar compounds, the interpreted lateral extent of diesel- + oil-range TPH is very similar to that of gasoline-range TPH, except that there are exceedances also detected in two intertidal seeps along the shoreline on the northern portion of the 901 property. Using data with SGC, the interpreted extent of diesel- + oil-range TPH exceedances is limited to the eastern portion of the 709 and 901 properties and extending just into the 505 property to the west; there are no exceedances detected within 400 feet of the Hylebos Waterway.

For groundwater within the 25-foot zone, the extent of benzene exceedances is considerably larger than that in the 15-foot zone, but the extent of gasoline-range TPH is considerably smaller (just the northwestern portion of the 901 property). The highest benzene concentrations generally occur along the northwest portion of the 901 property, beneath Alexander Avenue, and approximately 400 feet into the 505 property. The 25-foot-zone benzene exceedances extend to shoreline wells along the Blair and Hylebos Waterways, with higher concentrations detected along the Hylebos shoreline; however, no benzene exceedances were detected in three intertidal piezometers installed in the Hylebos Waterway and screened in the elevation interval of the 25-foot zone.

Using data without SGC, diesel- + oil-range TPH exceedances in the 25-foot zone occur across much of the 901 property and the southern portion of the 709 property; the exceedances occur in shoreline wells on the 901 property. Using data with SGC, there are no groundwater diesel- + oil-range TPH exceedances in the 25-foot zone, indicating that the bulk of the detectable "TPH" is likely polar organics (petroleum breakdown products), which the available literature indicates have substantially lower toxicity than petroleum hydrocarbons (Zemo, 2013).

The groundwater TPH and benzene exceedances are generally vertically bounded to the 25-foot zone, except for benzene exceedances detected within a localized area of the 50-foot zone in the 901 property. No benzene exceedances are detected in the 50-foot zone within approximately 350 feet of the Hylebos Waterway.

Samples of Hylebos Waterway sediment collected along the east edge of the Site contained detectable diesel- and oil-range TPH (up to 1,250 mg/kg) and HPAH concentrations exceeding SQOs. The five sediment samples with highest detected hydrocarbon concentrations passed confirmatory biological testing.

### 7.2.2 CVOCs Distribution

In unsaturated soil above the water table, the highest concentrations of PCE and TCE occur within the embankment fill on the 605 and 709 properties. Lower concentrations of PCE have been sporadically detected in soil across the 709 and 901 properties.

In 15-foot-zone groundwater, PCE, TCE, and/or VC exceedances occur on the 605 property, the northwestern and eastern portions of the 709 property, and the northeast portion of the 901 property. The general distribution of the individual CVOCs is consistent with reductive dechlorination occurring as groundwater migrates toward the southeast, with PCE exceedances extending furthest north, TCE exceedances occurring predominantly on the 709 property and 901 property, and VC exceedances generally limited to the northern portion of the 901 property. The groundwater pH data also indicates a southeastward migration of alkalinity derived from the OCC site.

Of the three CVOCs in 15-foot-zone groundwater, TCE has the greatest lateral extent posing a vapor intrusion risk – encompassing much of the eastern half of both the 709 property and northern 901 property. In terms of surface water protection, concentrations of one or more of the CVOCs exceed screening levels for surface water protection at selected shoreline wells on the 709 and northern 901 properties, but only VC exceeds its screening level at two of three intertidal piezometer locations. TCE and VC were detected at one historical seep sample on the northern portion of the 901 property. None of the CVOCs exceed screening levels at the three intertidal seep locations on the 901 property sampled during the RI.

In 25-foot-zone groundwater, for which vapor intrusion is not considered, the extent of VC exceedances (surface water protection screening level) encompasses the extents of PCE and TCE exceedances. The VC exceedances occur across much of the 709 property and the northwestern corner of the 901 property, and extend west across the Alexander Avenue right-of-way into the eastern portion of the 500 property. VC is the only CVOC exceeding screening levels at wells along the Hylebos Waterway shoreline, which are located within the footprint of the embankment fill. VC exceeded its screening level at one subtidal porewater sample location offshore of the embankment fill, in the northeast corner of the 709 property, but not at the subtidal piezometer locations on the 709 and 901 properties.

The majority of cVOCs detections in soil and groundwater, particularly those on the 605 and 709 properties, appear likely to be associated with the OCC site. Some detections of cVOCs in soil within the former tank farm footprints, particularly in the northeast portion of the 901 property, are not contiguous with the OCC site and are likely from historical Site operations. However, the soil detections in the northeast portion of the 901 property are sporadically distributed, low level, and do not appear to significantly impact groundwater quality.

## 7.3 Fate and Transport of IHS

Site IHS in petroleum products released at the former tank farm facilities can be transported or destroyed via a number of mechanisms. LNAPL is relatively immobile at the Site based on LNAPL measurements and recoverability testing; however, hydrocarbon constituents in LNAPL or absorbed to soil may dissolve into groundwater and be transported via groundwater flow towards neighboring surface water receptors (the Hylebos Waterway to the east, and the Blair Waterway to the west)[23]. Volatile contaminants in soil, LNAPL, or groundwater may also volatilize into soil gas and be transported via pressure gradients towards the ground surface and into ambient air.

In nearshore areas of the Site, the tidal fluctuations propagate inland within the water-bearing units, as measured during site water level monitoring. These processes affect the behavior of nearshore groundwater and porewater within sediments by inducing twice daily reversals in flow directions, thus increasing groundwater flow path length and hydrodynamic dispersion, as well as circulating oxygenated, sulfate-rich seawater into the nearshore water-bearing unit. These natural processes create a hydraulically and geochemically dynamic nearshore environment that contributes to substantial natural attenuation[24] of contaminants discharging to the Waterways; the attenuation is measured empirically by a reduction in contaminant concentrations in shoreline seeps relative to those measured in upland wells. The only IHS detected above screening levels in the shoreline seeps is diesel- + oil-range TPH when measured without using SGC in the laboratory analysis; there are no diesel- + oil-range TPH exceedances measured in the seeps when using SGC in the analysis. Benzene and gasoline-range TPH were also detected in the seep samples, but detections were below the screening level.

Contaminants may be converted via chemical or biological processes into other chemicals and ultimately mineralized via metabolic pathways to carbon dioxide. Biodegradation processes contributing to the natural attenuation of petroleum hydrocarbons and chlorinated VOCs at the Site are described below.

### 7.3.1 Biodegradation of Petroleum Hydrocarbons

Natural attenuation of petroleum hydrocarbons, including biodegradation and mineralization of the compounds, is a well-documented process that occurs to some degree at all petroleum sites due to the presence of indigenous microorganisms that consume petroleum compounds. As part of the RI, groundwater monitoring for geochemical indicators of the biodegradation component of natural attenuation was conducted at a subset of 11 monitoring wells located across the Site. The eleven monitoring wells were located along two separate east-west transects: one along the 709 property and one along northern portion of the 901 property. Geochemical data pertinent to understanding biodegradation processes, including dissolved oxygen, nitrate/nitrite, sulfate, alkalinity, dissolved manganese, and methane, are summarized on Figure 7-1.

The geochemical indicators are generally consistent with on-going biodegradation of petroleum hydrocarbons: low or non-detect levels of electron acceptors (including dissolved oxygen, nitrate/nitrite, and sulfate) within the area of petroleum impacts and elevated alkalinity, dissolved manganese, and methane which are generated during anaerobic biodegradation of hydrocarbons. The one exception is that, close to the

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[23] Utility lines and surrounding bedding can create preferential pathways for LNAPL and contaminated groundwater migration. However, with the exception of the sanitary sewer line in Alexander Avenue, Site utilities, including stormwater lines and outfalls on the 901 property, are believed to be located above the water table and present limited opportunities for preferential groundwater migration.

[24] Natural attenuation includes biodegradation, sorption, volatilization, dispersion, and dilution.

shoreline, high concentrations of sulfate were observed in several wells, which is attributable to seawater intrusion. The contribution of sulfate from seawater intrusion enhances biodegradation of petroleum via sulfate-reducing metabolic processes and is a likely contributor to the significant natural attenuation of petroleum hydrocarbons observed along the shoreline.

Ongoing biodegradation of petroleum compounds is also indicated by the high concentration of polar compounds in and downgradient of petroleum-contaminated areas, as measured by TPH analyses with and without SGC. As discussed in Section 6.1.2.1, many of these polar compounds are likely biodegradation products of petroleum hydrocarbons.

### 7.3.2 Biodegradation of Chlorinated VOCs

Chlorinated VOCs, including PCE, TCE, and VC, also undergo natural attenuation processes including biodegradation. Based on the geochemical indicators described above, conditions conducive to biodegradation of PCE and TCE (i.e., highly reducing conditions) are present at the Site. Evidence of biodegradation of chlorinated VOCs is also shown by the presence of cis-1,2-dichloroethene (DCE)[25] and VC, both being biodegradation products of PCE and TCE. Under reducing conditions, PCE is transformed through reductive dechlorination to TCE, then to cis-dichloroethene, and then VC. VC may be further dechlorinated under reducing conditions to ethene or aerobically degraded if conditions are sufficiently oxidizing.

The presence of petroleum contamination can be an enhancement to natural attenuation of chlorinated VOCs, not only through the creation of reducing conditions conducive for reductive dechlorination but also through the process of cometabolism. This relationship, coupled with the generally low concentrations of chlorinated VOCs present at and around the Site, likely explains why the chlorinated VOC plumes slightly overlap the petroleum plumes but are not extensively commingled.

## 7.4 Potentially Complete Exposure Pathways and Receptors

The Site qualifies as an industrial property under MTCA. Under the current and future industrial land use of the Site, the following potentially complete exposure pathways and receptors are identified:

- Marine benthic and aquatic organisms in the Hylebos and Blair Waterways, if contaminants migrate and discharge to surface water via groundwater;
- Fisherpersons consuming benthic and/or aquatic organisms which could be impacted if contaminants migrate and discharge to surface water;
- Occasional industrial Site workers who could be exposed to contaminated soil and/or groundwater (incidental ingestion, dermal contact) or could inhale volatilized contaminants from unsaturated soils or groundwater during construction, maintenance, and/or utility work; and

[25] Present in groundwater at some wells at concentrations below its screening level, therefore not discussed in Section 6.

- On-site office and warehouse workers that could be exposed to contaminants in indoor air if groundwater or soil contaminants volatilize and migrate into indoor work areas via VI.

Based on the collected data, it is likely that Site contamination is not posing an unacceptable risk to human health or the environment under the current Site use, for the following reasons:

- Concentrations of COCs in groundwater discharging to adjacent waterways (seep samples) are generally below surface water protection-based screening levels. The exception is concentrations of TPH (without SGC) that slightly exceeded ecological and/or human health-based screening levels in two seep samples. However, as discussed in Section 6, these screening levels are likely highly conservative if applied without SGC.

- Storm sewer lines are higher in elevation than seasonally high groundwater levels (Figure 3.2-2), making groundwater infiltration and transport to surface water through storm sewer lines improbable.

- Site buildings are not considered a VI concern. The former Navy Warehouse building on the 901 property is located south of the area of groundwater contamination exceeding VI-based screening levels. The northern warehouse on that property occurs within the footprint of groundwater exceeding VI-based screening level, but it is not constructed for occupancy and consists of an uninsulated steel shed above pavement. There are no offices, bathrooms, or other enclosed spaces and no HVAC system to create pressure differential between the air and the subsurface. The building is currently vacant and is planned for being used for storage only. The building would only be occupied by workers when moving materials in or out..

- Access to contaminated soils and groundwater is limited by pavement on the 901 and 500 properties and the City right-of-way, and fences and locked gates restrict access to the 901 and 709 properties. The 709 property is vacant and will likely remain so in the foreseeable future.

Nevertheless, Site contamination exceeds soil and groundwater screening levels over portions of four properties (709, 901, 1001, and 500 properties) and the Alexander Avenue right-of-way. There is a potential for exposure to workers accessing underground utilities, subsurface construction for future development, or to utility workers from contaminants migrating into the sanitary sewer line in Alexander Avenue, which is below the water table within the groundwater plume. Additional actions may be warranted to comply with MTCA requirements and protect potential exposure pathways in the future. The FS will identify remedial action objectives and potential cleanup standards, develop and evaluate a range of remedial alternatives, and propose a cleanup action for the Site.

## 7.5 Data Gaps for Conducting the FS

In general, the data collected during the RI field program address the data gaps identified in the *RI/FS Work Plan*. However, to assist in preparing the FS, additional data for Site IHSs at selected monitoring wells and seeps were collected in December 2015, February

2016, May 2016, and July 2016 to further evaluate long-term trends in contaminant concentrations. That data will be presented in the FS and used to evaluate plume stability and estimate restoration time frames in accordance with Ecology's Guidance on Remediation of Petroleum-Contaminated Ground Water by Natural Attenuation (Ecology, 2005).

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# TABLES

# Table 5-1 - Calculation Parameters for Site Screening Levels

Project No. 130097, Alexander Avenue Petroleum Tank Facilities Site
Tacoma, Washington

| | | Parameters for Cross-Media Calculations | | | | | | | | Toxicological Parameters | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CAS | Potential Chemical of Concern | Henry's Law constant (13C)[1] | Kd (Soil) | Kd (Sediment) | Foc (Soil) (g/g) | Foc (Sediment) (g/g) | Koc | BCF | CB/NT SQO (mg/kg) | CPFo | RfDo | CPFi | RfDi | Inhalation Correction Factor | TEQ Multiplier |
| | **Petroleum Hydrocarbons** | | | | | | | | | | | | | | |
| na | Gasoline | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| na | Diesel + Heavy Oil | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| | **Volatile Organics** | | | | | | | | | | | | | | |
| 67-64-1 | Acetone | 9.72E-04 | 0.00048 | 0.00648516 | 0.0008 | 0.011 | 0.575 | -- | -- | -- | 0.9 | -- | 8.85714 | 2 | -- |
| 107-13-1 | Acrylonitrile | 2.02E-03 | 0.00757 | 0.10150687 | 0.0008 | 0.011 | 9 | 30 | -- | 0.54 | 0.04 | 0.238 | 0.00057 | 2 | -- |
| 71-43-2 | Benzene | 1.33E-01 | 0.05216 | 0.69926958 | 0.0008 | 0.011 | 62 | 5.2 | -- | 0.055 | 0.004 | 0.0273 | 0.00857 | 2 | -- |
| 67-66-3 | Chloroform | 9.17E-02 | 0.04459 | 0.59776271 | 0.0008 | 0.011 | 53 | 3.75 | -- | 0.031 | 0.01 | 0.0805 | 0.028 | 2 | -- |
| 107-06-2 | Dichloroethane -1,2 (EDC) | 2.28E-02 | 0.03197 | 0.42858458 | 0.0008 | 0.011 | 38 | 1.2 | -- | 0.091 | 0.006 | 0.091 | 0.002 | 2 | -- |
| 156-59-2 | Dichloroethene - cis 1,2 | 1.01E-01 | 0.02987 | 0.40038823 | 0.0008 | 0.011 | 36 | -- | -- | -- | 0.002 | -- | -- | 2 | -- |
| 156-60-5 | Dichloroethene - trans 1,2 | 2.42E-01 | 0.03197 | 0.42858458 | 0.0008 | 0.011 | 38 | 1.58 | -- | -- | 0.02 | -- | -- | 2 | -- |
| 75-35-4 | Dichloroethene -1,1 | 7.07E-01 | 0.05469 | 0.73310521 | 0.0008 | 0.011 | 65 | 5.6 | -- | -- | 0.05 | -- | 0.05714 | 2 | -- |
| 100-41-4 | Ethylbenzene | 1.65E-01 | 0.17164 | 2.3008225 | 0.0008 | 0.011 | 204 | 37.5 | 0.01 | -- | 0.1 | -- | 0.28571 | 2 | -- |
| 98-82-8 | Isopropylbenzene | 2.48E-01 | -- | -- | 0.0008 | 0.011 | -- | -- | -- | -- | 0.1 | -- | 0.11429 | 2 | -- |
| 75-09-2 | Methylene Chloride | 5.68E-02 | 0.00841 | 0.11278542 | 0.0008 | 0.011 | 10 | 0.9 | -- | 0.002 | 0.006 | 0.000035 | 0.17143 | 2 | |
| 104-51-8 | n-Butylbenzene | -- | -- | -- | 0.0008 | 0.011 | -- | -- | -- | -- | 0.05 | -- | -- | 2 | -- |
| 103-65-1 | n-propylbenzene | 1.92E-01 | -- | -- | 0.0008 | 0.011 | -- | -- | -- | -- | 0.1 | -- | 0.28571 | 2 | -- |
| 99-87-6 | p-Isopropyltoluene | A | A | A | 0.0008 | 0.011 | A | A | -- | A | A | A | A | A | -- |
| 135-98-8 | sec-Butylbenzene | -- | -- | -- | 0.0008 | 0.011 | -- | -- | -- | -- | 0.1 | -- | -- | 2 | -- |
| 127-18-4 | Tetrachlolorethene (PCE) | 4.00E-01 | 0.22296 | 2.98881354 | 0.0008 | 0.011 | 265 | 31 | 0.057 | 0.0021 | 0.006 | 0.00091 | 0.01143 | 2 | -- |
| 79-34-5 | Tetrachloroethane-1,1,2,2 | 7.22E-03 | 0.06647 | 0.89100479 | 0.0008 | 0.011 | 79 | 5 | -- | 0.2 | 0.02 | 0.203 | -- | 2 | -- |
| 108-88-3 | Toluene | 1.48E-01 | 0.11779 | 1.57899583 | 0.0008 | 0.011 | 140 | 10.7 | -- | -- | 0.08 | -- | 1.42857 | 2 | -- |
| 79-01-6 | Trichloroethene (TCE) | 2.40E-01 | 0.07909 | 1.06018292 | 0.0008 | 0.011 | 94 | 11 | -- | Guidance | 0.0005 | Guidance | 0.00057 | 2 | -- |
| 95-63-6 | Trimethylbenzene -1,2,4 | 1.10E-01 | -- | -- | 0.0008 | 0.011 | -- | -- | -- | -- | -- | -- | 0.002 | 2 | -- |
| 108-67-8 | Trimethylbenzene-1,3,5 | -- | -- | -- | 0.0008 | 0.011 | -- | -- | -- | -- | 0.01 | -- | -- | 2 | -- |
| 75-01-4 | Vinyl Chloride | 8.10E-01 | 0.01565 | 0.20978087 | 0.0008 | 0.011 | 18.6 | 1.17 | -- | 1.5 | 0.003 | 0.031 | 0.02857 | 2 | -- |
| 1330-20-7 | Xylenes (Total) | 1.03E-01 | 0.19604 | 2.62790021 | 0.0008 | 0.011 | 233 | -- | 0.04 | -- | 0.2 | -- | 0.02857 | 2 | -- |

# Table 5-1 - Calculation Parameters for Site Screening Levels

Project No. 130097, Alexander Avenue Petroleum Tank Facilities Site
Tacoma, Washington

| | | Parameters for Cross-Media Calculations | | | | | | | | Toxicological Parameters | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CAS | Potential Chemical of Concern | Henry's Law constant (13C)[1] | Kd (Soil) | Kd (Sediment) | Foc (Soil) (g/g) | Foc (Sediment) (g/g) | Koc | BCF | CB/NT SQO (mg/kg) | CPFo | RfDo | CPFi | RfDi | Inhalation Correction Factor | TEQ Multiplier |
| | **Semivolatile Organics** | | | | | | | | | | | | | | |
| 117-81-7 | Bis-2ethylhexyl Phthalate | 6.43E-07 | 93 | 1253 | 0.0008 | 0.011 | 111123 | 130 | 1.3 | 0.014 | 0.02 | 0.0084 | -- | 1 | -- |
| 86-74-8 | Carbazole | 1.70E-07 | 2.9 | 38 | 0.0008 | 0.011 | 3390 | -- | -- | -- | -- | -- | -- | 1 | -- |
| 132-64-9 | Dibenzofuran | -- | -- | -- | 0.0008 | 0.011 | -- | -- | 0.54 | -- | 0.001 | -- | -- | 1 | -- |
| 84-66-2 | Diethyl Phthalate | 4.66E-06 | 0.069 | 0.92 | 0.0008 | 0.011 | 82 | 73 | 0.2 | -- | 0.8 | -- | -- | 1 | -- |
| 131-11-3 | Dimethyl Phthalate | -- | -- | -- | 0.0008 | 0.011 | -- | 36 | 0.16 | -- | -- | -- | -- | 1 | -- |
| 87-68-3 | Hexachloro 1,3-butadiene | 1.38E-01 | 45 | 606 | 0.0008 | 0.011 | 53700 | 2.78 | 0.011 | 0.078 | 0.001 | 0.077 | -- | 2 | -- |
| 118-74-1 | Hexachlorobenzene | 1.36E-02 | 67 | 902 | 0.0008 | 0.011 | 80000 | 8690 | 0.022 | 1.6 | 0.0008 | 1.61 | -- | 1 | -- |
| 87-86-5 | Pentachlorophenol | 2.04E-07 | 0.50 | 6.7 | 0.0008 | 0.011 | 592 | 11 | 0.36 | 0.4 | 0.005 | 0.01785 | -- | 1 | -- |
| 108-95-2 | Phenol | 6.75E-06 | 0.024 | 0.32 | 0.0008 | 0.011 | 29 | 1.4 | 0.42 | -- | 0.3 | -- | 0.057 | 2 | -- |
| | **cPAHs** | | | | | | | | | | | | | | |
| 56-55-3 | Benzo(a)anthracene | 2.79E-05 | 301 | 4032 | 0.0008 | 0.011 | 357537 | 30 | 1.6 | 0.73 | -- | 0.385 | -- | 1 | 0.1 |
| 50-32-8 | Benzo(a)pyrene | 6.18E-06 | 815 | 10926 | 0.0008 | 0.011 | 968774 | 30 | 1.6 | 7.3 | -- | 3.85 | -- | 1 | 1 |
| 205-99-2 | Benzo(b)fluoranthene | 7.51E-04 | 1035 | 13873 | 0.0008 | 0.011 | 1230000 | 30 | 3.6 | 0.73 | -- | 0.385 | -- | 1 | 0.1 |
| 207-08-9 | Benzo(k)fluoranthene | 5.22E-06 | 1035 | 13873 | 0.0008 | 0.011 | 1230000 | 30 | 3.6 | 0.073 | -- | 0.385 | -- | 1 | 0.1 |
| 218-01-9 | Chrysene | 7.37E-04 | 335 | 4489 | 0.0008 | 0.011 | 398000 | 30 | 2.8 | 0.0073 | -- | 0.0385 | -- | 1 | 0.01 |
| 53-70-3 | Dibenz(a,h)anthracene | 2.41E-08 | 1505 | 20178 | 0.0008 | 0.011 | 1789101 | 30 | 0.23 | 7.3 | -- | 4.2 | -- | 1 | 0.1 |
| 193-39-5 | Indeno(1,2,3-cd)pyrene | 8.15E-06 | 2920 | 39137 | 0.0008 | 0.011 | 3470000 | 30 | 0.69 | 0.73 | -- | 0.385 | -- | 1 | 0.1 |
| na | cPAH (TEQ) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| | **Other PAHs** | | | | | | | | | | | | | | |
| 208-96-8 | Acenaphthylene | -- | -- | -- | 0.0008 | 0.011 | -- | -- | 1.3 | -- | -- | -- | -- | 1 | -- |
| 83-32-9 | Acenaphthene | 2.13E-03 | 4.1 | 55.2 | 0.0008 | 0.011 | 4898 | 242 | 0.5 | -- | 0.06 | -- | -- | 1 | -- |
| 120-12-7 | Anthracene | 7.76E-04 | 20 | 265 | 0.0008 | 0.011 | 23493 | 30 | 0.96 | -- | 0.3 | -- | -- | 1 | -- |
| 191-24-2 | Benzo(g,h,i)perylene | -- | -- | -- | 0.0008 | 0.011 | -- | -- | 0.72 | -- | -- | -- | -- | 1 | -- |
| 206-44-0 | Fluoranthene | 1.66E-04 | 41 | 554 | 0.0008 | 0.011 | 49096 | 1150 | 2.5 | -- | 0.04 | -- | -- | 1 | -- |
| 86-73-7 | Fluorene | 8.74E-04 | 6.5 | 86.9 | 0.0008 | 0.011 | 7707 | 30 | 0.54 | -- | 0.04 | -- | -- | 2 | -- |
| 90-12-0 | Methylnaphthalene-1 | -- | -- | -- | 0.0008 | 0.011 | -- | -- | -- | 0.029 | 0.07 | -- | -- | 2 | -- |
| 91-57-6 | Methylnaphthalene-2 | -- | 57.2062 | 766.850605 | 0.0008 | 0.011 | 67992 | -- | 0.67 | -- | 0.004 | -- | -- | 2 | -- |
| 91-20-3 | Naphthalene | 8.20E-03 | 1.0 | 13.4 | 0.0008 | 0.011 | 1191 | 10.5 | 2.1 | -- | 0.02 | 0.119 | 0.00086 | 2 | -- |
| 85-01-8 | Phenanthrene | -- | -- | -- | 0.0008 | 0.011 | -- | -- | 1.5 | -- | -- | -- | -- | 1 | -- |
| 129-00-0 | Pyrene | 1.06E-04 | 57 | 767 | 0.0008 | 0.011 | 67992 | 30 | 3.3 | -- | 0.03 | -- | -- | 1 | -- |

# Table 5-1 - Calculation Parameters for Site Screening Levels

Project No. 130097, Alexander Avenue Petroleum Tank Facilities Site
Tacoma, Washington

| | | Parameters for Cross-Media Calculations | | | | | | | | Toxicological Parameters | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CAS | Potential Chemical of Concern | Henry's Law constant (13C)[1] | Kd (Soil) | Kd (Sediment) | Foc (Soil) (g/g) | Foc (Sediment) (g/g) | Koc | BCF | CB/NT SQO (mg/kg) | CPFo | RfDo | CPFi | RfDi | Inhalation Correction Factor | TEQ Multiplier |
| | **Metals** | | | | | | | | | | | | | | |
| | **Heavy Metals** | | | | | | | | | | | | | | |
| 7440-38-2 | Arsenic | -- | 29 | 29 | 0.0008 | 0.011 | -- | 44 | 57 | 1.5 | 0.0003 | 15.05 | 4.3E-06 | 1 | -- |
| 7440-50-8 | Copper | -- | 22 | 22 | 0.0008 | 0.011 | -- | 36 | 390 | -- | 0.04 | -- | -- | 1 | -- |
| 7439-92-1 | Lead | -- | 10000 | 10000 | 0.0008 | 0.011 | -- | -- | 450 | -- | -- | -- | -- | 1 | -- |
| 7440-02-0 | Nickel | -- | 65 | 65 | 0.0008 | 0.011 | -- | 47 | 140 | -- | 0.02 | 0.91 | 2.6E-05 | 1 | -- |
| 7440-66-6 | Zinc | -- | 62 | 62 | 0.0008 | 0.011 | -- | 47 | 410 | -- | 0.3 | -- | -- | 1 | -- |
| | **Organometals** | | | | | | | | | | | | | | |
| 78-00-2 | Tetraethyl Lead | -- | -- | -- | 0.0008 | 0.011 | -- | -- | -- | -- | 1.0E-07 | -- | -- | 2 | -- |

**Notes:**
A: Chemical is not present in CLARC Database as of 2/6/2016.
1: Temperature corrected Henry's Law Constant not provided in CLARC database. Henry's law value adjusted to 13C in accordance with EPA (2001) Fact Sheet: Correcting the Henry's Law Constant for Soil Temperature.

BCF = bioconcentration factor
CB/NT SQO = Commencement Bay/ Nearshore Tideflats Sediment Quality Objective
cPAH = carcinogenic polycyclic aromatic hydrocarbon
CPFi = cancer potency factor, inhalation
CPFo = cancer potency factor, oral
Foc = fraction organic carbon
g/g = gram per gram
Kd = soil-water partition coefficient
Koc = soil organic carbon-water partition coefficient
mg/kg = milligrams per kiligram
PAH = polycyclic aromatic hydrocarbon
RfDo = reference dose, oral
TEQ = toxicity equivalent quotient

# Table 5-2 - Sediment Quality Objectives

Project No. 130097, Alexander Avenue Petroleum Tank Facilities Site
Tacoma, Washington

| CAS | | | CB/NT SQO (mg/kg) |
|---|---|---|---|
| **Petroleum Hydrocarbon Mixtures** | | | |
| na | | Gasoline | -- |
| na | | Diesel + Heavy Oil | -- |
| **Volatile Organics** | | | |
| 67-64-1 | | Acetone | -- |
| 107-13-1 | | Acrylonitrile | -- |
| 71-43-2 | | Benzene | -- |
| 67-66-3 | | Chloroform | -- |
| 107-06-2 | | Dichloroethane -1,2 (EDC) | -- |
| 156-59-2 | | Dichloroethene - cis 1,2 | -- |
| 156-60-5 | | Dichloroethene - trans 1,2 | -- |
| 75-35-4 | | Dichloroethene -1,1 | -- |
| 100-41-4 | | Ethylbenzene | 0.01 |
| 98-82-8 | | Isopropylbenzene | -- |
| 75-09-2 | | Methylene Chloride | -- |
| 104-51-8 | | n-Butylbenzene | -- |
| 103-65-1 | | n-propylbenzene | -- |
| 99-87-6 | | p-Isopropyltoluene | -- |
| 135-98-8 | | sec-Butylbenzene | -- |
| 127-18-4 | | Tetrachlolorethene (PCE) | 0.057 |
| 79-34-5 | | Tetrachloroethane-1,1,2,2 | -- |
| 108-88-3 | | Toluene | -- |
| 79-01-6 | | Trichloroethene (TCE) | -- |
| 95-63-6 | | Trimethylbenzene-1,2,4 | -- |
| 108-67-8 | | Trimethylbenzene-1,3,5 | -- |
| 75-01-4 | | Vinyl Chloride | -- |
| 1330-20-7 | | Xylenes (Total) | 0.04 |
| **Semivolatile Organics** | | | |
| 117-81-7 | | Bis-2ethylhexyl Phthalate | 1.3 |
| 86-74-8 | | Carbazole | -- |
| 132-64-9 | | Dibenzofuran | 0.54 |
| 84-66-2 | | Diethyl Phthalate | 0.2 |
| 131-11-3 | | Dimethyl Phthalate | 0.16 |
| 87-68-3 | | Hexachloro 1,3-butadiene | 0.011 |
| 118-74-1 | | Hexachlorobenzene | 0.022 |
| 87-86-5 | | Pentachlorophenol | 0.36 |
| 108-95-2 | | Phenol | 0.42 |

# Table 5-2 - Sediment Quality Objectives

Project No. 130097, Alexander Avenue Petroleum Tank Facilities Site
Tacoma, Washington

| CAS | | | CB/NT SQO (mg/kg) |
|---|---|---|---|
| **PAHs** | | | |
| na | | Low Molecular Weight PAH (LPAH) | 5.2 |
| 91-20-3 | | Naphthalene | 2.1 |
| 208-96-8 | | Acenaphthylene | 1.3 |
| 83-32-9 | | Acenaphthene | 0.5 |
| 120-12-7 | | Anthracene | 0.96 |
| 86-73-7 | | Fluorene | 0.54 |
| 85-01-8 | | Phenanthrene | 1.5 |
| 91-57-6 | | Methylnaphthalene-2 | 0.67 |
| 90-12-0 | | Methylnaphthalene-1 | -- |
| na | | High Molecular Weight PAH (HPAH) | 17 |
| 206-44-0 | | Fluoranthene | 2.5 |
| 129-00-0 | | Pyrene | 3.3 |
| 56-55-3 | | Benzo(a)anthracene | 1.6 |
| 218-01-9 | | Chrysene | 2.8 |
| 205-99-2 | | Benzo(b)fluoranthene | 3.6 |
| 207-08-9 | | Benzo(k)fluoranthene | 3.6 |
| 50-32-8 | | Benzo(a)pyrene | 1.6 |
| 193-39-5 | | Indeno(1,2,3-cd)pyrene | 0.69 |
| 53-70-3 | | Dibenz(a,h)anthracene | 0.23 |
| 191-24-2 | | Benzo(g,h,i)perylene | 0.72 |
| na | | cPAH (TEQ) | -- |
| **Metals** | | | |
| | | **Inorganic Metals** | |
| 7440-38-2 | | Arsenic | 57 |
| 7440-50-8 | | Copper | 390 |
| 7439-92-1 | | Lead | 450 |
| 7440-02-0 | | Nickel | 140 |
| 7440-66-6 | | Zinc | 410 |
| | | **Organometals** | |
| 78-00-2 | | Tetraethyl Lead | -- |

**Notes:**

--: CB/NT SQO not available.

# Table 5-3 - Groundwater Screening Levels

Project No. 130097, Alexander Avenue Petroleum Tank Facilities Site
Tacoma, Washington

| | | Compiled Applicable Screening Values (ug/L) | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Ecological: Marine Toxicity | | | | | Human Health via Marine Water | | | | | | | | Human Health via Indoor Air | | | | | | Screening Levels | | RI Data Memo | |
| | | ARARs | | | TBC | | ARARs | | MTCA Method A | Calculated MTCA Cleanup Levels (applicable if is no sufficiently protective criterion in ARARs) | | | | | | | | | Modifying Factors | | 15 Foot Zone | 25 Foot Zone | 15 Foot Zone | 25 Foot Zone |
| CAS | Potential Chemical of Concern | WA State SW Regs (Ch 173-201A WAC) (chronic) | Clean Water Act Section 304(a) (chronic) | National Toxics Rule (40 CFR 131) (chronic) | EPA Ecotox Database | Lowest Value, Marine Toxicity | Clean Water Act Section 304(a) | National Toxics Rule (40 CFR 131.36) | Table 720-1 WAC 173-340-900 | Method B (Carcinogen) | Method B (Non-Carcinogen) | Method C (Carcinogen) | Method C (Non-Carcinogen) | Lowest Value, Human Health via Surface Water | Ecology Guidance Screening Level (Method C Carcinogen) | Ecology Guidance Screening Level (Method C Non-Carcinogen) | Lowest Value, Human Health via Indoor Air | Lowest Value, All Receptor Pathways | Puget Sound Natural Back-ground Concen-trations | Practical Quanti-tation Limits (PQLs) | Alexander Avenue Site Groundwater Screening Levels (ug/L) | Alexander Avenue Site Groundwater Screening Levels (ug/L) | Alexander Avenue Site Preliminary Groundwater Screening Levels (ug/L) | Alexander Avenue Site Preliminary Groundwater Screening Levels (ug/L) |
| **Petroleum Hydrocarbon Mixtures** | | | | | | | | | | | | | | | | | | | | | | | | |
| na | Gasoline | -- | -- | -- | -- | -- | -- | -- | 800 | -- | -- | -- | -- | -- | -- | -- | -- | 800 | - | 250 | **800** | **800** | **800** | **800** |
| na | Diesel + Heavy Oil | -- | -- | -- | -- | -- | -- | -- | 500 | -- | -- | -- | -- | -- | -- | -- | -- | 500 | - | 250 | **500** | **500** | **500** | **500** |
| na | Gasoline + Diesel + Oil | -- | -- | -- | 720 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 720 | - | 250 | **720** | **720** | **--** | **--** |
| **Volatile Organics** | | | | | | | | | | | | | | | | | | | | | | | | |
| 67-64-1 | Acetone | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 32000000 | 32000000 | 32000000 | - | 20 | **32000000** | **--** | **--** | **--** |
| 107-13-1 | Acrylonitrile | -- | -- | -- | -- | -- | 7 | 0.66 | -- | 0.4 | 3500 | 10 | 8600 | 0.66 | 180 | 990 | 180 | 0.66 | - | 0.5 | **0.66** | **0.66** | **160** | **--** |
| 71-43-2 | Benzene | -- | -- | -- | -- | -- | 58 | 71 | -- | 23 | 2000 | 570 | 5000 | 58 | 24 | 220 | 24 | 24 | - | 0.5 | **24** | **58** | **24** | **51** |
| 67-66-3 | Chloroform | -- | -- | -- | -- | -- | 2000 | 470 | -- | 55 | 6800 | 1400 | 17000 | 470 | 12 | 1100 | 12 | 12 | - | 0.5 | **12** | **470** | **12** | **470** |
| 107-06-2 | Dichloroethane -1,2 (EDC) | -- | -- | -- | -- | -- | 650 | 99 | -- | 59 | 13000 | 1500 | 32000 | 99 | 42 | 310 | 42 | 42 | - | 0.5 | **42** | **99** | **37** | **37** |
| 156-59-2 | Dichloroethene - cis 1,2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | - | 0.5 | **--** | **--** | **--** | **--** |
| 156-60-5 | Dichloroethene - trans 1,2 | -- | -- | -- | -- | -- | 4000 | -- | -- | -- | 32000 | -- | 81000 | 4000 | -- | -- | -- | 4000 | - | 0.5 | **4000** | **4000** | **250** | **10000** |
| 75-35-4 | Dichloroethene -1,1 | -- | -- | -- | -- | -- | 20000 | 3.2 | -- | -- | 23000 | -- | 58000 | 3.2 | -- | 280 | 280 | 3.2 | - | 0.5 | **3.2** | **3.2** | **3.2** | **3.2** |
| 100-41-4 | Ethylbenzene | -- | -- | -- | -- | -- | 130 | 29000 | -- | -- | 6800 | -- | 17000 | 130 | -- | 6000 | 6000 | 130 | - | 0.5 | **130** | **130** | **4** | **4** |
| 98-82-8 | Isopropylbenzene | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1600 | 1600 | 1600 | - | 2 | **1600** | **--** | **1600** | **--** |
| 75-09-2 | Methylene Chloride | -- | -- | -- | -- | -- | 1000 | 1600 | -- | 3600 | 17000 | 90000 | 43000 | 1000 | 44000 | 11000 | 11000 | 1000 | - | 2 | **1000** | **1000** | **590** | **590** |
| 104-51-8 | n-Butylbenzene | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | - | 0.5 | **--** | **--** | **--** | **--** |
| 103-65-1 | n-Propylbenzene | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5200 | 5200 | 5200 | - | 2 | **5200** | **--** | **--** | **--** |
| 99-87-6 | p-Isopropyltoluene | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.5 | **--** | **--** | **--** | **--** |
| 135-98-8 | sec-Butylbenzene | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | - | 0.5 | **--** | **--** | **--** | **--** |
| 127-18-4 | Tetrachlolorethene (PCE) | -- | -- | -- | -- | -- | 29 | 8.9 | -- | 100 | 500 | 2500 | 1300 | 8.9 | 240 | 100 | 100 | 8.9 | - | 0.5 | **8.9** | **8.9** | **3.3** | **3.3** |
| 79-34-5 | Tetrachloroethane-1,1,2,2 | -- | -- | -- | -- | -- | 3 | 11 | -- | 6.5 | 10000 | 160 | 26000 | 3 | 60 | -- | 60 | 3.0 | - | 0.5 | **3** | **3** | **4.0** | **4.0** |
| 108-88-3 | Toluene | -- | -- | -- | -- | -- | 520 | 200000 | -- | -- | 19000 | -- | 47000 | 520 | -- | 34000 | 34000 | 520 | - | 0.5 | **520** | **520** | **15000** | **15000** |
| 79-01-6 | Trichloroethene (TCE) | -- | -- | -- | -- | -- | 7 | 81 | -- | 13 | 120 | 320 | 290 | 7 | 26 | 8 | 8.3 | 7.0 | - | 0.5 | **7** | **7** | **8.4** | **30** |
| 95-63-6 | Trimethylbenzene-1,2,4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 63 | 63 | 63 | - | 2 | **63** | **--** | **61** | **--** |
| 108-67-8 | Trimethylbenzene-1,3,5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | - | 2 | **--** | **--** | **--** | **--** |
| 75-01-4 | Vinyl Chloride | -- | -- | -- | -- | -- | 1.6 | 530 | -- | 3.7 | 6500 | 84 | 16000 | 1.6 | 5 | 120 | 5 | 1.6 | - | 0.5 | **1.6** | **1.6** | **2.4** | **2.4** |
| 1330-20-7 | Xylenes (Total) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 970 | 970 | 970 | - | 0.5 | **970** | **--** | **9** | **15** |
| **Semivolatile Organics** | | | | | | | | | | | | | | -- | | | | | | | | | | |
| 117-81-7 | Bis-2ethylhexyl Phthalate | -- | -- | -- | -- | -- | 0.37 | 5.9 | -- | 3.6 | 400 | 100 | 1000 | 0.37 | 16000000 | -- | 16000000 | 0.4 | - | 1.0 | **1** | **1** | **1.0** | **1.0** |
| 86-74-8 | Carbazole | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | - | 0.2 | **--** | **--** | **--** | **--** |
| 132-64-9 | Dibenzofuran | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | - | 0.2 | **--** | **--** | **--** | **--** |
| 84-66-2 | Diethyl Phthalate | -- | -- | -- | -- | -- | 600 | 120000 | -- | -- | 28000 | -- | 71000 | 600 | -- | -- | -- | 600 | - | 0.2 | **600** | **600** | **216** | **216** |
| 131-11-3 | Dimethyl Phthalate | -- | -- | -- | -- | -- | 2000 | 2900000 | -- | -- | -- | -- | -- | 2000 | -- | -- | -- | 2000 | - | 0.2 | **2000** | **2000** | **1100000** | **1100000** |
| 87-68-3 | Hexachloro 1,3-butadiene | -- | -- | -- | -- | -- | 0.01 | 50 | -- | 30 | 930 | 740 | 2300 | 0.01 | 8 | -- | 8.2 | 0.01000 | - | 0.2 | **0.2** | **0.2** | **0.2** | **0.2** |
| 118-74-1 | Hexachlorobenzene | -- | -- | -- | -- | -- | 0.000079 | 0.00077 | -- | 0.00047 | 0.24 | 0.012 | 0.6 | 0.000079 | 4 | -- | 4.0 | 0.00008 | - | 0.2 | **0.2** | **0.2** | **0.2** | **0.2** |
| 87-86-5 | Pentachlorophenol | 7.9 | 7.9 | 7.9 | -- | 7.9 | 0.04 | 8.2 | -- | 1.5 | 1200 | 37 | 2900 | 0.04 | 24000000 | -- | 24000000 | 0.04 | - | 1 | **1** | **1** | **3.0** | **3.0** |
| 108-95-2 | Phenol | -- | -- | -- | -- | -- | 300000 | 4600000 | -- | -- | 560000 | -- | 1400000 | 300000 | -- | 30000000 | 30000000 | 300000 | - | 0.5 | **300000** | **300000** | **1300** | **1300** |

**Table 5-3 - Groundwater Screening Levels**
Project No. 130097, Alexander Avenue Petroleum Tank Facilities Site
Tacoma, Washington

| CAS | Potential Chemical of Concern | Compiled Applicable Screening Values (ug/L): Ecological: Marine Toxicity – ARARs – WA State SW Regs (Ch 173-201A WAC) (chronic) | Ecological: Marine Toxicity – ARARs – Clean Water Act Section 304(a) (chronic) | Ecological: Marine Toxicity – ARARs – National Toxics Rule (40 CFR 131) (chronic) | Ecological: Marine Toxicity – TBC – EPA Ecotox Database | Lowest Value, Marine Toxicity | Human Health via Marine Water – ARARs – Clean Water Act Section 304(a) | Human Health via Marine Water – ARARs – National Toxics Rule (40 CFR 131.36) | Human Health via Marine Water – MTCA Method A – Table 720-1 WAC 173-340-900 | Calculated MTCA Cleanup Levels (applicable if is no sufficiently protective criterion in ARARs) – Method B (Carcinogen) | Method B (Non-Carcinogen) | Method C (Carcinogen) | Method C (Non-Carcinogen) | Lowest Value, Human Health via Surface Water | Human Health via Indoor Air – Ecology Guidance Screening Level (Method C Carcinogen) | Ecology Guidance Screening Level (Method C Non-Carcinogen) | Lowest Value, Human Health via Indoor Air | Lowest Value, All Receptor Pathways | Modifying Factors – Puget Sound Natural Back-ground Concen-trations | Modifying Factors – Practical Quanti-tation Limits (PQLs) | Screening Levels – 15 Foot Zone – Alexander Avenue Site Groundwater Screening Levels (ug/L) | Screening Levels – 25 Foot Zone – Alexander Avenue Site Groundwater Screening Levels (ug/L) | RI Data Memo – 15 Foot Zone – Alexander Avenue Site Preliminary Groundwater Screening Levels (ug/L) | RI Data Memo – 25 Foot Zone – Alexander Avenue Site Preliminary Groundwater Screening Levels (ug/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **cPAHs** | | | | | | | | | | | | | | | | | | | | | | | |
| 56-55-3 | Benzo(a)anthracene | -- | -- | -- | -- | -- | 0.0013 | 0.031 | -- | 0.3 | -- | 10 | -- | 0.0013 | 8100 | -- | 8100 | 0.001 | - | 0.02 | **0.02** | **0.02** | **0.02** | **0.02** |
| 50-32-8 | Benzo(a)pyrene | -- | -- | -- | -- | -- | 0.00013 | 0.031 | -- | 0.03 | -- | 0.74 | -- | 0.00013 | 3700 | -- | 3700 | 0.000 | - | 0.02 | **0.02** | **0.02** | **0.02** | **0.02** |
| 205-99-2 | Benzo(b)fluoranthene | -- | -- | -- | -- | -- | 0.0013 | 0.031 | -- | 0.3 | -- | 7.4 | -- | 0.0013 | 300 | -- | 300 | 0.001 | - | 0.02 | **0.02** | **0.02** | **0.02** | **0.02** |
| 207-08-9 | Benzo(k)fluoranthene | -- | -- | -- | -- | -- | 0.013 | 0.031 | -- | 3 | -- | 74 | -- | 0.013 | 44000 | -- | 44000 | 0.013 | - | 0.02 | **0.02** | **0.02** | **0.02** | **0.02** |
| 218-01-9 | Chrysene | -- | -- | -- | -- | -- | 0.13 | 0.031 | -- | 30 | -- | 740 | -- | 0.031 | 3100 | -- | 3100 | 0.031 | - | 0.02 | **0.03** | **0.031** | **0.02** | **0.02** |
| 53-70-3 | Dibenz(a,h)anthracene | -- | -- | -- | -- | -- | 0.00013 | 0.031 | -- | 0.03 | -- | 0.74 | -- | 0.00013 | 860000 | -- | 860000 | 0.0001 | - | 0.02 | **0.02** | **0.02** | **0.02** | **0.02** |
| 193-39-5 | Indeno(1,2,3-cd)pyrene | -- | -- | -- | -- | -- | 0.0013 | 0.031 | -- | 0.3 | -- | 7.4 | -- | 0.0013 | 28000 | -- | 28000 | 0.001 | - | 0.02 | **0.02** | **0.02** | **0.02** | **0.02** |
| na | cPAH (TEQ) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | - | 0.02 | **0.02** | **0.02** | **0.02** | **0.02** |
| | **Noncarcinogenic PAHs** | | | | | | | | | | | | | | | | | | | | | | | |
| 208-96-8 | Acenaphthylene | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | - | 0.02 | **--** | **--** | **--** | **--** |
| 83-32-9 | Acenaphthene | -- | -- | -- | -- | -- | 90 | -- | -- | -- | 650 | -- | 1600 | 90 | -- | -- | -- | 90 | - | 0.02 | **90** | **90** | **9** | **9** |
| 120-12-7 | Anthracene | -- | -- | -- | -- | -- | 400 | 110000 | -- | -- | 26000 | -- | 65000 | 400 | -- | -- | -- | 400 | - | 0.02 | **400** | **400** | **4** | **4** |
| 191-24-2 | Benzo(g,h,i)perylene | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | - | 0.02 | **--** | **--** | **--** | **--** |
| 206-44-0 | Fluoranthene | -- | -- | -- | -- | -- | 20 | 370 | -- | -- | 86 | -- | 220 | 20 | -- | -- | -- | 20 | - | 0.02 | **20** | **20** | **5** | **5** |
| 86-73-7 | Fluorene | -- | -- | -- | -- | -- | 70 | 14000 | -- | -- | 3500 | -- | 8600 | 70 | -- | -- | -- | 70 | - | 0.02 | **70** | **70** | **6** | **6** |
| 90-12-0 | Methylnaphthalene-1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | - | 0.02 | **--** | **--** | **--** | **--** |
| 91-57-6 | Methylnaphthalene-2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | - | 0.02 | **--** | **--** | **--** | **--** |
| 91-20-3 | Naphthalene | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4700 | -- | 12000 | 4700 | 90 | 370 | 90 | 90 | - | 0.02 | **90** | **4700** | **156** | **156** |
| 85-01-8 | Phenanthrene | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | - | 0.02 | **--** | **--** | **--** | **--** |
| 129-00-0 | Pyrene | -- | -- | -- | -- | -- | 30 | 11000 | -- | -- | 2600 | -- | 6500 | 30 | -- | -- | -- | 30 | - | 0.02 | **30** | **30** | **4** | **4** |
| **Metals** | | | | | | | | | | | | | | | | | | | | | | | | |
| | **Heavy Metals** | | | | | | | | | | | | | | | | | | | | | | | |
| 7440-38-2 | Arsenic | 36 | 36 | 36 | -- | 36 | 0.14 | 0.14 | -- | 0.098 | 18 | 0 | 44 | -- | -- | -- | -- | 36 | 5 | 0.50 | **5** | **5** | **5.0** | **5.0** |
| 7440-50-8 | Copper | 3.1 | 3.1 | 2.4 | -- | 2.4 | -- | -- | -- | -- | 2900 | -- | 7200 | 2900 | -- | -- | -- | 2.4 | - | 0.1 | **2.4** | **2.4** | **3.1** | **3.1** |
| 7439-92-1 | Lead | 8.1 | 8.1 | 8.1 | -- | 8.1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 8.1 | - | 0.02 | **8.1** | **8.1** | **8.1** | **8.1** |
| 7440-02-0 | Nickel | 8.2 | 8.2 | 8.2 | -- | 8.2 | 4600 | 4600 | -- | -- | 1100 | -- | 2800 | 1100 | -- | -- | -- | 8.2 | - | 0.2 | **8.2** | **8.2** | **8.2** | **8.2** |
| 7440-66-6 | Zinc | 81 | 81 | 81 | -- | 81 | 26000 | -- | -- | -- | 17000 | -- | 41000 | 17000 | -- | -- | -- | 81 | - | 0.5 | **81** | **81** | **81** | **81** |
| | **Organometals** | | | | | | | | | | | | | | | | | | | | | | | |
| 78-00-2 | Tetraethyl Lead | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | - | 0.0005 | **--** | **--** | **--** | **--** |

**Notes:**

**--** Indicates that no value is available. In the case of ARARs, the referenced sources do not publish value for the noted chemicals. In the case of calculated Screening Levels, one or more input parameter values is not available.

