WORK PLAN FOR REMEDIAL INVESTIGATION/FEASIBILITY STUDY

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. 130097-001-02 • June 18, 2014 Final

earth + water

Aspect CONSULTING

Aspect CONSULTING

WORK PLAN FOR REMEDIAL INVESTIGATION/FEASIBILITY STUDY

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. 130097-001-02 • June 18, 2014 Final

Aspect Consulting, LLC

JEREMY J. PORTER STATE OF WASHINGTON 39941 REGISTERED PROFESSIONAL ENGINEER

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

Dave Rugh, LHG
Project Hydrogeologist
drugh@aspectconsulting.com

Steve Germiat, LHG
Sr. Associate Hydrogeologist
sgermiat@aspectconsulting.com

V:\130097 POT Alexander Ave\Deliverables\RI-FS Work Plan\Ecology Review Draft\Alex Ave Draft RI-FS Work Plan-Aspect.docx

Contents

List of Tables

List of Figures

List of Appendices

Acronyms

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
cm	centimeter
COC	chain of custody
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CVOC	chlorinated volatile organic compound
DCA	disproportionate cost analysis
DMMU	Dredge Material Management Unit

DNR	Washington Department of Natural Resources
DQO	data quality objectives
Ecology	Washington State Department of Ecology
EDB	ethylene dibromide
EDC	1,2-dichloroethane
EDD	electronic data deliverable
EDL	estimated detection limit
EIM	Environmental Information Management
EPA	U.S. Environmental Protection Agency
ESA	Environmental Site Assessment
FEH	freshwater equivalent head
Fletcher	Fletcher Oil Company
FS	Feasibility Study
FSP	Field Sampling Plan
General	General Petroleum Company
HDPE	high density polyethylene
HSP	Health and Safety Plan
ID	identification
lb	pound
JARPA	Joint Aquatic Resources Permit Application
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
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
MSD	matrix spike duplicate
MDL	method detection limit
mg/kg	milligrams/kilograms
mg/L	milligrams per liter

MHHW	mean higher high water
MLLW	mean lower low water
MS	matrix spike
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
NTU	nephelometric turbidity unit
NGVD	National Geodetic Vertical Datum
OCC	Occidental Chemical Corporation
ORP	oxidation-reduction potential
PAH	polycyclic aromatic hydrocarbon
pCOC	Preliminary Chemical of Concern
PCC	Pacific Coast Container
PARCCS	precision, accuracy, representativeness, comparability, completeness, and sensitivity
PCE	tetrachloroethylene (perchloroethylene)
PDB	passive diffusion bag
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
PLP	Potentially Liable Person
PQL	practical quantitation limit
PRI	PRI Northwest, Inc.
PSL	Preliminary Screening Levels
Pyron	Pyron Environmental, Inc.
QAPP	Quality Assurance Project Plan

QA/QC	quality assurance/quality control
%R	percent recovery
RAO	remedial action objective
RCW	Revised Code of Washington
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RL	reporting limit
RPD	relative percent difference
SAP	Sampling Analysis Plan
SDG	sample delivery group
SEPA	State Environmental Policy Act
Site	Alexander Avenue Petroleum Tank Facilities Site
SMA	Sediment Management Area
SVOC	semivolatile organic compound
TCE	trichloroethylene
TEE	Terrestrial Ecological Evaluation
TEQ	toxic equivalent quotient/concentration
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

1 Introduction

This document is a Work Plan to conduct a Remedial Investigation (RI) and Feasibility Study (FS) for the Alexander Avenue Petroleum Tank Facilities Site (Site) located at 709, 901, and 1001 Alexander Avenue in Tacoma, Washington (Figure 1.1). The RI/FS Work Plan 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 purpose of the RI/FS is to evaluate the nature and extent of hazardous substances in environmental media at the Site and, using that information, develop and evaluate cleanup action alternatives for the Site.

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 721 property, and collectively referred to as the tank farm properties (Figure 2.1).

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 is believed to overlap 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 the Site RI/FS is to assess the relationship between contaminants originating at the Site and contaminants originating from the OCC Site. This information can then be used to develop remedial alternatives for this Site which will be compatible with Occidental Site response actions.

The Site RI/FS will be 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). The RI/FS is intended to provide sufficient data and evaluation to enable Ecology to select a cleanup action for the Site in accordance with MTCA. To that end, specific objectives of the Site RI/FS 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);
- Use the information collected to assess potential risk to human health and the environment through complete exposure pathways under the planned future land use;
- Identify preliminary cleanup levels and points of compliance;
- Identify potential cleanup actions for the Site, and identify and evaluate the alternatives for doing so based on Site contaminants, environmental conditions, and risk, consistent with land use plans; and
- Report the methods and findings of the RI/FS to Ecology and project stakeholders, including the local community.

1.1 Project Management

The Site RI/FS is being conducted by Aspect Consulting, LLC (Aspect) on behalf of the Port and Mariana. Ecology is providing regulatory oversight of the RI/FS activities in accordance with the Agreed Order. The designated project coordinators are listed below.

The project coordinator for Ecology is:

Joyce Mercuri
Department of Ecology – Toxics Cleanup Program
P.O. Box 47775
Olympia, WA 98504-7775
Phone: (360) 407-6260
E-mail: Joyce.Mercuri@ecy.wa.gov

The project coordinators for the Port and Mariana are:

Jason Jordan
Port of Tacoma
P.O. Box 1837
Tacoma, WA 98401
Phone: (253) 830-5321
E-mail: jjordan@portoftacoma.com

Clint Babcock
Mariana Properties, Inc.
5005 LBJ Freeway, Suite 1350
Dallas, TX 75244-6119
Phone: (972) 687-7506

E-mail: Clint_Babcock@oxy.com

Each project coordinator is responsible for overseeing the implementation of the scope of work under the Agreed Order.

The Port and Mariana's consultant project team consists of representatives from Aspect and its subconsultants and subcontractors. Aspect's lead personnel and their roles for the RI/FS are as follows:

- Jeremy Porter, PE, is the project manager with final authority and responsibility for the consultant team's activities. He is also the FS task manager, responsible for directing the FS;
- Steve Germiat, LHG, is the technical lead responsible for implementation of the RI;
- Dave Rugh, LHG, is the RI task manager responsible for directing the RI field program and managing and reporting the data; and
- Eric Marhofer, PE, is the lead engineer responsible for implementation of the FS.

Aspect will also use other technical staff for completion of the RI and FS tasks.

Aspect's expected primary subconsultants for the RI/FS include:

- KPFF, providing civil engineering support for developing and evaluating remedial alternatives;
- Anchor QEA, providing support for sediment RI/FS tasks; and
- Pyron Environmental, providing assistance with the Quality Assurance Project Plan (QAPP) preparation, analytical laboratory coordination, and data quality validation for newly collected data.

Aspect's expected primary subcontractors for the RI/FS include:

- Analytical Resources, Inc., providing analytical laboratory services;
- Cascade Drilling or Holt Services, providing drilling and construction of soil borings and monitoring wells; and
- Research Support Services, providing in-water data collection support for subtidal sediment and sediment porewater sampling.

1.2 Public and Agency Involvement

Ecology, along with the Port and Mariana, will promote Ecology's public involvement efforts throughout the RI/FS and cleanup stages for the Site, as required by WAC 173-340-600. Public involvement may include, but not be limited to, preparation of fact sheets published for public information, establishing public comment periods to solicit public comment on key deliverables, status updates published in the Ecology Site Registry, mailings to addresses within the vicinity of the Site, and posting of public information at the Site.

The known 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.

1.3 Work Plan Organization

The remaining sections of this Work Plan are organized as follows:

- Section 2—Site History and Background describes the Site location, ownership, zoning, operational history, and environmental setting, as obtained from readily available existing information.
- Section 3—Environmental Setting 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—Preliminary Conceptual Site Model identifies the potential sources of contaminants and the potential migration pathways and environmental media where they are suspected or confirmed to be found, and the potential contaminant exposure pathways and receptors.
- Section 5—Preliminary Screening Levels describes the derivation of numerical screening levels for soil, groundwater, and sediment that are proposed for evaluation of the environmental data collected during the RI.
- Section 6—Previous Remedial Actions and Existing Data describes the previous investigations and cleanup actions conducted at the tank farm properties, and summarizes the current understanding of contaminant nature and extent based on usable data from the previous remedial actions.
- Section 7—Identification of Data Gaps identifies data gaps for determining contaminant nature, extent, and migration sufficiently to develop and evaluate alternative cleanup actions for the Site.
- Section 8—Feasibility Study Approach describes how Site cleanup action alternatives will be developed and evaluated in accordance with MTCA, and identifies additional data warranted to complete the FS.

- Section 9—Proposed Data Collection to Address Data Gaps describes the rationale and methodology of data collection activities planned to address identified data gaps for completion of the RI/FS.
- Section 10—Schedule and Reporting provides details regarding the field activity schedule and reports.
- Section 11—References lists documents used or referenced in this Work Plan.

Appendices to the Work Plan include the following:

- Appendix A—Sampling and Analysis Plan (SAP) includes a Field Sampling Plan (FSP) providing the details regarding sample collection and handling during the proposed data collection activities, and a QAPP providing analytical laboratory requirements for quality assurance/quality control (QA/QC) procedures.
- Appendix B—Preliminary Chemicals of Concern and Screening Levels Technical Memorandum includes a copy of the Port's (2013) memorandum presenting in detail the derivation of preliminary screening levels for soil, groundwater, and sediment to be applied in the Site RI/FS and the Port's Response to Ecology's January 2014 Comments..
- Appendix C—Selected Historical Documents includes for reference copies of historical documents pertinent to scoping and completion of the Site RI/FS.
- Appendix D—Data Summary Tables includes tables presenting historical data reviewed for selecting preliminary chemicals of concern.
- Appendix E—Extent of OCC-related Preliminary Chemicals of Concern (pCOCs) in Groundwater includes figures of arsenic, copper, nickel, pH >8.5, tetrachloroethylene (PCE), tricholorethylene (TCE), and vinyl chloride (VC) in the 15-foot and 25-foot aquifer zones.
- Appendix F—Excerpts from the *Draft Sediment Monitoring Report, Hylebos Bridge Rehabilitation Project* (GeoEngineers, 2011), which contain information on background sediment quality in the Hylebos Waterway.

Aspect will prepare under separate cover a site-specific Health and Safety Plan (HSP), as required by WAC 173-340-810, to be used by Aspect employees during execution of the proposed RI field activities.

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 2.1). 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 721 property).

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 Work Plan)
  Facility/Site ID: 1377
  Facility Address: 721 Alexander Avenue

- Site Name: Glenn Springs Holdings, Inc./ PRI Northwest, Inc. (subject of Agreed Order DE 93TC-301 between PRI and Ecology).
  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 action under Agreed Order DE 93TC-301has 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.

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

  A portion of this property was originally the shoreline and adjacent uplands of the former 721 property. The 1001 property is a large irregularly shaped parcel, and the area and issues that caused this site listing are not close to the subject site.

2.2 Properties History and Ownership

The development history of 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 Work Plan, 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 Work Plan and Work Plan figures 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.

2.2.1 Development History of Blair-Hylebos Peninsula

The Hylebos Peninsula was created in the 1920s with approximately 16 to 20 feet of dredge fill 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 were 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

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.

A portion of the 709 property along the shoreline was filled with wastes, including wastes from the adjacent OCC facility, and likely other sources (see Figure 2.2 "Embankment Fill Area"). The date of this fill is uncertain but it is known that this fill is 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.

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 treat and temporarily store contaminated sediments removed by OCC from the Hylebos Waterway (Area 5106 Removal Action) under EPA oversight (EPA, 2002). The sediments were stored on the adjacent 605 Alexander Avenue property then slurried through piping to the 709 Alexander Avenue property for treatment. Following treatment, the sediments were removed from the Site and disposed in a nearby confined disposal facility.

2.2.3 Ownership/Operational History of the 721 Property

The 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 of the 721 property 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 721 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 721 property boring logs.

In the early 1940s, General Petroleum Company (General) began operating on and leasing the property from Maxwell, and eventually purchased the property in 1951. General sold the 721 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 2.1). In 1966, the USAF sold the remainder of the 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 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 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).

2.3 Surrounding Properties

2.3.1 605 Alexander Avenue Property

North of the tank farm properties 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 in1929 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

West of the tank farm properties on the other side of Alexander Avenue is 500 Alexander Avenue (500 property). The 500 property is owned by the Port and currently leased to Totem Ocean Trailer Express (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 was inconclusive as to whether the tank remains or has been removed (Hart Crowser, 2012a).

2.3.3 905 Alexander Avenue Property

South of the tank farm properties 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 and is currently referred to as "Port Building 50" (Figure 2.2). This property is now part of the 901 Alexander Avenue property, but is referred to as the former 905 property in this report to distinguish it from the 721 property (which has been combined with the 905 property to form the 901 property). This property is currently owned by the Port and leased to Pacific Coast Container (PCC) for cargo handling and shipping logistics. An abandoned UST (P-24) reportedly used for leaded gasoline storage exists in the northwest portion of the former 905 property (Figure 2.2). Further discussion of the P-24 UST is presented in Section 4.1.3.

2.3.4 Hylebos Waterway

The eastern portions of the tank farm properties include intertidal and subtidal portions of the Hylebos Waterway. The remainder of the section of the Hylebos Waterway offshore east of the tank farm properties are 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 Commencement Bay/ Nearshore Tideflats Superfund Site. The tank farm properties are adjacent to and the portions of the properties below ordinary high water are part of Segments 5 of the Mouth of the Hylebos Waterway Problem Area.

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) 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, 2014). Additionally, the intertidal and subtidal embankments adjacent to Port Building 50 on the 905 Alexander Avenue property, south of the 721 property, have been designated as a Natural Recovery Area SMA 534.

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 721 properties. Further action under Agreed Order DE 93TC-301 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 721 properties is limited through locked chain-link fencing. The 709 property is locked and fenced on all sides, and the 721 property is fenced on the west, north, and east sides. The south side of the former 721 property is open to the adjacent property located to the south, however, that property is fenced to the south at a distance of approximately 500 feet from the former 721/905 property boundary. Access to the western portion of the Site on the 500 property is also limited by locked chain-link fencing.

Two docks in the Hylebos Waterway on the 709 and 721 properties are partially intact, but are currently inactive. The 605, 721, and former 905 properties were each historically served by their own stub railroad lines which connected to the spur railroad line along the western side of Alexander Avenue. The rail lines serving the former 721 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 former 905 property is still intact and serves a warehouse in the northeast portion of the property.

Between the tank farm 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). . A Right-of-Way Permit (including Traffic Control Plan) from the City of Tacoma will be required to complete the soil and groundwater sampling described in Section 9.1.

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.

	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 721 property is paved, and stormwater is conveyed via five catch basins distributed evenly across the property (Figure 3.1). These catch basins are connected to a single stormwater drain line that outfalls to the Hylebos Waterway at the northeast corner of the 721 property.

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 summarized in the *Data Summary Report - 709 and 721 Alexander Avenue* (CRA, 2012b), and is presented 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 near the 709/721 property boundary. Cross Section B-B' (Figure 3.2-3) presents a north-south transect across the central portion of the 709/721 properties.

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 from 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 is occurs between the water table and the native tideflats deposit. The water table generally occurs from 2 to 6 feet NGVD (5 to 9 feet bgs). The native tideflats 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.

- **25-foot Zone –** includes the uppermost sandy deltaic deposits beneath the native tideflat deposits, although the tideflat is considered part of this zone. This zone is defined as a zone at or near a plane at elevation of -10 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.

- **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 721 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. A proposed monitoring well located west of Alexander Avenue (discussed in Section 9.2.1) avenue may confirm the location of the divide in the 25 foot zone. 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). 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 Serfes (1991) average freshwater equivalent heads (FEHs) 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.

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 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).

Based on site-specific data, 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 3.2-4. The groundwater divide for the 25-foot zone is located slightly west of the groundwater divide for the 15-foot zone. 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. Though these average gradients incorporate tidal extremes and short-term groundwater flow reversals, they are the most appropriate values for representing contaminant attenuation and transport at the Site.

Based on the site-specific data, vertical hydraulic gradients between the 15-foot and 25-foot zones are generally downwards, 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 3.2-6) located just east of Alexander Avenue;
- The 721-MW12 well cluster (Figure 3.2-7) located 250 feet east of Alexander Avenue and 600 feet west of the Hylebos Waterway;
- The 721-MW5 well cluster located 270 feet west of the Hylebos Waterway shoreline (Figure 3.2-8); and
- The 721-MW9 well cluster located 40 feet from the Hylebos Waterway shoreline (Figure 3.2-9).

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.

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 terrestrial ecological habitat. 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 an exclusion from conducting a Terrestrial Ecological Evaluation (TEE) in accordance with MTCA (WAC 173-340-7491(b)). The current and planned future land use is industrial, and contaminated soil is or will be covered with buildings, pavement, or other physical barriers that will prevent terrestrial wildlife from being exposed to the soil contamination.

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 formed by the mouth of Hylebos Creek and 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 11th 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 (approximate 200-feet wide) generally extends to a depth of -41 feet NGVD.

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 Current and Future Land Use

3.5.1 709 Alexander Avenue Parcel

As mentioned above, the 709 property is vacant and zoned for industrial use. 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.

3.5.2 721 Alexander Avenue Parcel

The 721 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 planned future use is maritime industrial, consistent with the current industrial use.

3.6 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.

3.6.1 Structures

No structures, other than the inactive docks (see Section 2.4), remain on either the 709 or 721 properties. The docks, which are constructed of creosote-treated timbers, are only partially intact. Additionally, no structures remain on the southern portion of the 605 property adjacent to the Site. A warehouse (Port Building 845) is present on the eastern portion of the former 905 property at the 721/905 property boundary. This warehouse is not regularly occupied by workers and is intermittently used for repackaging of bulk dry goods using heavy machinery.

3.6.2 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. As a former petroleum storage and distribution facility, the interior of the 709 and 721 properties are generally free of electrical utilities. Existing electrical lines are located in areas outside of historical tank areas and containment berms.

Water Supply

The tank farm 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 721 property, the water service currently ends approximately 50 feet east of Alexander Avenue. No water lines are currently mapped on the 709 property, although an abandoned water line is known to exist in the northwest corner of the property near the former office building (Figure 3.1).

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 (Figure 3.1). 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. Petroleum sheen was discovered in this sewer line in 1984, which resulted in the initial environmental investigations at the 709 and 721 properties. The sewer line investigations are further described in Section 6.5.

Stormwater

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

Stormwater conveyance utilities are present on the 721 property. A storm drain line and a series of catch basins are installed in an East-West line along the center of the property; this storm drain line discharges into the Hylebos Waterway between the 721 Alexander Avenue dock and the 709 Alexander Avenue pier (Figure 3.1). The depth of stormwater lines is not known but will be surveyed during the upcoming RI field work.

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 Site) as mapped in 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 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 of this utility is unknown.

4 Preliminary Conceptual Site Model

The preliminary conceptual site model describes potential 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.

4.1 Potential Sources of Contamination

The primary potential contaminant sources for the Site are described below.

4.1.1 709 Property

As discussed above, 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;
- A product pipeline (running mostly on the northern portion of the 721 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).

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.

4.1.2 721 Property

As discussed above, the 721 property 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 721 property docks, pipelines that connected the 721 docks to the 721 bermed area, a product pipeline than ran north-south between the 709 and 721 bermed areas, product pipelines that ran between the ASTs within the 721 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 721 property include (CRA, 2012b):

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

4.1.3 Neighboring Properties

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.

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), as discussed in Section 2.3.3, located along the east side of this property and just west of the tank farm properties; it is uncertain whether the UST remains in place or not (Hart Crowser, 2012a and 2012c), however recent investigations have documented the presence of petroleum hydrocarbons in soil and groundwater at the mapped location.

Potential sources of contamination located to the south associated with historical operations at the former US Naval Station on the 905 property include:

- UST P-24, located approximately 150 feet south of the former 721/905 property boundary, at the northwest corner of the 905 property large warehouse (Port Building 50). The UST was reportedly used for leaded gasoline storage and was abandoned in place after 1985. No evidence of petroleum contamination from the UST was observed during a 2012 investigation of adjacent soil and groundwater (Hart Crowser, 2012b).

To the east of Building 50 at the Hylebos Waterway shoreline is a dock (the “Navy Dock”) that was used by instrumentalities of the United States as part of World War Two and post-war ship fueling and servicing. The dock is now owned by the Port, is only occasionally used for boat docking, and is currently inactive. To the south of Building 50, the World War Two and post-war activities reportedly involved the use of solvents and other materials in an equipment maintenance shop.

4.2 Contaminant Migration Pathways

The previous investigations confirm that soil and groundwater are media of concern for the Site. Potential migration pathways for contaminants in Site soil and groundwater include the following:

- Leaching of contaminants from soil to groundwater;
- Dissolution of contaminants from separate-phase petroleum product to groundwater;
- Migration of dissolved-phase contaminants in groundwater and, near the shoreline, discharge of groundwater to the surface waters of the Hylebos Waterway;
- Sorption of dissolved phase contaminants onto Hylebos Waterway sediments from discharging groundwater;
- Transport of contaminants to adjacent marine surface water and sediment via surface water runoff;
- Erosion of upland bank soil containing hazardous substances along the shoreline in areas that are not armored or where the armoring has failed; and

- Vapor-phase transport of volatile contaminants from unsaturated zone soil or shallow groundwater to soil gas and then to indoor air within future occupied structures.

A number of physical, chemical, and biological processes can affect the transport and fate of organic and inorganic contaminants. Of particular importance for the Site, tidal fluctuations induce twice-daily reversals in nearshore groundwater flow directions. This increases groundwater flow path length and hydrodynamic dispersion, and circulates seawater into the subsurface, creating a physically and chemically dynamic nearshore groundwater environment.

4.3 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 exposure pathways and receptors were identified for purposes of establishing Preliminary Screening Levels (PSLs; refer to Port of Tacoma, 2013, which is included as Appendix B):

- Marine benthic and aquatic organisms in the Hylebos Waterway, if sediments are impacted by contaminants that were historically released to the waterway, or 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 sediments are impacted by contaminants that were historically released to the Hylebos Waterway, or 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).

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 flow discharges directly into the marine waters of the Hylebos Waterway; 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.

(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.

(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[1].

As described in Section 3.3.2, the Site also qualifies for an exclusion from conducting a TEE in accordance with MTCA (WAC 173-340-7491(1)(b)), and terrestrial wildlife contact with Site soil is not a complete exposure pathway.

[1] 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).

5 Preliminary Screening Levels

Based on exposure pathways/receptors identified in Section 4, this section describes the numerical screening levels against which soil, groundwater, and sediment data are compared for identifying constituents of concern during the Site RI. The PSLs do not necessarily represent values that will be equivalent to Site cleanup levels that will be calculated under MTCA during the FS. Additional information collected during the RI/FS will support selection of appropriate cleanup levels for the Site, in accordance with MTCA.

5.1 Tabulated Screening Levels

Draft PSLs for the Site were previously developed and submitted to Ecology for review (Port of Tacoma, 2013). The Ecology review draft version of that memorandum is included as Appendix B to this Work Plan along with a response to Ecology comments, both of which provide more detail regarding screening level derivation.

Tables 5.1, 5.2, and 5.3 present the resulting PSLs for Site groundwater, soil, and sediment, respectively. Table 5.4 presents chemical and site-specific parameters used in the calculation of the PSLs. Screening levels for sediment porewater and seeps, which are not tabulated separately, are not identical to groundwater PSLs identified in Table 5.1 but rather are the lowest of the Table 5.1 values that are based on marine protection, not vapor intrusion (e.g., the sediment porewater/seep PSL for benzene is 51 µg/L, not 24 µg/L).

5.2 Points of Compliance for PSLs

The point of compliance is that location where the final cleanup levels for each medium are applied. Because final Site cleanup levels will be developed as part of the FS (see Section 8.1), points of compliance with respect to preliminary screening levels for each medium are outlined below.

5.2.1 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 cleanup levels (Ecology, 2009) throughout the upper water bearing zone of the Site, or wherever structures could be built on grade in the future. 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 Waterway. Therefore, a groundwater conditional point of compliance within the sediment bioactive zone, or in intertidal seeps, would achieve protection of the marine environment (both sediment and surface water).

However, at this stage of the RI, the MTCA standard point of compliance will be assumed, and data from each well has been compared against groundwater PSLs protective of both VI and the marine environment. To inform the development of remedial alternatives in the FS, evaluations of the nature and extent of contamination will focus on shoreline monitoring well data relative to PSLs based on protection of the marine environment and VI PSLs will be used only for the upper water-bearing zone.

5.2.2 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.

5.2.3 Sediment Point of Compliance

Consistent with the Record of Decision for the Commencement Bay Nearshore Tideflats Superfund Site, the point of compliance for sediment screening levels is the sediment biologically active zone, which, is defined as the upper 10 centimeters (cm) of sediment.

6 Previous Remedial Actions and Existing Data

This section describes the previous investigations and cleanup actions conducted at the properties, and summarizes the current understanding of contaminant nature and extent based on usable data from the previous remedial actions.

6.1 Previous Investigations

A total of 15 separate environmental investigations have been completed at the Site, starting in 1989 and ending with sampling completed during OCC's 2012 Comprehensive Site Investigation (CSI). Figure 6.1 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 recent Comprehensive Site Investigation (Data Summary Report; CRA, 2013a), undertaken by OCC, contains the most comprehensive and up-to-date Site data, as follows:

- Soil sampling at 34 new soil boring locations, including 15 on the 709 property and 19 on the 721 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 721 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).

Additionally, UST investigations at UST N-11 on the 500 property and at UST P-24 on the 905 property were conducted in 2010 under the Port's UST program (Hart Crowser, 2012a and 2012b). Both investigations generated relevant soil and groundwater data.

6.2 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 lead, and 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).

6.3 Existing Environmental Data

OCC's technical consultant CRA has assembled analytical data from the prior investigations at the Site undertaken by OCC into a comprehensive environmental database covering the OCC Site and this Site. That database was made available to Aspect for completion of the Site RI/FS, and serves as the basis for the current understanding of Site contaminant nature and extent and thus for identifying data gaps to be addressed in the RI. The database includes soil and groundwater chemistry data from investigations performed between 1989 and 2012 (prior explorations shown on Figure 6.1). CRA's existing database covers a large portion of the Hylebos peninsula. For the purposes of the data tables and figures presented in this report, any data collected 230 feet north of the 605/709 property boundary was excluded for clarity. The following section summarizes the available historical data and how historical data was used in this Work Plan.

6.3.1 Data Summary

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". For the purposes of this Work Plan, statistical summaries of data collected over the area displayed on Figure 6.1 (including the 709 property, 721 property, and portions of adjacent properties) were prepared. This includes the tank farm properties as well as, for context, portions of the adjoining OCC Site (most significantly, the embankment fill area), and adjacent Port properties.

Statistical summaries of available data at sampling locations shown on Figure 3.2-1 are presented in Table 6.1 (soil in 0- to 30-foot depth interval), Table 6.2 (soil at depths greater than 30 feet), Table 6.3 (groundwater in 0- to 30-foot depth interval, which includes the 15-foot and 25-foot zones), Table 6.4 (groundwater at depths greater than 30 feet, which includes the 50-foot and deeper zones), Table 6.5 (sediment porewater/seeps), and Table 6.6 (sediment). The summary tables for each medium present the number of locations where samples were collected, number of samples from all locations, number of detections, minimum and maximum detected concentrations, PSLs, number of exceedances of the PSL, exceedance frequency, and maximum exceedance factor (magnitude of exceedance). All soil data in the Site database are included in the statistical summaries.

No indoor air or soil gas samples have been collected at the tank farm properties. No regularly occupied structures currently exist on the properties; therefore, VI is not considered a currently complete exposure pathway. However, Port Building 50 may be within or sufficiently close to the southern boundary of the Site so that the VI pathway may need to be re-evaluated after the RI. Currently, to be conservative, the groundwater PSLs include values protective to humans via the VI pathway (see Section 4). Additional discussion regarding how to address VI in the RI/FS is provided in Section 7.

6.3.2 Data Usability

Because petroleum releases from historical petroleum handling operations likely occurred decades ago, and petroleum hydrocarbons can degrade substantially over time, the RI/FS will emphasize the most recent data as most representative of current Site conditions. For example:

- For monitoring wells with data from different times, the most current groundwater data are used to represent current conditions.
- Soil data collected prior to 2008 are considered in developing the conceptual site model, but where older and newer soil hydrocarbon data exists for an area, the interpretation of current conditions uses the newer data.

For purposes of this Work Plan, the figures in this section present all soil data in the database. In addition, the figures in this section presenting existing soil data divide soils at depths less than a 5-foot depth as unsaturated (unsaturated zone) soil, versus greater than a 5-foot depth as saturated soil. Although different soil screening levels based on the soil-leaching-to-groundwater pathway apply for unsaturated versus saturated soil (refer to cross-media values in Table 5-1), data from all depths are compared against the more conservative saturated-soil screening levels for purposes of this Work Plan. Further assessment of soil data age/reliability, and segregation of data into saturated versus unsaturated soil (with appropriate cross-media soil screening levels), will be conducted as part of the RI.

Similarly, all historic Site groundwater data has been retained as part of this Work Plan and are represented in the Summary Statistics. The figures in this section present all groundwater data in the database, except for wells with more than one sample result, for which the most recent data are displayed. Because samples collected from monitoring wells are considered more representative of groundwater conditions than samples collected from Geoprobe® borings or test pits, monitoring well groundwater sample results are displayed using a larger symbol on all figures. Further assessment of groundwater data usability will be conducted as part of the RI.

6.4 Preliminary Chemicals of Concern

Preliminary chemicals of concern (pCOCs) were established by first reviewing the prior analytical data over the area displayed on Figure 6.1, as described in the *Preliminary Chemicals of Concern and Screening Levels Technical Memorandum* (Port of Tacoma, 2013, provided as Appendix B). A tabular summary of this data is presented in Appendix D. Chemicals with a frequency of detection greater than 5 percent were retained as pCOCs.

Potential COCs for each media, and summary statistics for their occurrence, are listed in Tables 6.1 through 6.6. Indicator pCOCs for the Site were identified for the purposes of this Work Plan based on frequency and magnitude of PSL exceedance (Tables 6.1 through 6.6). The indicator pCOCs are chemicals likely to drive the extent of remedial actions and are used in the Work Plan to illustrate the maximum magnitude and extent of contamination.

Based on the comparison of existing analytical data to the identified PSLs (Tables 6.1 through 6.6), the following are identified as indicator pCOCs at the Site:

- Benzene[2];
- Gasoline-range TPH;
- Diesel-range plus heavy-oil range TPH;
- Carcinogenic polycyclic aromatic hydrocarbons (cPAHs);
- Lead; and
- Chlorinated volatile organic compounds (CVOCs).

While other compounds have been detected above PSLs at the Site, these are detected at a lower frequency and over a smaller area than similar indicator pCOCs (see Tables 6.1 through 6.6). For example, the areas of toluene, ethylbenzene, and xylenes above PSLs are less extensive than benzene, which has a greater toxicity and mobility than the other BTEX compounds.

Several compounds sometimes associated with petroleum were not detected frequently (see Appendix D) or did not have PSL exceedances, so were not identified as pCOCs. These include PCBs (7 detections in 143 soil samples and 1 detection in 139 groundwater samples for Aroclor 1260, the most commonly detected Aroclor); MTBE (0 detections in 2 soil and 34 groundwater samples); and EDB (0 detections in 32 soil and 72 groundwater samples).

In addition, there are non-carcinogenic PAHs (e.g., naphthalene, fluorene) present in shallow soil at concentrations exceeding PSLs throughout the Site (Table 6.1). However, the soil PSLs are based on groundwater protection and there are extremely limited groundwater exceedances for non-carcinogenic PAHs detected in groundwater samples collected at the Site. There are no exceedances for non-carcinogenic PAHs in groundwater beneath the 25-foot zone (Table 6.4). Two of 93 groundwater samples collected from the 15-foot zone contained fluorene concentrations marginally exceeding the 4 µg/L screening level (up to 4.7 µg/L in 2012 samples from wells 721-MW12-15 and 721-MW14-15 on the western side of the 709 property). One of 148 groundwater samples collected from the 15-foot zone contained naphthalene concentrations exceeding the 93 µg/L screening level (110 µg/L in 1989 grab groundwater sample from P-10 location) (Table 6.3). The groundwater PSLs for those compounds are based on protection of marine sediment. There are no detected groundwater exceedances for those

[2] Note that benzene, toluene, ethylbenzene, and xylenes (BTEX) are present at concentrations above screening levels (see Tables 6.1 through 6.4). However, the BTEX compounds are generally collocated, and benzene has the highest exceedance frequency and is the primary risk driver of the group. Therefore, for purposes of this Work Plan, benzene is considered the key pCOC of the BTEX group for this Site.

compounds within 500 feet of the marine shoreline, and there are no detected exceedances for those compounds in marine sediment samples within the Hylebos Waterway adjacent to the Site; in fact, there are no exceedances for light molecular weight PAHs (LPAHs) in the Site sediment samples (Table 6.6). There are also no exceedances of non-carcinogenic PAHs in soil deeper than 30 feet (Table 6.2)—further indicating limited transport. The collective empirical data indicate that the soil concentrations of non-carcinogenic PAHs are protective of Site groundwater and the corresponding PSLs are overly conservative for this Site. As such, non-carcinogenic PAHs are not identified as pCOCs for the Site.

Sections 6.5 through 6.8 describe the current understanding of light nonaqueous phase liquid (LNAPL) petroleum presence, followed by the current understanding of indicator pCOC distributions in Site soil and groundwater (15-foot and 25-foot water-bearing zones) and in Hylebos Waterway sediment and sediment porewater/seeps.

6.5 Occurrence of Light Nonaqueous Phase Liquid (LNAPL)

In 1987, "oil" was reportedly observed in the sanitary sewer line Manhole 30 located near the northwest 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 721 property (Figure 6.5-1). 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."

Figure 6.5-1 displays the most recent information regarding potential indicators of LNAPL presence at the Site based on May through August 2012 observations of petroleum sheen/odor, dye test results, and observed LNAPL at new wells and borings (CRA, 2013a); previously existing monitoring wells were not tested for LNAPL presence. The 2012 observations were collected during the summer months when groundwater levels would generally be lower and thus thicknesses of LNAPL accumulations should generally be greater. During the 2012 investigation, LNAPL was observed in explorations on the central and southern portions of the 721 property and northern edge of the 905 property. The southeastern extent of LNAPL presence on the 905 property, and the southwestern extent of LNAPL presence on the 721 property, are not defined with the current information. LNAPL was not observed on the 709 property; however, petroleum sheen and strong odor were observed in the western and central portions of that property. Petroleum sheen and strong odor, but not LNAPL, were observed in shoreline explorations on the 721 property. The extent of petroleum sheen and odor, dye test results, and observed LNAPL is consistent with the extent of gasoline-range TPH and diesel-range TPH exceedances in groundwater, as depicted on Figure 6.5-1.

6.6 pCOCs in Soil

As expected for a petroleum related contaminants, the contamination is predominantly concentrated in the shallow soils at or near the water table.

6.6.1 Gasoline-Range TPH and Benzene in Soil

6.6.1.1 Unsaturated Zone Soils

In unsaturated zone soil, the highest concentrations of gasoline-range TPH (greater than 1,000 mg/kg) occur within the 709 property's bermed fuel tank area (Figure 6.6-1). The highest benzene concentration detected in unsaturated zone soil (13 mg/kg at HC-TP-05-95 and 5.3 mg/kg at 709-MW-13) also occurs in this area (Figure 6.6-2).

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 721 properties (boring 721-BH-17);
- The western portion of the bermed area on the 721 property, encompassing fuel tank 11 (diesel), the USAF sludge pit, and tanks 12 and 13 (kerosene and solvent, respectively); and
- On the southeast side of tank 4 (gasoline) in the southeast portion of the 721 property (boring 721-BH-03).

The interpreted spatial extent of gasoline-range TPH in unsaturated zone soil exceeding the 30 mg/kg PSL encompasses the high concentration areas described above; the data indicate relatively sharp declines in concentrations away from the high-concentration source areas (Figure 6.6-1).

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; Figure 6.6-2).

Data exist to laterally bound gasoline-range TPH and benzene exceedances in unsaturated zone soil adjacent to the Hylebos Waterway shoreline (borings 709-BH-01, 709-BH-02, and 709-BH-03; and 721-BH-01 and 721-BH-02; Figures 6.6-1 and 6.6-2).

With the current data, the lateral extent of gasoline-range TPH and benzene exceedances in unsaturated zone soil is not adequately bounded on the north-central portion of the 709 property, on the west side of the 709/721 properties (beneath and west of Alexander Avenue), and on the southeast portion of the 721 property. There is also an area lacking data in the east-central portion of the 709 property, generally between explorations 709-BH-02 on the northwest and 721-BH-01/HC-TP-02-92 on the southeast (Figure 6.6-1).

6.6.1.2 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 6.6-3 and 6.6-4, gasoline-range TPH and benzene exceedances were detected across the western portion of the 709 property, the majority of the 721 property, and at the location of UST N-11 on the west side of Alexander Avenue. Gasoline-range TPH concentrations were below the screening level in saturated soil at the two borings within Alexander Avenue (709-BH-12B and 721-BH-17), but boring 721-BH-17, just west of the 709/721 properties boundary, had a benzene exceedance (9.5 mg/kg).

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 (compare Figure 6.6-3 [saturated] to Figure 6.6-1 [unsaturated]).

On the 709 property, data exist to laterally bound gasoline-range TPH and benzene exceedances in saturated zone soil adjacent to the Hylebos Waterway shoreline (borings 709-BH-01, 709-BH-02, and 709-BH-03, and HC-TP-09-95). On the 721 property, however, gasoline-range TPH exceedances in saturated soil extend to the explorations closest to the shoreline (1,100 mg/kg at 721-BH-01 and 1,900 mg/kg at 721-BH-02; Figure 6.6-3). In addition, soils at both of these locations exhibited sheen/staining, odor, and high PID readings during CRA's 2012 investigation (CRA, 2013a). These locations are 30 and 160 feet, respectively, from the shoreline.

The lateral extent of gasoline-range TPH and benzene exceedances in saturated zone soil is not adequately bounded on the west side of the 709/721 properties (west of Alexander Avenue), or on the east, southeast, and south portions of the 721 property.

The vertical extent of gasoline-range TPH and benzene is bounded. No exceedances have been detected in soil samples collected at depths greater than 30 feet (Table 6.2).

6.6.2 *Diesel-Range and Oil-Range TPH in Soil*

For purposes of this RI/FS Work Plan, concentrations of diesel-range and oil-range TPH are summed to calculate and present a single TPH value for each sample(e.g., Figures 6.6-7, 6.6-8, and 6.6-9) in accordance with Ecology's 2004 Technical Memorandum #4 (Ecology, 2004). More detailed evaluation may be conducted during the RI/FS to refine interpretation of petroleum product types, if warranted for evaluation of remedial alternatives.

6.6.2.1 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 6.6-7) 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, the west-central portion of the 709 property, the central and southern portion of the 721 property, and at boring 721-BH-13 located adjacent to tanks 12 and 13 (kerosene and solvent, respectively) toward the west end of the 721 property. The highest concentration (31,300 mg/kg) was detected at boring 721-BH-08 located on the south side of tank 11 (diesel).

On the 709 and 721 properties, data exist to laterally bound diesel + oil-range TPH exceedances in unsaturated zone soil adjacent to the Hylebos Waterway shoreline, except the 9,000 mg/kg concentration at older exploration HC08-B113 on the 709 property; Figure 6.6-7).

With the current data, the lateral extent of diesel + oil-range TPH exceedances in unsaturated zone soil is not adequately bounded on the west side of the 709/721 properties (beneath and west of Alexander Avenue), or on the southeast portion of the 721 property—generally the same as for gasoline-range TPH, as well as adjacent to boring HC08-B113 along the shoreline of the 709 property and on the southern portion of the 605 property north of borings 709-BH-05 and 709-BH-06 (Figure 6.6-7).

6.6.2.2 Saturated Zone Soils

In saturated soil, diesel+ oil-range TPH exceedances are more spatially extensive than in unsaturated zone soil (Figure 6.6-8). 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 6.6-9).

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 western portion of the 709 property, the majority of the 721 property, and at the location of UST N-11 on the west side of Alexander Avenue (one sample location). Diesel + oil-range TPH concentrations were well below the 2,000 mg/kg PSL in saturated soil at borings 709-BH-12B and 721-BH-17 within 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 on the west end of the 721 property and southwest portion of the 709 property, as well as on the east-central portion of the 721 property (at boring 721-BH-04; Figure 6.6-8).

On the 709 property, data exist to laterally bound diesel- and oil-range TPH exceedances in saturated zone soil adjacent to the Hylebos Waterway shoreline (borings 709-BH-01, 709-BH-02, and 709-BH-03; and older explorations HC-TP-09-95, HC-TP-03-93, HC-TP-07-93, and HC-TP-02-93). On the 721 property, the detected diesel- and oil-range TPH concentration in saturated soil was below the PSL at nearshore boring 721-BH-01 (1,400 mg/kg) on the north end of the property, and was above the PSL at 721-BH-02 (6,100 mg/kg), 160 feet from the shoreline on the south end of the property.

With the current data, the lateral extent of diesel-range TPH exceedances in saturated zone soil is not adequately bounded on the west side of the 709/721 properties (west of Alexander Avenue), or on the south, east, and southeast portions of the 721 property—generally the same as the data gap for gasoline-range TPH.

No diesel + oil-range TPH soil exceedances are detected in the 15- to 30-foot depth interval (Figure 6.6-9); therefore, the vertical extent is adequately defined.

6.6.3 cPAHs in Soil

6.6.3.1 Unsaturated Zone Soils

Total cPAH toxic equivalent quotient (TEQ) concentrations above the highly conservative PSL (0.02 mg/kg) are distributed in unsaturated soils across the central portions of the 709 and 721 properties (maximum of 1.16 mg/kg at HC08-EP18), in the embankment fill portion of the 709 property (maximum of 3.7 mg/kg at HC-TP-03-93), and along the southern portion of the 721 property (maximum of 0.27 mg/kg at 721-MW10 adjacent to the shoreline) (Figure 6.6-10). All detected total cPAH (TEQ) concentrations in unsaturated soil are below the 18 mg/kg Method C soil cleanup level based on industrial worker direct contact.

6.6.3.2 Saturated Zone Soils

In the 5- to 15-foot depth interval of saturated soil, relatively low-level total cPAH (TEQ) exceedances are located west of Alexander Avenue at the UST N-11 location (0.07 mg/kg at HC-N11-TP-1-2), across central portions of the 709 and 721 properties (maximum of 0.34 mg/kg at 721-BH-13), and along the south boundary of the 721 property (up to 0.12 mg/kg at 721-BH-07). The highest saturated-soil concentrations are within the embankment fill on the north side of the 709 property (up to 11.1 mg/kg at HC-TP-03-03; Figure 6.6-11).

Only one cPAH soil exceedance was detected within the 15- to 30-foot depth interval of saturated soil: 0.17 mg/kg at 709-MW-03 located at the north end of the 709 property (Figure 6.6-12).

All detected total cPAH (TEQ) concentrations in saturated soil are below the 18 mg/kg Method C soil cleanup level based on industrial worker direct contact (point of compliance extends to 15-foot depth).

Note that the soil PSLs for total cPAH (TEQ)—0.02 mg/kg for saturated soil and 0.3 mg/kg for unsaturated soil—are below typical urban background concentrations as based on Ecology's extensive sampling conducted in Seattle urban neighborhoods (90th percentile total cPAH [TEQ] concentration of 0.39 mg/kg; Ecology, 2011).

6.6.4 Lead in Soil

The lead at the Site is predominantly the inorganic form. Tetraethyl lead has been analyzed for in 126 soil samples, but with few detections (6) and low concentrations (maximum 2.1 mg/kg) and low exceedance frequency (4%), so it was not identified as an indicator pCOC. The distribution of total lead in soil is described below.

6.6.4.1 Unsaturated Zone Soils

Lead concentrations exceeding the 81 mg/kg PSL in unsaturated zone soil occur across the south-central portion of the 709 property and central and southeast portions of the 721 property, with a maximum of 899 mg/kg at boring 721-BH-05. Soil lead concentrations at and adjacent to the former tetraethylead plant on the 709 property are below the PSL. (Figure 6.6-13). Notably higher lead concentrations are present within unsaturated soils of the embankment fill on the 709 property and north into the 605 property.

6.6.4.2 Saturated Zone Soils

Lead is not detected in saturated soil at concentrations exceeding the PSL outside of the embankment fill, which is not part of this Site. Soil lead concentrations within the embankment fill are substantially lower in the 15- to 30-foot zone than in the 5- to 15-foot zone (see Figures 6.6-14 and 6.6-15).

Outside of the embankment fill, the detected soil lead concentrations throughout the Site are below the 1,000 mg/kg Method C soil cleanup level based on industrial worker exposure. The 81 mg/kg soil PSL for lead is based on leaching to groundwater for marine protection. The fact that groundwater lead concentrations detected from monitoring wells within the 15-foot and 25-foot zones at well location 721-MW-15 (0.4 to 0.5 µg/L; refer to Figures 6.7-10 and 6.7-11 discussed in Section 6.7), located just downgradient of boring 721-BH-05 are well below the 8.1 µg/L groundwater PSL provides empirical evidence that the 899 mg/kg lead concentration detected in unsaturated soil at that boring is protective of groundwater in accordance with MTCA. Likewise, groundwater lead concentrations well below the 8.1 µg/L groundwater PSL in the 15-foot and 25-foot zones at shoreline wells 95-15 and 721-MW-10 provide empirical evidence that upgradient soil lead concentrations exceeding the 81 mg/kg PSL are protective of groundwater.

Additional soil lead data are warranted to better define lateral extent on the south sides of samples 721-BH-05 and 721-BH-03.

6.6.5 Chlorinated VOCs in Soil

CVOCs are present in Site media at concentrations exceeding PSLs, and as such are being evaluated as part of this RI/FS to assess whether they originated from activities associated with historic petroleum storage and processing facilities that were operated on the 709 and 721 properties[3]. For purposes of this RI/FS Work Plan, the CVOCs are described as a group, with mapping of PCE and TCE as illustrative of the contaminant extents for the group. Cis-DCE (0 exceedances in 268 samples) and vinyl chloride (8 exceedances in 332 samples) have infrequently been detected above screening levels.

[3] 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."

Figures 6.6-16, 6.6-17, and 6.6-18 present PCE soil data for the 0- to 5-foot (unsaturated soil), 5- to 15-foot (saturated soil), and 15- to 30-foot (saturated soil) depth intervals, respectively. Figures 6.6-19, 6.6-20, and 6.6-21 present TCE soil data for the 0- to 5-foot (unsaturated soil), 5- to 15-foot (saturated soil), and 15- to 30-foot (saturated soil) depth intervals, respectively.

6.6.5.1 Unsaturated Zone Soils

Higher concentrations of PCE (up to 12 mg/kg) with lower concentrations of TCE (up to 0.68 mg/kg) occur within unsaturated soils comprising the embankment fill. In unsaturated soil outside of the embankment fill, there are scattered low PCE exceedances (less than 0.03 mg/kg) and no TCE exceedances (Figures 6.6-16 and 6.6-19). The unsaturated soil data do not indicate surface releases of CVOCs on the 709 or 721 properties outside of the embankment fill.

6.6.5.2 Saturated Zone Soils

Within the 5- to 15-foor depth interval of saturated soil, the highest PCE concentrations (up to 4.8 mg/kg) are detected within the embankment fill. Scattered low-level PCE exceedances also occur in the western portion of the 721 property (up to 0.17 mg/kg) and at single borings near the northern and southern boundaries of the 709 property (0.12 mg/kg at 709-MW-15 and 0.072 mg/kg at 709-MW-8, respectively) (Figure 6.6-17). No TCE soil exceedances are detected in the 5- to 15-foot depth interval outside of the embankment fill (Figure 6.6-20).

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 0.69 mg/kg at 709-MW-19) to the eastern edge of the 721 property (up to 0.062 mg/kg at 721-MW-8). The low-level exceedances observed in the 5- to 15-foot zone within the western portion of the 721 property do not persist into the deeper zone (Figure 6.6-18). A low-level TCE exceedance likewise occurs at the 721-MW-8 location (0.14 mg/kg) (Figure 6.6-21). There is a data gap regarding lateral and vertical extent of CVOCs in saturated soil within the east-central portion of the 709 property, between the bermed tank farm and embankment fill.

6.7 pCOCs in Groundwater

As mentioned previously, the petroleum related contamination at the Site is predominantly concentrated in the shallow soils at or near the water table. Much lower concentrations of petroleum-related contamination were detected in groundwater at depths greater than 30 feet (Table 6.4) relative to shallower groundwater (Table 6.3).