***** PQL based on EPA Method 8270 Analysis.

(Gray shading) Gray shaded values are not applicable under MTCA (WAC 173-340-730-3Ciii), given that other "sufficiently protective" federal standards are available.

## Table 5-4 - Soil Screening Levels

Project No. 130097, Alexander Avenue Petroleum Tank Facilities Site
Tacoma, Washington

| | | | MTCA Method C Calculated Values (Human Health) | | MTCA Cross-Media (Soil to Groundwater to Surface Water) Values | | | Modifying Factors | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CAS** | **Potential Chemical of Concern** | Method A Industrial Land Use | Industrial Land Use (carcinogen) | Industrial Land Use (non carcinogen) | Human Health (Protection of Surface Water)* | Human Health (Protection of Surface Water)* | **Lowest Value, All Receptor Pathways (mg/kg)**** | Puget Sound Natural Back-ground Concen-trations | Practical Quanti-tation Limits (PQLs) | **UPDATED Alexander Avenue Site Screening Levels (mg/kg)** | **RI Data Memo Alexander Avenue Site Preliminary Screening Levels (mg/kg)** |
| | **Petroleum Hydrocarbon Mixtures** | | | | | | | | | | |
| na | Gasoline | 30 | -- | -- | -- | -- | 30 | -- | 5 | **30** | **30** |
| na | Diesel + Heavy Oil | 2000 | -- | -- | -- | -- | 2000 | -- | 25 | **2000** | **2000** |
| | **Volatile Organics** | | | | | | | | | | |
| 67-64-1 | Acetone | -- | -- | 3200000 | -- | -- | 3200000 | -- | 0.02 | **3200000** | **3150000** |
| 107-13-1 | Acrylonitrile | -- | 240 | 140000 | 0.0027 | 0.00019 | 0.00019 | -- | 1 | **1** | **--** |
| 71-43-2 | Benzene | dw | 2400 | 14000 | 0.31 | 0.02 | 0.02 | -- | 0.005 | **0.02** | **0.02** |
| 67-66-3 | Chloroform | -- | 4200 | 35000 | *2.4* | *0.16* | 4200 | -- | 0.005 | **4200** | **0.2** |
| 107-06-2 | Dichloroethane -1,2 (EDC) | -- | 1400 | 21000 | *0.46* | *0.032* | 1400 | -- | 0.005 | **1400** | **0.01** |
| 156-59-2 | Dichloroethene - cis 1,2 | -- | -- | 7000 | -- | -- | 7000 | -- | 0.005 | **7000** | **35000** |
| 156-60-5 | Dichloroethene - trans 1,2 | -- | -- | 70000 | *20* | *1.3* | 70000 | -- | 0.005 | **70000** | **3.2** |
| 75-35-4 | Dichloroethene -1,1 | -- | -- | 180000 | *0.02* | *0.0011* | 180000 | -- | 0.005 | **180000** | **0.005** |
| 100-41-4 | Ethylbenzene | dw | -- | 350000 | 1 | 0.06 | 0.06 | -- | 0.005 | **0.06** | **0.01** |
| 98-82-8 | Isopropylbenzene | -- | -- | 350000 | -- | -- | 350000 | -- | 0.02 | **350000** | **350000** |
| 75-09-2 | Methylene Chloride | dw | 66000 | 21000 | *4.3* | *0.3* | 21000 | -- | 0.01 | **21000** | **0.2** |
| 104-51-8 | n-Butylbenzene | -- | -- | 180000 | -- | -- | 180000 | -- | na | **180000** | **--** |
| 103-65-1 | n-propylbenzene | -- | -- | 350000 | -- | -- | 350000 | -- | 0.02 | **350000** | **--** |
| 99-87-6 | p-Isopropyltoluene | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **--** |
| 135-98-8 | sec-Butylbenzene | -- | -- | 350000 | -- | -- | 350000 | -- | na | **350000** | **--** |
| 127-18-4 | Tetrachlolorethene (PCE) | dw | 63000 | 21000 | 0.081 | 0.0045 | 0.0045 | -- | 0.005 | **0.005** | **0.005** |
| 79-34-5 | Tetrachloroethane-1,1,2,2 | -- | 660 | 70000 | *0.02* | *0.0011* | 660 | -- | 0.005 | **660** | **0.005** |
| 108-88-3 | Toluene | dw | -- | 280000 | *3.4* | *0.21* | 280000 | -- | 0.005 | **280000** | **6.4** |
| 79-01-6 | Trichloroethene (TCE) | dw | 2900 | 1800 | 0.042 | 0.0026 | 0.0026 | -- | 0.005 | **0.005** | **0.01** |
| 95-63-6 | Trimethylbenzene-1,2,4 | -- | -- | -- | *--* | -- | -- | -- | na | **--** | **--** |
| 108-67-8 | Trimethylbenzene-1,3,5 | -- | -- | 35000 | *--* | -- | 35000 | -- | na | **35000** | **--** |
| 75-01-4 | Vinyl Chloride | -- | 88 | 11000 | 0.0091 | 0.00048 | 0.00048 | -- | 0.005 | **0.005** | **0.005** |
| 1330-20-7 | Xylenes (Total) | dw | -- | 700000 | -- | -- | 700000 | -- | 0.005 | **700000** | **0.005** |
| | **Semivolatile Organics** | | | | | | | | | | |
| 117-81-7 | Bis-2ethylhexyl Phthalate | -- | 9400 | 70000 | 0.69 | 0.035 | 0.035 | -- | 0.10 | **0.04** | **0.1** |
| 86-74-8 | Carbazole | -- | -- | -- | -- | -- | -- | -- | na | **--** | **--** |
| 132-64-9 | Dibenzofuran | -- | -- | 3500 | -- | -- | 3500 | -- | 0.0005 | **3500** | **7000** |
| 84-66-2 | Diethyl Phthalate | -- | -- | 2800000 | *3.2* | *0.21* | 2800000 | -- | 0.01 | **2800000** | **0.05** |
| 131-11-3 | Dimethyl Phthalate | -- | -- | -- | -- | -- | -- | -- | 0.01 | **--** | **3500000** |
| 87-68-3 | Hexachloro 1,3-butadiene | -- | 1700 | 3500 | *0.01* | *0.00045* | 1700 | -- | 0.01 | **0.01** | **0.01** |
| 118-74-1 | Hexachlorobenzene | -- | 82 | 2800 | *0.0001* | *0.0000053* | 82 | -- | 0.01 | **0.01** | **0.01** |
| 87-86-5 | Pentachlorophenol | -- | 330 | 18000 | *0.001* | *0.000031* | 330 | -- | 0.1 | **0.1** | **0.1** |
| 108-95-2 | Phenol | -- | -- | 1100000 | *1300* | *93* | 1100000 | -- | 0.03 | **1100000** | **0.2** |

## Table 5-4 - Soil Screening Levels

Project No. 130097, Alexander Avenue Petroleum Tank Facilities Site
Tacoma, Washington

| CAS | Potential Chemical of Concern | | MTCA Method C Calculated Values (Human Health) | | MTCA Cross-Media (Soil to Groundwater to Surface Water) Values | | | Modifying Factors | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Method A Industrial Land Use | Industrial Land Use (carcinogen) | Industrial Land Use (non carcinogen) | Human Health (Protection of Surface Water)* | Human Health (Protection of Surface Water)* | Lowest Value, All Receptor Pathways (mg/kg)** | Puget Sound Natural Back-ground Concen-trations | Practical Quanti-tation Limits (PQLs) | UPDATED Alexander Avenue Site Screening Levels (mg/kg) | RI Data Memo Alexander Avenue Site Preliminary Screening Levels (mg/kg) |
| | **cPAHs[1]** | | | | | | | | | | |
| 56-55-3 | Benzo(a)anthracene | | 99 | -- | *0.01* | 0.00039 | 99 | -- | 0.0300 | (note 2) | **0.006** |
| 50-32-8 | Benzo(a)pyrene | dw | 10 | -- | *0.002* | 0.00011 | 10 | -- | 0.030 | (note 2) | **0.02** |
| 205-99-2 | Benzo(b)fluoranthene | | 99 | -- | *0.03* | 0.0013 | 99 | -- | 0.030 | (note 2) | **0.02** |
| 207-08-9 | Benzo(k)fluoranthene | | 990 | -- | *0.27* | 0.013 | 990 | -- | 0.030 | (note 2) | **0.02** |
| 218-01-9 | Chrysene | | 9900 | -- | *0.21* | 0.01 | 9900 | -- | 0.030 | (note 2) | **0.007** |
| 53-70-3 | Dibenz(a,h)anthracene | | 10 | -- | *0.004* | 0.0002 | 10 | -- | 0.030 | (note 2) | **0.01** |
| 193-39-5 | Indeno(1,2,3-cd)pyrene | | 99 | -- | *0.08* | 0.0038 | 99 | -- | 0.030 | (note 2) | **0.04** |
| na | cPAH (TEQ)[1] | dw | 10 | -- | -- | -- | 10 | -- | 0.030 | **10** | **0.02** |
| | **Other PAHs** | | | | | | | | | | |
| 208-96-8 | Acenaphthylene | -- | -- | -- | -- | -- | -- | -- | 0.0005 | **--** | **--** |
| 83-32-9 | Acenaphthene | -- | -- | 210000 | *7.8* | 0.4 | 210000 | -- | 0.001 | **210000** | **0.03** |
| 120-12-7 | Anthracene | -- | -- | 1100000 | *160* | 8 | 1100000 | -- | 0.001 | **1100000** | **0.05** |
| 191-24-2 | Benzo(g,h,i)perylene | -- | -- | -- | -- | -- | -- | -- | 0.0005 | **--** | **--** |
| 206-44-0 | Fluoranthene | -- | -- | 140000 | *17* | 0.83 | 140000 | -- | 0.001 | **140000** | **0.1** |
| 86-73-7 | Fluorene | -- | -- | 140000 | *9.4* | 0.47 | 140000 | -- | 0.001 | **140000** | **0.03** |
| 90-12-0 | Methylnaphthalene-1 | -- | 4500 | 250000 | -- | -- | 4500 | -- | 0.001 | **4500** | **--** |
| 91-57-6 | Methylnaphthalene-2 | -- | -- | 14000 | -- | -- | 14000 | -- | 0.001 | **14000** | **320** |
| 91-20-3 | Naphthalene | dw | -- | 70000 | 110 | 6.1 | 6.1 | -- | 0.001 | **6.1** | **0.1** |
| 85-01-8 | Phenanthrene | -- | -- | -- | -- | -- | -- | -- | 0.0005 | **--** | **--** |
| 129-00-0 | Pyrene | -- | -- | 110000 | *34* | 1.7 | 110000 | -- | 0.001 | **110000** | **0.2** |
| | **Metals** | | | | | | | | | | |
| | **Heavy Metals** | | | | | | | | | | |
| 7440-38-2 | Arsenic | dw | 88 | 1100 | -- | -- | 88 | 20 | 0.5 | **88** | **20** |
| 7440-50-8 | Copper | | -- | 140000 | 1300 | 65 | 65 | 36 | 0.1 | **65** | **36** |
| 7439-92-1 | Lead | 1000 | -- | -- | -- | -- | 1000 | 24 | 0.05 | **1000** | **81** |
| 7440-02-0 | Nickel | 70000 | -- | 70000 | 1400 | 72 | 72 | 48 | 0.2 | **72** | **48** |
| 7440-66-6 | Zinc | 1050000 | -- | 1100000 | 21000 | 1100 | 1100 | 1100 | 0.5 | **1100** | **85** |
| | **Organometals** | | | | | | | | | | |
| 78-00-2 | Tetraethyl Lead | -- | -- | 0.35 | -- | -- | 0.35 | -- | -- | **0.35** | **0.35** |

**Notes:**

dw Identifies that a value exists in MTCA tables but that value is not applicable to this site because it is based on protecting drinking water sources.

Puget Sound background metals concentrations from *Natural Background Soil Metals Concentrations in Washington State* (Ecology, 1994), except arsenic which is based on Washington State background concentrations.

1 = cPAH screening levels consider exposure via ingestion and dermal exposure in accordance with MTCA 173-340-745(iii)
2 = Total cPAH screening level used in lieu of individual cPAH screening levels.

* Italic and gray format indicates no or limited exceedance in groundwater, not adjacent to surface water. Xmedia CUL not calculated.
** Gray numbering indicates value not selected as screening level due to background or PQL values.

## Table 6-1 - Statistical Summary of Sediment Data

Project No. 130097, Alexander Avenue Petroleum Tank Facilities Site
Tacoma, Washington

| Analyte | Total Number of Locations with Analysis* | Total Number of Samples Analyzed* | Total Number of Detections | Minimum Detected Concentration | Maximum Detected Concentration | Sediment Quality Objective | Units | Exceedance Information: No. of Exceedances | Exceedance Frequency (%) | Maximum Exceedance Factor |
|---|---|---|---|---|---|---|---|---|---|---|
| **Petroleum Hydrocarbons without silica gel cleanup** | | | | | | | | | | |
| Gasoline Range Hydrocarbons | 15 | 16 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Diesel Range Hydrocarbons | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Oil Range Hydrocarbons | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Total TPHs D+O (ND=1/2U) | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Total TPHs G+D+O (ND=1/2U) | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| **Petroleum Hydrocarbons with silica gel cleanup** | | | | | | | | | | |
| Diesel Range Hydrocarbons | 14 | 15 | 15 | 24 | 270 | -- | -- | -- | -- | -- |
| Oil Range Hydrocarbons | 14 | 15 | 15 | 49 | 980 | -- | -- | -- | -- | -- |
| Total TPHs D+O (ND=1/2U) | 14 | 15 | 15 | 73 | 1250 | -- | -- | -- | -- | -- |
| Total TPHs G+D+O (ND=1/2U) | 14 | 15 | 15 | 76 | 1300 | -- | -- | -- | -- | -- |
| **Volatile Organics** | | | | | | | | | | |
| Acetone | 15 | 16 | 16 | 0.035 | 0.32 | -- | mg/kg | -- | -- | -- |
| Acrylonitrile | 15 | 16 | 0 | NA | NA | -- | mg/kg | -- | -- | -- |
| Benzene | 15 | 16 | 8 | 0.0005 | 0.057 | -- | mg/kg | -- | -- | -- |
| Chloroform | 21 | 22 | 5 | 0.0003 | 4.82 | -- | mg/kg | -- | -- | -- |
| Dichloroethane -1,2 (EDC) | 15 | 16 | 0 | NA | NA | -- | mg/kg | -- | -- | -- |
| Dichloroethene - cis 1,2 | 21 | 22 | 7 | 0.0005 | 0.217 | -- | mg/kg | -- | -- | -- |
| Dichloroethene - trans 1,2 | 21 | 22 | 1 | 0.0112 | 0.0112 | -- | mg/kg | -- | -- | -- |
| Dichloroethene -1,1 | 21 | 22 | 1 | 0.00932 | 0.00932 | -- | mg/kg | -- | -- | -- |
| Ethylbenzene | 15 | 16 | 0 | NA | NA | 0.01 | mg/kg | 0 | -- | -- |
| Isopropylbenzene (cumene) | 15 | 16 | 0 | NA | NA | -- | mg/kg | -- | -- | -- |
| Methylene Chloride | 21 | 22 | 11 | 0.0007 | 0.021 | -- | mg/kg | -- | -- | -- |
| n-Butylbenzene | 15 | 16 | 0 | NA | NA | -- | mg/kg | -- | -- | -- |
| n-Propylbenzene | 15 | 16 | 0 | NA | NA | -- | mg/kg | -- | -- | -- |
| p-Isopropyltoluene | 15 | 16 | 5 | 0.0006 | 0.0014 | -- | mg/kg | -- | -- | -- |
| sec-Butylbenzene | 15 | 16 | 0 | NA | NA | -- | mg/kg | -- | -- | -- |
| Tetrachloroethene (PCE) | 21 | 22 | 7 | 0.0004 | 8.11 | 0.057 | mg/kg | 2 | 10% | 142 |
| Tetrachloroethane-1,1,2,2 | 21 | 22 | 1 | 0.0639 | 0.0639 | -- | mg/kg | -- | -- | -- |
| Toluene | 15 | 16 | 14 | 0.0003 | 0.0022 | -- | mg/kg | -- | -- | -- |
| Trichloroethene (TCE) | 21 | 22 | 12 | 0.0004 | 0.494 | -- | mg/kg | -- | -- | -- |
| Trimethylbenzene -1,2,4 | 15 | 16 | 0 | NA | NA | -- | mg/kg | -- | -- | -- |
| Trimethylbenzene-1,3,5 | 15 | 16 | 0 | NA | NA | -- | mg/kg | -- | -- | -- |
| Vinyl Chloride | 21 | 22 | 1 | 0.0145 | 0.0145 | -- | mg/kg | -- | -- | -- |
| Xylenes (total) | 15 | 16 | 1 | 0.0006 | 0.0006 | 0.04 | mg/kg | 0 | -- | -- |
| **Semivolatile Organics** | | | | | | | | | | |
| Bis-2ethylhexyl Phthalate | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Carbazole | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Dibenzofuran | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Diethyl Phthalate | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Dimethyl Phthalate | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Hexachloro 1,3-butadiene | 21 | 22 | 7 | 0.0008 | 1.5 | 0.011 | mg/kg | 5 | 24% | 136 |
| Hexachlorobenzene | 6 | 6 | 5 | 0.0046 | 0.3 | 0.022 | mg/kg | 4 | 67% | 14 |
| Pentachlorophenol | 4 | 4 | 2 | 0.086 | 0.7 | 0.36 | mg/kg | 1 | 25% | 2 |
| Phenol | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| **Semivolatile Organics: cPAHs** | | | | | | | | | | |
| Benz(a)anthracene | 14 | 15 | 15 | 0.043 | 1.3 | 1.6 | mg/kg | 0 | -- | -- |
| Benzo(a)pyrene | 14 | 15 | 15 | 0.037 | 0.71 | 1.6 | mg/kg | 0 | -- | -- |
| Benzo(b)fluoranthene | 14 | 15 | 15 | 0.063 | 1.4 | 3.6 | mg/kg | 0 | -- | -- |
| Benzo(k)fluoranthene | 14 | 15 | 15 | 0.034 | 0.65 | 3.6 | mg/kg | 0 | -- | -- |
| Chrysene | 14 | 15 | 15 | 0.092 | 2.2 | 2.8 | mg/kg | 0 | -- | -- |
| Dibenz(a,h)anthracene | 14 | 15 | 12 | 0.029 | 0.12 | 0.23 | mg/kg | 0 | -- | -- |
| Indeno (1,2,3-cd)pyrene | 14 | 15 | 14 | 0.031 | 0.39 | 0.69 | mg/kg | 0 | -- | -- |
| Total cPAH (TEQ) | 14 | 15 | 15 | 0.057 | 1.05 | -- | -- | -- | -- | -- |
| **Semivolatile Organics: Other PAHs** | | | | | | | | | | |
| Acenaphthylene | 14 | 15 | 7 | 0.026 | 0.19 | 1.3 | mg/kg | 0 | -- | -- |
| Acenaphthene | 14 | 15 | 7 | 0.024 | 0.12 | 0.5 | mg/kg | 0 | -- | -- |
| Anthracene | 14 | 15 | 15 | 0.028 | 0.47 | 0.96 | mg/kg | 0 | -- | -- |
| Benzo(g,h,i)perylene | 14 | 15 | 15 | 0.045 | 0.6 | 0.72 | mg/kg | 0 | -- | -- |
| Fluoranthene | 14 | 15 | 15 | 0.17 | 11 | 2.5 | mg/kg | 3 | 21% | 4 |
| Fluorene | 14 | 15 | 8 | 0.026 | 0.17 | 0.54 | mg/kg | 0 | -- | -- |
| Methylnaphthalene-1 | 14 | 15 | 5 | 0.024 | 0.06 | -- | mg/kg | -- | -- | -- |
| Methylnaphthalene-2 | 14 | 15 | 9 | 0.031 | 0.22 | 0.67 | mg/kg | 0 | -- | -- |
| Naphthalene | 15 | 16 | 13 | 0.0013 | 0.48 | 2.1 | mg/kg | 0 | -- | -- |
| Phenanthrene | 14 | 15 | 15 | 0.078 | 1.4 | 1.5 | mg/kg | 0 | -- | -- |
| Pyrene | 14 | 15 | 15 | 0.19 | 12 | 3.3 | mg/kg | 3 | 21% | 4 |
| Total HPAH in mg/kg | 14 | 15 | 15 | 0.73 | 28.5 | 17 | mg/kg | 2 | 13% | 2 |
| Total LPAH in mg/kg | 14 | 15 | 15 | 0.22 | 1.88 | 5.2 | mg/kg | 0 | -- | -- |
| **Metals** | | | | | | | | | | |
| ***Heavy Metals*** | | | | | | | | | | |
| Arsenic | 5 | 5 | 5 | 4.5 | 18.2 | 57 | mg/kg | 0 | -- | -- |
| Copper | 5 | 5 | 5 | 26.4 | 1310 | 390 | mg/kg | 1 | 20% | 3 |
| Lead | 5 | 5 | 5 | 68.7 | 18900 | 450 | mg/kg | 3 | 60% | 42 |
| Nickel | 5 | 5 | 5 | 16.2 | 80.8 | 140 | mg/kg | 0 | -- | -- |
| Zinc | 5 | 5 | 5 | 36 | 108 | 410 | mg/kg | 0 | -- | -- |
| ***Organometals*** | | | | | | | | | | |
| Tetraethyl Lead | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |

**Notes:**

Commencement Bay Sediment Quality Objectives for organic and inorganic contaminants are based on dry weight (mg/kg-dw); therefore, all sediment data are reported as dry weight.

Statistics are based on data from 2000-2015 (Appendix B).

-- dashes indicate screening level not established.

NA = not available.

* Each sediment composite sample is counted as multiple "locations" (for each constituent grab) and collectively as a single sample.

# Table 6-2 - Statistical Summary of Groundwater Data (15-foot Zone)

Project No. 130097, Alexander Avenue Petroleum Tank Facilities Site
Tacoma, Washington

| | | | | | | | | Exceedance Information | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Analyte | Total Number of Locations with Analysis | Total Number of Samples Analyzed | Total Number of Detections | Minimum Detected Concentration | Maximum Detected Concentration | Screening Level | Units | No. of Exceedances | Exceedance Frequency (%) | Maximum Exceedance Factor |
| **Petroleum Hydrocarbons without silica gel cleanup** | | | | | | | | | | |
| Gasoline Range Hydrocarbons | 106 | 185 | 123 | 18 | 9100 | 800 | ug/L | 94 | 51% | 11 |
| Diesel Range Hydrocarbons | 71 | 112 | 70 | 12 | 27000 | 500 | ug/L | 53 | 47% | 54 |
| Oil Range Hydrocarbons | 69 | 110 | 53 | 26 | 4200 | 500 | ug/L | 34 | 31% | 8 |
| Total TPHs D+O (ND=0U) | 51 | 92 | 68 | 18 | 30000 | 500 | ug/L | 51 | 55% | 60 |
| Total TPHs D+O (ND=1/2U) | 71 | 112 | 71 | 39 | 30000 | 500 | ug/L | 56 | 50% | 60 |
| Total TPHs G+D+O (ND=0U) | 50 | 85 | 74 | 18 | 32000 | 720 | ug/L | 59 | 69% | 44 |
| Total TPHs G+D+O (ND=1/2U) | 50 | 85 | 74 | 59 | 32000 | 720 | ug/L | 61 | 72% | 44 |
| **Petroleum Hydrocarbons with silica gel cleanup** | | | | | | | | | | |
| Diesel Range Hydrocarbons | 33 | 91 | 51 | 100 | 8300 | 500 | ug/L | 27 | 30% | 17 |
| Oil Range Hydrocarbons | 33 | 91 | 4 | 250 | 1200 | 500 | ug/L | 1 | 1% | 2 |
| Total TPHs D+O (ND=0U) | 33 | 91 | 51 | 100 | 8570 | 500 | ug/L | 27 | 30% | 17 |
| Total TPHs D+O (ND=1/2U) | 33 | 91 | 53 | 50 | 8570 | 500 | ug/L | 34 | 37% | 17 |
| Total TPHs G+D+O (ND=0U) | 32 | 84 | 69 | 18 | 13470 | 720 | ug/L | 58 | 69% | 19 |
| Total TPHs G+D+O (ND=1/2U) | 32 | 84 | 69 | 360 | 13470 | 720 | ug/L | 62 | 74% | 19 |
| **Volatile Organics** | | | | | | | | | | |
| Acetone | 98 | 165 | 28 | 1.8 | 250 | 32000000 | ug/L | 0 | -- | -- |
| Acrylonitrile | 62 | 115 | 4 | 1.5 | 31 | 0.66 | ug/L | 4 | 3% | 44 |
| Benzene | 121 | 226 | 140 | 0.08 | 2400 | 24 | ug/L | 72 | 32% | 100 |
| Chloroform | 134 | 268 | 20 | 0.08 | 16 | 12 | ug/L | 1 | 0.4% | 1 |
| Dichloroethane -1,2 (EDC) | 88 | 151 | 0 | NA | NA | 42 | ug/L | 0 | -- | -- |
| Dichloroethene - cis 1,2 | 134 | 268 | 93 | 0.07 | 300 | -- | ug/L | -- | -- | -- |
| Dichloroethene - trans 1,2 | 134 | 268 | 52 | 0.08 | 14 | 4000 | ug/L | 0 | -- | -- |
| Dichloroethene -1,1 | 134 | 268 | 13 | 0.0795 | 1.42 | 3.2 | ug/L | 0 | -- | -- |
| Ethylbenzene | 133 | 242 | 124 | 0.06 | 460 | 130 | ug/L | 24 | 10% | 4 |
| Isopropylbenzene (cumene) | 80 | 134 | 97 | 0.29 | 36 | 1600 | ug/L | 0 | -- | -- |
| Methylene Chloride | 134 | 268 | 0 | NA | NA | 1000 | ug/L | 0 | -- | -- |
| n-Butylbenzene | 80 | 134 | 63 | 0.3 | 8 | -- | ug/L | -- | -- | -- |
| n-Propylbenzene | 80 | 134 | 92 | 0.23 | 58 | 5200 | ug/L | 0 | -- | -- |
| p-Isopropyltoluene | 80 | 134 | 36 | 0.2 | 5.7 | -- | ug/L | -- | -- | -- |
| sec-Butylbenzene | 80 | 134 | 80 | 0.22 | 6.4 | -- | ug/L | -- | -- | -- |
| Tetrachloroethene (PCE) | 122 | 252 | 84 | 0.0648 | 150 | 8.9 | ug/L | 46 | 18% | 17 |
| Tetrachloroethane-1,1,2,2 | 122 | 252 | 2 | 0.77 | 1.1 | 3 | ug/L | 0 | -- | -- |
| Toluene | 133 | 242 | 113 | 0.06 | 310 | 520 | ug/L | 0 | -- | -- |
| Trichloroethene (TCE) | 122 | 252 | 87 | 0.106 | 96 | 7 | ug/L | 39 | 15% | 14 |
| Trimethylbenzene -1,2,4 | 80 | 134 | 56 | 0.24 | 180 | 63 | ug/L | 6 | 4% | 3 |
| Trimethylbenzene-1,3,5 | 80 | 134 | 52 | 0.2 | 52 | -- | ug/L | -- | -- | -- |
| Vinyl Chloride | 134 | 268 | 56 | 0.066 | 93 | 1.6 | ug/L | 31 | 12% | 58 |
| Xylenes (total) | 107 | 189 | 92 | 0.41 | 1000 | 970 | ug/L | 1 | 1% | 1 |
| **Semivolatile Organics** | | | | | | | | | | |
| Bis-2ethylhexyl Phthalate | 13 | 13 | 1 | 1.1 | 1.1 | 1 | ug/L | 1 | 8% | 1 |
| Carbazole | 13 | 13 | 1 | 1.1 | 1.1 | -- | ug/L | -- | -- | -- |
| Dibenzofuran | 16 | 16 | 2 | 1.2 | 1.8 | -- | ug/L | -- | -- | -- |
| Diethyl Phthalate | 13 | 13 | 4 | 1 | 7.4 | 600 | ug/L | 0 | -- | -- |
| Dimethyl Phthalate | 13 | 13 | 2 | 2.7 | 3.3 | 2000 | ug/L | 0 | -- | -- |
| Hexachloro 1,3-butadiene | 92 | 169 | 3 | 0.00726 | 0.1 | 0.2 | ug/L | 0 | -- | -- |
| Hexachlorobenzene | 25 | 48 | 7 | 0.00753 | 0.0432 | 0.2 | ug/L | 0 | -- | -- |
| Pentachlorophenol | 23 | 41 | 4 | 0.0377 | 0.0461 | 1 | ug/L | 0 | -- | -- |
| Phenol | 13 | 13 | 2 | 3.4 | 21 | 300000 | ug/L | 0 | -- | -- |
| **Semivolatile Organics: cPAHs** | | | | | | | | | | |
| Benz(a)anthracene | 46 | 51 | 5 | 0.0029 | 0.015 | 0.02 | ug/L | 0 | -- | -- |
| Benzo(a)pyrene | 46 | 51 | 0 | NA | NA | 0.02 | ug/L | 0 | -- | -- |
| Benzo(b)fluoranthene | 46 | 51 | 2 | 0.003 | 0.01 | 0.02 | ug/L | 0 | -- | -- |
| Benzo(k)fluoranthene | 40 | 45 | 0 | NA | NA | 0.02 | ug/L | 0 | -- | -- |
| Chrysene | 46 | 51 | 2 | 0.0049 | 0.019 | 0.03 | ug/L | 0 | -- | -- |
| Dibenz(a,h)anthracene | 46 | 51 | 2 | 0.0027 | 0.0046 | 0.02 | ug/L | 0 | -- | -- |
| Indeno (1,2,3-cd)pyrene | 46 | 51 | 2 | 0.0036 | 0.0053 | 0.02 | ug/L | 0 | -- | -- |
| Total cPAH (TEQ) | 46 | 51 | 7 | 0.0074 | 0.014 | 0.02 | ug/L | 0 | -- | -- |
| **Semivolatile Organics: Other PAHs** | | | | | | | | | | |
| Acenaphthylene | 46 | 51 | 3 | 0.33 | 0.42 | -- | ug/L | -- | -- | -- |
| Acenaphthene | 46 | 51 | 26 | 0.0098 | 4.6 | 90 | ug/L | 0 | -- | -- |
| Anthracene | 46 | 51 | 27 | 0.0038 | 0.14 | 400 | ug/L | 0 | -- | -- |
| Benzo(g,h,i)perylene | 16 | 16 | 1 | 0.013 | 0.013 | -- | ug/L | -- | -- | -- |
| Fluoranthene | 46 | 51 | 6 | 0.0075 | 0.026 | 20 | ug/L | 0 | -- | -- |
| Fluorene | 46 | 51 | 27 | 0.004 | 4.7 | 70 | ug/L | 0 | -- | -- |
| Methylnaphthalene-1 | 9 | 9 | 3 | 4.2 | 140 | -- | ug/L | -- | -- | -- |
| Methylnaphthalene-2 | 46 | 51 | 38 | 0.0025 | 200 | -- | ug/L | -- | -- | -- |
| Naphthalene | 114 | 214 | 84 | 0.0035 | 240 | 90 | ug/L | 3 | 1% | 3 |
| Phenanthrene | 46 | 51 | 18 | 0.0093 | 3.8 | -- | ug/L | -- | -- | -- |
| Pyrene | 46 | 51 | 10 | 0.0039 | 0.073 | 30 | ug/L | 0 | -- | -- |
| **Metals** | | | | | | | | | | |
| ***Heavy Metals - Total*** | | | | | | | | | | |
| Arsenic | 34 | 38 | 33 | 0.41 | 51.7 | 5 | ug/L | 13 | 34% | 10 |
| Copper | 34 | 35 | 27 | 0.24 | 25.5 | 2.4 | ug/L | 11 | 31% | 11 |
| Lead | 40 | 47 | 35 | 0.051 | 868 | 8.1 | ug/L | 3 | 6% | 107 |
| Nickel | 34 | 35 | 23 | 0.2 | 26.1 | 8.2 | ug/L | 2 | 6% | 3 |
| Zinc | 34 | 35 | 16 | 0.84 | 46.8 | 81 | ug/L | 0 | -- | -- |
| ***Heavy Metals - Dissolved*** | | | | | | | | | | |
| Arsenic | 33 | 61 | 31 | 2.73 | 618 | 5 | ug/L | 29 | 48% | 124 |
| Copper | 30 | 58 | 33 | 5.9 | 107 | 2.4 | ug/L | 33 | 57% | 45 |
| Lead | 60 | 94 | 24 | 0.065 | 67.6 | 8.1 | ug/L | 5 | 5% | 8 |
| Nickel | 14 | 42 | 34 | 21.2 | 148 | 8.2 | ug/L | 34 | 81% | 18 |
| Zinc | 14 | 42 | 10 | 9.52 | 115 | 81 | ug/L | 1 | 2% | 1 |
| ***Organometals*** | | | | | | | | | | |
| Tetraethyl Lead | 28 | 29 | 7 | 0.00087 | 0.00599 | -- | ug/L | -- | -- | -- |

**Notes:**
Statistics are based on data from 2000-2015 (Appendix B).
-- dashes indicate screening level not established.
NA = not available.

## Table 6-3 - Statistical Summary of Groundwater Data (25-foot Zone)

Project No. 130097, Alexander Avenue Petroleum Tank Facilities Site
Tacoma, Washington

| Analyte | Total Number of Locations with Analysis | Total Number of Samples Analyzed | Total Number of Detections | Minimum Detected Concentration | Maximum Detected Concentration | Screening Level | Units | Exceedance Information: No. of Exceedances | Exceedance Frequency (%) | Maximum Exceedance Factor |
|---|---|---|---|---|---|---|---|---|---|---|
| **Petroleum Hydrocarbons without silica gel cleanup** | | | | | | | | | | |
| Gasoline Range Hydrocarbons | 61 | 107 | 33 | 13 | 2200 | 800 | ug/L | 6 | 6% | 3 |
| Diesel Range Hydrocarbons | 25 | 41 | 30 | 20 | 8100 | 500 | ug/L | 23 | 56% | 16 |
| Oil Range Hydrocarbons | 25 | 41 | 28 | 21 | 2500 | 500 | ug/L | 19 | 46% | 5 |
| Total TPHs D+O (ND=0U) | 18 | 34 | 29 | 25 | 11000 | 500 | ug/L | 24 | 71% | 22 |
| Total TPHs D+O (ND=1/2U) | 25 | 41 | 31 | 41 | 10600 | 500 | ug/L | 27 | 66% | 21 |
| Total TPHs G+D+O (ND=0U) | 18 | 34 | 33 | 18 | 13000 | 720 | ug/L | 23 | 68% | 18 |
| Total TPHs G+D+O (ND=1/2U) | 18 | 34 | 33 | 170 | 13000 | 720 | ug/L | 25 | 74% | 18 |
| **Petroleum Hydrocarbons with silica gel cleanup** | | | | | | | | | | |
| Diesel Range Hydrocarbons | 20 | 57 | 20 | 14 | 430 | 500 | ug/L | 0 | -- | -- |
| Oil Range Hydrocarbons | 20 | 57 | 0 | NA | NA | 500 | ug/L | 1 | -- | -- |
| Total TPHs D+O (ND=0U) | 20 | 57 | 20 | 14 | 430 | 500 | ug/L | 2 | -- | -- |
| Total TPHs D+O (ND=1/2U) | 20 | 57 | 20 | 110 | 690 | 500 | ug/L | 3 | 5% | 1 |
| Total TPHs G+D+O (ND=0U) | 20 | 57 | 25 | 82 | 2400 | 720 | ug/L | 8 | 14% | 3 |
| Total TPHs G+D+O (ND=1/2U) | 20 | 57 | 25 | 340 | 2500 | 720 | ug/L | 12 | 21% | 3 |
| **Volatile Organics** | | | | | | | | | | |
| Acetone | 72 | 115 | 29 | 5.9 | 1800 | -- | ug/L | -- | -- | -- |
| Acrylonitrile | 51 | 86 | 1 | 12 | 12 | 0.66 | ug/L | 1 | 1% | 17 |
| Benzene | 79 | 139 | 125 | 0.08 | 1800 | 58 | ug/L | 77 | 55% | 31 |
| Chloroform | 91 | 168 | 7 | 0.095 | 2.3 | 470 | ug/L | 0 | -- | -- |
| Dichloroethane -1,2 (EDC) | 72 | 115 | 0 | NA | NA | 99 | ug/L | 0 | -- | -- |
| Dichloroethene - cis 1,2 | 91 | 167 | 45 | 0.0696 | 810 | -- | ug/L | -- | -- | -- |
| Dichloroethene - trans 1,2 | 91 | 168 | 16 | 0.11 | 39 | 4000 | ug/L | 0 | -- | -- |
| Dichloroethene -1,1 | 91 | 168 | 9 | 0.165 | 5.8 | 3.2 | ug/L | 2 | 1% | 2 |
| Ethylbenzene | 79 | 139 | 46 | 0.21 | 27 | 130 | ug/L | 0 | -- | -- |
| Isopropylbenzene (cumene) | 59 | 94 | 23 | 0.2 | 16 | -- | ug/L | -- | -- | -- |
| Methylene Chloride | 91 | 168 | 9 | 1.9 | 9 | 1000 | ug/L | 0 | -- | -- |
| n-Butylbenzene | 59 | 94 | 5 | 0.25 | 2 | -- | ug/L | -- | -- | -- |
| n-Propylbenzene | 59 | 94 | 18 | 0.2 | 17 | -- | ug/L | -- | -- | -- |
| p-Isopropyltoluene | 59 | 94 | 4 | 0.29 | 1.6 | -- | ug/L | -- | -- | -- |
| sec-Butylbenzene | 59 | 94 | 9 | 0.28 | 2.7 | -- | ug/L | -- | -- | -- |
| Tetrachloroethene (PCE) | 91 | 168 | 18 | 0.105 | 34 | 8.9 | ug/L | 5 | 3% | 4 |
| Tetrachloroethane-1,1,2,2 | 91 | 168 | 1 | 0.0912 | 0.0912 | 3 | ug/L | 0 | -- | -- |
| Toluene | 79 | 139 | 62 | 0.08 | 39 | 520 | ug/L | 0 | -- | -- |
| Trichloroethene (TCE) | 91 | 168 | 29 | 0.1 | 23 | 7 | ug/L | 4 | 2% | 3 |
| Trimethylbenzene -1,2,4 | 59 | 94 | 7 | 0.2 | 5.5 | -- | ug/L | -- | -- | -- |
| Trimethylbenzene-1,3,5 | 59 | 94 | 6 | 0.23 | 5.4 | -- | ug/L | -- | -- | -- |
| Vinyl Chloride | 91 | 168 | 30 | 0.241 | 160 | 1.6 | ug/L | 20 | 12% | 100 |
| Xylenes (total) | 70 | 118 | 44 | 0.23 | 110 | -- | ug/L | -- | -- | -- |
| **Semivolatile Organics** | | | | | | | | | | |
| Bis-2ethylhexyl Phthalate | 5 | 7 | 2 | 1.1 | 2.4 | 1 | ug/L | 2 | 29% | 2 |
| Carbazole | 4 | 5 | 0 | NA | NA | -- | ug/L | -- | -- | -- |
| Dibenzofuran | 5 | 6 | 0 | NA | NA | -- | ug/L | -- | -- | -- |
| Diethyl Phthalate | 5 | 6 | 1 | 24 | 24 | 600 | ug/L | 0 | -- | -- |
| Dimethyl Phthalate | 5 | 6 | 0 | NA | NA | 2000 | ug/L | 0 | -- | -- |
| Hexachloro 1,3-butadiene | 72 | 124 | 0 | NA | NA | 0.2 | ug/L | 0 | -- | -- |
| Hexachlorobenzene | 17 | 35 | 1 | 0.0109 | 0.0109 | 0.2 | ug/L | 0 | -- | -- |
| Pentachlorophenol | 15 | 30 | 1 | 0.13 | 0.13 | 1 | ug/L | 0 | -- | -- |
| Phenol | 5 | 6 | 3 | 65 | 81 | 300000 | ug/L | 0 | -- | -- |
| **Semivolatile Organics: cPAHs** | | | | | | | | | | |
| Benz(a)anthracene | 20 | 25 | 5 | 0.0033 | 0.012 | 0.02 | ug/L | 0 | -- | -- |
| Benzo(a)pyrene | 20 | 25 | 1 | 0 | 0 | 0.02 | ug/L | 0 | -- | -- |
| Benzo(b)fluoranthene | 20 | 25 | 3 | 0.0041 | 0.021 | 0.02 | ug/L | 1 | 4% | 1 |
| Benzo(k)fluoranthene | 19 | 24 | 2 | 0 | 0 | 0.02 | ug/L | 0 | -- | -- |
| Chrysene | 20 | 25 | 2 | 0.0034 | 0.0078 | 0.03 | ug/L | 0 | -- | -- |
| Dibenz(a,h)anthracene | 20 | 25 | 3 | 0.0062 | 0.021 | 0.02 | ug/L | 1 | 4% | 1 |
| Indeno (1,2,3-cd)pyrene | 20 | 25 | 3 | 0.0067 | 0.033 | 0.02 | ug/L | 1 | 4% | 2 |
| Total cPAH (TEQ) | 20 | 25 | 8 | 0.0075 | 0.062 | 0.02 | ug/L | 2 | 8% | 3 |
| **Semivolatile Organics: Other PAHs** | | | | | | | | | | |
| Acenaphthylene | 20 | 25 | 1 | 0.004 | 0.004 | -- | ug/L | -- | -- | -- |
| Acenaphthene | 20 | 25 | 10 | 0.0088 | 0.5 | 90 | ug/L | 0 | -- | -- |
| Anthracene | 20 | 25 | 9 | 0.0063 | 0.073 | 400 | ug/L | 0 | -- | -- |
| Benzo(g,h,i)perylene | 5 | 6 | 0 | NA | NA | -- | ug/L | -- | -- | -- |
| Fluoranthene | 20 | 25 | 2 | 0.0048 | 0.013 | 20 | ug/L | 0 | -- | -- |
| Fluorene | 20 | 25 | 14 | 0.007 | 0.57 | 70 | ug/L | 0 | -- | -- |
| Methylnaphthalene-1 | 1 | 1 | 0 | NA | NA | -- | ug/L | -- | -- | -- |
| Methylnaphthalene-2 | 20 | 25 | 17 | 0.0033 | 19 | -- | ug/L | -- | -- | -- |
| Naphthalene | 67 | 117 | 21 | 0.03 | 15 | 4700 | ug/L | 0 | -- | -- |
| Phenanthrene | 20 | 25 | 10 | 0.012 | 0.69 | -- | ug/L | -- | -- | -- |
| Pyrene | 20 | 25 | 4 | 0.0042 | 0.015 | 30 | ug/L | 0 | -- | -- |
| **Metals** | | | | | | | | | | |
| ***Heavy Metals - Total*** | | | | | | | | | | |
| Arsenic | 20 | 22 | 20 | 0.26 | 570 | 5 | ug/L | 6 | 27% | 114 |
| Copper | 20 | 22 | 15 | 0.34 | 159 | 2.4 | ug/L | 8 | 36% | 66 |
| Lead | 21 | 25 | 18 | 0.0228 | 20 | 8.1 | ug/L | 3 | 12% | 2 |
| Nickel | 20 | 22 | 17 | 0.21 | 520 | 8.2 | ug/L | 5 | 23% | 63 |
| Zinc | 20 | 22 | 11 | 0.89 | 52.2 | 81 | ug/L | 0 | -- | -- |
| ***Heavy Metals - Dissolved*** | | | | | | | | | | |
| Arsenic | 23 | 40 | 15 | 1.2 | 364 | 5 | ug/L | 14 | 35% | 73 |
| Copper | 23 | 40 | 21 | 7.4 | 150 | 2.4 | ug/L | 21 | 53% | 63 |
| Lead | 42 | 60 | 11 | 0.0223 | 18 | 8.1 | ug/L | 2 | 3% | 2 |
| Nickel | 14 | 31 | 20 | 11.9 | 56 | 8.2 | ug/L | 20 | 65% | 7 |
| Zinc | 14 | 31 | 5 | 0.415 | 55.5 | 81 | ug/L | 0 | -- | -- |
| ***Organometals*** | | | | | | | | | | |
| Tetraethyl Lead | 16 | 17 | 0 | NA | NA | -- | ug/L | -- | -- | -- |

**Notes:**

Statistics are based on data from 2000-2015 (Appendix B).

-- dashes indicate screening level not established.

NA = not available.

# Table 6-4 - Statistical Summary of Groundwater Data (Deeper Than 25-foot Zone)

Project No. 130097, Alexander Avenue Petroleum Tank Facilities Site
Tacoma, Washington

| | | | | | | | | Exceedance Information | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Analyte | Total Number of Locations with Analysis | Total Number of Samples Analyzed | Total Number of Detections | Minimum Detected Concentration | Maximum Detected Concentration | Screening Level | Units | No. of Exceedances | Exceedance Frequency (%) | Maximum Exceedance Factor |
| **Petroleum Hydrocarbons without silica gel cleanup** | | | | | | | | | | |
| Gasoline Range Hydrocarbons | 23 | 28 | 7 | 13 | 41 | 800 | ug/L | 0 | -- | -- |
| Diesel Range Hydrocarbons | 13 | 14 | 4 | 17 | 44 | 500 | ug/L | 0 | -- | -- |
| Oil Range Hydrocarbons | 13 | 14 | 2 | 67 | 97 | 500 | ug/L | 0 | -- | -- |
| Total TPHs D+O (ND=0U) | 13 | 14 | 4 | 17 | 140 | 500 | ug/L | 0 | -- | -- |
| Total TPHs D+O (ND=1/2U) | 13 | 14 | 4 | 84 | 295 | 500 | ug/L | 0 | -- | -- |
| Total TPHs G+D+O (ND=0U) | 13 | 14 | 8 | 13 | 140 | 720 | ug/L | 0 | -- | -- |
| Total TPHs G+D+O (ND=1/2U) | 13 | 14 | 8 | 210 | 420 | 720 | ug/L | 0 | -- | -- |
| **Petroleum Hydrocarbons with silica gel cleanup** | | | | | | | | | | |
| Diesel Range Hydrocarbons | 10 | 11 | 4 | 25 | 64 | 500 | ug/L | 0 | -- | -- |
| Oil Range Hydrocarbons | 10 | 11 | 0 | NA | NA | 500 | ug/L | 0 | -- | -- |
| Total TPHs D+O (ND=0U) | 10 | 11 | 4 | 25 | 64 | 500 | ug/L | 0 | -- | -- |
| Total TPHs D+O (ND=1/2U) | 10 | 11 | 4 | 290 | 334 | 500 | ug/L | 0 | -- | -- |
| Total TPHs G+D+O (ND=0U) | 10 | 11 | 6 | 13 | 83 | 720 | ug/L | 0 | -- | -- |
| Total TPHs G+D+O (ND=1/2U) | 10 | 11 | 6 | 350 | 460 | 720 | ug/L | 0 | -- | -- |
| **Volatile Organics** | | | | | | | | | | |
| Acetone | 18 | 24 | 5 | 5 | 72 | -- | ug/L | -- | -- | -- |
| Acrylonitrile | 5 | 6 | 0 | NA | NA | 0.66 | ug/L | 0 | -- | -- |
| Benzene | 48 | 64 | 27 | 0.08 | 170 | 58 | ug/L | 4 | 6% | 3 |
| Chloroform | 53 | 90 | 21 | 0.08 | 39 | 470 | ug/L | 0 | -- | -- |
| Dichloroethane -1,2 (EDC) | 20 | 26 | 0 | NA | NA | 99 | ug/L | 0 | -- | -- |
| Dichloroethene - cis 1,2 | 53 | 90 | 33 | 0.07 | 19 | -- | ug/L | -- | -- | -- |
| Dichloroethene - trans 1,2 | 53 | 90 | 8 | 0.11 | 8.8 | 4000 | ug/L | 0 | -- | -- |
| Dichloroethene -1,1 | 53 | 90 | 0 | NA | NA | 3.2 | ug/L | 0 | -- | -- |
| Ethylbenzene | 48 | 64 | 12 | 0.05 | 96 | 130 | ug/L | 0 | -- | -- |
| Isopropylbenzene (cumene) | 9 | 10 | 0 | NA | NA | -- | ug/L | -- | -- | -- |
| Methylene Chloride | 53 | 90 | 5 | 0.16 | 0.28 | 1000 | ug/L | 0 | -- | -- |
| n-Butylbenzene | 9 | 10 | 0 | NA | NA | -- | ug/L | -- | -- | -- |
| n-Propylbenzene | 9 | 10 | 0 | NA | NA | -- | ug/L | -- | -- | -- |
| p-Isopropyltoluene | 9 | 10 | 0 | NA | NA | -- | ug/L | -- | -- | -- |
| sec-Butylbenzene | 9 | 10 | 0 | NA | NA | -- | ug/L | -- | -- | -- |
| Tetrachloroethene (PCE) | 53 | 90 | 4 | 0.07 | 0.163 | 8.9 | ug/L | 0 | -- | -- |
| Tetrachloroethane-1,1,2,2 | 53 | 90 | 0 | NA | NA | 3 | ug/L | 0 | -- | -- |
| Toluene | 48 | 64 | 28 | 0.06 | 26 | 520 | ug/L | 0 | -- | -- |
| Trichloroethene (TCE) | 53 | 90 | 17 | 0.137 | 2.3 | 7 | ug/L | 0 | -- | -- |
| Trimethylbenzene -1,2,4 | 9 | 10 | 0 | NA | NA | -- | ug/L | -- | -- | -- |
| Trimethylbenzene-1,3,5 | 9 | 10 | 0 | NA | NA | -- | ug/L | -- | -- | -- |
| Vinyl Chloride | 53 | 90 | 20 | 0.12 | 220 | 1.6 | ug/L | 9 | 10% | 138 |
| Xylenes (total) | 44 | 60 | 15 | 0.26 | 88 | -- | ug/L | -- | -- | -- |
| **Semivolatile Organics** | | | | | | | | | | |
| Bis(2-ethylhexyl) phthalate | 3 | 3 | 0 | NA | NA | 1 | ug/L | 0 | -- | -- |
| Carbazole | 3 | 3 | 0 | NA | NA | -- | ug/L | -- | -- | -- |
| Dibenzofuran | 3 | 3 | 0 | NA | NA | -- | ug/L | -- | -- | -- |
| Diethyl phthalate | 3 | 3 | 0 | NA | NA | 600 | ug/L | 0 | -- | -- |
| Dimethyl phthalate | 3 | 3 | 0 | NA | NA | 2000 | ug/L | 0 | -- | -- |
| Hexachlorobutadiene | 15 | 45 | 0 | NA | NA | 0.2 | ug/L | 0 | -- | -- |
| Hexachlorobenzene | 9 | 38 | 7 | 0.00931 | 0.14 | 0.2 | ug/L | 0 | -- | -- |
| Pentachlorophenol | 9 | 38 | 0 | NA | NA | 1 | ug/L | 0 | -- | -- |
| Phenol | 3 | 3 | 0 | NA | NA | 300000 | ug/L | 0 | -- | -- |
| **Semivolatile Organics: cPAHs** | | | | | | | | | | |
| Benz(a)anthracene | 23 | 28 | 7 | 0.0033 | 0.0055 | 0.02 | ug/L | 0 | -- | -- |
| Benzo(a)pyrene | 23 | 28 | 0 | NA | NA | 0.02 | ug/L | 0 | -- | -- |
| Benzo(b)fluoranthene | 23 | 28 | 1 | 0.0028 | 0.0028 | 0.02 | ug/L | 0 | -- | -- |
| Benzo(k)fluoranthene | 23 | 28 | 1 | 0 | 0 | 0.02 | ug/L | 0 | -- | -- |
| Chrysene | 23 | 28 | 3 | 0.0038 | 0.0063 | 0.03 | ug/L | 0 | -- | -- |
| Dibenz(a,h)anthracene | 23 | 28 | 0 | NA | NA | 0.02 | ug/L | 0 | -- | -- |
| Indeno (1,2,3-cd)pyrene | 23 | 28 | 1 | 0.0029 | 0.0029 | 0.02 | ug/L | 0 | -- | -- |
| Total cPAH (TEQ) | 23 | 28 | 7 | 0.012 | 0.015 | 0.02 | ug/L | 0 | -- | -- |
| **Semivolatile Organics: Other PAHs** | | | | | | | | | | |
| Acenaphthylene | 23 | 28 | 4 | 0.004 | 0.014 | -- | ug/L | -- | -- | -- |
| Acenaphthene | 23 | 28 | 8 | 0.0044 | 0.02 | 90 | ug/L | 0 | -- | -- |
| Anthracene | 23 | 28 | 3 | 0.0068 | 0.039 | 400 | ug/L | 0 | -- | -- |
| Benzo(g,h,i)perylene | 3 | 3 | 0 | NA | NA | -- | ug/L | -- | -- | -- |
| Fluoranthene | 23 | 28 | 1 | 0.0048 | 0.0048 | 20 | ug/L | 0 | -- | -- |
| Fluorene | 23 | 28 | 15 | 0.0039 | 0.027 | 70 | ug/L | 0 | -- | -- |
| Methylnaphthalene-1 | 0 | 0 | 0 | NA | NA | -- | ug/L | -- | -- | -- |
| Methylnaphthalene-2 | 23 | 28 | 22 | 0.0032 | 0.21 | -- | ug/L | -- | -- | -- |
| Naphthalene | 29 | 37 | 22 | 0.018 | 0.68 | 4700 | ug/L | 0 | -- | -- |
| Phenanthrene | 23 | 28 | 16 | 0.005 | 0.049 | -- | ug/L | -- | -- | -- |
| Pyrene | 23 | 28 | 6 | 0.0038 | 0.0058 | 30 | ug/L | 0 | -- | -- |
| **Metals** | | | | | | | | | | |
| ***Heavy Metals - Total*** | | | | | | | | | | |
| Arsenic | 36 | 38 | 38 | 0.32 | 34 | 5 | ug/L | 3 | 8% | 7 |
| Copper | 36 | 38 | 31 | 0.22 | 127 | 2.4 | ug/L | 15 | 39% | 53 |
| Lead | 36 | 38 | 30 | 0.024 | 68 | 8.1 | ug/L | 3 | 8% | 8 |
| Nickel | 36 | 38 | 27 | 0.21 | 31.1 | 8.2 | ug/L | 6 | 16% | 4 |
| Zinc | 36 | 38 | 12 | 3.39 | 156 | 81 | ug/L | 3 | 8% | 2 |
| ***Heavy Metals - Dissolved*** | | | | | | | | | | |
| Arsenic | 13 | 42 | 13 | 2.03 | 270 | 5 | ug/L | 11 | 26% | 54 |
| Copper | 13 | 42 | 15 | 6.5 | 2600 | 2.4 | ug/L | 15 | 36% | 1083 |
| Lead | 13 | 42 | 4 | 2.2 | 270 | 8.1 | ug/L | 2 | 5% | 33 |
| Nickel | 9 | 38 | 23 | 9 | 59.5 | 8.2 | ug/L | 23 | 61% | 7 |
| Zinc | 9 | 38 | 4 | 25 | 77.2 | 81 | ug/L | 0 | -- | -- |
| ***Organometals*** | | | | | | | | | | |
| Tetraethyl Lead | 22 | 24 | 0 | NA | NA | -- | ug/L | -- | -- | -- |

**Notes:**
Statistics are based on data from 2000-2015 (Appendix B).
-- dashes indicate screening level not established.
NA = not available.

## Table 6-5 - Statistical Summary of Seep Data

Project No. 130097, Alexander Avenue Petroleum Tank Facilities Site
Tacoma, Washington

| Analyte | Total Number of Locations with Analysis | Total Number of Samples Analyzed | Total Number of Detections | Minimum Detected Concentration | Maximum Detected Concentration | Screening Level | Units | Exceedance Information: No. of Exceedances | Exceedance Information: Exceedance Frequency (%) | Exceedance Information: Maximum Exceedance Factor |
|---|---|---|---|---|---|---|---|---|---|---|
| **Petroleum Hydrocarbons without silica gel cleanup** | | | | | | | | | | |
| Gasoline Range Hydrocarbons | 3 | 5 | 1 | 320 | 320 | 800 | ug/L | 0 | -- | -- |
| Diesel Range Hydrocarbons | 3 | 3 | 3 | 190 | 520 | 500 | ug/L | 1 | 33% | 1 |
| Oil Range Hydrocarbons | 3 | 3 | 1 | 320 | 320 | 500 | ug/L | 0 | -- | -- |
| Total TPHs D+O (ND=0U) | 3 | 3 | 3 | 190 | 750 | 500 | ug/L | 2 | 67% | 2 |
| Total TPHs D+O (ND=1/2U) | 3 | 3 | 3 | 290 | 750 | 500 | ug/L | 2 | 67% | 2 |
| Total TPHs G+D+O (ND=0U) | 3 | 3 | 3 | 190 | 750 | 720 | ug/L | 1 | 33% | 1 |
| Total TPHs G+D+O (ND=1/2U) | 3 | 3 | 3 | 420 | 880 | 720 | ug/L | 2 | 67% | 1 |
| **Petroleum Hydrocarbons with silica gel cleanup** | | | | | | | | | | |
| Diesel Range Hydrocarbons | 3 | 5 | 0 | NA | NA | 500 | ug/L | 0 | -- | -- |
| Oil Range Hydrocarbons | 3 | 5 | 1 | NA | NA | 500 | ug/L | 0 | -- | -- |
| Total TPHs D+O (ND=0U) | 3 | 5 | 2 | NA | NA | 500 | ug/L | 0 | -- | -- |
| Total TPHs D+O (ND=1/2U) | 3 | 5 | 3 | NA | NA | 500 | ug/L | 0 | -- | -- |
| Total TPHs G+D+O (ND=0U) | 3 | 5 | 1 | 320 | 320 | 720 | ug/L | 0 | -- | -- |
| Total TPHs G+D+O (ND=1/2U) | 3 | 5 | 1 | 470 | 470 | 720 | ug/L | 0 | -- | -- |
| **Volatile Organics** | | | | | | | | | | |
| Acetone | 3 | 5 | 0 | NA | NA | -- | ug/L | -- | -- | -- |
| Acrylonitrile | 3 | 5 | 0 | NA | NA | 0.66 | ug/L | 0 | -- | -- |
| Benzene | 3 | 5 | 4 | 0.21 | 48 | 58 | ug/L | 0 | -- | -- |
| Chloroform | 7 | 9 | 0 | NA | NA | 470 | ug/L | 0 | -- | -- |
| Dichloroethane -1,2 (EDC) | 3 | 5 | 0 | NA | NA | 99 | ug/L | 0 | -- | -- |
| Dichloroethene - cis 1,2 | 7 | 9 | 2 | 17 | 175 | -- | ug/L | -- | -- | -- |
| Dichloroethene - trans 1,2 | 6 | 8 | 0 | NA | NA | 4000 | ug/L | 0 | -- | -- |
| Dichloroethene -1,1 | 6 | 8 | 0 | NA | NA | 3.2 | ug/L | 0 | -- | -- |
| Ethylbenzene | 3 | 5 | 1 | 0.32 | 0.32 | 130 | ug/L | 0 | -- | -- |
| Isopropylbenzene (cumene) | 3 | 5 | 2 | 0.29 | 1 | -- | ug/L | -- | -- | -- |
| Methylene Chloride | 6 | 8 | 3 | 8 | 8.8 | 1000 | ug/L | 0 | -- | -- |
| n-Butylbenzene | 3 | 5 | 0 | NA | NA | -- | ug/L | -- | -- | -- |
| n-Propylbenzene | 3 | 5 | 1 | 0.79 | 0.79 | -- | ug/L | -- | -- | -- |
| p-Isopropyltoluene | 3 | 5 | 0 | NA | NA | -- | ug/L | -- | -- | -- |
| sec-Butylbenzene | 3 | 5 | 1 | 0.21 | 0.21 | -- | ug/L | -- | -- | -- |
| Tetrachloroethene (PCE) | 7 | 9 | 1 | 4 | 4 | 8.9 | ug/L | 0 | -- | -- |
| Tetrachloroethane-1,1,2,2 | 6 | 8 | 0 | NA | NA | 3 | ug/L | 0 | -- | -- |
| Toluene | 3 | 5 | 1 | 0.5 | 0.5 | 520 | ug/L | 0 | -- | -- |
| Trichloroethene (TCE) | 7 | 9 | 1 | 13 | 13 | 7 | ug/L | 1 | 11% | 2 |
| Trimethylbenzene -1,2,4 | 3 | 5 | 0 | NA | NA | -- | ug/L | -- | -- | -- |
| Trimethylbenzene-1,3,5 | 3 | 5 | 0 | NA | NA | -- | ug/L | -- | -- | -- |
| Vinyl Chloride | 7 | 9 | 1 | 6.5 | 6.5 | 1.6 | ug/L | 1 | 11% | 4 |
| Xylenes (total) | 3 | 5 | 0 | NA | NA | -- | ug/L | -- | -- | -- |
| **Semivolatile Organics** | | | | | | | | | | |
| Bis-2ethylhexyl Phthalate | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Carbazole | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Dibenzofuran | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Diethyl Phthalate | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Dimethyl Phthalate | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Hexachloro 1,3-butadiene | 3 | 5 | 0 | NA | NA | 0.2 | ug/L | 0 | -- | -- |
| Hexachlorobenzene | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Pentachlorophenol | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Phenol | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| **Semivolatile Organics: cPAHs** | | | | | | | | | | |
| Benz(a)anthracene | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Benzo(a)pyrene | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Benzo(b)fluoranthene | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Benzo(k)fluoranthene | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Chrysene | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Dibenz(a,h)anthracene | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Indeno (1,2,3-cd)pyrene | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Total cPAH (TEQ) | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| **Semivolatile Organics: Other PAHs** | | | | | | | | | | |
| Acenaphthylene | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Acenaphthene | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Anthracene | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Benzo(g,h,i)perylene | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Fluoranthene | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Fluorene | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Methylnaphthalene-1 | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Methylnaphthalene-2 | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Naphthalene | 3 | 5 | 1 | 0.62 | 0.62 | 4700 | ug/L | 0 | -- | -- |
| Phenanthrene | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Pyrene | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| **Metals** | | | | | | | | | | |
| ***Heavy Metals - Total*** | | | | | | | | | | |
| Arsenic | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Copper | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Lead | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Nickel | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Zinc | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| ***Heavy Metals - Dissolved*** | | | | | | | | | | |
| Arsenic | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Copper | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Lead | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Nickel | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| Zinc | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |
| ***Organometals*** | | | | | | | | | | |
| Tetraethyl Lead | 0 | 0 | 0 | NA | NA | -- | -- | -- | -- | -- |

**Notes:**

Statistics are based on data from 2000-2015 (Appendix B).

-- dashes indicate screening level not established.

NA = not available.

## Table 6-6 - Statistical Summary of Soil Data (0- to 30-foot Depth)

Project No. 130097, Alexander Avenue Petroleum Tank Facilities Site
Tacoma, Washington

| | | | | | | | | Exceedance Information | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Analyte** | **Total Number of Locations with Analysis** | **Total Number of Samples Analyzed** | **Total Number of Detections** | **Minimum Detected Concentration** | **Maximum Detected Concentration** | **Screening Level** | **Units** | **No. of Exceedances** | **Exceedance Frequency (%)** | **Maximum Exceedance Factor** |
| **Petroleum Hydrocarbons without silica gel cleanup** | | | | | | | | | | |
| Gasoline Range Hydrocarbons | 103 | 277 | 81 | 1.6 | 14000 | 30 | mg/kg | 55 | 20% | 467 |
| Diesel Range Hydrocarbons | 70 | 196 | 93 | 2 | 28000 | 2000 | mg/kg | 35 | 18% | 14 |
| Oil Range Hydrocarbons | 73 | 199 | 72 | 4.1 | 10000 | 2000 | mg/kg | 3 | 2% | 5 |
| Total TPHs D+O (ND=1/2U) | 73 | 199 | 99 | 6.1 | 31300 | 2000 | mg/kg | 39 | 20% | 16 |
| **Petroleum Hydrocarbons with silica gel cleanup** | | | | | | | | | | |
| Diesel Range Hydrocarbons | 43 | 102 | 36 | 6 | 54000 | 2000 | mg/kg | 17 | 17% | 27 |
| Oil Range Hydrocarbons | 43 | 102 | 21 | 24 | 4000 | 2000 | mg/kg | 1 | 1% | 2 |
| Total TPHs D+O (ND=1/2U) | 43 | 102 | 36 | 12 | 54390 | 2000 | mg/kg | 17 | 17% | 27.195 |
| **Volatile Organics** | | | | | | | | | | |
| Acetone | 67 | 166 | 94 | 0.0044 | 0.58 | 3200000 | mg/kg | 0 | -- | -- |
| Acrylonitrile | 48 | 124 | 0 | NA | NA | 1 | mg/kg | 0 | -- | -- |
| Benzene | 113 | 316 | 168 | 0.000078 | 36 | 0.02 | mg/kg | 91 | 29% | 1800 |
| Chloroform | 117 | 396 | 18 | 0.004 | 2.31 | 4200 | mg/kg | 0 | -- | -- |
| Dichloroethane -1,2 (EDC) | 67 | 166 | 0 | NA | NA | 1400 | mg/kg | 0 | -- | -- |
| Dichloroethene - cis 1,2 | 117 | 396 | 48 | 0.00028 | 2.3 | 7000 | mg/kg | 0 | -- | -- |
| Dichloroethene - trans 1,2 | 117 | 396 | 24 | 0.00033 | 0.13 | 70000 | mg/kg | 0 | -- | -- |
| Dichloroethene -1,1 | 117 | 396 | 12 | 0.00042 | 0.0631 | 180000 | mg/kg | 0 | -- | -- |
| Ethylbenzene | 113 | 317 | 114 | 0.00014 | 200 | 0.06 | mg/kg | 0 | -- | -- |
| Isopropylbenzene (cumene) | 67 | 162 | 32 | 0.0013 | 37 | 350000 | mg/kg | 0 | -- | -- |
| Methylene Chloride | 117 | 397 | 133 | 0.00137 | 1.3 | 21000 | mg/kg | 0 | -- | -- |
| n-Butylbenzene | 67 | 162 | 35 | 0.0012 | 56 | 180000 | mg/kg | 0 | -- | -- |
| n-Propylbenzene | 67 | 162 | 42 | 0.0012 | 98 | 350000 | mg/kg | 0 | -- | -- |
| p-Isopropyltoluene | 67 | 162 | 29 | 0.0014 | 39 | -- | mg/kg | -- | -- | -- |
| sec-Butylbenzene | 67 | 162 | 37 | 0.0015 | 28 | 350000 | mg/kg | 0 | -- | -- |
| Tetrachloroethene (PCE) | 117 | 396 | 142 | 0.00024 | 12 | 0.005 | mg/kg | 55 | 14% | 2400 |
| Tetrachloroethane-1,1,2,2 | 117 | 393 | 4 | 0.0021 | 3.1 | 660 | mg/kg | 0 | -- | -- |
| Toluene | 113 | 316 | 157 | 0.0002 | 22 | 280000 | mg/kg | 0 | -- | -- |
| Trichloroethene (TCE) | 117 | 396 | 84 | 0.00021 | 1.92 | 0.005 | mg/kg | 30 | 8% | 384 |
| Trimethylbenzene -1,2,4 | 67 | 162 | 28 | 0.0011 | 700 | -- | mg/kg | -- | -- | -- |
| Trimethylbenzene-1,3,5 | 67 | 162 | 25 | 0.0011 | 75 | 35000 | mg/kg | 0 | -- | -- |
| Vinyl Chloride | 117 | 393 | 28 | 0.00029 | 0.073 | 0.005 | mg/kg | 9 | 2% | 15 |
| Xylenes (total) | 85 | 269 | 134 | 0.00045 | 360 | 700000 | mg/kg | 0 | -- | -- |
| **Semivolatile Organics** | | | | | | | | | | |
| Bis-2ethylhexyl Phthalate | 22 | 56 | 1 | 0.16 | 0.16 | 0.04 | mg/kg | 1 | 2% | 5 |
| Carbazole | 22 | 56 | 0 | NA | NA | -- | mg/kg | -- | -- | -- |
| Dibenzofuran | 22 | 56 | 5 | 0.022 | 0.72 | 3500 | mg/kg | 0 | -- | -- |
| Diethyl Phthalate | 22 | 56 | 0 | NA | NA | 2800000 | mg/kg | 0 | -- | -- |
| Dimethyl Phthalate | 22 | 56 | 0 | NA | NA | -- | mg/kg | -- | -- | -- |
| Hexachloro 1,3-butadiene | 82 | 250 | 31 | 0.0011 | 9.1 | 0.01 | mg/kg | 17 | 7% | 910 |
| Hexachlorobenzene | 38 | 148 | 24 | 0.0000975 | 0.771 | 0.01 | mg/kg | 16 | 11% | 77 |
| Pentachlorophenol | 37 | 132 | 13 | 0.00166 | 1.1 | 0.1 | mg/kg | 5 | 4% | 11 |
| Phenol | 22 | 56 | 1 | 0.14 | 0.14 | 1100000 | mg/kg | 0 | -- | -- |
| **Semivolatile Organics: cPAHs** | | | | | | | | | | |
| Benz(a)anthracene | 64 | 218 | 116 | 0.00073 | 0.58 | -- | mg/kg | -- | -- | -- |
| Benzo(a)pyrene | 64 | 218 | 68 | 0.00079 | 0.81 | -- | mg/kg | -- | -- | -- |
| Benzo(b)fluoranthene | 64 | 218 | 73 | 0.0011 | 1.2 | -- | mg/kg | -- | -- | -- |
| Benzo(k)fluoranthene | 46 | 182 | 44 | 0.00087 | 0.77 | -- | mg/kg | -- | -- | -- |
| Chrysene | 64 | 218 | 113 | 0.0008 | 1 | -- | mg/kg | -- | -- | -- |
| Dibenz(a,h)anthracene | 64 | 218 | 41 | 0.00082 | 0.05 | -- | mg/kg | -- | -- | -- |
| Indeno (1,2,3-cd)pyrene | 64 | 218 | 51 | 0.00088 | 0.61 | -- | mg/kg | -- | -- | -- |
| Total cPAH (TEQ) | 64 | 218 | 130 | 0.0016 | 1.2 | 10 | mg/kg | 0 | -- | -- |
| **Semivolatile Organics: Other PAHs** | | | | | | | | | | |
| Acenaphthylene | 64 | 218 | 35 | 0.00079 | 0.15 | -- | mg/kg | -- | -- | -- |
| Acenaphthene | 64 | 218 | 92 | 0.00097 | 6.4 | 210000 | mg/kg | 0 | -- | -- |
| Anthracene | 64 | 218 | 86 | 0.00059 | 1.5 | 1100000 | mg/kg | 0 | -- | -- |
| Benzo(g,h,i)perylene | 27 | 61 | 4 | 0.015 | 0.68 | -- | mg/kg | -- | -- | -- |
| Fluoranthene | 64 | 218 | 106 | 0.001 | 1.7 | 140000 | mg/kg | 0 | -- | -- |
| Fluorene | 64 | 218 | 116 | 0.00062 | 11 | 140000 | mg/kg | 0 | -- | -- |
| Methylnaphthalene-1 | 18 | 36 | 4 | 0.0076 | 15 | 4500 | mg/kg | 0 | -- | -- |
| Methylnaphthalene-2 | 64 | 218 | 152 | 0.00051 | 160 | 14000 | mg/kg | 0 | -- | -- |
| Naphthalene | 104 | 319 | 174 | 0.00061 | 250 | 6.1 | mg/kg | 19 | 6% | 41.66666667 |
| Phenanthrene | 64 | 218 | 158 | 0.0016 | 22 | -- | mg/kg | -- | -- | -- |
| Pyrene | 64 | 218 | 128 | 0.00076 | 2.1 | 110000 | mg/kg | 0 | -- | -- |
| **Metals** | | | | | | | | | | |
| ***Heavy Metals*** | | | | | | | | | | |
| Arsenic | 77 | 288 | 232 | 0.15 | 268 | 20 | mg/kg | 16 | 7% | 13 |
| Copper | 77 | 288 | 288 | 2.98 | 7070 | 36 | mg/kg | 25 | 11% | 196 |
| Lead | 94 | 320 | 266 | 0.63 | 37500 | 1000 | mg/kg | 17 | 6% | 38 |
| Nickel | 53 | 236 | 236 | 0.857 | 962 | 48 | mg/kg | 21 | 9% | 20 |
| Zinc | 53 | 236 | 231 | 7.07 | 2540 | 85 | mg/kg | 25 | 11% | 30 |
| ***Organometals*** | | | | | | | | | | |
| Tetraethyl Lead | 32 | 126 | 6 | 0.32 | 2.1 | 0.35 | mg/kg | 5 | 4% | 6 |

**Notes:**

Statistics are based on data from 2000-2015 (Appendix B).

-- dashes indicate screening level not established.

NA = not available.

## Table 6-7 - Statistical Summary of Soil Data (Greater Than 30-foot Depth)

Project No. 130097, Alexander Avenue Petroleum Tank Facilities Site
Tacoma, Washington

| Analyte | Total Number of Locations with Analysis | Total Number of Samples Analyzed | Total Number of Detections | Minimum Detected Concentration | Maximum Detected Concentration | Screening Level | Units | Exceedance Information: No. of Exceedances | Exceedance Information: Exceedance Frequency (%) | Exceedance Information: Maximum Exceedance Factor |
|---|---|---|---|---|---|---|---|---|---|---|
| **Petroleum Hydrocarbons without silica gel cleanup** | | | | | | | | | | |
| Gasoline Range Hydrocarbons | 1 | 2 | 0 | NA | NA | 30 | mg/kg | 0 | -- | -- |
| Diesel Range Hydrocarbons | 1 | 2 | 0 | NA | NA | 2000 | mg/kg | 0 | -- | -- |
| Oil Range Hydrocarbons | 1 | 2 | 1 | 5.2 | 5.2 | 2000 | mg/kg | 0 | -- | -- |
| Total TPHs D+O (ND=1/2U) | 1 | 2 | 1 | 20.7 | 20.7 | 2000 | mg/kg | 0 | -- | -- |
| **Petroleum Hydrocarbons with silica gel cleanup** | | | | | | | | | | |
| Diesel Range Hydrocarbons | 0 | 0 | 0 | NA | NA | 2000 | mg/kg | -- | -- | -- |
| Oil Range Hydrocarbons | 0 | 0 | 0 | NA | NA | 2000 | mg/kg | -- | -- | -- |
| Total TPHs D+O (ND=1/2U) | 0 | 0 | 0 | NA | NA | 2000 | mg/kg | -- | -- | -- |
| **Volatile Organics** | | | | | | | | | | |
| Acetone | 0 | 0 | 0 | NA | NA | 3200000 | mg/kg | 0 | -- | -- |
| Acrylonitrile | 0 | 0 | 0 | NA | NA | 1 | mg/kg | 0 | -- | -- |
| Benzene | 1 | 2 | 2 | 0.00008 | 0.0002 | 0.02 | mg/kg | 0 | -- | -- |
| Chloroform | 1 | 2 | 0 | NA | NA | 4200 | mg/kg | 0 | -- | -- |
| Dichloroethane -1,2 (EDC) | 0 | 0 | 0 | NA | NA | 1400 | mg/kg | 0 | -- | -- |
| Dichloroethene - cis 1,2 | 1 | 2 | 0 | NA | NA | 7000 | mg/kg | 0 | -- | -- |
| Dichloroethene - trans 1,2 | 1 | 2 | 0 | NA | NA | 70000 | mg/kg | 0 | -- | -- |
| Dichloroethene -1,1 | 1 | 2 | 0 | NA | NA | 180000 | mg/kg | 0 | -- | -- |
| Ethylbenzene | 1 | 2 | 1 | 0.00032 | 0.00032 | 0.06 | mg/kg | 0 | -- | -- |
| Isopropylbenzene (cumene) | 0 | 0 | 0 | NA | NA | 350000 | mg/kg | 0 | -- | -- |
| Methylene Chloride | 1 | 2 | 0 | NA | NA | 21000 | mg/kg | 0 | -- | -- |
| n-Butylbenzene | 0 | 0 | 0 | NA | NA | 180000 | mg/kg | 0 | -- | -- |
| n-Propylbenzene | 0 | 0 | 0 | NA | NA | 350000 | mg/kg | 0 | -- | -- |
| p-Isopropyltoluene | 0 | 0 | 0 | NA | NA | -- | mg/kg | -- | -- | -- |
| sec-Butylbenzene | 0 | 0 | 0 | NA | NA | 350000 | mg/kg | 0 | -- | -- |
| Tetrachloroethene (PCE) | 1 | 2 | 0 | NA | NA | 0.005 | mg/kg | 0 | -- | -- |
| Tetrachloroethane-1,1,2,2 | 1 | 2 | 0 | NA | NA | 660 | mg/kg | 0 | -- | -- |
| Toluene | 1 | 2 | 2 | 0.00044 | 0.00087 | 280000 | mg/kg | 0 | -- | -- |
| Trichloroethene (TCE) | 1 | 2 | 0 | NA | NA | 0.005 | mg/kg | 0 | -- | -- |
| Trimethylbenzene -1,2,4 | 0 | 0 | 0 | NA | NA | -- | mg/kg | -- | -- | -- |
| Trimethylbenzene-1,3,5 | 0 | 0 | 0 | NA | NA | 35000 | mg/kg | 0 | -- | -- |
| Vinyl Chloride | 1 | 2 | 0 | NA | NA | 0.005 | mg/kg | 0 | -- | -- |
| Xylenes (total) | 1 | 2 | 0 | NA | NA | 700000 | mg/kg | 0 | -- | -- |
| **Semivolatile Organics** | | | | | | | | | | |
| Bis-2ethylhexyl Phthalate | 0 | 0 | 0 | NA | NA | 0.04 | mg/kg | 0 | -- | -- |
| Carbazole | 0 | 0 | 0 | NA | NA | -- | mg/kg | -- | -- | -- |
| Dibenzofuran | 0 | 0 | 0 | NA | NA | 3500 | mg/kg | 0 | -- | -- |
| Diethyl Phthalate | 0 | 0 | 0 | NA | NA | 2800000 | mg/kg | 0 | -- | -- |
| Dimethyl Phthalate | 0 | 0 | 0 | NA | NA | -- | mg/kg | -- | -- | -- |
| Hexachloro 1,3-butadiene | 0 | 0 | 0 | NA | NA | 0.01 | mg/kg | 0 | -- | -- |
| Hexachlorobenzene | 0 | 0 | 0 | NA | NA | 0.01 | mg/kg | 0 | -- | -- |
| Pentachlorophenol | 0 | 0 | 0 | NA | NA | 0.1 | mg/kg | 0 | -- | -- |
| Phenol | 0 | 0 | 0 | NA | NA | 1100000 | mg/kg | 0 | -- | -- |
| **Semivolatile Organics: cPAHs** | | | | | | | | | | |
| Benz(a)anthracene | 1 | 2 | 1 | 0.00073 | 0.00073 | -- | mg/kg | -- | -- | -- |
| Benzo(a)pyrene | 1 | 2 | 0 | NA | NA | -- | mg/kg | -- | -- | -- |
| Benzo(b)fluoranthene | 1 | 2 | 0 | NA | NA | -- | mg/kg | -- | -- | -- |
| Benzo(k)fluoranthene | 1 | 2 | 0 | NA | NA | -- | mg/kg | -- | -- | -- |
| Chrysene | 1 | 2 | 1 | 0.0009 | 0.0009 | -- | mg/kg | -- | -- | -- |
| Dibenz(a,h)anthracene | 1 | 2 | 0 | NA | NA | -- | mg/kg | -- | -- | -- |
| Indeno (1,2,3-cd)pyrene | 1 | 2 | 0 | NA | NA | -- | mg/kg | -- | -- | -- |
| Total cPAH (TEQ) | 1 | 2 | 1 | 0.0023 | 0.0023 | 10 | mg/kg | 0 | -- | -- |
| **Semivolatile Organics: Other PAHs** | | | | | | | | | | |
| Acenaphthylene | 1 | 2 | 0 | NA | NA | -- | mg/kg | -- | -- | -- |
| Acenaphthene | 1 | 2 | 0 | NA | NA | 210000 | mg/kg | 0 | -- | -- |
| Anthracene | 1 | 2 | 0 | NA | NA | 1100000 | mg/kg | 0 | -- | -- |
| Benzo(g,h,i)perylene | 0 | 0 | 0 | NA | NA | -- | mg/kg | -- | -- | -- |
| Fluoranthene | 1 | 2 | 0 | NA | NA | 140000 | mg/kg | 0 | -- | -- |
| Fluorene | 1 | 2 | 0 | NA | NA | 140000 | mg/kg | 0 | -- | -- |
| Methylnaphthalene-1 | 0 | 0 | 0 | NA | NA | 4500 | mg/kg | 0 | -- | -- |
| Methylnaphthalene-2 | 1 | 2 | 2 | 0.00077 | 0.0034 | 14000 | mg/kg | 0 | -- | -- |
| Naphthalene | 1 | 2 | 1 | 0.0012 | 0.0012 | 6.1 | mg/kg | 0 | -- | -- |
| Phenanthrene | 1 | 2 | 1 | 0.004 | 0.004 | -- | mg/kg | -- | -- | -- |
| Pyrene | 1 | 2 | 1 | 0.00083 | 0.00083 | 110000 | mg/kg | 0 | -- | -- |
| **Metals** | | | | | | | | | | |
| ***Heavy Metals*** | | | | | | | | | | |
| Arsenic | 1 | 2 | 2 | 0.57 | 1.14 | 20 | mg/kg | 0 | -- | -- |
| Copper | 1 | 2 | 2 | 9.73 | 13.1 | 36 | mg/kg | 0 | -- | -- |
| Lead | 1 | 2 | 2 | 1.17 | 1.41 | 1000 | mg/kg | 0 | -- | -- |
| Nickel | 1 | 2 | 2 | 6.25 | 8.71 | 48 | mg/kg | 0 | -- | -- |
| Zinc | 1 | 2 | 0 | NA | NA | 85 | mg/kg | 0 | -- | -- |
| ***Organometals*** | | | | | | | | | | |
| Tetraethyl Lead | 1 | 2 | 0 | NA | NA | 0.35 | mg/kg | 0 | -- | -- |

**Notes:**
Statistics are based on data from 2000-2015 (Appendix B).
-- dashes indicate screening level not established.
NA = not available.

# Table 6-8 - Summary of Site COCs, IHSs, and Screening Levels

Project No. 130097, Alexander Avenue Petroleum Tank Facilities Site
Tacoma, Washington

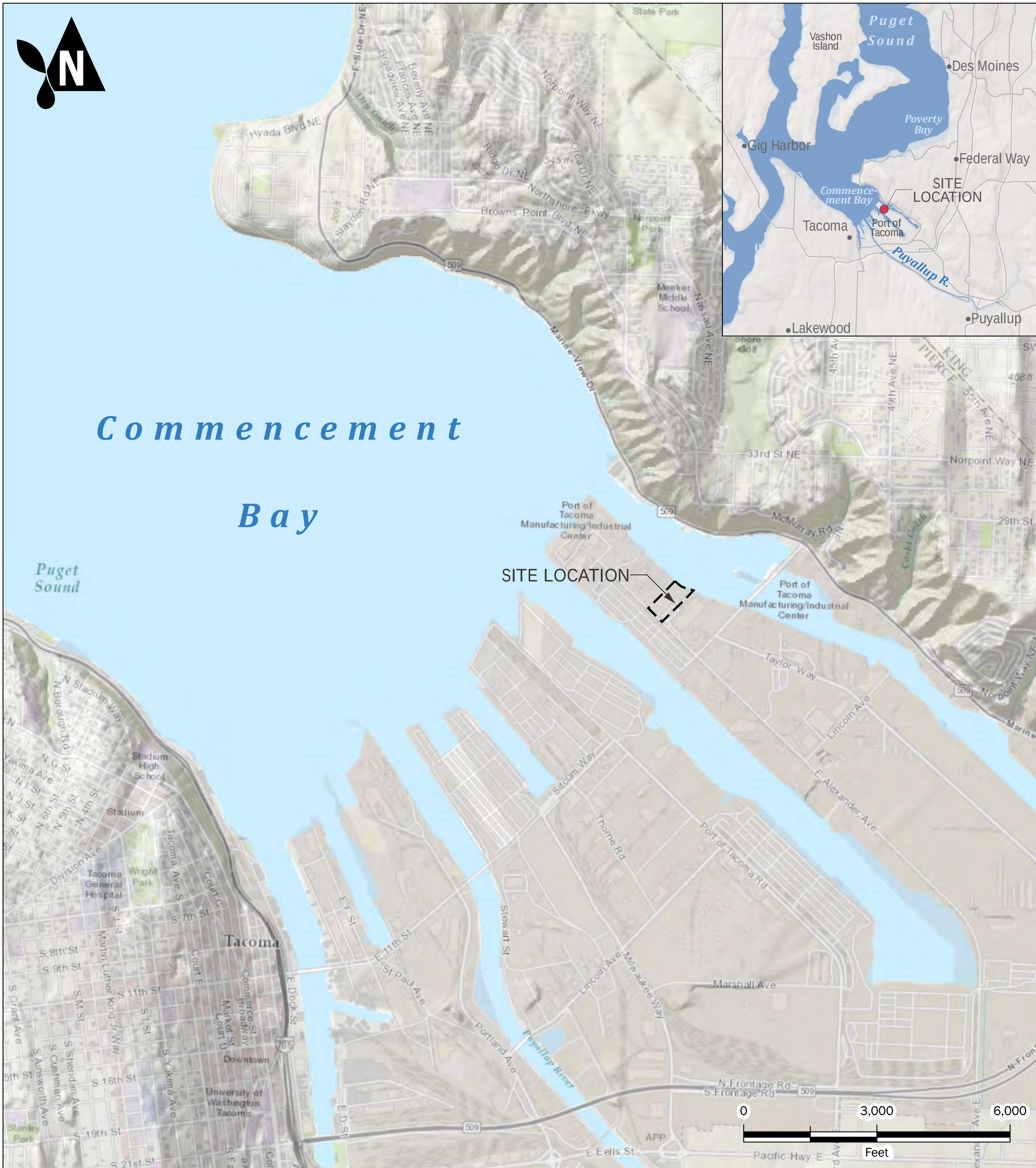
| | Soil Screening Levels | | Groundwater Screening Levels | |
|---|---|---|---|---|
| **Analyte** | **Direct Contact Based (mg/kg)** | **Groundwater Protection Based (mg/kg)** | **Surface Water Protection Based (ug/L)** | **Vapor Protection Based (ug/L)** |
| **Petroleum Hydrocarbons** | | | | |
| Gasoline Range Hydrocarbons | -- | 30 | 800 | -- |
| Diesel Range Hydrocarbons | -- | 2000 | 500 | -- |
| Oil Range Hydrocarbons | -- | 2000 | 500 | -- |
| Total TPH (D+O Range) | -- | 2000 | 500 | -- |
| Total TPH (G+D+O Range) | -- | -- | 720 | -- |
| **Volatile Organics** | | | | |
| Benzene | 2400 | 0.02 | 58 | 24 |
| Dichloroethene -1,1 | 180000 | -- | 3.2 | 280 |
| Ethylbenzene | 350000 | 0.06 | 130 | 6000 |
| Tetrachloroethene (PCE) | 21000 | 0.005 | 8.9 | 100 |
| Trichloroethene (TCE) | 1800 | 0.005 | 7 | 8.3 |
| Trimethylbenzene -1,2,4 | -- | -- | -- | 63 |
| Vinyl Chloride | 88 | 0.005 | 1.6 | 5.4 |
| Xylenes (total) | 700000 | -- | -- | 970 |
| **Semivolatile Organics: PAHs** | | | | |
| Naphthalene | 70000 | 6.1 | 4700 | 90 |

**Notes:**

-- dashes indicate screening level not established.

Indicator Hazardous Substances (IHSs)

# FIGURES



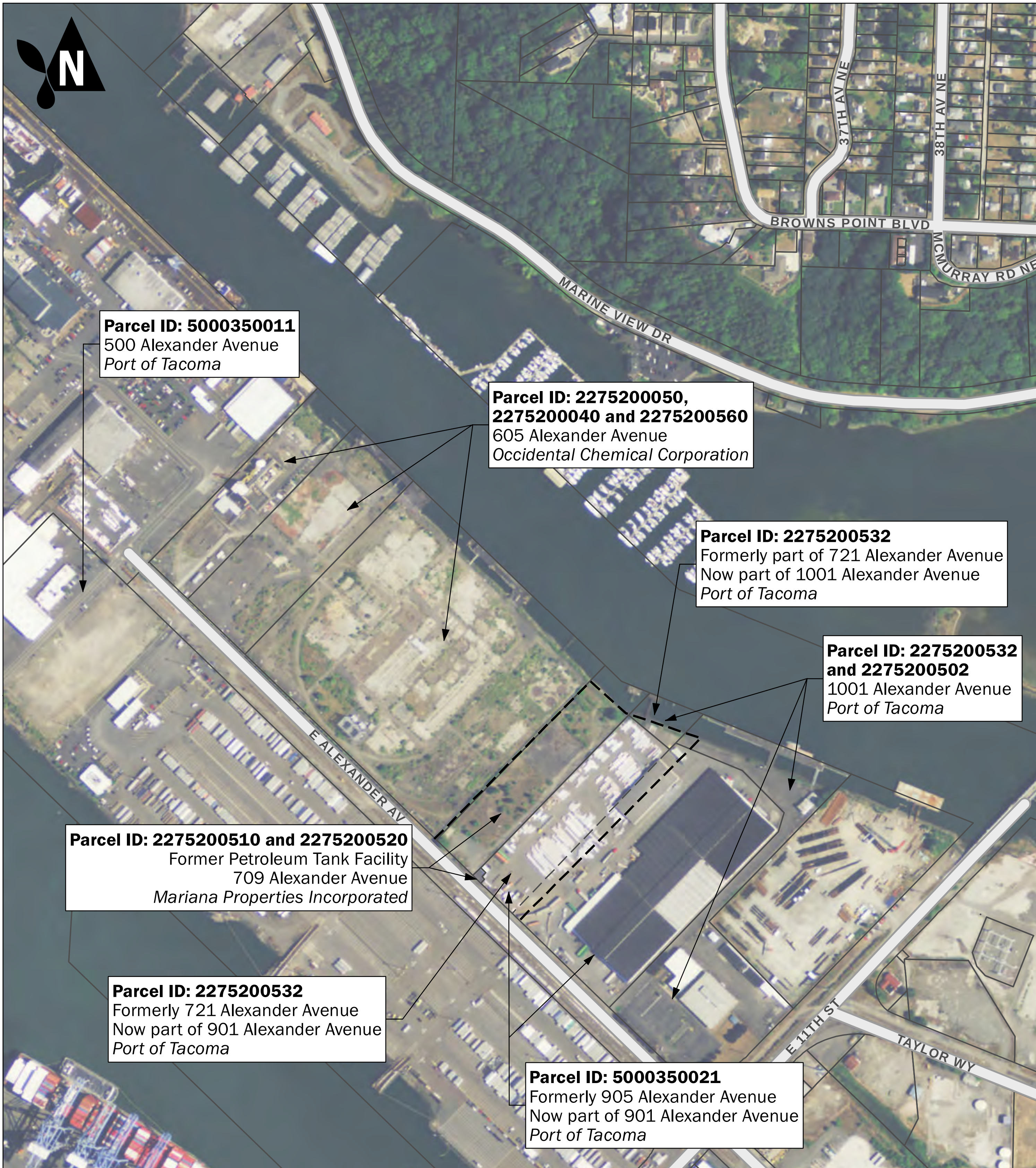


# Site Location Map

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

| | | | |
|---|---|---|---|
| Aspect CONSULTING | FEB-2016 | BY: DFR / EAC | FIGURE NO. |
| | PROJECT NO. 130097-01D | REVISED BY: AET / RAP | 1.1 |

GIS Path: T:\projects_8\Port_of_Tacoma\AlexanderAve_130097\Delivered\RemedialInvestigationReport\1.1 Site Vicinity.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 2/24/2016 || User: rbobich || Print Date: 3/31/2016




Parcel ID → **Parcel ID: 2275200532**
Parcel Address and Information → 1001 Alexander Avenue
Owner → *Port of Tacoma*

- - - Subject Properties Outline
— — Former Parcel Line
Tax Parcel Boundary

0 500 1,000
Feet

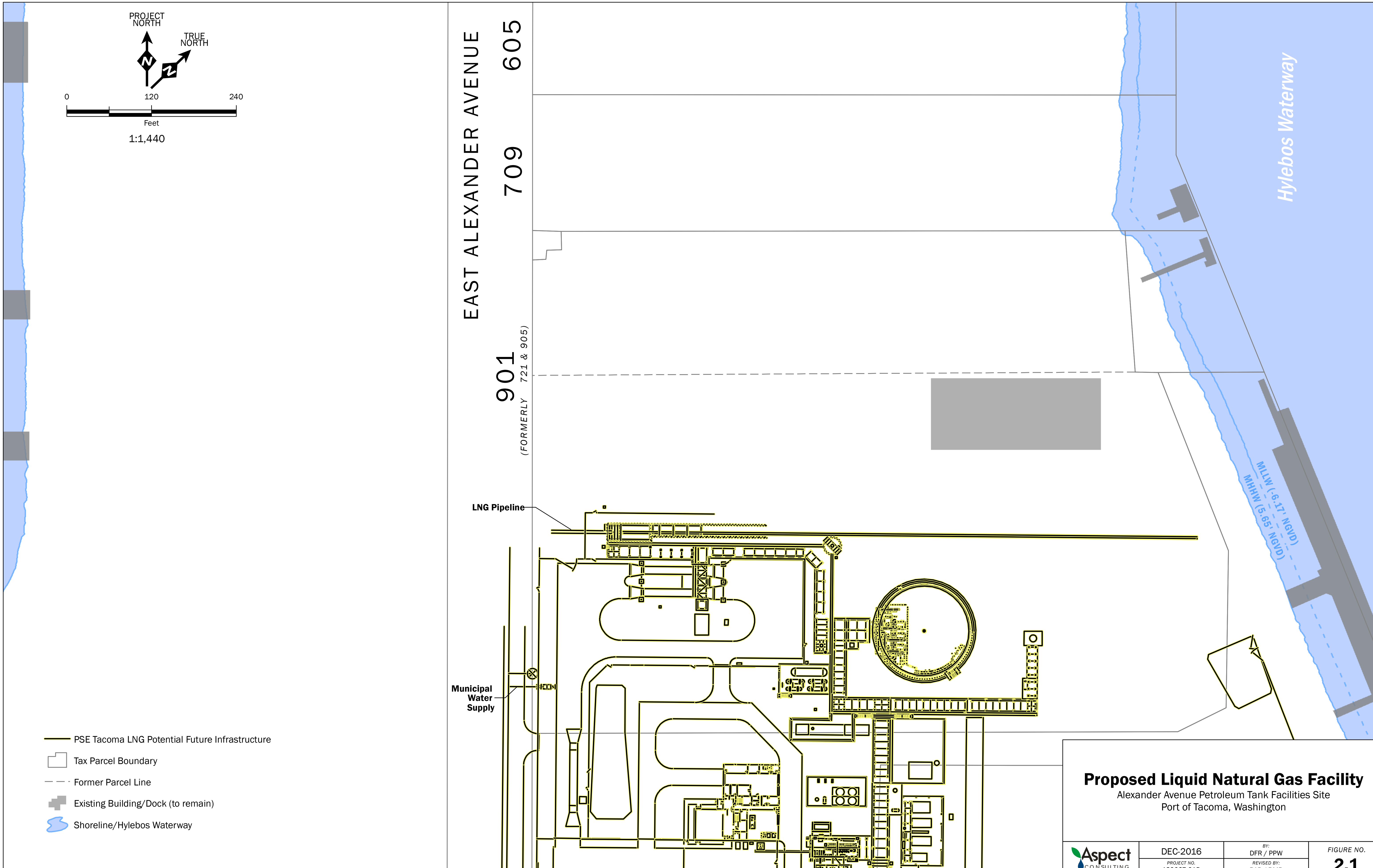
# Site Properties Map

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING

| | | | |
|---|---|---|---|
| FEB-2016 | BY: DFR / EAC | FIGURE NO. 1.2 |
| PROJECT NO. 130097-01D | REVISED BY: AET / RAP | |