6.7.1 Gasoline-Range TPH and Benzene in Groundwater

6.7.1.1 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 PSLs (800 µg/L and 24 µg/L, respectively) generally matches the distribution of those constituents in soil — covering the western portion of the 709 property, essentially all of the 721 property, and into the UST 11 area west of Alexander Avenue (Figures 6.7-1 and 6.7-2). Benzene concentrations exceeding 240 µg/L (10 times the screening level) occur across the western and southern portions of the 721 property, and at the UST 11 location west of Alexander Avenue. The data bound the eastern (downgradient) extent of gasoline-range TPH and benzene groundwater exceedances in the 15-foot zone on the 709 property but not on the 721 property or to the west in the UST N-11 area.

6.7.1.2 25-Foot Zone

In the deeper water-bearing zone (25-foot zone), only one well, 721-MW15-25 in the southwest corner of the 721 property, had a detected exceedance for gasoline-range TPH (Figure 6.7-3). However, benzene exceedances are more extensive, extending across the southern half of the 709 property and all of the 721 property (there are no groundwater data in this depth interval from the UST N-11 area west of Alexander Avenue). Groundwater benzene exceedances extend to the upland shoreline monitoring wells, but no exceedances were detected during one-time sampling of the three wells 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 721 property, but at concentrations (15 and 4.7 µg/L at 721-PZ-01 and 721-PZ-02 respectively) below the 24 µg/L screening level (based on VI); these concentrations are well below the most stringent criterion for marine protection (51 µg/L) (Figure 6.7-4). The groundwater samples collected from the intertidal piezometers were not tested for gasoline- or diesel-range TPH.

Figures 6.7-5A and 6.7-5B depict the spatial distribution of benzene in groundwater along cross sections A-A’ and B-B’;(cross section locations shown on Figure 2.2). Intertidal well 721-PZ-02 is depicted on cross section A-A’ (Figure 6.7-5A). 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 6.7-5B) shows the area near 721-MW-13 where elevated benzene was detected in the 50-foot zone. Note that cross section AA’(Figure 6.7-5A) does not depict the southern portion of the 721 property where benzene in groundwater does reach the shore. Benzene concentrations in this area exceed the 51 µg/L marine-based screening level the in 15-foot zone at 721-GP-9 [Figure 6.7-2]; and in the 25-foot zone at 721-MW9, 721-GP8, 721-GP9, and 721-MW10 [Figure 6.7-4].

With the current data, the lateral extent of gasoline-range TPH and benzene exceedances in groundwater is not adequately bounded on the west side of the 709/721 properties (into and west of Alexander Avenue at UST N-11 area) or on the south and southeast edges of the 721 property.

6.7.1.3 50-Foot Zone

During CRA’s 2012 investigation, an anomalously high benzene concentration (170 µg/L) was detected in 50-foot-zone monitoring well 721-MW-13-50, which was screened from approximately 44 to 49 feet bgs just south of the 721 property boundary. The deep benzene detection is much greater than the 0.29 µg/L detection in the 15-foot zone monitoring well and greater than the 75 µg/L detection in the 25-foot zone monitoring well at that same location. However, CRA has reviewed the field sampling forms and no discrepancies or inconsistencies in sample labeling were noted. Additional sampling of those wells during the RI investigation is warranted to confirm the CRA 2012 investigation results.

As summarized in Table 6.4, only two of 57 groundwater samples collected at depths below 30 feet exceed the screening level. One of those is the value discussed above. The other was from a temporary probe sample; subsequent monitoring well installation and sampling in the area of that probe sample did not indicate a benzene exceedance. Benzene has not been detected above screening levels at any other wells from the 50-foot zone.

6.7.2 Diesel-Range and Oil-Range TPH in Groundwater

6.7.2.1 15-Foot Zone

Within the 15-foot zone, diesel + oil-range TPH exceedances in groundwater occur across the western portion of the 709 property and much of the 721 property; however, detected concentrations in shoreline wells are all below the 500 µg/L PSL (Figure 6.7-6). The 2008 groundwater sample HC08-EP18, located in the south-central portion of the 709 property, contained an anomalously high diesel + oil-range TPH concentration (26,250 µg/L) compared to the other Site wells. Diesel + oil-range TPH exceedances occur along the western edge of the 721 property and on the 500 property in the UST N-11 area located west of Alexander Avenue (Figure 6.7-6).

Based on the current information for the 15-foot zone, data gaps include the western extent of diesel + oil -range TPH groundwater exceedance on the 500 property south and west of well HC-N11-6 , and the southern extent into the 905 property, south of wells 721-MW6-15 and 721-MW11-15.

6.7.2.2 25-Foot Zone

Low-level exceedances for diesel + oil-range TPH (up to 690 µg/L) in 25-foot-zone groundwater occur along the western edge of the 709 property, and in one shoreline well 95C-25 on the 721 property (885 µg/L) (Figure 6.7-7). However, two of the three reported exceedances on the western end of the 709 property (wells 709-MW11-25 and 709-MW21-25) occur only because ½ the analytical reporting limit for oil-range TPH is included in the summation for diesel- plus oil-range concentrations (i.e., adding up to 260 µg/L for non-detected oil-range concentrations); if the non-detected values are not added in, the detected concentrations of diesel-range TPH are below screening levels in both monitoring wells. Likewise, at well 709-MW18-25, the exceedance is a result of adding in an estimated oil-range TPH concentration (480 µg/L J) below the reporting limit.

With the current data for the 25-foot zone, the lateral extent of diesel + oil-range TPH exceedances in groundwater is considered adequately bounded for purposes of developing and evaluating cleanup alternatives for the Site.

6.7.3 cPAHs in Groundwater

6.7.3.1 15-Foot and 25-Foot Zones

No cPAH exceedances are detected in groundwater samples from the 15-foot zone (Figure 6.7-8). Two wells in the 25-foot zone, 709-MW21-25 and 709-MW11-25, located in the southwest corner of the 709 property, had total cPAH (TEQ) concentrations (0.0625 µg/L and 0.0583 µg/L, respectively) marginally exceeding the highly conservative 0.018 µg/L screening level (Figure 6.7-9). Even minute amounts of suspended solids in groundwater samples can create those extremely low detections of total cPAH concentrations.

The cPAH groundwater screening level is based on life-long human consumption of aquatic organisms, and the only cPAH groundwater concentrations exceeding that screening level were detected in wells hundreds of feet from the Hylebos Waterway. Consequently, cPAHs in groundwater are considered adequately characterized for purposes of the RI.

6.7.4 Lead in Groundwater

6.7.4.1 15-Foot Zone

In the 15-foot zone, lead concentrations exceeding the 8.1 µg/L groundwater screening level are detected in wells across much of the 709 property, and extending north onto the 605 property. No groundwater lead exceedances are detected on the 721 property (Figure 6.7-10).

In the 2012 groundwater data (CRA 2013a), the highest groundwater lead concentration detected on the Site was 868 µg/L in well 709-MW-05, located within the area of embankment fill.

While a 1990 groundwater sample collected adjacent to the tetraethyl lead plant detected 147 µg/L lead (location P-5; Ecology and Environment, 1990), the 2012 data from downgradient wells 709-MW-02, 709-MW20-15, and 709-MW-04 indicate no groundwater lead exceedances approaching the shoreline from the tetraethyl lead plant area. This groundwater data is supported by a lack of elevated lead concentrations in soil adjacent to the tetraethyl lead plant on the 709 property. In addition, lead was not detected in a total of ten groundwater samples collected at five depth intervals from intertidal borings NL-28 and NL-29 completed offshore of the 709 property.

6.7.4.2 25-Foot Zone

Within the 25-foot zone, lead was detected in the groundwater sample from one well (721-MW9-25) at a concentration (9.0 µg/L) marginally above the screening level (Figure 6.7-11).

6.7.5 Chlorinated VOCs in Groundwater

6.7.5.1 15-Foot Zone

PCE and TCE concentrations exceeding respective PSLs occur in 15-foot-zone groundwater throughout the eastern portion of the 709 and 721 properties and extending north onto the 605 property (Figures 6.7-14 and 6.7-16). Somewhat higher concentrations have been observed in the embankment fill area and immediately to the west (hydraulically upgradient of the embankment fill). On the 709 property, groundwater PCE and TCE exceedances occur at shoreline wells throughout the embankment fill, but concentrations were below respective PSLs at the downgradient intertidal seep and piezometer samples. On the 721 property, PCE and TCE exceedances along the shoreline are limited to well 721-GP8, for which there is not a corresponding downgradient intertidal sampling location (Figures 6.7-14 and 6.7-16).

Figure 6.7-16 depicts the groundwater VC data for the 15-foot zone, which indicates exceedances across much of the eastern half of the 721 property but not on the 709 property.

The downgradient extent of 15-foot-zone groundwater CVOCs from the 721 property into the Waterway is a data gap.

A data gap exists regarding CVOC distribution within the 15-foot zone on the west-central portion of the 721 property, generally near Former Tank 11 and the southwest corner of the Former USAF Sludge Area.

6.7.5.2 25-Foot Zone

PCE and TCE groundwater exceedances in the 25-foot zone are limited to the eastern portion of the 709 property, extending north onto the 605 property (6.7-15 and 6.7-17). The PCE exceedance in shoreline well 709-MW20-25 does not extend to downgradient intertidal piezometer/seep sample locations.

In the 25-foot zone groundwater, VC exceedances are more spatially extensive than PCE or TCE, occurring across much of the 709 property and northern portion of the 721 property. VC exceeds the PSL in one intertidal seep sample along the northern edge of the 709 property (5.6 µg/L at NL-28) (Figure 6.7-17).

A data gap exists regarding CVOC distribution within the 25-foot zone on the east-central portion of the 709 property, generally between the bermed tank farm area and well 709-MW20-25.

6.7.6 Extent of pH and Metals Other than Lead 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 709/721 properties. The extent of high pH (>8.5) and metals other than lead exceeding PSLs at the Site in shallow groundwater is shown in Appendix E. 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.

No specific data gaps are identified for groundwater pH or metals other than lead for the Site.

6.8 pCOCs in Sediment and Sediment Porewater/Seeps

Subtidal sediment and intertidal sediment porewater (seep) data have been collected from the tank farm properties as part of OCC Site-related investigations – primarily along the embankment fill area of the 709 property with limited sampling on the 721 property. The seep and sediment sample locations on the 709 and 721 properties are shown on Figures 3.2-1. Analytes for sediment samples include selected VOCs (BTEX and PCE) metals (antimony, arsenic, cadmium, copper, chromium, lead, nickel, silver, thallium, and zinc), selected semivolatile organic compounds [SVOCs] including PAHs, dioxins/furans, PCB aroclors and PCB congeners, chlorinated pesticides, ammonia. Analytes for porewater/seep samples included VOCs, target analyte metals (24 metals), alkalinity, dissolved silica, sulfate, chloride, SVOCs including PAHs, PCB aroclors, and chlorinated pesticides. A subset of historical samples were analyzed for Site pCOCs (including benzene, lead, and CVOCs). The available data for Site pCOCs in these media are shown on Figures 6.8-1 through 6.8-4 and are described below. Very limited data for petroleum hydrocarbons and PAHs are available (see Tables 6.5 and 6.6); these analytes were not detected in historical seep samples but had elevated detection limits and were not mapped for this Work Plan.

Sediments east of the Site docks were dredged in 2003 as part of the Commencement Bay/Nearshore Tideflats Superfund Site (CRA, 2013b). Along the tank farm properties shoreline, dredging only occurred along the deepest portions of the Hylebos Waterway, at depths greater than -30 feet MLLW. The existing sediment data discussed in this section is from outside of the areas dredged in 2003.

6.8.1 Benzene in Sediment and Sediment Porewater/Seeps

Benzene was not detected at a detection limit of 1 µg/L in four seep samples collected along the shoreline east of the 721 property (Figure 6.8-1).

6.8.2 Lead in Sediment and Sediment Porewater/Seeps

Along the toe of the embankment fill shoreline of the 709 property (outside the Site), detected lead concentrations in subtidal sediment ranged from 141 mg/kg to 130,000 mg/kg. Each of the five intertidal seep samples collected along the embankment fill shoreline contained concentrations of total lead exceeding the 8.1 µg/L screening level for porewater (Figure 6.8-2[4]). When filtered, three of the four samples contained dissolved lead exceedances. Counterintuitively, the maximum detected dissolved lead concentration was more than three times the maximum detected total lead concentration for the same sample (Table 6-5). The one intertidal seep sample (Seep-94) collected from the 721 property shoreline contained no detectable lead (Figure 6.8-2).

The elevated lead concentrations detected on the 709 property shoreline are inferred to be associated with high lead concentrations in the embankment fill, and, as such, are not associated with the Site.

6.8.3 Chlorinated VOCs in Sediment and Sediment Porewater/Seeps

A low-level exceedance of PCE (0.084 mg/kg) was detected in composite sample A-2 of five subtidal sediment subsamples collected from the 709 property shoreline adjacent to the embankment fill. PCE concentrations in adjacent discrete sediment samples were below the 0.057 mg/kg PSL. No sediment samples were collected for CVOC analysis on the 721 property (Figure 6.8-3). TCE concentrations detected in subtidal sediment samples from the 709 property were below the sediment PSL (Figure 6.8-4).

PCE concentrations exceeding the 0.33 µg/L PSL were detected in intertidal seep samples collected from the 709 property adjacent to the embankment fill (up to 14 µg/L). PCE exceedances (up to 46 µg/L) were detected in three of seven porewater/seep samples

[4] The higher of total or dissolved lead concentrations are displayed on Figure 6.8-2.

collected along the 721 property shoreline; the exceedances are localized around the former dock structure (Figure 6.8-3).

TCE concentrations in porewater/seep samples from the 709 property shoreline were below PSLs, whereas exceedances (up to 39 µg/L) were detected in porewater/seep samples collected around the former dock structure on the 721 property (Figure 6.8-4).

7 Identification of RI Data Gaps

Based on synthesis of the existing usable data, this section identifies data gaps for determining contaminant nature, extent, and migration sufficiently to develop and evaluate alternative cleanup actions for the Site in the FS. A significant amount of investigation has been completed on the Site to date, as summarized in Section 6; that data will be incorporated into the RI and supplemented with additional investigation data that will be collected to address data gaps identified below.

No indoor air or soil gas samples have been collected at the Site. No regularly occupied structures currently exist; therefore, VI is not considered a currently complete exposure pathway. PSLs for groundwater consider VI (see Section 5) and the proposed exploration program is designed to establish boundaries of groundwater contamination exceeding VI-based screening levels. The potential for VI in future developments can sufficiently be evaluated based on soil and groundwater data, using VI-based groundwater screening levels and, if necessary, on soil-to-indoor air modeling using the Johnson-Ettinger model, in accordance with draft Ecology vapor intrusion guidance (Ecology, 2009). FS alternatives will consider remedies that either remediate surface soil and shallow groundwater to be protective of VI or include institutional/engineering controls to mitigate VI concerns for future structures in the affected area. Therefore, air or soil gas characterization at the Site has not been proposed for the RI.

A summary of data gaps for completing the RI and FS is provided below, organized by the type and purpose of the data. Activities proposed to fill these data gaps are presented in Section 9.

7.1 Extent of Contamination Data Gaps

7.1.1 TPH and BTEX

Data gaps include the following:

- The northern extent of gasoline and diesel in surface soils to the north of 709 property, in the vicinity of 709-BH-05 and -06;
- The southern extent of gasoline-range TPH and BTEX in saturated soil and groundwater south of the 721 property, including near the shoreline;
- Gasoline-and diesel-range TPH and BTEX in soil and groundwater east of the 721 property along the shoreline and in groundwater discharging to the Hylebos Waterway;
- Gasoline-range TPH, diesel-range TPH, and BTEX in groundwater and soil in the Alexander Avenue right-of-way and between the tank farm properties and the 500 property to the west;

- The westerly and southerly extent of gasoline-range TPH, diesel-range TPH, and BTEX in groundwater and soil west of former UST N-11 located on the 500 property;
- The presence of gasoline- and diesel-range TPH and BTEX in the central and south-central area of the 721 property (near the fuel loading rack and tanks 6, 7, 8, 9, and 11) in saturated soil and groundwater;
- Concentration trends of gasoline-range TPH and BTEX in groundwater over time where high levels of contamination have been detected in the past (e.g., 709-MW09, 721-MW2 and 721-MW15-15);
- The potential for historical releases of gasoline- and diesel-range TPH during loading or unloading operations at the docks to have impacted nearshore sediments;
- If TPH is detected in sediments above the TPH screening level, the acceptable concentration of TPH in sediments for marine life protection needs to be determined; and
- If TPH is detected in groundwater discharging to the Hylebos, the acceptable concentration of TPH in groundwater for marine life protection needs to be determined so that a groundwater cleanup level for protection of surface water can be determined.

7.1.2 Lead

Data gaps include the following:

- Lead distribution in soil in the center of 721 tank farm area;
- Lead distribution in surface soil on the 709 property between 709-BH-04 and HC-TP-02-93; and
- The extent of lead in surface soil south of the 721 property near 721-BH-03 and 721-MW10.

7.1.3 Chlorinated VOCs

Data gaps include the following:

- Distribution of CVOCs in soil and groundwater, particularly in the 25-foot zone, between the 709 tank farm area and the 709 embankment fill area; and
- Distribution of CVOCs in soil and groundwater, particularly in the 15-foot zone, in the west central portion of the 721 property near Former Tank 11 and the SW corner of the Former USAF Sludge Area.

7.1.4 LNAPL

Data gaps include the following:

- LNAPL presence and thickness at Site monitoring wells; and
- LNAPL occurrence in the center of the 721 property.

7.2 Contaminant Fate-and-Transport Data Gaps

Data gaps for contaminant fate and transport include the following:

- Natural organic carbon content of soil in the fill and native units;
- Conduciveness of conditions for natural attenuation of petroleum hydrocarbons or CVOCs, including in and outside areas of elevated pH; and
- Seasonal and longer-term trends in contaminant concentrations in groundwater.

8 Feasibility Study Approach

This section introduces an overview of the anticipated Site FS process and identifies additional data warranted to complete the FS.

8.1 Feasibility Study Approach

The FS will develop and evaluate remedial alternatives to address contaminants originating from historical petroleum handling operations on the properties. The FS will consider how the presence of Site contaminants potentially comingled with those originating from the OCC Site will impact potential Site remedial actions and also the potential impact of Site remedial actions on current and future OCC Site actions. The general content and approach of the FS is provided below.

8.1.1 Establish Cleanup Standards

Site-specific cleanup standards will be established in the FS and will subsequently be used to evaluate the sufficiency of cleanup action alternatives. Cleanup standards include cleanup levels and points of compliance.. Cleanup levels will be proposed in the RI to assist the interpretation of the RI data. Remediation levels may be developed in the FS to identify chemical concentrations where different cleanup technologies may be applied. In accordance with WAC 173-340-350(9), cleanup levels will be established for hazardous substances in each medium and for each complete pathway using WAC 173-340-700 through -760. MTCA requires evaluation of cleanup action alternatives that meet the cleanup levels at both standard and conditional points of compliance; the points of compliance will be established in the FS in accordance with WAC 173-340-320 through -360. Remediation levels will be developed, if appropriate, in accordance with WAC 173-340-355.

8.1.2 Identify Applicable or Relevant and Appropriate Requirements (ARARs)

MTCA requires that all cleanup actions comply with applicable local, state, and federal laws, which are defined as “legally applicable requirements and those requirements that the department determines…are relevant and appropriate requirements”. The applicable local, state, and federal laws for the Site will be identified in the FS. The FS Report will include an evaluation of the compliance requirements of all potentially applicable laws and regulations.

8.1.3 Delineate Media Requiring Remedial Action

The results of the RI will be relied upon to identify and delineate the areas and/or volumes of affected media to be included in the evaluation of cleanup action alternatives.

8.1.4 Develop Remedial Action Objectives

Remedial action objectives (RAOs) will be presented in the FS report as the basis for the evaluation of cleanup action alternatives. The RAOs will identify the goals to be achieved by a cleanup alternative to meet cleanup standards and provide adequate protection of human health and the environment. The RAOs are expected to be action-specific and/or media-specific.

8.1.5 Develop Cleanup Action Alternatives

A focused range of applicable cleanup action alternatives will be developed for the Site. The objective of the FS process is to develop a range of technically feasible cleanup action alternatives for detailed analysis.

The FS will include a preliminary screening of technologies based on potential relative effectiveness, implementability, and cost, and their potential applicability to the Site. Aspect will assemble potentially applicable technologies into remediation alternatives and screen potential remediation alternatives to determine which meet the minimum requirements of MTCA for cleanup. For this Site, it is expected that most cleanup action alternatives will consist of a combination of remediation technologies and regulatory mechanisms. Potential remediation alternatives will be discussed with Ecology before identifying remedial alternatives retained for detailed analysis. The remaining cleanup action alternatives developed for further evaluation will protect human health and the environment by eliminating, reducing, or otherwise controlling risks posed through each exposure pathway and migration route, as required by WAC 173-340-350.

8.1.6 Conduct Detailed Analysis of Cleanup Action Alternatives

The primary criteria for evaluating the cleanup action alternatives are the minimum requirements established by MTCA. As defined in WAC 173-340-360, the selected cleanup action must meet the minimum “threshold” requirements as follows:

- Protect human health and the environment;
- Comply with the cleanup standards (WAC 700 through 173-340-760);
- Comply with applicable local, state, and federal laws; and
- Provide for compliance monitoring (WAC 173-340-410, and 720 through 173-340-760).

Additionally, the selected cleanup action will:

- Use permanent solutions to the maximum extent practicable (as defined in WAC 173-340-360(3));
- Provide for a reasonable restoration timeframe (as defined in WAC 173-340-360(4)); and
- Consider public concerns (WAC 173-340-600).

8.1.7 Disproportionate Cost Analysis

MTCA defines a permanent solution as one in which cleanup standards can be met without further action. To determine whether a cleanup action alternative is permanent to the “maximum extent practicable”, MTCA requires that a disproportionate cost analysis (DCA) be conducted (WAC 173-340-360(3)(b)). A comparative analysis of the cleanup action alternatives is conducted using the following evaluation criteria in the DCA:

- **Protectiveness—**Overall protectiveness of human health and the environment;
- **Permanence—**The degree to which the alternative permanently reduces the toxicity, mobility, or volume of hazardous substances;
- **Cost—**The cost to implement the alternative;
- **Effectiveness over the Long Term—**The degree of certainty, the reliability of the alternative, the magnitude of residual risk, and the effectiveness of controls;
- **Management of Short-term Risks—**The risk to human health and the environment associated with implementation of the cleanup action alternative;
- **Technical and Administrative Implementability—**Technical feasibility of the cleanup action alternative and administrative and regulatory requirements; and
- **Consideration of Public Concerns—**Whether the community has concerns regarding the alternative and, if so, the extent to which the alternative addresses those concerns.

The evaluation will provide the basis for selection of a preferred cleanup action, which may include one or more of the alternatives evaluated. In accordance with MTCA, preference will be given to the cleanup action alternative that uses permanent solutions to the maximum extent practicable. If the preferred cleanup action alternative is clearly the most permanent, a DCA may not be conducted.

8.2 Feasibility Study Data Gaps

Table 8.1 summarizes common remedial technologies for addressing petroleum and related contaminants in soil and groundwater[5]. This table also includes an initial screening of the effectiveness, implementability, and cost of each technology and site-specific applicability to assist the identification of FS-related data needs.

To assemble technologies into remedial alternatives and conduct a detailed analysis of alternatives typically requires a good understanding of contaminant distribution and extent, including the extent of contaminant source area hot spots. In addition, valuable site-specific information for potentially applicable technologies may include:

- Geotechnical data, for developing excavation and shoring plans;
- Geochemical data and contaminant concentration trends, to evaluate ongoing natural attenuation and the potential for monitored natural attenuation (MNA) with or without bioremediation enhancements to be a feasible technology; and
- LNAPL recoverability, to determine potential volumes and applicable techniques for LNAPL recovery.
- Based on our current understanding of the Site, the existing data in combination with data to be collected to address the previously noted RI data gaps are

[5] If a source of cVOCs from petroleum-handling operations is identified during the RI that requires remedial action, the FS will also evaluate technologies for addressing cVOCs

sufficient to assemble and evaluate remedial alternatives for the Site. The tank farm properties and surrounding area have been the subject of previous geotechnical studies, which should provide adequate geotechnical information for the FS. However, additional data that would be useful for the FS includes thickness and recoverability of LNAPL at Site wells containing free product.

Additional technology-specific data needs may be identified as more data is collected and FS alternatives are developed. These may include Site characterization data or bench or pilot testing of potential remedial technologies as the effectiveness of many technologies, particularly *in situ* technologies, is site-specific.

9 Proposed Data Collection to Address Data Gaps

Proposed data collection activities and the objectives of additional data collection are as follows:

- **Direct-push soil and groundwater sampling**, to fill data gaps regarding the extent of TPH, BTEX, 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 plume boundaries and fill data gaps regarding long-term trends in groundwater quality;
- **LNAPL monitoring and recovery testing,** to fill data gaps regarding the 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.

Proposed exploration locations are shown on Figure 9.1. Work to accomplish each objective is summarized below and the techniques and QA/QC procedures to be employed in the work are described in the Sampling and Analysis Plan provided as Appendix A.

9.1 Direct-Push Soil and Groundwater Sampling

A direct-push investigation would be conducted to address the following data gaps:

- The extent of gasoline-range TPH, BTEX, and lead south of the 721 property;
- The extent of gasoline-range TPH, diesel-range TPH, and BTEX in the Alexander Avenue right-of-way east of the property and its potential continuity with contamination around former UST N-11 on the 500 property;
- The westerly extent of gasoline-range TPH, diesel-range TPH, and BTEX on the 500 property;
- The northerly extent of gasoline- and diesel-range TPH north of the 709 property;
- The extent of gasoline- and diesel-range TPH and BTEX along the shoreline east of the 721 property, and in the northeast corner of the 905 property;
- The extent of gasoline- and diesel-range TPH, BTEX, and lead in the center and south of the 721 tank farm area;

- The extent of lead and CVOCs east of the 709 tank farm area;
- The extent of CVOCs in the west-central portion of the 721 tank farm area; and
- The organic carbon content of fill and native soils.

The direct-push investigation would provide a preliminary assessment of contaminated groundwater extent. After the direct-push investigation is completed, a set of new monitoring wells would then be installed to confirm the direct-push data and provide permanent boundary monitoring points (see Section 9.2).

9.1.1 Gasoline-Range TPH, BTEX, CVOCs, Lead, and Organic Carbon

The direct-push investigation for TPH, BTEX, lead, and organic carbon characterization would be conducted as follows:

- Advance soil borings to a depth of 24 feet[6]. Continuous core soil samples would be collected for logging soil lithology and inspected for evidence of contamination based on sheen, odor, staining, and VOC presence as measured with a photoionization detector (PID). One soil sample would be collected for chemical analysis from soil exhibiting the highest level of potential contamination in each of three depth intervals: 0 to 5 feet (unsaturated zone), 5 to 15 feet, and 15 to 24 feet. If evidence of contamination is detected at the bottom of the boring, the boring would be extended deeper until no evidence of contamination is observed, at which point a final soil sample will be collected to define the vertical extent of contamination. Up to four soil samples would be collected from each boring and archived for potential analysis for organic carbon. Borings would be abandoned using pressurized grout to prevent compromising confining layers between the 15-foot and 25-foot groundwater zones.
- Groundwater samples would be collected from two depth intervals at each direct push soil boring: one from approximately 8 to 12 feet deep (corresponding to the 15-foot groundwater zone), and one from approximately 20 to 24 feet deep (corresponding to the 25-foot groundwater zone). Groundwater would be sampled with a peristaltic pump. Water levels and field parameters (pH, temperature, dissolved oxygen, and conductivity) would be recorded for each sample.
- Soil samples would be submitted from each boring for analysis of the following:
  - TPH by Ecology Method NWTPH-G and NWTPH-Dx; and
  - VOCs by EPA Method 8260.
- Groundwater samples would be submitted from each boring for analysis of the following:
  - TPH by Ecology Method NWTPH-G; and
  - VOCs by EPA Method 8260.

[6] Soil borings to the north of the 709 property will be extended to a depth of 15 feet since only shallow soil impacts have been observed in this area.

- Soil samples in three areas: 1)the upper 15 feet from borings on the eastern portion of the 709 property;2) south of 721-BH-03; and 3) southeast of 721-BH-05 will also be submitted for lead analysis by EPA Method 6010. Groundwater samples will from the eastern portion of the 709 property (Borings B-112, 113, and 114) will also be analyzed for lead by EPA Method 6010. Soil will be analyzed for total lead and groundwater samples will be field-filtered and analyzed for dissolved lead. Soil samples will be archived for potential analysis of organic lead and the sample with the highest total lead concentration in each area will be analyzed for organic lead.

If clear evidence of contamination (strong odors, sheens, or product) is observed at a boring that is intended to identify a boundary (i.e., to the south of the 721 property or west on the 500 property), a “step-out” boring would be advanced approximately 50 feet away (dependent upon access/utility constraints). To facilitate rapid follow up, potential step-out boring locations will be identified prior to conducting utility clearances for the field program.

Following the receipt and review of laboratory data from the soil borings, the draft data will be transmitted to Ecology. If chemical data indicate additional borings are needed, the drill rig will be remobilized and additional step-out borings will be advanced at locations to be discussed with Ecology.

After TPH and VOC data is received, approximately 10 soil samples from a variety of intervals without significant detectable contamination would be analyzed for total organic carbon (TOC) by EPA Method 415.1.

9.2 Groundwater Monitoring

Groundwater monitoring would be conducted to address the following data gaps:

- Confirming boundaries of gasoline-range TPH and BTEX in groundwater as identified by historical groundwater data and the direct-push investigation;
- Confirm boundaries of diesel-range TPH in groundwater as identified by historical groundwater data and to the south of the 721 property;
- Provide additional delineation of the CVOC plume; and
- Provide additional characterization of seasonal variability and long-term trends in contaminant concentrations.

Work would be conducted in three phases:

- Installation and development of additional monitoring wells;
- Sampling of new and a subset of existing monitoring wells (at least 1 week after development in accordance with Section A2.3 of the SAP); and
- Ongoing monitoring of groundwater quality and water levels at key well locations to track long-term trends and seasonal variations. A Work Plan addendum describing the groundwater monitoring program will be prepared after the data from the first round of monitoring is received.

9.2.1 Monitoring Well Installation and Development

After the direct-push investigation is completed, additional monitoring wells would be installed to confirm plume boundaries in two areas:

- West of the former UST on the 500 property: approximately two monitoring wells—one at the 15-foot zone and one in the 25-foot zone; and
- East of the 721 property: approximately 2 monitoring wells – one at the 15-foot zone and one at the 25-foot zone;
- South of the 721 property: approximately six monitoring wells—three at the 15-foot zone and three at the 25-foot zone.

Preliminary locations are shown on Figure 9.1; final locations will be determined in consultation with Ecology after direct-push investigation data is received. Well locations will be documented in a memorandum at that time. Monitoring wells will be installed using a direct-push drill rig with 2-inch-diameter, pre-packed screens, and developed after installation.

9.2.2 Groundwater Sampling

New monitoring wells will be sampled after development and select existing wells will be sampled at the same time. Subsequent monitoring will be conducted at a subset of wells (to be determined based on initial sampling results) to provide additional data for seasonal and long-term trend analysis. The initial set of monitoring wells to be sampled are shown on Figure 9.2 (15-foot zone) and Figure 9.3 (25-foot-zone).

Monitoring wells will be sampled using a peristaltic pump and low-flow sampling techniques in accordance with the SAP. Water levels and field parameters (temperature, pH, conductivity, and dissolved oxygen) will be recorded at each well and will be tabulated for inclusion in the RI report. Groundwater samples will be analyzed for the following:

- TPH by Ecology Methods NWTPH-G and NWTPH-Dx (with silica gel cleanup);
- VOCs by EPA Method 8260; and
- Dissolved lead by EPA Method 6010. A subset of samples will also be tested for total lead by EPA Method 6010.

A subset of monitoring wells along two east-west transects, one along the 709 property (709 MW-12-15, 709MW9-15, 709MW9-25, 709MW20-15, 709MW20-25) and one on the 721 property (HC-N11-6, 721-MW12-15, 721-MW12-25, MW107-15, MW-110-15, MW-110-25), will also be analyzed for the following natural attenuation parameters:

- Ferrous iron and dissolved manganese;
- Nitrate/nitrite;
- Sulfate;
- Alkalinity;
- Dissolved gases (methane, ethane, ethane); and

- Total organic carbon.

9.3 LNAPL Characterization

LNAPL characterization would be conducted to address the following data gaps:

- LNAPL presence and thickness at Site monitoring wells;
- LNAPL occurrence in the center of the 721 property; and
- LNAPL recoverability.

Work would be conducted in three phases:

- Installation of new monitoring wells;
- Seasonal monitoring of LNAPL thickness at monitoring wells within the area where LNAPL indicators have been observed; and
- Conducting LNAPL recovery tests at up to three wells with the most significant LNAPL thicknesses.

9.3.1 Monitoring Well Installation and Development

Two soil borings would be advanced in the center of the 721 property, at locations shown on Figure 9.1, to a depth of 15 feet. Continuous core soil samples would be collected for logging soil lithology; and inspected for evidence of contamination based on sheen, odor, staining, LNAPL based on observations of product; and VOC presence as measured with a PID. Soil samples will be collected and analyzed in accordance with Section 9.1.1.The boring would then be completed as a monitoring well with 10 feet of 2-inch-diameter, pre-packed screen placed across the water table.

9.3.2 LNAPL Monitoring

All monitoring wells in the 15-foot zone within the area of LNAPL indicators (see Figure 6.5-1) will be monitored for LNAPL presence during wet and dry seasons. If LNAPL is observed, the thickness will be recorded.

9.3.3 LNAPL Recovery

LNAPL thicknesses are typically greatest during the dry season when water levels are lowest. Up to three wells will be selected for LNAPL recovery testing based on the results of dry season LNAPL monitoring. Recovery testing will be performed during the dry season as follows:

- The initial thickness will be measured;
- LNAPL will be removed down to a sheen using a peristaltic pump, absorbent sock, or other method;
- The rate of LNAPL recovery will be measured. The frequency of monitoring will depend upon the rate of recovery; and
- Once LNAPL approaches its initial thickness or is no longer significantly accumulating in the well, LNAPL will be removed and the rate of recovery measured one more time.

9.4 Sediment Sampling

- Sediment sampling will be conducted in the Hylebos Waterway to address the data gap regarding the potential for sediment impacts resulting from historical petroleum releases at the Site docks and from groundwater discharging from the Site uplands.

To address this data gap, approximately 13 surface sediment samples will be collected adjacent to the docks and shoreline and 2 surface sediment samples will be collected at locations away from the docks and potential area of shoreline impacts to evaluate potential area background. Sample locations are shown on Figure 9.1. This includes a “background” sample SS-Background-1, located along the shoreline south of the area of estimated Site impacts (to be verified by upland probes prior to collection). A second background sample, SS-Background-2, will be collected farther away from the Site, along the western shoreline of the Hylebos by the 11th Street Bridge, reoccupying a historical 4-point composite sample location performed during the bridge rehabilitation project (sample location map and previous chemistry data provided in Appendix F; sample coordinates provided in Appendix A). Sediment samples in the intertidal zone will be collected using hand tools during low tide, and sediment samples beyond the MLLW will be collected using a Van Veen sediment sampler. One sample from each location will be analyzed, as follows:

- TPH by Ecology Methods NWTPH-G and NWTPH-Dx on rush turnaround time;
- VOCs by EPA Method 8260;
- PAHs by EPA Method 8270 and
- TOC.

One sediment sample from each location will be archived for potential bioassay analysis. If any sediment samples exceed preliminary sediment screening levels for TPH and are above the area background samples, up to five of the highest concentration samples will be submitted for bioassay analysis. The decision on bioassay testing, and which samples would be tested, would be made in consultation with Ecology after TPH results are received. If chemical and/or bioassay testing indicate site-related contamination is present in surface sediments, sediment core sampling and/or additional surface sediment sampling may be implemented. Sediment core sampling may also be implemented if soil or groundwater data indicate a potential for groundwater plume to be intersecting with and impacting deeper sediments. A Work Plan addendum for additional surface sediment or sediment core sampling would be prepared if warranted.

This sediment sampling will require a Nationwide 6 permit from the USACE. The Port has initiated approval through a Joint Aquatic Resources Permit Application (JARPA), which will also provide exposure of the planned work to DNR, EPA, WDFW, Ecology (shoreline), and the City of Tacoma.

9.5 Seep Sampling

Seep sampling will be conducted to address the following data gap:

- Concentrations of TPH and VOCs in groundwater discharging to the Hylebos Waterway adjacent to the 721 property.
- To address this data gap, two seep samples will be collected along the shoreline as shown on Figure 9.1. Seep samples would be submitted for analysis of the following:
  - VOCs by EPA Method 8260B; and
  - TPH by Ecology Method NWTPH-G and NWTPH-Dx.

Depending on the results of seep sampling, sediment sampling, and soil and groundwater sampling along the shoreline, sediment porewater samples may also be collected using either passive diffusion bags deployed in the sediment or temporary well points driven into shallow sediments. A Work Plan addendum for porewater sampling would be prepared if warranted. Seep and any required sediment porewater sampling will be conducted under an approved Nationwide 6 permit from the USACE, as discussed above in Section 9.4.

10 Schedule and Reporting

Section VII, Item K of the Agreed Order establishes the general RI/FS schedule and reporting requirements. Based on an Agreed Order effective date of October 3, 2013, and an assumed Ecology review duration of 30 days for each major deliverable, the following schedule and reporting requirements are established:

Task	Item	Schedule	Estimated Due Date
A	Draft Chemicals of Concern and Screening Levels Technical Memorandum	45 days from the effective date of the Agreed Order	11/17/2013
A	Final Chemicals of Concern and Screening Levels Technical Memorandum	Draft Memorandum, revised table, and Response to Comments to be included in final RI-FS Work Plan	-
B	Draft RI/FS Work Plan	90 days from the effective date of the Agreed Order	1/1/2014
B	Final RI/FS Work Plan	30 days from receiving Ecology comments on the Draft Work Plan	6/19/2014
C	Begin RI/FS Field Work	30 days from Ecology approval of the Final RI/FS Work Plan	7/7/2014
D	Submit Laboratory Results	15 days from Potentially Liable Persons (PLPs) receipt of laboratory data	(see detailed schedule below)
D	Submit Field Screening results	15 days from conducting field screening	(see detailed schedule below)
E	RI Data Memorandum and Data Spreadsheets	45 days from PLPs receipt of laboratory data	9/19/2015
F	Electronic Data Submittal to EIM	30 days from completion of data validation	9/26/2015
G	Initial Draft RI/FS Report	145 days from completion of field work	12/14 /2015
G	Final Draft RI/FS Report	60 days from receiving Ecology comments on the Draft RI/FS Report	3/13/2016
H	Initial Draft Cleanup Action Plan (CAP)	60 days from Ecology approval of the Final RI/FS Report	6/11/2016
H	Revised Draft CAP	30 days from receiving Ecology comments on the initial Draft CAP	8/10/2016
I	Progress Reports	Monthly	-
I	Meetings	Prior to development of each deliverable report; after field investigation events; upon availability of validated laboratory data; prior to determining alternatives to evaluate in the RI/FS report	-

Anticipated RI/FS Field Work Start Date	7/7/2014

Task	Item	Anticipated Schedule	Due Date
C.1a	Surface Sediment Sampling	2 weeks from field work kick off	7/21/2014
C.1b	Receive TPH results from surface sediment sampling	2 days from sediment sampling	7/23/2014
C.1c	Submit TPH results to Ecology and determine need for bioassay analysis	2 days after receipt of data	7/24/2014
C.2	Seep sampling	2 weeks from field work kick off	7/21/2014
C.3	Direct Push Soil and Groundwater Sampling	5 weeks from field work kick off	8/11/2014
C.4	Receive lab data from surface sediments, seep, soil, and groundwater	2 weeks from sample submittal	8/25/2014
C.5	Submit laboratory results to Ecology	2 weeks from PLP receipt of lab results	9/8/2014
C.6	Receive comments from Ecology on initial laboratory data	1 week from Ecology receipt of laboratory results	9/15/2014
C.7	Install and develop monitoring wells based on Ecology comments	4 weeks from PLP receipt of Ecology comments	10/13/2014
C.8	Sample new and existing monitoring wells	2 weeks from development of new wells	10/27/2014
C.9	Receive lab data from dry season groundwater sampling event	2 weeks from sample submittal	11/10/2014
C.10	Submit laboratory results to Ecology	2 weeks from PLP receipt of lab results	11/24/2014
C.11	LNAPL Recovery Testing	Dry season	10/27/2014
C.12	Sample subset of new and existing monitoring wells (quarterly monitoring:TBD)	3, 6, and 9 months from dry season sampling event	7/24/2015
C.13	Receive lab data from last quarterly groundwater sampling event	2 weeks from sample submittal	8/7/2015

If further investigation, beyond that identified in this Work Plan, is warranted to delineate the nature and extent of hazardous substances at the Site sufficiently to develop and evaluate cleanup action alternatives, the Port and Mariana will develop and submit a scope of work, schedule, and submittal requirements for additional field activities to Ecology for review and approval. In particular, potential work plan addenda identified in this Work Plan, and an approximate schedule, if needed, include:

- Porewater Sampling: after collection and receipt of preliminary data for surface sediment, seep, and direct-push soil and groundwater samples (September 2014).
- Sediment Core Sampling: after collection and receipt of preliminary data for surface sediment, seep, and direct-push soil and groundwater samples (September 2014).
- Groundwater Monitoring: after collection and receipt of preliminary data from the first quarter of monitoring (November 2014).

- Determination of acceptable TPH concentrations in sediments for marine life protection, following the collection of surface sediment samples (September 2014).

In addition, as described in Section 6.3.1, the VI pathway may be re-evaluated after the RI.

11 References

AGI Technologies (AGI) 1995. Petroleum Hydrocarbon Evaluation, 721 Alexander Avenue. October 27, 1995.

Conestoga-Rovers Associates (CRA), 2012a, Comprehensive Supplemental Investigation Work Plan - Groundwater and Sediment Remediation - Occidental Chemical Corporation - Tacoma, Washington. April, 2012.

Conestoga-Rovers Associates (CRA), 2012b, Data Summary Report - 709 And 721 Alexander Avenue. September, 2012.

Conestoga-Rovers Associates (CRA), 2013a, Data Summary Report - 709 And 721 Alexander Avenue. October, 2013.

Conestoga-Rovers Associates (CRA), 2014, Remedial Action Construction Report - Segment 5 And Slip 1- Mouth of the Hylebos Problem Area, Commencement Bay Nearshore/Tideflats Superfund Site - Tacoma, Washington. April 2014.

Cultural Resource Consultants, Inc. (CRC), 2009, Cultural Resources Overview for the Blair-Hylebos Terminal Redevelopment Project. February 18, 2009.

Ecology and Environment 1990. Site Inspection Recommendations, PRI Northwest Inc. Special Study. May 18, 1990.

EPA, 1989, Commencement Bay Nearshore/Tideflats Record of Decision, September 1989.

EPA, 2002, Unilateral Administrative Order for Area 5106 Removal Action, EPA Docket No. CERCLA 10-2002-0064, March 25, 2002.

EPA, 2005, Administrative Order on Consent for Removal Activities Embankment and Area 5106, EPA Docket No. 10-97-0011 CERCLA, as Amended February 1, 2005.

EPA, 2005 b RD/RA Consent Decree, Mouth of Hylebos Problem Area, C05-5103 FDB, March 15, 2005.

GeoEngineers, Inc., 2008, Fast Freight Site, Draft Data Review Summary and Site Investigation Work Plan Memorandum, March 24, 2008.

GeoEngineers, 2010a, Final Report, 721 East Alexander. January 25, 2010.

GeoEngineers, 2010b, Work Plan, 721 East Alexander. April 1, 2010.

Hart-Crowser, Inc., 1974, Geology of the Port of Tacoma.

Hart Crowser, Inc., 2012a, Revised Final UST N-11 Site-Specific Summary Report Addendum, Port of Tacoma UST Remediation Program, Tacoma, Washington, April 27, 2012.

Hart Crowser, Inc., 2012b, Revised Final UST P-24 Site-Specific Summary Report, Port of Tacoma UST Remediation Program, August 6, 2012.

Hart Crowser, Inc., 2012c, UST N-11 Site-Specific Summary Report, Port of Tacoma UST Remediation Program, Tacoma, Washington, August 8, 2012.

Pacific International Engineering, 1999, Hylebos Waterway Potential SMA Sites Habitat Assessment and Evaluation, Presented as Appendix C to EPA 1999 - Hylebos Waterway Pre-Remedial Design Program, Pre-Remedial Design Evaluation Report, Prepared for the Hylebos Cleanup Committee: ASARCO, Elf Atochem North America, General Metals of Tacoma, Kaiser Aluminum & Chemical Corporation, Occidental Chemical Corporation, and the Port of Tacoma, July 23, 1999.

Port of Tacoma, 2013, Technical Memorandum: Preliminary Chemicals of Concern and Screening Levels, Alexander Avenue Petroleum Tank Facilities Site, October 31, 2013.

Serfes, M.E., 1991, Determining the Mean Hydraulic Gradient of Ground Water Affected by Tidal Fluctuations, Ground Water, v. 29, no. 4, July-August 1991.

Torkelson Geochemistry Inc, 2008, Analysis and Evaluation of One Product Sample from Fast Freight – Port of Tacoma Project, March 7, 2008.

Washington State Department of Ecology (Ecology), 2004, Determining Compliance with Method A Cleanup Levels for Diesel and Heavy Oil: Implementation Memo #4. Ecology Publication 04-09-086, June 2004.

Washington State Department of Ecology (Ecology), 2009, Draft Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action. Ecology Publication No. 09-09-047, October 2009.

Washington State Department of Ecology (Ecology), 2010, fact sheet for NPDES Permit WA0037265 – Occidental Chemical Corporation. February, 2010.

Washington State Department of Ecology (Ecology), 2011, Urban Seattle Area Soil Dioxin and PAH Concentrations - Initial Summary Report. Ecology Publication No. 09-09-047, September 2011.