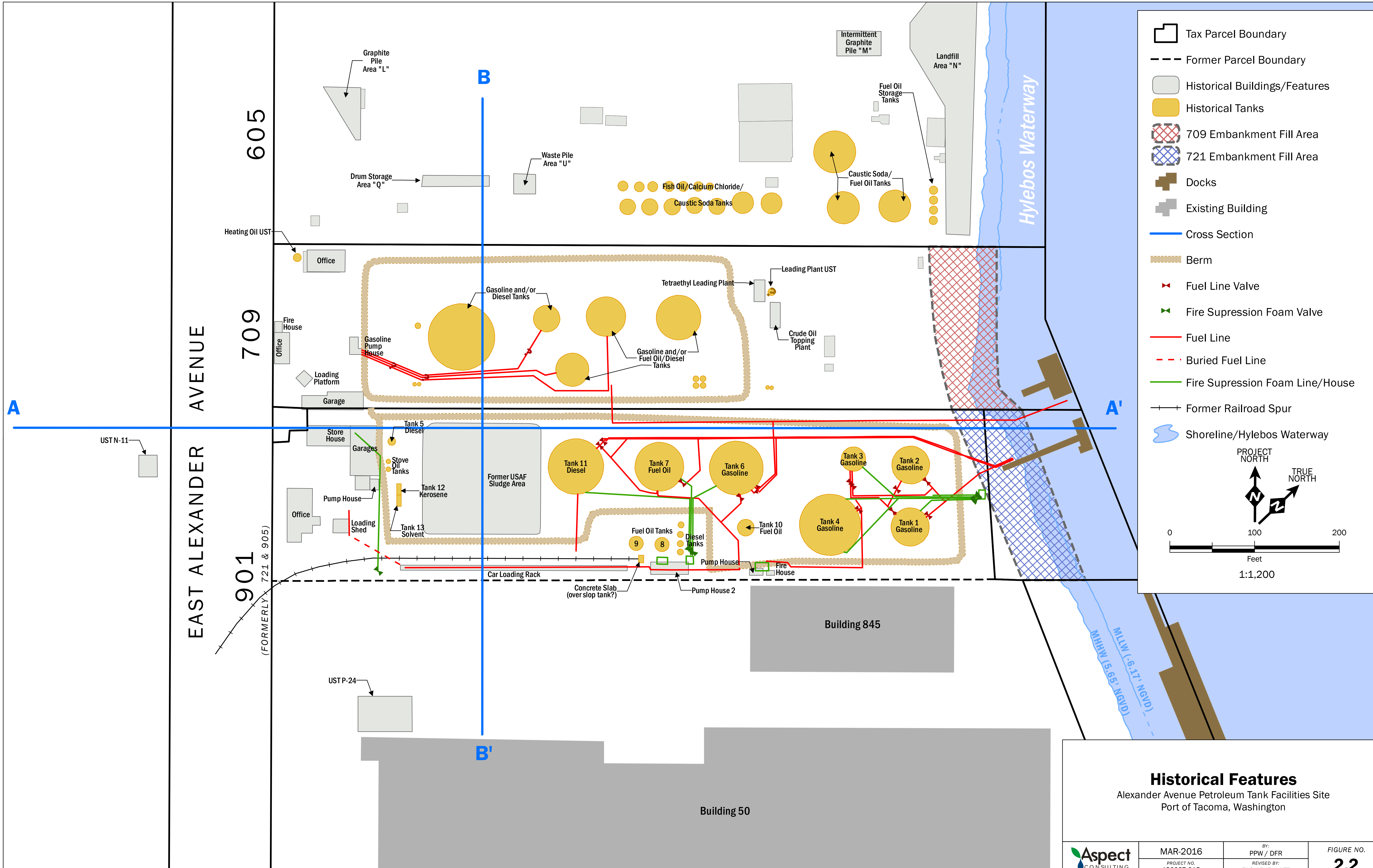
GIS Path: T:\projects_8\Port_of_Tacoma\AlexanderAve_130097\Delivered\RemedialInvestigationReport\1.2 Site Properties Aerial.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 2/24/2016 || User: rbobich || Print Date: 3/31/2016




**Proposed Liquid Natural Gas Facility**

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

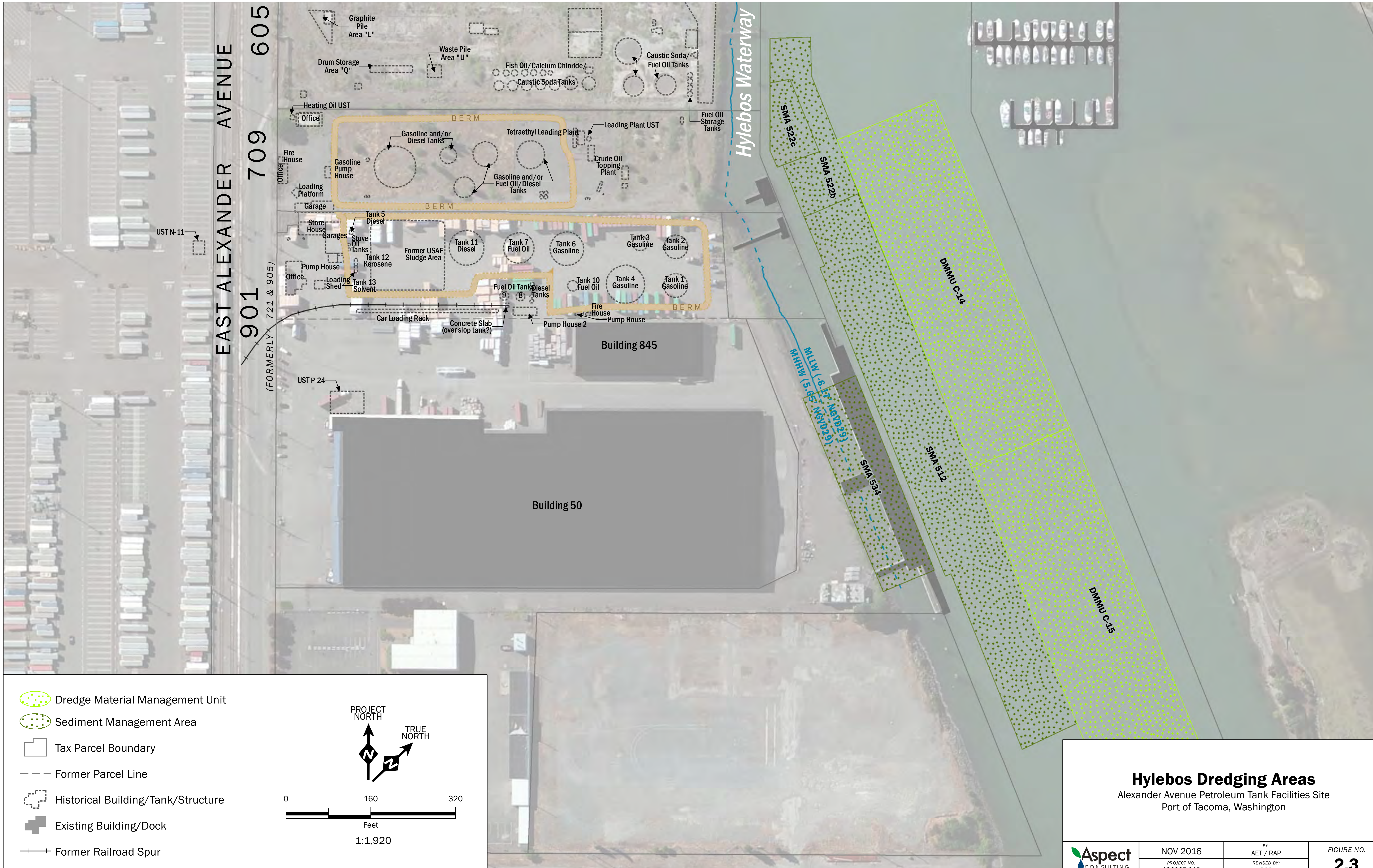
| | | | |
|---|---|---|---|
| Aspect CONSULTING | DEC-2016 | BY: DFR / PPW | FIGURE NO. |
| | PROJECT NO. 130097-01D | REVISED BY: RAP / RMB | 2.1 |




## Historical Features

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

| Aspect Consulting | MAR-2016 | BY: PPW / DFR | FIGURE NO. |
|---|---|---|---|
| | PROJECT NO. 130097-01B | REVISED BY: EAC / RAP / AET | 2.2 |

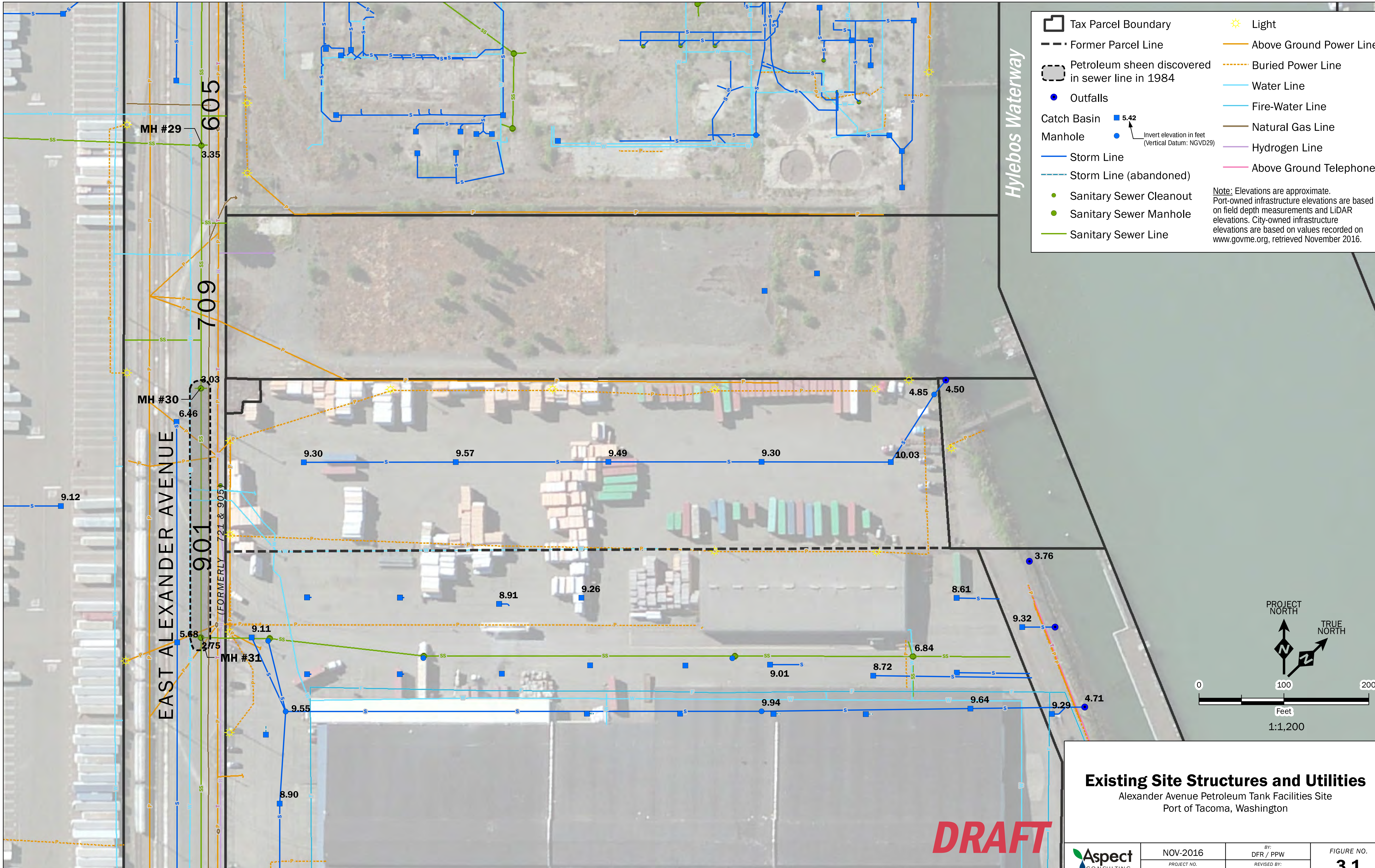



# Hylebos Dredging Areas

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING | NOV-2016 | PROJECT NO. 130097-01B | BY: AET / RAP | REVISED BY: SCC | FIGURE NO. 2.3

Basemap Layer Credits || Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

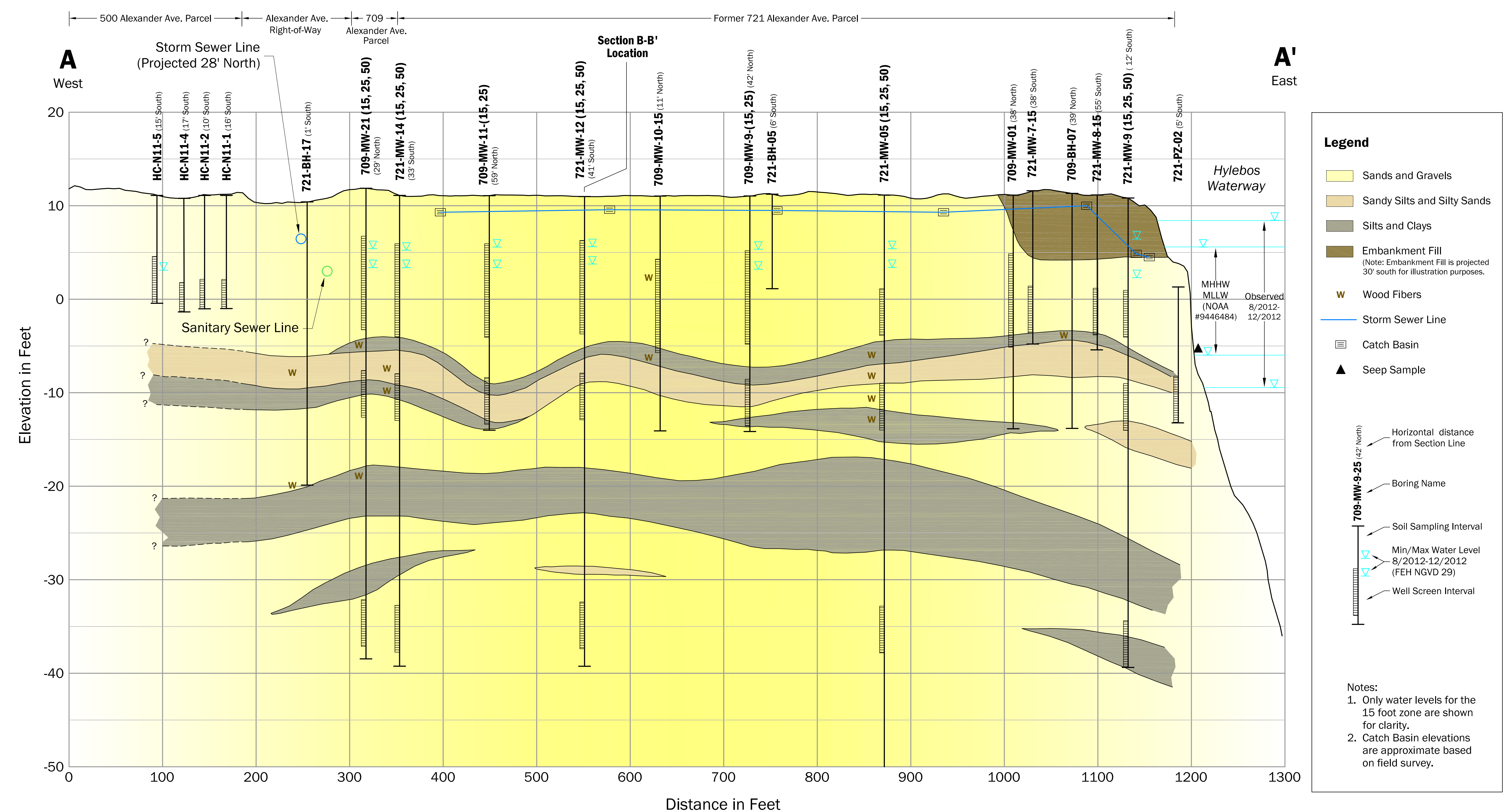



# Existing Site Structures and Utilities

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

| Aspect CONSULTING | NOV-2016 / PROJECT NO. 130097-01B | BY: DFR / PPW / REVISED BY: AET / RAP | FIGURE NO. 3.1 |
|---|---|---|---|

GIS Path: T:\projects_8\Port_of_Tacoma\AlexanderAve_130097\Delivered\RemedialInvestigationReport\3-1 Existing Site Structures and Utilities.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 11/29/2016 || User: rpepin || Print Date: 11/29/2016



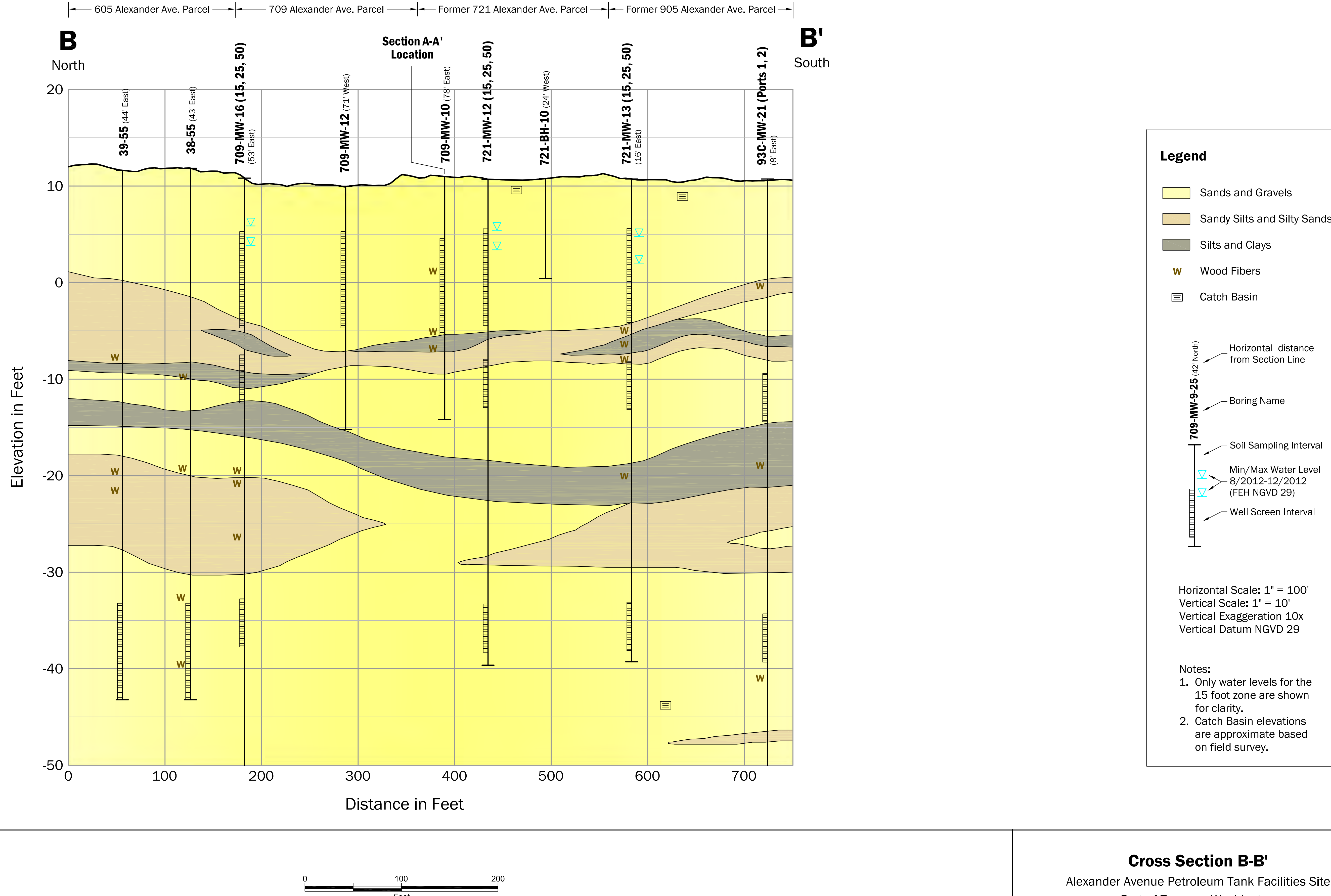

Horizontal Scale: 1" = 100'
Vertical Scale: 1" = 10'
Vertical Exaggeration 10x
Vertical Datum NGVD 29

0 100 200
Feet

**Cross Section A-A'**

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect Consulting | Nov-2016 | BY: DFR/SCC | FIGURE NO.
PROJECT NO. 130097 | REV BY: SCC | 3.2-2

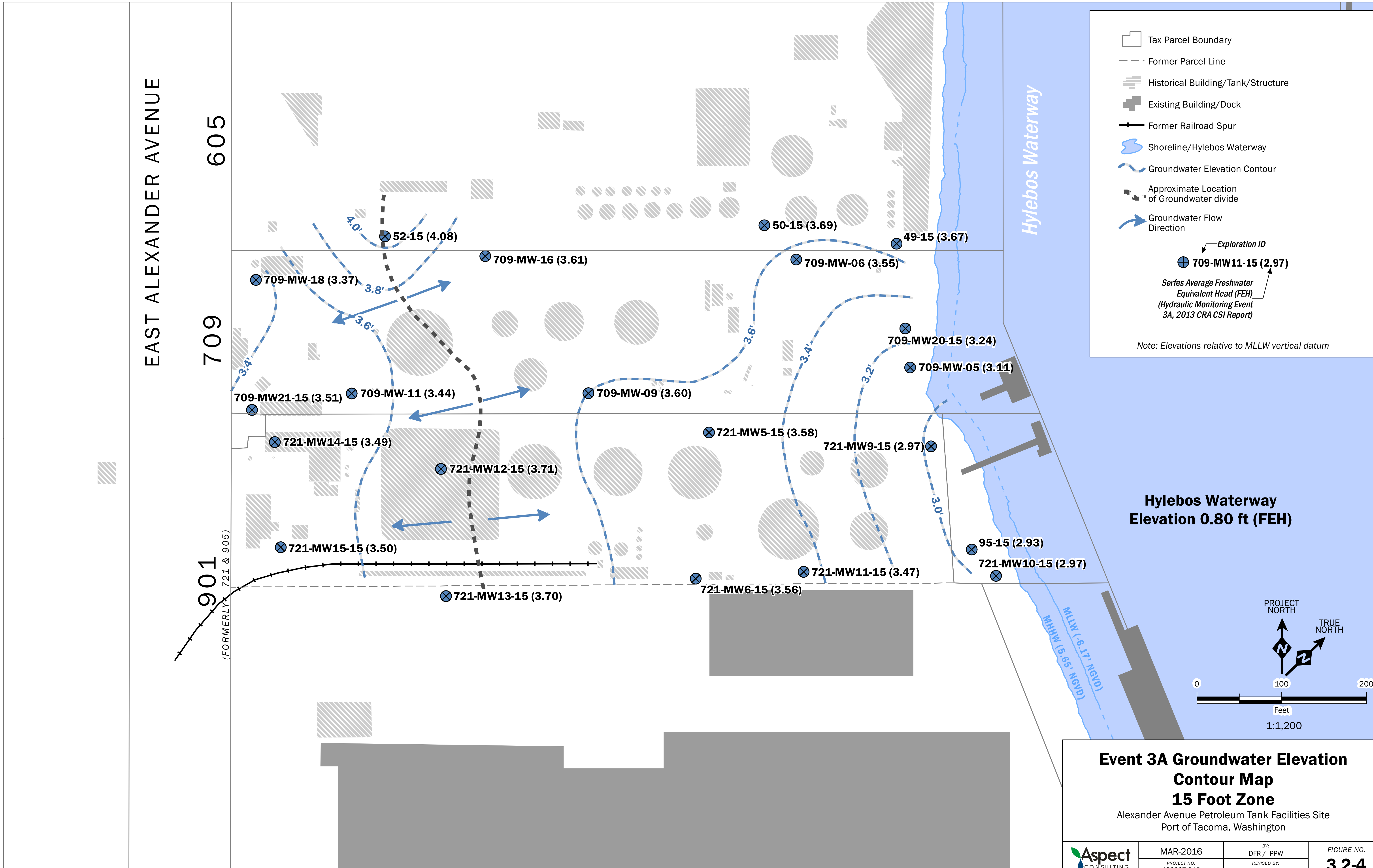



**Cross Section B-B'**

Alexander Avenue Petroleum Tank Facilities Site

Port of Tacoma, Washington

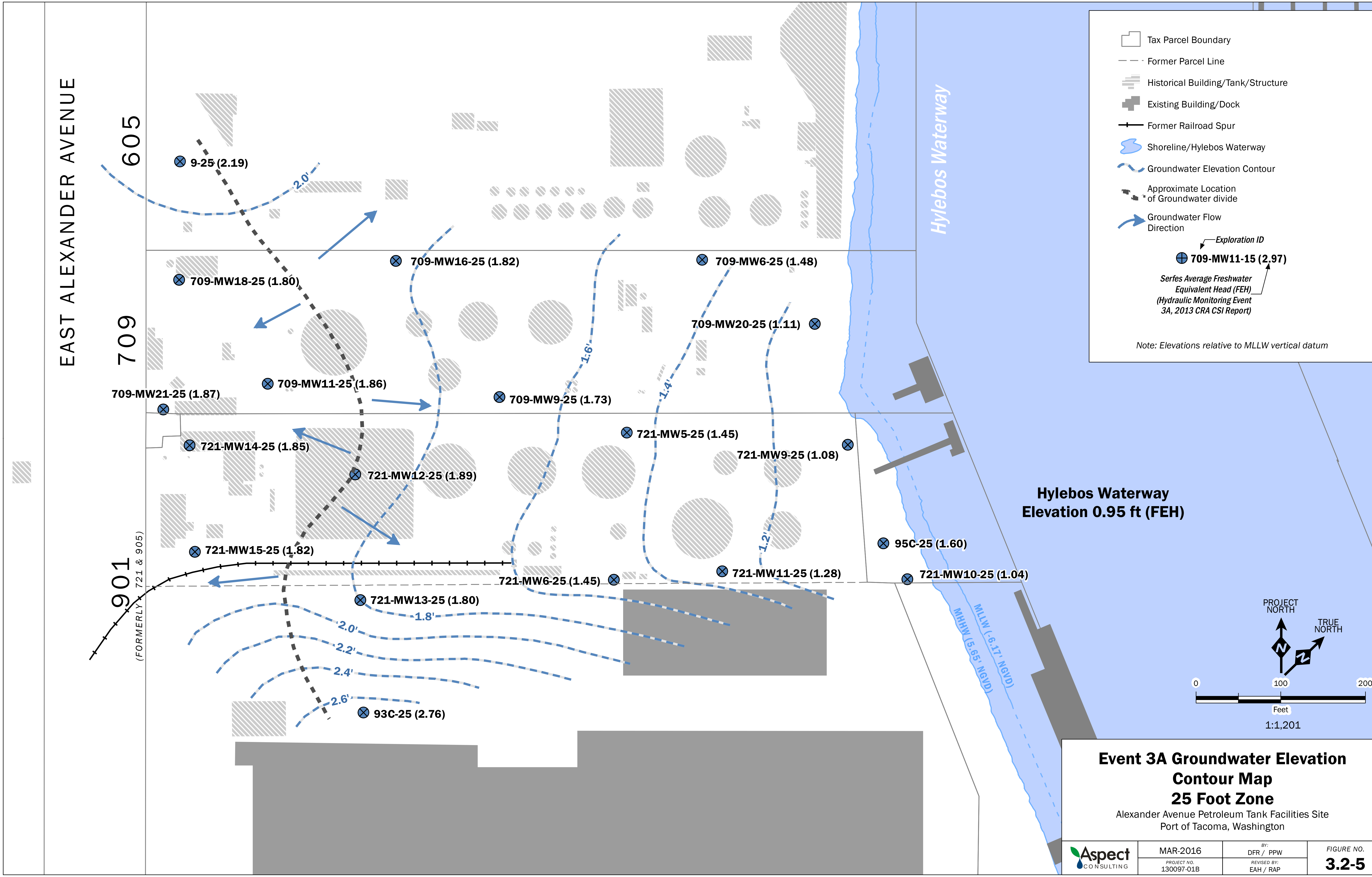
| Aspect CONSULTING | Sep-2016 | BY: DFR/SCC | FIGURE NO. |
|---|---|---|---|
| | PROJECT NO. 130097 | REV BY: SCC | 3.2-3 |




# Event 3A Groundwater Elevation Contour Map
## 15 Foot Zone

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

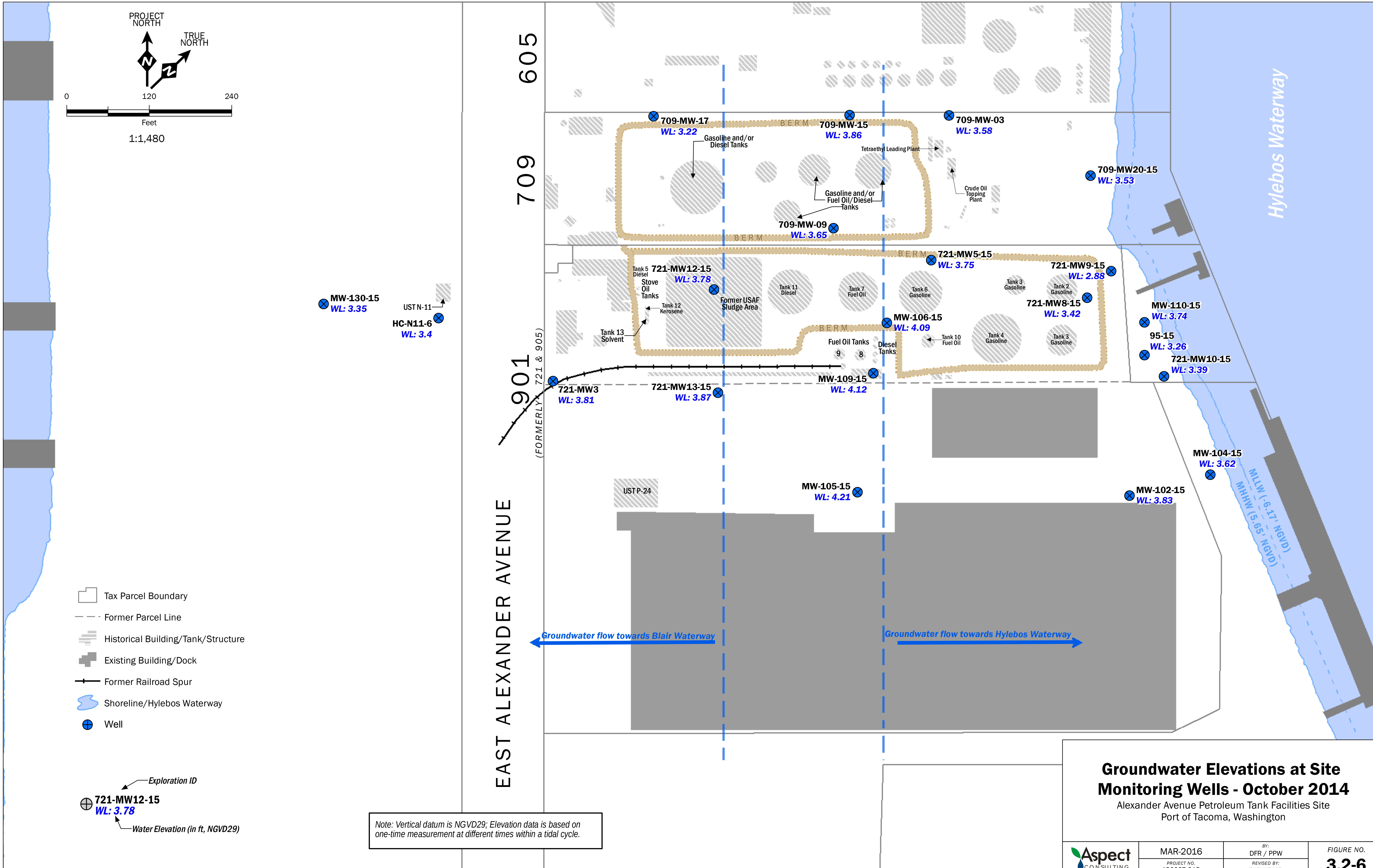
| | | | |
|---|---|---|---|
| Aspect CONSULTING | MAR-2016 | BY: DFR / PPW | FIGURE NO. |
| | PROJECT NO. 130097-01B | REVISED BY: EAH / RAP | 3.2-4 |




**Event 3A Groundwater Elevation Contour Map**
**25 Foot Zone**

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

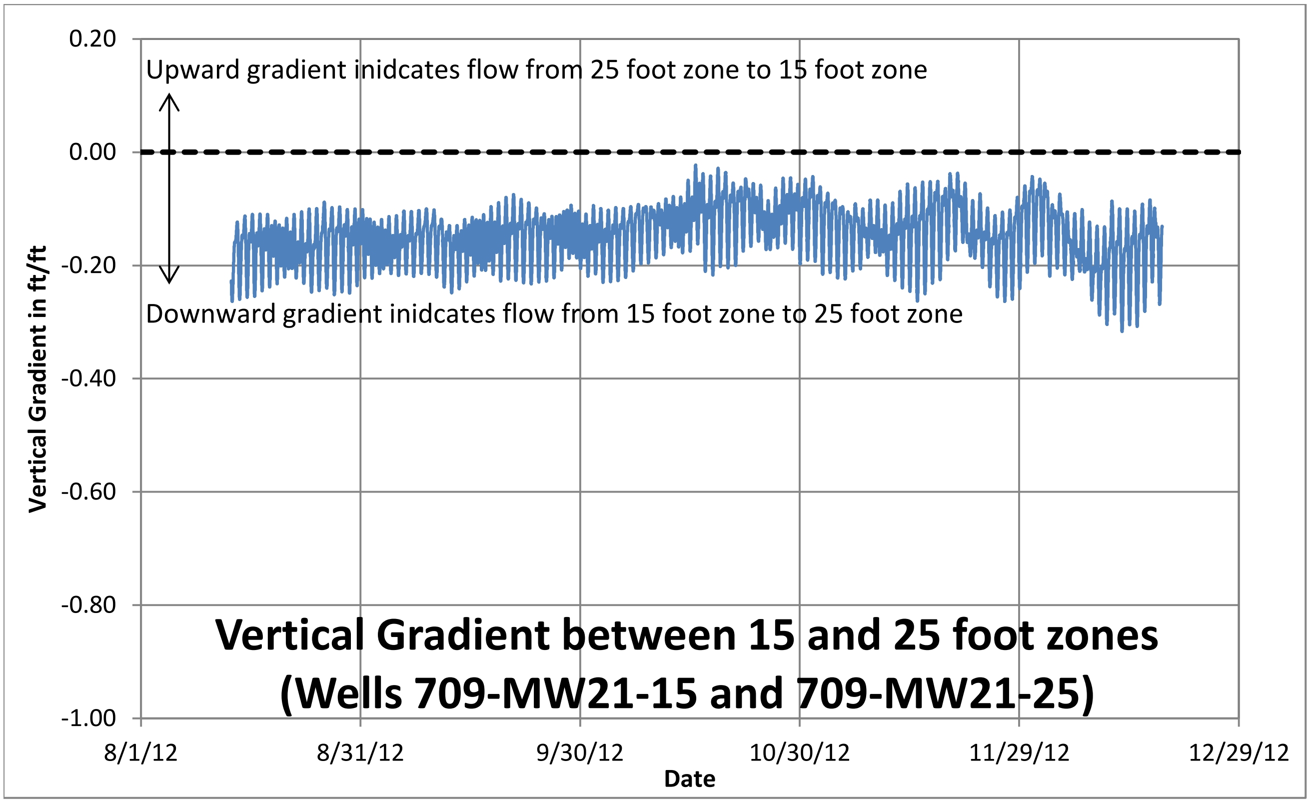
| | | | |
|---|---|---|---|
| Aspect CONSULTING | MAR-2016 | BY: DFR / PPW | FIGURE NO. |
| | PROJECT NO. 130097-01B | REVISED BY: EAH / RAP | **3.2-5** |




## Groundwater Elevations at Site Monitoring Wells - October 2014

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING | MAR-2016 | BY: DFR / PPW | FIGURE NO. 3.2-6
PROJECT NO. 130097-01D | REVISED BY: RAP / RMB



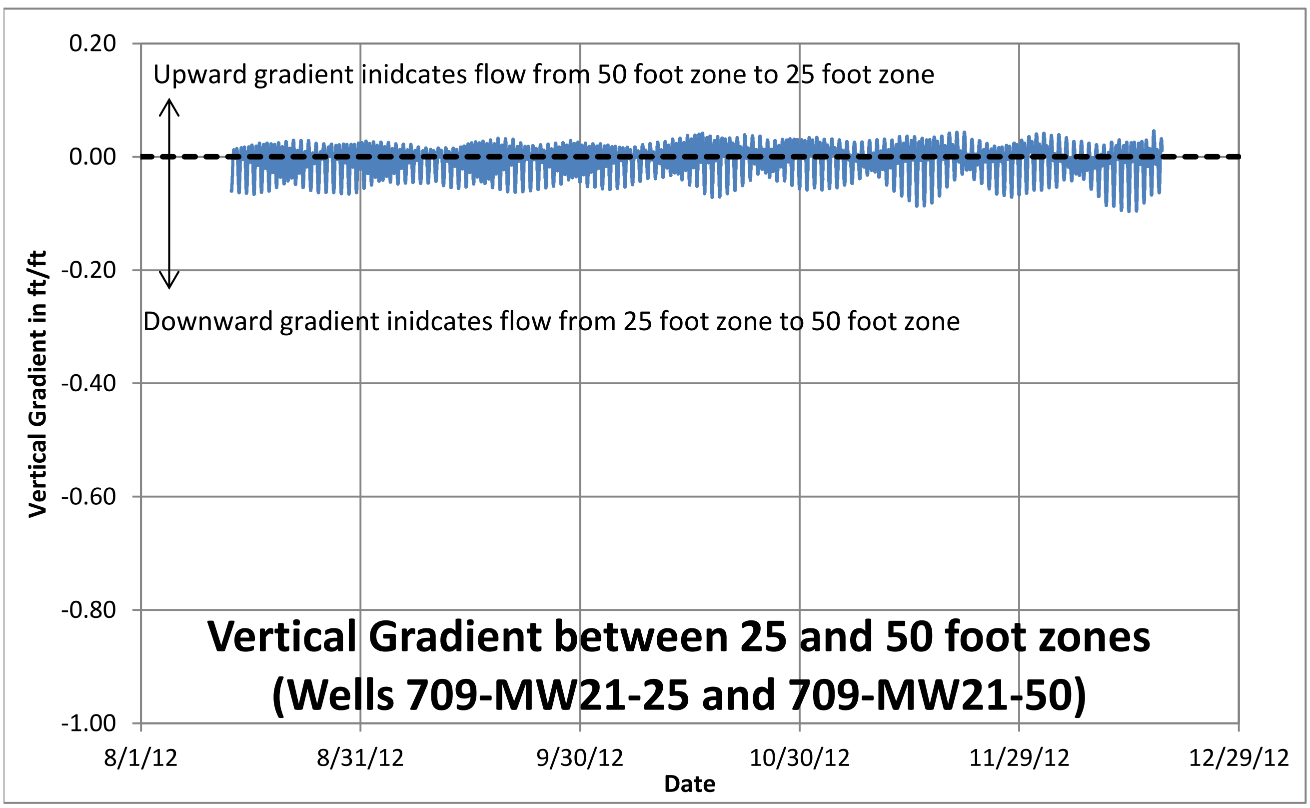




**Figure 3.2-7**

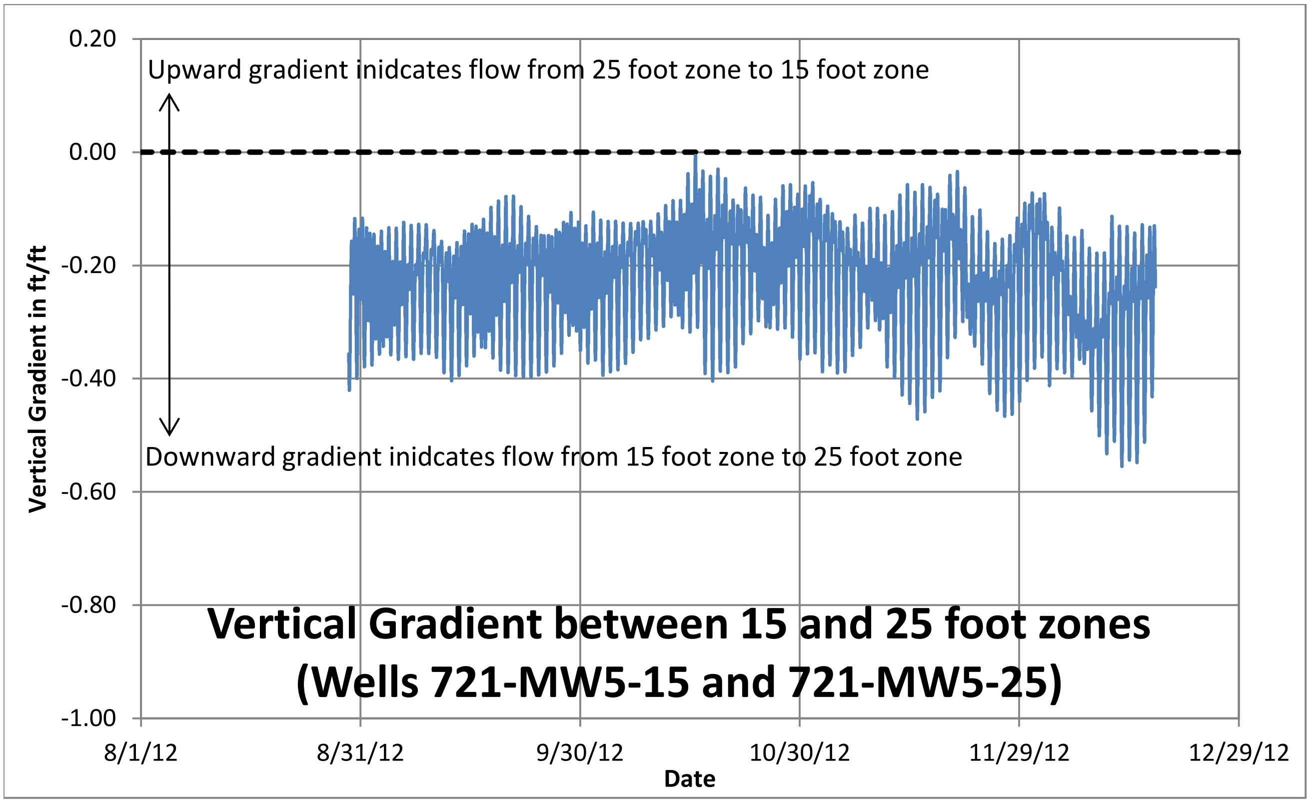
**Vertical Gradients at 709-MW21 Well Cluster**

Alexander Avenue Petroleum Tank Facilities Site, RI/FS Work Plan

**Aspect Consulting**

6/4/2014

*V:\130097 POT Alexander Ave\Deliverables\RI\Feb 2016 Draft\Figures\3-2-7 709-MW21 Vertical Gradient Figure.xlsx*



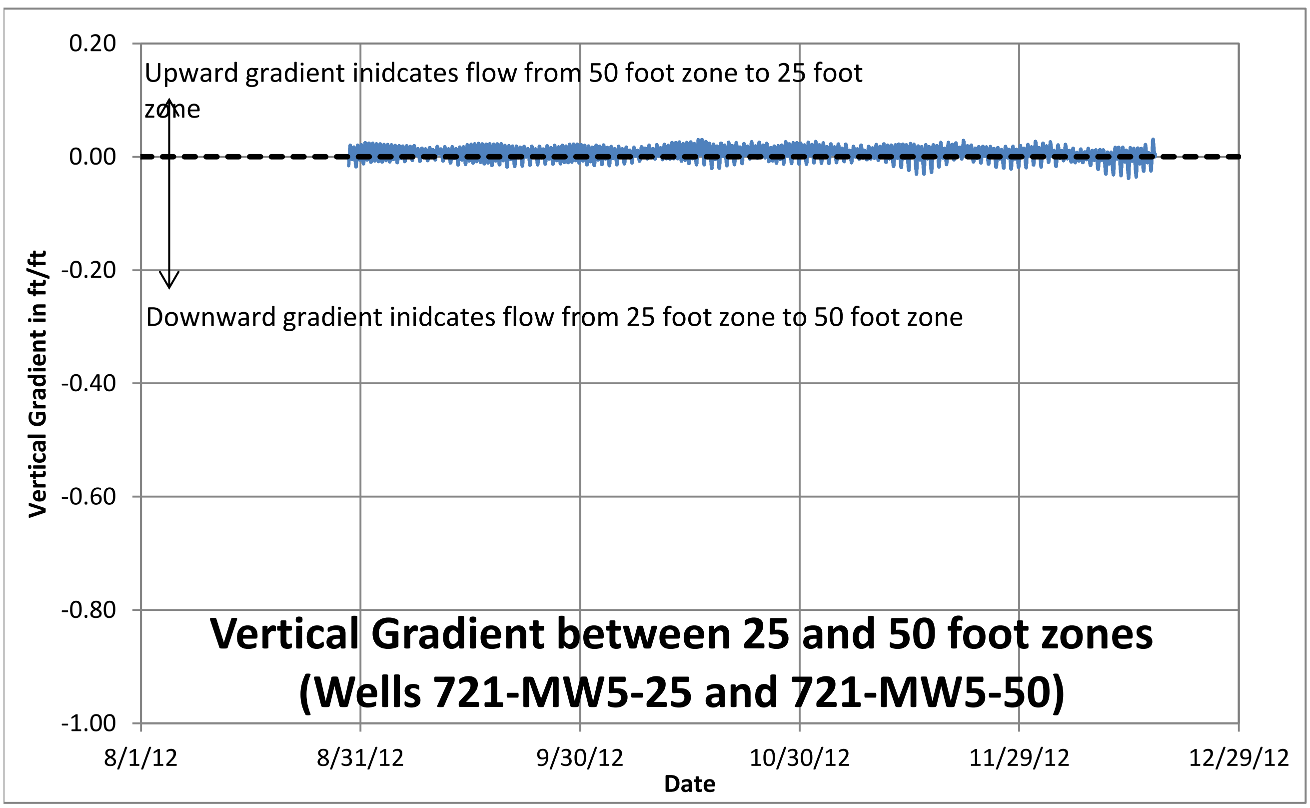
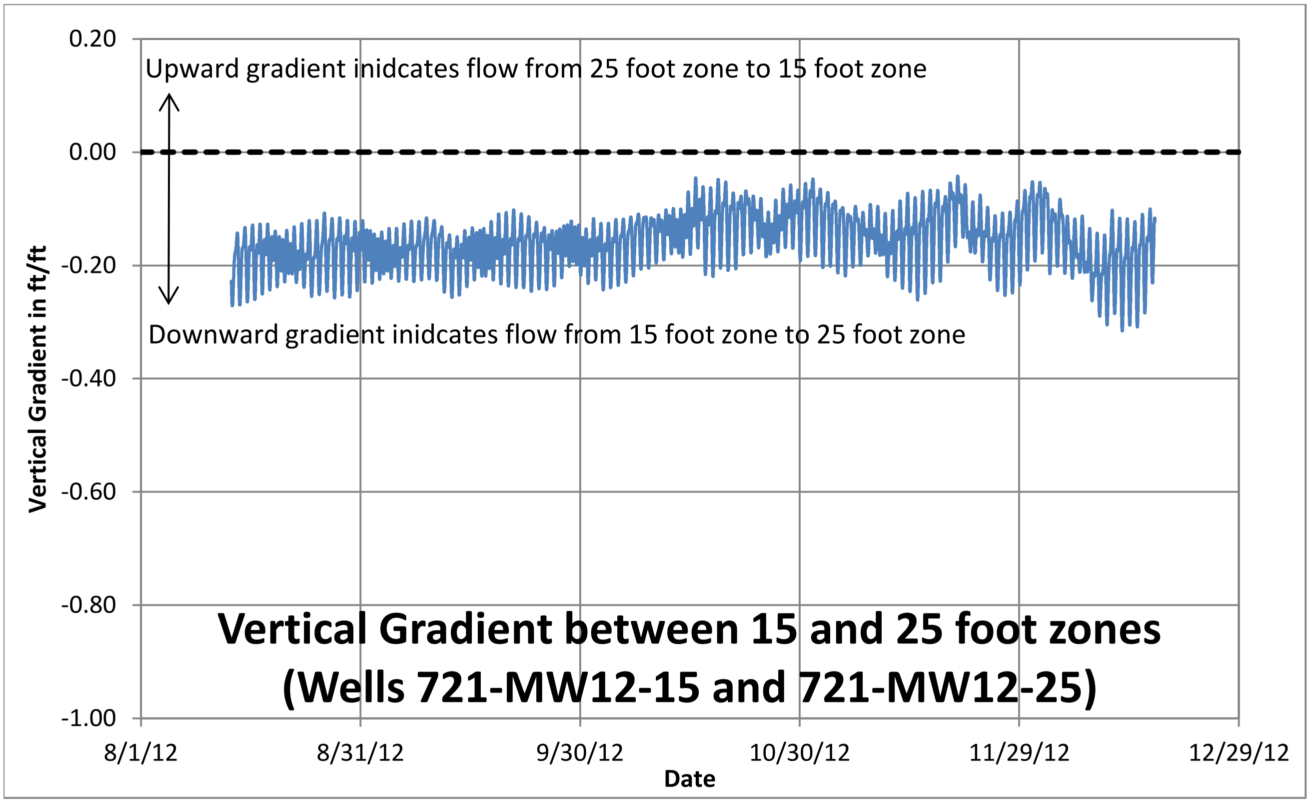




**Figure 3.2-8**
**Vertical Gradients at 721-MW5 Well Cluster**
Alexander Avenue Petroleum Tank Facilities Site, RI

**Aspect Consulting**
6/4/2014
*\\seastore2.aspect.local\Documents\130097 POT Alexander Ave\Deliverables\RI\Feb 2016 Draft\Figures\3-2-8 721-MW5 Vertical Gradient Figure.xlsx*