TABLES

Notes for Port of Tacoma Alexandria Avenue Work Plan Tables

BCF – bioconcentration factor

CAS – Chemical Abstracts Service Registry Number

CB/NT SQO – Commencement Bay, Nearshore/Tideflats Sediment Quality Objective

cPAH – carcinogenic polycyclic aromatic hydrocarbon

CPFi – inhalation cancer potency factor

CPFo – oral cancer potency factor

Foc – fraction of organic carbon

Kd – distribution coefficient

Koc – soil organic carbon-water partitioning coefficient

mg/kg – milligrams per kilogram

PAH – polycyclic aromatic hydrocarbon

RfDO – oral reference dose

RfDi – inhalation reference dose

TEQ – toxics equivalent quotient/concentration

ug/L – micrograms per liter

Table 5.1 - Groundwater Preliminary Screening Levels

130097 Alexander Avenue Petroleum Tank Facilities Site
Tacoma, WA

		Parameters for Cross-Media Calculations						Compiled Applicable Screening Values (ug/L): Ecological: Marine Toxicity – ARARs			Calculated		Human Health via Marine Water – ARARs		MTCA Method A	Calculated MTCA Cleanup Levels (applicable if is no sufficiently protective criterion in ARARs)					Human Health via Indoor Air					Modifying Factors				
CAS	Potential Chemical of Concern	Henry's Law constant	Kd	foc	Koc	BCF	CB/NT SQO (mg/kg)	WA State SW Regs (Ch 173-201A WAC) (chronic)	Clean Water Act Section 304(a) (chronic)	National Toxics Rule (40 CFR 131) (chronic)	Cross-Media Groundwater to Marine Sediment	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)	Risk Driver (Carcinogen or 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 Preliminary Groundwater Screening Levels (ug/L)	Occidental site Screening Levels (CRA, 2012)	Difference Code
Petroleum Hydrocarbon Mixtures																														
na	Gasoline	--	--	0.019	--	--	--	--	--	--	--	--	--	--	800	--	--	--	--	--	--	--	--	--	800	-	250	**800**	800	--
na	Diesel	--	--	0.019	--	--	--	--	--	--	--	--	--	--	500	--	--	--	--	--	--	--	--	--	500	-	250	**500**	500	--
na	Heavy Oil	--	--	0.019	--	--	--	--	--	--	--	--	--	--	500	--	--	--	--	--	--	--	--	--	500	-	500	**500**	500	--
Volatile Organics																														
67-64-1	Acetone	0.00159	0.011	0.019	0.575	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	-	20	**--**	--	--
107-13-1	Acrylonitrile	--	--	0.019	--	30	--	--	--	--	--		--	--	--	--	--	--	--	--	160	850	C	160	160	-	0.5	**160**	--	NV (VI)
71-43-2	Benzene	0.228	1.178	0.019	62	5.2	--	--	--	--	--	--	51	71	--	23	1994	567	4986	51	24	230	C	24	24	-	0.5	**24**	71	304(a); VI
67-66-3	Chloroform	0.15	1.007	0.019	53	3.75	--	--	--	--	--	--	470	470	--	--	6914	--	17284	470	12	--	C	12	12	-	1	**12**	470	VI
107-06-2	Dichloroethane -1,2 (EDC)	0.0401	0.722	0.019	38	1.2	--	--	--	--	--	--	37	99	--	59	43210	1484	108025	37	42	--	C	42	37	-	0.5	**37**	--	NV
156-59-2	Dichloroethene - cis 1,2	0.167	0.675	0.019	35.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	-	0.5	**--**	16	No CPF
156-60-5	Dichloroethene - trans 1,2	0.385	0.722	0.019	38	1.58	--	--	--	--	--	--	10000	--	--	--	32818	--	82044	10000	--	250	NC	250	250	-	0.5	**250**	10000	VI
75-35-4	Dichloroethene -1,1	1.07	1.235	0.019	65	5.6	--	--	--	--	--	--	7100	3.2	--	--	23148	--	57870	3.2	--	280	NC	280	3.2	-	0.5	**3.2**	3.2	
100-41-4	Ethylbenzene	0.323	3.876	0.019	204	37.5	0.01	--	--	--	3	3	2100	29000	--	--	6914	--	17284	2100	--	6100	NC	6100	3	-	0.5	**3**	3.1	Seds TOC
98-82-8	Isopropylbenzene (cumene)	--	--	0.019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1600	NC	1600	1600	-	2	**1600**	--	NV (VI)
75-09-2	Methylene Chloride	0.0898	0.19	0.019	10	0.9	--	--	--	--	--	--	590	1600	--	960	172840	24005	432099	590	940	--	C	940	590	-	2	**590**	1600	304(a)
104-51-8	n-Butylbenzene	--	--	0.019	--	--	--	--	--	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	-	0.5	**--**	--	--
103-65-1	n-Propylbenzene	--	--	0.019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	-	2	**--**	--	--
99-87-6	p-Isopropyltoluene	--	--	0.019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	-	0.5	**--**	--	--
135-98-8	sec-Butylbenzene	--	--	0.019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	-	0.5	**--**	--	--
127-18-4	Tetrachloroethene (PCE)	0.754	5.035	0.019	265	31	0.057	--	--	--	11	11	3.3	8.85	--	100	502	2489	1254	3.3	240	100	NC	100	3.3	-	0.5	**3.3**	8.9	304(a)
79-34-5	Tetrachloroethane-1,1,2,2	0.014	1.501	0.019	79	5	--	--	--	--	--	--	4.0	11	--	6.5	--	162	--	4.0	--	--		--	4.0	-	0.5	**4.0**	11	304(a)
108-88-3	Toluene	0.272	2.66	0.019	140	10.7	--	--	--	--	--	--	15000	200000	--	--	19384	--	48460	15000	--	34000	NC	34000	15000	-	0.5	**15000**	640	Tox Chg ?
79-01-6	Trichloroethene (TCE)	0.422	1.786	0.019	94	11	--	--	--	--	--	--	30	81	--	13	118	317	295	30	26	8.4	NC	8.4	8.4	-	0.5	**8.4**	81	304(a); VI
95-63-6	Trimethylbenzene -1,2,4	--	--	0.019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	61	NC	61	61	-	2	**61**	--	NV (VI)
108-67-8	Trimethylbenzene-1,3,5	--	--	0.019	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	-	2	**--**	--	--
75-01-4	Vinyl Chloride	1.11	0.353	0.019	18.6	1.17	--	--	--	--	--	--	2.4	525	--	--	6648	--	16619	2.4	3.5	120	C	3.5	2.4	-	0.5	**2.4**	2.4	--
1330-20-7	Xylenes (Total)	0.279	4.427	0.019	233	--	0.04	--	--	--	9	9	--	--	--	--	--	--	--	--	--	720	NC	720	9	-	0.5	**9**	1600	SQO Calc
Semivolatile Organics																														
117-81-7	Bis-2ethylhexyl Phthalate	4.18E-08	2109	0.019	111000	130	1.3	--	--	--	0.6	0.6	2.2	5.9	--	4	399	89	997	2.2	--	--	--	--	0.6	-	1.0	**0.6**	1*	Seds TOC
86-74-8	Carbazole	6.26E-07	64.41	0.019	3390	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	-	0.2	**--**	--	--
132-64-9	Dibenzofuran	--	--	0.019	--	--	0.54	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	-	0.2	**--**	--	--
84-66-2	Diethyl Phthalate	0.000019	1.558	0.019	82	73	0.2	--	--	--	128	128	44000	120000	--	--	28412	--	71030	28412	--	--	--	--	128	-	0.2	**128**	--	NV
131-11-3	Dimethyl Phthalate	--	--	0.019	--	36	0.16	--	--	--	--	--	1100000	2900000	--	--	--	--	--	1100000	--	--	--	--	1100000	-	0.2	**1100000**	--	NV
87-68-3	Hexachloro 1,3-butadiene	0.334	1020	0.019	53700	2.78	0.011	--	--	--	0.01	0.01	18	50	--	30	187	747	466	18	8.1	--	C	8.1	0.01	-	0.2	**0.2**	0.2*	--
118-74-1	Hexachlorobenzene	0.054	1520	0.019	80000	8690	0.022	--	--	--	0.01	0.01	0.00029	0.00077	--	0.0005	--	--	1	0.00029	--	--	--	--	0.00029	-	0.2	**0.2**	0.2*	--
87-86-5	Pentachlorophenol	0.000001	11.25	0.019	592	11	0.36	7.9	7.9	7.9	32	7.9	3.0	8.2	--	4.9	7071	123	17677	3.0	--	--	--	--	3	-	1	**3.0**	7.9	304(a)
108-95-2	Phenol	0.0000163	0.547	0.019	28.8	1.4	0.42	--	--	--	768	768	8.60E+05	4.60E+06	--	--	4800	--	1388889	4800	--	--	--	--	768	-	0.5	**768**	--	NV
cPAHs																														
56-55-3	Benz(a)anthracene	0.000137	6793	0.019	357537	30	1.6	--	--	--	0.24	0.24	0.018	0.031	--	0.30	--	7.0	--	0.018	--	--	--	--	0.018	-	0.02	**0.02**	0.02	--
50-32-8	Benzo(a)pyrene	0.0000463	18407	0.019	968774	30	1.6	--	--	--	0.09	0.09	0.018	0.031	--	0.03	--	1.0	--	0.018	--	--	--	--	0.018	-	0.02	**0.02**	0.02	--
205-99-2	Benzo(b)fluoranthene	0.00455	23370	0.019	1230000	30	see B(k)F	--	--	--	see B(k)F	see B(k)F	0.018	0.031	--	0.30	--	7.0	--	0.018	--	--	--	--	0.018	-	0.02	**0.02**	0.02	--
207-08-9	Benzo(k)fluoranthene	0.000034	23370	0.019	1230000	30	3.6	--	--	--	0.15	0.15	0.018	0.031	--	2.96	--	74	--	0.018	--	--	--	--	0.018	-	0.02	**0.02**	0.02	--
218-01-9	Chrysene	0.00388	7562	0.019	398000	30	2.8	--	--	--	0.37	0.37	0.018	0.031	--	29.60	--	740	--	0.018	--	--	--	--	0.018	-	0.02	**0.02**	0.02	--
53-70-3	Dibenz(a,h)anthracene	6.03E-07	33993	0.019	1789101	30	0.23	--	--	--	0.007	0.007	0.018	0.031	--	0.03	--	1.0	--	0.018	--	--	--	--	0.007	-	0.02	**0.02**	0.02	--
193-39-5	Indeno (1,2,3-cd)pyrene	0.0000656	65930	0.019	3470000	30	0.69	--	--	--	0.010	0.010	0.018	0.031	--	0.30	--	7.0	--	0.018	--	--	--	--	0.010	-	0.02	**0.02**	0.02	--
na	cPAH (TEQ)							--	--	--	--	--	0.018	0.031	--	0.03	--	1.0	--	0.018	--	--	--	--	0.018	-	0.02	**0.02**	0.02	--

Table 5.1 - Groundwater Preliminary Screening Levels

130097 Alexander Avenue Petroleum Tank Facilities Site
Tacoma, WA

		Parameters for Cross-Media Calculations						Compiled Applicable Screening Values (ug/L): Ecological: Marine Toxicity – ARARs			Ecological: Marine Toxicity – Calculated		Human Health via Marine Water – ARARs		MTCA Method A	Human Health via Marine Water – Calculated MTCA Cleanup Levels (applicable if is no sufficiently protective criterion in ARARs)					Human Health via Indoor Air					Modifying Factors				
CAS	**Potential Chemical of Concern**	**Henry's Law constant**	**Kd**	**foc**	**Koc**	**BCF**	**CB/NT SQO (mg/kg)**	**WA State SW Regs (Ch 173-201A WAC) (chronic)**	**Clean Water Act Section 304(a) (chronic)**	**National Toxics Rule (40 CFR 131) (chronic)**	**Cross-Media Groundwater to Marine Sediment**	**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)	Risk Driver (Carcinogen or 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 Preliminary Groundwater Screening Levels (ug/L)**	Occidental site Screening Levels (CRA, 2012)	Difference Code
	Noncarcinogenic PAHs																													
208-96-8	Acenaphthylene	--	--	0.019	--	--	0.13	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	-	0.02	**--**	--	--
83-32-9	Acenaphthene	0.00636	93.06	0.019	4898	242	0.5	--	--	--	5	5	990	--	--	--	643	--	1607	643	--	--	--	--	5	-	0.02	**5**	643	SQO Calc
120-12-7	Anthracene	0.00267	446.4	0.019	23493	30	0.96	--	--	--	2	2	40000	110000	--	--	25926	--	64815	25926	--	--	--	--	2	-	0.02	**2**	110000	SQO Calc
191-24-2	Benzo(g,h,i)perylene	--	--	0.019	--	--	0.72	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	-	0.02	**--**		SQO Calc
206-44-0	Fluoranthene	0.00066	932.8	0.019	49096	1150	2.5	--	--	--	3	3	140	370	--	--	90	--	225	90	--	--	--	--	3	-	0.02	**3**	90.2	SQO Calc
86-73-7	Fluorene	0.00261	146.4	0.019	7707	30	0.54	--	--	--	4	4	5300	14000	--	--	3457	--	8642	3457	--	--	--	--	4	-	0.02	**4**	640	SQO Calc
90-12-0	Methylnaphthalene-1	--	--	0.019	--	30	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	-	0.02	**--**	--	--
91-57-6	Methylnaphthalene-2	--	--	0.019	--	30	0.67	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	-	0.02	**--**	32	Tox chg?
91-20-3	Naphthalene	0.0198	22.63	0.019	1191	30	2.1	--	--	--	93	93	--	--	--	--	1728	--	4321	1728	--	360	NC	360	93	-	0.02	**93**	160	VI
94-09-7	Phenanthrene	--	--	0.019	--	30	1.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	-	0.02	**--**	--	--
129-00-0	Pyrene	0.000451	1292	0.019	67992	30	3.3	--	--	--	3	3	4000	11000	--	--	2593	--	6481	2593	--	--	--	--	3	-	0.02	**3**	480	SQO Calc
Metals																														
	Heavy Metals																													
7440-38-2	Arsenic	0	29	--	--	44	57	36	36	36	1966	36	0.14	0.14	--	0.10	18	2.0	44	0.14	--	--	--	--	0.14	5.00	0.50	**5.0**	0.5*	Bkgd
7440-50-8	Copper	0	22	--	--	36	390	3.1	3.1	--	17727	3.1	--	--	--	--	2665	--	6662	2665	--	--	--	--	3.1	-	0.1	**3.1**	2.4	NTR NA
7439-92-1	Lead	0	10000	--	--	--	450	8.1	8.1	8.1	45.0	8.1	--	--	--	--	--	--	--	--	--	--	--	--	8.1	-	0.02	**8.1**	8.1	--
7440-02-0	Nickel	0	65	--	--	47	140	8.2	610	8.2	2154	8.2	4600	4600	--	--	1103	--	2758	1103	--	--	--	--	8.2	-	0.2	**8.2**	8.2	--
7440-66-6	Zinc	0	62	--	--	47	410	81	7400	81	6613	81	26000	--	--	--	16548	--	41371	16548	--	--	--	--	81	-	0.5	**81**	81	--
	Organometals																													
78-00-0	Tetraethyl Lead	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	-	0.0005	**--**	0.0008	Tox chg?

-- 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

5 Gray-shaded values are not applicable under MTCA, given that other "sufficiently protective" values are available under other regulations.

Difference Codes:

--	No difference.
304(a)	Site PSLs used Clean Water Act Section 304(a) values as ARARs.
Bkgd	Site PSLs adjusted to local background concentrations when those concentrations exceeded the lowest ARARs and calculated values.
NTR NA	Site PSLs do not use the National Toxics Rule value due to its inapplicability to WA state.
NV	No corresponding value for comparison.
Summed	Individual isomer values summed and therefore not directly comparable.
SQO Calc	Difference appears to be related to calculation using Sediment SQOs.
Tox chg?	Difference appears to be related to changes in underlying toxicity values over time.
VI	Site PSLs include Ecology's draft Vapor Intrusion Tier I screening levels.

Table 5.2 - Soil Preliminary Screening Levels

130097 Alexander Avenue Petroleum Tank Facilities Site
Tacoma, WA

		Compiled Applicable Screening Values (mg/kg)								Modifying Factors				
		MTCA Method A Values (Human Health) (Table 745-1)	MTCA Method C Calculated Values (Human Health)		MTCA Cross-Media (Soil to Groundwater to Surface Water) Calculated Values									
					Unsaturated Soils		Saturated Soils							
CAS	**Potential Chemical of Concern**	Method A Industrial Land Use	Industrial Land Use (carcinogen)	Industrial Land Use (non carcinogen)	Ecological	Human Health	Ecological	Human Health	**Lowest Value, All Receptor Pathways (mg/kg)**	Puget Sound Natural Back-ground Concen-trations	Practical Quanti-tation Limits (PQLs)	**Alexander Avenue Site Preliminary Screening Levels (mg/kg)**	Occidental site Screening Levels; Lowest of Saturated and Un-saturated Soils	Difference Code
Petroleum Hydrocarbon Mixtures														
na	Gasoline	30**	--	--	--	--	--	--	30	--	5	**30**	30	--
na	Diesel	2000**	--	--	--	--	--	--	2000	--	25	**2000**	2000	--
na	Heavy Oil	2000**	--	--	--	--	--	--	2000	--	100	**2000**	2000	--
Volatile Organics														
67-64-1	Acetone	--	--	3150000	--	--	--	--	3150000	--	0.02	**3150000**	--	NV
107-13-1	Acrylonitrile	--	--	--	--	--	--	--	--	--	na	**--**	--	--
71-43-2	Benzene	dw	2386	14000	--	0.3	--	0.02	0.02	--	0.005	**0.02**	0.025	Xmedia
67-66-3	Chloroform	--	--	35000	--	2.5	--	0.2	0.2	--	0.005	**0.2**	0.16	--
107-06-2	Dichloroethane -1,2 (EDC)	--	1442	70000	--	0.2	--	0.01	0.01	--	0.005	**0.01**	--	NV
156-59-2	Dichloroethene - cis 1,2	--	--	35000	--	--	--	--	35000	--	0.005	**35000**	--	NV
156-60-5	Dichloroethene - trans 1,2	--	--	70000	--	54.3	--	3.2	3.2	--	0.005	**3.2**	3.2	--
75-35-4	Dichloroethene -1,1	--	--	175000	--	0.023	--	0.001	0.001	--	0.005	**0.005**	0.001	PQL
100-41-4	Ethylbenzene	dw	--	350000	0.022	18.1	0.0013	1.0	0.0013	--	0.01	**0.01**	0.63	Xmedia
98-82-8	Isopropylbenzene	--	--	350000	--	--	--	--	350000	--	0.02	**350000**	--	NV
75-09-2	Methylene Chloride	dw	17500	210000	--	2.6	--	0.2	0.2	--	0.01	**0.2**	0.48	Xmedia
104-51-8	n-Butylbenzene	--	--	--	--	--	--	--	--	--	na	**--**	--	--
103-65-1	n-propylbenzene	--	--	--	--	--	--	--	--	--	0.02	**--**	--	--
99-87-6	p-Isopropyltoluene	--	--	--	--	--	--	--	--	--	na	**--**	--	--
135-98-8	sec-Butylbenzene	--	--	--	--	--	--	--	--	--	na	**--**	--	--
127-18-4	Tetrachlolorethene (PCE)	dw	62500	21000	0.1	0.04	0.01	0.002	0.002	--	0.005	**0.005**	0.005	--
79-34-5	Tetrachloroethane-1,1,2,2	--	656	--	--	0.022	--	0.001	0.001	--	0.005	**0.005**	0.004	PQL
108-88-3	Toluene	dw	--	280000	--	109.1	--	6.4	6.4	--	0.01	**6.4**	0.27	Xmedia
79-01-6	Trichloroethene (TCE)	dw	2829	1750	--	0.2	--	0.01	0.01	--	0.005	**0.01**	0.031	Xmedia
95-63-6	Trimethylbenzene -1,2,4	--	--	--	--	--	--	--	--	--	na	**--**	--	--
108-67-8	Trimethylbenzene-1,3,5	--	--	--	--	--	--	--	--	--	na	**--**	--	--
75-01-4	Vinyl Chloride	--	--	10500	--	0.015	--	0.0007	0.0007	--	0.005	**0.005**	0.00073	PQL
1330-20-7	Xylenes (Total)	dw	--	700000	0.083	--	0.0047	--	0.0047	--	0.005	**0.005**	0.8315	Xmedia
Semivolatile Organics														
117-81-7	Bis-2ethylhexyl Phthalate	--	9375	70000	1	4.9	0.07	0.24	0.07	--	0.10	**0.1**	0.08	Xmedia
86-74-8	Carbazole	--	--	--	--	--	--	--	--	--	na	**--**	--	--
132-64-9	Dibenzofuran	--	--	7000	--	--	--	--	7000	--	0.0005	**7000**	--	NV
84-66-2	Diethyl Phthalate	--	--	2800000	1	160	0.05	10	0.05	--	0.01	**0.05**	--	NV
131-11-3	Dimethyl Phthalate	--	--	3500000	--	--	--	--	3500000	--	0.01	**3500000**	--	NV
87-68-3	Hexachloro 1,3-butadiene	--	1683	700	0.012	19	0.0006	1.0	0.0006	--	0.01	**0.01**	0.0007	Xmedia
118-74-1	Hexachlorobenzene	--	82	2800	--	0.0005	--	0.00002	0.00002	--	0.010	**0.01**	0.00006	PQL
87-86-5	Pentachlorophenol	--	1094	105000	0.13	0.05	0.007	0.003	0.003	--	0.10	**0.1**	0.007	PQL
108-95-2	Phenol	--	--	1050000	3.5	22	0.2	2	0.2	--	0.03	**0.2**	--	NV

Table 5.2 - Soil Preliminary Screening Levels

130097 Alexander Avenue Petroleum Tank Facilities Site
Tacoma, WA

CAS	Potential Chemical of Concern	Compiled Applicable Screening Values (mg/kg): MTCA Method A Values (Human Health) (Table 745-1): Method A Industrial Land Use	MTCA Method C Calculated Values (Human Health): Industrial Land Use (carcinogen)	MTCA Method C Calculated Values (Human Health): Industrial Land Use (non carcinogen)	MTCA Cross-Media (Soil to Groundwater to Surface Water) Calculated Values: Unsaturated Soils: Ecological	Unsaturated Soils: Human Health	Saturated Soils: Ecological	Saturated Soils: Human Health	Lowest Value, All Receptor Pathways (mg/kg)	Modifying Factors: Puget Sound Natural Back-ground Concen-trations	Modifying Factors: Practical Quanti-tation Limits (PQLs)	Alexander Avenue Site Preliminary Screening Levels (mg/kg)	Occidental site Screening Levels; Lowest of Saturated and Un-saturated Soils	Difference Code
cPAHs														
56-55-3	Benzo(a)anthracene		see TEQ	--	2	0.1	0.08	0.006	0.006	--	0.0005	**0.006**	0.0064	--
50-32-8	Benzo(a)pyrene	dw	see TEQ	--	2	0.3	0.08	0.02	0.02	--	0.001	**0.02**	0.029	Xmedia
205-99-2	Benzo(b)fluoranthene		see TEQ	--	--	0.4	--	0.02	0.02	--	0.001	**0.02**	0.022	--
207-08-9	Benzo(k)fluoranthene		see TEQ	--	4	0.4	0	0.02	0.02	--	0.001	**0.02**	0.022	--
218-01-9	Chrysene		see TEQ	--	3	0.1	0	0.007	0.007	--	0.001	**0.007**	0.007	--
53-70-3	Dibenz(a,h)anthracene		see TEQ	--	0	0.6	0.0	0.03	0.01	--	0.001	**0.01**	0.032	--
193-39-5	Indeno(1,2,3-cd)pyrene		see TEQ	--	1	1.2	0	0.06	0.04	--	0.001	**0.04**	0.062	--
na	cPAH (TEQ)	dw	18	--	--	--	--	--	0.02		0.001	**0.02**	--	NV
Other PAHs														
208-96-8	Acenaphthylene	--	--	--	--	--	--	--	--	--	0.0005	**--**	--	--
83-32-9	Acenaphthene	--	--	210000	0.5	66	0.028	3	0.028	--	0.001	**0.03**	3.3	Xmedia
120-12-7	Anthracene	--	--	1050000	1.0	12285	0.05	617	0.05	--	0.001	**0.05**	2616	Xmedia
191-24-2	Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--	0.0005	**--**	--	--
206-44-0	Fluoranthene	--	--	140000	2.6	89	0.13	4	0.13	--	0.001	**0.1**	4.5	Xmedia
86-73-7	Fluorene	--	--	140000	0.6	547	0.029	28	0.029	--	0.001	**0.03**	0.51	Xmedia
90-12-0	Methylnaphthalene-1	--	--	--	--	--	--	--	--	--	0.001	**--**	--	--
91-57-6	Methylnaphthalene-2	--	--	14000	--	--	--	--	14000	--	0.001	**320**	0.0003	Xmedia
91-20-3	Naphthalene	dw	--	70000	3	--	0.1	--	0.1	--	0.001	**0.1**	0.24	Xmedia
94-09-7	Phenanthrene	--	--	--	--	--	--	--	--	--	0.0005	**--**	--	--
129-00-0	Pyrene	--	--	105000	3	3536	0.2	177	0.2	--	0.001	**0.2**	33	Xmedia
Metals														
Heavy Metals														
7440-38-2	Arsenic	dw	88	1050	21	0.0818	1.05	0.004	0.004	20	0.5	**20**	146	Xmedia
7440-50-8	Copper		--	129500	1.4	1183	0.07	59	0.07	36	0.1	**36**	53.5	Xmedia
7439-92-1	Lead	1000	--	--	1620	--	81	--	81	24	0.05	**81**	81002	Xmedia
7440-02-0	Nickel	70000	--	70000	11	1438	0.5	72	0.5	48	0.2	**48**	535	Xmedia
7440-66-6	Zinc	1050000	--	1050000	101	20586	5.0	1031	5.0	85	0.5	**85**	5045	Xmedia
Organometals														
78-00-2	Tetraethyl Lead	--	0.35	--	--	--	--	--	0.35	--	--	**0.35**	--	Xmedia

Notes:

Occidental Site screening level is 14.6 and 0.8 mg/kg for total xylenes for unsaturated zone and saturated zone soils, respectively.

Denotes value from MTCA Method A Industrial Table where no value is calculated under MTCA Method C. Value based on preventing accumulation of free product.

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.

dw = Site PSLs do not include values based on protection of drinking water.

Difference Codes:

--	No difference.
NV	No corresponding value for comparison.
PQL	Difference due to adjustments to Practical Quantitation Limits (PQLs).
Xmedia	Difference occurs in Site cross-media calculations, in most cases likely due to differences in groundwater PSLs.

Table 5.3 - Sediment Preliminary Screening Levels
130097 Alexander Avenue Petroleum Tank Facilities Site
Tacoma, WA

CAS			CB/NT SQO (mg/kg)
Petroleum Hydrocarbon Mixtures			
na		Gasoline	--
na		Diesel	--
na		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 5.3 - Sediment Preliminary Screening Levels
130097 Alexander Avenue Petroleum Tank Facilities Site
Tacoma, WA

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
94-09-7	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	see B(k)F
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	--

--: CB/NT SQO not available.

Table 5-4 - Calculation Paramaters for Preliminary Site Screening Levels

130097 Alexander Avenue Petroleum Tank Facilities Site
Tacoma, WA

		Parameters for Cross-Media Calculations						Toxicological Parameters					
CAS	Potential Chemical of Concern	Henry's Law constant	Kd	Foc	Koc	BCF	CB/NT SQO (mg/kg)	CPFo	RfDo	CPFi	RfDi	Inhalation Correction Factor	TEQ Multiplier
	Petroleum Hydrocarbons												
na	Gasoline	--	--	--	--	--	--	--	--	--	--	--	--
na	Diesel	--	--	--	--	--	--	--	--	--	--	--	--
na	Heavy Oil	--	--	--	--	--	--	--	--	--	--	--	--
	Volatile Organics												
67-64-1	Acetone	0.00159	0.0006	0.001	0.575	--	--	--	0.9	--	--	2	--
107-13-1	Acrylonitrile	--	--	--	--	30	--	0.54	--				--
71-43-2	Benzene	0.228	0.062	0.001	62	5.2	--	0.055	0.004	0.0273	0.00857	2	--
67-66-3	Chloroform	0.15	0.053	0.001	53	3.75	--	--	0.01	--	--	--	--
107-06-2	Dichloroethane -1,2 (EDC)	0.0401	0.038	0.001	38	1.2	--	0.091	0.02	--	--	--	--
156-59-2	Dichloroethene - cis 1,2	0.167	0.036	0.001	35.5	--	--	--	0.01	--	--	--	--
156-60-5	Dichloroethene - trans 1,2	0.385	0.038	0.001	38	1.58	--	--	0.02	--	--	--	--
75-35-4	Dichloroethene -1,1	1.07	0.065	0.001	65	5.6	--	--	0.05	--	--	--	--
100-41-4	Ethylbenzene	0.323	0.20	0.001	204	37.5	0.01	--	0.1	--	0.286	2	--
98-82-8	Isopropylbenzene	--	--	--	--	--	--	--	0.1	--	--	--	--
75-09-2	Methylene Chloride	0.0898	0.010	0.001	10	0.9	--	0.0075	0.06	0.00	--	2.00	
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)	0.754	0.27	0.001	265	31	0.057	0.0021	0.006	0.00091	0.0114	2	--
79-34-5	Tetrachloroethane-1,1,2,2	0.014	0.079	0.001	79	5	--	0.2	--				--
108-88-3	Toluene	0.272	0.14	0.001	140	10.7	--	0.2	0.08	--	1.43	2	--
79-01-6	Trichloroethene (TCE)	0.422	0.094	0.001	94	11	--	0.0464	0.0005	see notes	see notes	2	--
95-63-6	Trimethylbenzene -1,2,4	--	--	--	--	--	--	--	--	--	--	--	--
108-67-8	Trimethylbenzene-1,3,5	--	--	--	--	--	--	--	--	--	--	--	--
75-01-4	Vinyl Chloride	1.11	0.019	0.001	18.6	1.17	--	--	0.003	--	0.028571	2	--
1330-20-7	Xylenes (Total)	0.279	0.23	0.001	233	--	0.04	--	0.2	--	--	2	--

Table 5-4 - Calculation Paramaters for Preliminary Site Screening Levels

130097 Alexander Avenue Petroleum Tank Facilities Site
Tacoma, WA

		Parameters for Cross-Media Calculations						Toxicological Parameters					
CAS	Potential Chemical of Concern	Henry's Law constant	Kd	Foc	Koc	BCF	CB/NT SQO (mg/kg)	CPFo	RfDo	CPFi	RfDi	Inhalation Correction Factor	TEQ Multiplier
	Semivolatile Organics												
117-81-7	Bis-2ethylhexyl Phthalate	4.18E-08	111	0.001	111000	130	1.3	0.014	0.02	--	--	--	--
86-74-8	Carbazole	--	--	--	--	--	--	--	--	--	--	--	--
132-64-9	Dibenzofuran	--	--	--	--	--	0.54	--	0.002	--	--	--	--
84-66-2	Diethyl Phthalate	0.000019	0.082	0.001	82	73	0.2	--	0.8	--	--	--	--
131-11-3	Dimethyl Phthalate	--	--	--	--	36	0.16	--	1	--	--	--	--
87-68-3	Hexachloro 1,3-butadiene	0.334	54	0.001	53700	2.78	0.011	0.0780	0.0002	--	--	--	--
118-74-1	Hexachlorobenzene	0.054	80	0.001	80000	8690	0.022	1.6000	0.0008	--	--	--	--
87-86-5	Pentachlorophenol	0.000001	0.59	0.001	592	11	0.36	0.12	0.03	--	--	--	--
108-95-2	Phenol	0.0000163	0.029	0.001	28.8	1.4	0.42	--	0.3	--	--	--	--
	cPAHs												
56-55-3	Benzo(a)anthracene	0.000137	358	0.001	357537	30	1.6	0.73	--	--	--	1	0.1
50-32-8	Benzo(a)pyrene	0.0000463	969	0.001	968774	30	1.6	7.3	--	--	--	1	1
205-99-2	Benzo(b)fluoranthene	0.00455	1230	0.001	1230000	30	see B(k)F	0.73	--	--	--	1	0.1
207-08-9	Benzo(k)fluoranthene	0.000034	1230	0.001	1230000	30	3.6	0.07	--	--	--	1	0.1
218-01-9	Chrysene	0.00388	398	0.001	398000	30	2.8	0.01	--	--	--	1	0.01
53-70-3	Dibenz(a,h)anthracene	0.000000603	1789	0.001	1789101	30	0.23	7.30	--	--	--	1	0.1
193-39-5	Indeno(1,2,3-cd)pyrene	0.0000656	3470	0.001	3470000	30	0.69	0.73	--	--	--	1	0.1
na	cPAH (TEQ)	--	--	--	--	--	--	--	--	--	--	--	--
	Other PAHs												
208-96-8	Acenaphthylene	--	--	--	--	--	1.3	--	--	--	--	--	--
83-32-9	Acenaphthene	0.00636	4.9	0.001	4898	242	0.5	--	0.06	--	--	1	--
120-12-7	Anthracene	0.00267	23	0.001	23493	30	0.96	--	0.3	--	--	--	--
191-24-2	Benzo(g,h,i)perylene	--	--	--	--	--	0.72	--	--	--	--	--	--
206-44-0	Fluoranthene	0.00066	49	0.001	49096	1150	2.5	--	0.04	--	--	--	--
86-73-7	Fluorene	0.00261	7.7	0.001	7707	30	0.54	--	0.04	--	--	--	--
90-12-0	Methylnaphthalene-1	--	--	--	--	--	--	--	--	--	--	--	--
91-57-6	Methylnaphthalene-2	--	--	--	--	--	0.67	--	0.004	--	--	--	--
91-20-3	Naphthalene	0.0198	1.2	0.001	1191	10.5	2.1	--	0.02	--	0.000857	2	--
94-09-7	Phenanthrene	--	--	--	--	--	1.5	--	--	--	--	--	--
129-00-0	Pyrene	0.000451	68	0.001	67992	30	3.3	--	0.03	--	--	--	--
	Metals												
	Heavy Metals												
7440-38-2	Arsenic	0	29	--	--	44	57	1.5	0.0003	15.05	--	1	--
7440-50-8	Copper	0	22	--	--	36	390	--	0.037	--	--	--	--
7439-92-1	Lead	0	10000	--	--	--	450	--	--	--	--	--	--
7440-02-0	Nickel	0	65	--	--	47	140	--	0.02	--	--	--	--
7440-66-6	Zinc	0	62	--	--	47	410	--	0.3	--	--	--	--
	Organometals												
78-00-2	Tetraethyl Lead	--	--	--	--	--	--	--	1.0E-07	--	--	2	--

Table 6.1 - Statistical Summary of Existing Soil Data (0- to 30-foot Depth)

130097 Alexander Avenue Petroleum Tank Facilities Site

Analyte	Total Number of Locations with Analysis	Total Number of Samples Analyzed	Total Number of Detections	Minimum Detected Concentration	Maximum Detected Concentration	Preliminary Screening Level	Units	Exceedance Information: No. of Exceedances	Exceedance Frequency (%)	Maximum Exceedance Factor
Petroleum Hydrocarbons										
Gasoline	64	160	67	1.6	14000	30	mg/kg	50	31%	467
Diesel	66	171	115	2	54000	2000	mg/kg	49	29%	27
Heavy Oil	66	168	82	4.1	10000	2000	mg/kg	6	4%	5
Total TPH (D+O Range)	78	207	131	6.1	54390	2000	mg/kg	55	27%	27
Volatile Organics										
Acetone	54	105	18	0.0095	4.1	72000	mg/kg	0	--	--
Acrylonitrile	9	26	0	NA	NA	--	mg/kg	--	--	--
Benzene	113	272	146	0.000078	36	0.02	mg/kg	84	31%	1800
Chloroform	104	357	42	0.004	11	0.16	mg/kg	21	6%	69
Dichloroethane -1,2 (EDC)	54	105	0	NA	NA	0.012	mg/kg	0	--	--
Dichloroethene - cis 1,2	67	268	44	0.00028	2.3	800	mg/kg	0	--	--
Dichloroethene - trans 1,2	66	267	22	0.00033	0.13	3.2	mg/kg	0	--	--
Dichloroethene -1,1	104	338	13	0.00042	0.25	0.005	mg/kg	3	1%	50
Ethylbenzene	113	295	119	0.00014	72	0.01	mg/kg	83	28%	7200
Isopropylbenzene (cumene)	11	28	12	0.0013	6.4	8000	mg/kg	0	--	--
Methylene Chloride	104	362	87	0.0011	5	0.18	mg/kg	34	9%	28
n-Butylbenzene	11	28	12	0.0013	7.1	--	mg/kg	--	--	--
n-Propylbenzene	11	28	15	0.0016	10	--	mg/kg	--	--	--
p-Isopropyltoluene	11	28	13	0.0014	7	--	mg/kg	--	--	--
sec-Butylbenzene	11	28	11	0.0021	3.6	--	mg/kg	--	--	--
Tetrachloroethene (PCE)	104	360	171	0.00024	12	0.005	mg/kg	88	24%	2400
Tetrachloroethane-1,1,2,2	104	332	5	0.0021	3.1	0.005	mg/kg	4	1%	620
Toluene	113	272	151	0.0002	180	6.4	mg/kg	10	4%	28
Trichloroethene (TCE)	104	360	101	0.00021	11	0.01	mg/kg	36	10%	1100
Trimethylbenzene -1,2,4	13	30	12	0.0024	56	--	mg/kg	--	--	--
Trimethylbenzene-1,3,5	13	30	9	0.0022	19	--	mg/kg	--	--	--
Vinyl Chloride	104	332	27	0.00029	0.068	0.005	mg/kg	8	2%	14
Xylene (m)	0	0	0	NA	NA	--	--	--	--	--
Xylene (o)	55	180	72	0.00014	19	0.1	mg/kg	24	13%	190
Xylene (p)	0	0	0	NA	NA	--	--	--	--	--
Semivolatile Organics										
Bis-2ethylhexyl Phthalate	22	63	24	0.12	15	0.1	mg/kg	24	38%	150
Carbazole	6	22	0	NA	NA	--	mg/kg	--	--	--
Dibenzofuran	22	67	12	0.022	7.4	7000	mg/kg	0	--	--
Diethyl Phthalate	22	44	0	NA	NA	0.05	mg/kg	0	--	--
Dimethyl Phthalate	22	44	0	NA	NA	3500000	mg/kg	0	--	--
Hexachloro 1,3-butadiene	43	162	51	0.0011	9.1	0.01	mg/kg	36	22%	910
Hexachlorobenzene	38	155	39	0.0000975	1.4	0.01	mg/kg	31	20%	140
Pentachlorophenol	37	139	22	0.00166	1.5	0.1	mg/kg	14	10%	15
Phenol	22	44	3	0.14	0.43	0.2	mg/kg	1	2%	2

Table 6.1 - Statistical Summary of Existing Soil Data (0- to 30-foot Depth)

130097 Alexander Avenue Petroleum Tank Facilities Site

Analyte	Total Number of Locations with Analysis	Total Number of Samples Analyzed	Total Number of Detections	Minimum Detected Concentration	Maximum Detected Concentration	Preliminary Screening Level	Units	Exceedance Information: No. of Exceedances	Exceedance Information: Exceedance Frequency (%)	Exceedance Information: Maximum Exceedance Factor
Semivolatile Organics: cPAHs										
Benz(a)anthracene	63	225	124	0.00073	8.2	0.006	mg/kg	56	25%	1367
Benzo(a)pyrene	63	225	74	0.00079	8.1	0.02	mg/kg	19	8%	405
Benzo(b)fluoranthene	63	225	84	0.0011	9.4	0.02	mg/kg	30	13%	470
Benzo(k)fluoranthene	61	223	52	0.00087	6.1	0.02	mg/kg	18	8%	305
Chrysene	63	225	123	0.0008	9.8	0.007	mg/kg	70	31%	1400
Dibenz(a,h)anthracene	63	225	49	0.00082	1.6	0.01	mg/kg	17	8%	160
Indeno (1,2,3-cd)pyrene	63	225	58	0.00088	3.6	0.04	mg/kg	16	7%	90
Total cPAHs (TEQ)	63	225	142	0.0016	11	0.02	mg/kg	45	20%	550
Semivolatile Organics: Other PAHs										
Acenaphthylene	63	206	35	0.00079	0.15	--	mg/kg	--	--	--
Acenaphthene	63	229	98	0.00097	6.9	0.03	mg/kg	54	24%	230
Anthracene	63	225	95	0.00059	3.3	0.05	mg/kg	39	17%	66
Benzo(g,h,i)perylene	27	68	11	0.015	3.2	--	mg/kg	--	--	--
Fluoranthene	63	225	121	0.001	16	0.1	mg/kg	35	16%	160
Fluorene	63	229	122	0.00062	14	0.03	mg/kg	56	24%	467
Methylnaphthalene-1	2	2	2	0.14	15	--	mg/kg	--	--	--
Methylnaphthalene-2	63	210	155	0.00051	160	320	mg/kg	0	--	--
Naphthalene	63	230	173	0.00061	51	0.1	mg/kg	70	30%	510
Phenanthrene	63	229	171	0.0016	22	--	mg/kg	--	--	--
Pyrene	63	225	137	0.00076	16	0.2	mg/kg	29	13%	80
Total LPAHs	3	7	7	0.9	19.5	--	mg/kg	--	--	--
Total HPAHs	3	7	7	1.54	82	--	mg/kg	--	--	--
Metals										
Heavy Metals										
Arsenic	64	273	268	0.15	268	20	mg/kg	16	6%	13
Copper	64	273	273	2.98	7070	36	mg/kg	36	13%	196
Lead	80	301	283	0.63	37500	81	mg/kg	63	21%	463
Nickel	64	273	273	0.857	962	48	mg/kg	27	10%	20
Zinc	64	274	269	7.07	2540	85	mg/kg	38	14%	30
Organometals										
Tetraethyl Lead	32	126	6	0.32	2.1	0.35	mg/kg	5	4%	6

Notes:
-- dashes indicate screening level not established
NA = not available

Table 6.2 - Statistical Summary of Existing Soil Data (Greater than 30-foot Depth)

130097 Alexander Avenue Petroleum Tank Facilities Site

Analyte	Total Number of Locations with Analysis	Total Number of Samples Analyzed	Total Number of Detections	Minimum Detected Concentration	Maximum Detected Concentration	Preliminary Screening Level	Units	Exceedance Information: No. of Exceedances	Exceedance Information: Exceedance Frequency (%)	Exceedance Information: Maximum Exceedance Factor
Petroleum Hydrocarbons										
Gasoline	1	2	0	NA	NA	30	mg/kg	0	--	--
Diesel	1	2	0	NA	NA	2000	mg/kg	0	--	--
Heavy Oil	1	2	1	5.2	5.2	2000	mg/kg	0	--	--
Total TPH (D+O Range)	1	2	1	20.7	20.7	2000	mg/kg	0	--	--
Volatile Organics										
Acetone	0	0	0	NA	NA	72000	mg/kg	0	--	--
Acrylonitrile	0	0	0	NA	NA	--	mg/kg	--	--	--
Benzene	1	2	2	0.00008	0.0002	0.02	mg/kg	0	--	--
Chloroform	1	2	0	NA	NA	0.16	mg/kg	0	--	--
Dichloroethane -1,2 (EDC)	0	0	0	NA	NA	0.012	mg/kg	0	--	--
Dichloroethene - cis 1,2	1	2	0	NA	NA	800	mg/kg	0	--	--
Dichloroethene - trans 1,2	1	2	0	NA	NA	3.2	mg/kg	0	--	--
Dichloroethene -1,1	1	2	0	NA	NA	0.005	mg/kg	0	--	--
Ethylbenzene	1	2	1	0.00032	0.00032	0.01	mg/kg	0	--	--
Isopropylbenzene (cumene)	0	0	0	NA	NA	8000	mg/kg	0	--	--
Methylene Chloride	1	2	0	NA	NA	0.18	mg/kg	0	--	--
n-Butylbenzene	0	0	0	NA	NA	--	mg/kg	--	--	--
n-Propylbenzene	0	0	0	NA	NA	--	mg/kg	--	--	--
p-Isopropyltoluene	0	0	0	NA	NA	--	mg/kg	--	--	--
sec-Butylbenzene	0	0	0	NA	NA	--	mg/kg	--	--	--
Tetrachloroethene (PCE)	1	2	0	NA	NA	0.005	mg/kg	0	--	--
Tetrachloroethane-1,1,2,2	1	2	0	NA	NA	0.005	mg/kg	0	--	--
Toluene	1	2	2	0.00044	0.00087	6.4	mg/kg	0	--	--
Trichloroethene (TCE)	1	2	0	NA	NA	0.01	mg/kg	0	--	--
Trimethylbenzene -1,2,4	0	0	0	NA	NA	--	mg/kg	--	--	--
Trimethylbenzene-1,3,5	0	0	0	NA	NA	--	mg/kg	--	--	--
Vinyl Chloride	1	2	0	NA	NA	0.005	mg/kg	0	--	--
Xylene (m)	0	0	0	NA	NA	--	--	--	--	--
Xylene (o)	1	2	0	NA	NA	0.1	mg/kg	0	--	--
Xylene (p)	0	0	0	NA	NA	--	--	--	--	--
Semivolatile Organics										
Bis-2ethylhexyl Phthalate	0	0	0	NA	NA	0.1	mg/kg	0	--	--
Carbazole	0	0	0	NA	NA	--	mg/kg	--	--	--
Dibenzofuran	0	0	0	NA	NA	7000	mg/kg	0	--	--
Diethyl Phthalate	0	0	0	NA	NA	0.05	mg/kg	0	--	--
Dimethyl Phthalate	0	0	0	NA	NA	3500000	mg/kg	0	--	--
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	0.2	mg/kg	0	--	--

Table 6.2 - Statistical Summary of Existing Soil Data (Greater than 30-foot Depth)

130097 Alexander Avenue Petroleum Tank Facilities Site

Analyte	Total Number of Locations with Analysis	Total Number of Samples Analyzed	Total Number of Detections	Minimum Detected Concentration	Maximum Detected Concentration	Preliminary Screening Level	Units	Exceedance Information: No. of Exceedances	Exceedance Information: Exceedance Frequency (%)	Exceedance Information: Maximum Exceedance Factor
Semivolatile Organics: cPAHs										
Benz(a)anthracene	1	2	1	0.00073	0.00073	0.006	mg/kg	0	--	--
Benzo(a)pyrene	1	2	0	NA	NA	0.02	mg/kg	0	--	--
Benzo(b)fluoranthene	1	2	0	NA	NA	0.02	mg/kg	0	--	--
Benzo(k)fluoranthene	1	2	0	NA	NA	0.02	mg/kg	0	--	--
Chrysene	1	2	1	0.0009	0.0009	0.007	mg/kg	0	--	--
Dibenz(a,h)anthracene	1	2	0	NA	NA	0.01	mg/kg	0	--	--
Indeno (1,2,3-cd)pyrene	1	2	0	NA	NA	0.04	mg/kg	0	--	--
Total cPAHs (TEQ)	1	2	1	0.0023	0.0023	0.02	mg/kg	0	--	--
Semivolatile Organics: Other PAHs										
Acenaphthylene	1	2	0	NA	NA	--	mg/kg	--	--	--
Acenaphthene	1	2	0	NA	NA	0.03	mg/kg	0	--	--
Anthracene	1	2	0	NA	NA	0.05	mg/kg	0	--	--
Benzo(g,h,i)perylene	0	0	0	NA	NA	--	mg/kg	--	--	--
Fluoranthene	1	2	0	NA	NA	0.1	mg/kg	0	--	--
Fluorene	1	2	0	NA	NA	0.03	mg/kg	0	--	--
Methylnaphthalene-1	0	0	0	NA	NA	--	mg/kg	--	--	--
Methylnaphthalene-2	1	2	2	0.00077	0.0034	320	mg/kg	0	--	--
Naphthalene	1	2	1	0.0012	0.0012	0.1	mg/kg	0	--	--
Phenanthrene	1	2	1	0.004	0.004	--	mg/kg	--	--	--
Pyrene	1	2	1	0.00083	0.00083	0.2	mg/kg	0	--	--
Total LPAHs	0	0	0	NA	NA	--	mg/kg	--	--	--
Total HPAHs	0	0	0	NA	NA	--	mg/kg	--	--	--
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	81	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:

-- dashes indicate screening level not established

NA = not available

Table 6.3 - Statistical Summary of Existing Groundwater Data (0- to 30-foot Depth)

130097 Alexander Avenue Petroleum Tank Facilities Site

								Exceedance Information		
Analyte	Total Number of Locations with Analysis	Total Number of Samples Analyzed	Total Number of Detections	Minimum Detected Concentration	Maximum Detected Concentration	Preliminary Screening Level	Units	No. of Exceedances	Exceedance Frequency (%)	Maximum Exceedance Factor
Petroleum Hydrocarbons										
Gasoline	66	84	65	13	15000	800	ug/L	31	37%	19
Diesel	64	75	41	12	25000	500	ug/L	17	23%	50
Heavy Oil	63	70	15	21	850	500	ug/L	2	3%	2
Total TPH (D+O Range)	65	95	44	39	26250	500	ug/L	24	25%	52
Volatile Organics										
Acetone	81	145	40	1.8	1800	--	ug/L	--	--	--
Acrylonitrile	12	13	5	1.5	31	160	ug/L	0	--	--
Benzene	104	230	131	0.08	3200	24	ug/L	75	33%	133
Chloroform	118	308	58	0.08	16	12	ug/L	7	2%	1
Dichloroethane -1,2 (EDC)	61	115	2	6	13	37	ug/L	0	--	--
Dichloroethene - cis 1,2	103	222	112	0.0696	810	--	ug/L	--	--	--
Dichloroethene - trans 1,2	103	230	51	0.08	39	250	ug/L	0	--	--
Dichloroethene -1,1	118	307	27	0.0795	7	3.2	ug/L	5	2%	2
Ethylbenzene	116	249	107	0.06	1000	3	ug/L	85	34%	333
Isopropylbenzene (cumene)	14	15	12	1.3	33	1600	ug/L	0	--	--
Methylene Chloride	117	300	22	1.9	90	590	ug/L	0	--	--
n-Butylbenzene	14	15	6	1.4	8	--	ug/L	--	--	--
n-Propylbenzene	14	15	10	1.5	58	--	ug/L	--	--	--
p-Isopropyltoluene	14	15	6	0.22	3.8	--	ug/L	--	--	--
sec-Butylbenzene	14	15	8	1.3	5.3	--	ug/L	--	--	--
Tetrachloroethene (PCE)	106	295	157	0.0648	1100	3.3	ug/L	113	38%	333
Tetrachloroethane-1,1,2,2	105	291	10	0.0912	2	4	ug/L	0	--	--
Toluene	116	246	98	0.06	1800	15000	ug/L	0	--	--
Trichloroethene (TCE)	106	295	164	0.1	230	8.4	ug/L	76	26%	27
Trimethylbenzene -1,2,4	14	15	9	1	54	61	ug/L	0	--	--
Trimethylbenzene-1,3,5	14	15	8	0.36	9	--	ug/L	--	--	--
Vinyl Chloride	118	307	76	0.066	270	2.4	ug/L	43	14%	112
Xylene (m)	0	0	0	NA	NA	--	--	--	--	--
Xylene (o)	89	133	48	0.08	56	166	ug/L	0	--	--
Xylene (p)	0	0	0	NA	NA	--	--	--	--	--
Semivolatile Organics										
Bis-2ethylhexyl Phthalate	28	41	4	1.1	7	0.6	ug/L	4	10%	12
Carbazole	10	11	1	1.1	1.1	--	ug/L	--	--	--
Dibenzofuran	31	42	2	1.2	1.8	--	ug/L	--	--	--
Diethyl Phthalate	29	41	6	1	24	128	ug/L	0	--	--
Dimethyl Phthalate	28	39	2	2.7	3.3	1100000	ug/L	0	--	--
Hexachloro 1,3-butadiene	44	107	3	0.00726	0.1	0.2	ug/L	0	--	--
Hexachlorobenzene	40	103	8	0.00753	0.0432	0.2	ug/L	0	--	--
Pentachlorophenol	30	82	6	0.0377	10	3	ug/L	1	1%	3
Phenol	29	47	10	2	81	768	ug/L	0	--	--