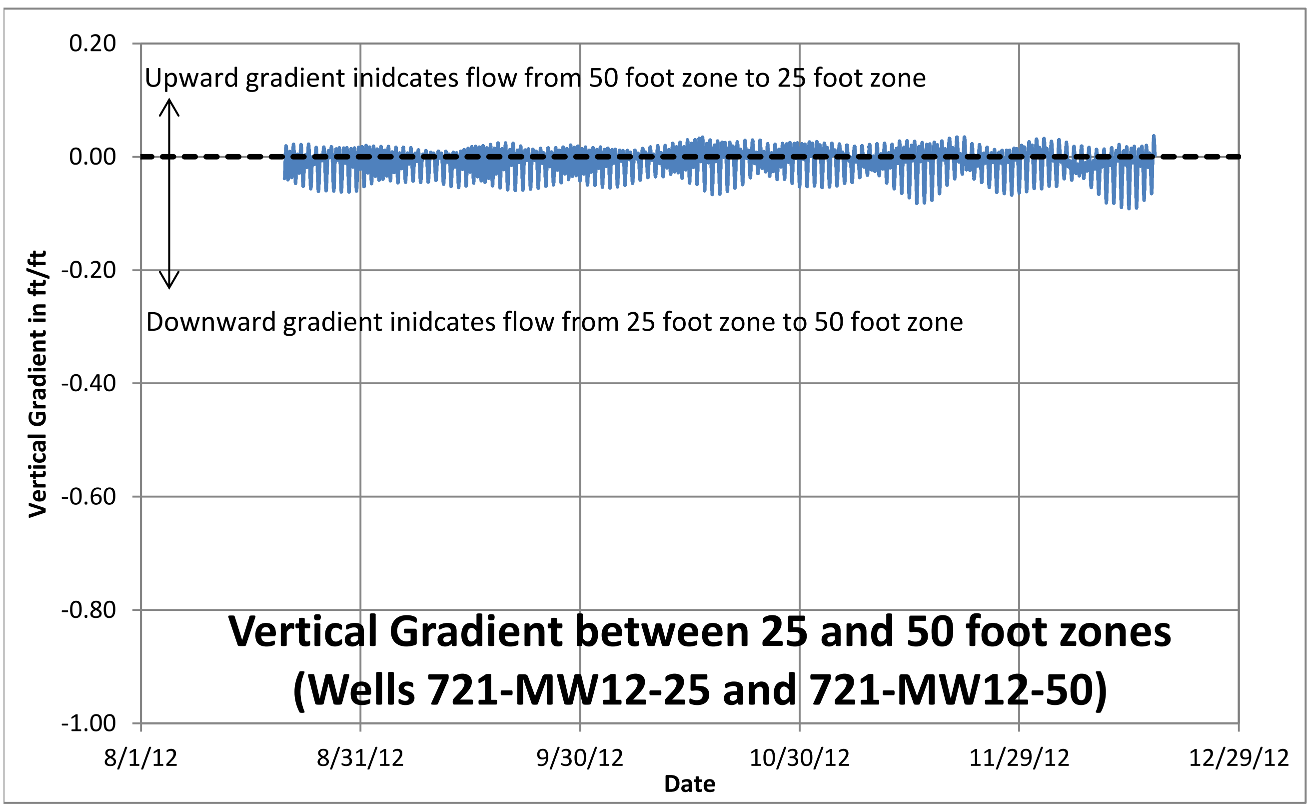
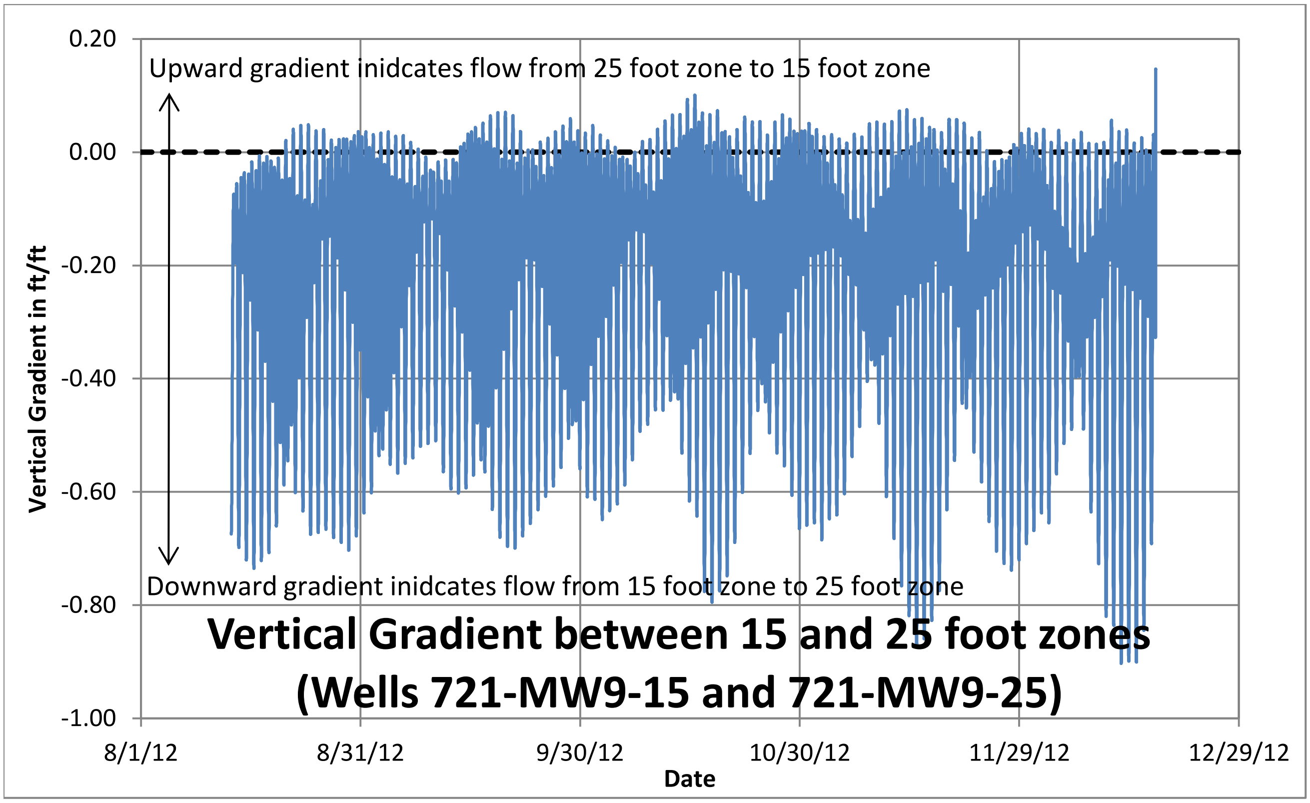




**Figure 3.2-9**
**Vertical Gradients at 721-MW12 Well Cluster**
Alexander Avenue Petroleum Tank Facilities Site, RI



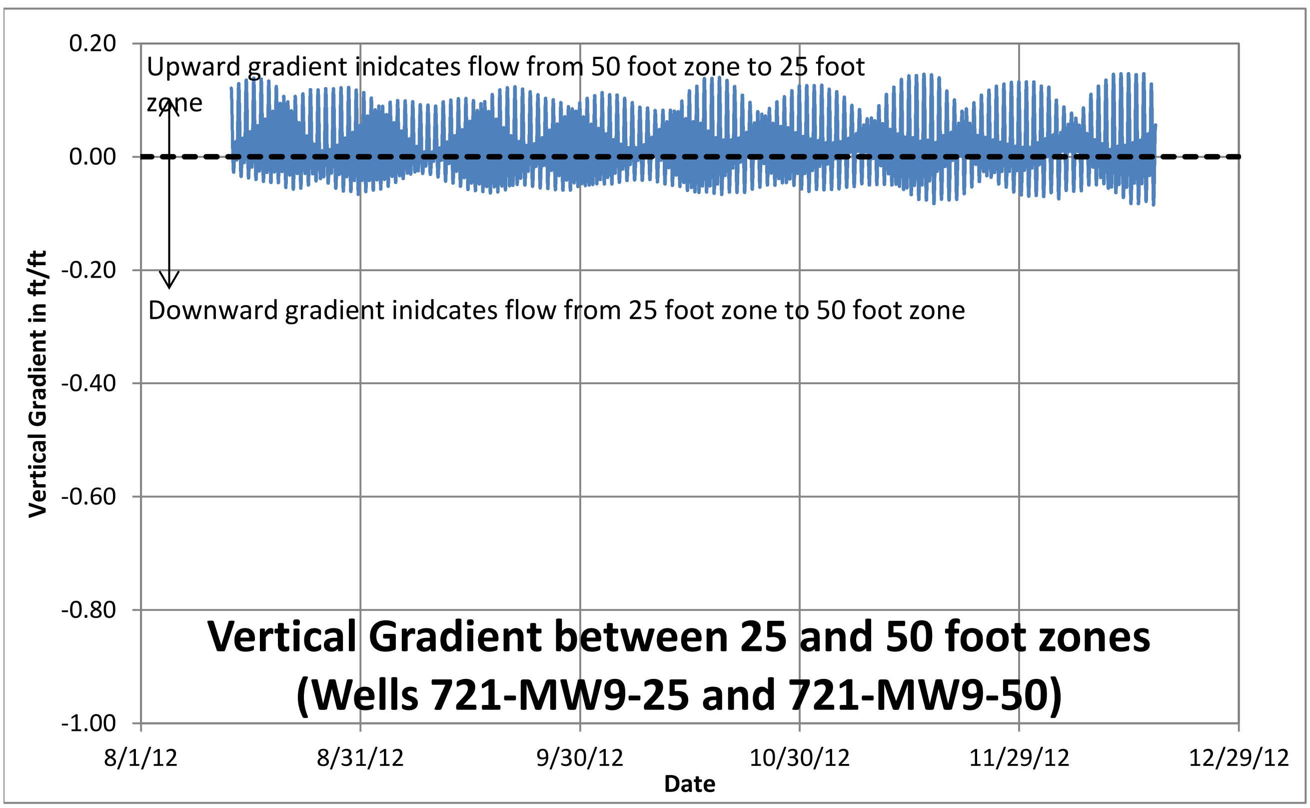
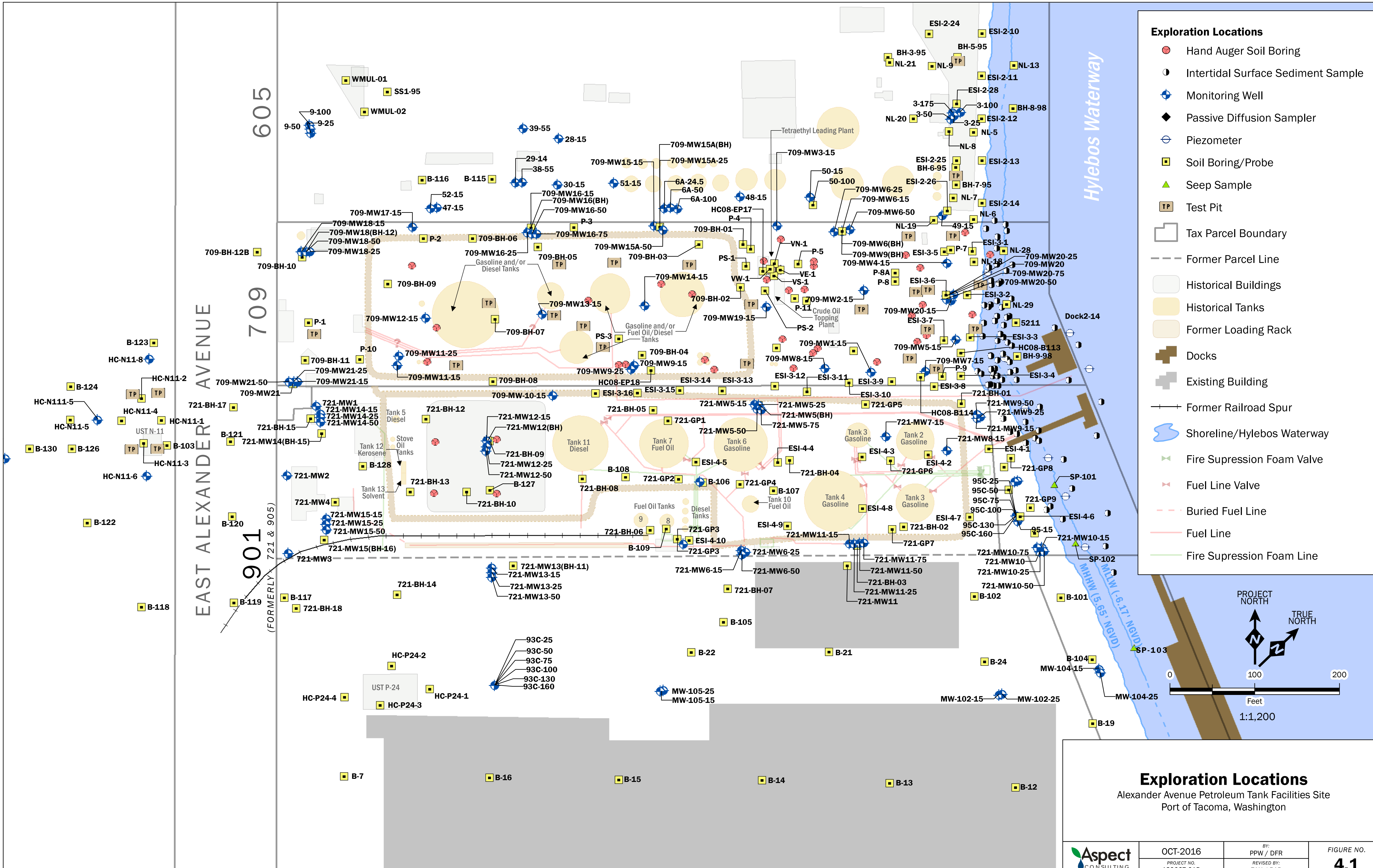




**Figure 3.2-10**
**Vertical Gradients at 721-MW9 Well Cluster**
Alexander Avenue Petroleum Tank Facilities Site, RI

**Aspect Consulting**
6/4/2014
*\\seastore2.aspect.local\Documents\130097 POT Alexander Ave\Deliverables\RI\Feb 2016 Draft\Figures\3-2-10 721-MW9 Vertical Gradient Figure.xlsx*



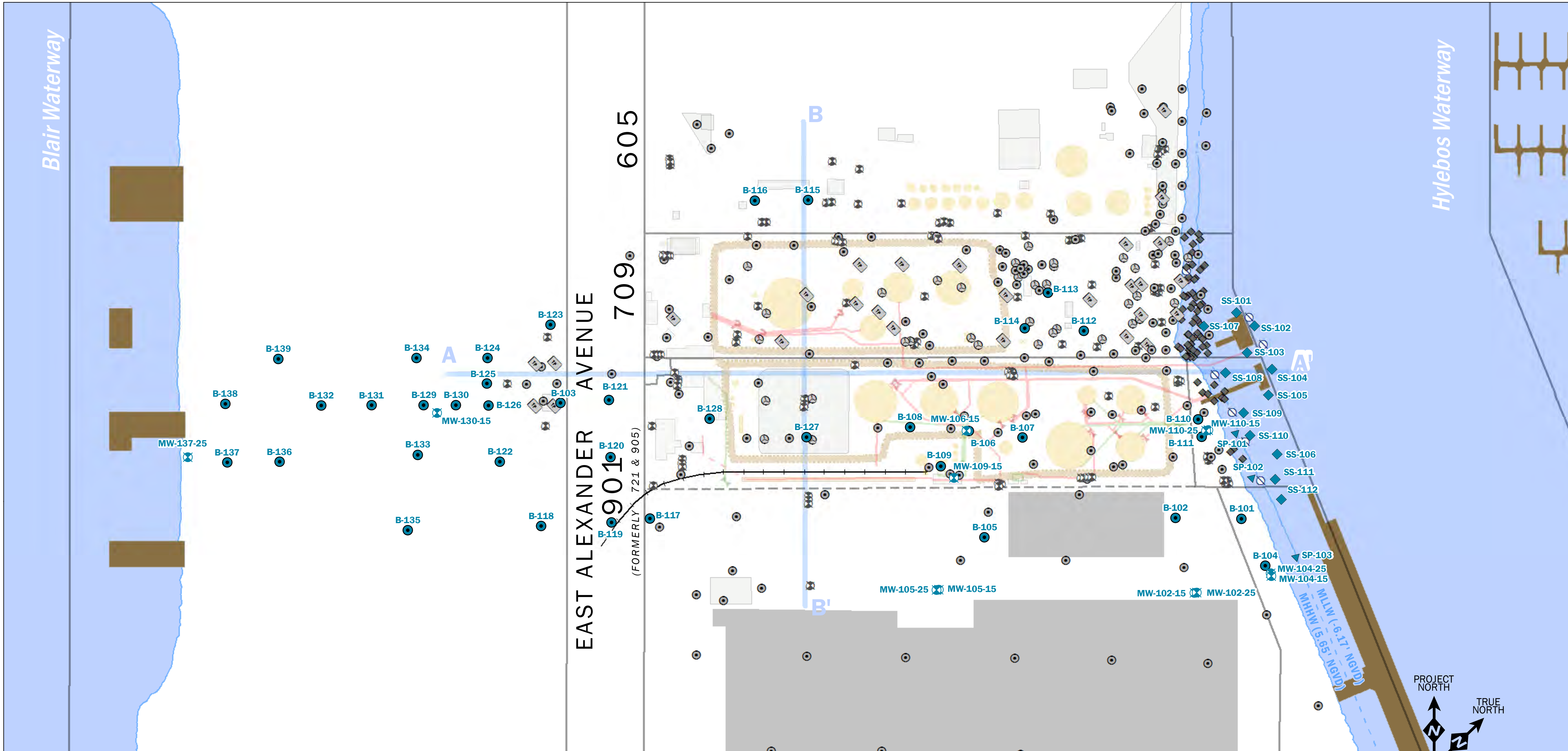

# Exploration Locations

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING

| | | | |
|---|---|---|---|
| OCT-2016 | BY: PPW / DFR | FIGURE NO. |
| PROJECT NO. 130097-01D | REVISED BY: EAH / RAP | 4.1 |

GIS Path: T:\projects_8\Port_of_Tacoma\AlexanderAve_130097\Delivered\FS\4.1 Exploration Locations.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 10/27/2016 || User: rpepin || Print Date: 10/27/2016




**RI Exploration Locations**

- Soil Boring
- Monitoring Well
- Seep Sample
- Surface Sediment Sample

**Previous Exploration Locations**

- Hand Auger Soil Boring
- Intertidal Surface Sediment Sample
- Monitoring Well
- Passive Diffusion Sampler
- Piezometer
- Soil Boring
- Test Pit

- Tax Parcel Boundary
- Former Parcel Line
- Historical Buildings
- Historical Tanks
- Former Loading Rack
- Docks
- Existing Building

- Cross Section
- Former Railroad Spur
- Shoreline/Waterway
- Fire Supression Foam Valve
- Fuel Line Valve
- Buried Fuel Line
- Fuel Line
- Fire Supression Foam Line

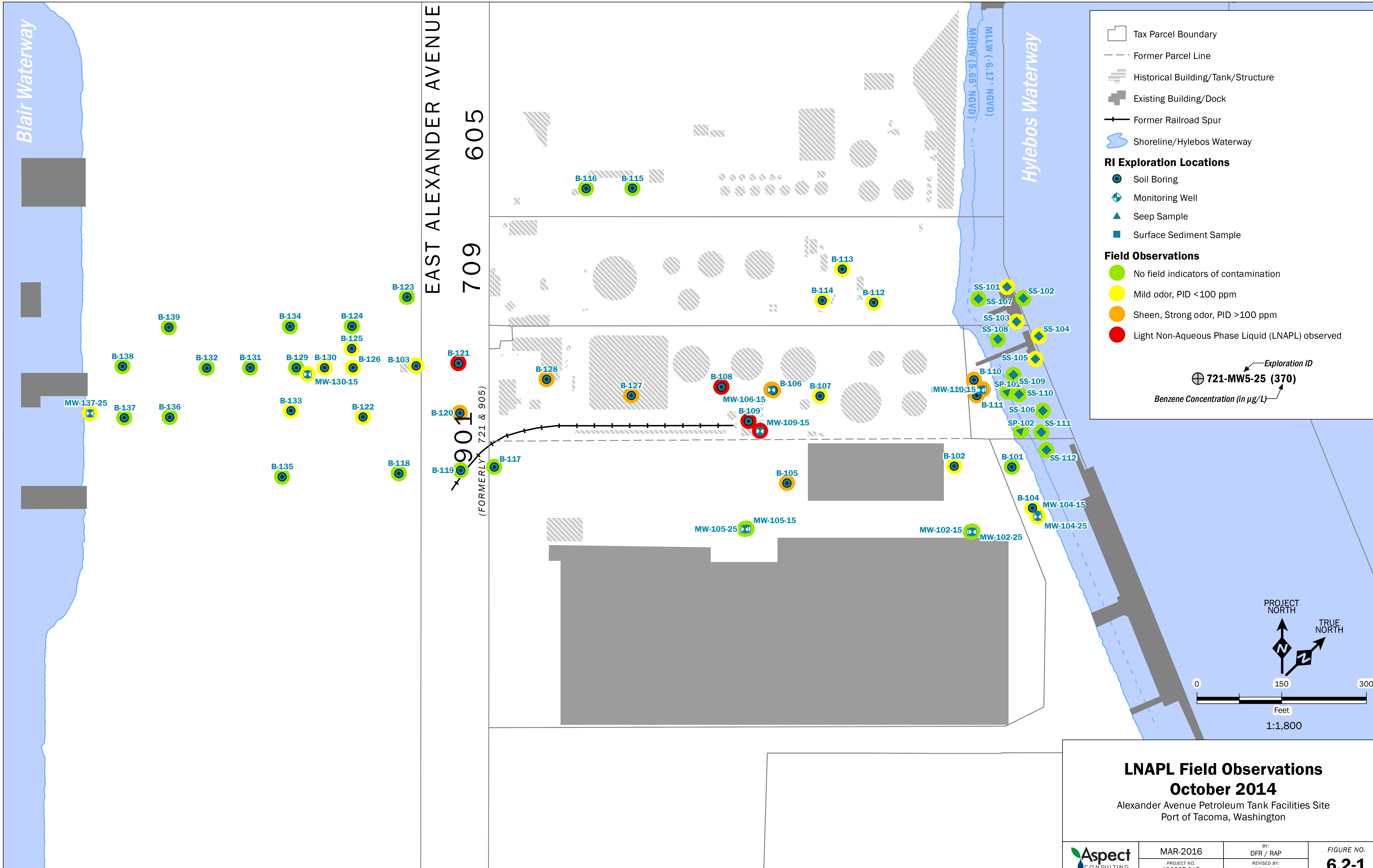
*Note: Only RI Explorations are labeled.*

## RI Explorations and Cross Section Location Map

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING

| | | | |
|---|---|---|---|
| MAR-2016 | BY: DFR / RAP | FIGURE NO. |
| PROJECT NO. 130097-01D | REVISED BY: AET / RAP | 4.2 |

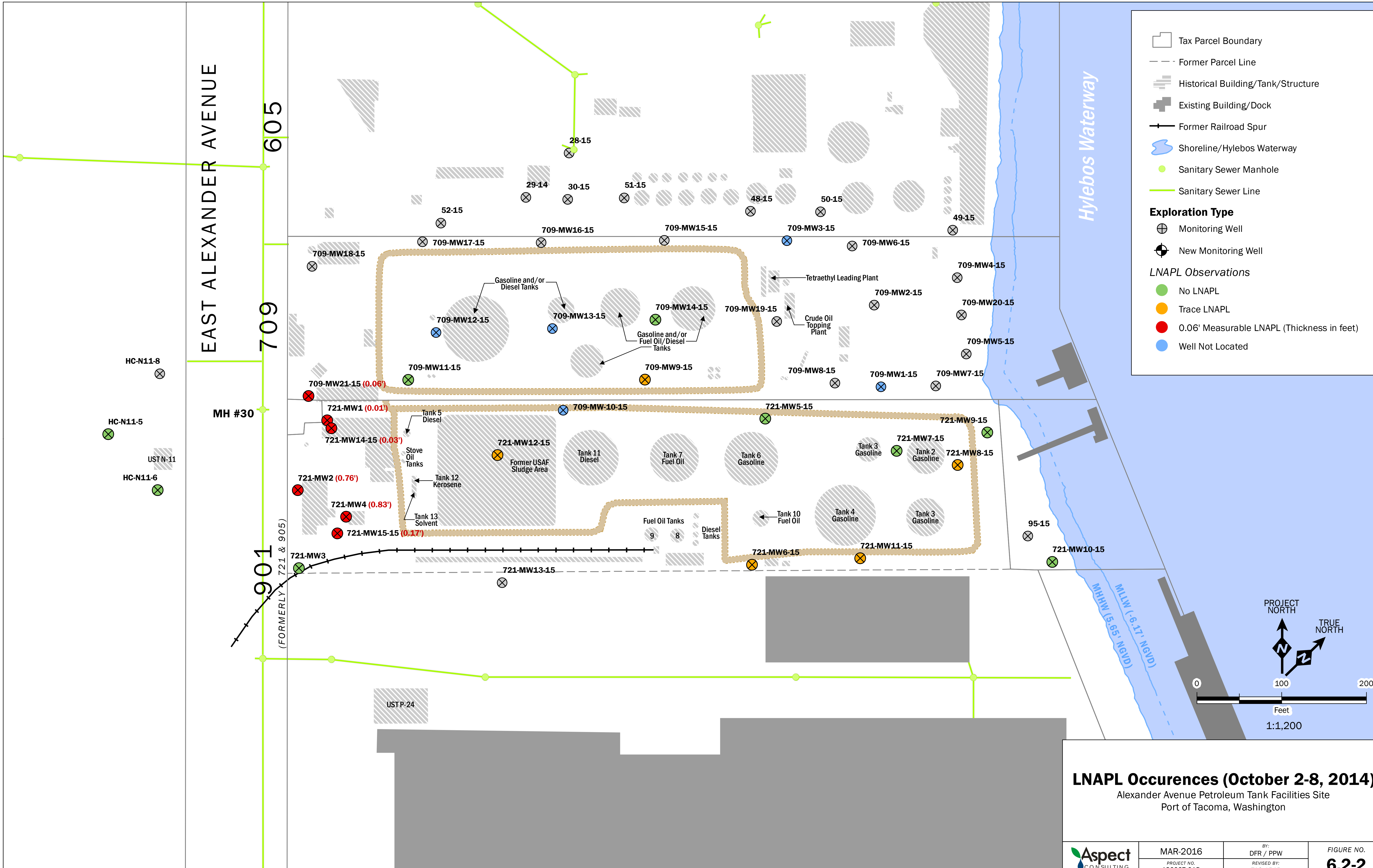



# LNAPL Field Observations
# October 2014

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING

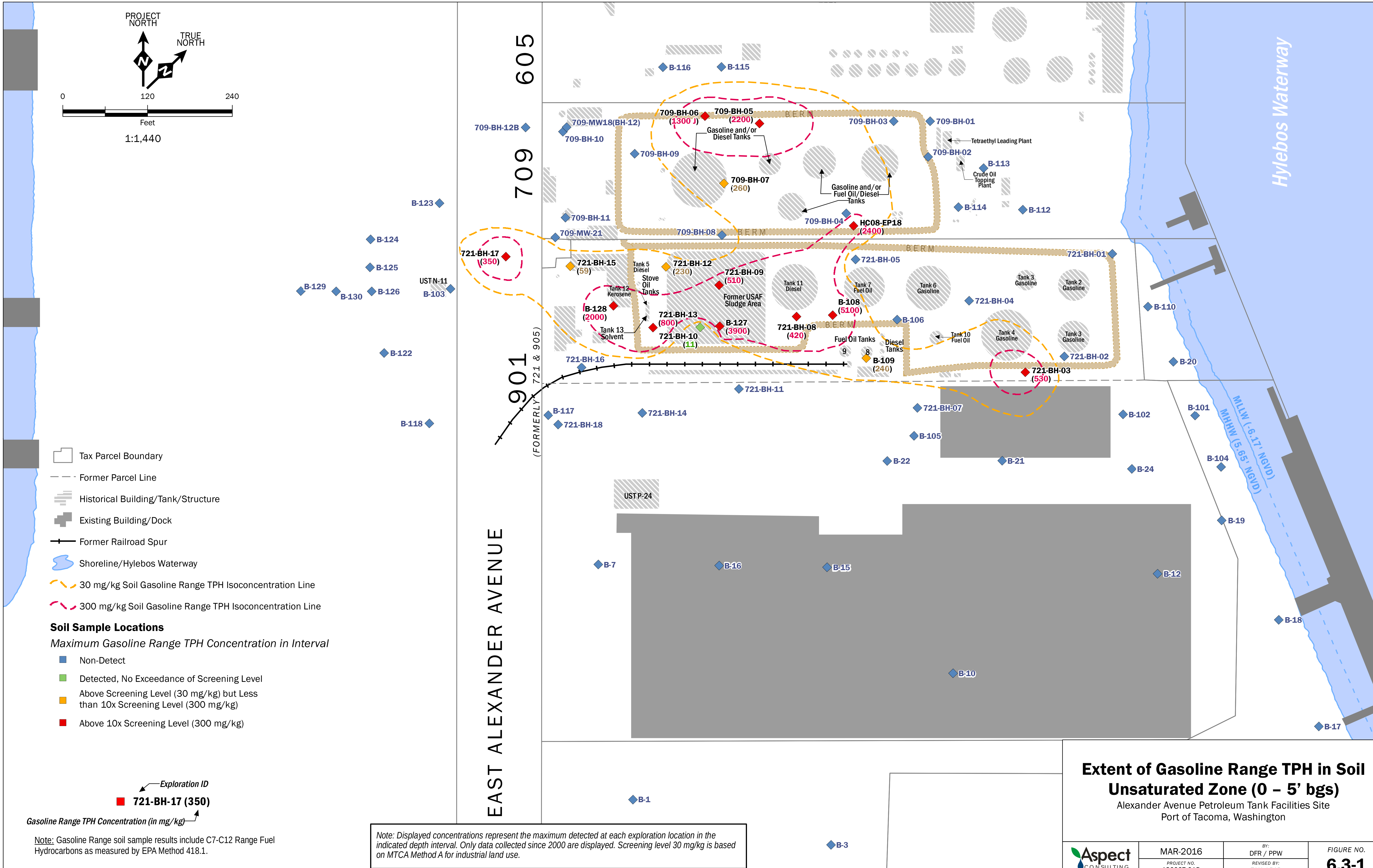
| MAR-2016 | BY: DFR / RAP | FIGURE NO. |
|---|---|---|
| PROJECT NO. 130097-01D | REVISED BY: AET / RAP | 6.2-1 |




# LNAPL Occurences (October 2-8, 2014)

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

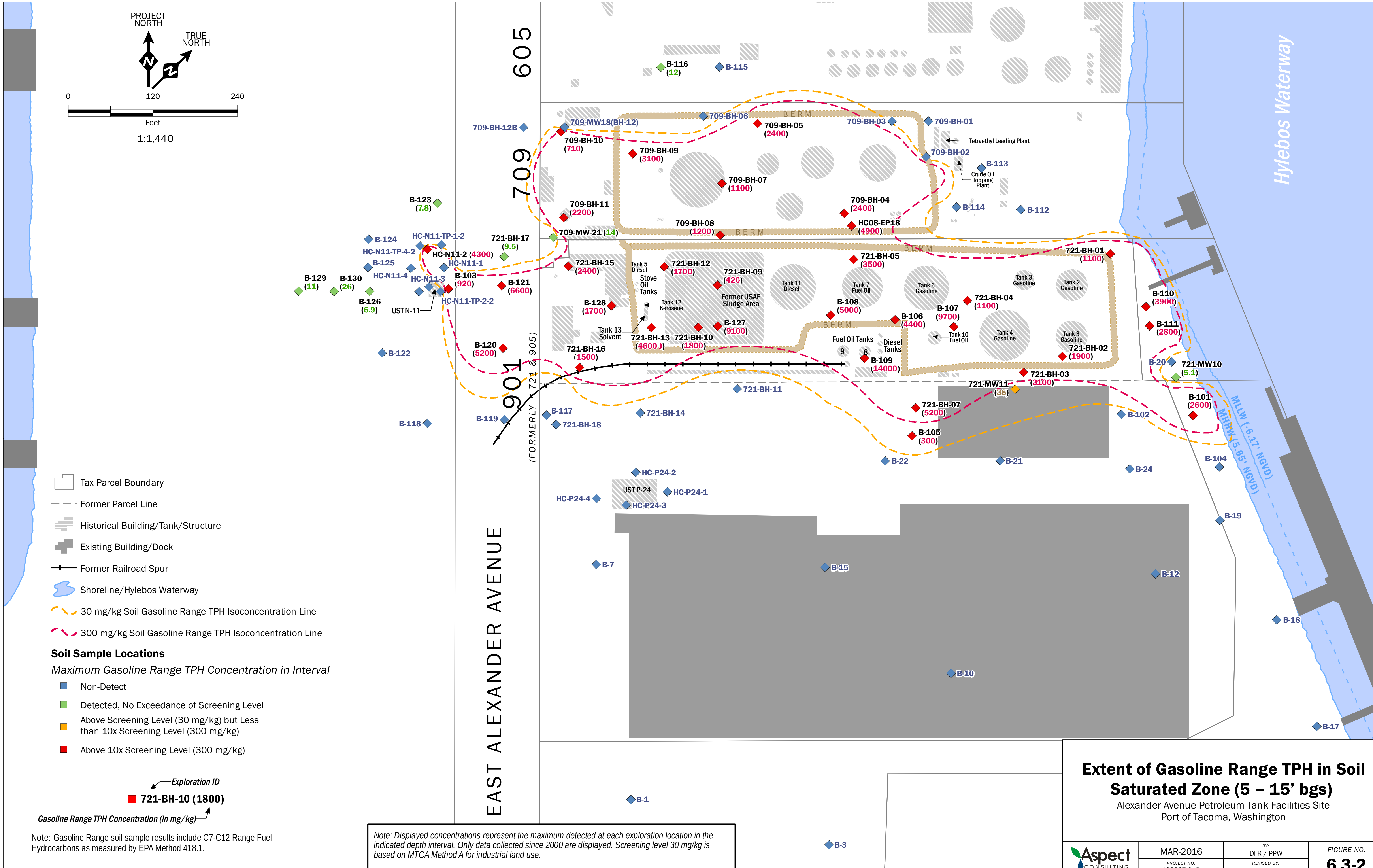
| | | | |
|---|---|---|---|
| Aspect CONSULTING | MAR-2016 | BY: DFR / PPW | FIGURE NO. |
| | PROJECT NO. 130097-01D | REVISED BY: EAC / RAP | 6.2-2 |




# Extent of Gasoline Range TPH in Soil Unsaturated Zone (0 – 5' bgs)

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

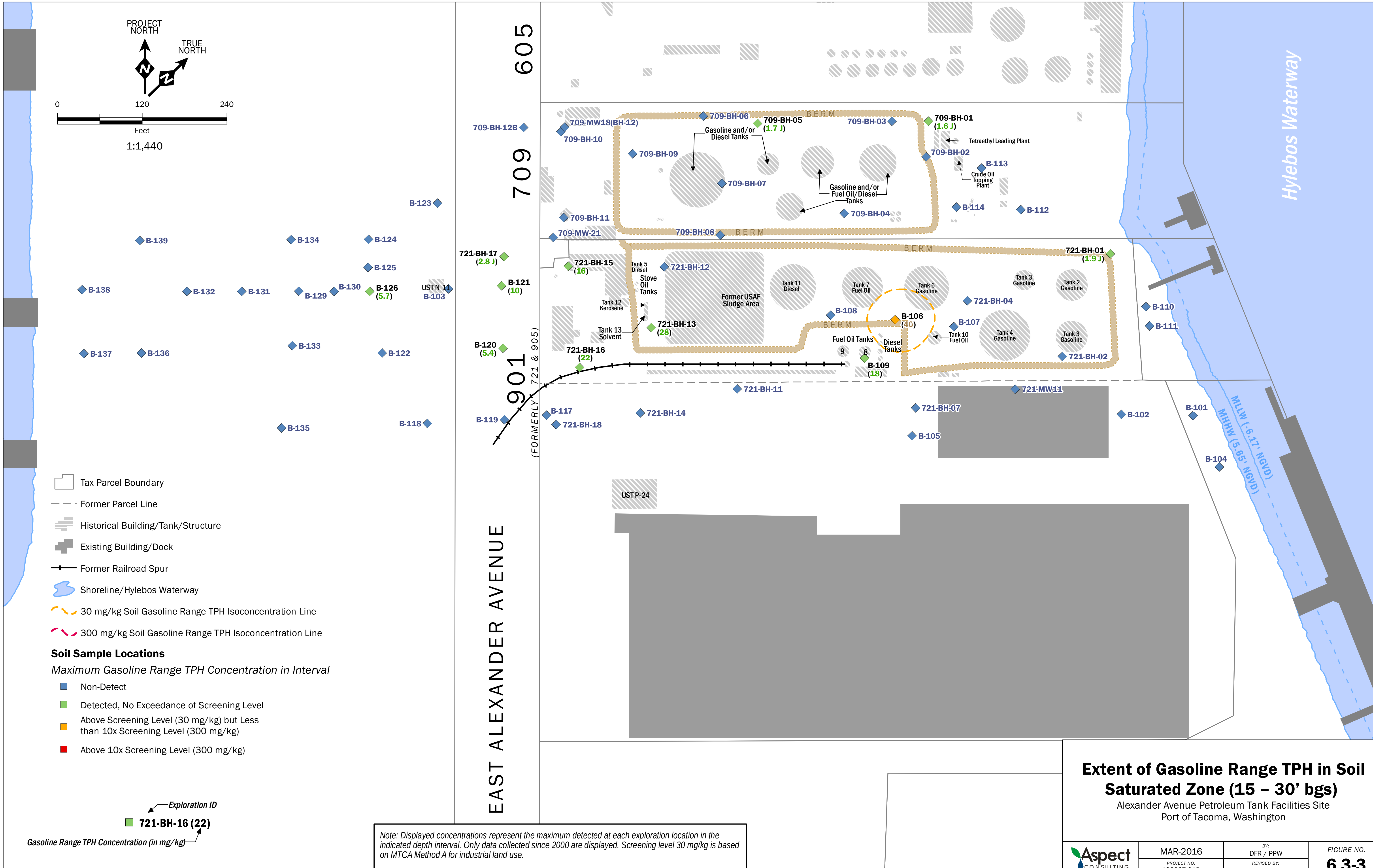
Aspect CONSULTING | MAR-2016 | BY: DFR / PPW | FIGURE NO. 6.3-1
PROJECT NO. 130097-01D | REVISED BY: EAH / RAP




**Extent of Gasoline Range TPH in Soil Saturated Zone (5 – 15' bgs)**

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

| | | | |
|---|---|---|---|
| Aspect CONSULTING | MAR-2016 | BY: DFR / PPW | FIGURE NO. |
| | PROJECT NO. 130097-01D | REVISED BY: EAC / RAP | 6.3-2 |

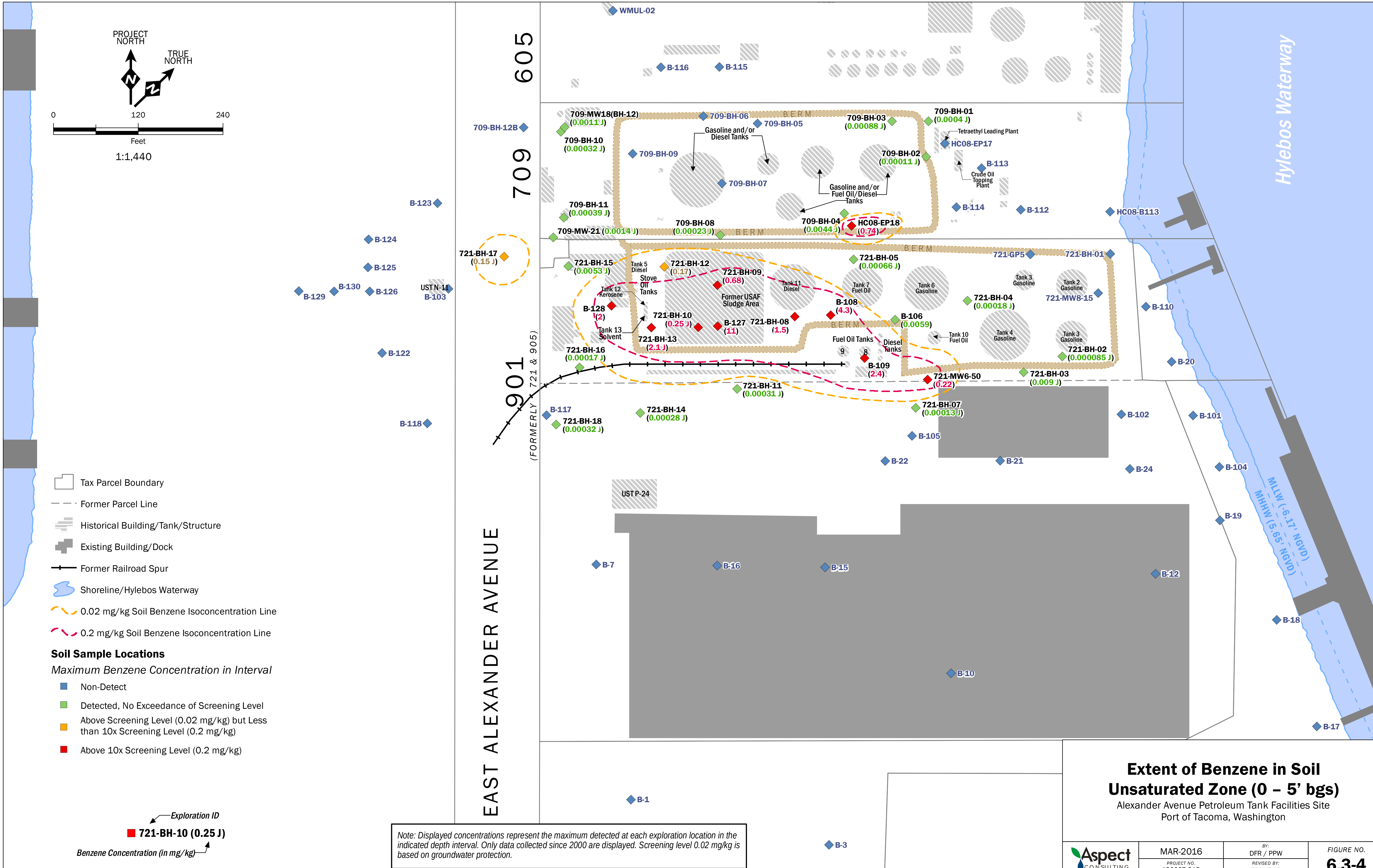



Note: Displayed concentrations represent the maximum detected at each exploration location in the indicated depth interval. Only data collected since 2000 are displayed. Screening level 30 mg/kg is based on MTCA Method A for industrial land use.