Table 6.3 - Statistical Summary of Existing Groundwater Data (0- to 30-foot Depth)

130097 Alexander Avenue Petroleum Tank Facilities Site

								Exceedance Information		
Analyte	Total Number of Locations with Analysis	Total Number of Samples Analyzed	Total Number of Detections	Minimum Detected Concentration	Maximum Detected Concentration	Preliminary Screening Level	Units	No. of Exceedances	Exceedance Frequency (%)	Maximum Exceedance Factor
Semivolatile Organics: cPAHs										
Benz(a)anthracene	67	96	6	0.0029	0.0083	0.02	ug/L	0	--	--
Benzo(a)pyrene	67	96	1	0.007	0.007	0.02	ug/L	0	--	--
Benzo(b)fluoranthene	67	96	4	0.003	0.021	0.02	ug/L	1	1%	1
Benzo(k)fluoranthene	67	96	2	0.0071	0.017	0.02	ug/L	0	--	--
Chrysene	67	96	3	0.0034	0.0078	0.02	ug/L	0	--	--
Dibenz(a,h)anthracene	67	96	5	0.0027	0.021	0.02	ug/L	1	1%	1
Indeno (1,2,3-cd)pyrene	67	96	5	0.0036	0.033	0.02	ug/L	1	1%	2
Total cPAHs (TEQ)	67	96	11	0.011	0.062	0.02	ug/L	2	2%	3
Semivolatile Organics: Other PAHs										
Acenaphthylene	67	96	4	0.004	0.42	--	ug/L	--	--	--
Acenaphthene	67	96	36	0.0088	4.6	5	ug/L	0	--	--
Anthracene	67	96	36	0.0038	0.14	2	ug/L	0	--	--
Benzo(g,h,i)perylene	31	42	0	NA	NA	--	ug/L	--	--	--
Fluoranthene	67	96	8	0.0048	0.026	3	ug/L	0	--	--
Fluorene	68	97	42	0.004	4.7	4	ug/L	2	2%	1
Methylnaphthalene-1	3	3	3	4.2	140	--	ug/L	--	--	--
Methylnaphthalene-2	68	97	57	0.0025	200	--	ug/L	--	--	--
Naphthalene	86	152	70	0.0035	110	93	ug/L	1	1%	1
Phenanthrene	67	96	28	0.0093	3.8	--	ug/L	--	--	--
Pyrene	67	96	14	0.0039	0.073	3	ug/L	0	--	--
Total LPAHs	0	0	0	NA	NA	--	--	--	--	--
Total HPAHs	0	0	0	NA	NA	--	--	--	--	--
Metals										
Heavy Metals - Total										
Arsenic	58	89	69	0.26	570	5	ug/L	35	39%	114
Copper	58	87	66	0.24	2230	3.1	ug/L	43	49%	719
Lead	82	129	86	0.036	34000	8.1	ug/L	34	26%	4198
Nickel	58	83	52	0.2	520	8.2	ug/L	18	22%	63
Zinc	58	87	47	0.84	2270	81	ug/L	13	15%	28
Heavy Metals - Dissolved										
Arsenic	25	96	53	1.2	618	5	ug/L	50	52%	124
Copper	22	93	58	5.9	107	3.1	ug/L	58	62%	35
Lead	48	124	20	0.065	350	8.1	ug/L	5	4%	43
Nickel	22	93	60	11.9	148	8.2	ug/L	60	65%	18
Zinc	22	93	18	0.415	130	81	ug/L	3	3%	2
Organometals										
Tetraethyl Lead	44	46	7	0.00087	0.00599	--	ug/L	--	--	--

Notes:
-- dashes indicate screening level not established
NA = not available

Table 6.4 - Statistical Summary of Existing Groundwater Data (Greater than 30-foot Depth)

130097 Alexander Avenue Petroleum Tank Facilities Site

Analyte	Total Number of Locations with Analysis	Total Number of Samples Analyzed	Total Number of Detections	Minimum Detected Concentration	Maximum Detected Concentration	Preliminary Screening Level	Units	Exceedance Information: No. of Exceedances	Exceedance Information: Exceedance Frequency (%)	Exceedance Information: Maximum Exceedance Factor
Petroleum Hydrocarbons										
Gasoline	23	25	7	13	41	800	ug/L	0	--	--
Diesel	23	25	8	17	64	500	ug/L	0	--	--
Heavy Oil	23	25	2	67	97	500	ug/L	0	--	--
Total TPH (D+O Range)	23	25	8	84	334	500	ug/L	0	--	--
Volatile Organics										
Acetone	12	17	4	5.5	72	--	ug/L	--	--	--
Acrylonitrile	3	3	0	NA	NA	160	ug/L	0	--	--
Benzene	44	57	22	0.08	170	24	ug/L	2	4%	7
Chloroform	52	89	21	0.08	39	12	ug/L	3	3%	3
Dichloroethane -1,2 (EDC)	14	19	0	NA	NA	37	ug/L	0	--	--
Dichloroethene - cis 1,2	49	83	33	0.07	19	--	ug/L	--	--	--
Dichloroethene - trans 1,2	52	89	8	0.11	8.8	250	ug/L	0	--	--
Dichloroethene -1,1	52	90	0	NA	NA	3.2	ug/L	0	--	--
Ethylbenzene	44	57	12	0.05	96	3	ug/L	2	4%	32
Isopropylbenzene (cumene)	3	3	0	NA	NA	1600	ug/L	0	--	--
Methylene Chloride	52	89	5	0.16	0.28	590	ug/L	0	--	--
n-Butylbenzene	3	3	0	NA	NA	--	ug/L	--	--	--
n-Propylbenzene	3	3	0	NA	NA	--	ug/L	--	--	--
p-Isopropyltoluene	3	3	0	NA	NA	--	ug/L	--	--	--
sec-Butylbenzene	3	3	0	NA	NA	--	ug/L	--	--	--
Tetrachloroethene (PCE)	52	89	5	0.07	98	3.3	ug/L	1	1%	30
Tetrachloroethane-1,1,2,2	52	89	0	NA	NA	4	ug/L	0	--	--
Toluene	44	57	25	0.06	26	15000	ug/L	0	--	--
Trichloroethene (TCE)	52	89	18	0.137	75	8.4	ug/L	1	1%	9
Trimethylbenzene -1,2,4	3	3	0	NA	NA	61	ug/L	0	--	--
Trimethylbenzene-1,3,5	3	3	0	NA	NA	--	ug/L	--	--	--
Vinyl Chloride	52	90	20	0.12	220	2.4	ug/L	9	10%	92
Xylene (m)	0	0	0	NA	NA	--	--	--	--	--
Xylene (o)	43	55	6	0.08	14	166	ug/L	0	--	--
Xylene (p)	0	0	0	NA	NA	--	--	--	--	--
Semivolatile Organics										
Bis-2ethylhexyl Phthalate	3	3	0	NA	NA	0.6	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	128	ug/L	0	--	--
Dimethyl Phthalate	3	3	0	NA	NA	1100000	ug/L	0	--	--
Hexachloro 1,3-butadiene	9	38	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	3	ug/L	0	--	--
Phenol	3	3	0	NA	NA	768	ug/L	0	--	--

Table 6.4 - Statistical Summary of Existing Groundwater Data (Greater than 30-foot Depth)

130097 Alexander Avenue Petroleum Tank Facilities Site

Analyte	Total Number of Locations with Analysis	Total Number of Samples Analyzed	Total Number of Detections	Minimum Detected Concentration	Maximum Detected Concentration	Preliminary Screening Level	Units	Exceedance Information: No. of Exceedances	Exceedance Frequency (%)	Maximum Exceedance Factor
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	0.0026	0.0026	0.02	ug/L	0	--	--
Chrysene	23	28	3	0.0038	0.0063	0.02	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	5	ug/L	0	--	--
Anthracene	23	28	3	0.0068	0.039	2	ug/L	0	--	--
Benzo(g,h,i)perylene	3	3	0	NA	NA	--	ug/L	--	--	--
Fluoranthene	23	28	1	0.0048	0.0048	3	ug/L	0	--	--
Fluorene	23	28	15	0.0039	0.027	4	ug/L	0	--	--
Methylnaphthalene-1	0	0	0	NA	NA	--	ug/L	--	--	--
Methylnaphthalene-2	23	28	22	0.0032	0.21	--	ug/L	--	--	--
Naphthalene	25	30	22	0.018	0.68	93	ug/L	0	--	--
Phenanthrene	23	28	16	0.005	0.049	--	ug/L	--	--	--
Pyrene	23	28	6	0.0038	0.0058	3	ug/L	0	--	--
Total LPAHs	0	0	0	NA	NA	--	--	--	--	--
Total HPAHs	0	0	0	NA	NA	--	--	--	--	--
Metals										
Heavy Metals - Total										
Arsenic	36	38	38	0.32	34	5	ug/L	3	8%	7
Copper	37	39	31	0.22	127	3.1	ug/L	15	38%	41
Lead	37	39	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	37	39	12	3.39	156	81	ug/L	3	8%	2
Heavy Metals - Dissolved										
Arsenic	9	38	11	2.03	210	5	ug/L	9	24%	42
Copper	9	38	13	6.5	106	3.1	ug/L	13	34%	34
Lead	9	38	2	2.2	2.8	8.1	ug/L	0	--	--
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:

-- dashes indicate screening level not established

NA = not available

Table 6.5 - Statistical Summary of Existing Sediment Porewater/Seep Data

130097 Alexander Avenue Petroleum Tank Facilities Site

Analyte	Total Number of Locations with Analysis	Total Number of Samples Analyzed	Total Number of Detections	Minimum Detected Concentration	Maximum Detected Concentration	Preliminary Screening Level	Units	Exceedance Information: No. of Exceedances	Exceedance Information: Exceedance Frequency (%)	Exceedance Information: Maximum Exceedance Factor
Petroleum Hydrocarbons										
Gasoline	0	0	0	NA	NA	--	--	--	--	--
Diesel	0	0	0	NA	NA	--	--	--	--	--
Heavy Oil	0	0	0	NA	NA	--	--	--	--	--
Total TPH (D+O Range)	2	3	0	NA	NA	500	ug/L	0	--	--
Volatile Organics										
Acetone	5	6	0	NA	NA	--	ug/L	--	--	--
Acrylonitrile	3	3	0	NA	NA	160	ug/L	0	--	--
Benzene	5	6	0	NA	NA	24	ug/L	0	--	--
Chloroform	9	10	4	1	11	12	ug/L	0	--	--
Dichloroethane -1,2 (EDC)	4	5	0	NA	NA	37	ug/L	0	--	--
Dichloroethene - cis 1,2	4	4	2	17	175	--	ug/L	--	--	--
Dichloroethene - trans 1,2	6	6	4	1.6	58	250	ug/L	0	--	--
Dichloroethene -1,1	8	9	0	NA	NA	3.2	ug/L	0	--	--
Ethylbenzene	9	10	0	NA	NA	3	ug/L	0	--	--
Isopropylbenzene (cumene)	0	0	0	NA	NA	--	--	--	--	--
Methylene Chloride	7	8	3	8	8.8	590	ug/L	0	--	--
n-Butylbenzene	0	0	0	NA	NA	--	--	--	--	--
n-Propylbenzene	0	0	0	NA	NA	--	--	--	--	--
p-Isopropyltoluene	0	0	0	NA	NA	--	--	--	--	--
sec-Butylbenzene	0	0	0	NA	NA	--	--	--	--	--
Tetrachloroethene (PCE)	13	14	10	1	46	3.3	ug/L	6	43%	14
Tetrachloroethane-1,1,2,2	8	9	2	8	400	4	ug/L	2	22%	100
Toluene	5	6	0	NA	NA	15000	ug/L	0	--	--
Trichloroethene (TCE)	13	14	9	1.6	39	8.4	ug/L	4	29%	5
Trimethylbenzene -1,2,4	0	0	0	NA	NA	--	--	--	--	--
Trimethylbenzene-1,3,5	0	0	0	NA	NA	--	--	--	--	--
Vinyl Chloride	9	10	3	4	10	2.4	ug/L	3	30%	4
Xylene (m)	0	0	0	NA	NA	--	--	--	--	--
Xylene (o)	0	0	0	NA	NA	--	--	--	--	--
Xylene (p)	0	0	0	NA	NA	--	--	--	--	--
Semivolatile Organics										
Bis-2ethylhexyl Phthalate	8	9	1	85	85	0.6	ug/L	1	11%	142
Carbazole	0	0	0	NA	NA	--	--	--	--	--
Dibenzofuran	8	9	0	NA	NA	--	ug/L	--	--	--
Diethyl Phthalate	8	9	0	NA	NA	128	ug/L	0	--	--
Dimethyl Phthalate	8	9	0	NA	NA	1100000	ug/L	0	--	--
Hexachloro 1,3-butadiene	8	9	0	NA	NA	0.2	ug/L	0	--	--
Hexachlorobenzene	8	9	0	NA	NA	0.2	ug/L	0	--	--
Pentachlorophenol	8	9	0	NA	NA	3	ug/L	0	--	--
Phenol	9	10	0	NA	NA	768	ug/L	0	--	--

Table 6.5 - Statistical Summary of Existing Sediment Porewater/Seep Data

130097 Alexander Avenue Petroleum Tank Facilities Site

Analyte	Total Number of Locations with Analysis	Total Number of Samples Analyzed	Total Number of Detections	Minimum Detected Concentration	Maximum Detected Concentration	Preliminary Screening Level	Units	Exceedance Information: No. of Exceedances	Exceedance Information: Exceedance Frequency (%)	Exceedance Information: Maximum Exceedance Factor
Semivolatile Organics: cPAHs										
Benz(a)anthracene	8	9	0	NA	NA	0.02	ug/L	0	--	--
Benzo(a)pyrene	8	9	0	NA	NA	0.02	ug/L	0	--	--
Benzo(b)fluoranthene	8	9	0	NA	NA	0.02	ug/L	0	--	--
Benzo(k)fluoranthene	8	9	0	NA	NA	0.02	ug/L	0	--	--
Chrysene	8	9	0	NA	NA	0.02	ug/L	0	--	--
Dibenz(a,h)anthracene	8	9	0	NA	NA	0.02	ug/L	0	--	--
Indeno (1,2,3-cd)pyrene	8	9	0	NA	NA	0.02	ug/L	0	--	--
Total cPAH (TEQ)	7	7	0	NA	NA	0.02	ug/L	0	--	--
Semivolatile Organics: Other PAHs										
Acenaphthylene	8	9	0	NA	NA	--	ug/L	--	--	--
Acenaphthene	8	9	0	NA	NA	5	ug/L	0	--	--
Anthracene	8	9	0	NA	NA	2	ug/L	0	--	--
Benzo(g,h,i)perylene	8	9	0	NA	NA	--	ug/L	--	--	--
Fluoranthene	8	9	0	NA	NA	3	ug/L	0	--	--
Fluorene	8	9	0	NA	NA	4	ug/L	0	--	--
Methylnaphthalene-1	0	0	0	NA	NA	--	--	--	--	--
Methylnaphthalene-2	8	9	0	NA	NA	--	ug/L	--	--	--
Naphthalene	9	10	0	NA	NA	93	ug/L	0	--	--
Phenanthrene	8	9	0	NA	NA	--	ug/L	--	--	--
Pyrene	8	9	0	NA	NA	3	ug/L	0	--	--
Total LPAHs	0	0	0	NA	NA	--	--	--	--	--
Total HPAHs	0	0	0	NA	NA	--	--	--	--	--
Metals										
Heavy Metals - Total										
Arsenic	6	7	1	6.7	6.7	5	ug/L	1	14%	1
Copper	6	7	6	8.3	95.8	3.1	ug/L	6	86%	31
Lead	5	6	6	18.7	260	8.1	ug/L	6	100%	32
Nickel	5	6	4	5.8	114	8.2	ug/L	2	33%	14
Zinc	6	7	3	13	23	81	ug/L	0	--	--
Heavy Metals - Dissolved										
Arsenic	2	3	1	6.6	6.6	5	ug/L	1	33%	1
Copper	4	6	2	3.3	6.6	3.1	ug/L	2	33%	2
Lead	4	6	3	15	219	8.1	ug/L	3	50%	27
Nickel	4	6	3	6.4	7.1	8.2	ug/L	0	--	--
Zinc	4	6	0	NA	NA	81	ug/L	0	--	--
Organometals										
Tetraethyl Lead	0	0	0	NA	NA	--	--	--	--	--

Notes:
-- dashes indicate screening level not established
NA = not available

Table 6.6 - Statistical Summary of Existing Sediment Data

130097 Alexander Avenue Petroleum Tank Facilities Site

Analyte	Total Number of Locations with Analysis*	Total Number of Samples Analyzed*	Total Number of Detections	Minimum Detected Concentration	Maximum Detected Concentration	Preliminary Screening Level	Units	Exceedance Information: No. of Exceedances	Exceedance Information: Exceedance Frequency (%)	Exceedance Information: Maximum Exceedance Factor
Petroleum Hydrocarbons										
Gasoline	6	1	0	NA	NA	--	mg/kg	--	--	--
Diesel	7	2	2	120	290	--	mg/kg	--	--	--
Heavy Oil	0	0	0	NA	NA	--	--	--	--	--
Total TPH (D+O Range)	7	2	2	290	730	--	mg/kg	--	--	--
Volatile Organics										
Acetone	0	0	0	NA	NA	--	--	--	--	--
Acrylonitrile	0	0	0	NA	NA	--	--	--	--	--
Benzene	0	0	0	NA	NA	--	--	--	--	--
Chloroform	6	6	2	0.49	4.82	--	mg/kg	--	--	--
Dichloroethane -1,2 (EDC)	0	0	0	NA	NA	--	--	--	--	--
Dichloroethene - cis 1,2	6	6	2	0.0035	0.217	--	mg/kg	--	--	--
Dichloroethene - trans 1,2	6	6	1	0.0112	0.0112	--	mg/kg	--	--	--
Dichloroethene -1,1	6	6	1	0.00932	0.00932	--	mg/kg	--	--	--
Ethylbenzene	8	3	0	NA	NA	0.01	mg/kg	0	--	--
Isopropylbenzene (cumene)	0	0	0	NA	NA	--	--	--	--	--
Methylene Chloride	6	6	2	0.018	0.021	--	mg/kg	--	--	--
n-Butylbenzene	0	0	0	NA	NA	--	--	--	--	--
n-Propylbenzene	0	0	0	NA	NA	--	--	--	--	--
p-Isopropyltoluene	0	0	0	NA	NA	--	--	--	--	--
sec-Butylbenzene	0	0	0	NA	NA	--	--	--	--	--
Tetrachloroethene (PCE)	14	9	6	0.0027	8.11	0.057	mg/kg	3	33%	142
Tetrachloroethane-1,1,2,2	6	6	1	0.0639	0.0639	--	mg/kg	--	--	--
Toluene	0	0	0	NA	NA	--	--	--	--	--
Trichloroethene (TCE)	14	9	6	0.0021	0.494	--	mg/kg	--	--	--
Trimethylbenzene -1,2,4	0	0	0	NA	NA	--	--	--	--	--
Trimethylbenzene-1,3,5	0	0	0	NA	NA	--	--	--	--	--
Vinyl Chloride	6	6	1	0.0145	0.0145	--	mg/kg	--	--	--
Xylene (m)	0	0	0	NA	NA	--	--	--	--	--
Xylene (o)	0	0	0	NA	NA	--	--	--	--	--
Xylene (p)	0	0	0	NA	NA	--	--	--	--	--
Semivolatile Organics										
Bis-2ethylhexyl Phthalate	8	3	3	0.23	0.5	1.3	mg/kg	0	--	--
Carbazole	0	0	0	NA	NA	--	--	--	--	--
Dibenzofuran	2	2	2	0.028	0.067	0.54	mg/kg	0	--	--
Diethyl Phthalate	2	2	0	NA	NA	0.2	mg/kg	0	--	--
Dimethyl Phthalate	2	2	0	NA	NA	0.16	mg/kg	0	--	--
Hexachloro 1,3-butadiene	14	9	9	0.0038	2.3	0.011	mg/kg	8	89%	209
Hexachlorobenzene	14	9	8	0.0046	0.77	0.022	mg/kg	7	78%	35
Pentachlorophenol	6	6	3	0.086	0.7	0.36	mg/kg	1	17%	2
Phenol	2	2	0	NA	NA	0.42	mg/kg	0	--	--

Table 6.6 - Statistical Summary of Existing Sediment Data

130097 Alexander Avenue Petroleum Tank Facilities Site

Analyte	Total Number of Locations with Analysis*	Total Number of Samples Analyzed*	Total Number of Detections	Minimum Detected Concentration	Maximum Detected Concentration	Preliminary Screening Level	Units	Exceedance Information: No. of Exceedances	Exceedance Frequency (%)	Maximum Exceedance Factor
Semivolatile Organics: cPAHs										
Benz(a)anthracene	8	3	3	0.31	0.91	1.6	mg/kg	0	--	--
Benzo(a)pyrene	8	3	3	0.24	0.61	1.6	mg/kg	0	--	--
Benzo(b)fluoranthene	8	3	3	0.49	1.1	3.6	mg/kg	0	--	--
Benzo(k)fluoranthene	8	3	3	0.42	0.92	3.6	mg/kg	0	--	--
Chrysene	8	3	3	0.51	1.8	2.8	mg/kg	0	--	--
Dibenz(a,h)anthracene	2	2	2	0.052	0.1	0.23	mg/kg	0	--	--
Indeno (1,2,3-cd)pyrene	8	3	3	0.17	0.38	0.69	mg/kg	0	--	--
Total cPAH (TEQ)	2	2	2	0.39	0.97	--	mg/kg	--	--	--
Semivolatile Organics: Other PAHs										
Acenaphthylene	2	2	0	NA	NA	1.3	mg/kg	0	--	--
Acenaphthene	2	2	2	0.024	0.072	0.5	mg/kg	0	--	--
Anthracene	2	2	2	0.091	0.55	0.96	mg/kg	0	--	--
Benzo(g,h,i)perylene	8	3	3	0.1	0.19	0.72	mg/kg	0	--	--
Fluoranthene	8	3	3	0.65	3.5	2.5	mg/kg	1	33%	1
Fluorene	2	2	2	0.03	0.16	0.54	mg/kg	0	--	--
Methylnaphthalene-1	0	0	0	NA	NA	--	--	--	--	--
Methylnaphthalene-2	2	2	1	0.028	0.028	0.67	mg/kg	0	--	--
Naphthalene	2	2	1	0.041	0.041	2.1	mg/kg	0	--	--
Phenanthrene	8	3	3	0.37	0.93	--	mg/kg	--	--	--
Pyrene	8	3	3	0.69	2.3	3.3	mg/kg	0	--	--
Total LPAHs	8	3	3	0.37	1.816	5.2	mg/kg	0	--	--
Total HPAHs	8	3	3	4	11.77	17	mg/kg	0	--	--
Metals										
Heavy Metals										
Arsenic	13	8	8	4.5	70	57	mg/kg	2	25%	1
Copper	13	8	8	26.4	1310	390	mg/kg	1	12%	3
Lead	13	8	8	68.7	130000	450	mg/kg	5	62%	289
Nickel	13	8	8	16.2	80.8	140	mg/kg	0	--	--
Zinc	13	8	8	36	487	410	mg/kg	1	12%	1
Organometals										
Tetraethyl Lead	0	0	0	NA	NA	--	--	--	--	--

Notes:

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

-- 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.

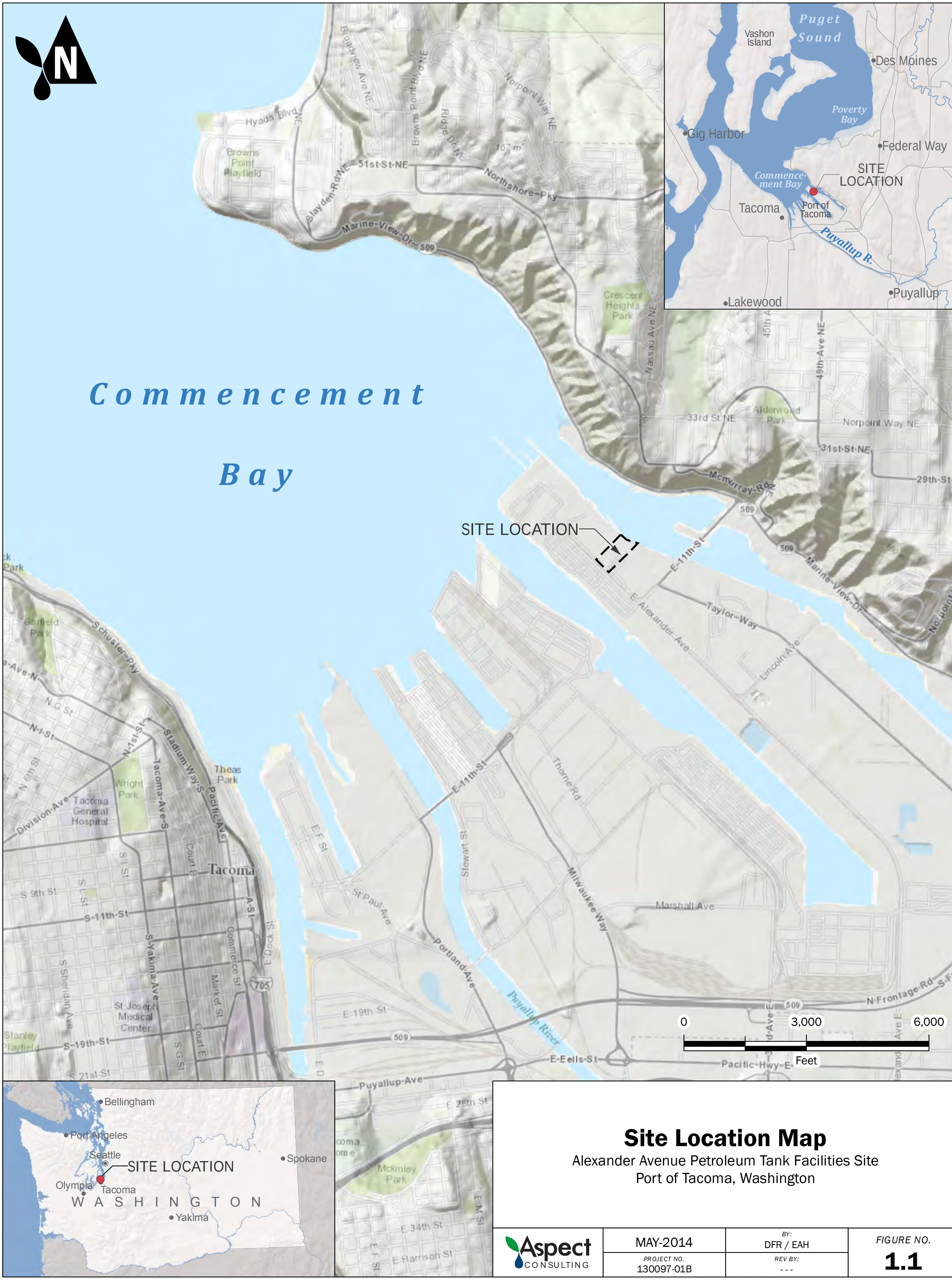
Table 8-1 - Preliminary Screening of Remedial Technologies

Project #130097 - Alexander Avenue Petroleum Facilities Site
Tacoma, Washington

Remedial Technology	Effectiveness	Implementability	Cost	Notes
Soil Vapor Extraction	Low	Low	Medium	Very limited unsaturated zone. Not effective for diesel-range TPH or metals.
Excavation and Off-site Disposal	High	Medium	High	Excavated soil would predominantly be non-hazardous. Excavation of soil with greater than 100 mg/kg lead potentially generates D008 characteristic waste. Phosphate stabilization may be performed to prevent leaching of lead, but phosphate stabilization is less effective at high pH near caustic groundwater. Would likely require shoring and dewatering.
In Situ Solidification	High	High	Medium	Soil amended with cement and/or bentonite to solidify soil and immobilize LNAPL to reduce leaching.
Air Sparging	Medium	Low	Medium	Very shallow groundwater; difficult to capture vapors. Low effectiveness for diesel, not effective for metals. Heterogeneous geology limits effectiveness of treatment of native soils.
In Situ Bioremediation	Medium	High	Medium	Involves aerating soil and groundwater, and can include amending with nutrients and sometimes bioaugmenting with specialized bacterial cultures. Effective for benzene and gasoline-range hydrocarbons, but constrained by anaerobic conditions. Less effective for diesel-range hydrocarbons and free-phase product. Not effective for lead. Would need to consider effect on cVOC plume as aerobic bioremediation may conflict with anaerobic degradation of cVOCs. May be applicable as polishing technology.
Excavation and *Ex-Situ* Bioremediation	Medium	Medium	High	Impacted soil excavated and treated by land farming, biopiles, or windrow piles. Soil is mechanically mixed to aerate and is amended with water, nutrients, and sometimes amplified bacteria to maintain optimal conditions. Biopiles include air injection. Can be used to treat soil to re-use conditions. Increases bioremediation effectiveness, but requires space and up to 24 months of treatment. Does not impact natural attenuation of cVOCs in groundwater.
Monitored Natural Attenuation	Medium	High	Low	Effective for petroleum hydrocarbons; most effective when applied in combination with active technologies
Groundwater Extraction and Treatment	Low	Medium	Medium	Low effectiveness, particularly for low solubility compounds such as diesel. Would likely require long-term operation.
Dual Phase Extraction	Medium	Medium	High	Recoverability of LNAPL unknown. High O&M costs over potentially long operational timeframe.
LNAPL Recovery	Unknown	High	Medium	Extent and recoverability of free-phase LNAPL has not been tested. LNAPL can be captured in shallow trenches and removed by skimming.
Surfactant Enhanced Recovery	Medium	Medium	High	Surfactants are applied to increase the mobility of hydrocarbons to enhance recovery. Without sufficient recovery, surfactants can enhance the release of contamination. Biodegradable surfactants limit long-term impacts.
Impermeable Barriers	Medium	High	Low	Has potential for spreading contamination unless combined with groundwater treatment (e.g., funnel-and-gate permeable reactive barrier) or encircling the contaminated area.
In Situ Thermal Treatment	Medium	Low	High	Not effective for metals. Removal more effective and cheaper than thermal treatment for shallow, accessible petroleum contamination.
Excavation and Low Temperature Thermal Desorption	High	Medium	High	Excavated soil treated on site in mobile unit by heating soil to 200 to 600 degrees Fahrenheit. Volatized contamination would be captured and treated. Reduces concentrations of hydrocarbons by >95%. Effective for sandy soil, but treatment cost increases for clayey soil. Wet soil would preferentially be dried to reduce energy costs. Treated soil would be re-used. Treatment cost likely higher than non-hazardous disposal cost.
Permeable Reactive Barriers	Medium	Medium	Medium	Reactive media/processes can be sequenced or combined to treat mixtures of petroleum, VOCs, and metals. Treatment of petroleum hydrocarbons could either be passive (e.g., GAC) or active (e.g., air injection).
In Situ Chemical Oxidation	Low	Medium	Medium	Typical oxidants for petroleum hydrocarbons include Fenton's reagent and persulfate. Heterogeneous geology reduces effectiveness in native soils. Generally only effective on contact. High natural oxygen demand requires higher dosage of oxidants and decreases longevity of residual oxidants. Chemical oxidation reduces groundwater pH, increasing metal mobility in the short term and potentially oxidizing chromium in the intermediate term. Elevated pH in some areas reduces the effectiveness of chemical oxidation.
Institutional Controls	Medium	High	Low	Generally implementable and effective for industrial sites.

Notes:
cVOC = chlorinated volatile organic compound
GAC = granular activated carbon
LNAPL = light non-aqueous phase liquid
O&M = operations and maintenance
VOC = volatile organic compound

FIGURES

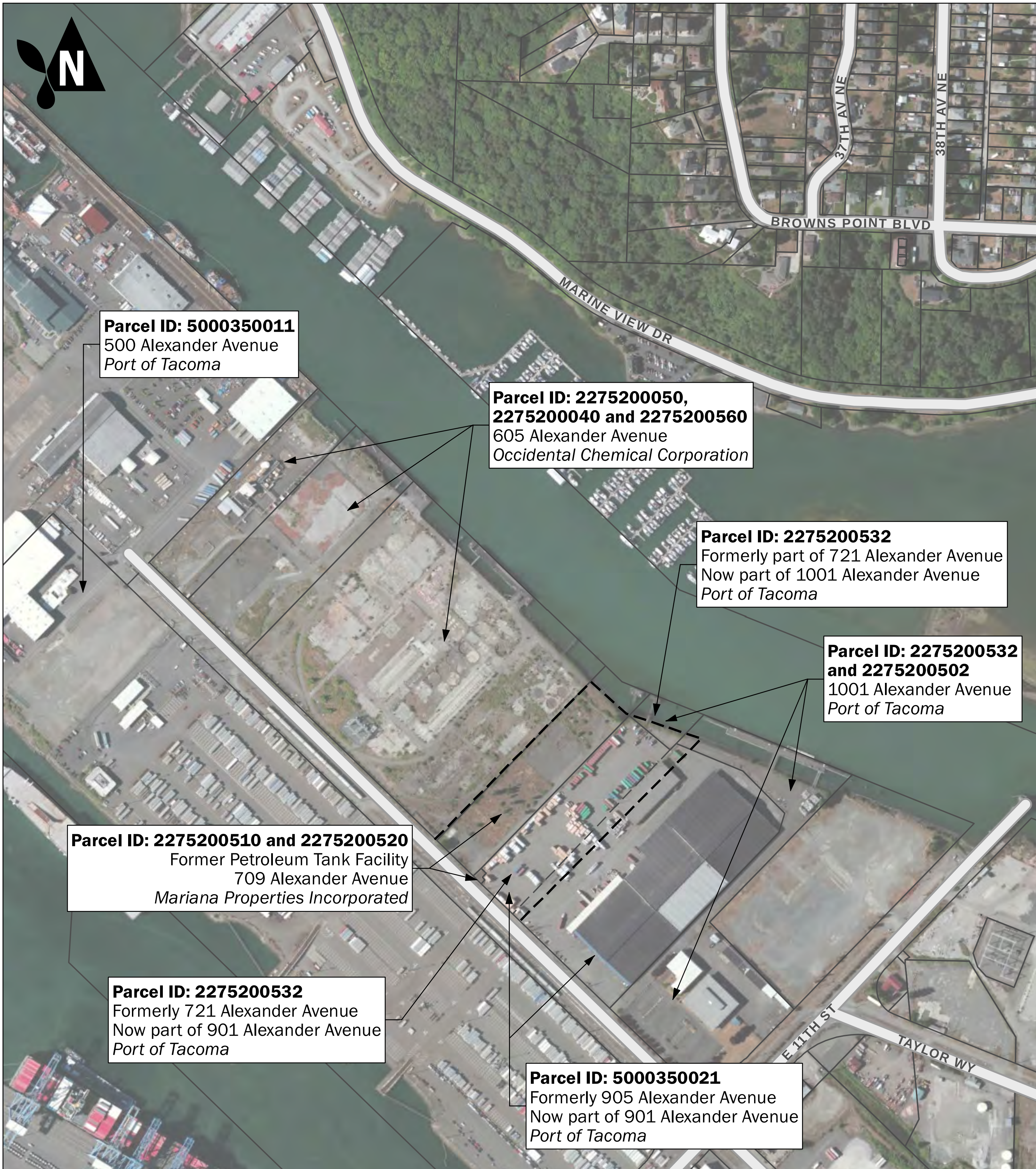


Site Location Map

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING	MAY-2014	BY: DFR / EAH	FIGURE NO.
	PROJECT NO. 130097-01B	REV BY: - - -	1.1

GIS Path: T:\projects_8\Port_of_Tacoma\AlexanderAve_130097\Delivered\FINAL_RIFS_WORKPLAN_JULY2014\1-1 Site Vicinity.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 5/29/2014 || User: ecrumbaker || Print Date: 5/29/2014



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

Subject Properties Outline

Tax Parcel Boundary

Former Parcel Line

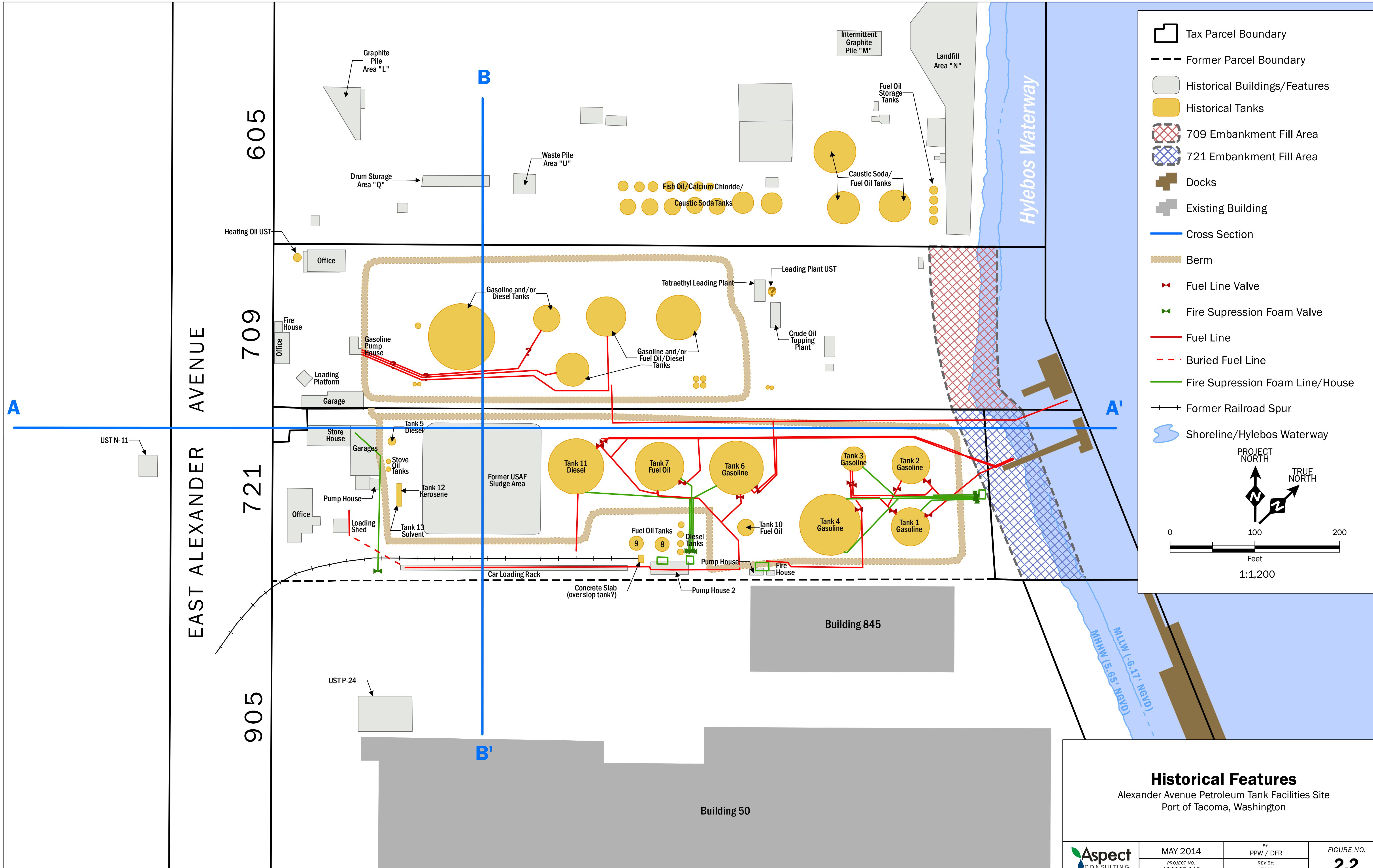
0 500 1,000
Feet

Site Properties Map

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING	MAY-2014	BY: DFR / EAH	*FIGURE NO.*
	PROJECT NO. 130097-01B	*REV BY:* - - -	**2.1**

GIS Path: T:\projects_8\Port_of_Tacoma\AlexanderAve_130097\Delivered\FINAL_RIFS_WORKPLAN_JULY2014\2-1 Site Properties_Aerial.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 5/29/2014 || User: ecumbaker || Print Date: 5/29/2014



Historical Features

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

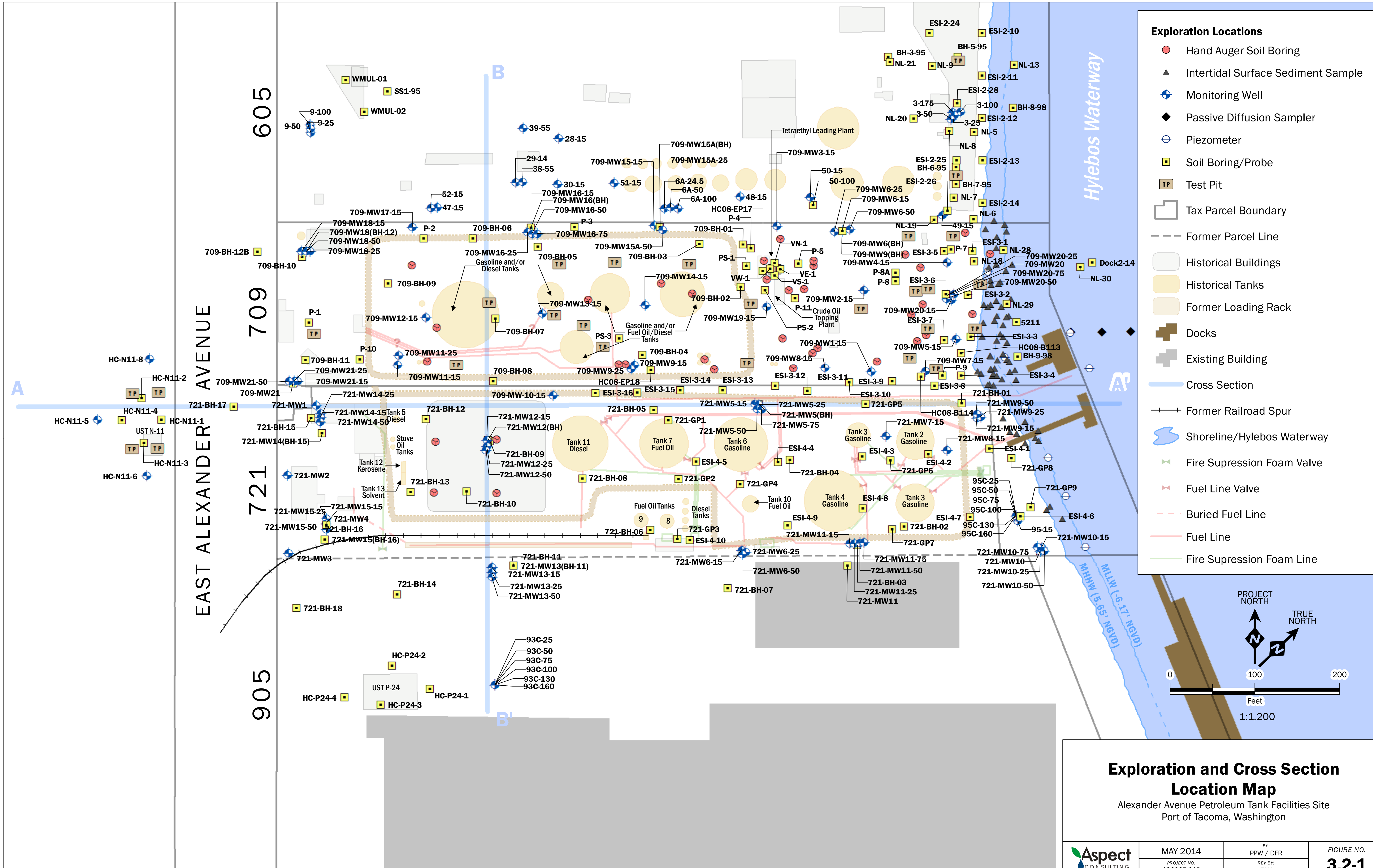
Aspect CONSULTING | MAY-2014 | BY: PPW / DFR | FIGURE NO. 2.2
PROJECT NO. 130097-01B | REV BY: EAH

Existing Site Structures and Utilities

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING	MAY-2014	BY: DFR / PPW	FIGURE NO.
	PROJECT NO. 130097-01B	REV BY: EAH	3.1

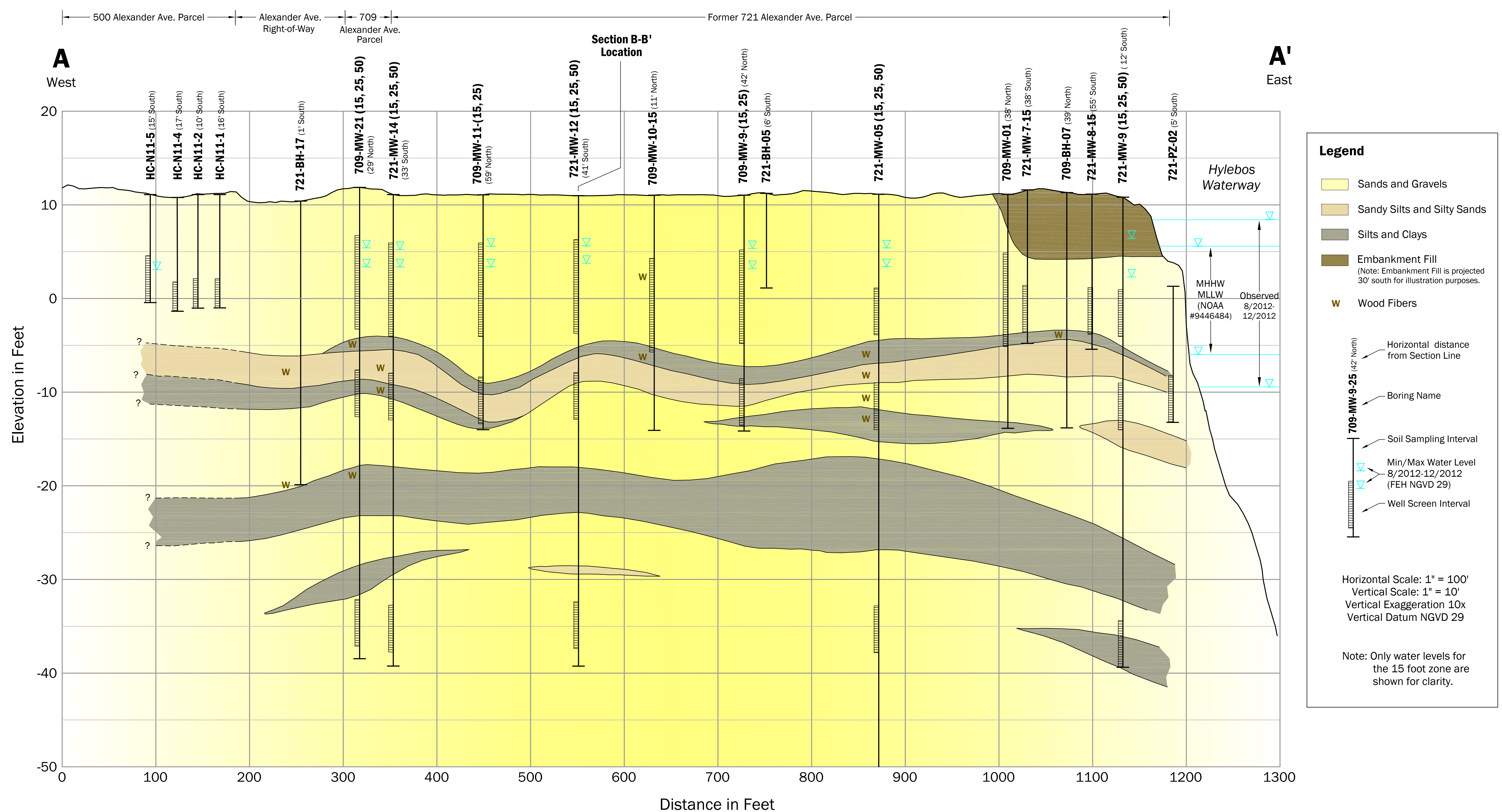
GIS Path: T:\projects_8\Port_of_Tacoma\AlexanderAve_130097\Delivered\FINAL_RIFS_WORKPLAN_JULY2014\3-1 Existing Site Structures and Utilities.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 5/29/2014 || User: ecrumbaker || Print Date: 5/29/2014



Exploration and Cross Section Location Map

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING	MAY-2014	BY: PPW / DFR	FIGURE NO.
	PROJECT NO. 130097-01B	REV BY: EAH	3.2-1

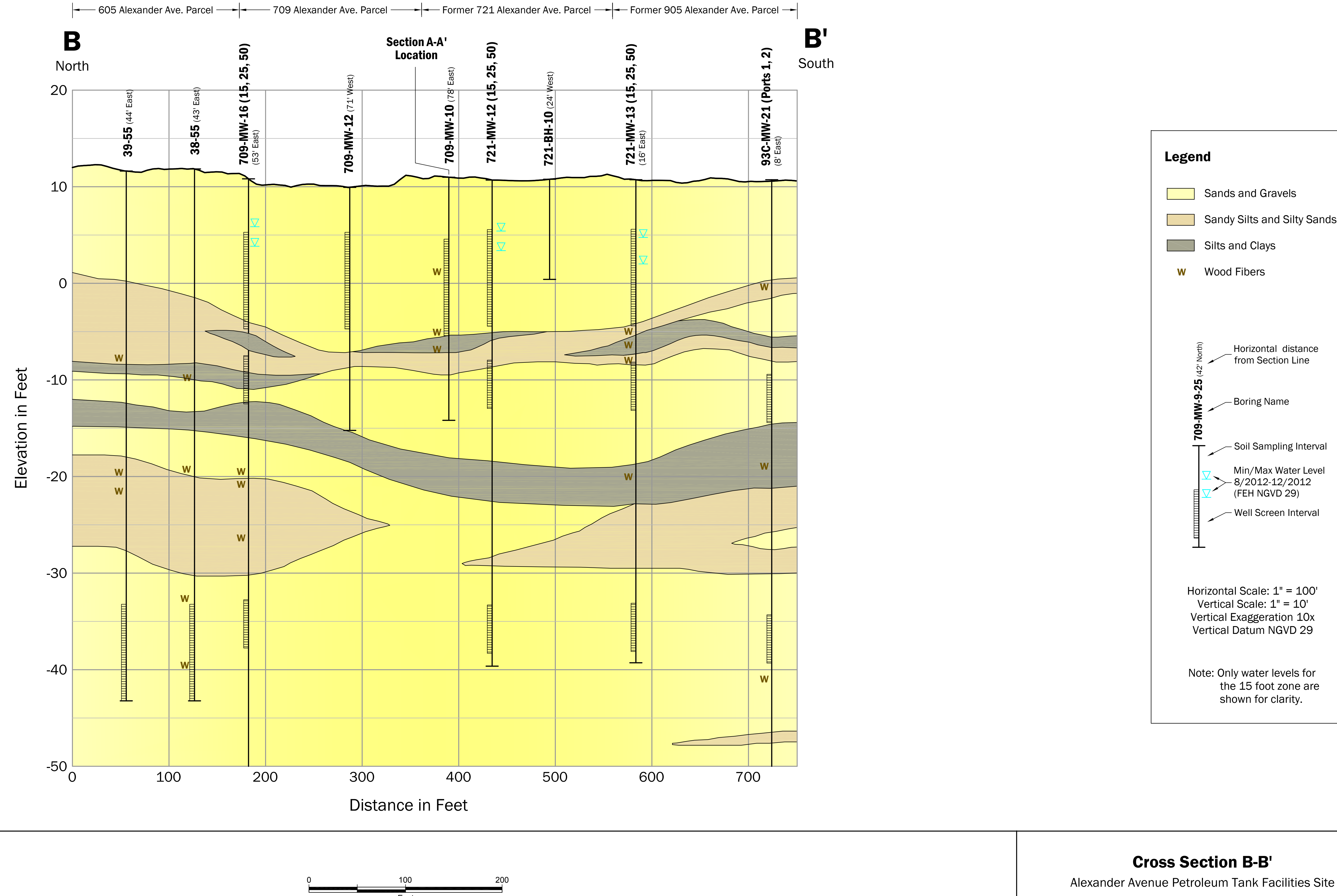


Cross Section A-A'

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect Consulting	APR-2014	BY: DFR/SCC	FIGURE NO.
	PROJECT NO. 130097	REV BY: SCC	3.2-2

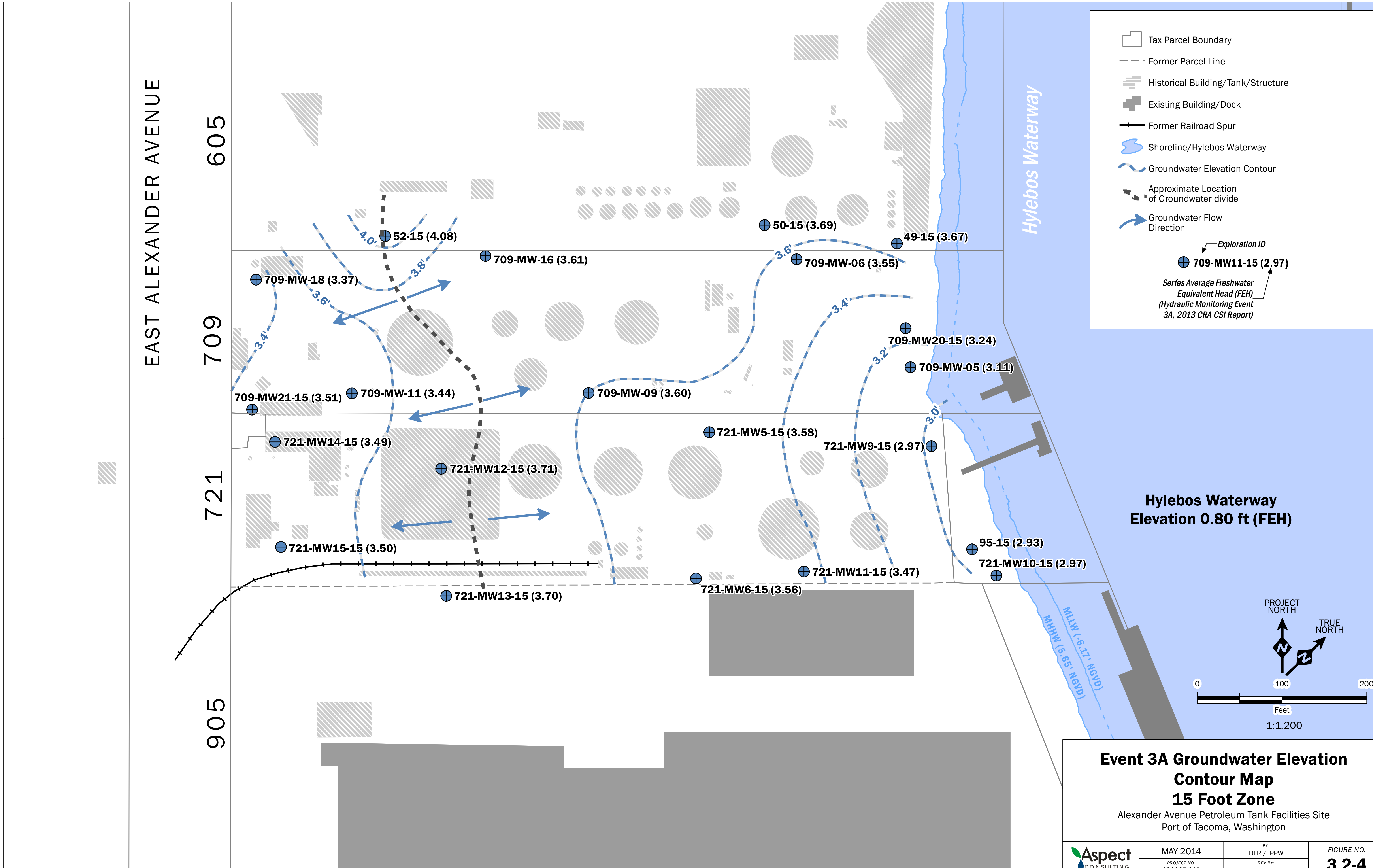
CAD Path: Q:\Port of Tacoma\130097 Alexander Ave Tank Facility\2014-04 Cross Sections\130097-AA.dwg Section A || Coordinate System: NAD 1983 State Plane Washington North FIPS 4601 Feet || Date Saved: Apr 23, 2014 12:21pm || User: scudd



Cross Section B-B'

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

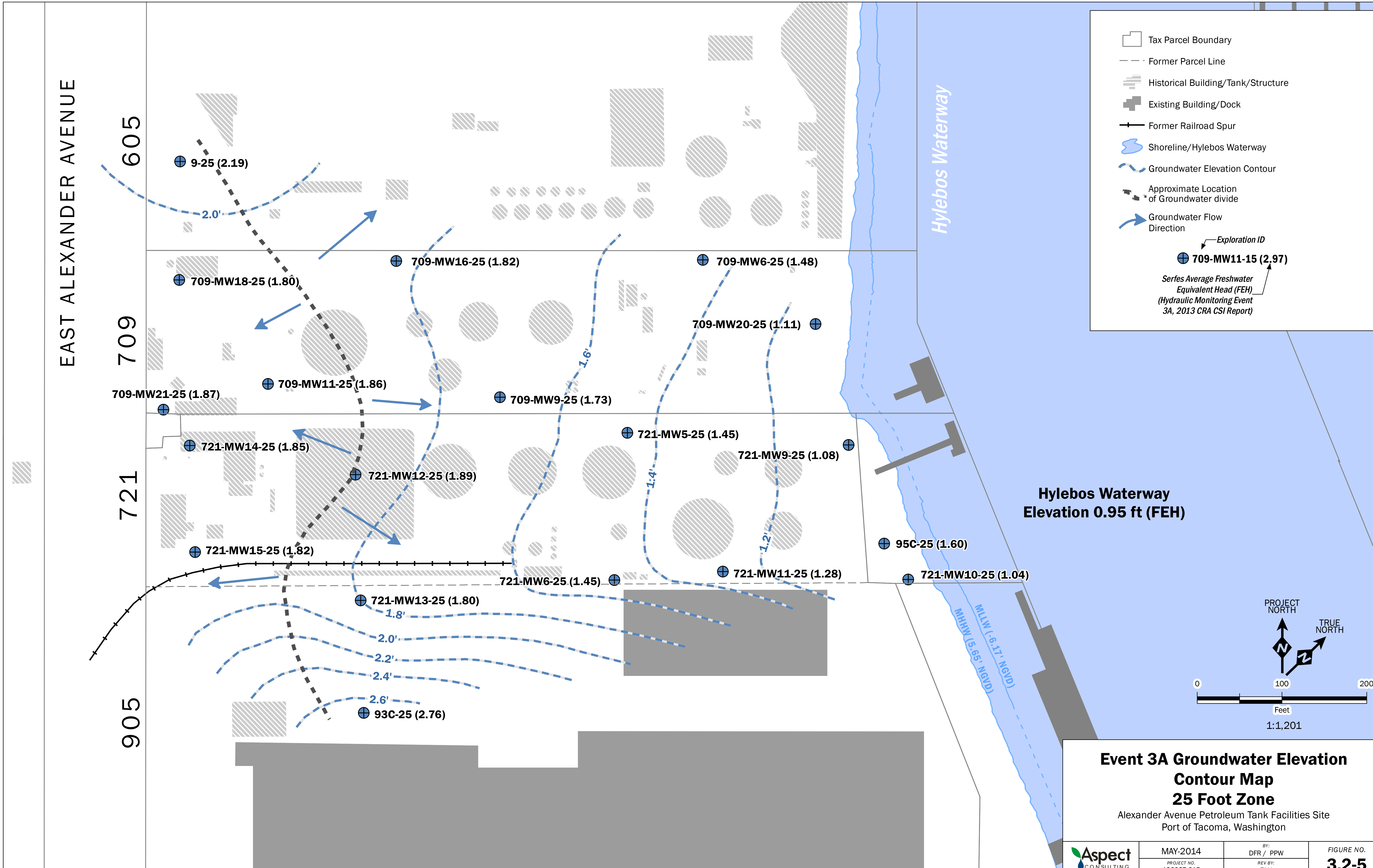
Aspect Consulting	APR-2014	BY: DFR/SCC	FIGURE NO.
	PROJECT NO. 130097	REV BY: SCC	3.2-3



Event 3A Groundwater Elevation Contour Map 15 Foot Zone

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING	MAY-2014	BY: DFR / PPW	FIGURE NO.
	PROJECT NO. 130097-01B	REV BY: EAH	3.2-4

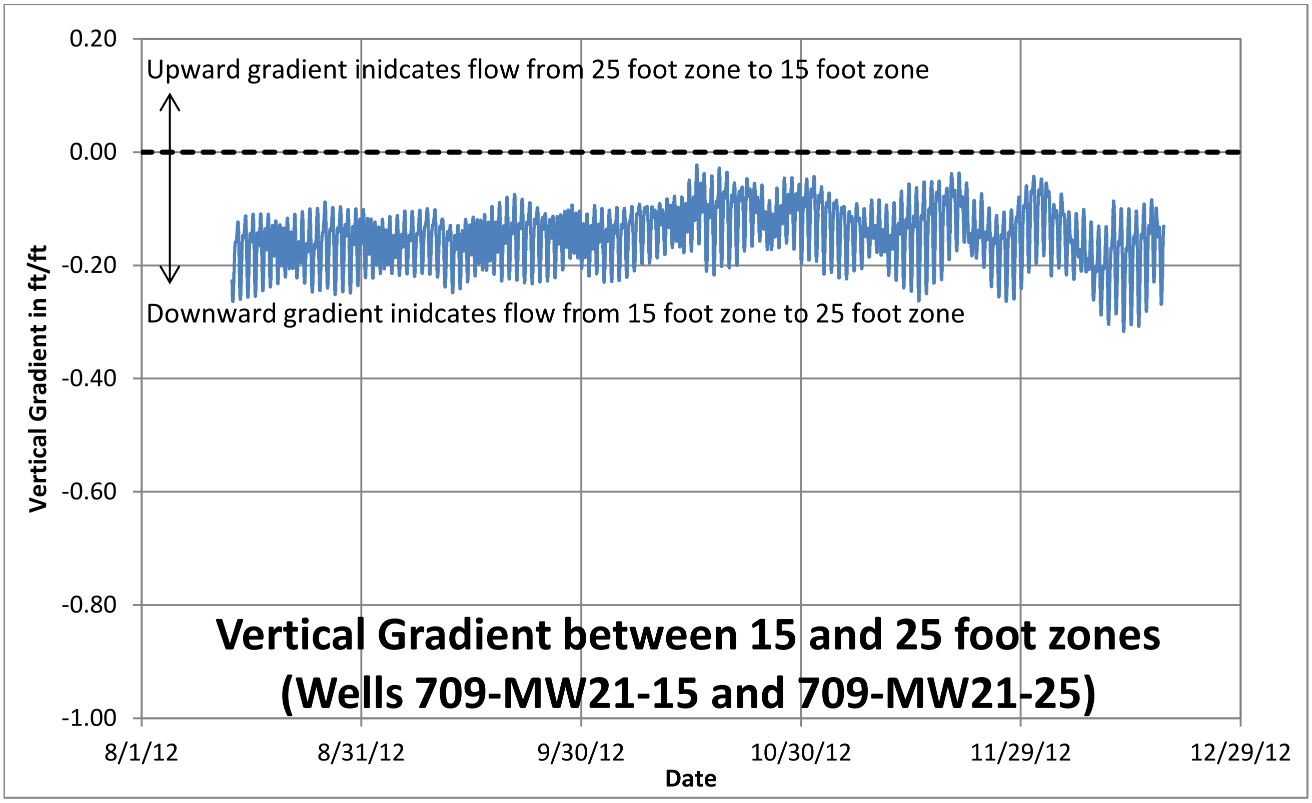


Event 3A Groundwater Elevation Contour Map
25 Foot Zone

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING

MAY-2014	BY: DFR / PPW	FIGURE NO. 3.2-5
PROJECT NO. 130097-01B	REV BY: EAH	



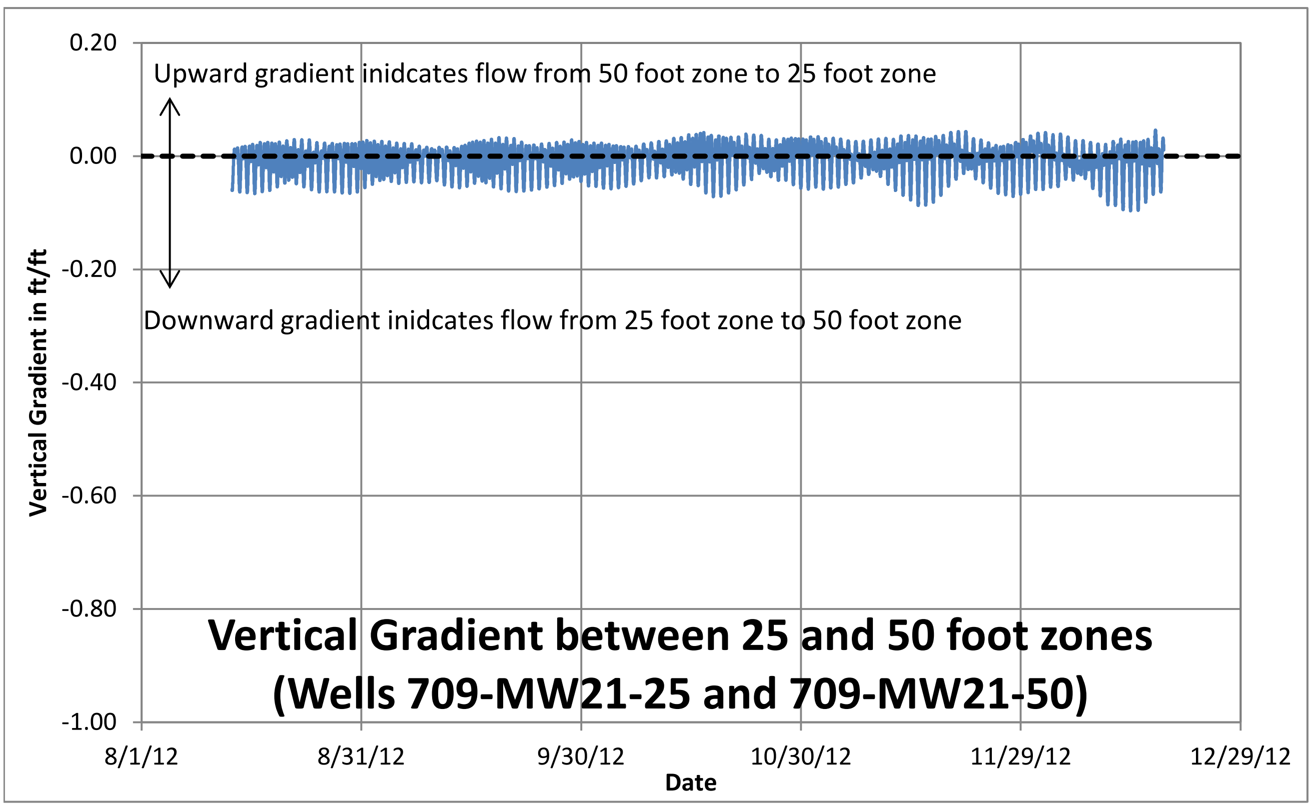
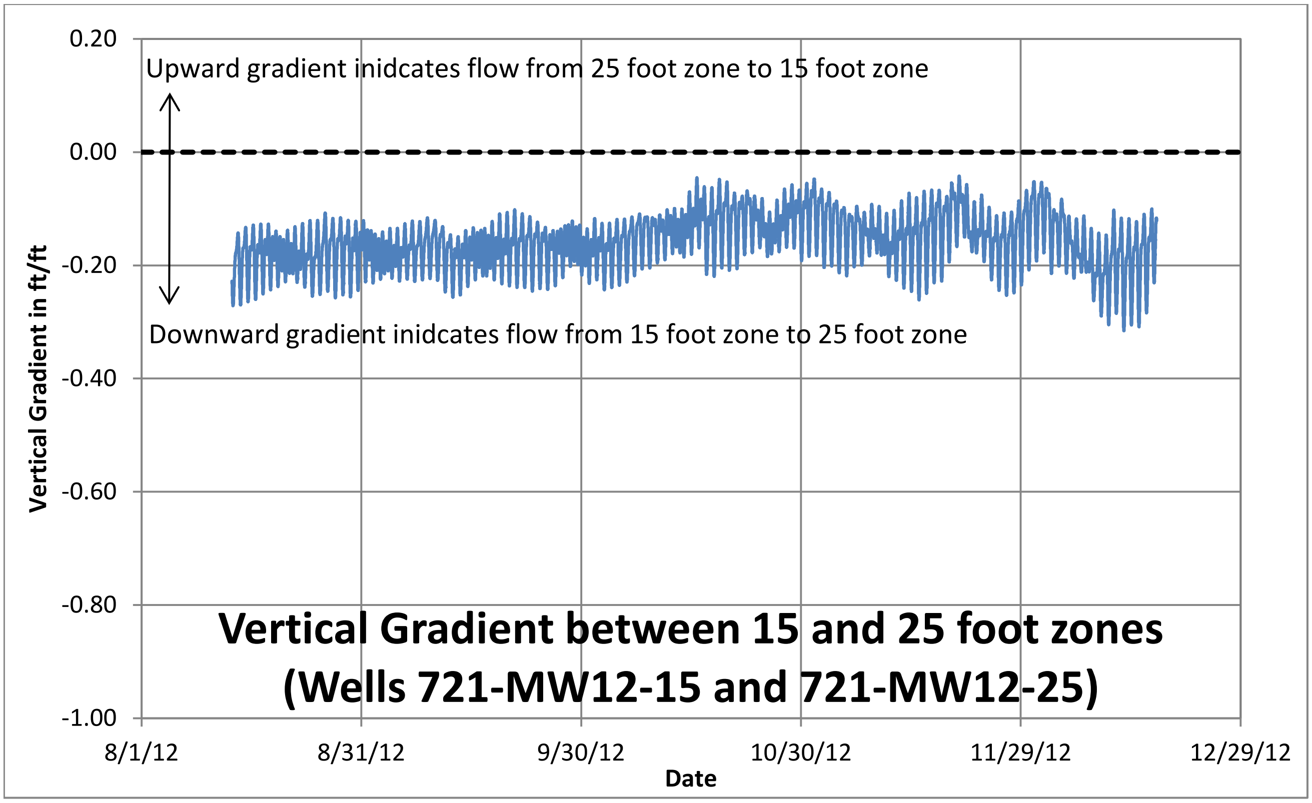


Figure 3.2-6
Vertical Gradients at 709-MW21 Well Cluster
Alexander Avenue Petroleum Tank Facilities Site, RI/FS Work Plan



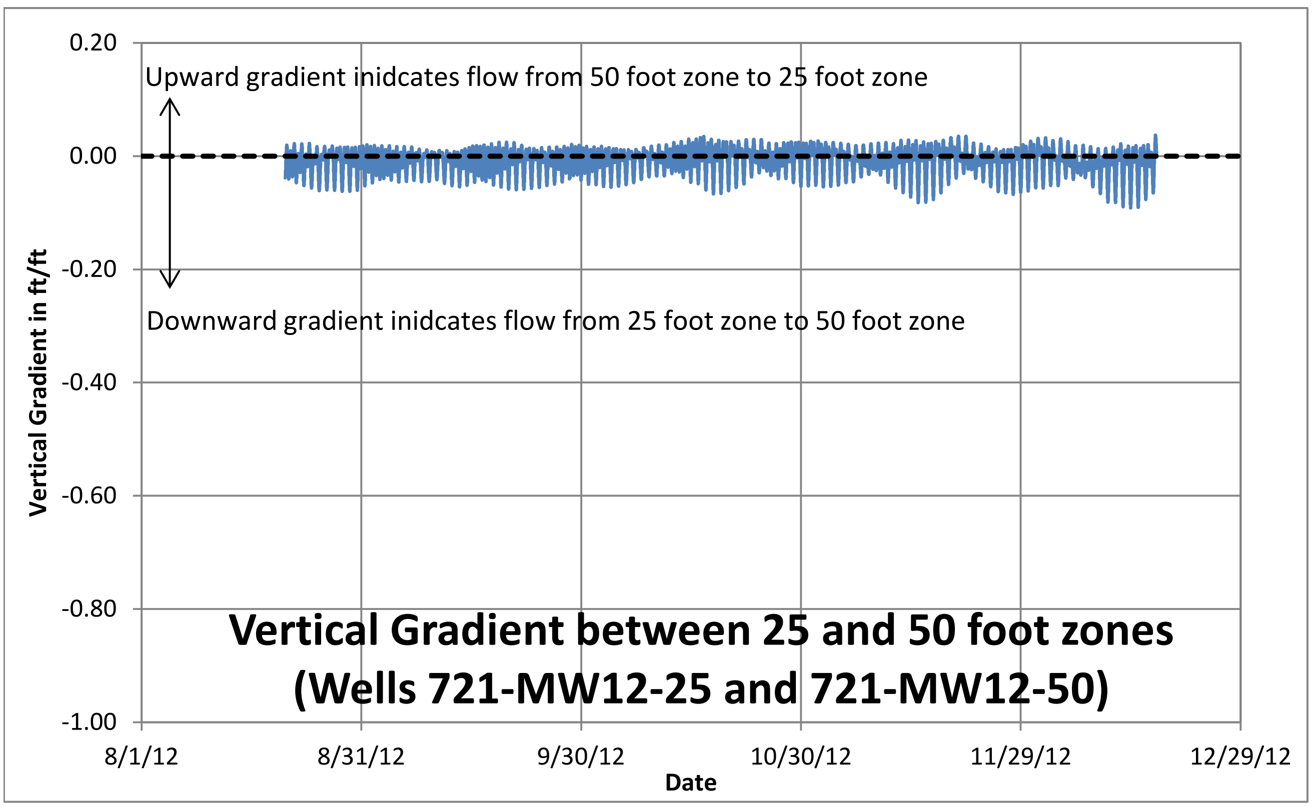
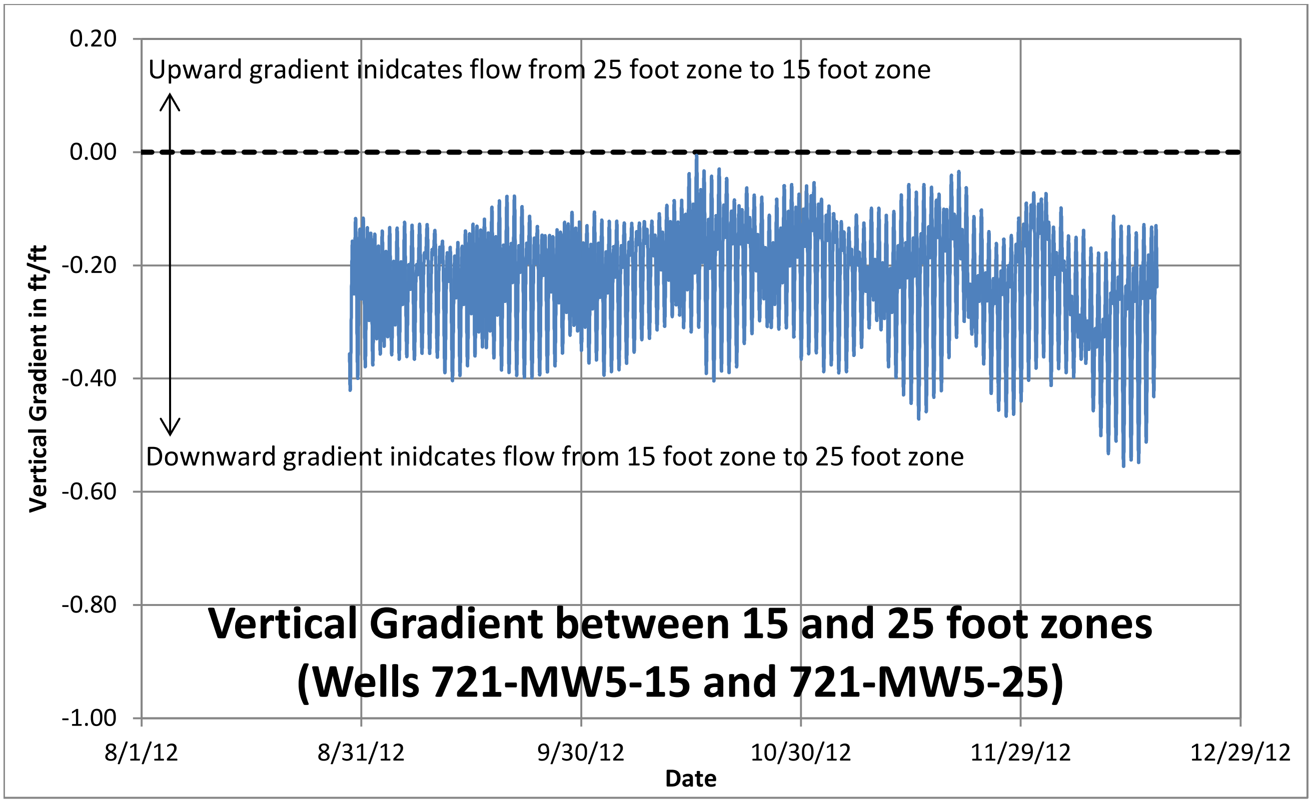


Figure 3.2-7
Vertical Gradients at 721-MW12 Well Cluster
Alexander Avenue Petroleum Tank Facilities Site, RI/FS Work Plan



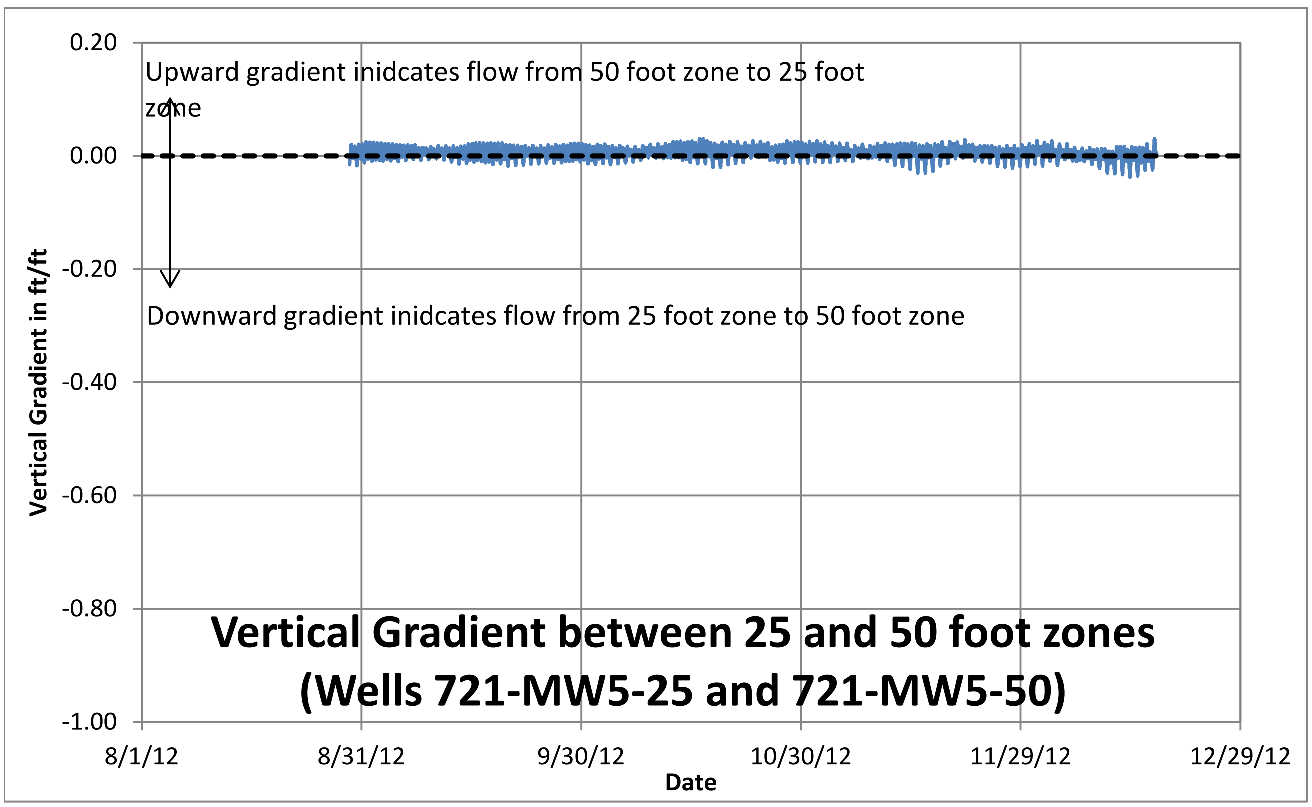
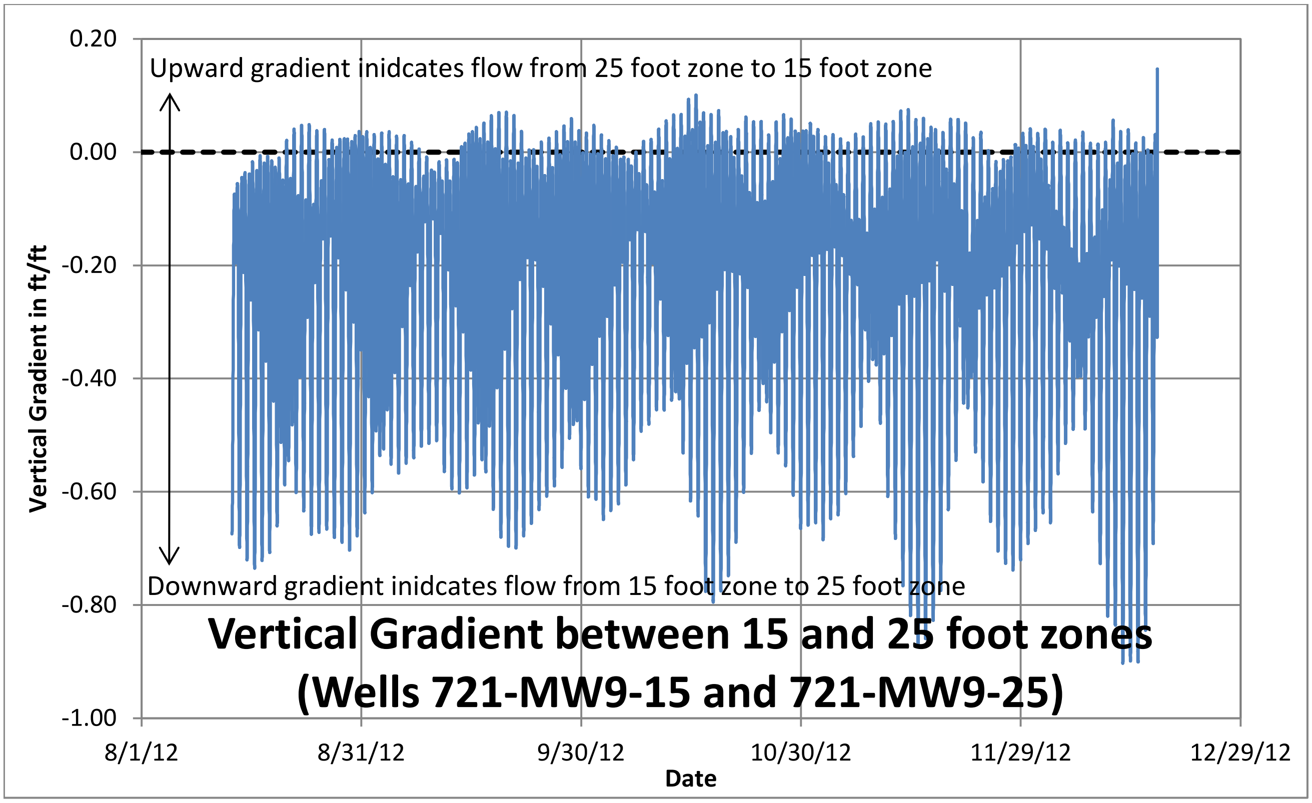


Figure 3.2-8
Vertical Gradients at 721-MW5 Well Cluster

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



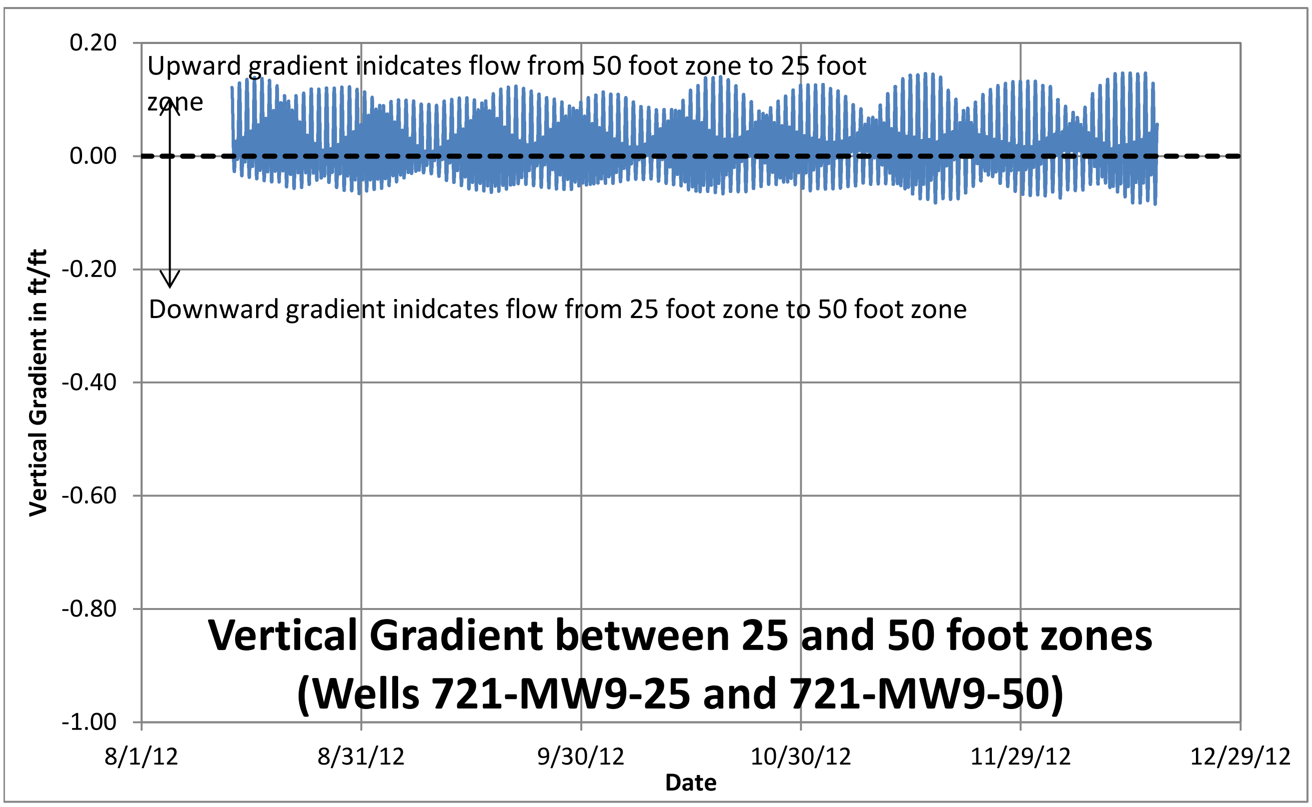


Figure 3.2-9

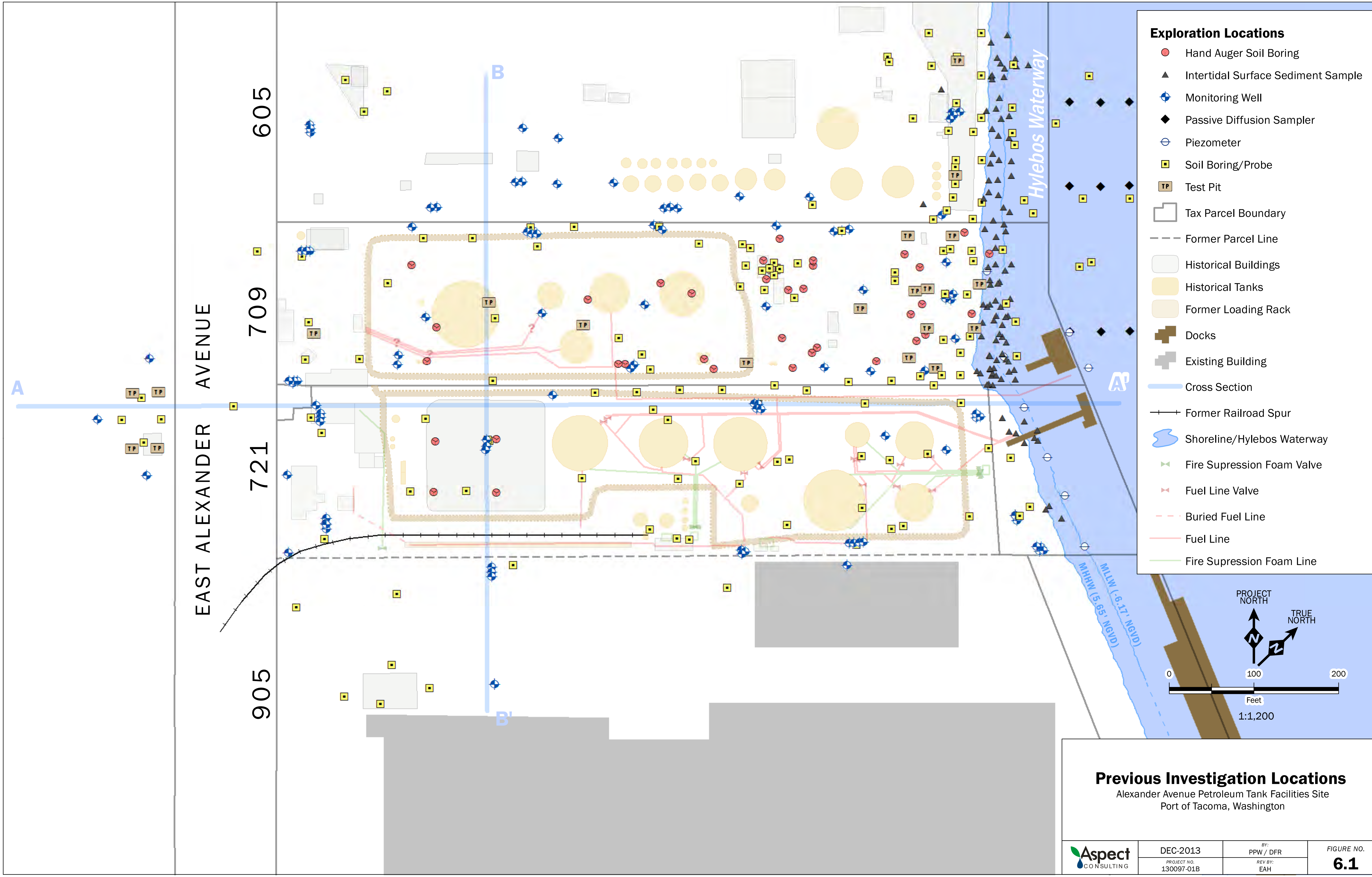
Vertical Gradients at 721-MW9 Well Cluster

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

Aspect Consulting

6/4/2014

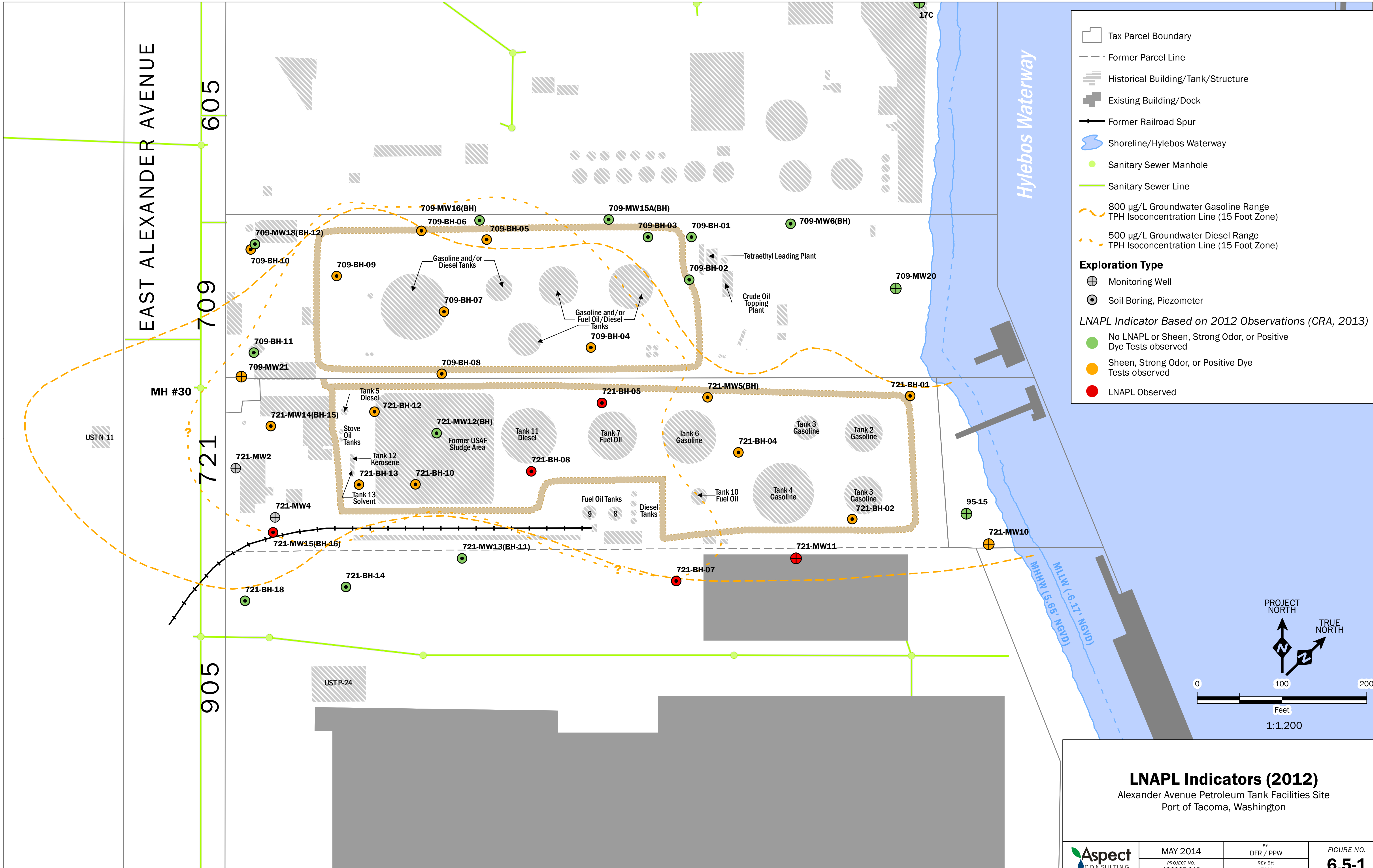
V:\130097 POT Alexander Ave\Deliverables\RI-FS Work Plan\Final\Figures\3-2-9 721-MW9 Vertical Gradient Figure