# Extent of Gasoline Range TPH in Soil Saturated Zone (15 – 30' bgs)

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

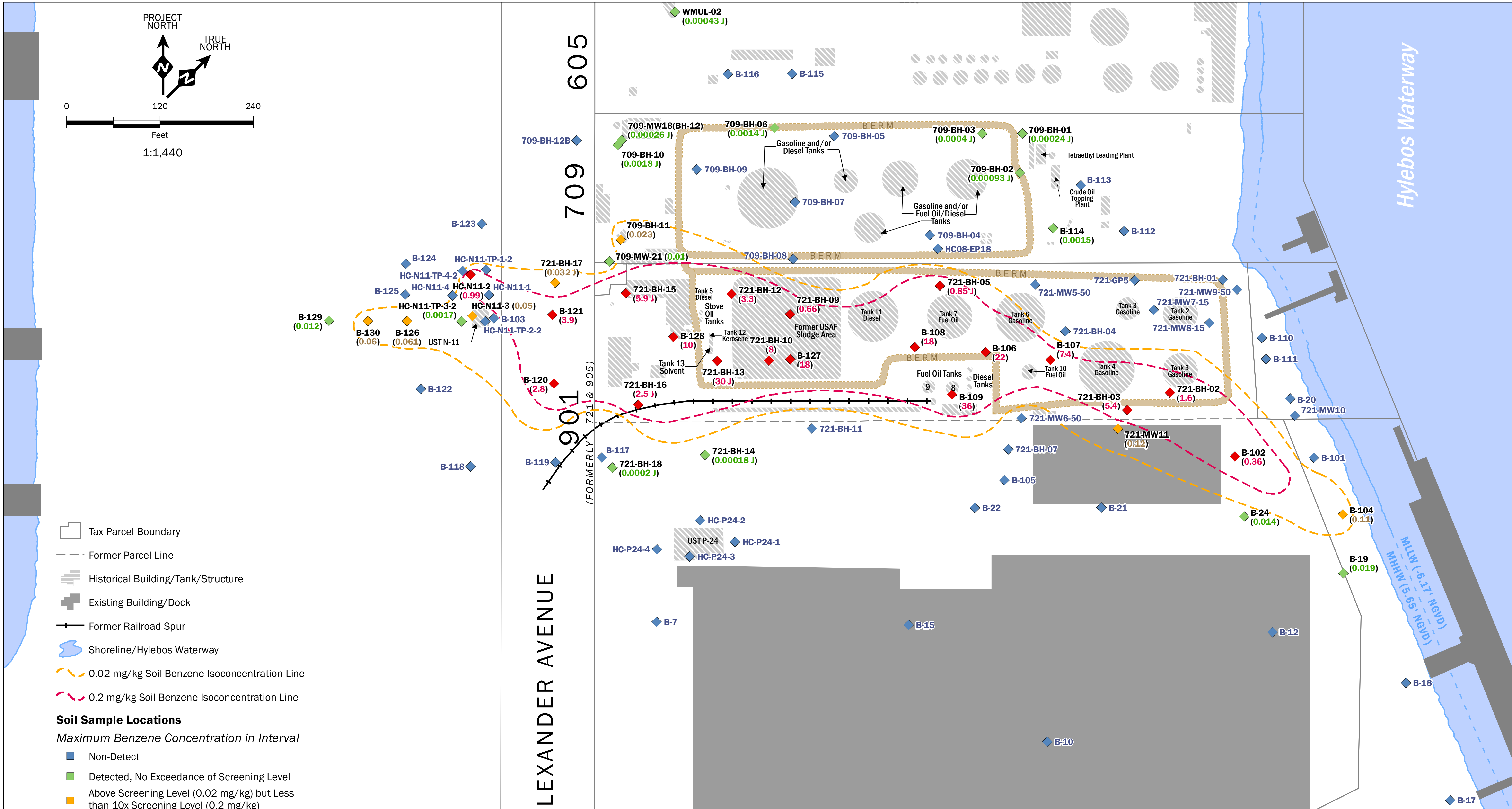
Aspect CONSULTING | MAR-2016 | BY: DFR / PPW | FIGURE NO. 6.3-3
PROJECT NO. 130097-01D | REVISED BY: EAC / RAP




# Extent of Benzene in Soil Unsaturated Zone (0 – 5' bgs)

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

| | | | |
|---|---|---|---|
| Aspect CONSULTING | MAR-2016 | BY: DFR / PPW | FIGURE NO. |
| | PROJECT NO. 130097-01D | REVISED BY: EAC / RAP | 6.3-4 |



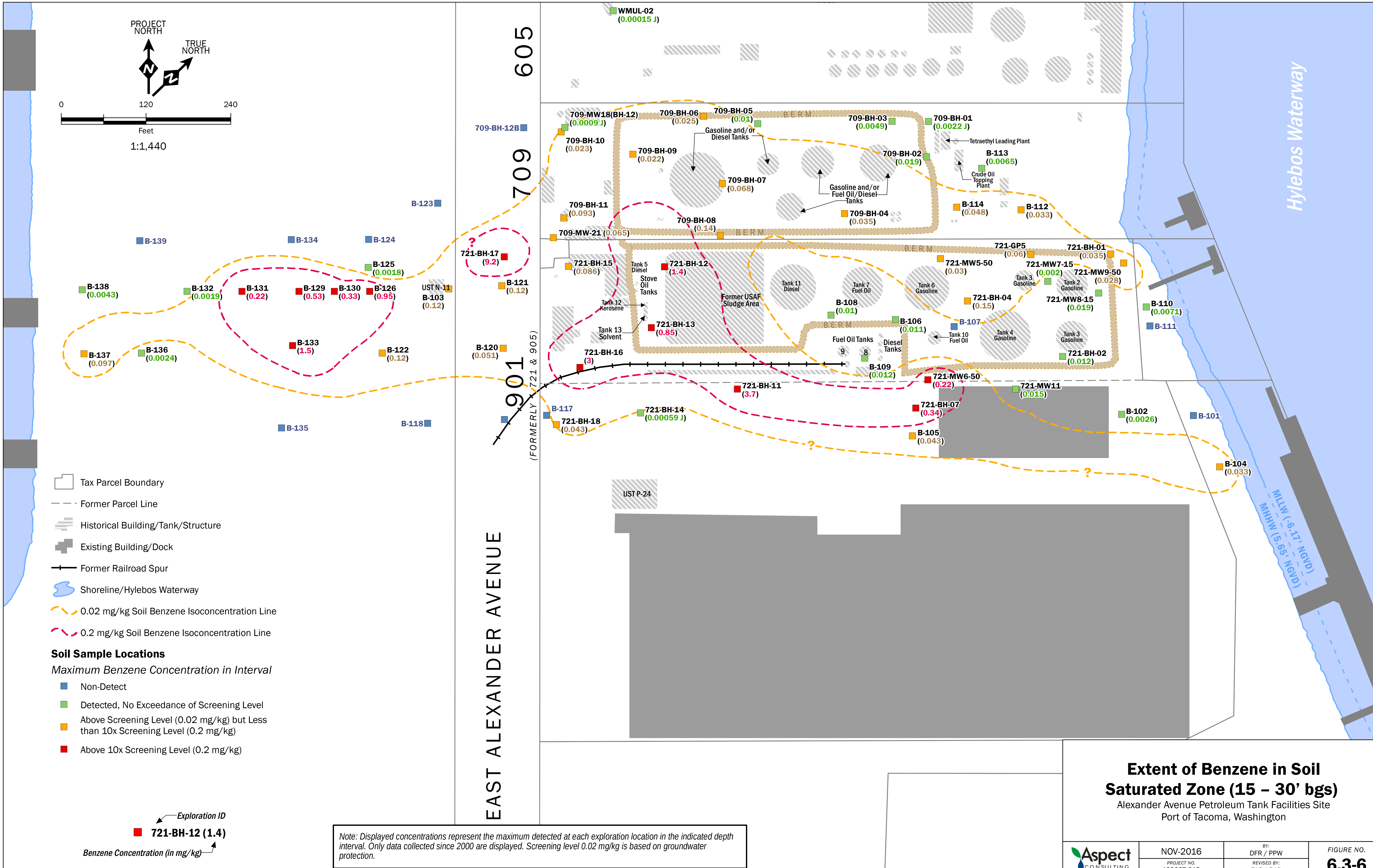

*Note: Displayed concentrations represent the maximum detected at each exploration location in the indicated depth interval. Only data collected since 2000 are displayed. Screening level 0.02 mg/kg is based on groundwater protection.*

# Extent of Benzene in Soil Saturated Zone (5 - 15' bgs )

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

| Aspect CONSULTING | MAR-2016 | BY: DFR / PPW | FIGURE NO. |
|---|---|---|---|
| | PROJECT NO. 130097-01D | REVISED BY: EAC / RAP | 6.3-5 |

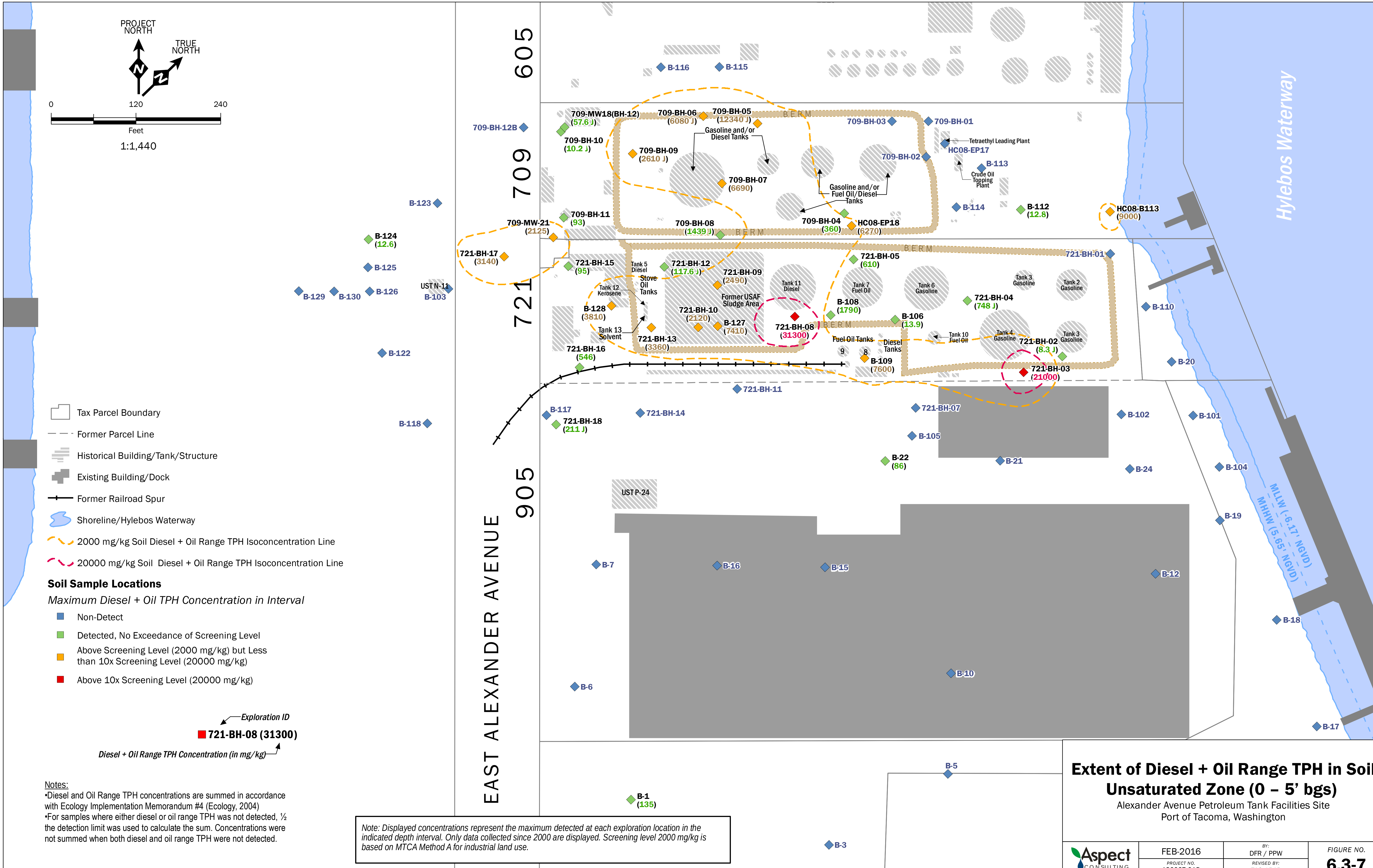
GIS Path: T:\projects_8\Port_of_Tacoma\AlexanderAve_130097\Delivered\RemedialInvestigationReport\6.3-5 Soil Benzene 5-15.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 3/31/2016 || User: rbobich || Print Date: 3/31/2016




**Extent of Benzene in Soil Saturated Zone (15 – 30' bgs)**

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING | NOV-2016 | BY: DFR / PPW | FIGURE NO. 6.3-6
PROJECT NO. 130097-01D | REVISED BY: EAC / RAP




Tax Parcel Boundary
Former Parcel Line
Historical Building/Tank/Structure
Existing Building/Dock
Former Railroad Spur
Shoreline/Hylebos Waterway
2000 mg/kg Soil Diesel + Oil Range TPH Isoconcentration Line
20000 mg/kg Soil Diesel + Oil Range TPH Isoconcentration Line

**Soil Sample Locations**

*Maximum Diesel + Oil TPH Concentration in Interval*

- Non-Detect
- Detected, No Exceedance of Screening Level
- Above Screening Level (2000 mg/kg) but Less than 10x Screening Level (20000 mg/kg)
- Above 10x Screening Level (20000 mg/kg)

*Exploration ID*

**721-BH-08 (31300)**

*Diesel + Oil Range TPH Concentration (in mg/kg)*

Notes:
•Diesel and Oil Range TPH concentrations are summed in accordance with Ecology Implementation Memorandum #4 (Ecology, 2004)
•For samples where either diesel or oil range TPH was not detected, ½ the detection limit was used to calculate the sum. Concentrations were not summed when both diesel and oil range TPH were not detected.

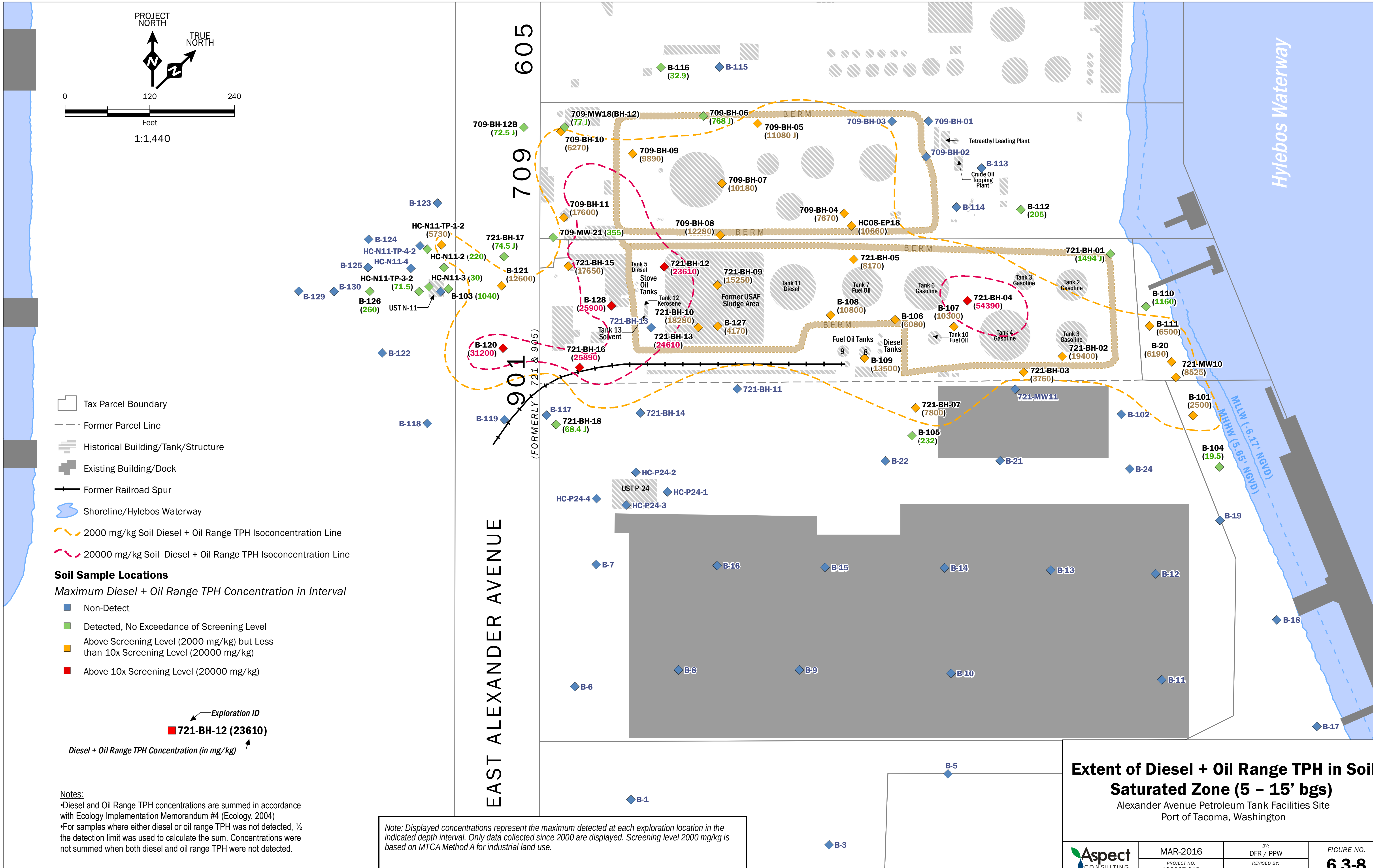
*Note: Displayed concentrations represent the maximum detected at each exploration location in the indicated depth interval. Only data collected since 2000 are displayed. Screening level 2000 mg/kg is based on MTCA Method A for industrial land use.*

# Extent of Diesel + Oil Range TPH in Soil Unsaturated Zone (0 – 5' bgs)

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

| | | | |
|---|---|---|---|
| Aspect CONSULTING | FEB-2016 | BY: DFR / PPW | FIGURE NO. |
| | PROJECT NO. 130097-01D | REVISED BY: EAC / RAP | 6.3-7 |

GIS Path: T:\projects_8\Port_of_Tacoma\AlexanderAve_130097\Delivered\RemedialInvestigationReport\6.3-7 Soil Diesel and Oil Range TPH 0-5.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 2/24/2016 || User: rbobich || Print Date: 3/31/2016




Notes:
•Diesel and Oil Range TPH concentrations are summed in accordance with Ecology Implementation Memorandum #4 (Ecology, 2004)
•For samples where either diesel or oil range TPH was not detected, ½ the detection limit was used to calculate the sum. Concentrations were not summed when both diesel and oil range TPH were not detected.

*Note: Displayed concentrations represent the maximum detected at each exploration location in the indicated depth interval. Only data collected since 2000 are displayed. Screening level 2000 mg/kg is based on MTCA Method A for industrial land use.*

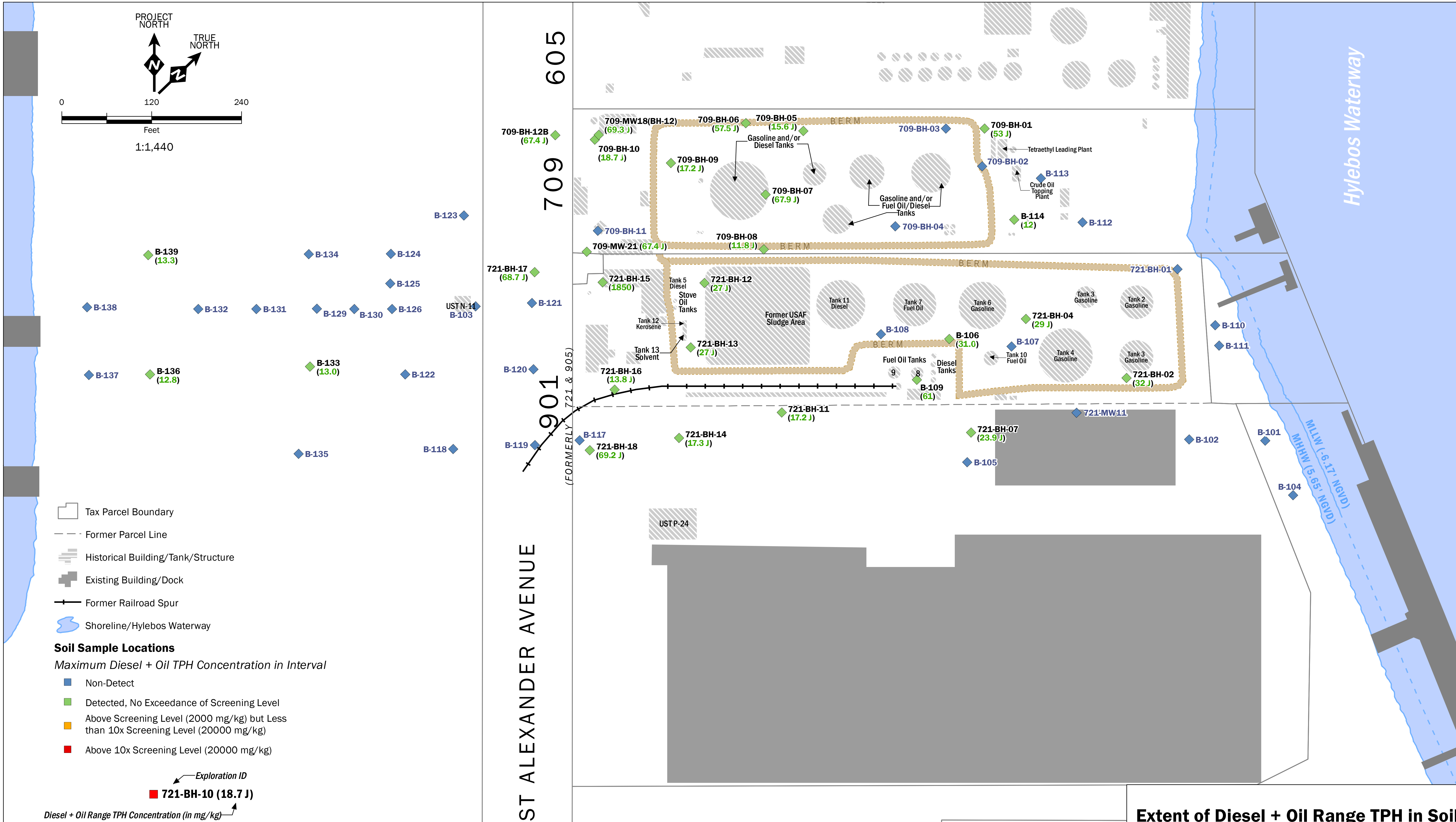
# Extent of Diesel + Oil Range TPH in Soil Saturated Zone (5 – 15' bgs)

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING

| | | |
|---|---|---|
| MAR-2016 | BY: DFR / PPW | FIGURE NO. 6.3-8 |
| PROJECT NO. 130097-01D | REVISED BY: EAC / RAP | |

GIS Path: T:\projects_8\Port_of_Tacoma\AlexanderAve_130097\Delivered\RemedialInvestigationReport\6.3-8 Soil Diesel and Oil Range TPH 5-15.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 3/31/2016 || User: rbolich || Print Date: 3/31/2016



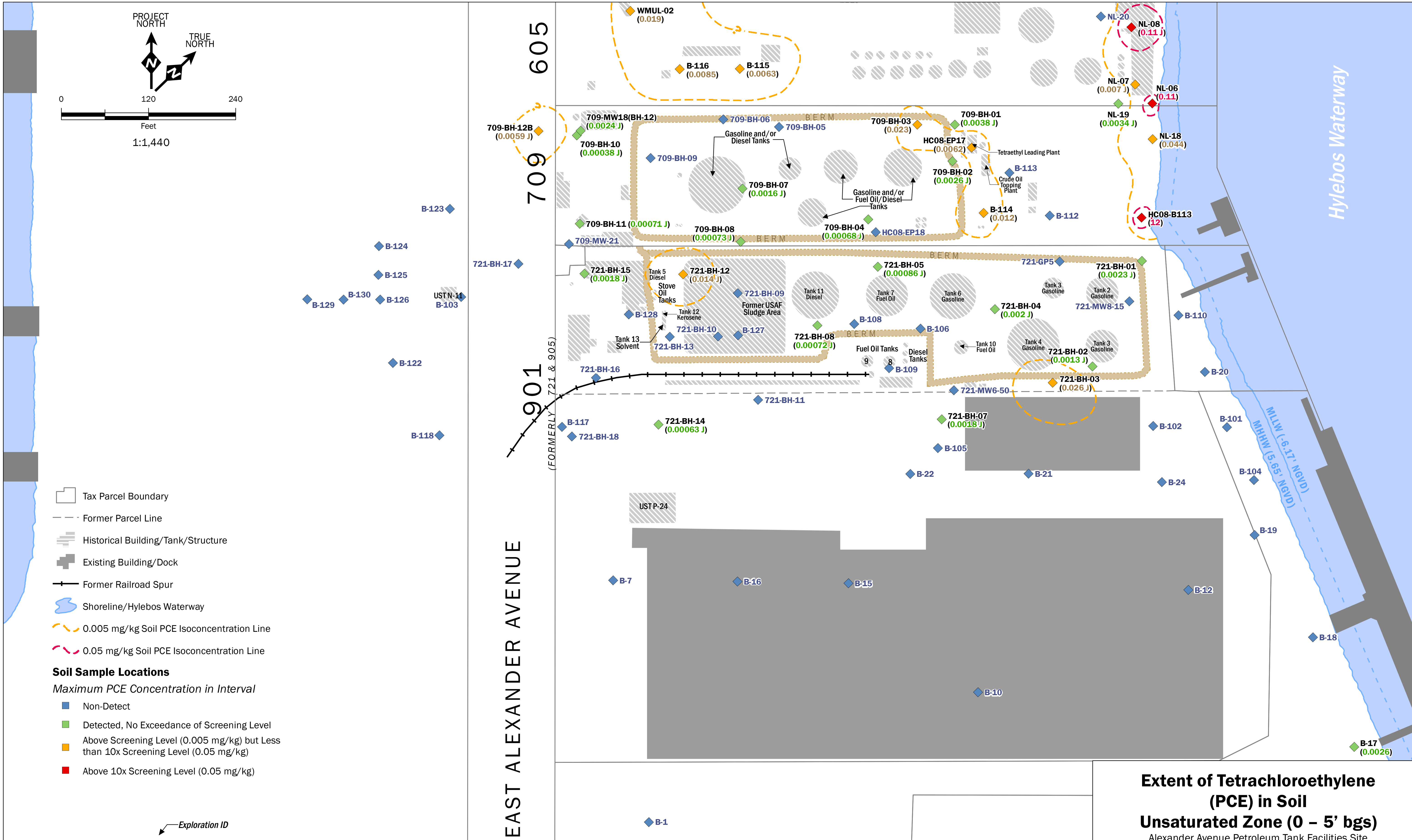

Notes:
•Diesel and Oil Range TPH concentrations are summed in accordance with Ecology Implementation Memorandum #4 (Ecology, 2004)
•For samples where either diesel or oil range TPH was not detected, ½ the detection limit was used to calculate the sum. Concentrations were not summed when both diesel and oil range TPH were not detected.

*Note: Displayed concentrations represent the maximum detected at each exploration location in the indicated depth interval. Only data collected since 2000 are displayed. Screening level 2000 mg/kg is based on MTCA Method A for industrial land use.*

# Extent of Diesel + Oil Range TPH in Soil Saturated Zone (15 – 30' bgs)

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

| Aspect CONSULTING | MAR-2016 | BY: DFR / PPW | FIGURE NO. |
|---|---|---|---|
| | PROJECT NO. 130097-01B | REVISED BY: EAC / RAP | 6.3-9 |




Tax Parcel Boundary

Former Parcel Line

Historical Building/Tank/Structure

Existing Building/Dock

Former Railroad Spur

Shoreline/Hylebos Waterway

0.005 mg/kg Soil PCE Isoconcentration Line

0.05 mg/kg Soil PCE Isoconcentration Line

**Soil Sample Locations**

*Maximum PCE Concentration in Interval*

- Non-Detect
- Detected, No Exceedance of Screening Level
- Above Screening Level (0.005 mg/kg) but Less than 10x Screening Level (0.05 mg/kg)
- Above 10x Screening Level (0.05 mg/kg)

*Exploration ID*

**NL-08 (0.11 J)**

*PCE Concentration (in mg/kg)*

*Note: Displayed concentrations represent the maximum detected at each exploration location in the indicated depth interval. Only data collected since 2000 are displayed. Screening level 0.005 mg/kg is based on the practical quantitaion limit (PQL).*

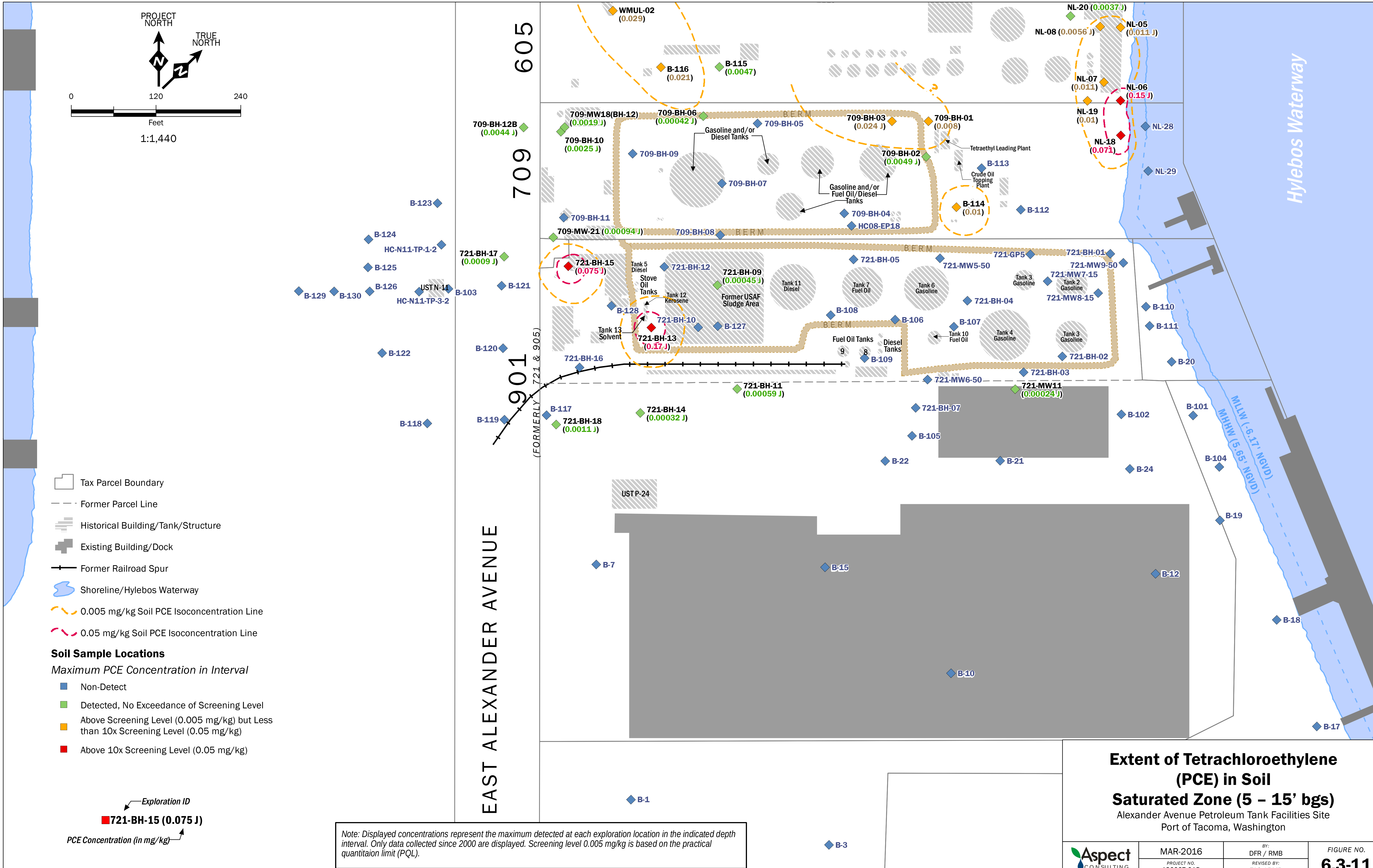
# Extent of Tetrachloroethylene (PCE) in Soil Unsaturated Zone (0 – 5' bgs)

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING

| | | | |
|---|---|---|---|
| MAR-2016 | BY: DFR / RMB | FIGURE NO. | |
| PROJECT NO. 130097-01D | REVISED BY: EAC / RAP | 6.3-10 | |

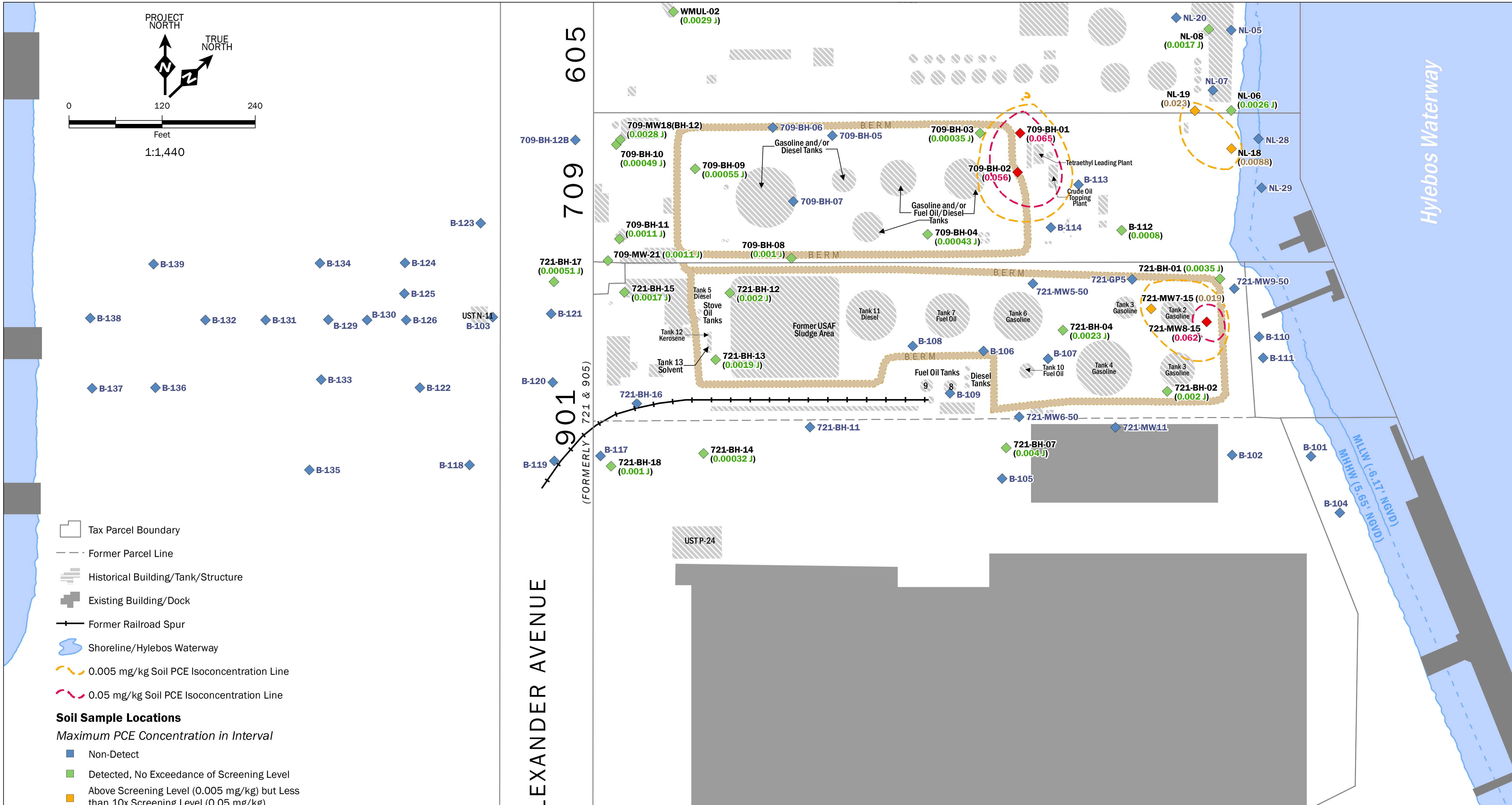
GIS Path: T:\projects_8\Port_of_Tacoma\AlexanderAve_130097\Deliverables\RemedialInvestigationReport\6.3-10 Soil PCE 0-5.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 3/31/2016 || User: rbobich || Print Date: 3/31/2016




# Extent of Tetrachloroethylene (PCE) in Soil
## Saturated Zone (5 – 15' bgs)

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

| Aspect CONSULTING | MAR-2016 | BY: DFR / RMB | FIGURE NO. |
|---|---|---|---|
| | PROJECT NO. 130097-01D | REVISED BY: EAC / RMB | 6.3-11 |



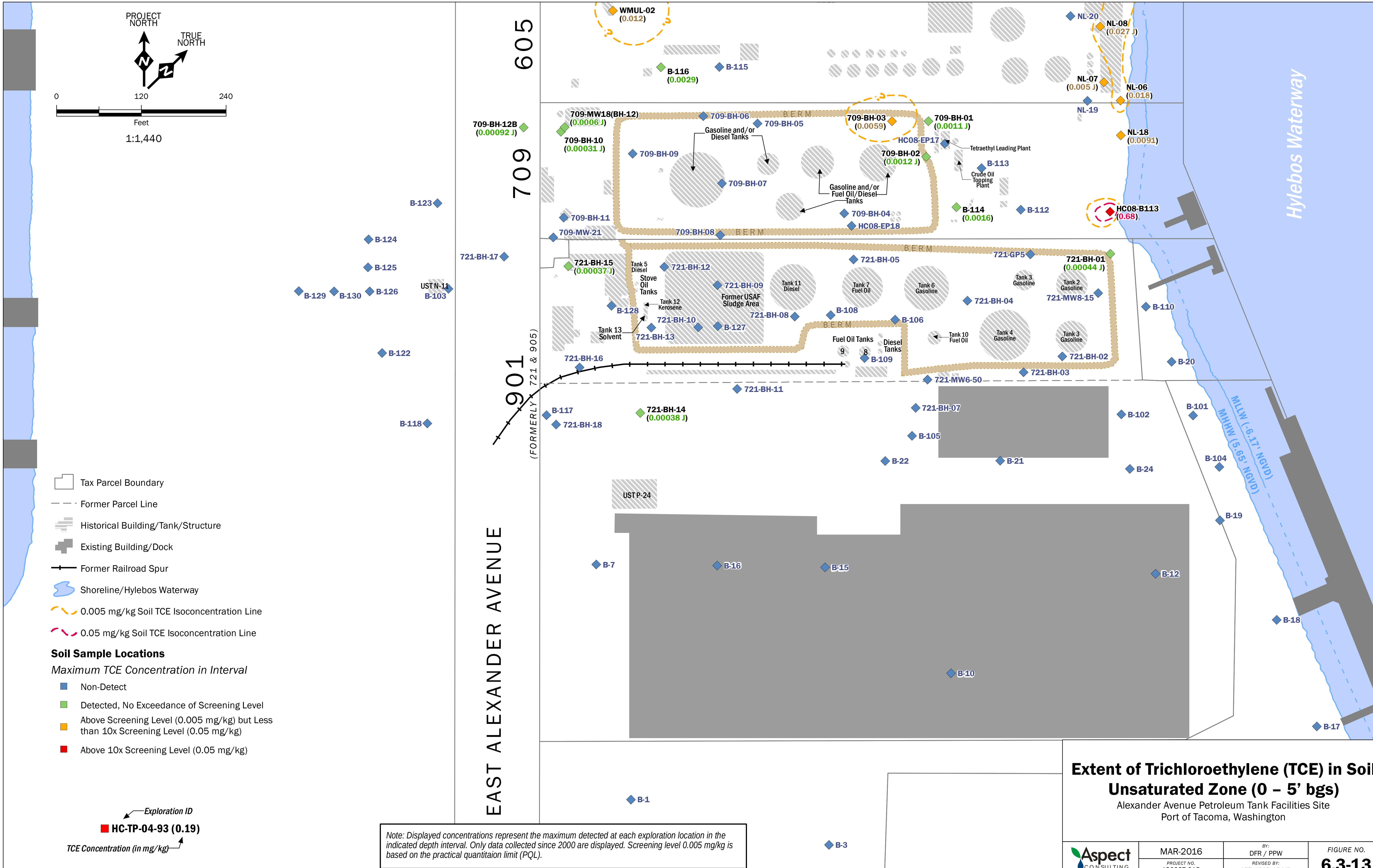

*Note: Displayed concentrations represent the maximum detected at each exploration location in the indicated depth interval. Only data collected since 2000 are displayed. Screening level 0.005 mg/kg is based on the practical quantitaion limit (PQL).*

# Extent of Tetrachloroethylene (PCE) in Soil Saturated Zone (15 – 30' bgs)

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING

| | | | |
|---|---|---|---|
| MAR-2016 | BY: DFR / RMB | FIGURE NO. | |
| PROJECT NO. 130097-01D | REVISED BY: EAC / RMB | 6.3-12 | |



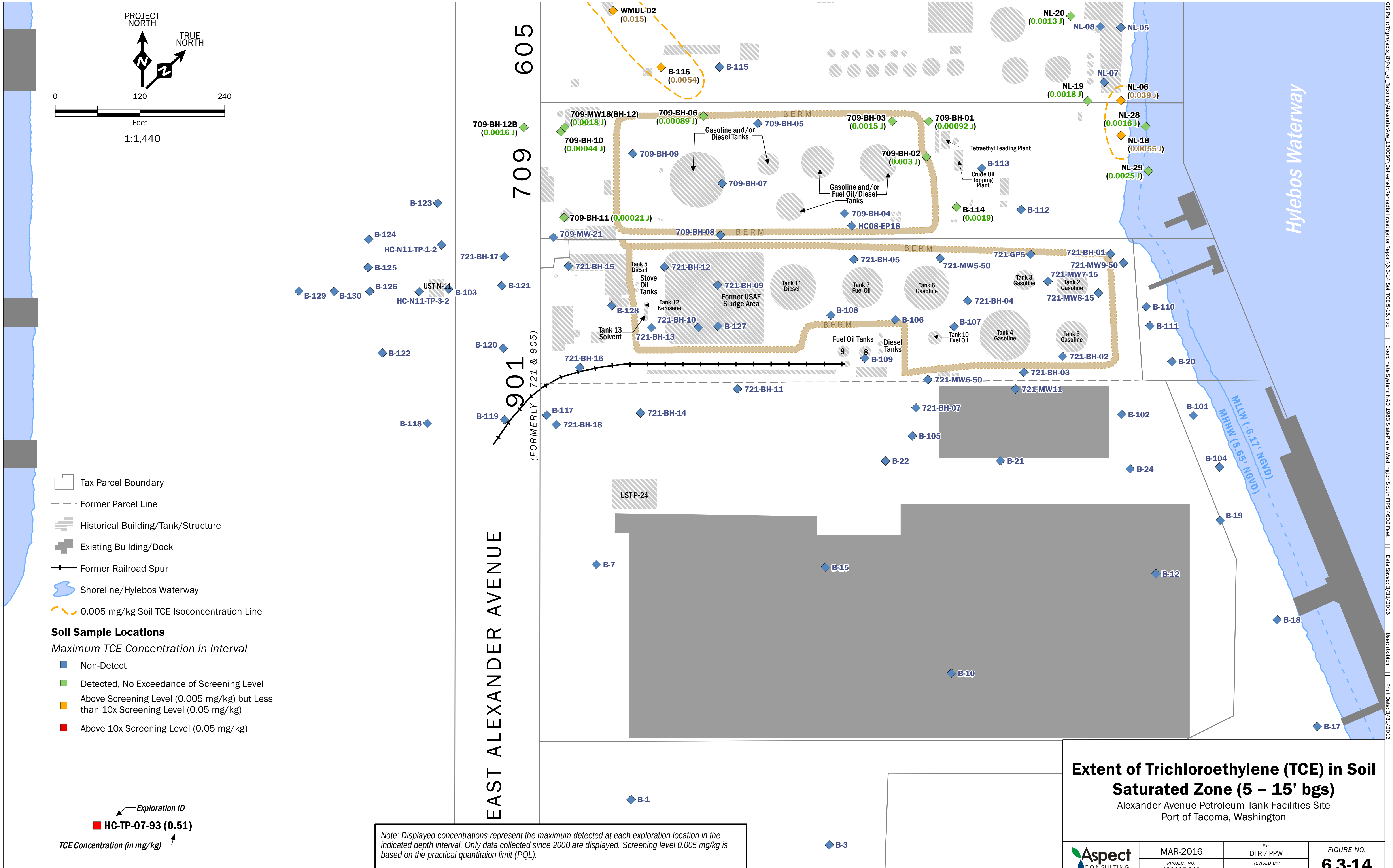

*Note: Displayed concentrations represent the maximum detected at each exploration location in the indicated depth interval. Only data collected since 2000 are displayed. Screening level 0.005 mg/kg is based on the practical quantitaion limit (PQL).*

# Extent of Trichloroethylene (TCE) in Soil Unsaturated Zone (0 – 5' bgs)

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

| | | | |
|---|---|---|---|
| Aspect CONSULTING | MAR-2016 | BY: DFR / PPW | FIGURE NO. |
| | PROJECT NO. 130097-01D | REVISED BY: AET / RAP / RMB | 6.3-13 |

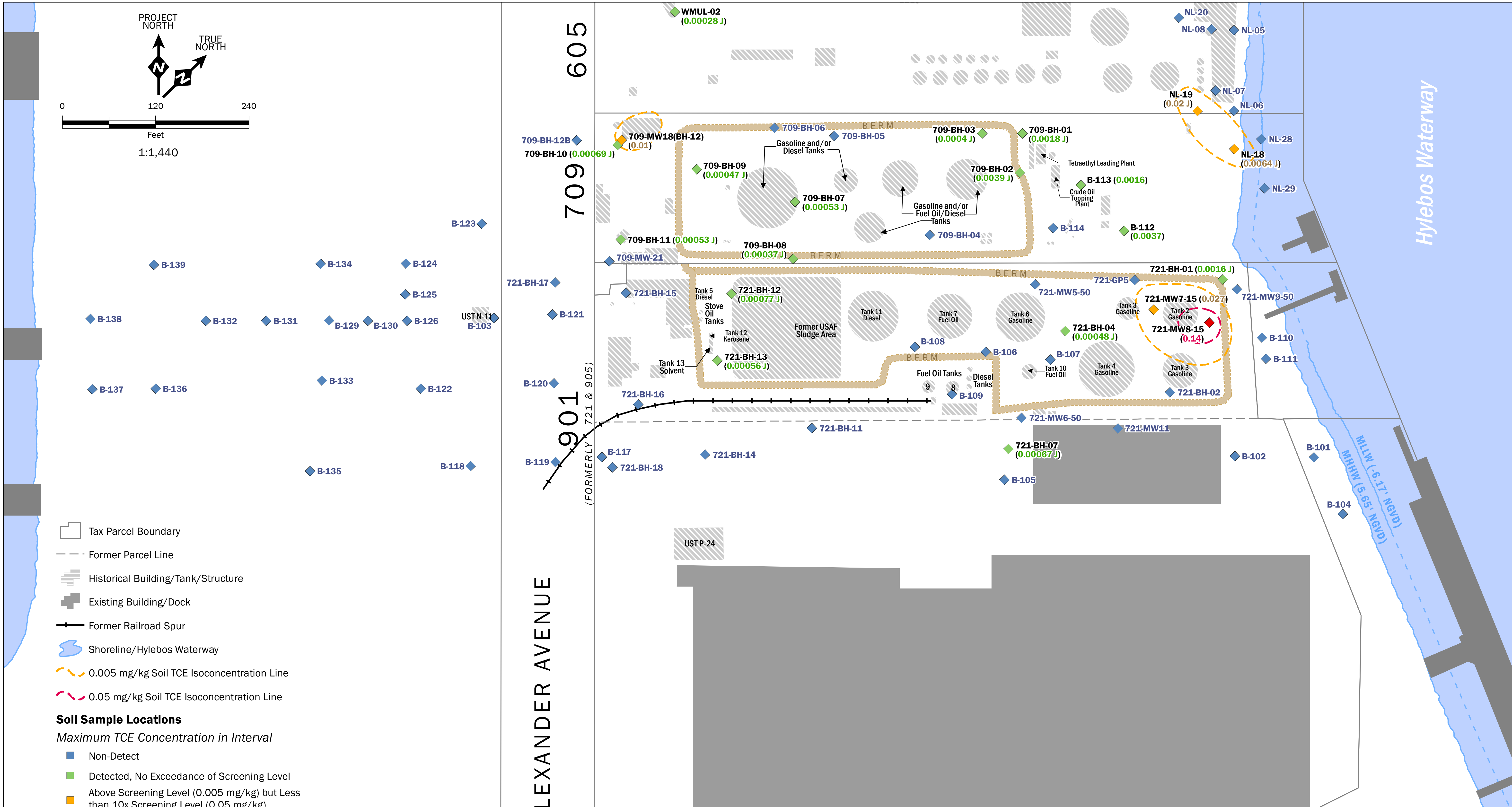
GIS Path: T:\projects_8\Port_of_Tacoma\AlexanderAve_130097\Delivered\RemedialInvestigationReport\6.3-13 Soil TCE 0-5.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 3/31/2016 || User: rbobich || Print Date: 3/31/2016




# Extent of Trichloroethylene (TCE) in Soil Saturated Zone (5 – 15' bgs)

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

| Aspect CONSULTING | MAR-2016 | BY: DFR / PPW | FIGURE NO. |
|---|---|---|---|
| | PROJECT NO. 130097-01D | REVISED BY: AET / RMB / RAP | 6.3-14 |




Tax Parcel Boundary

Former Parcel Line

Historical Building/Tank/Structure

Existing Building/Dock

Former Railroad Spur

Shoreline/Hylebos Waterway

0.005 mg/kg Soil TCE Isoconcentration Line

0.05 mg/kg Soil TCE Isoconcentration Line

**Soil Sample Locations**

*Maximum TCE Concentration in Interval*

- Non-Detect
- Detected, No Exceedance of Screening Level
- Above Screening Level (0.005 mg/kg) but Less than 10x Screening Level (0.05 mg/kg)
- Above 10x Screening Level (0.05 mg/kg)

*Exploration ID*

**709-MW-04 (0.13)**

*TCE Concentration (in mg/kg)*

*Note: Displayed concentrations represent the maximum detected at each exploration location in the indicated depth interval. Only data collected since 2000 are displayed. Screening level 0.005 mg/kg is based on the practical quantitaion limit (PQL).*

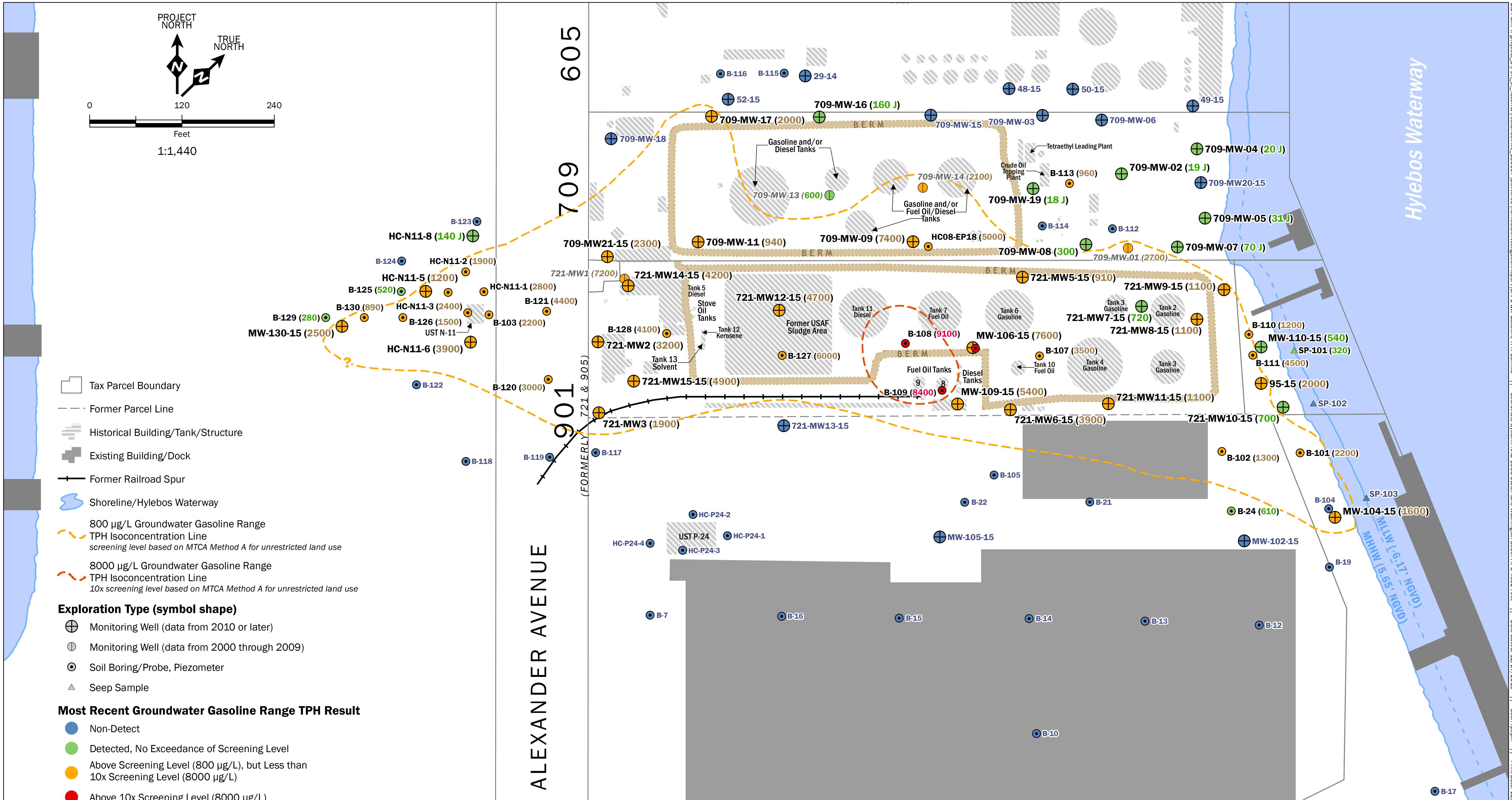
# Extent of Trichloroethylene (TCE) in Soil Saturated Zone (15 – 30' bgs)

Alexander Avenue Petroleum Tank Facilities Site

Port of Tacoma, Washington

| | | | |
|---|---|---|---|
| Aspect CONSULTING | MAR-2016 | BY: DFR / PPW | FIGURE NO. |
| | PROJECT NO. 130097-01D | REVISED BY: AET / RAP / RMB | 6.3-15 |

GIS Path: T:\projects_8\Port_of_Tacoma\AlexanderAve_130097\Delivered\RemedialInvestigationReport\6.3-15 Soil TCE 15-30.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 3/31/2016 || User: rbobich || Print Date: 3/31/2016