Previous Investigation Locations

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

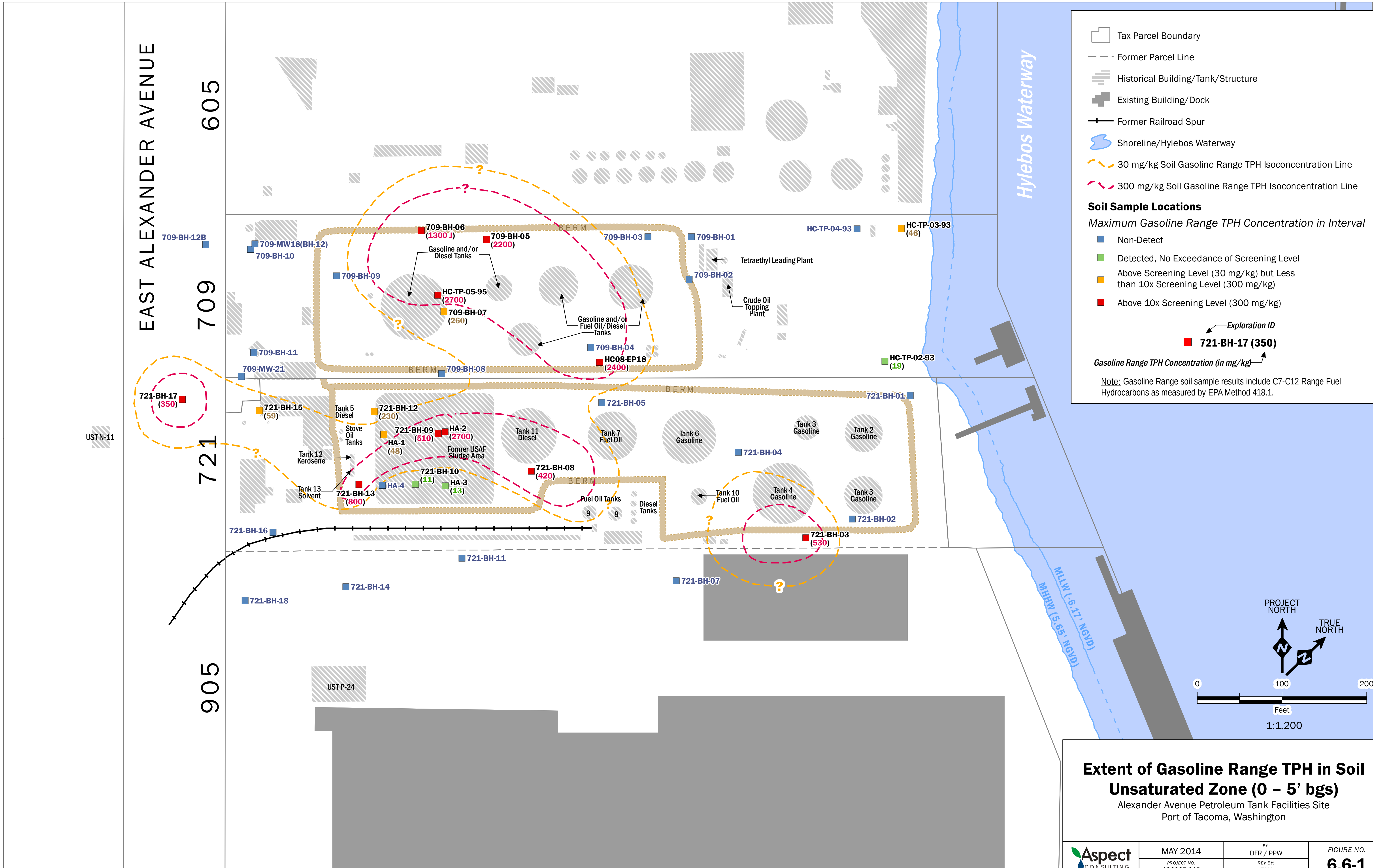
Aspect CONSULTING	DEC-2013	BY: PPW / DFR	FIGURE NO.
	PROJECT NO. 130097-01B	REV BY: EAH	6.1



LNAPL Indicators (2012)

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

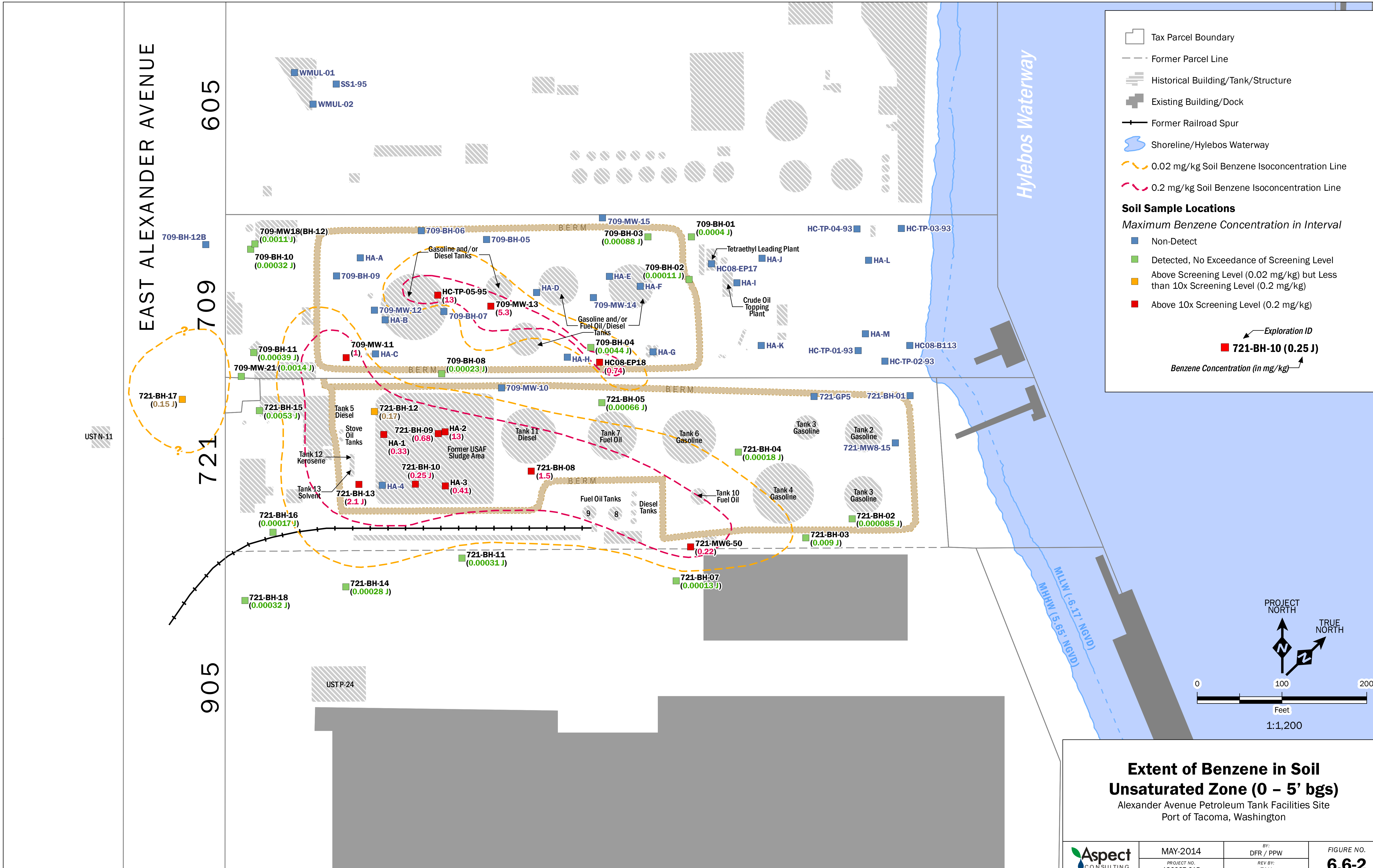
Aspect CONSULTING | MAY-2014 | PROJECT NO. 130097-01B | BY: DFR / PPW | REV BY: EAH | FIGURE NO. 6.5-1



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

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING	MAY-2014	BY: DFR / PPW	FIGURE NO.
	PROJECT NO. 130097-01B	REV BY: EAH	6.6-1

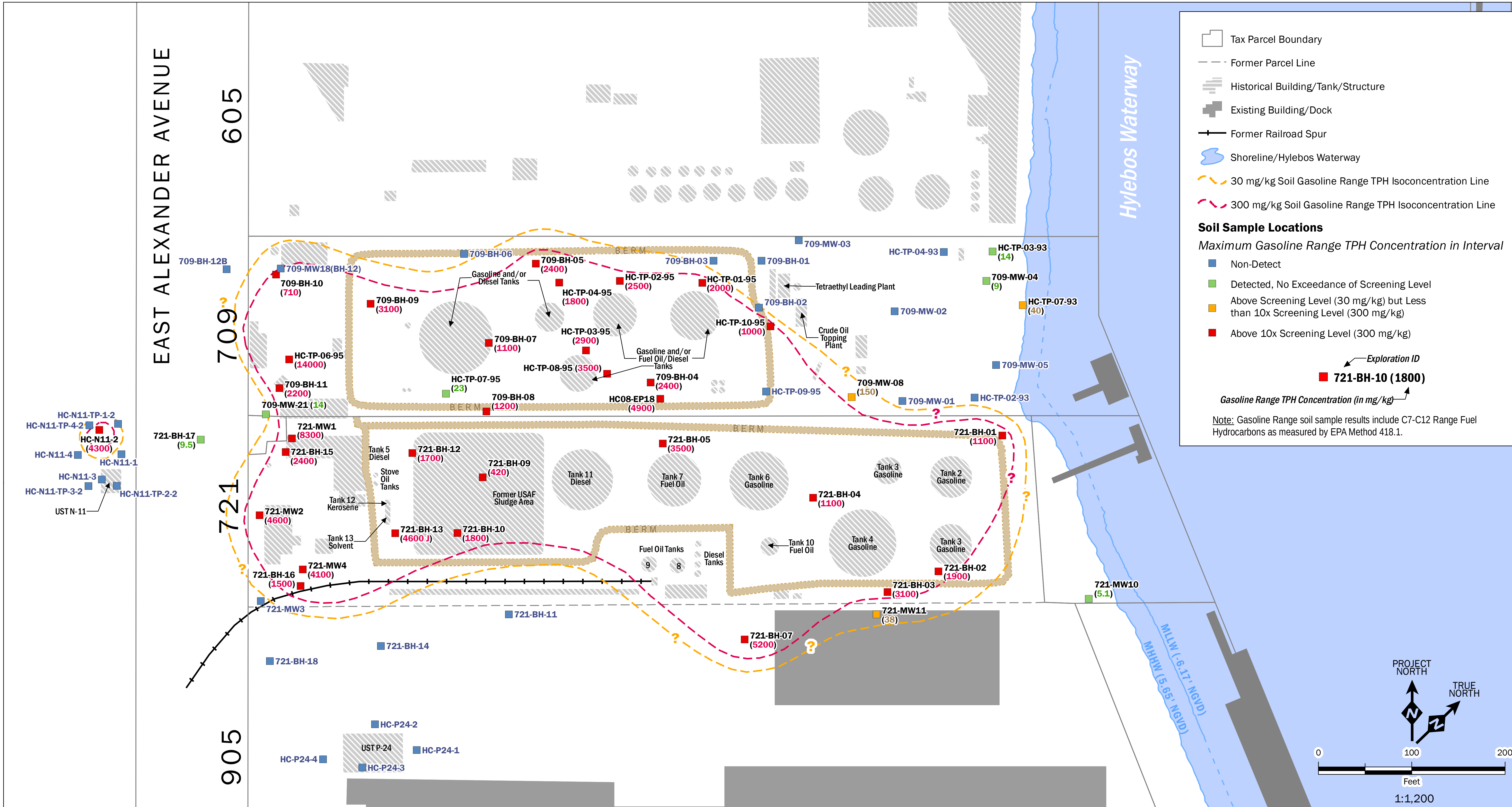


Extent of Benzene in Soil
Unsaturated Zone (0 – 5' bgs)

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING | MAY-2014 | BY: DFR / PPW | FIGURE NO. 6.6-2
PROJECT NO. 130097-01B | REV BY: EAH

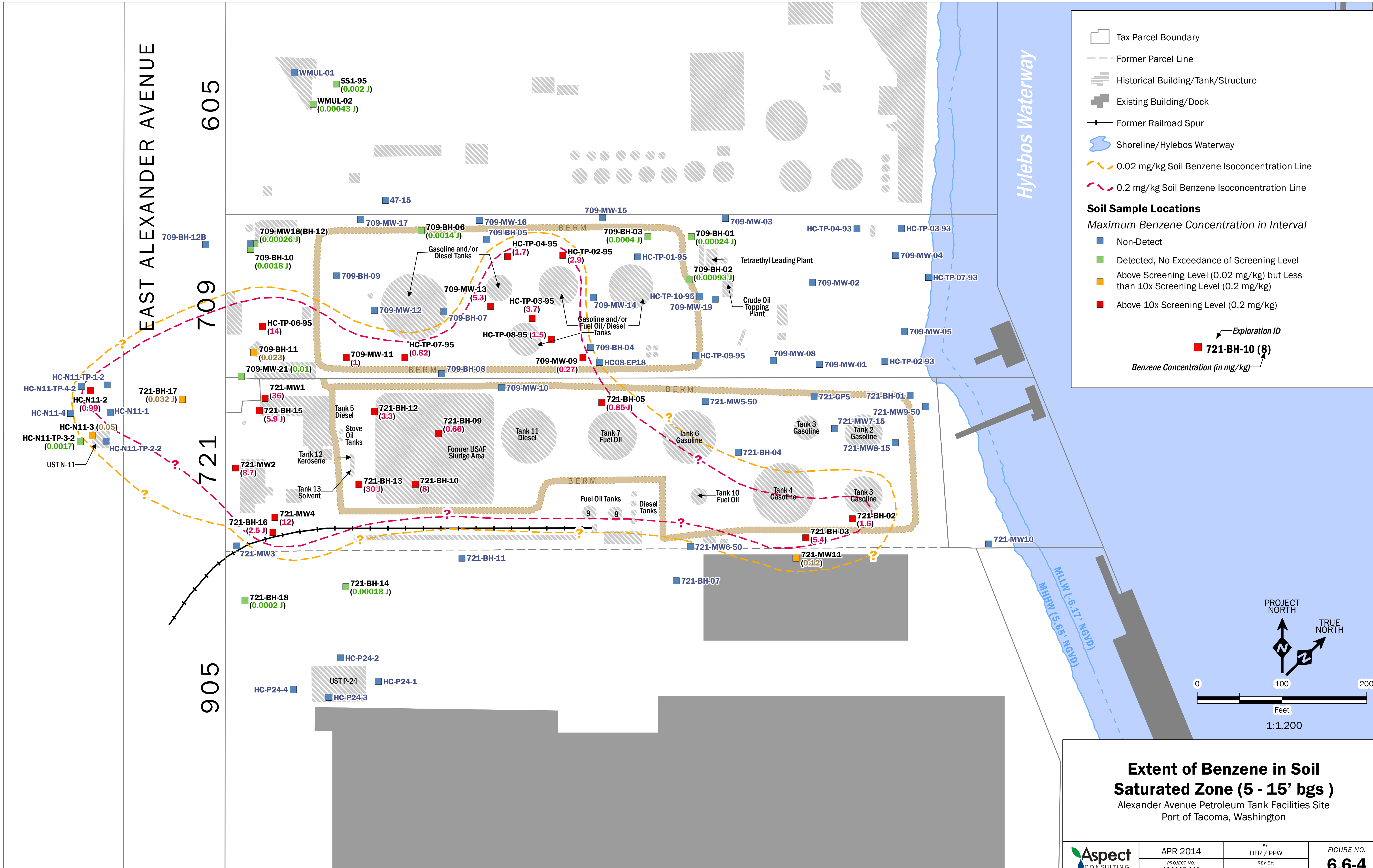
GIS Path: T:\projects_8\Port_of_Tacoma\AlexanderAve_130097\Delivered\FINAL_RIFS_WORKPLAN_JULY2014\6.6-2 Soil Benzene 0-5.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 5/29/2014 || User: ecrumbaker || Print Date: 5/29/2014



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

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING | MAY-2014 | BY: DFR / PPW | FIGURE NO. 6.6-3
PROJECT NO. 130097-01B | REV BY: EAH

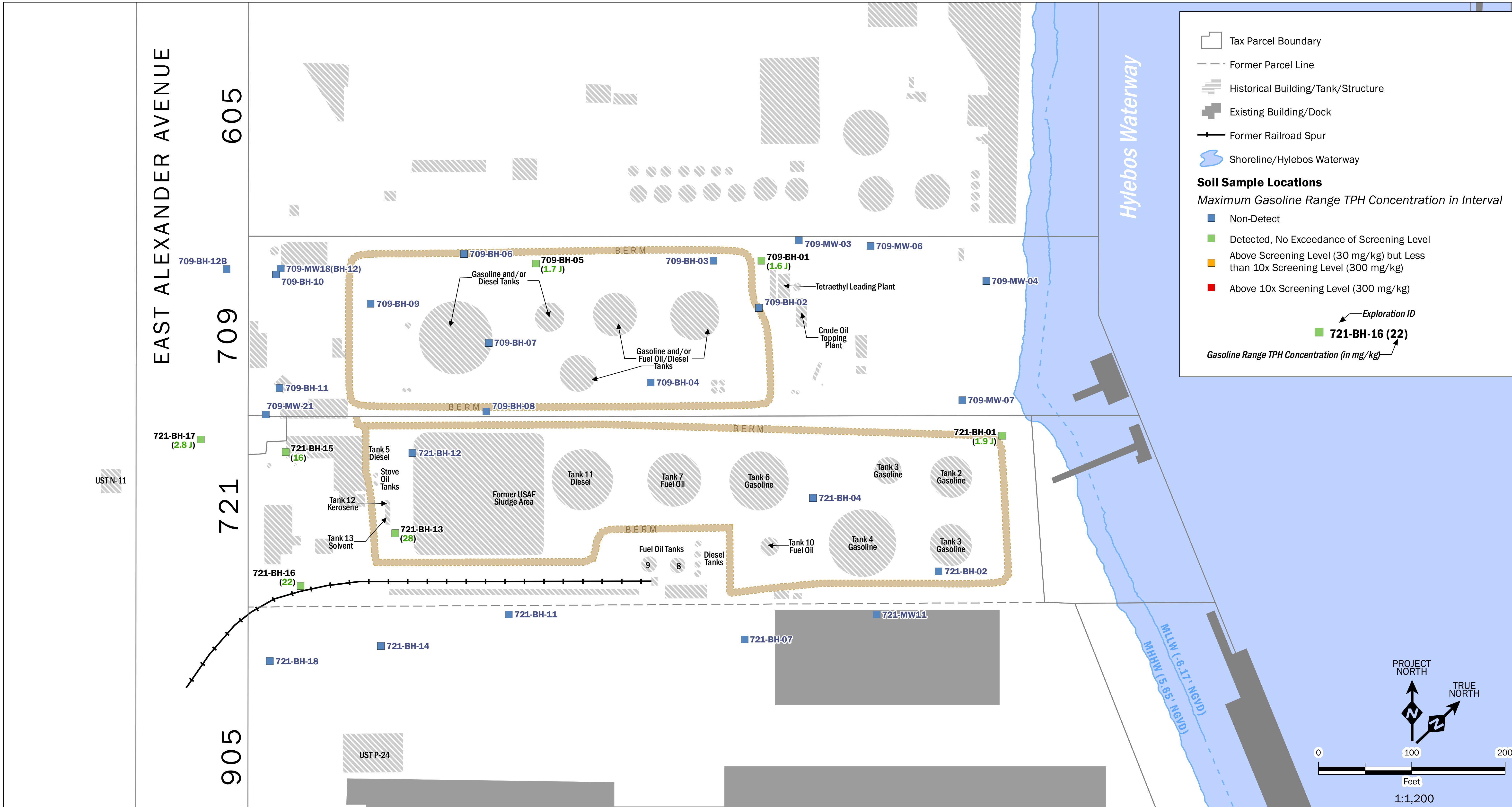


Extent of Benzene in Soil Saturated Zone (5 - 15' bgs)

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING

APR-2014	BY: DFR / PPW	FIGURE NO.
PROJECT NO. 130097-01B	REV BY: EAH	6.6-4



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

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING

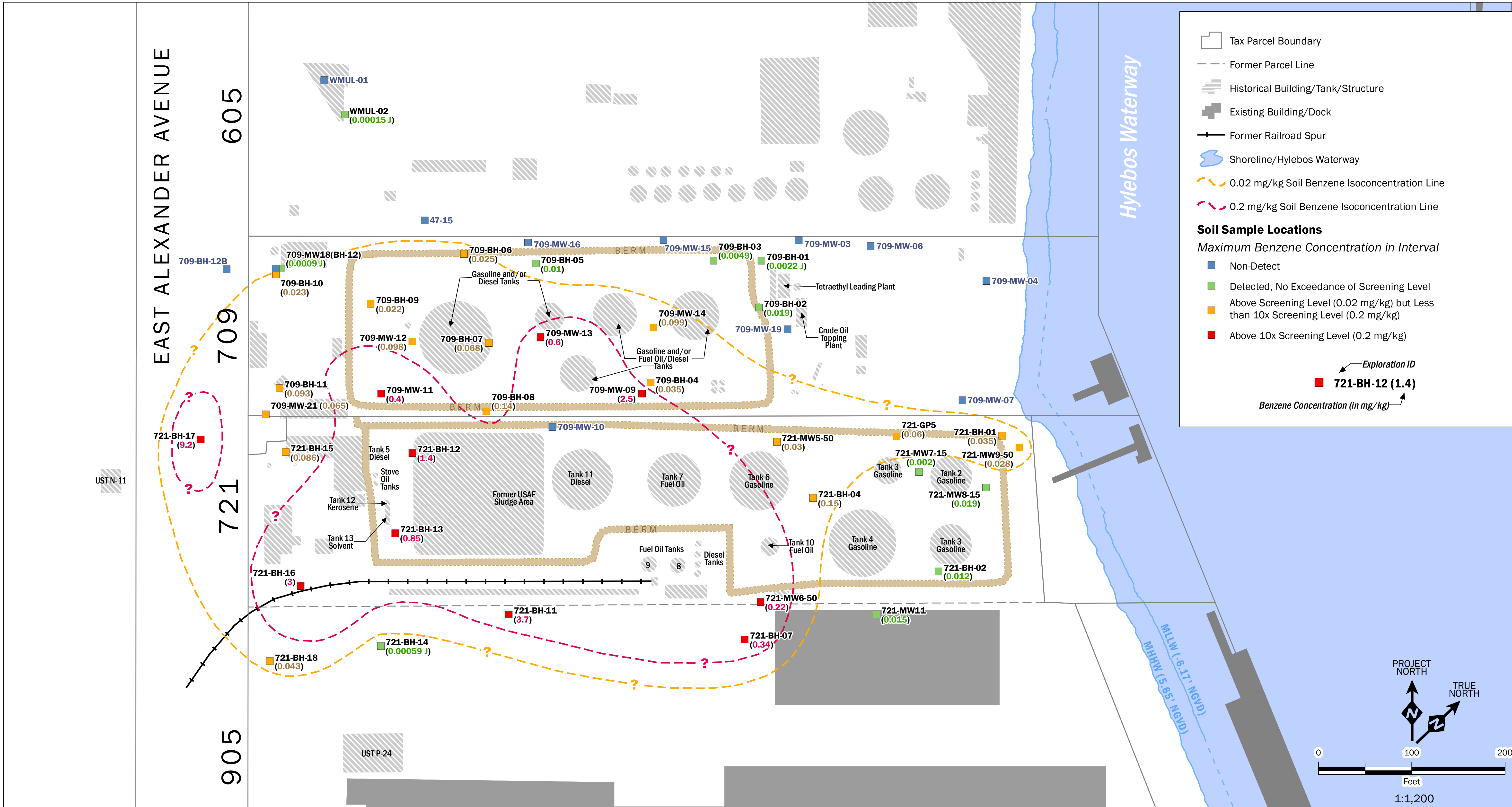
MAY-2014

PROJECT NO. 130097-01B

BY: DFR / PPW

REV BY: EAH

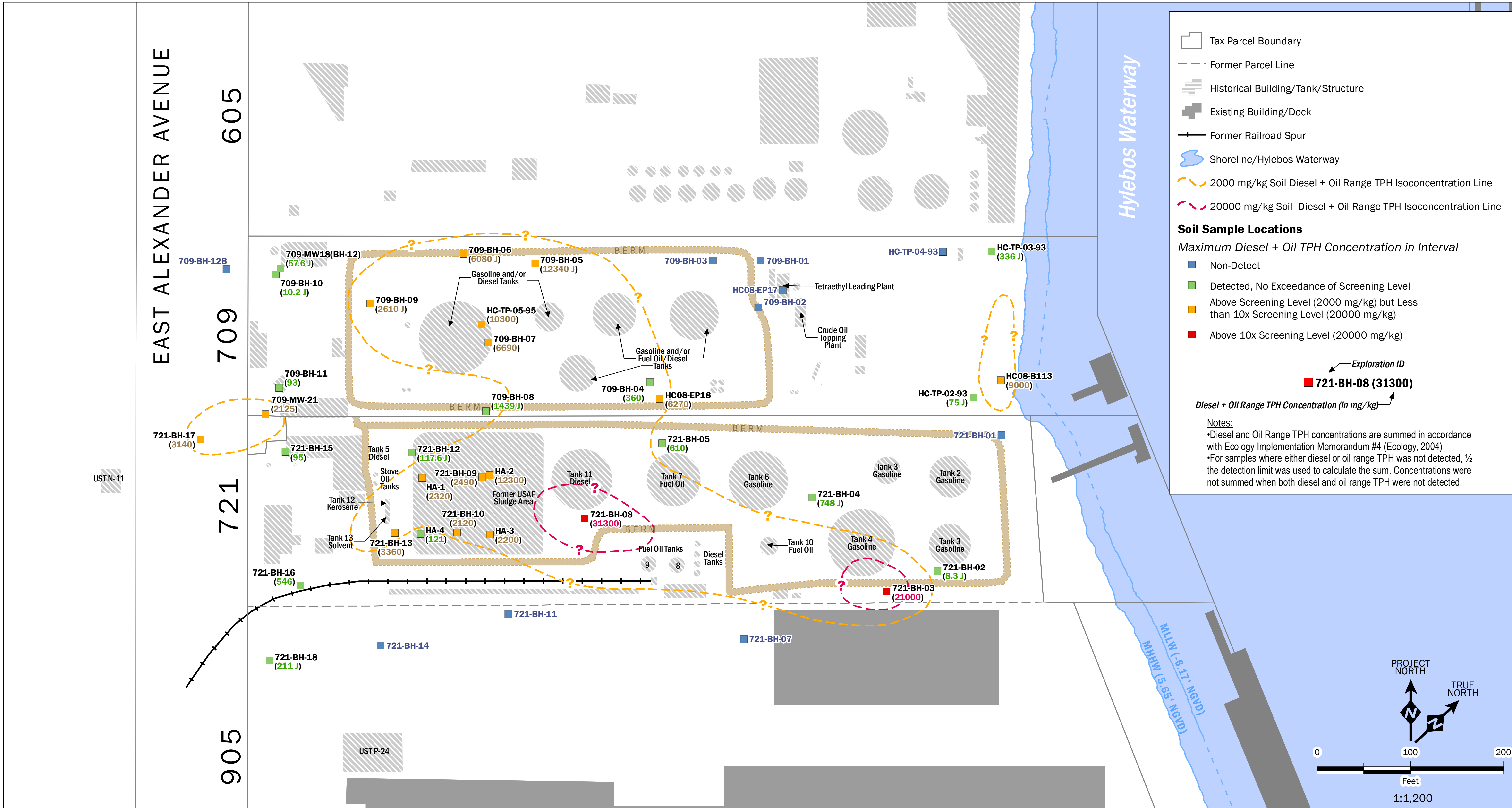
FIGURE NO. **6.6-5**



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

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect Consulting	MAY-2014	BY: DFR / PPW	FIGURE NO.
	PROJECT NO. 130097-01B	REV BY: EAH	6.6-6

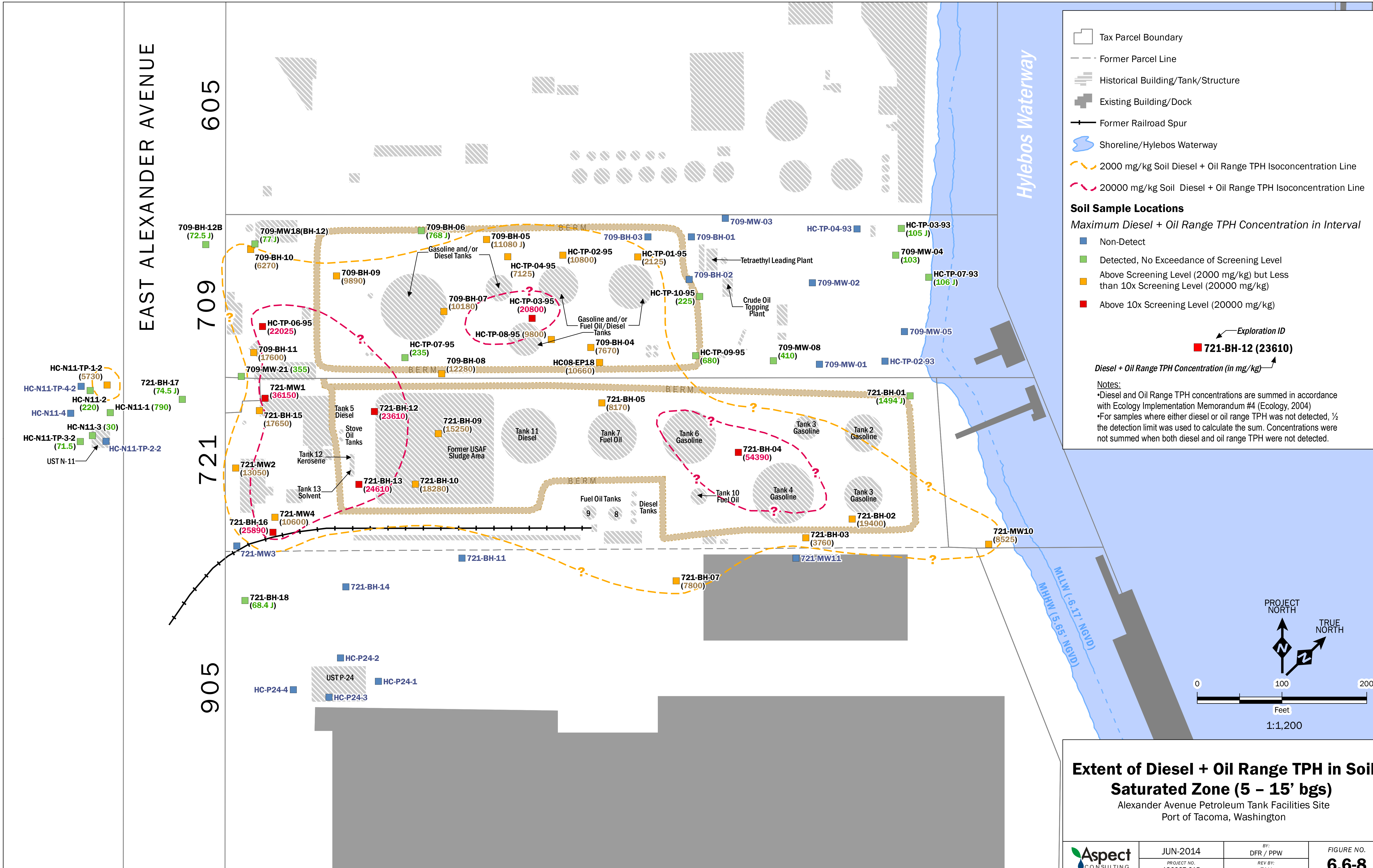


Extent of Diesel + Oil Range TPH in Soil Unsaturated Zone (0 – 5' bgs)

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect Consulting	JUN-2014	BY: DFR / PPW	FIGURE NO.
	PROJECT NO. 130097-01B	REV BY: EAH	6.6-7

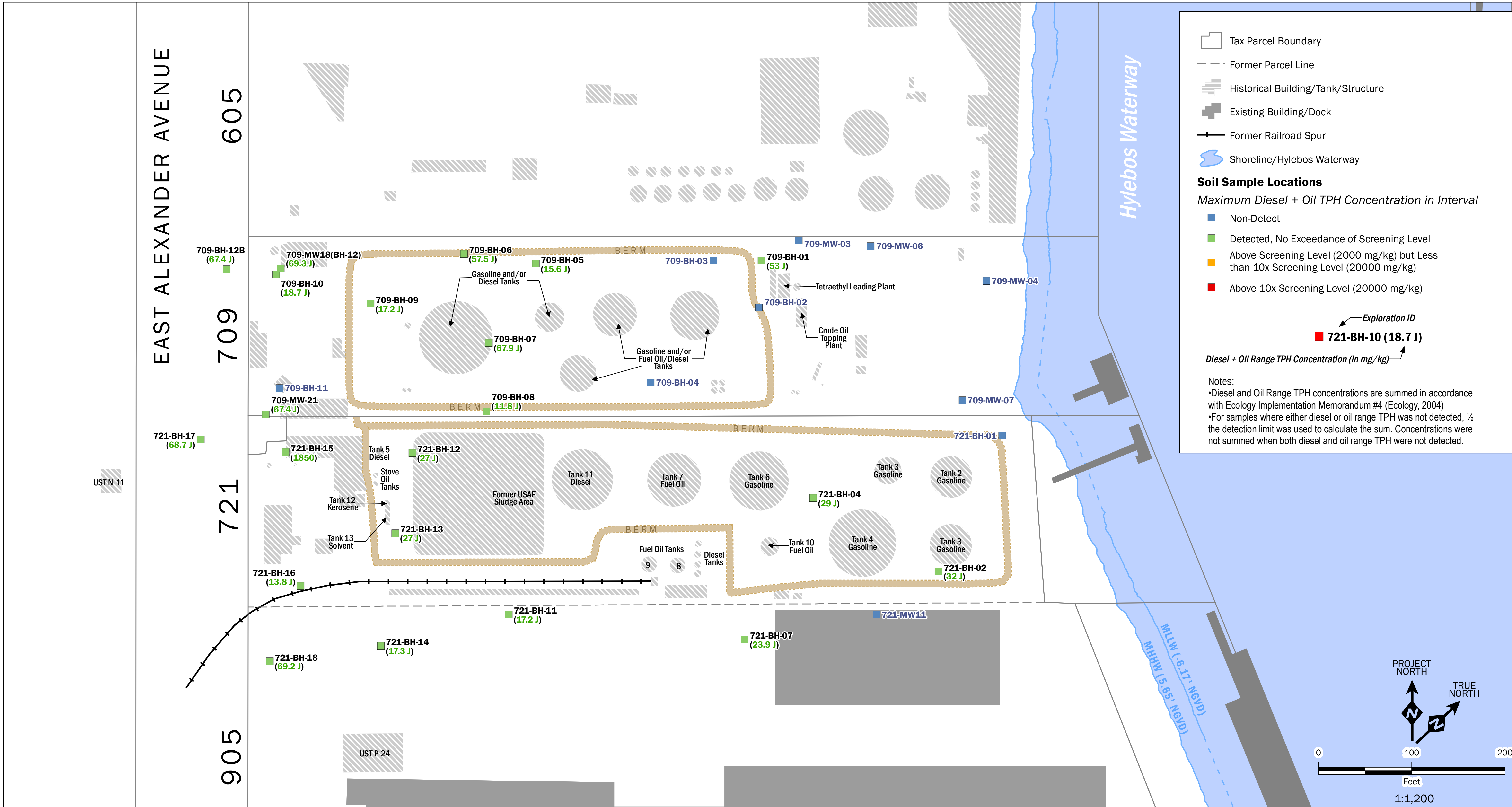
GIS Path: T:\projects_8\Port_of_Tacoma\AlexanderAve_130097\Delivered\FINAL_RIFS_Workplan_2014\6.6-7 Soil Diesel and Oil Range TPH 0-5.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 6/13/2014 || User: ecumbaker || Print Date: 6/13/2014



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

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

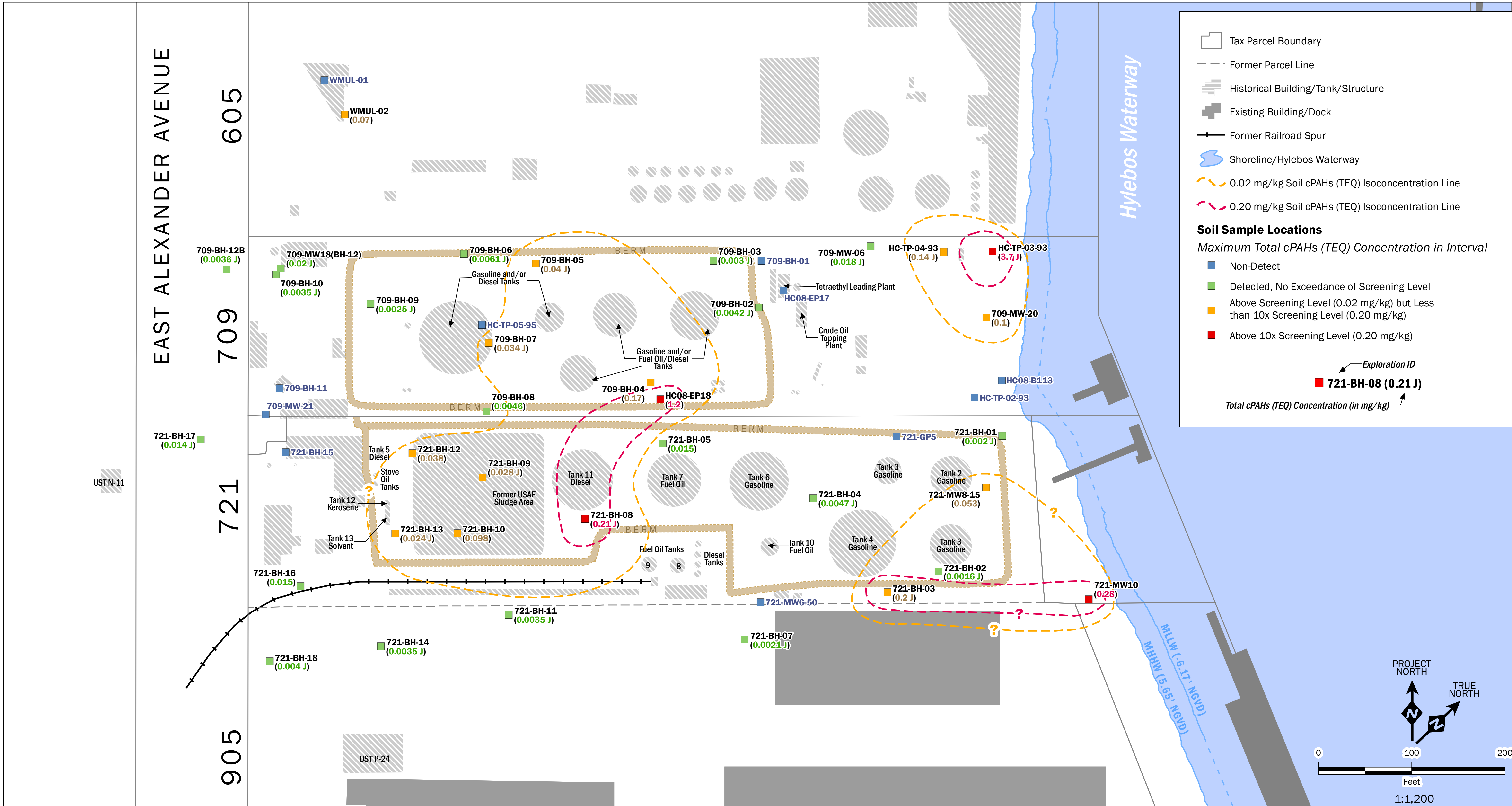
Aspect CONSULTING | JUN-2014 | BY: DFR / PPW | FIGURE NO. 6.6-8
PROJECT NO. 130097-01B | REV BY: EAH



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

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

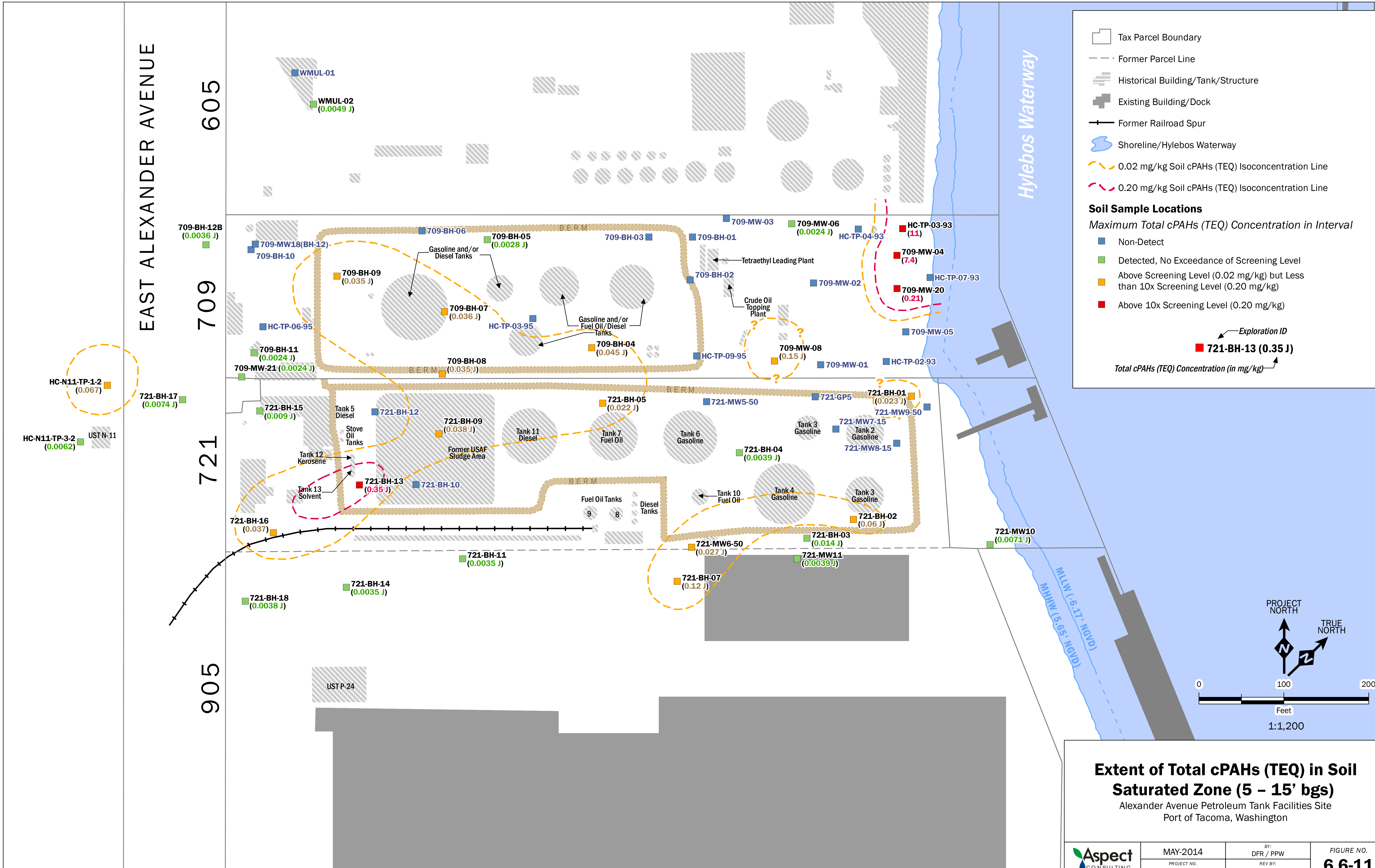
Aspect CONSULTING	JUN-2014	BY: DFR / PPW	FIGURE NO.
	PROJECT NO. 130097-01B	REV BY: EAH	6.6-9



Extent of Total cPAHs (TEQ) in Soil Unsaturated Zone (0 – 5' bgs)

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

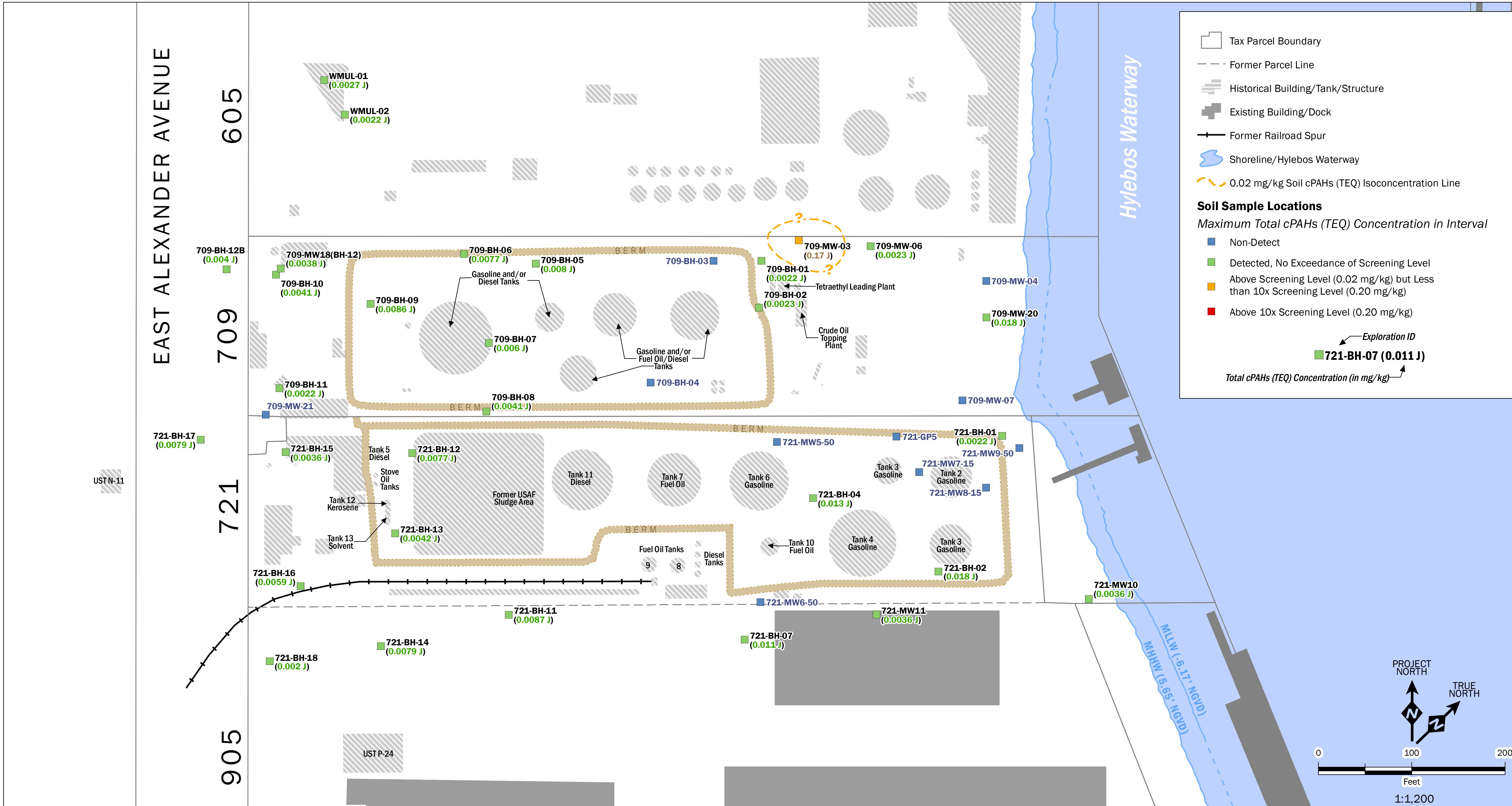
Aspect CONSULTING	MAY-2014	BY: DFR / PPW	FIGURE NO.
	PROJECT NO. 130097-01B	REV BY: EAH	6.6-10



Extent of Total cPAHs (TEQ) in Soil Saturated Zone (5 – 15' bgs)

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

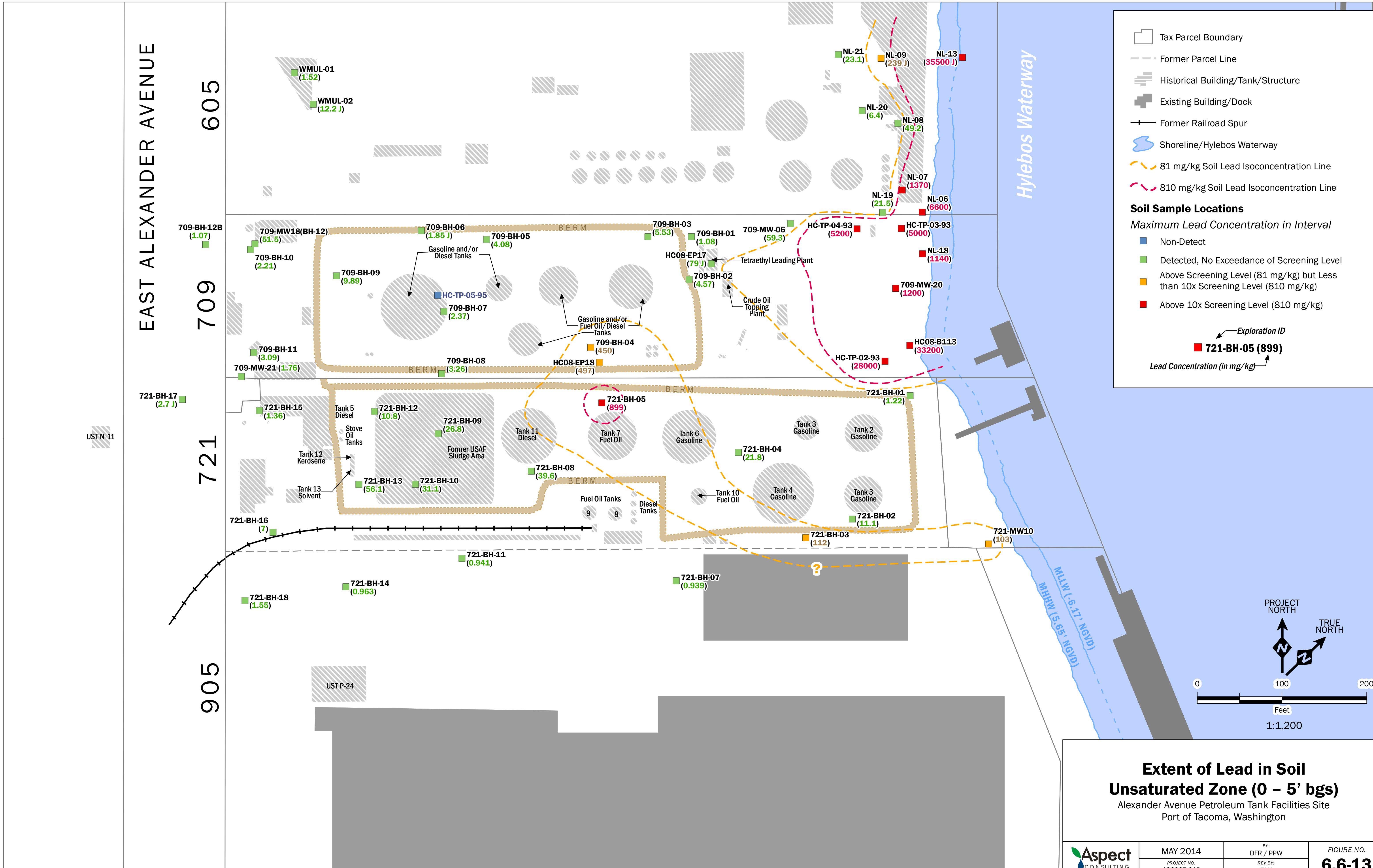
Aspect CONSULTING	MAY-2014 PROJECT NO. 130097-01B	BY: DFR / PPW REV BY: EAH	FIGURE NO. 6.6-11



Extent of Total cPAHs (TEQ) in Soil Saturated Zone (15 – 30' bgs)

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING | MAY-2014 | BY: DFR / PPW | FIGURE NO. 6.6-12
PROJECT NO. 130097-01B | REV BY: EAH

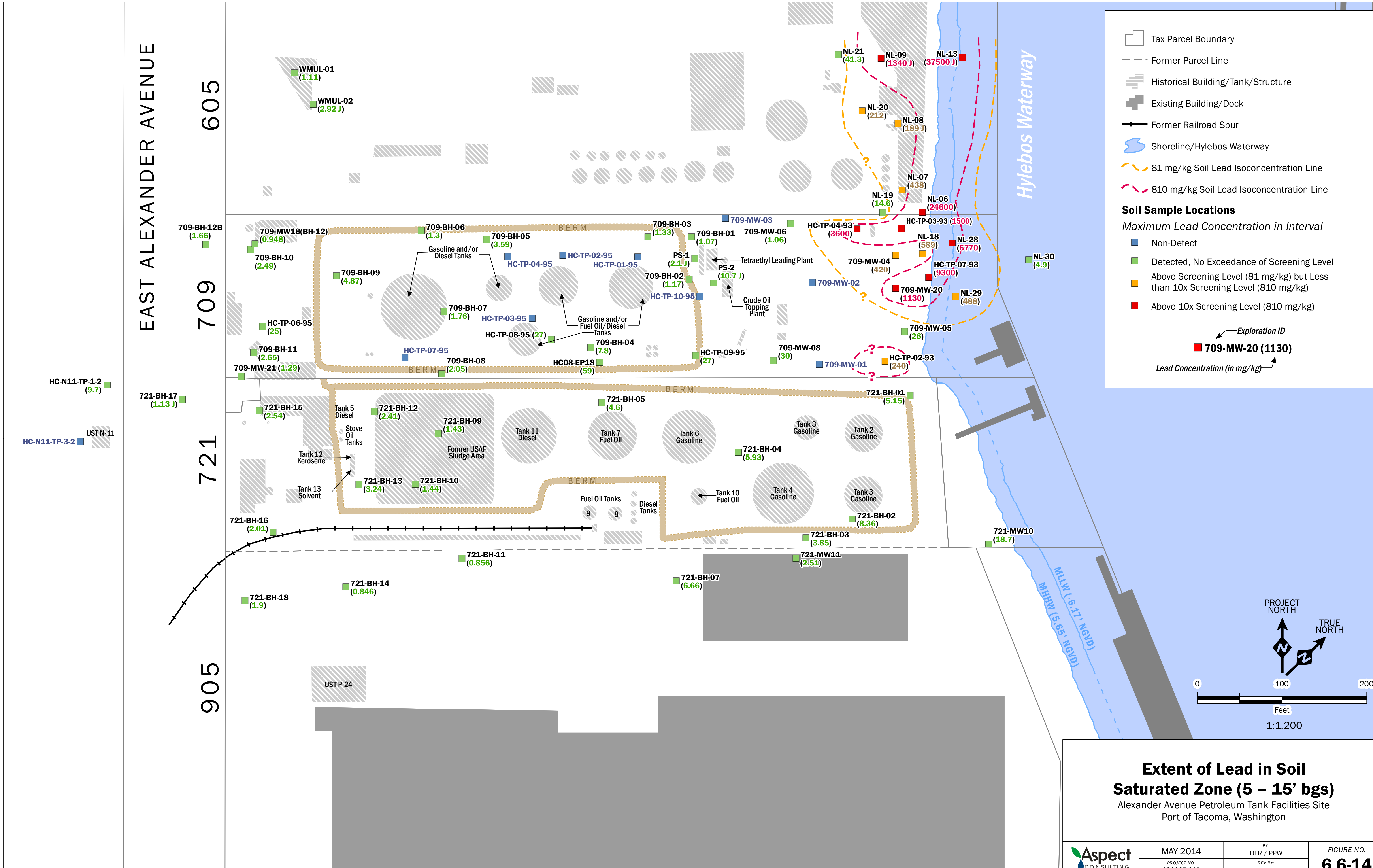


Extent of Lead in Soil
Unsaturated Zone (0 – 5' bgs)

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING

MAY-2014	BY: DFR / PPW	FIGURE NO.
PROJECT NO. 130097-01B	REV BY: EAH	6.6-13

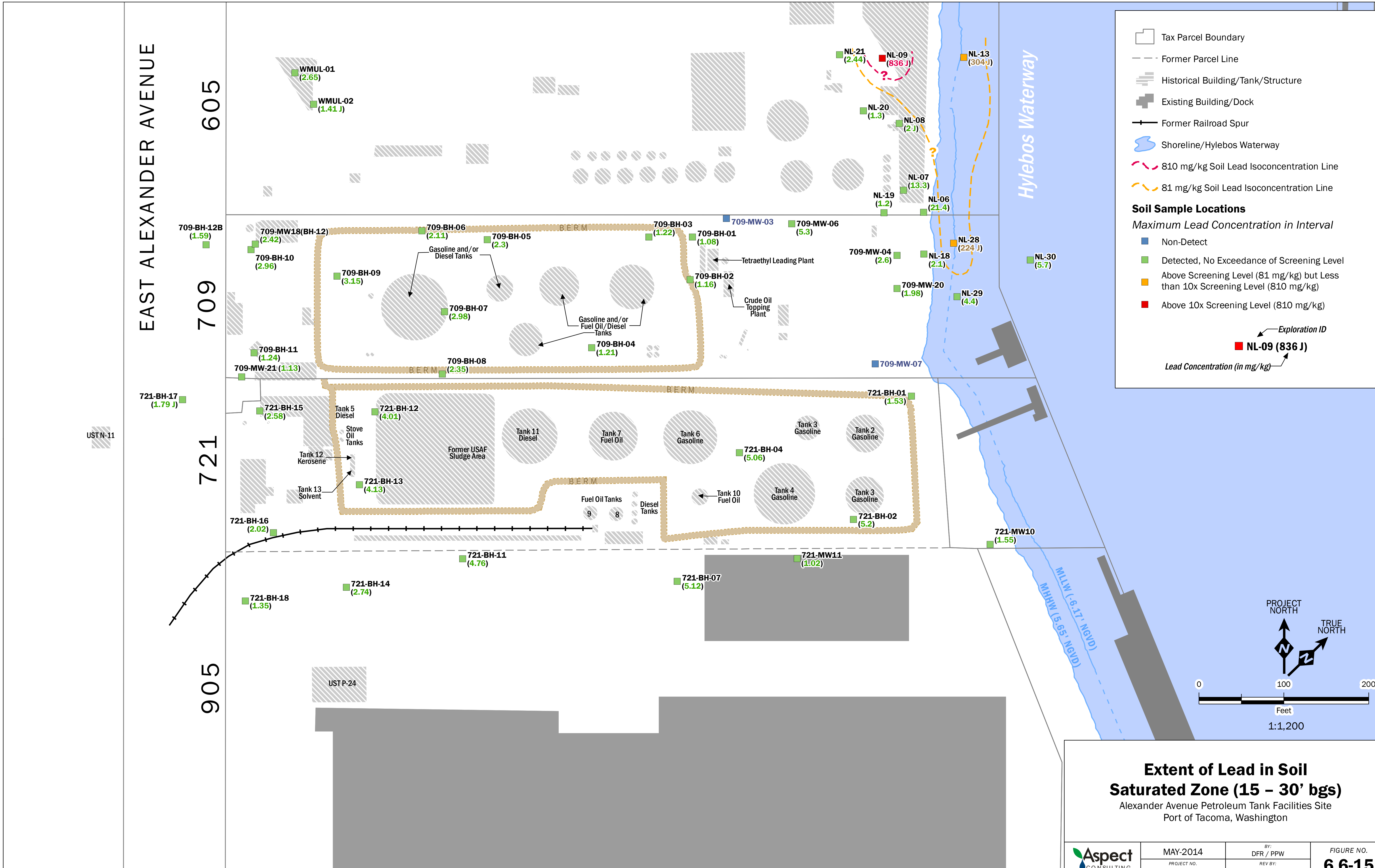


Extent of Lead in Soil
Saturated Zone (5 – 15' bgs)

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING

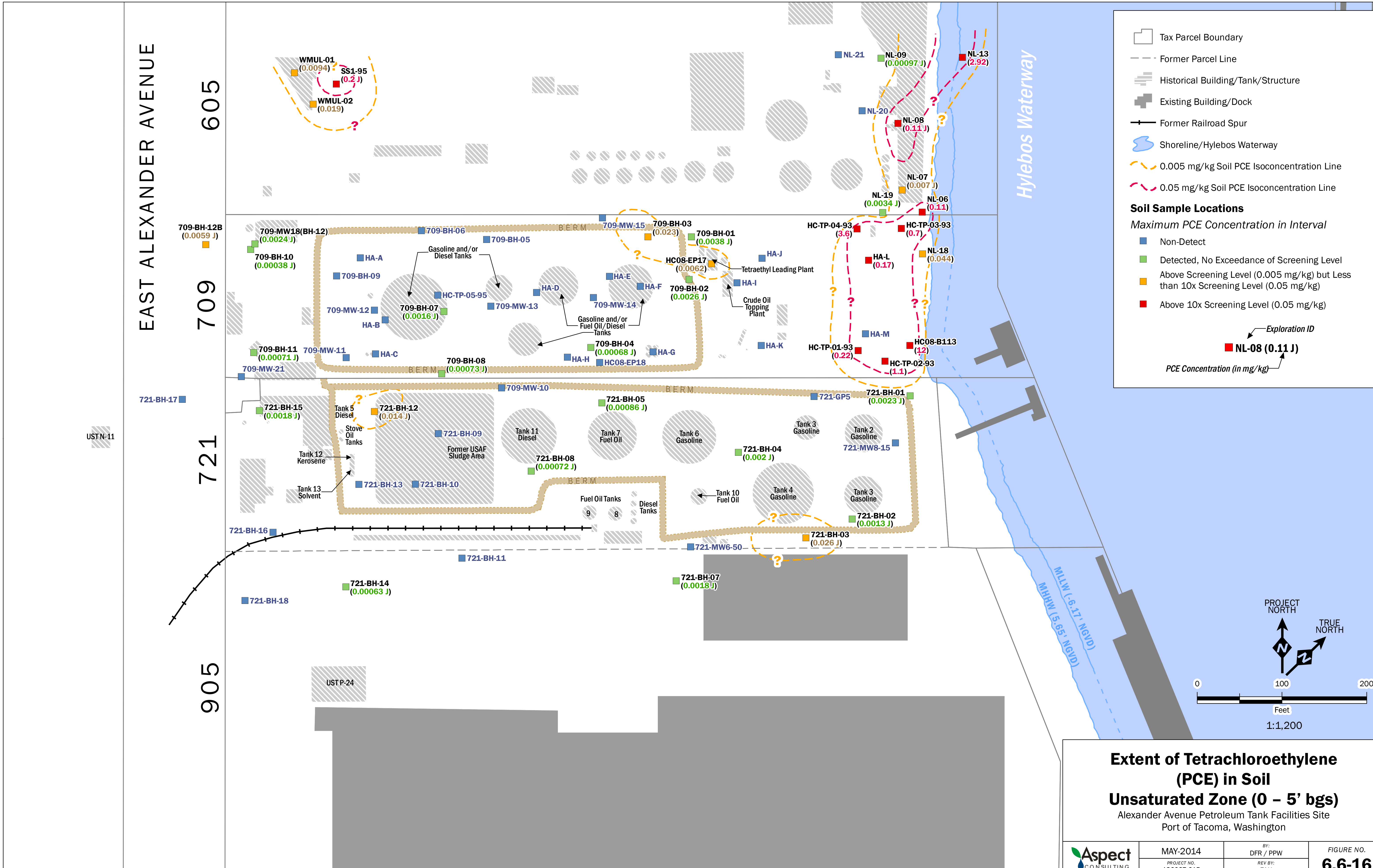
MAY-2014	BY: DFR / PPW	FIGURE NO.
PROJECT NO. 130097-01B	REV BY: EAH	6.6-14



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

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

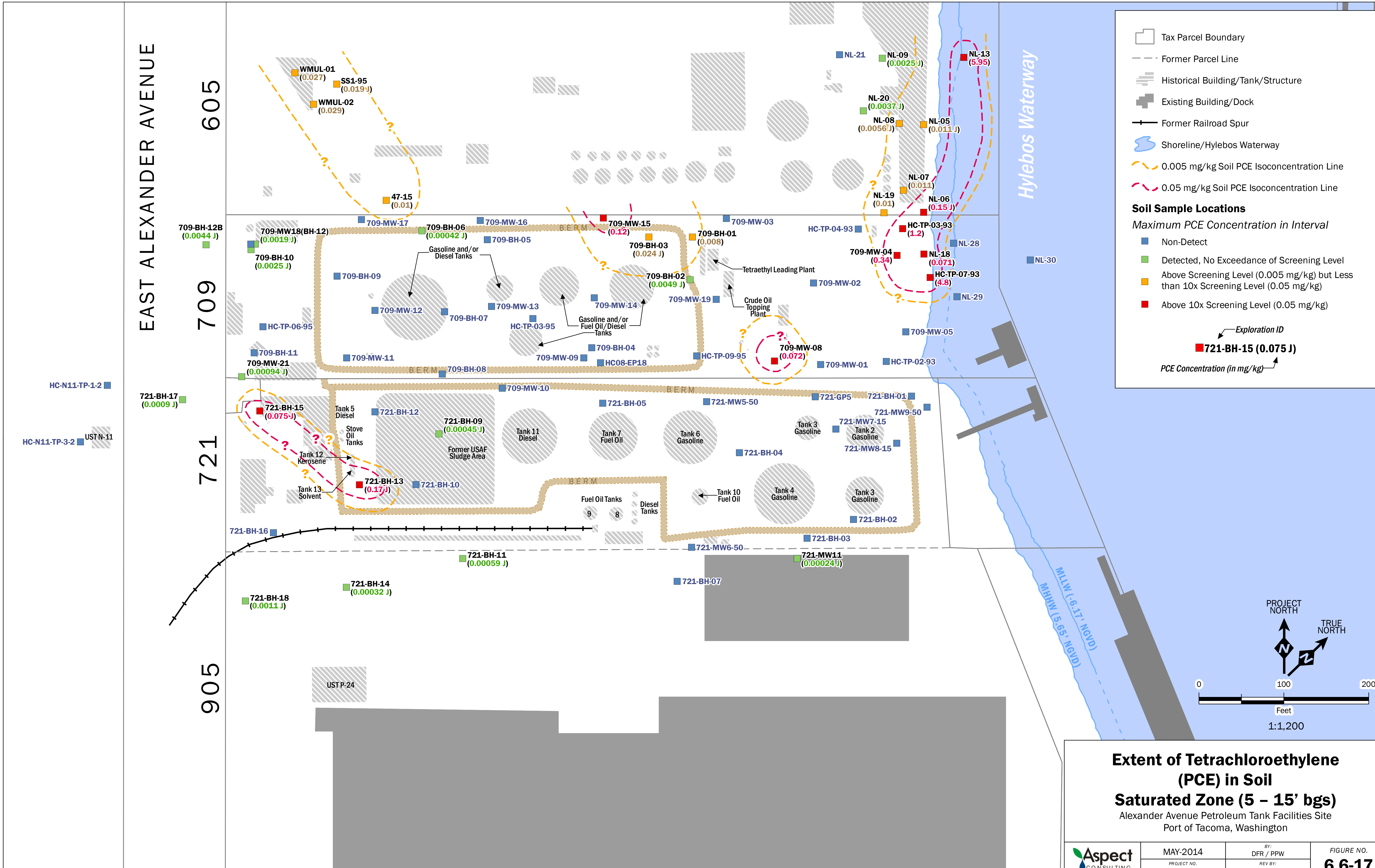
Aspect CONSULTING	MAY-2014	BY: DFR / PPW	FIGURE NO.
	PROJECT NO. 130097-01B	REV BY: EAH	6.6-15



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

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

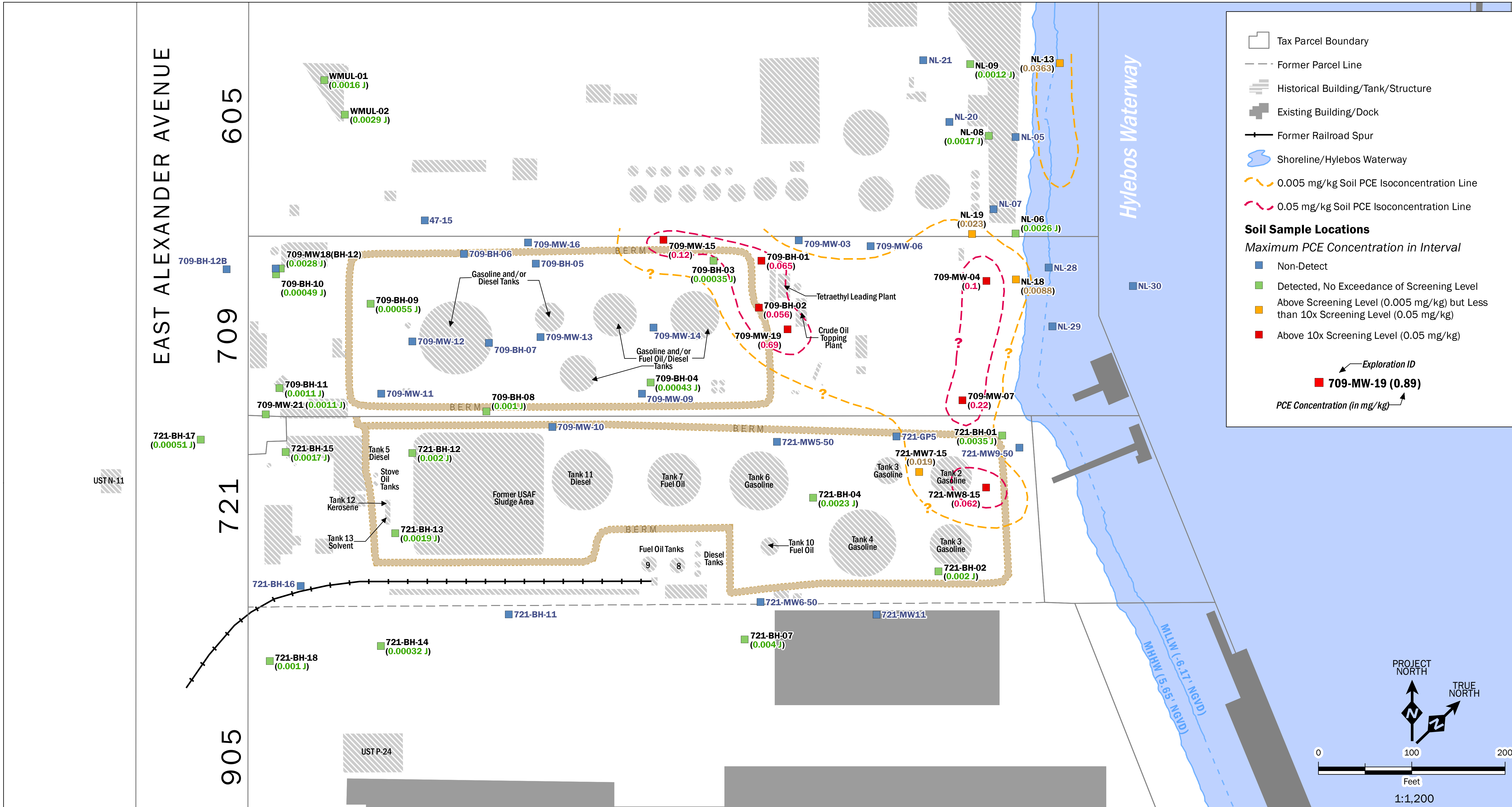
Aspect CONSULTING | MAY-2014 | BY: DFR / PPW | FIGURE NO. 6.6-16
PROJECT NO. 130097-01B | REV BY: EAH



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

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING	MAY-2014	BY: DFR / PPW	FIGURE NO.
	PROJECT NO. 130097-01B	REV BY: EAH	6.6-17

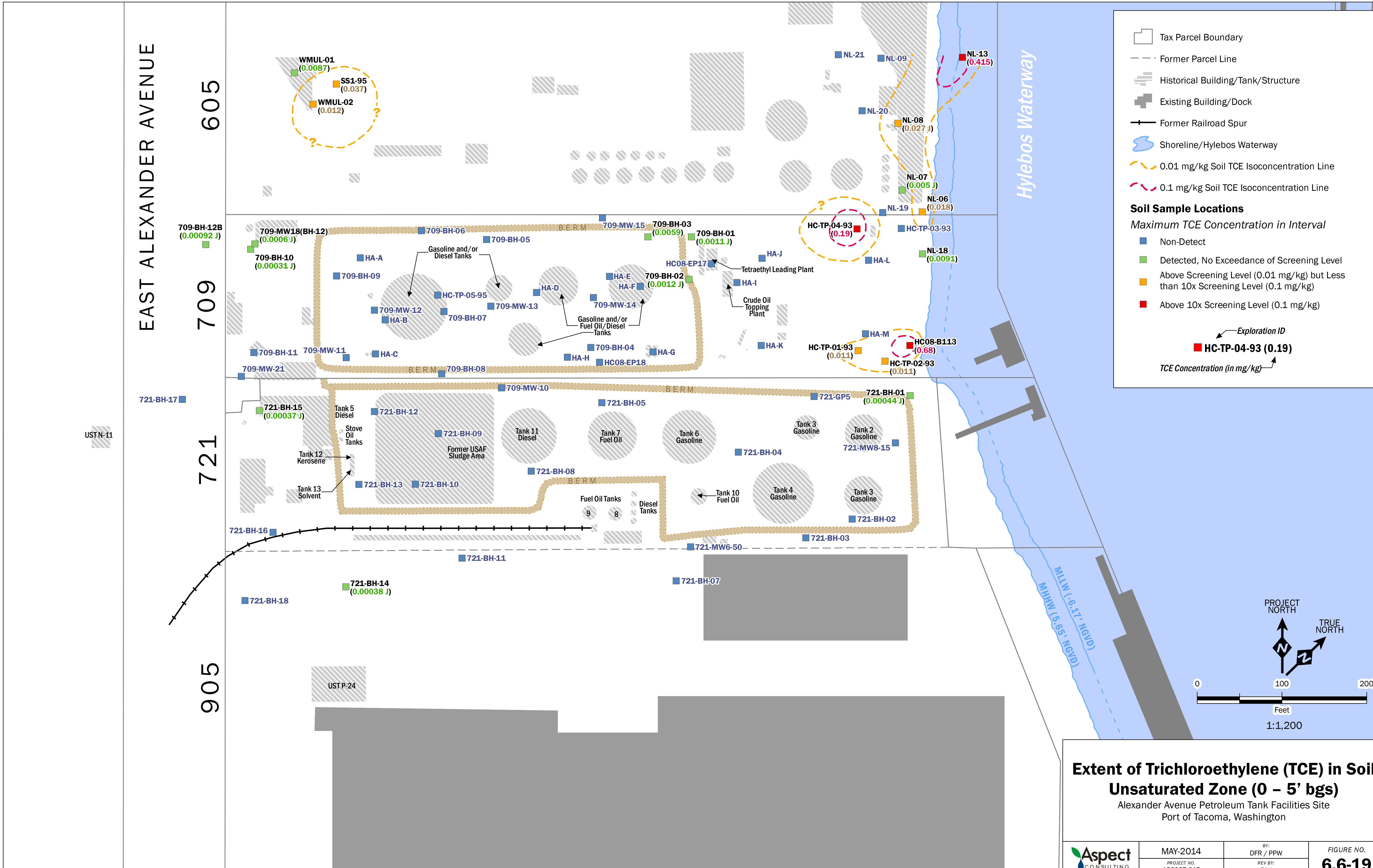


Extent of Tetrachloroethylene (PCE) in Soil Saturated Zone (15 – 30' bgs)

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING

MAY-2014	BY: DFR / PPW	FIGURE NO.	
PROJECT NO. 130097-01B	REV BY: EAH	6.6-18	



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

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING

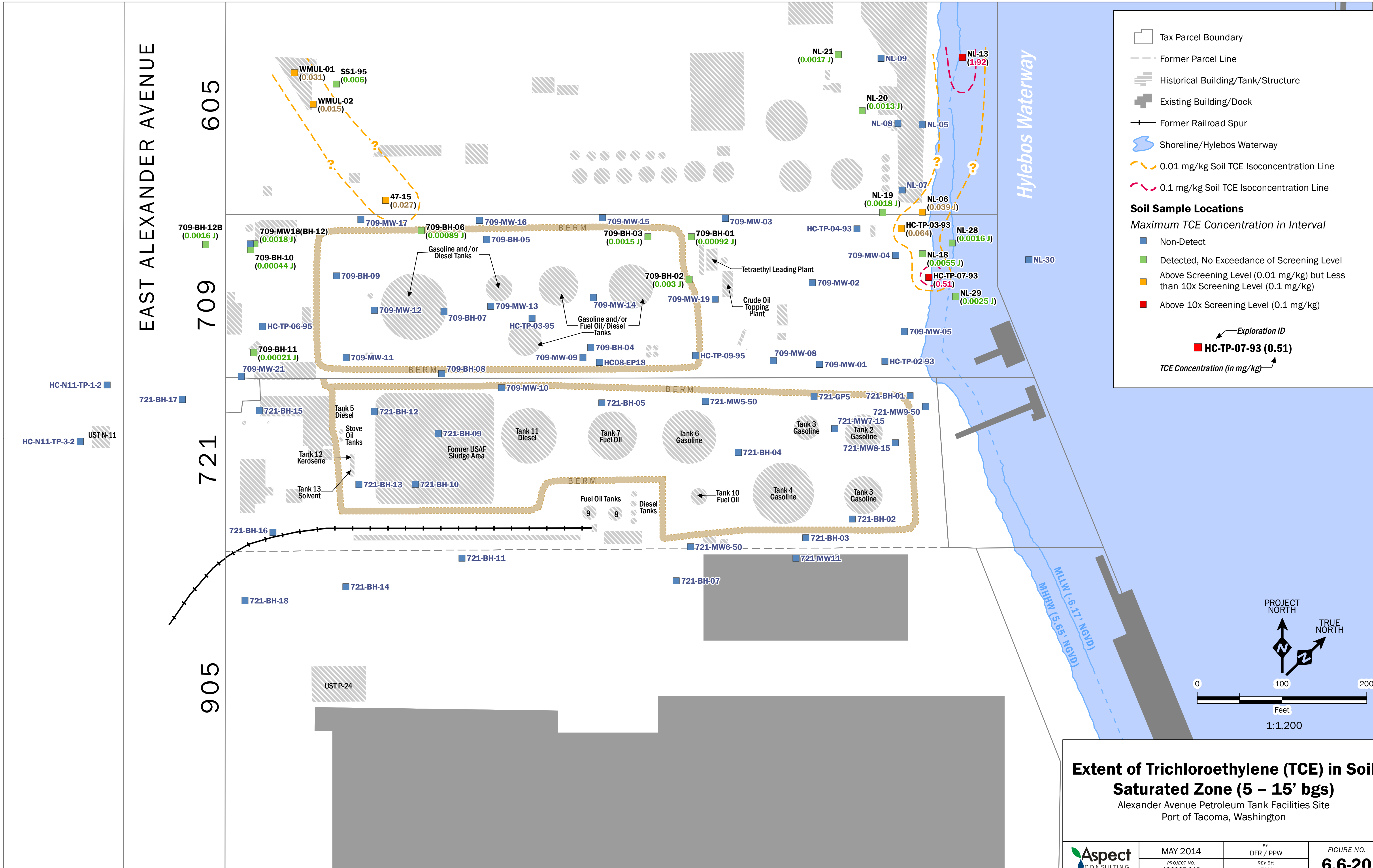
MAY-2014

PROJECT NO. 130097-01B

BY: DFR / PPW

REV BY: EAH

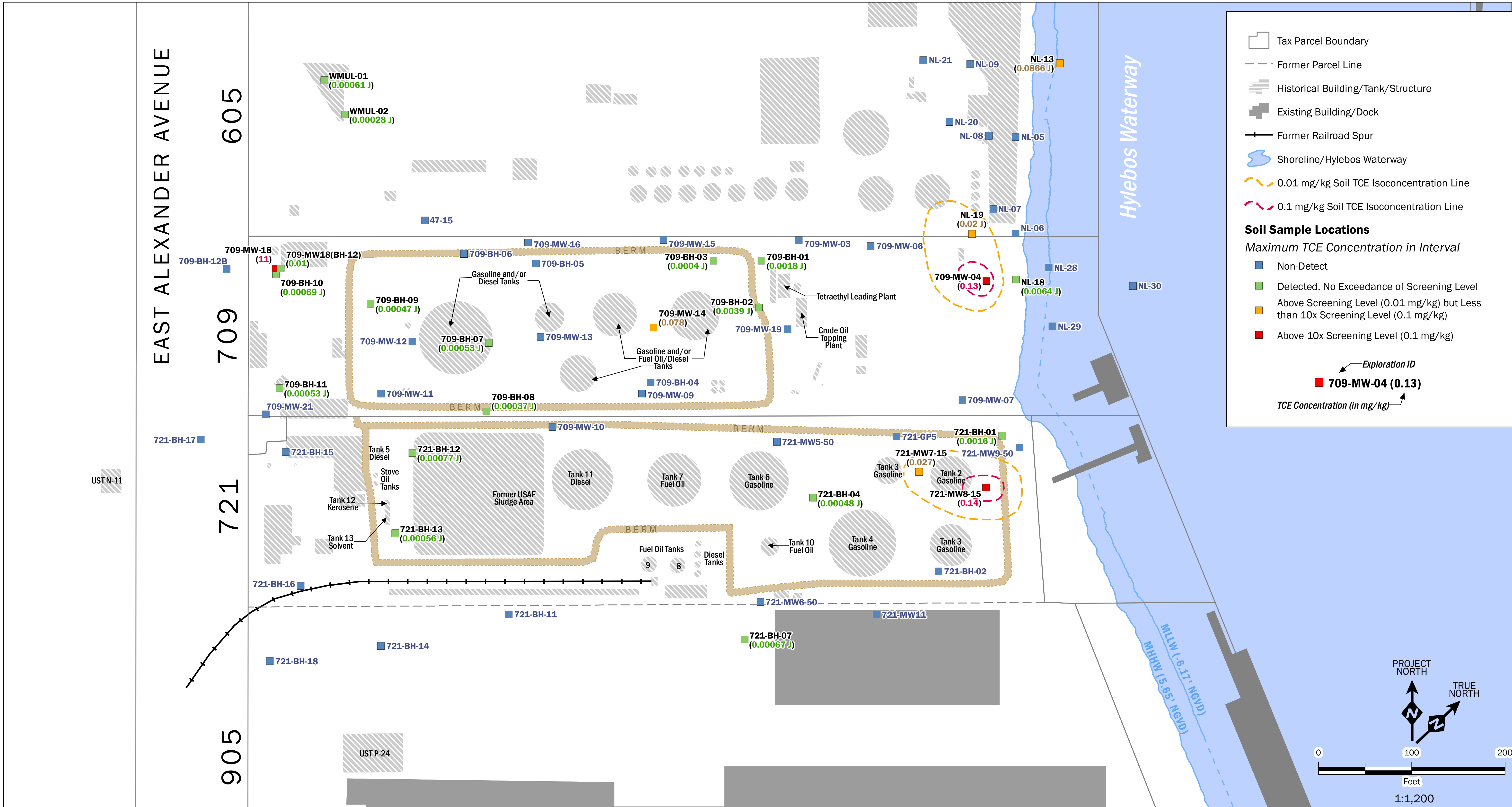
FIGURE NO. 6.6-19



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

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING	MAY-2014	BY: DFR / PPW	FIGURE NO.
	PROJECT NO. 130097-01B	REV BY: EAH	6.6-20

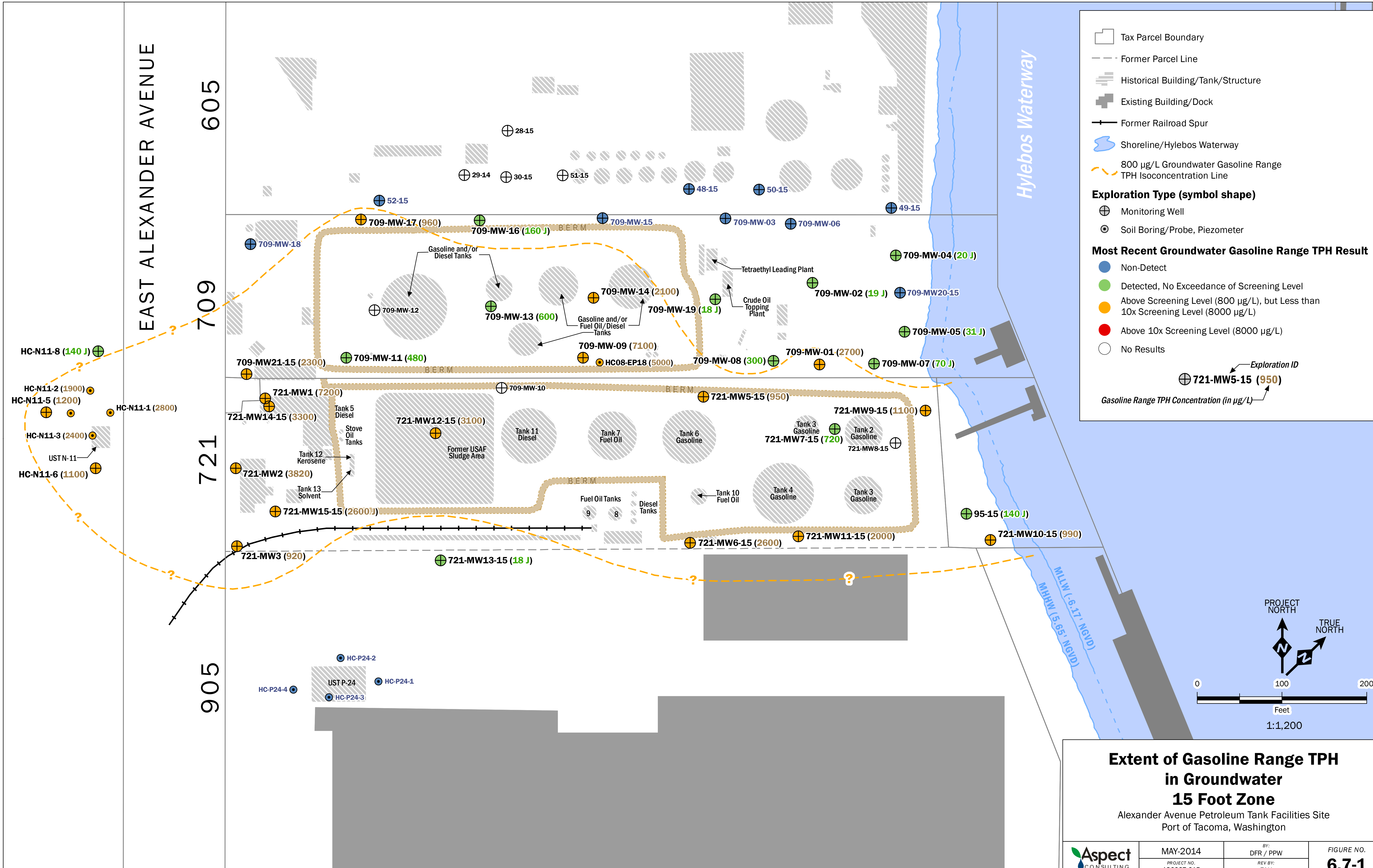


Extent of Trichloroethylene (TCE) in Soil Saturated Zone (15 – 30' bgs)

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING

MAY-2014	BY: DFR / PPW	FIGURE NO.	
PROJECT NO. 130097-01B	REV BY: EAH	6.6-21	

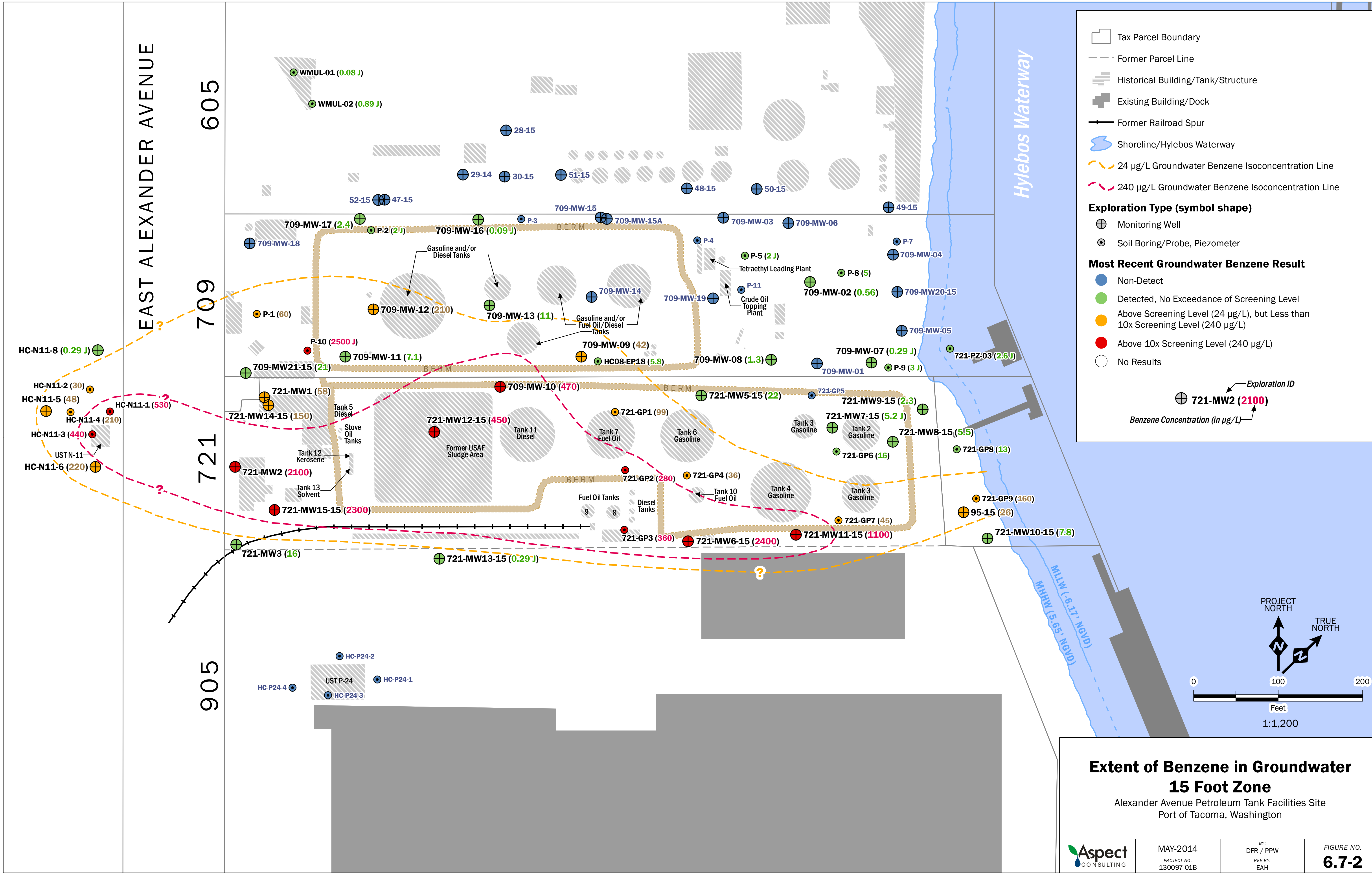


Extent of Gasoline Range TPH in Groundwater 15 Foot Zone

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

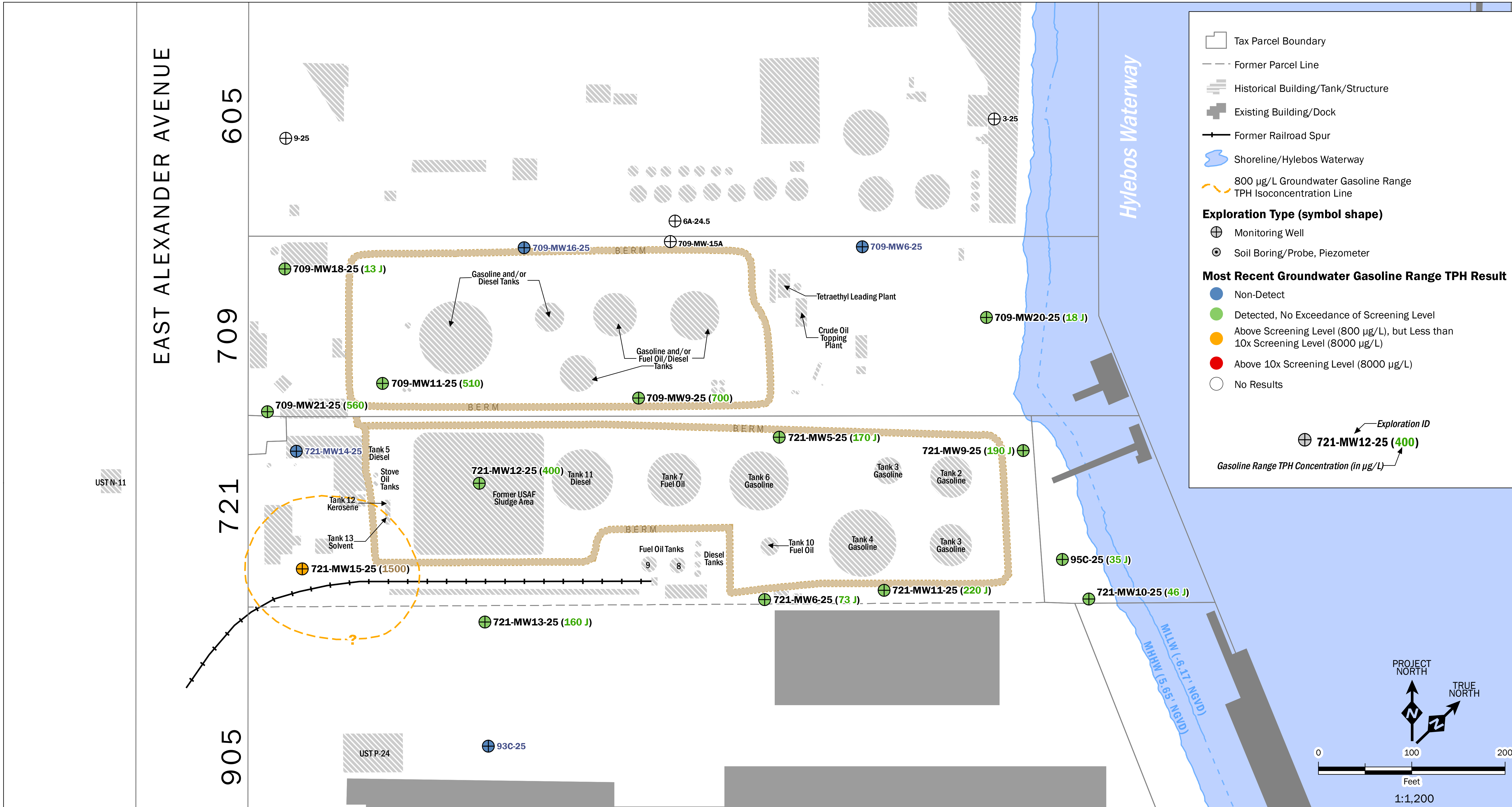
Aspect CONSULTING

MAY-2014
PROJECT NO. 130097-01B
BY: DFR / PPW
REV BY: EAH
FIGURE NO. 6.7-1



Extent of Benzene in Groundwater 15 Foot Zone

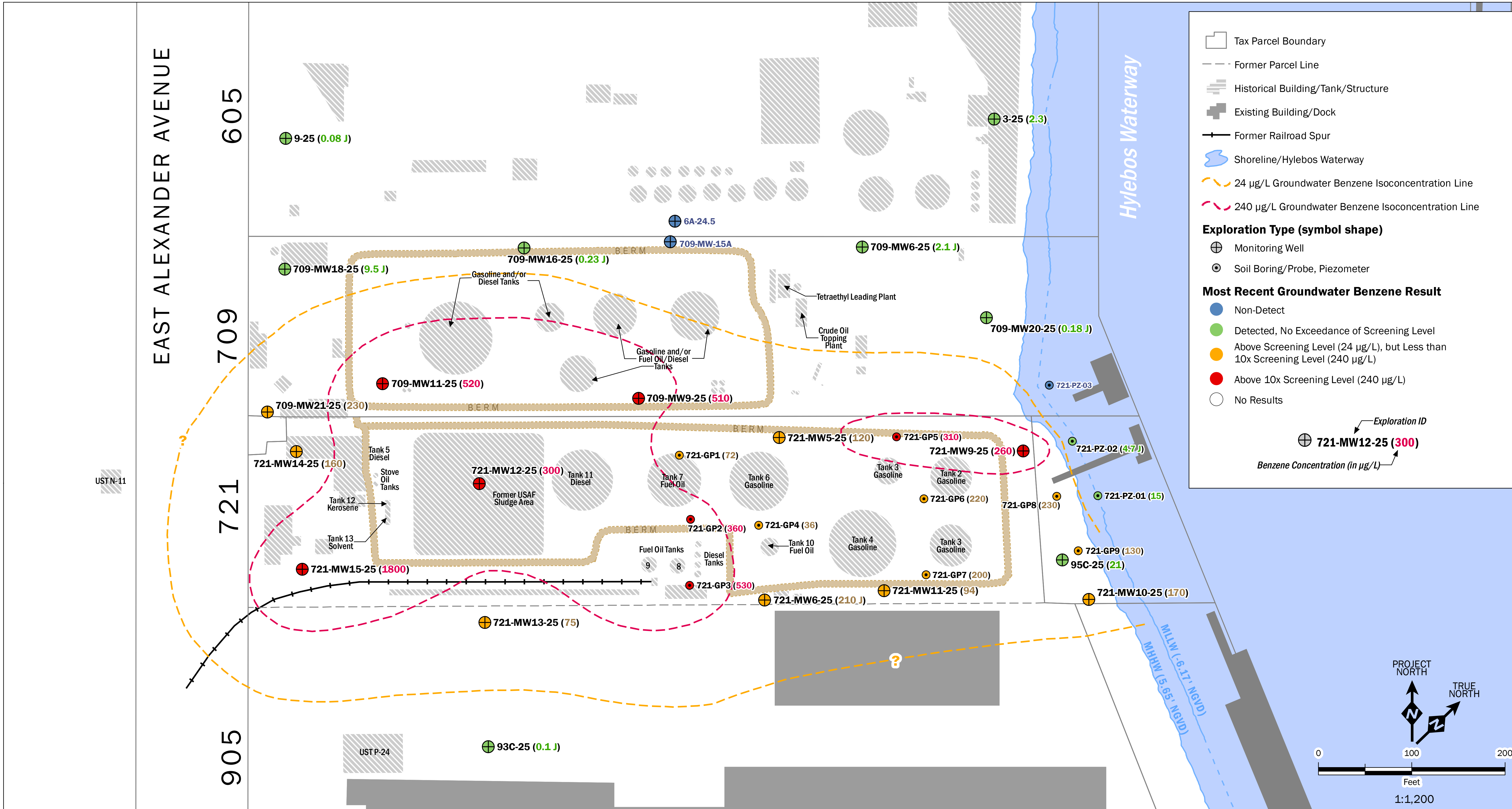
Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington