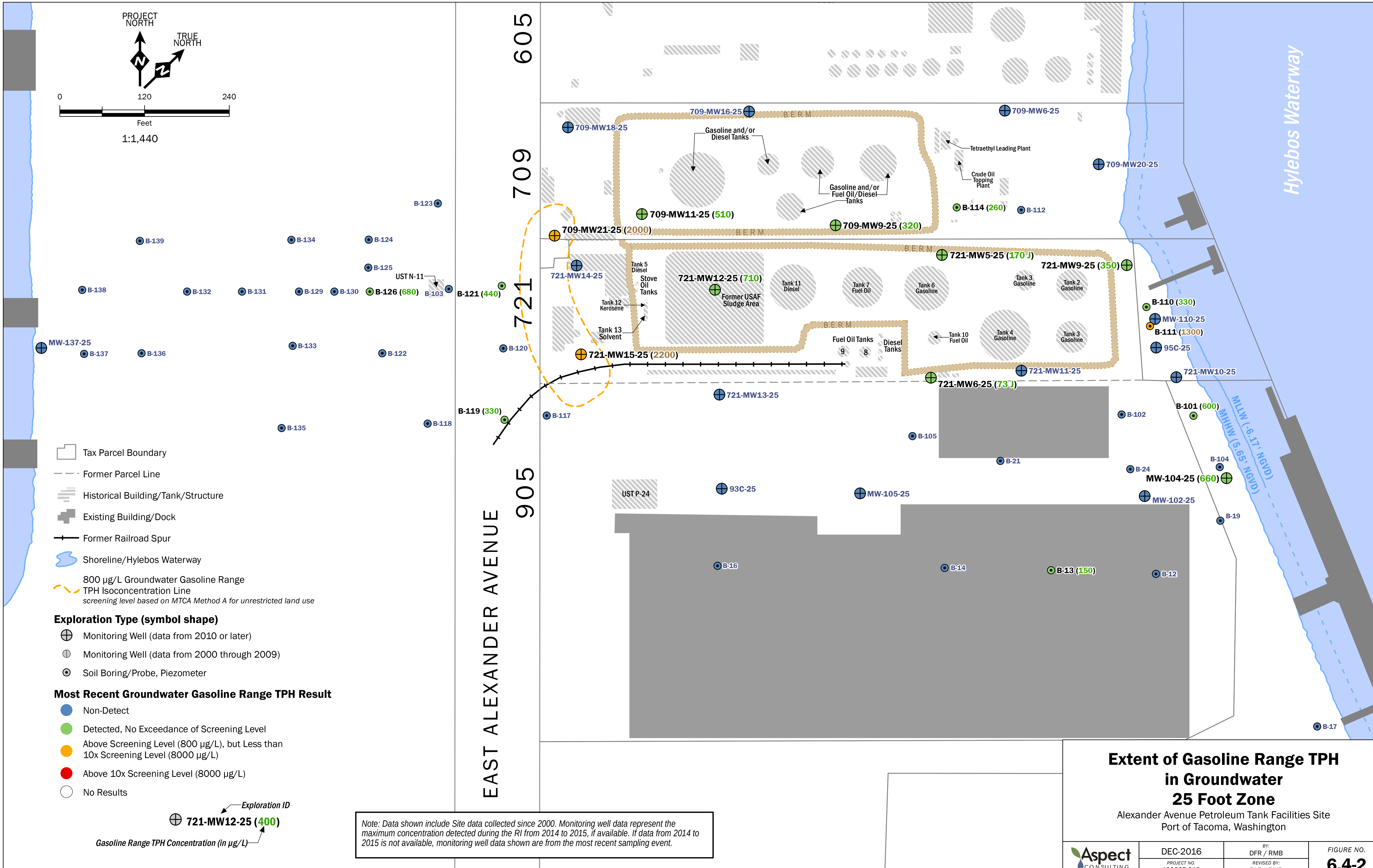



# Extent of Gasoline Range TPH in Groundwater 15 Foot Zone

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING

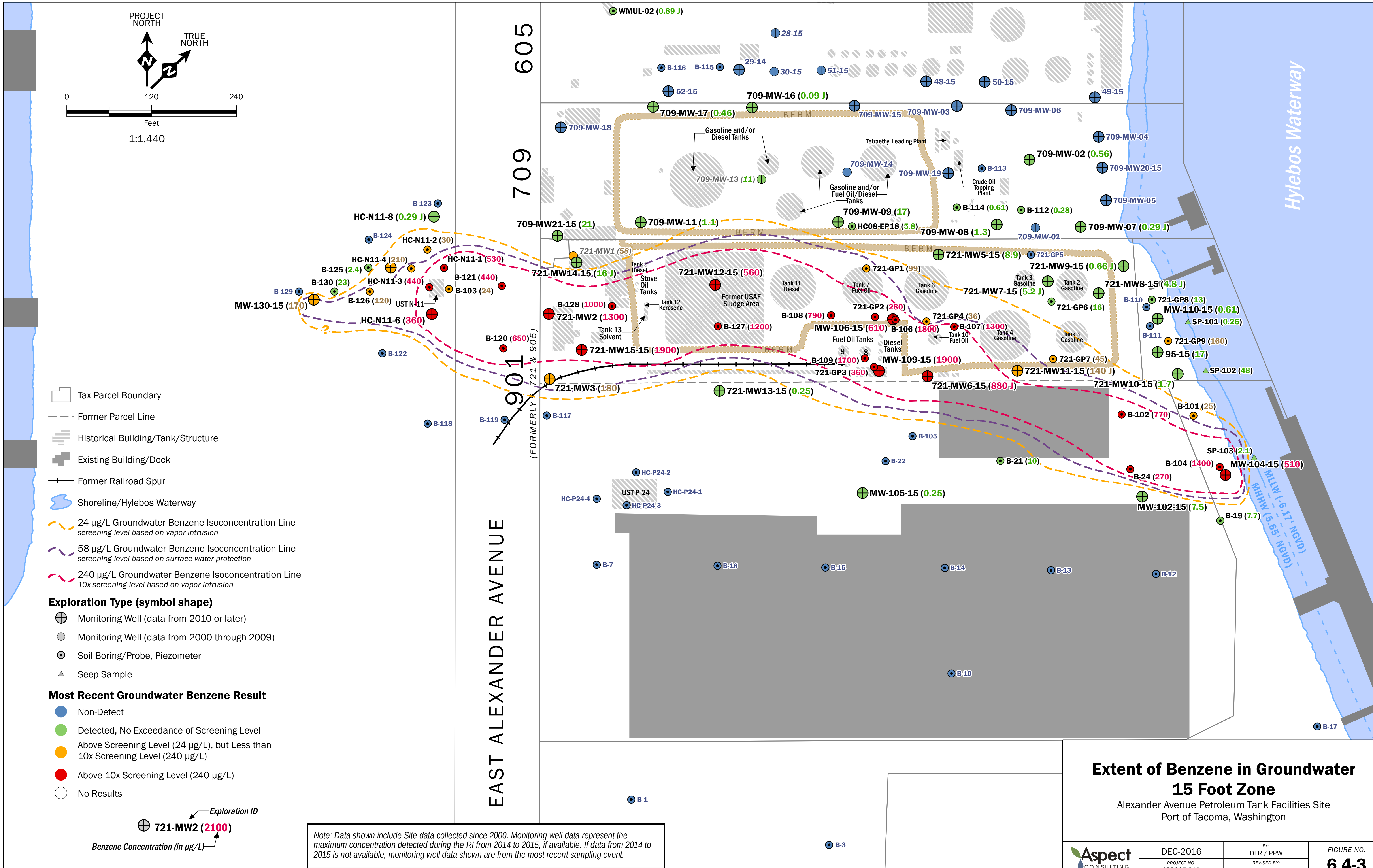
| | | |
|---|---|---|
| DEC-2016 | BY: DFR / RMB | FIGURE NO. |
| PROJECT NO. 130097-01D | REVISED BY: RAP / RMB | 6.4-1 |




*Note: Data shown include Site data collected since 2000. Monitoring well data represent the maximum concentration detected during the RI from 2014 to 2015, if available. If data from 2014 to 2015 is not available, monitoring well data shown are from the most recent sampling event.*

**Extent of Gasoline Range TPH in Groundwater 25 Foot Zone**

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

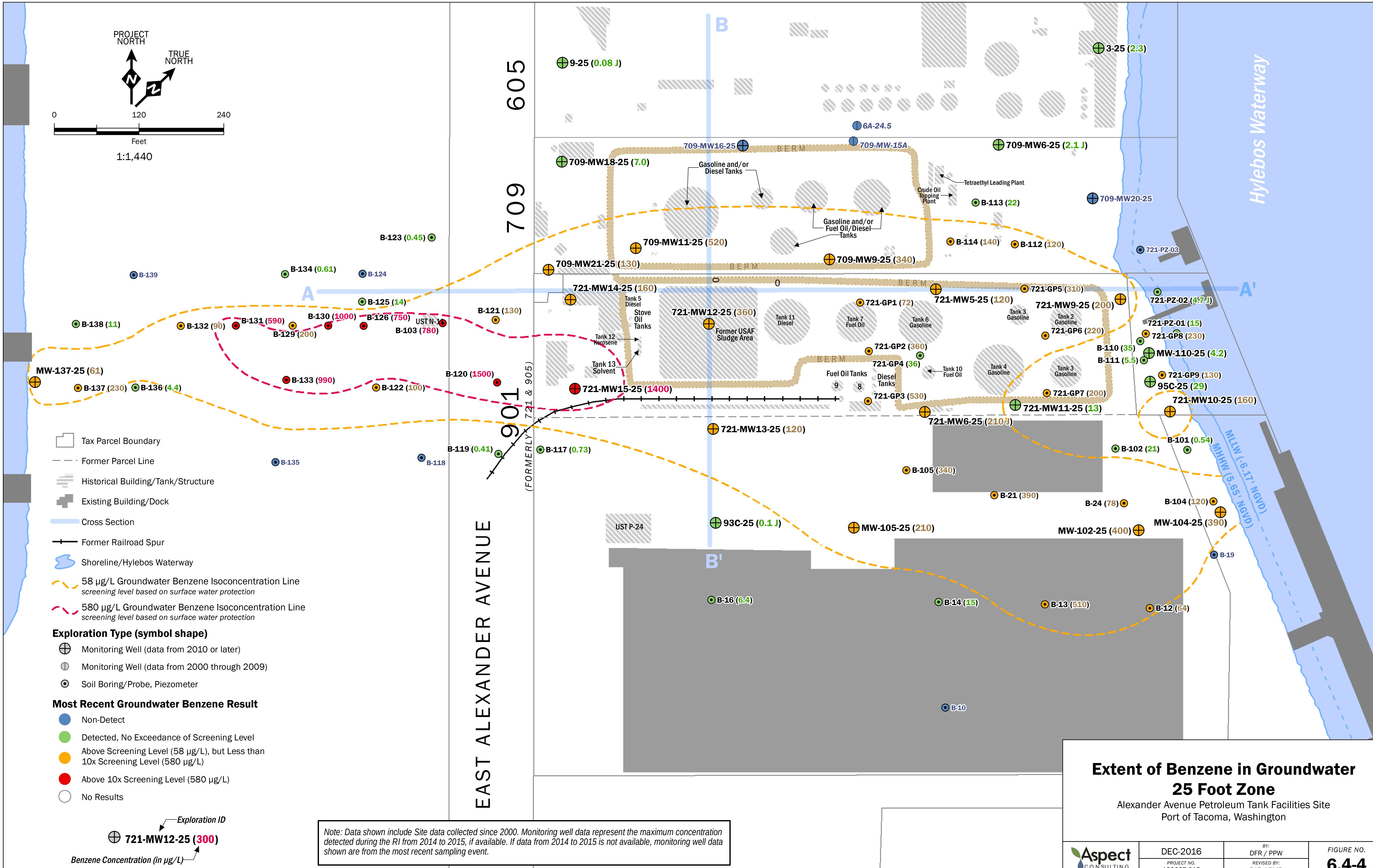



Note: Data shown include Site data collected since 2000. Monitoring well data represent the maximum concentration detected during the RI from 2014 to 2015, if available. If data from 2014 to 2015 is not available, monitoring well data shown are from the most recent sampling event.

# Extent of Benzene in Groundwater 15 Foot Zone

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING | DEC-2016 | BY: DFR / PPW | FIGURE NO. 6.4-3
PROJECT NO. 130097-01D | REVISED BY: RAP / RMB

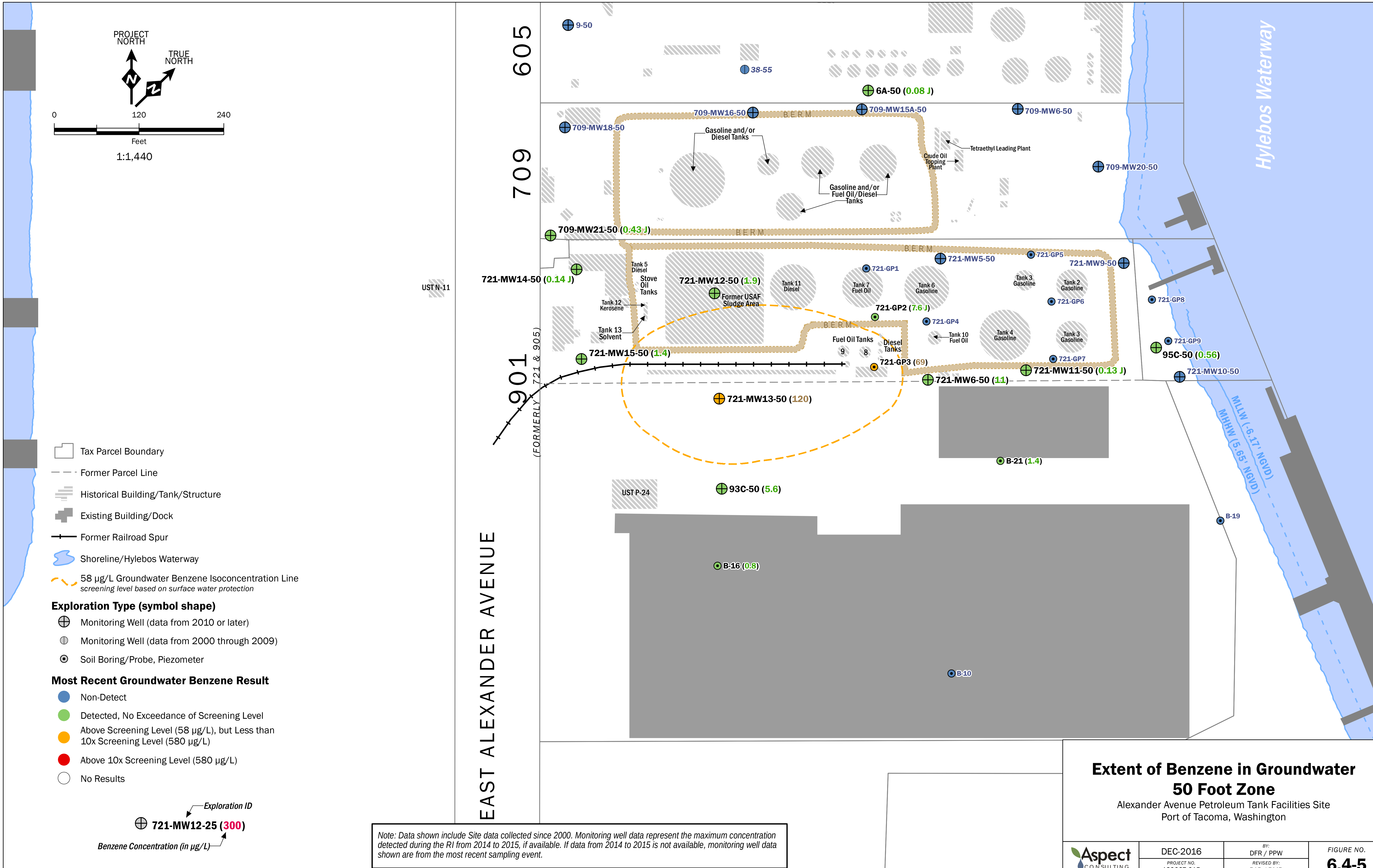



*Note: Data shown include Site data collected since 2000. Monitoring well data represent the maximum concentration detected during the RI from 2014 to 2015, if available. If data from 2014 to 2015 is not available, monitoring well data shown are from the most recent sampling event.*

## Extent of Benzene in Groundwater 25 Foot Zone

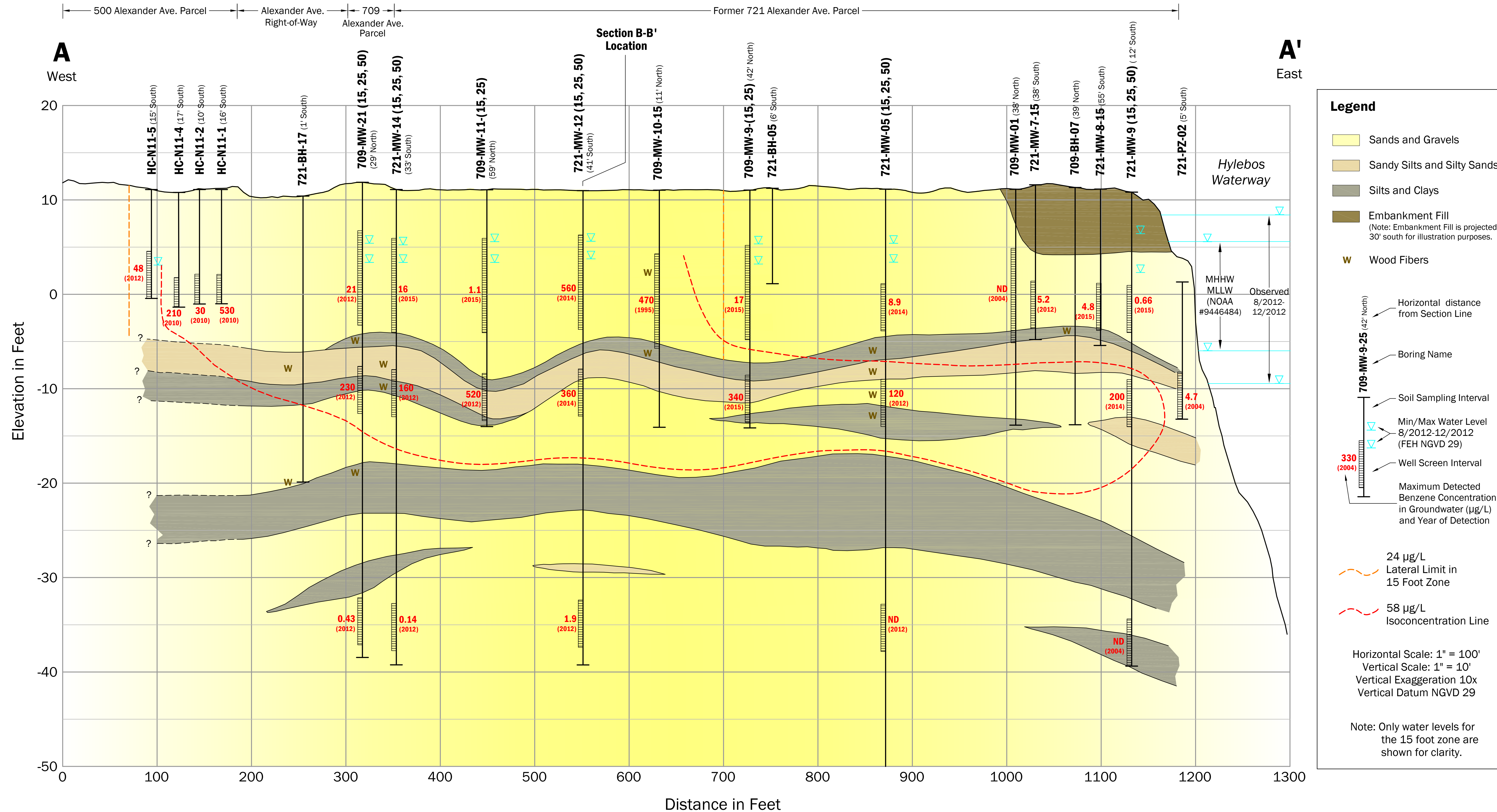
Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

| | | | |
|---|---|---|---|
| Aspect CONSULTING | DEC-2016 | BY: DFR / PPW | FIGURE NO. |
| | PROJECT NO. 130097-01B | REVISED BY: RAP / RMB | 6.4-4 |




**Extent of Benzene in Groundwater 50 Foot Zone**

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington




Note: Benzene screening level 24 µg/L is based on vapor intrusion, applicable in the 15 foot zone. Benzene screening level 58 µg/L is based on surface water protection.

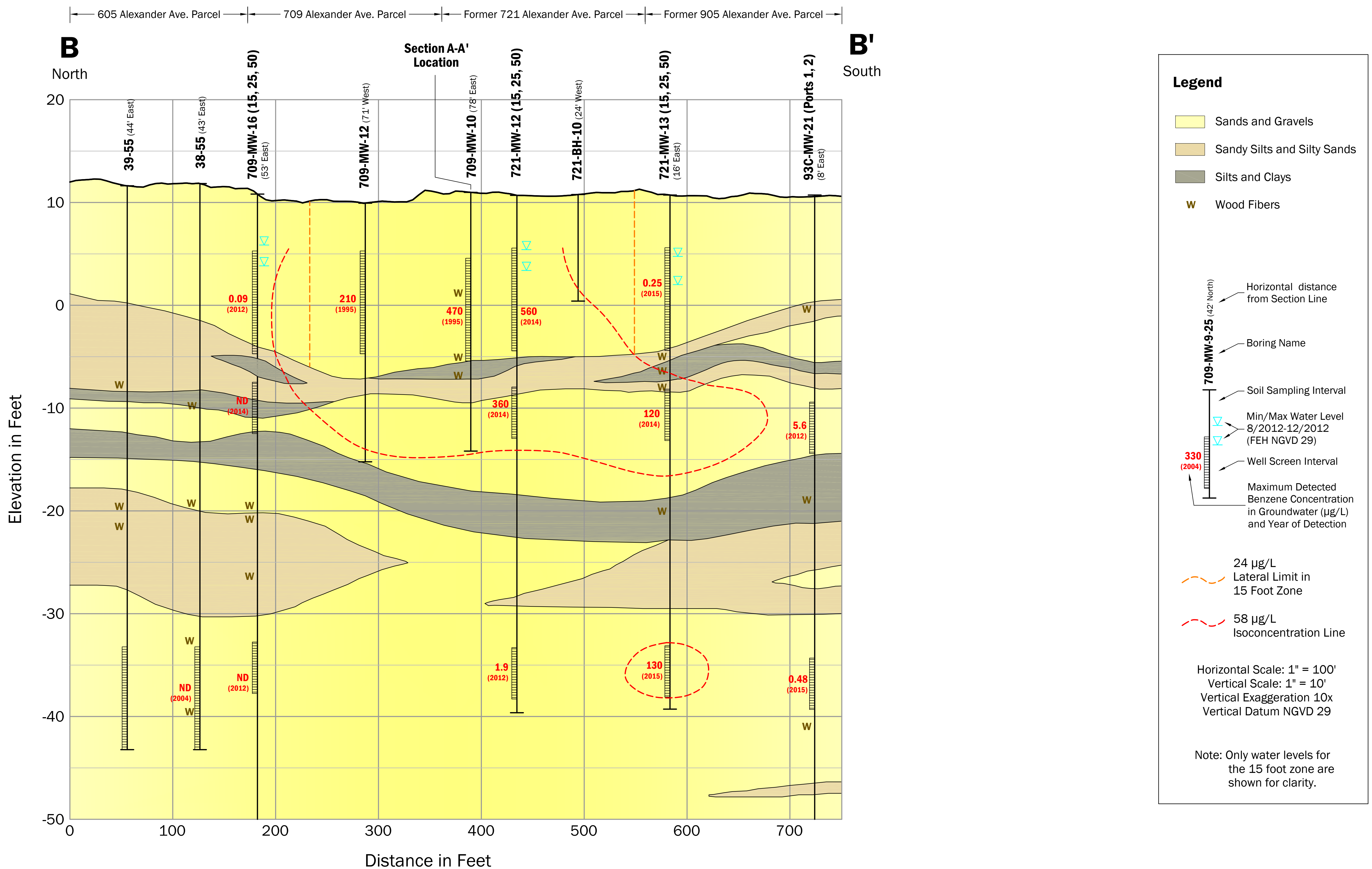
0 100 200
Feet

**Cross Section A-A' with Benzene Concentrations in Groundwater**

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING

| | | | |
|---|---|---|---|
| FEB-2016 | BY: DFR/SCC | FIGURE NO. 6.4-6A |
| PROJECT NO. 130097 | REV BY: SCC | |




Note: Benzene screening level 24 µg/L is based on vapor intrusion, applicable in the 15 foot zone. Benzene screening level 58 µg/L is based on surface water protection.

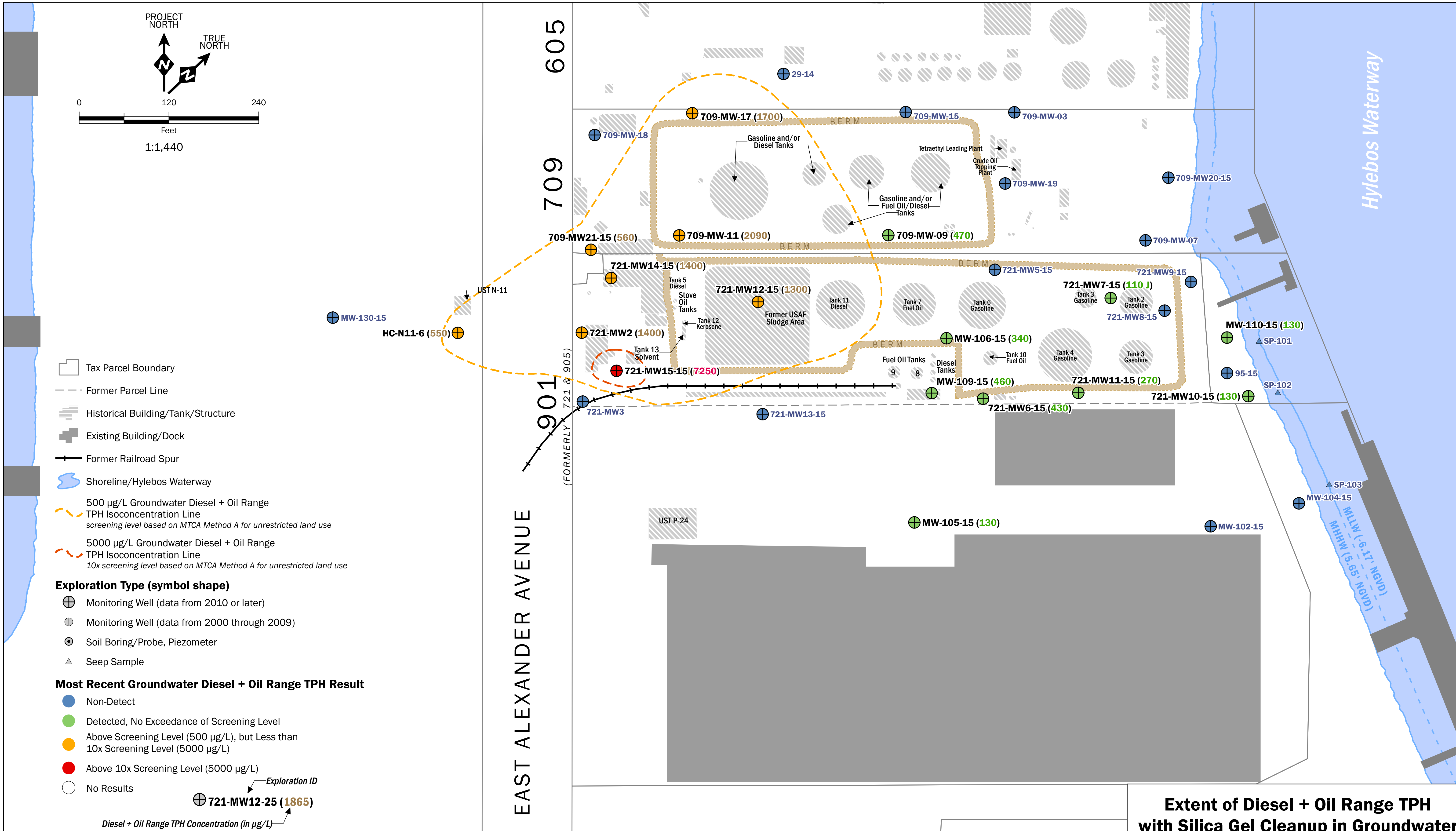
0 100 200
Feet

**Cross Section B-B' with Benzene Concentrations in Groundwater**

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

| | | | |
|---|---|---|---|
| Aspect CONSULTING | FEB-2016 | BY: DFR/SCC | FIGURE NO. |
| | PROJECT NO. 130097 | REV BY: SCC | 6.4-6B |

CAD Path: Q:\Port of Tacoma\130097 Alexander Ave Tank Facility\2016-02 RI-FS Cross Sections\130097-BB.dwg Benzene || Coordinate System: NAD 1983 State Plane Washington North FIPS 4601 Feet || Date Saved: Feb 24, 2016 12:26pm || User: scudd




Notes:
•Diesel and Oil Range TPH concentrations are summed in accordance with Ecology Implementation Memorandum #4 (Ecology, 2004)
•For samples where either diesel or oil range TPH was not detected, ½ the detection limit was used to calculate the sum. Concentrations were not summed when both diesel and oil range TPH were not detected.

*Note: Data shown include Site data collected since 2000. Monitoring well data represent the maximum concentration detected during the RI from 2014 to 2015, if available. If data from 2014 to 2015 is not available, monitoring well data shown are from the most recent sampling event.*

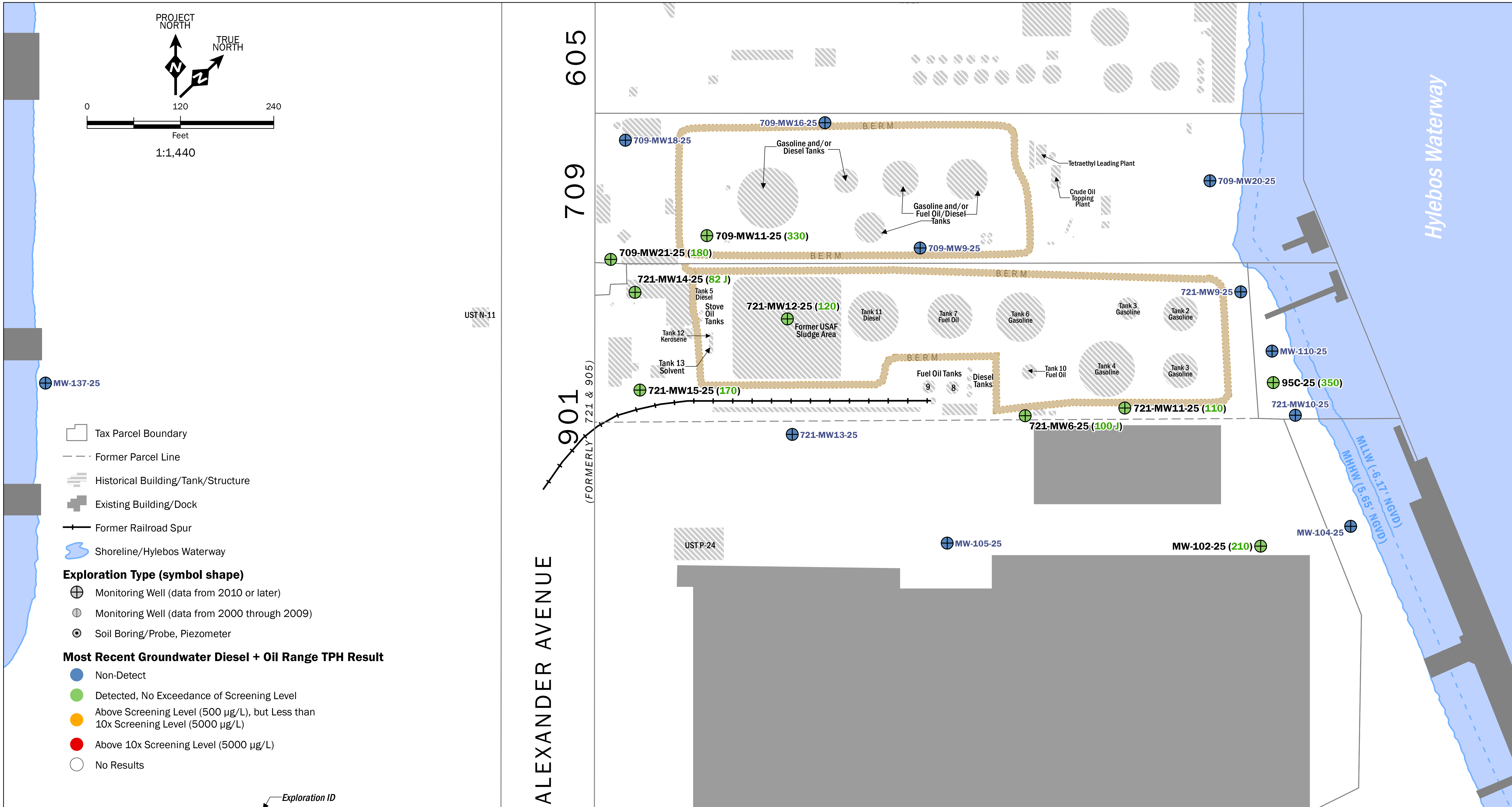
# Extent of Diesel + Oil Range TPH with Silica Gel Cleanup in Groundwater 15 Foot Zone

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING

| DEC-2016 | BY: DFR / PPW | FIGURE NO. |
|---|---|---|
| PROJECT NO. 130097-01D | REVISED BY: RAP / RMB | 6.4-7 |

GIS Path: T:\projects_8\Port_of_Tacoma\AlexanderAve_130097\Delivered\RemedialInvestigationReport\6.4-7 GW Diesel and Oil Range TPH 15 wSG.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 12/27/2016 || User: rpepin || Print Date: 12/27/2016




Tax Parcel Boundary
Former Parcel Line
Historical Building/Tank/Structure
Existing Building/Dock
Former Railroad Spur
Shoreline/Hylebos Waterway

**Exploration Type (symbol shape)**

- Monitoring Well (data from 2010 or later)
- Monitoring Well (data from 2000 through 2009)
- Soil Boring/Probe, Piezometer

**Most Recent Groundwater Diesel + Oil Range TPH Result**

- Non-Detect
- Detected, No Exceedance of Screening Level
- Above Screening Level (500 µg/L), but Less than 10x Screening Level (5000 µg/L)
- Above 10x Screening Level (5000 µg/L)
- No Results

*Exploration ID*
709-MW11-25 (590)
*Diesel + Oil Range TPH Concentration (in µg/L)*

Notes:
•Diesel and Oil Range TPH concentrations are summed in accordance with Ecology Implementation Memorandum #4 (Ecology, 2004)
•For samples where either diesel or oil range TPH was not detected, ½ the detection limit was used to calculate the sum. Concentrations were not summed when both diesel and oil range TPH were not detected.

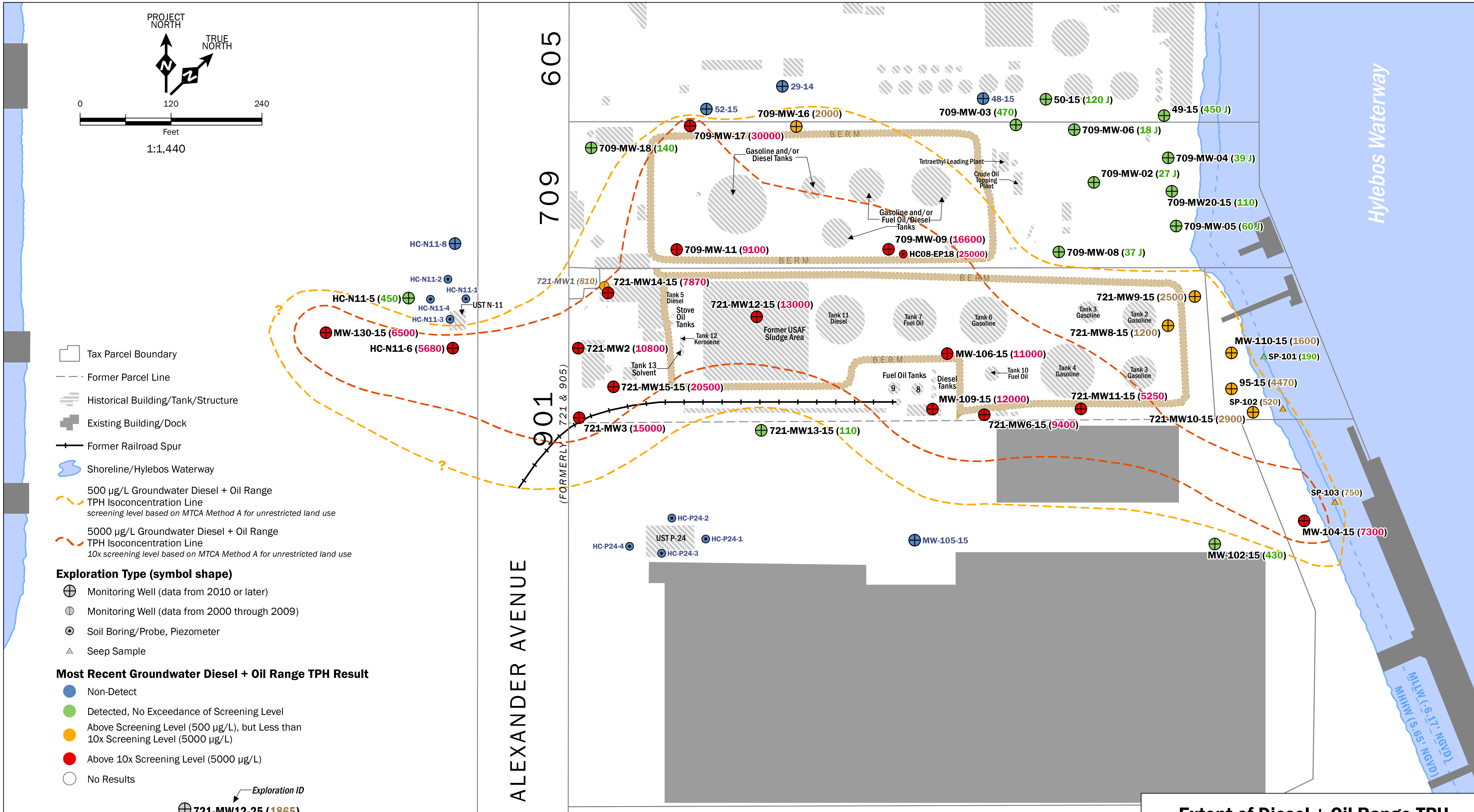
*Note: Data shown include Site data collected since 2000. Monitoring well data represent the maximum concentration detected during the RI from 2014 to 2015, if available. If data from 2014 to 2015 is not available, monitoring well data shown are from the most recent sampling event.*

# Extent of Diesel + Oil Range TPH with Silica Gel Cleanup in Groundwater 25 Foot Zone

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING | DEC-2016 | BY: DFR / PPW | FIGURE NO. 6.4-8
PROJECT NO. 130097-01D | REVISED BY: RAP / RMB

GIS Path: T:\projects_8\Port_of_Tacoma\AlexanderAve_130097\Delivered\RemedialInvestigationReport\6.4-8 GW Diesel and Oil Range TPH 25 wSG.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 12/27/2016 || User: rpepin || Print Date: 12/27/2016




Notes:
•Diesel and Oil Range TPH concentrations are summed in accordance with Ecology Implementation Memorandum #4 (Ecology, 2004)
•For samples where either diesel or oil range TPH was not detected, ½ the detection limit was used to calculate the sum. Concentrations were not summed when both diesel and oil range TPH were not detected.

*Note: Data shown include Site data collected since 2000. Monitoring well data represent the maximum concentration detected during the RI from 2014 to 2015, if available. If data from 2014 to 2015 is not available, monitoring well data shown are from the most recent sampling event.*

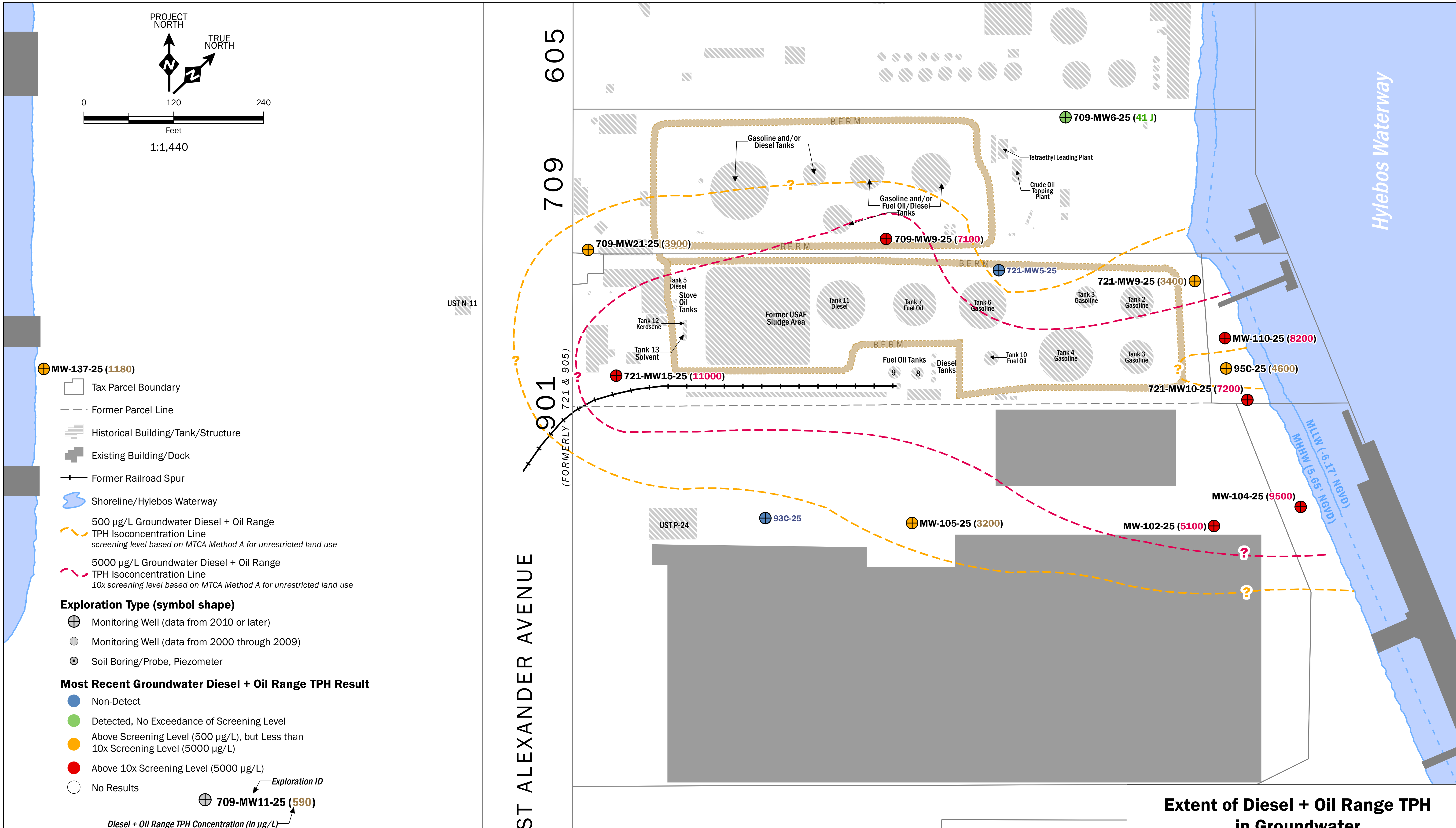
# Extent of Diesel + Oil Range TPH in Groundwater 15 Foot Zone

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING

| DEC-2016 | BY: DFR / RMB | FIGURE NO. |
|---|---|---|
| PROJECT NO. 130097-01D | REVISED BY: RAP / RMB | 6.4-9 |

GIS Path: T:\projects_8\Port_of_Tacoma\AlexanderAve_130097\Delivered\RemedialInvestigationReport\6.4-9 GW Diesel and Oil Range TPH 15.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 12/27/2016 || User: rpepin || Print Date: 12/27/2016




Notes:
•Diesel and Oil Range TPH concentrations are summed in accordance with Ecology Implementation Memorandum #4 (Ecology, 2004)
•For samples where either diesel or oil range TPH was not detected, ½ the detection limit was used to calculate the sum. Concentrations were not summed when both diesel and oil range TPH were not detected.

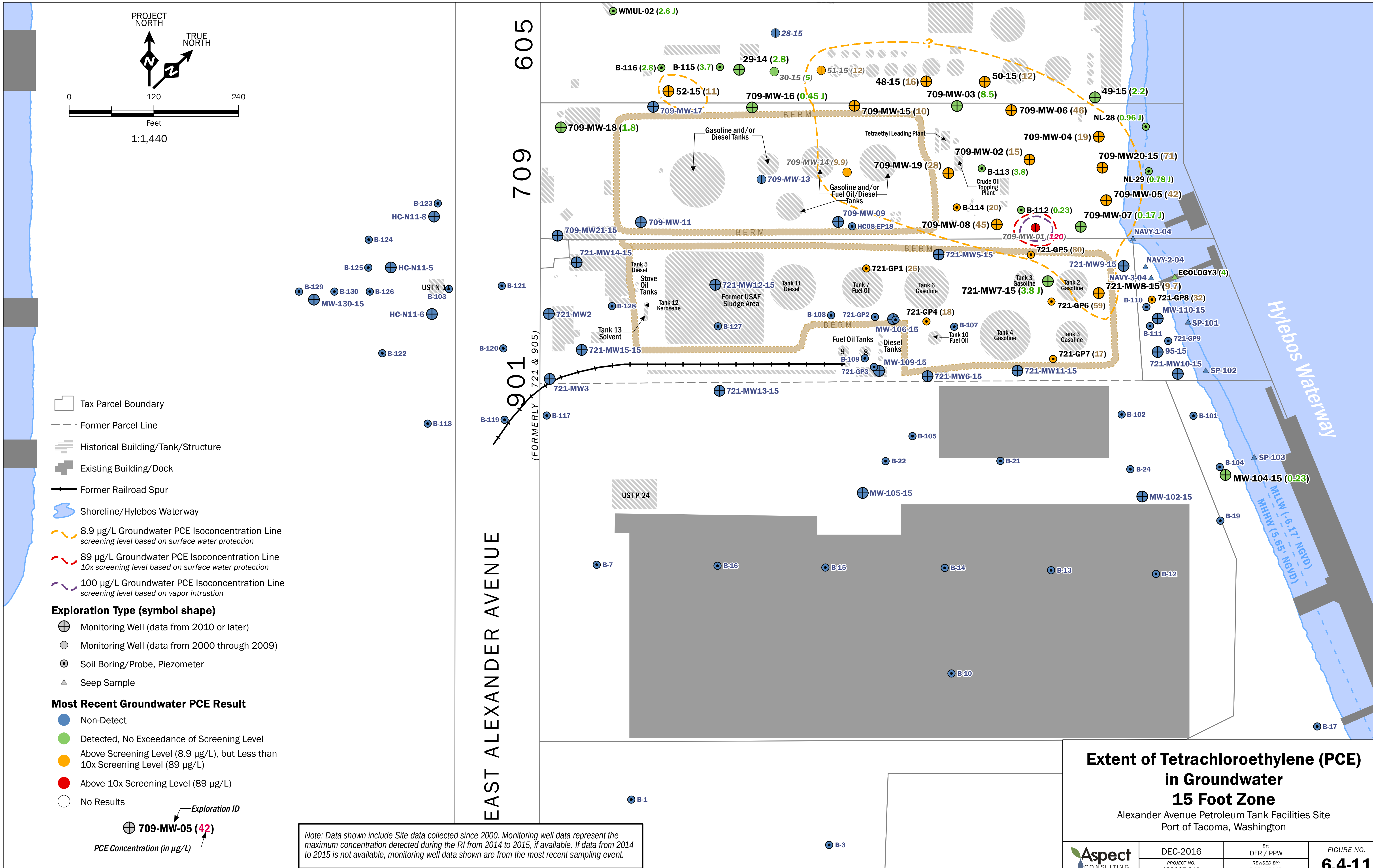
*Note: Data shown include Site data collected since 2000. Monitoring well data represent the maximum concentration detected during the RI from 2014 to 2015, if available. If data from 2014 to 2015 is not available, monitoring well data shown are from the most recent sampling event.*

# Extent of Diesel + Oil Range TPH in Groundwater 25 Foot Zone

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

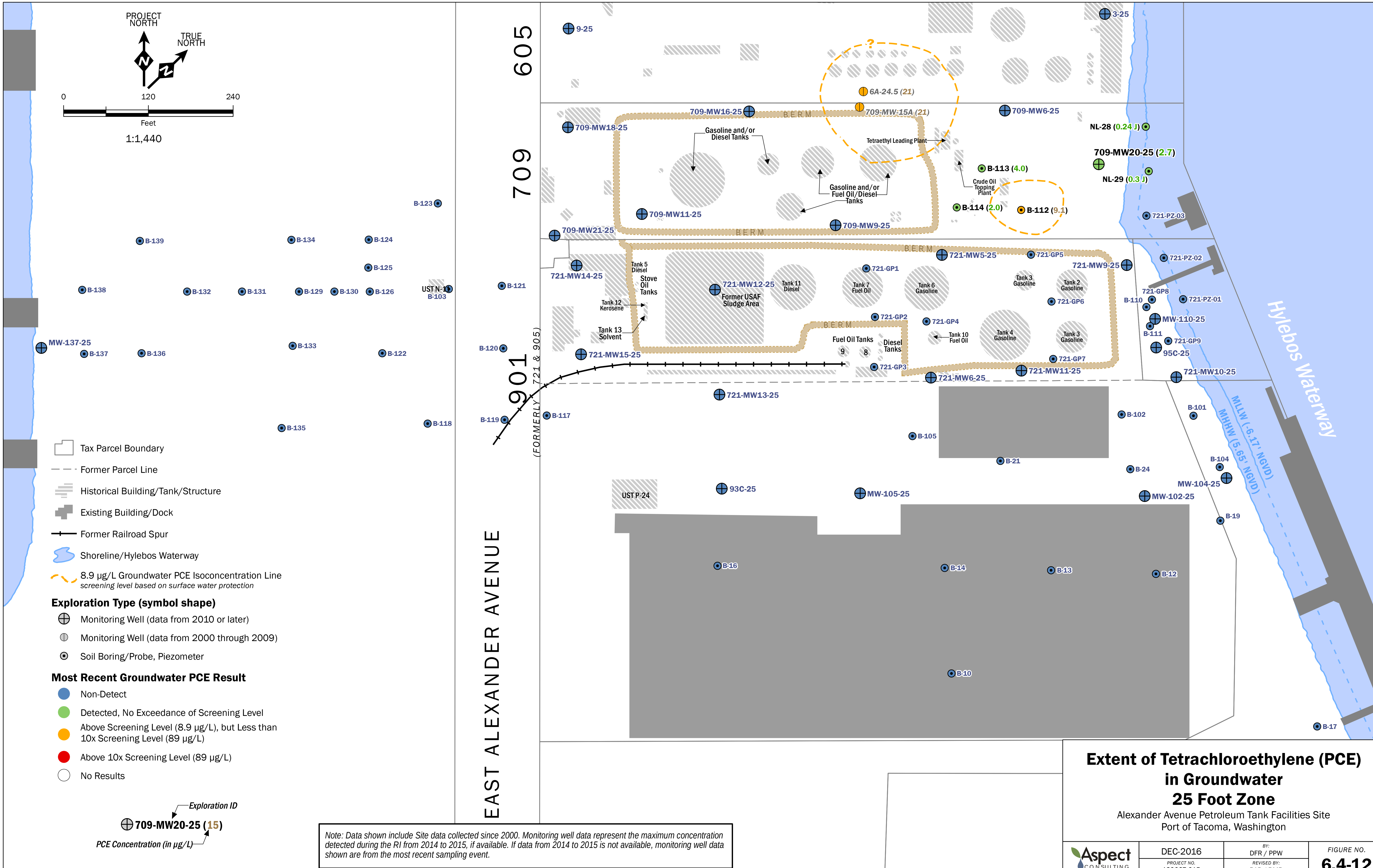
Aspect CONSULTING | DEC-2016 | BY: DFR / RMB | FIGURE NO. 6.4-10
PROJECT NO. 130097-01D | REVISED BY: RAP / RMB

GIS Path: T:\projects_8\Port_of_Tacoma\AlexanderAve_130097\Delivered\RemedialInvestigationReport\6.4-10 GW Diesel and Oil Range TPH 25.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 12/27/2016 || User: rpepin || Print Date: 12/27/2016




Extent of Tetrachloroethylene (PCE) in Groundwater
15 Foot Zone
Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING | DEC-2016 | BY: DFR / PPW | FIGURE NO. 6.4-11
PROJECT NO. 130097-01D | REVISED BY: RAP / RMB



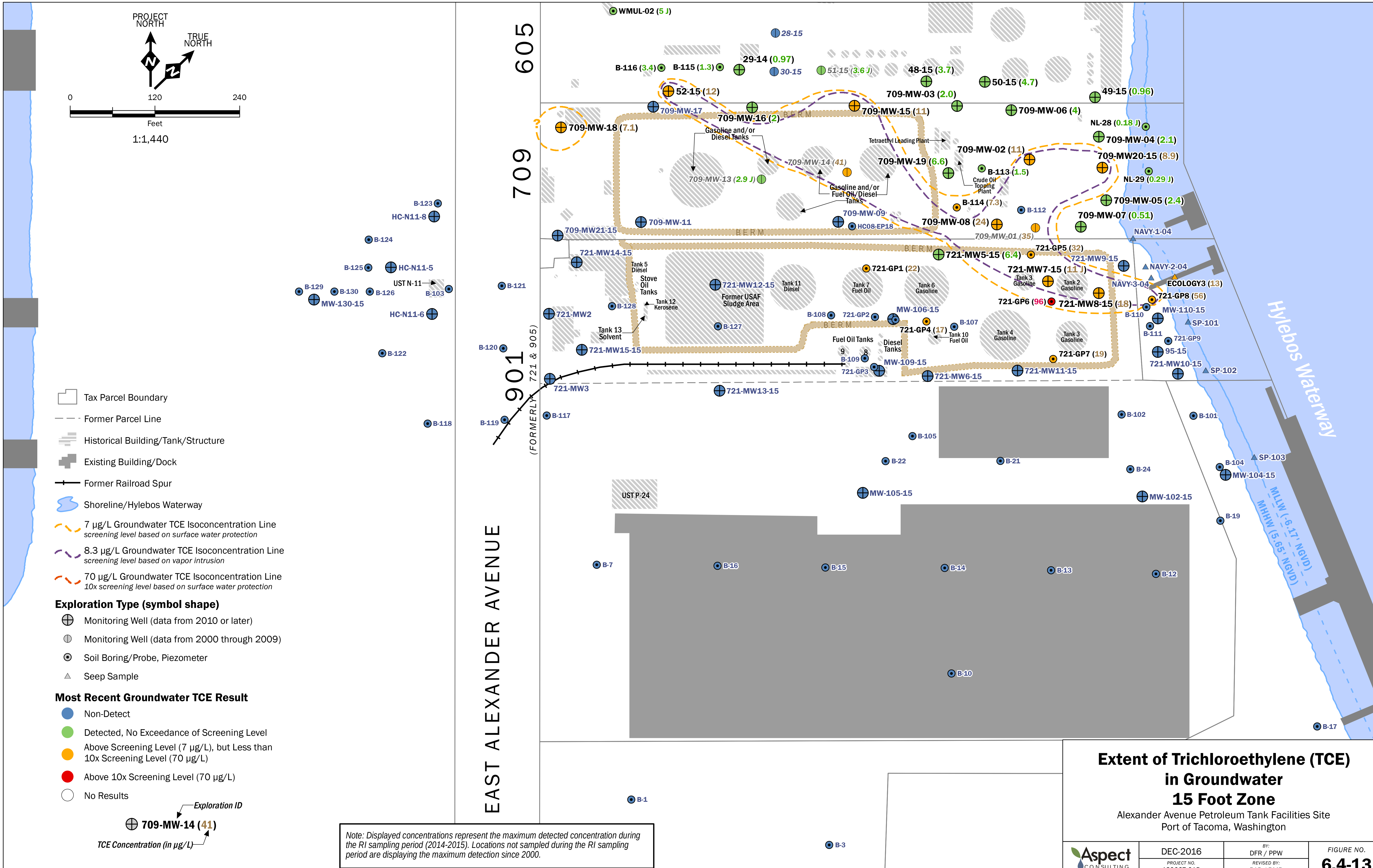

*Note: Data shown include Site data collected since 2000. Monitoring well data represent the maximum concentration detected during the RI from 2014 to 2015, if available. If data from 2014 to 2015 is not available, monitoring well data shown are from the most recent sampling event.*

# Extent of Tetrachloroethylene (PCE) in Groundwater 25 Foot Zone

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING

DEC-2016 | PROJECT NO. 130097-01B | BY: DFR / PPW | REVISED BY: RAP / RMB | FIGURE NO. 6.4-12

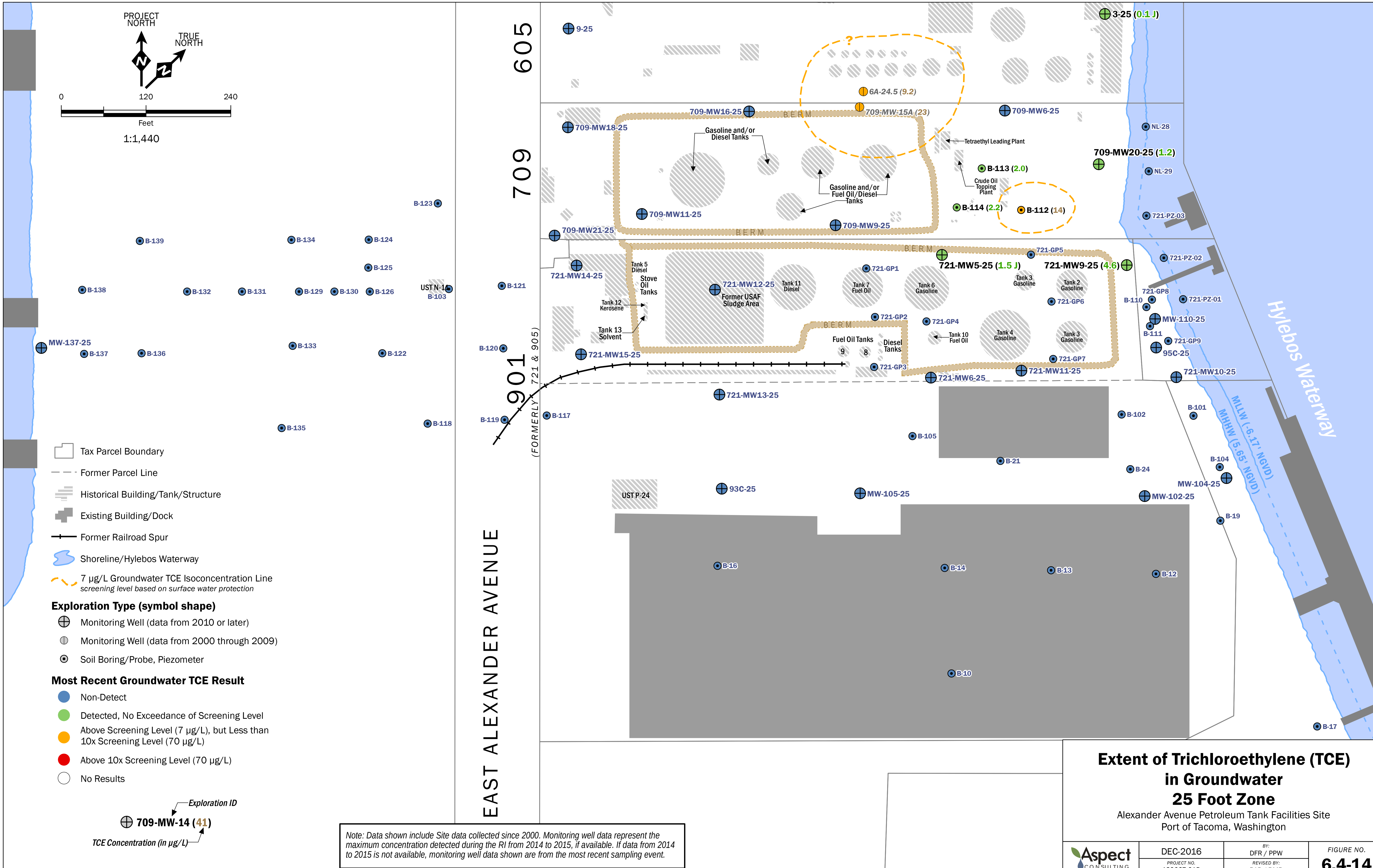



*Note: Displayed concentrations represent the maximum detected concentration during the RI sampling period (2014-2015). Locations not sampled during the RI sampling period are displaying the maximum detection since 2000.*

# Extent of Trichloroethylene (TCE) in Groundwater 15 Foot Zone

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

| Aspect CONSULTING | DEC-2016 | BY: DFR / PPW | FIGURE NO. |
|---|---|---|---|
| | PROJECT NO. 130097-01D | REVISED BY: RAP / RMB | 6.4-13 |



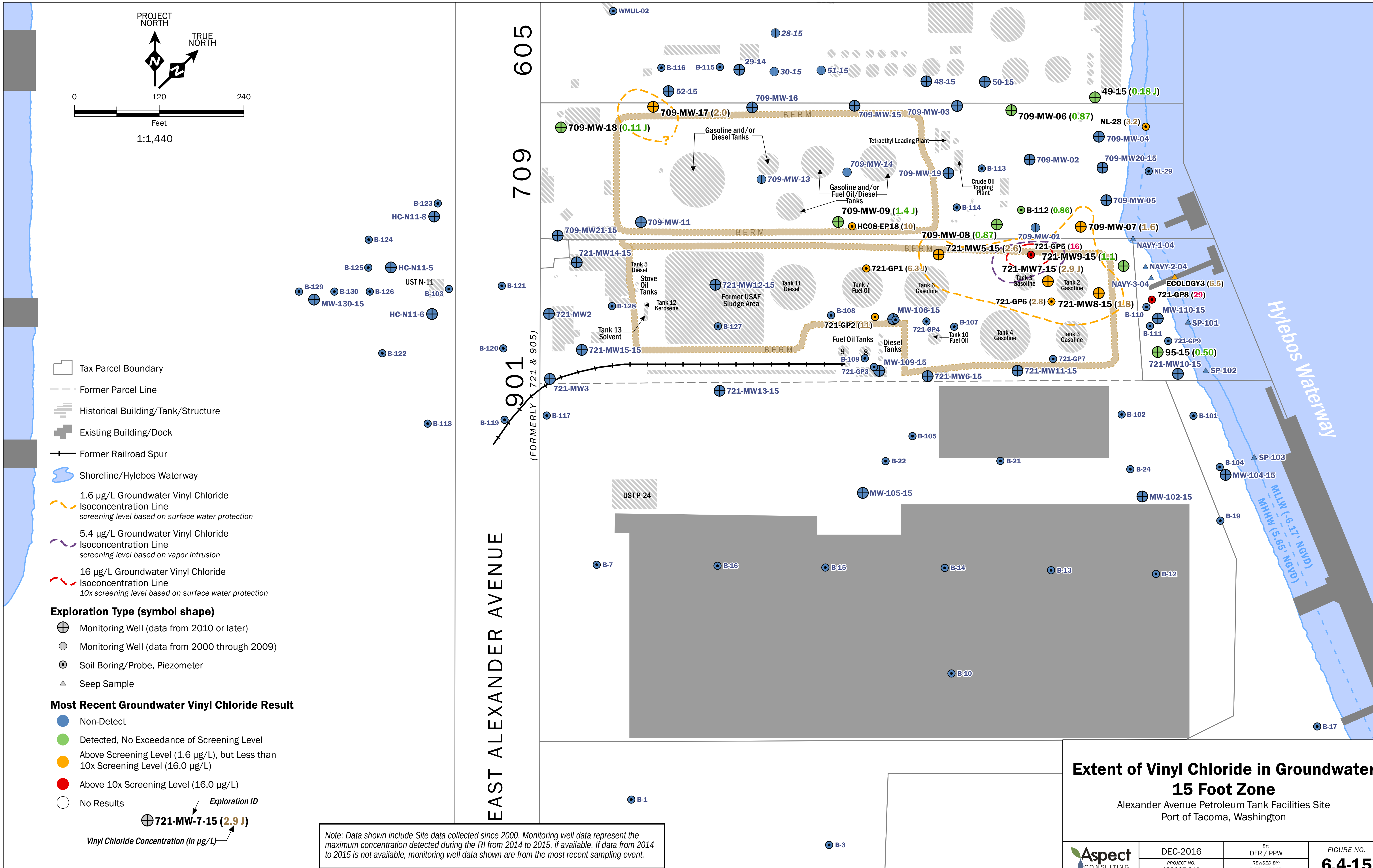

# Extent of Trichloroethylene (TCE) in Groundwater 25 Foot Zone

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING

DEC-2016 | PROJECT NO. 130097-01D | BY: DFR / PPW | REVISED BY: RAP / RMB

FIGURE NO. **6.4-14**



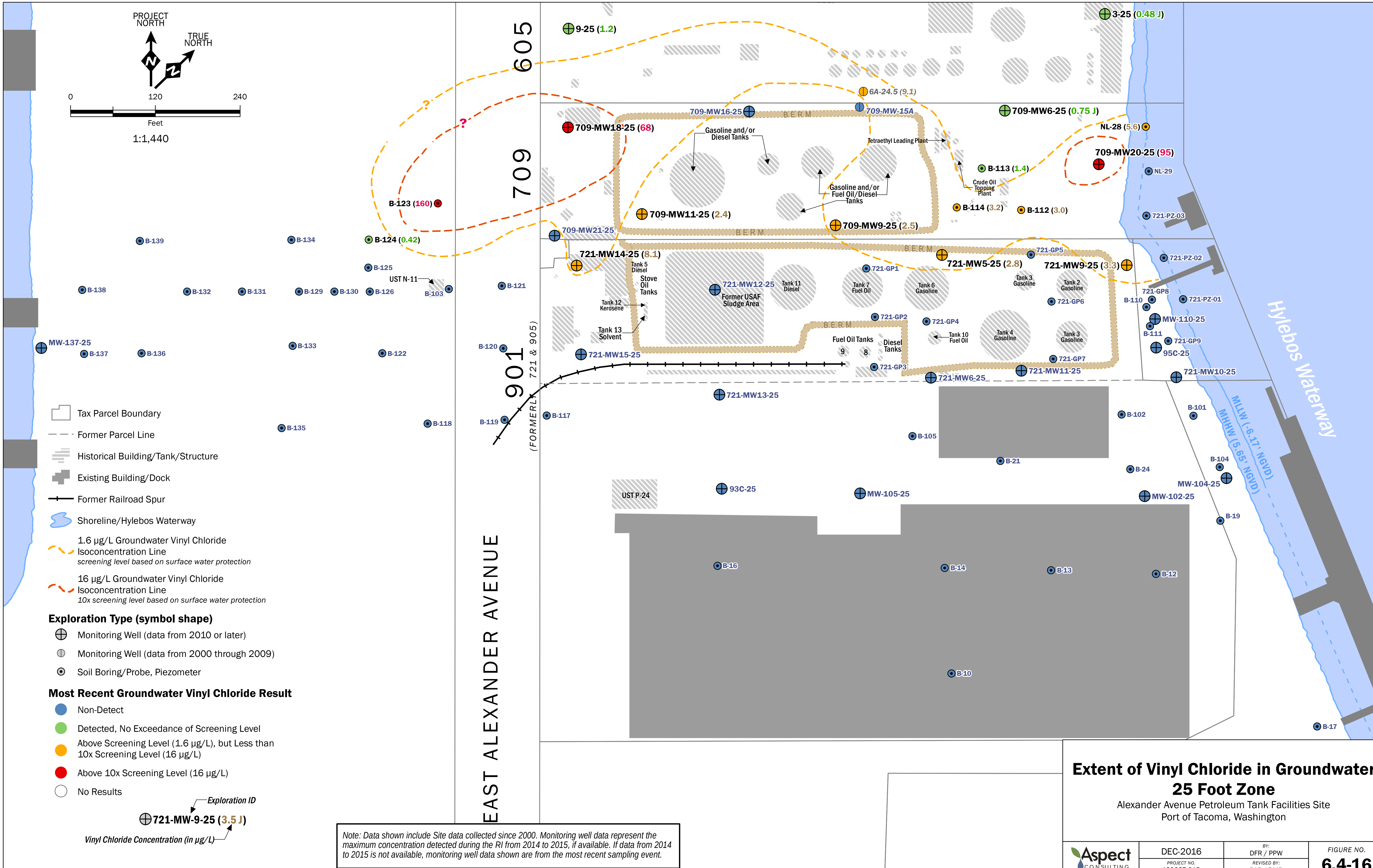

*Note: Data shown include Site data collected since 2000. Monitoring well data represent the maximum concentration detected during the RI from 2014 to 2015, if available. If data from 2014 to 2015 is not available, monitoring well data shown are from the most recent sampling event.*

# Extent of Vinyl Chloride in Groundwater 15 Foot Zone

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING

| | | |
|---|---|---|
| DEC-2016 | BY: DFR / PPW | FIGURE NO. |
| PROJECT NO. 130097-01D | REVISED BY: RAP / RMB | 6.4-15 |

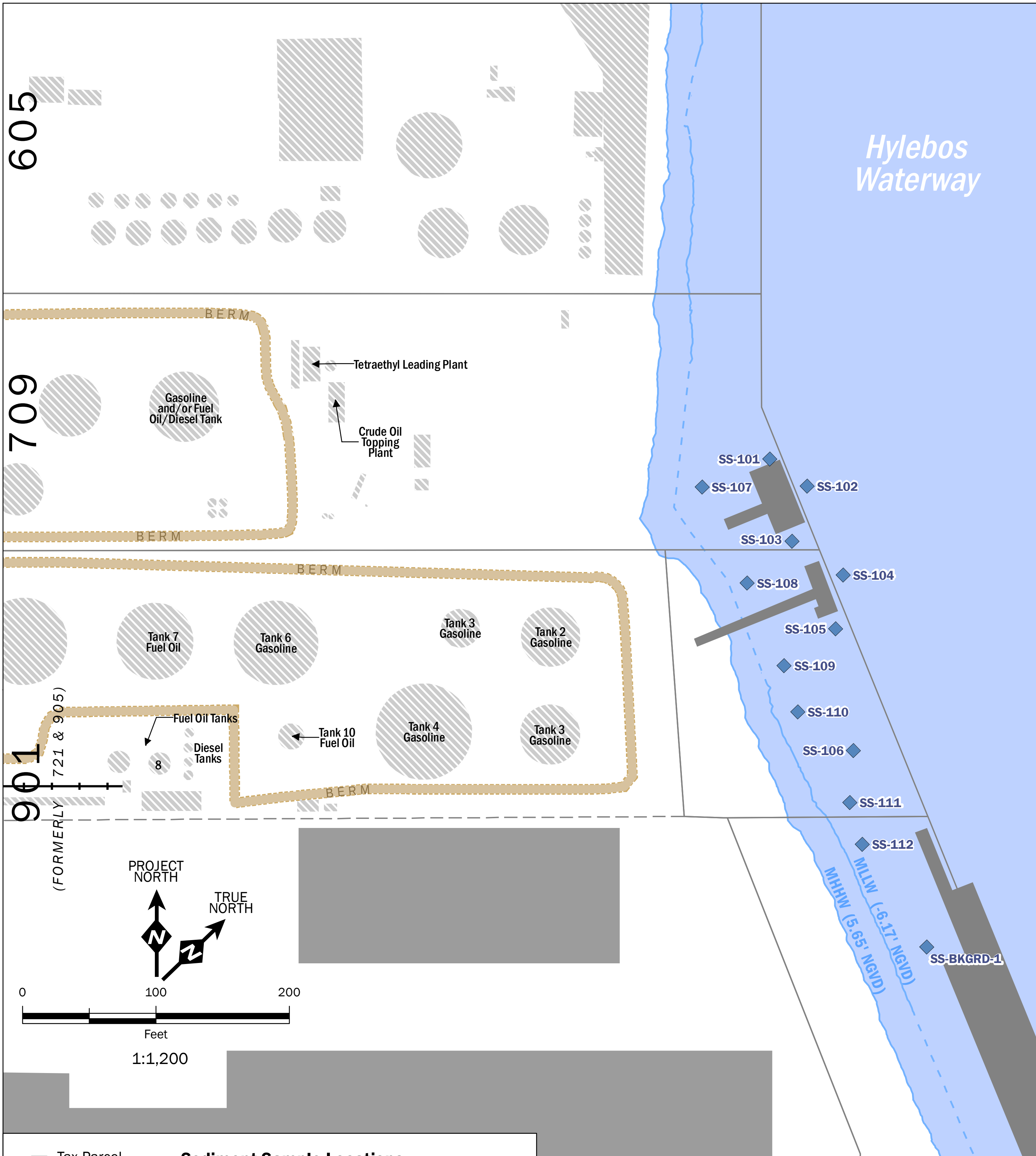



*Note: Data shown include Site data collected since 2000. Monitoring well data represent the maximum concentration detected during the RI from 2014 to 2015, if available. If data from 2014 to 2015 is not available, monitoring well data shown are from the most recent sampling event.*

# Extent of Vinyl Chloride in Groundwater 25 Foot Zone

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING | DEC-2016 | BY: DFR / PPW | FIGURE NO. 6.4-16
PROJECT NO. 130097-01D | REVISED BY: RAP / RMB




Tax Parcel Boundary

Former Parcel Line

Existing Building/ Dock

Former Railroad Spur

Shoreline/ Hylebos Waterway

**Sediment Sample Locations**

*Maximum Gasoline Range TPH Concentration*

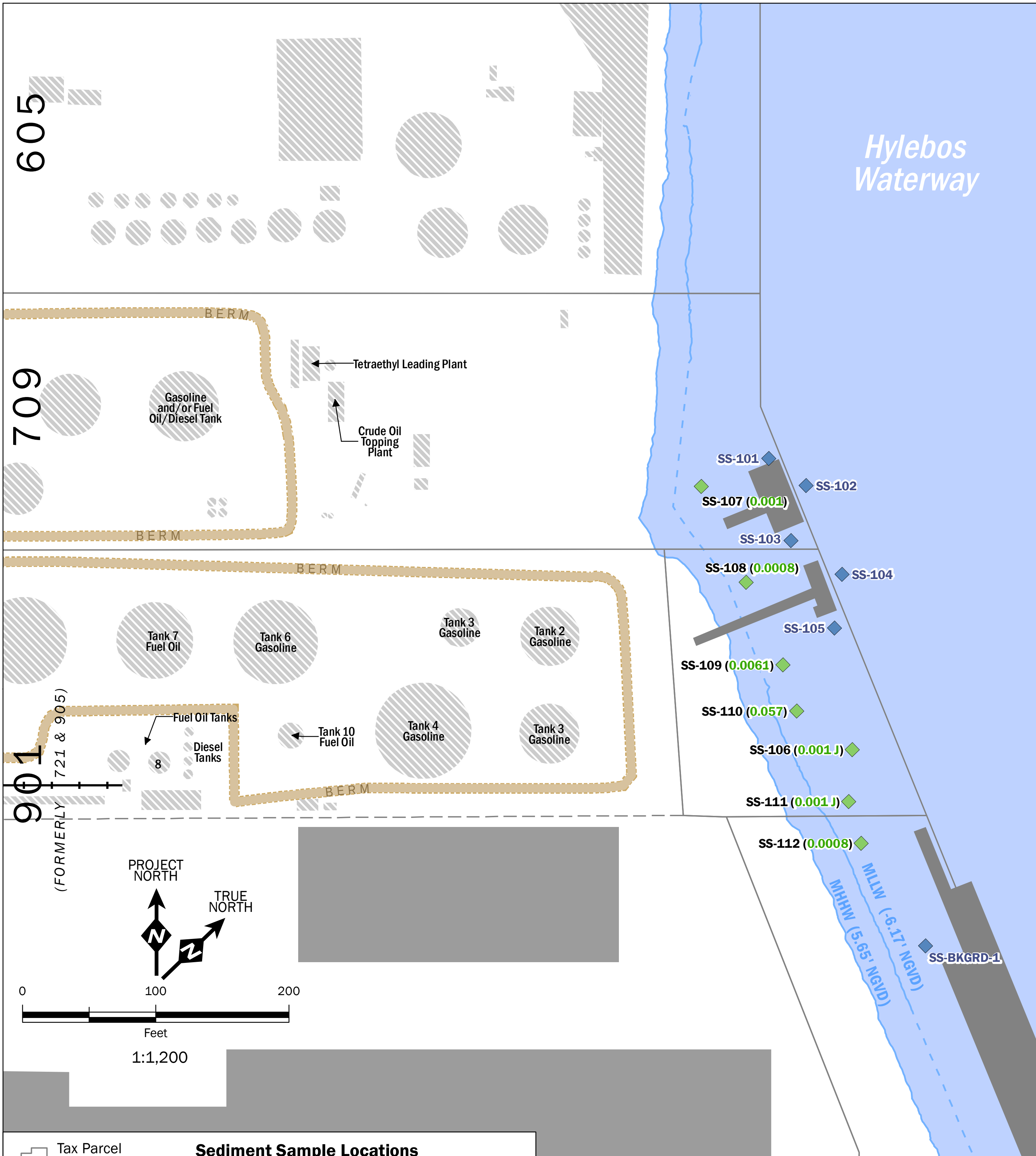
- Non-Detect
- Detected, No SQO

# Extent of Gasoline-Range TPH in Sediment

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

| Aspect CONSULTING | MAR-2016 | BY: DFR / PPW | FIGURE NO. |
|---|---|---|---|
| | PROJECT NO. 130097-01D | REVISED BY: RAP / RMB | 6.5-1 |

GIS Path: T:\projects_8\Port_of_Tacoma\AlexanderAve_130097\Delivered\RemedialInvestigationReport\6.5-1 Sediment Gasoline TPH.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 3/31/2016 || User: rbobich || Print Date: 3/31/2016




Tax Parcel Boundary

Former Parcel Line

Existing Building/ Dock

Former Railroad Spur

Shoreline/ Hylebos Waterway

**Sediment Sample Locations**

*Maximum Benzene Concentration*

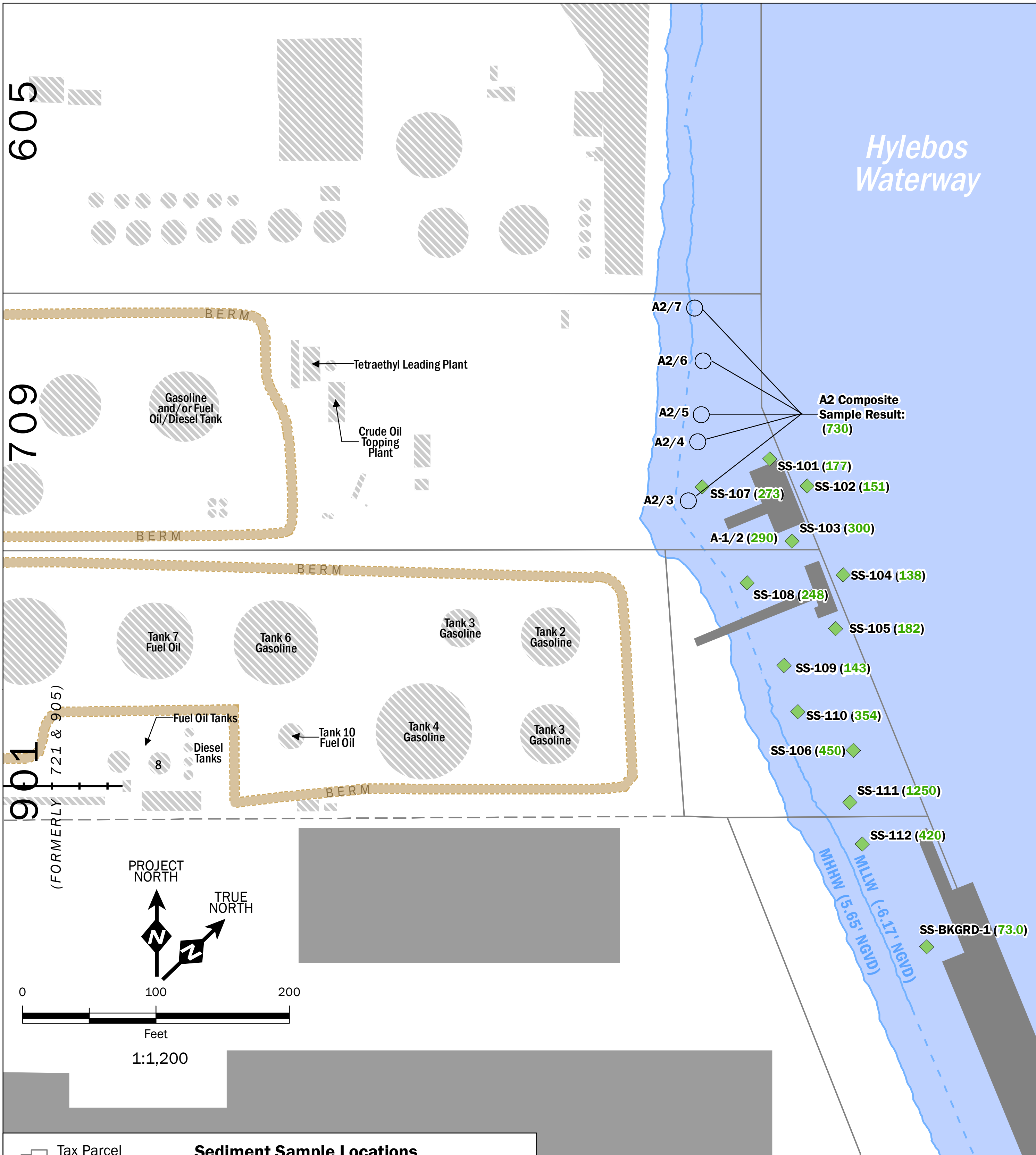
- Non-Detect
- Detected, No SQO

# Extent of Benzene in Sediment

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

| Aspect CONSULTING | MAR-2016 | BY: DFR / PPW | FIGURE NO. |
|---|---|---|---|
| | PROJECT NO. 130097-01D | REVISED BY: RAP / RMB | 6.5-2 |

GIS Path: T:\projects_8\Port_of_Tacoma\AlexanderAve_130097\Delivered\RemedialInvestigationReport\6.5-2 Sediment Benzene.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 3/31/2016 || User: rbobich || Print Date: 3/31/2016




Tax Parcel Boundary

Former Parcel Line

Existing Building/ Dock

Former Railroad Spur

Shoreline/ Hylebos Waterway

**Sediment Sample Locations**

*Maximum D+O Range TPH Concentration*

Non-Detect

Detected, No SQO

Composite Sample

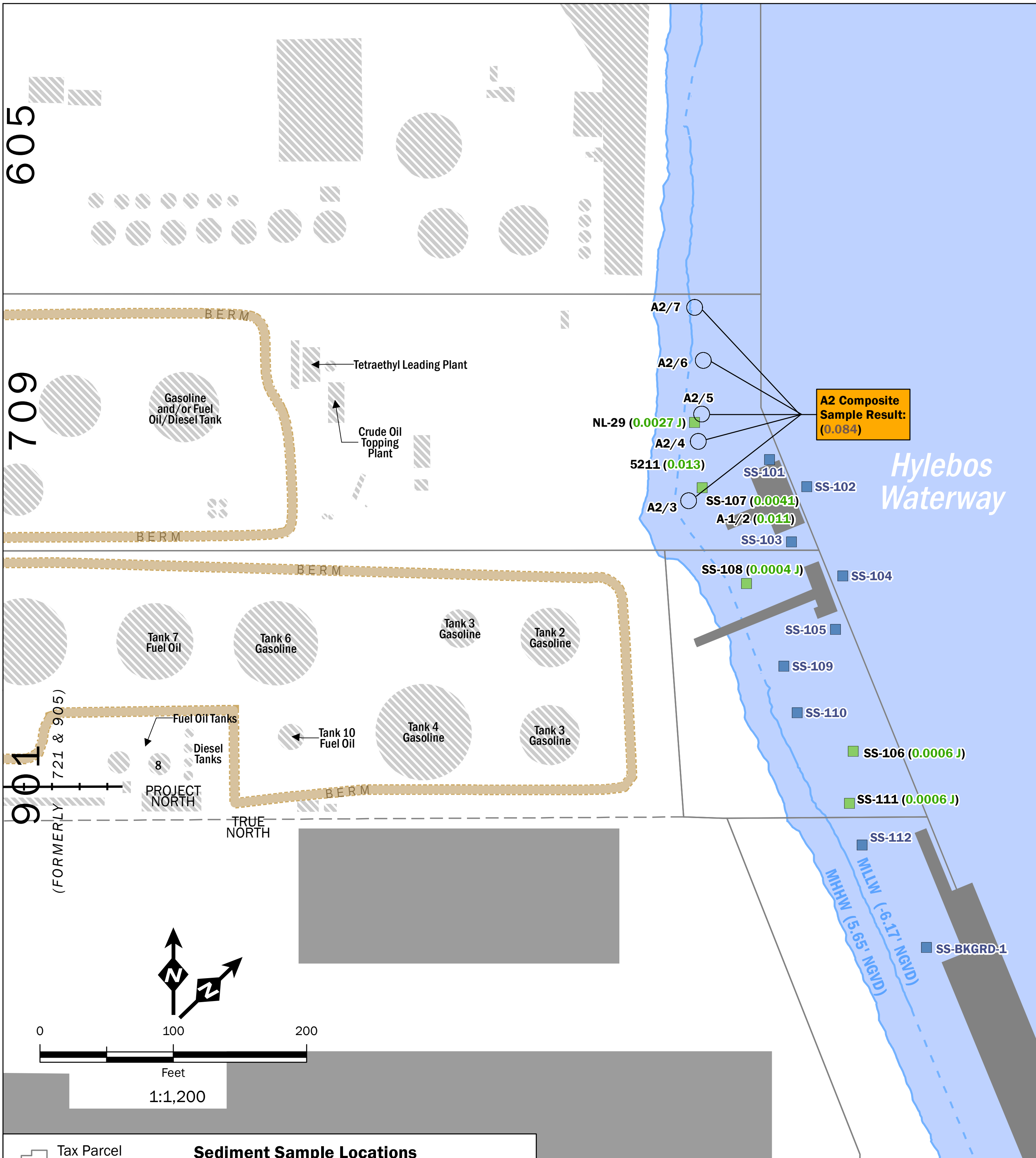
# Extent of Diesel + Oil Range TPH in Sediment

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING

| | | | |
|---|---|---|---|
| MAR-2016 | BY: DFR / PPW | FIGURE NO. | |
| PROJECT NO. 130097-01D | REVISED BY: RAP / RMB | 6.5-3 | |

GIS Path: T:\projects_8\Port_of_Tacoma\AlexanderAve_130097\Delivered\RemedialInvestigationReport\6.5-3 Sediment Diesel and Oil Range TPH.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 3/31/2016 || User: rbobich || Print Date: 3/31/2016




GIS Path: T:\projects_8\Port_of_Tacoma\AlexanderAve_130097\Delivered\RemedialInvestigationReport\6.5-4 Sediment PCE.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 4/4/2016 || User: rpepin || Print Date: 4/4/2016

Tax Parcel Boundary
Former Parcel Line
Existing Building/ Dock
Former Railroad Spur
Shoreline/ Hylebos Waterway

**Sediment Sample Locations**

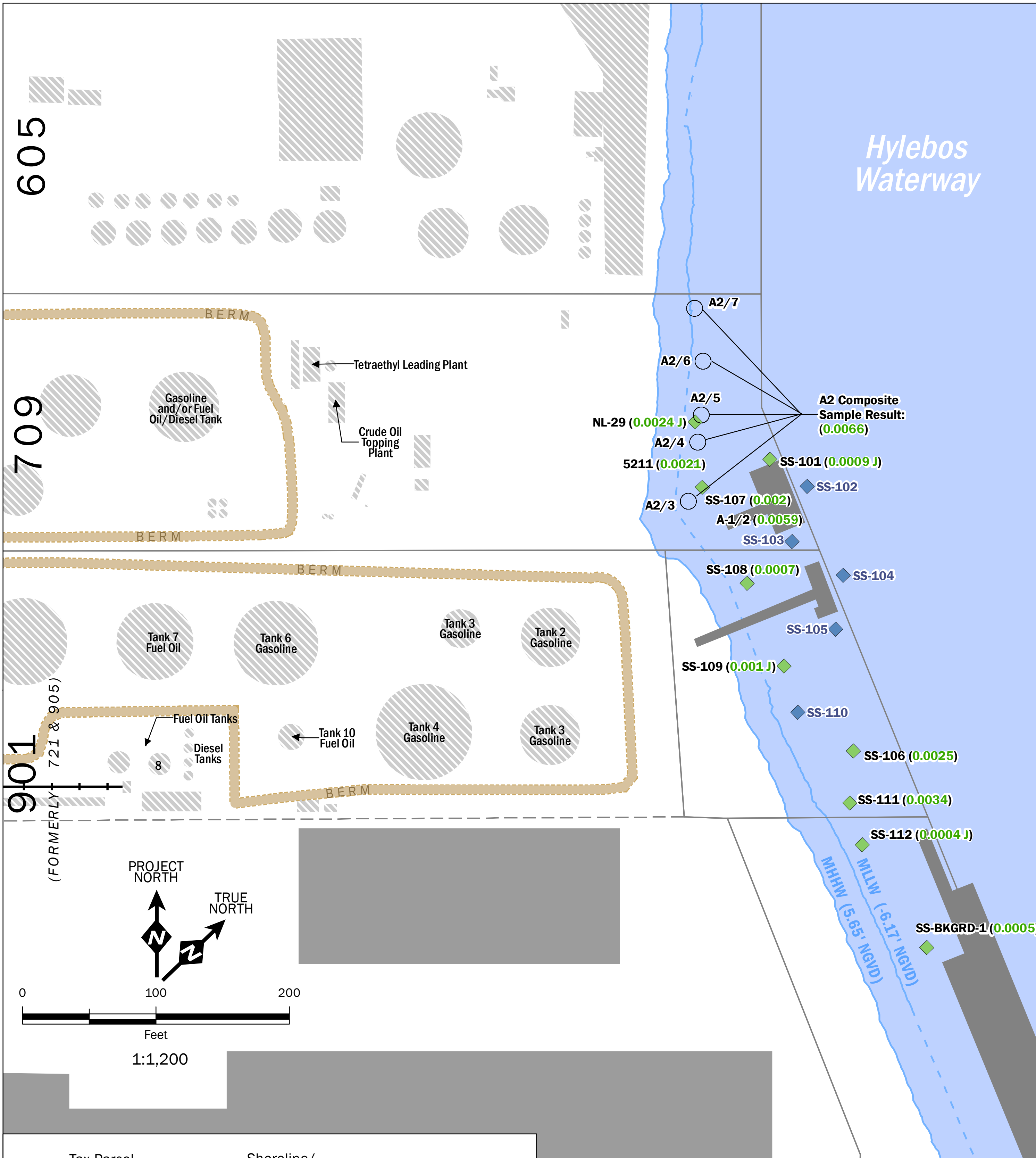
*Maximum PCE Concentration*

- Non-Detect
- Detected, No Exceedance of SQO
- Above SQO (0.057 mg/kg) but Less than 10x SQO (0.57 mg/kg)
- Above 10x SQO (0.57 mg/kg)
- Composite Sample

# Extent of PCE in Sediment

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

| | | | |
|---|---|---|---|
| Aspect CONSULTING | APR-2016<br>PROJECT NO. 130097-01D | BY: DFR / PPW<br>REVISED BY: RAP / RMB | FIGURE NO. **6.5-4** |




Tax Parcel Boundary

Former Parcel Line

Existing Building/ Dock

Former Railroad Spur

Shoreline/ Hylebos Waterway

**Sediment Sample Locations**

*Maximum TCE Concentration*

Non-Detect

Detected, No SQO

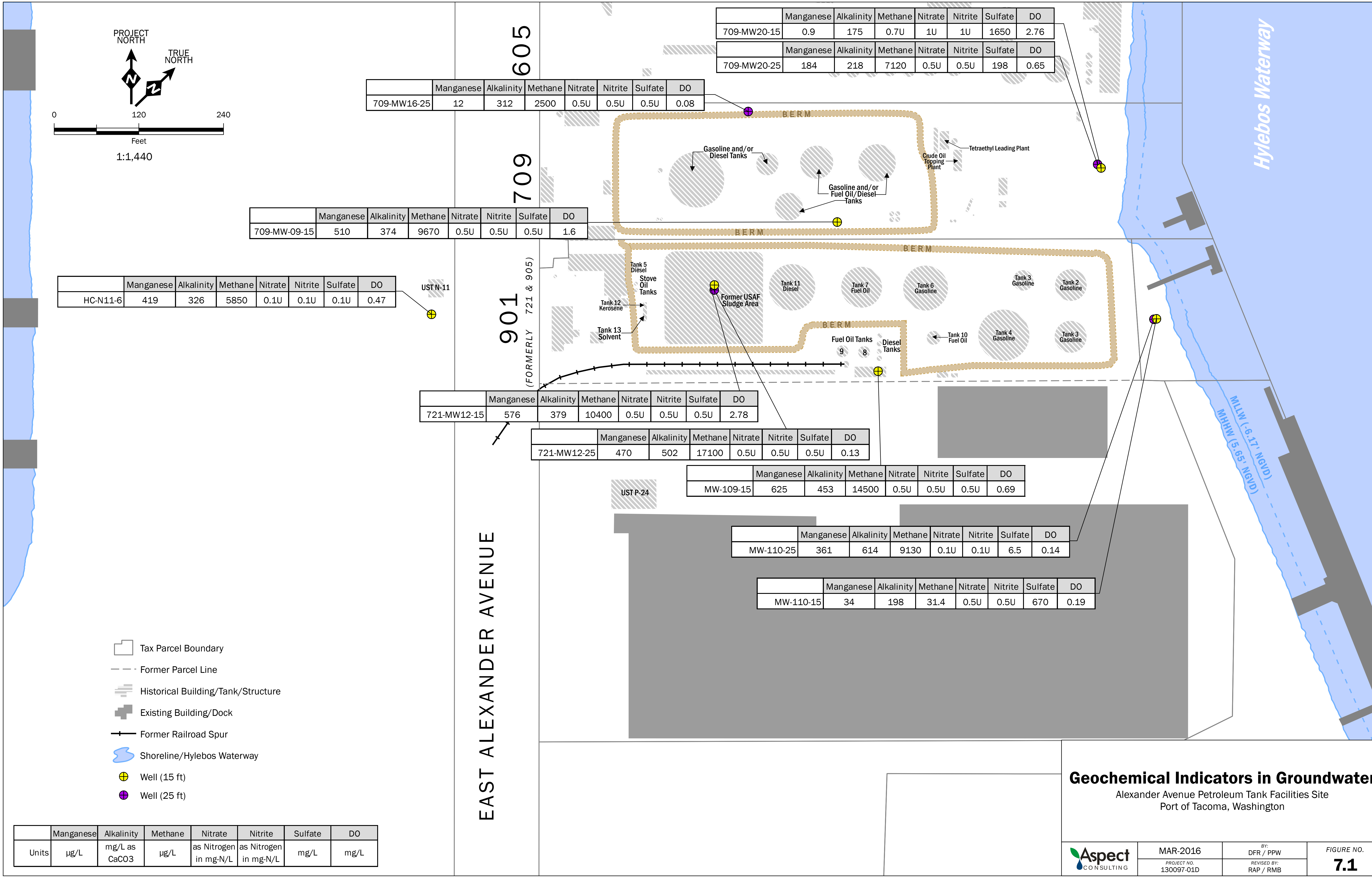
Composite Sample

# Extent of TCE in Sediment

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

| | | | |
|---|---|---|---|
| Aspect CONSULTING | MAR-2016 | BY: DFR / PPW | FIGURE NO. |
| | PROJECT NO. 130097-01D | REVISED BY: RAP / RMB | 6.5-5 |

GIS Path: T:\projects_8\Port_of_Tacoma\AlexanderAve_130097\Delivered\RemedialInvestigationReport\6.5-5 Sediment TCE.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 3/31/2016 || User: rbobich || Print Date: 3/31/2016




| | Manganese | Alkalinity | Methane | Nitrate | Nitrite | Sulfate | DO |
|---|---|---|---|---|---|---|---|
| 709-MW20-15 | 0.9 | 175 | 0.7U | 1U | 1U | 1650 | 2.76 |
| 709-MW20-25 | 184 | 218 | 7120 | 0.5U | 0.5U | 198 | 0.65 |
| 709-MW16-25 | 12 | 312 | 2500 | 0.5U | 0.5U | 0.5U | 0.08 |
| 709-MW-09-15 | 510 | 374 | 9670 | 0.5U | 0.5U | 0.5U | 1.6 |
| HC-N11-6 | 419 | 326 | 5850 | 0.1U | 0.1U | 0.1U | 0.47 |
| 721-MW12-15 | 576 | 379 | 10400 | 0.5U | 0.5U | 0.5U | 2.78 |
| 721-MW12-25 | 470 | 502 | 17100 | 0.5U | 0.5U | 0.5U | 0.13 |
| MW-109-15 | 625 | 453 | 14500 | 0.5U | 0.5U | 0.5U | 0.69 |
| MW-110-25 | 361 | 614 | 9130 | 0.1U | 0.1U | 6.5 | 0.14 |
| MW-110-15 | 34 | 198 | 31.4 | 0.5U | 0.5U | 670 | 0.19 |

| | Manganese | Alkalinity | Methane | Nitrate | Nitrite | Sulfate | DO |
|---|---|---|---|---|---|---|---|
| Units | μg/L | mg/L as CaCO3 | μg/L | as Nitrogen in mg-N/L | as Nitrogen in mg-N/L | mg/L | mg/L |

# Geochemical Indicators in Groundwater

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING

| | | | |
|---|---|---|---|
| MAR-2016 | BY: DFR / PPW | FIGURE NO. | 7.1 |
| PROJECT NO. 130097-01D | REVISED BY: RAP / RMB | | |