Extent of Gasoline Range TPH in Groundwater 25 Foot Zone

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING | MAY-2014 | BY: DFR / PPW | FIGURE NO.
PROJECT NO. 130097-01B | REV BY: EAH | 6.7-3

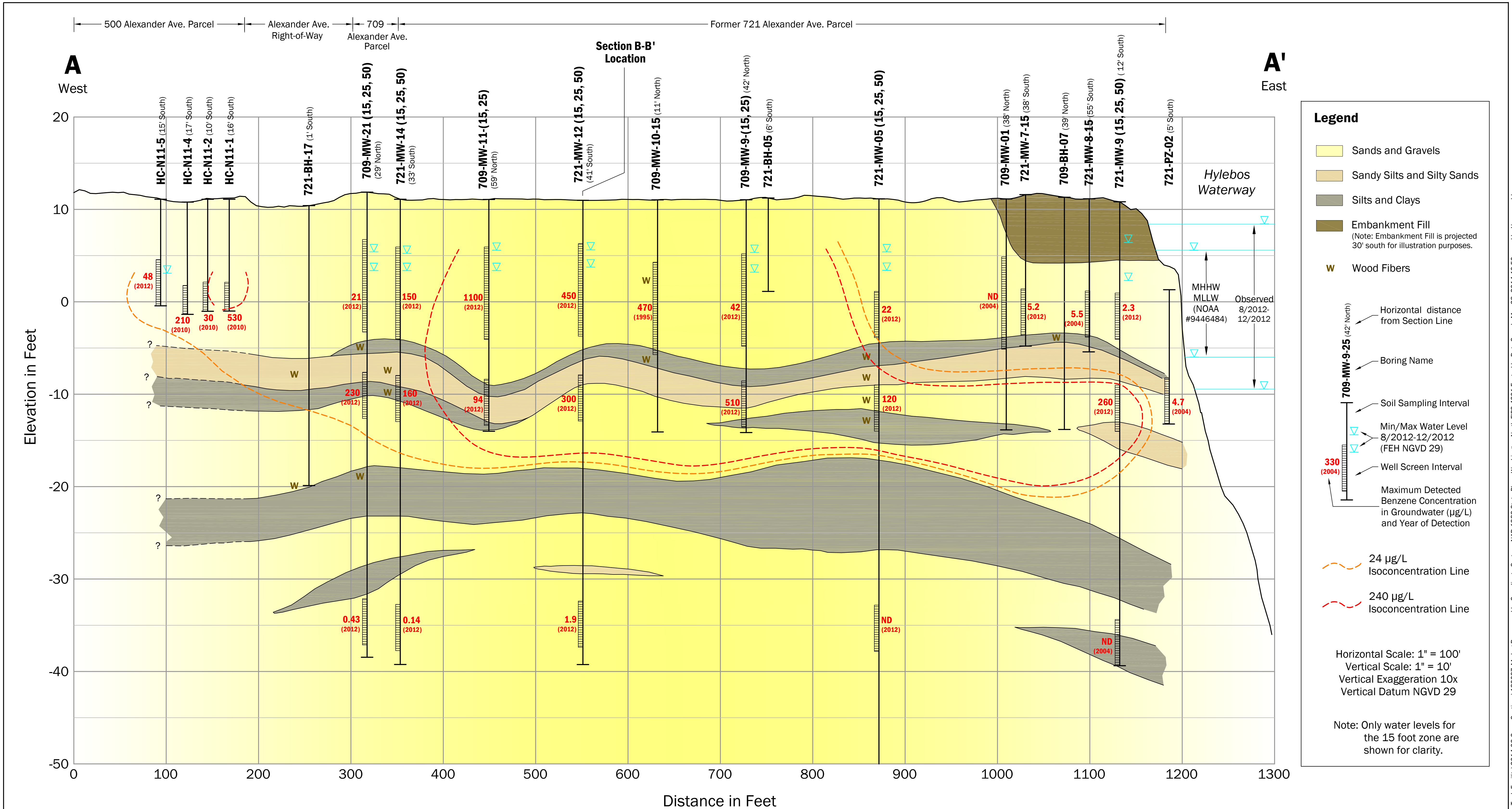


Extent of Benzene in Groundwater 25 Foot Zone

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING

MAY-2014	BY: DFR / PPW	FIGURE NO.	
PROJECT NO. 130097-01B	REV BY: EAH	6.7-4	



Feet

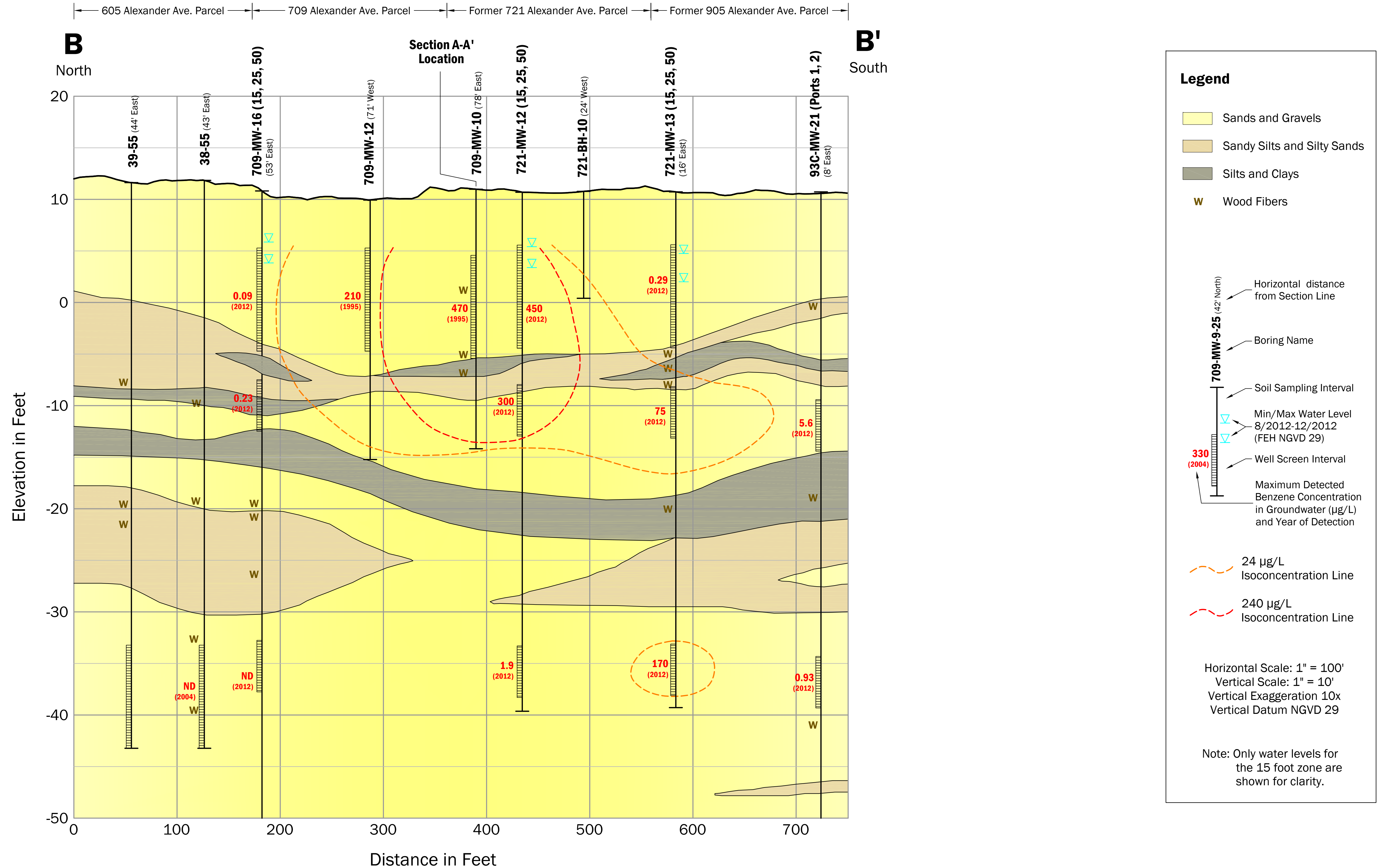
Cross Section A-A' with Benzene Concentrations in Groundwater

Alexander Avenue Petroleum Tank Facilities Site

Port of Tacoma, Washington

Aspect CONSULTING

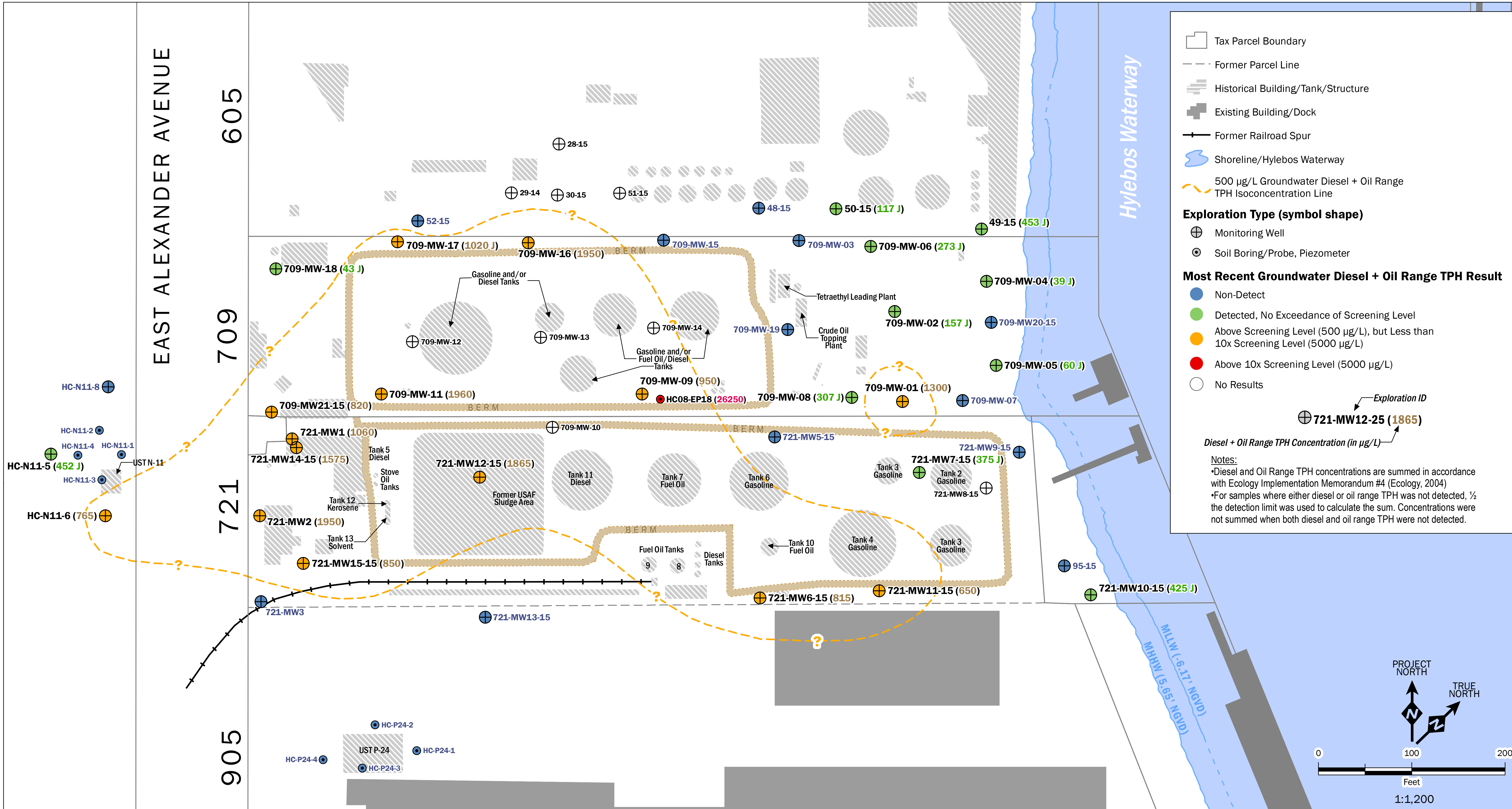
MAY-2014	BY: DFR/SCC	FIGURE NO.
PROJECT NO. 130097	REV BY: SCC	6.7-5A



Cross Section B-B' with Benzene Concentrations in Groundwater

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

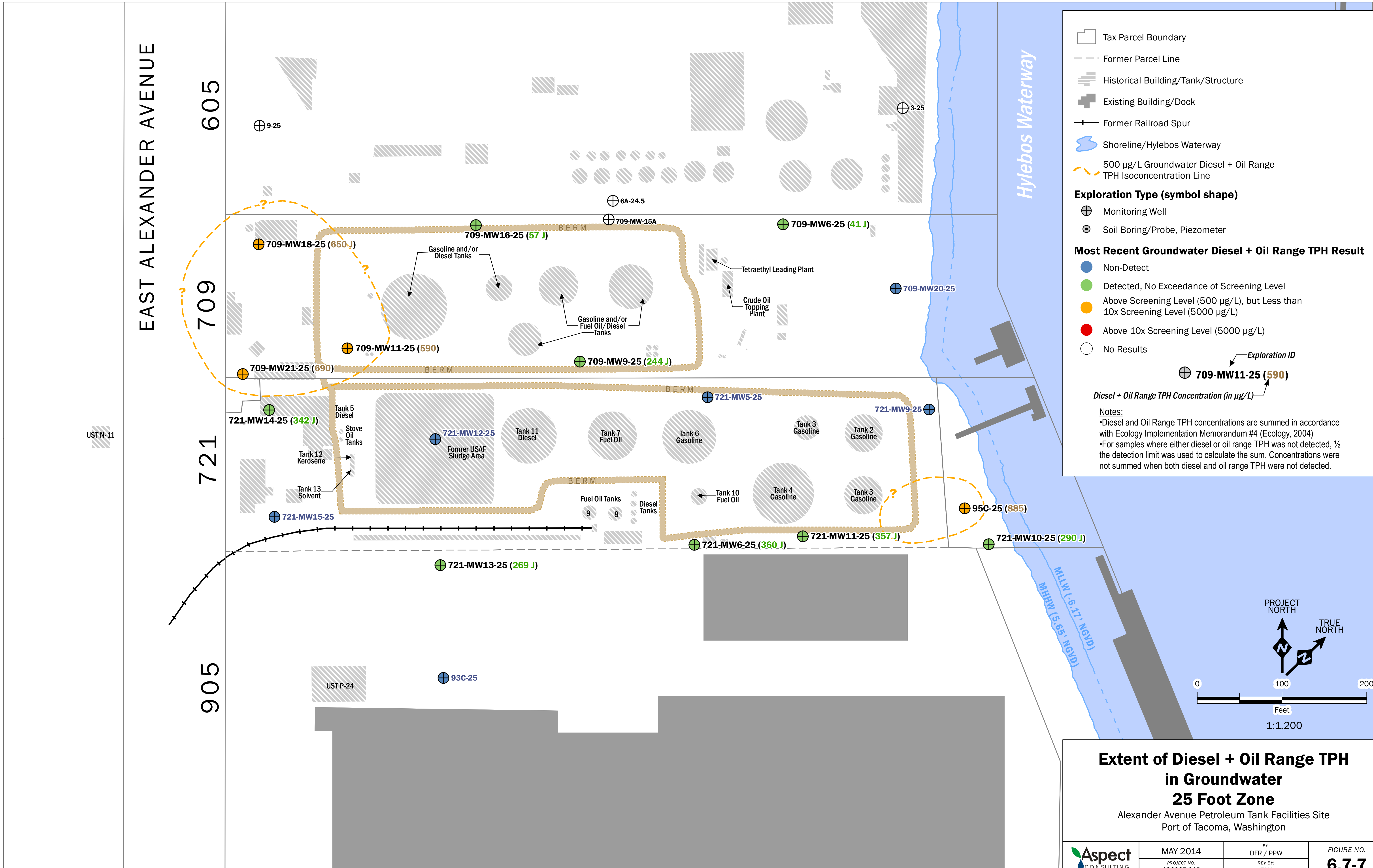
Aspect Consulting	MAY-2014	BY: DFR/SCC	FIGURE NO.
	PROJECT NO. 130097	REV BY: SCC	6.7-5B



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

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

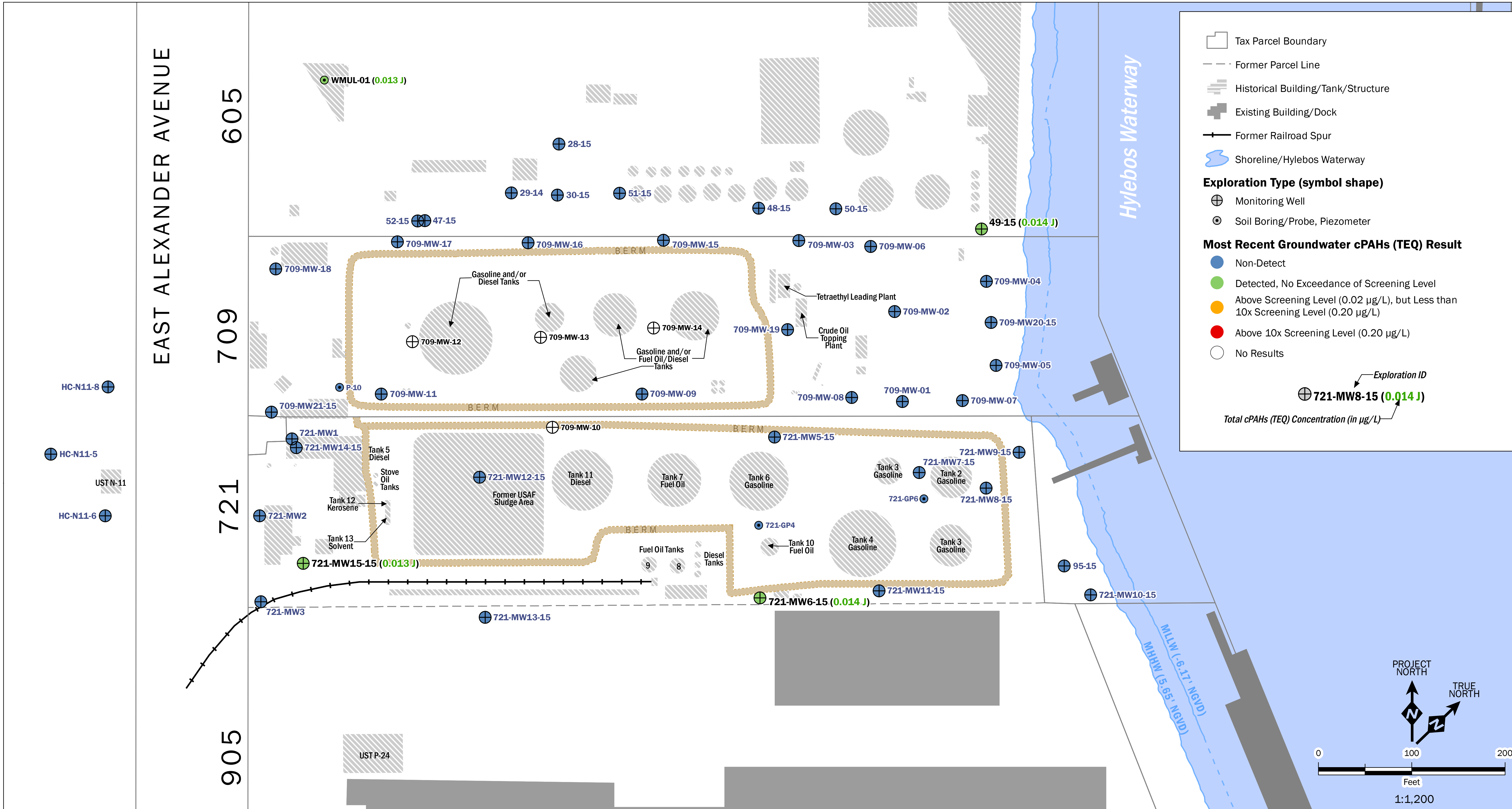
Aspect CONSULTING	JUN-2014	BY: DFR / PPW	FIGURE NO.
	PROJECT NO. 130097-01B	REV BY: EAH	6.7-6



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

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING | MAY-2014 | BY: DFR / PPW | FIGURE NO. 6.7-7
PROJECT NO. 130097-01B | REV BY: EAH

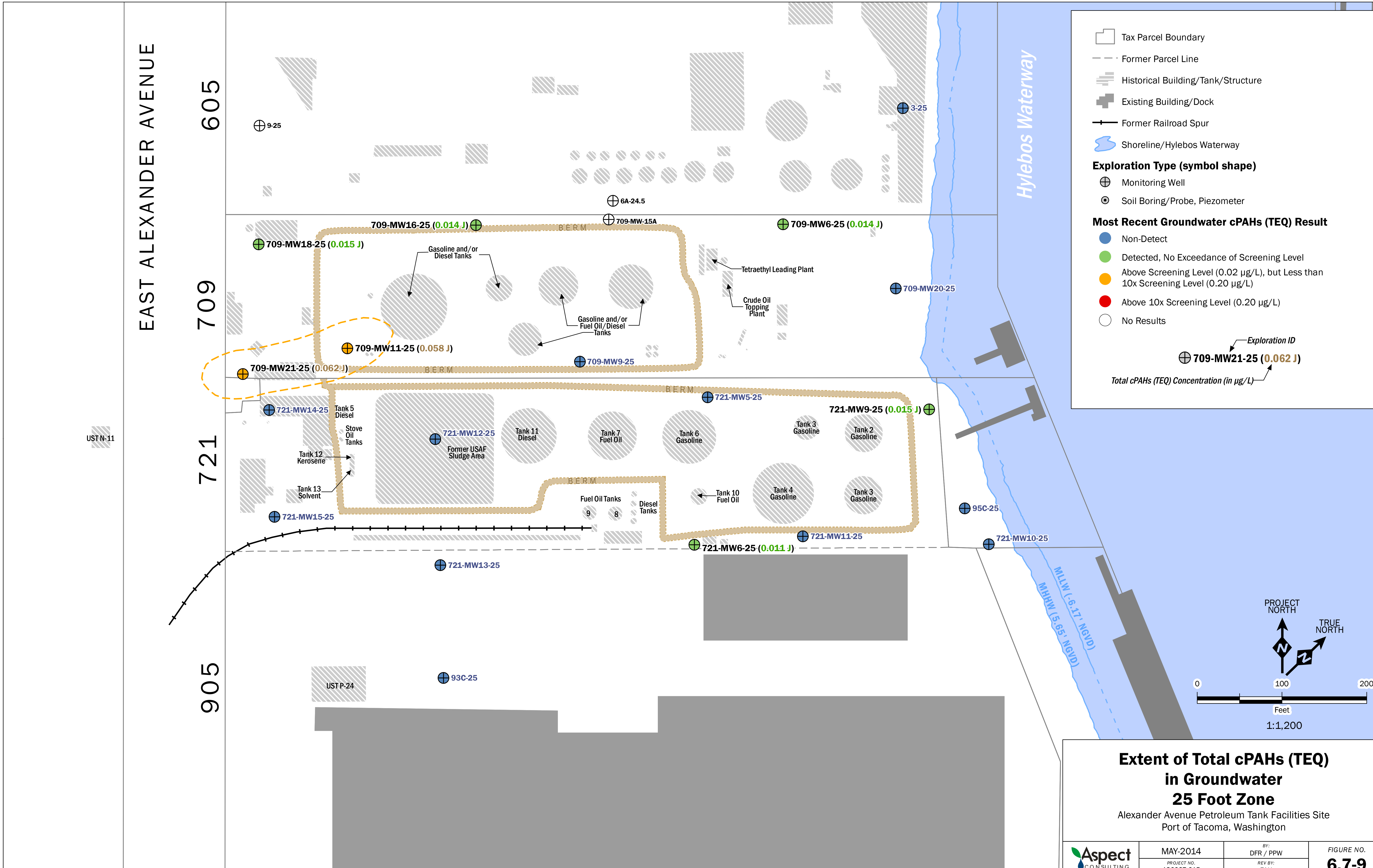


Extent of Total cPAHs (TEQ) in Groundwater 15 Foot Zone

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING

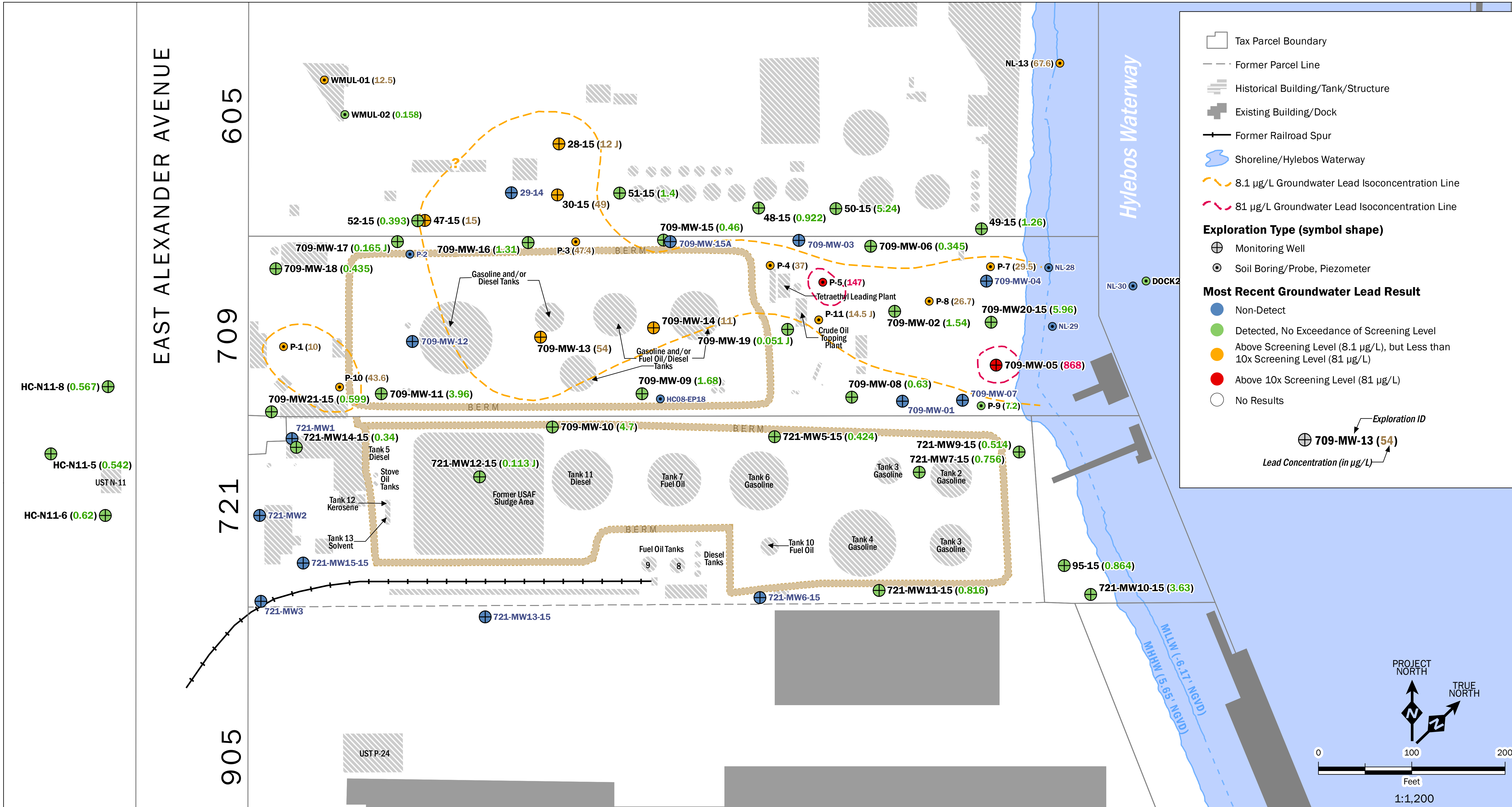
MAY-2014	BY: DFR / PPW	FIGURE NO.	
PROJECT NO. 130097-01B	REV BY: EAH	6.7-8	



Extent of Total cPAHs (TEQ) in Groundwater 25 Foot Zone

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

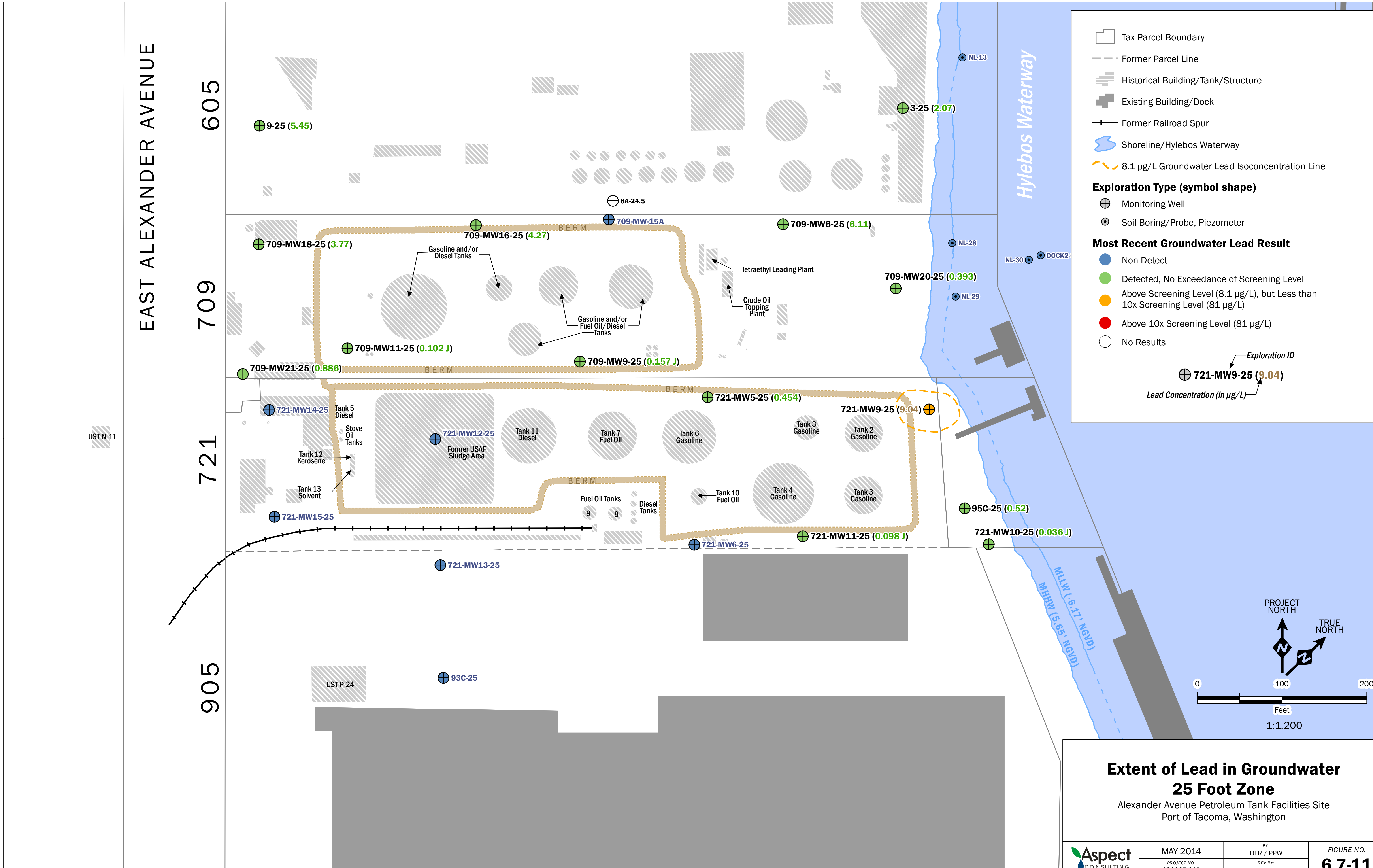
Aspect CONSULTING	MAY-2014	BY: DFR / PPW	FIGURE NO.
	PROJECT NO. 130097-01B	REV BY: EAH	6.7-9



Extent of Lead in Groundwater
15 Foot Zone

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

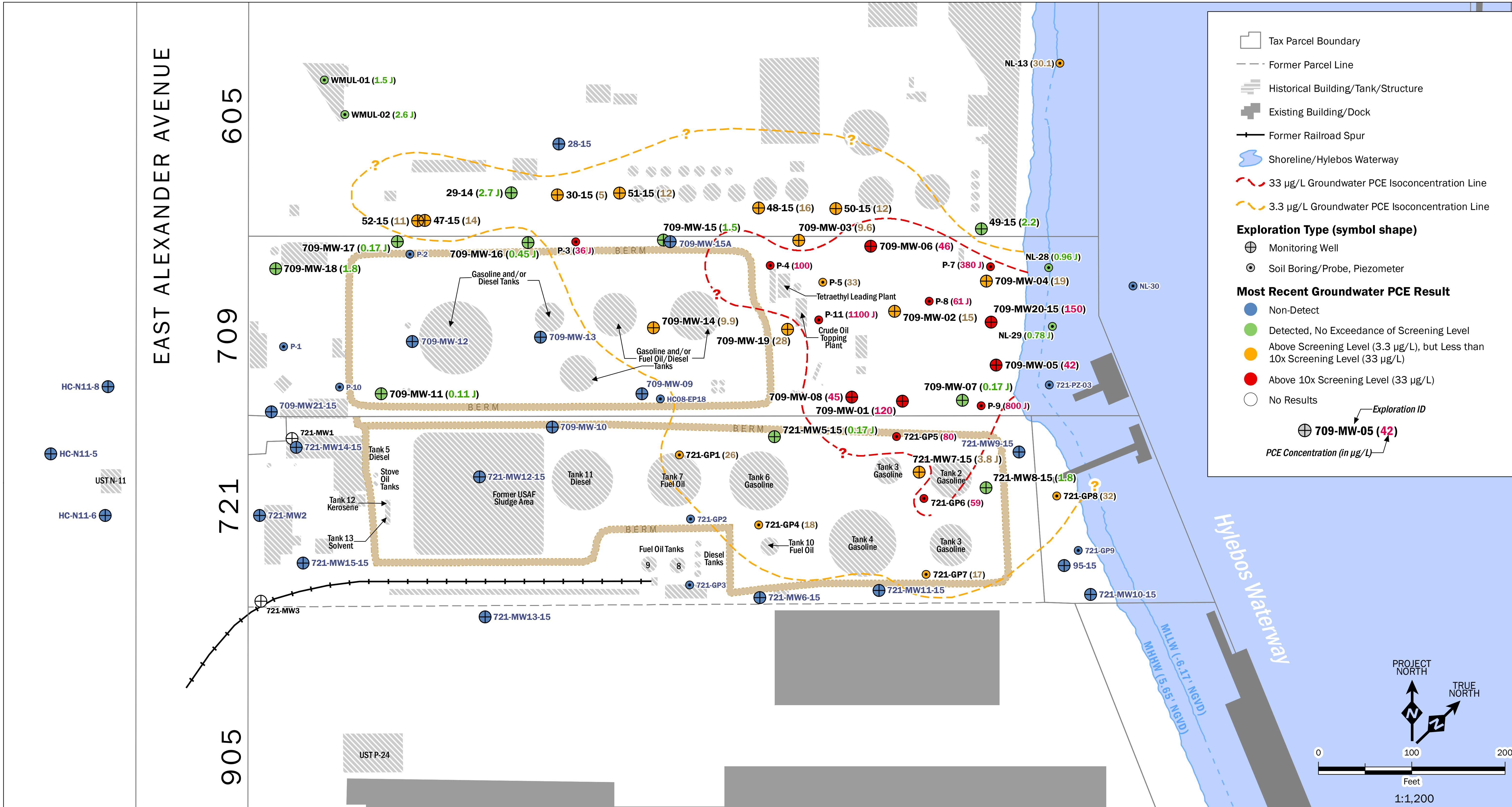
Aspect CONSULTING | MAY-2014 | BY: DFR / PPW | FIGURE NO.
PROJECT NO. 130097-01B | REV BY: EAH | 6.7-10



Extent of Lead in Groundwater
25 Foot Zone

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING	MAY-2014	BY: DFR / PPW	FIGURE NO.
	PROJECT NO. 130097-01B	REV BY: EAH	6.7-11

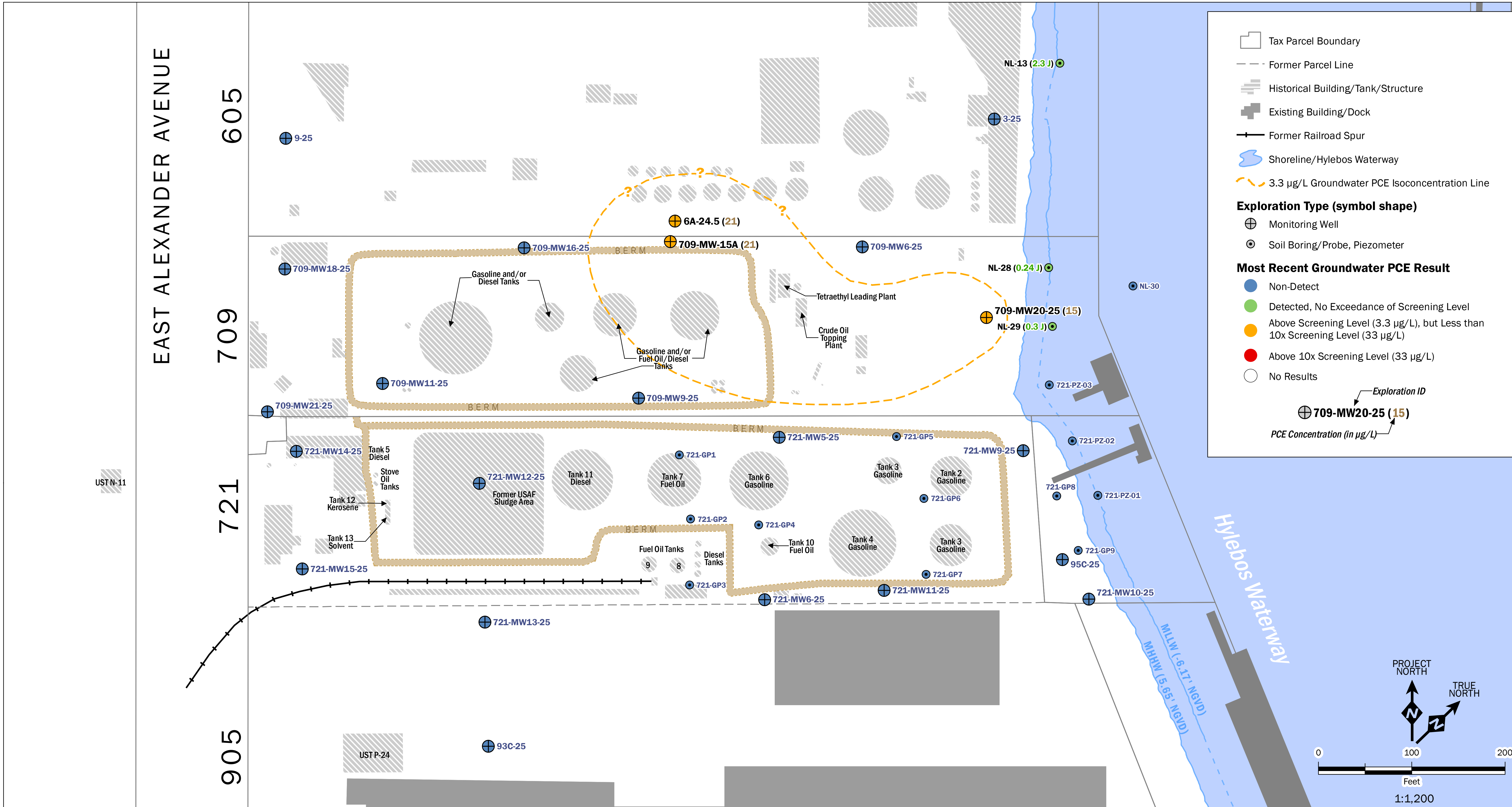


Extent of Tetrachloroethylene (PCE) in Groundwater 15 Foot Zone

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING	MAY-2014 PROJECT NO. 130097-01B	BY: DFR / PPW REV BY: EAH/PPW	FIGURE NO. 6.7-12

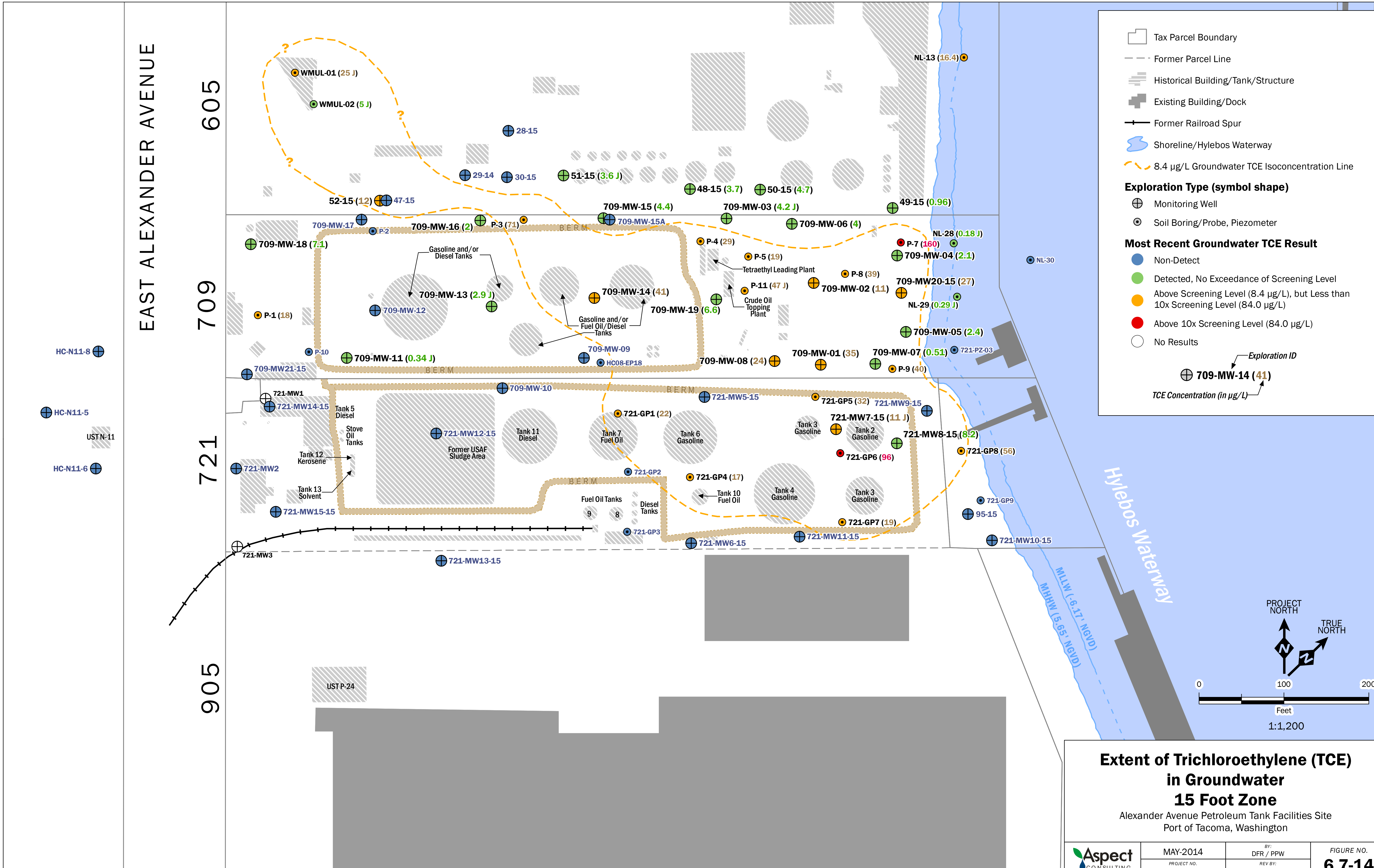
GIS Path: T:\projects_8\Port_of_Tacoma\AlexanderAve_130097\Delivered\FINAL_RIFS_WORKPLAN_JULY2014\6.7-12 GW PCE 15.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 5/29/2014 || User: ecumbaker || Print Date: 5/29/2014



Extent of Tetrachloroethylene (PCE) in Groundwater 25 Foot Zone

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

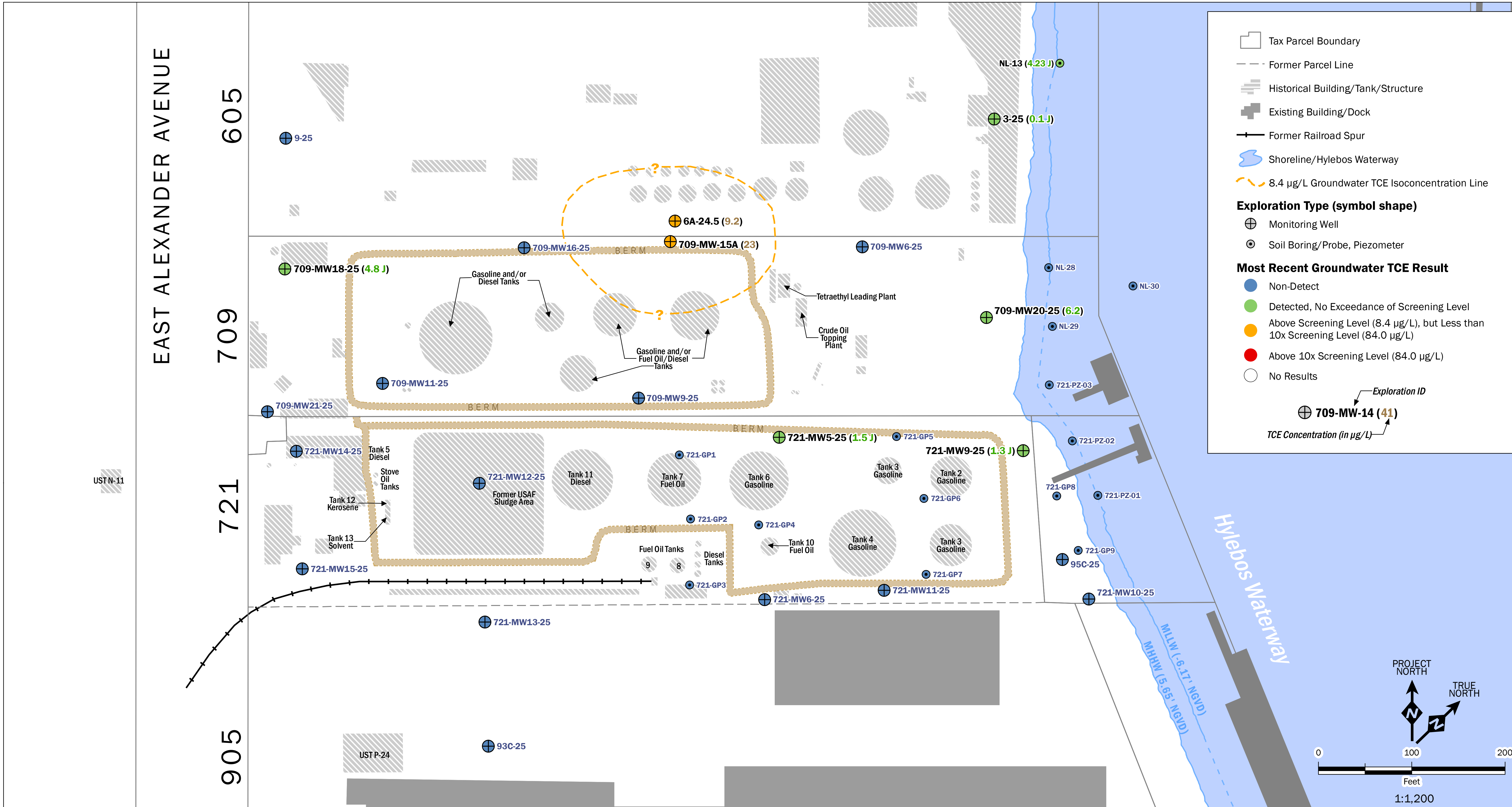
Aspect CONSULTING | MAY-2014 | BY: DFR / PPW | FIGURE NO. 6.7-13
PROJECT NO. 130097-01B | REV BY: EAH



Extent of Trichloroethylene (TCE) in Groundwater 15 Foot Zone

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING	MAY-2014	BY: DFR / PPW	FIGURE NO.
	PROJECT NO. 130097-01B	REV BY: EAH	6.7-14

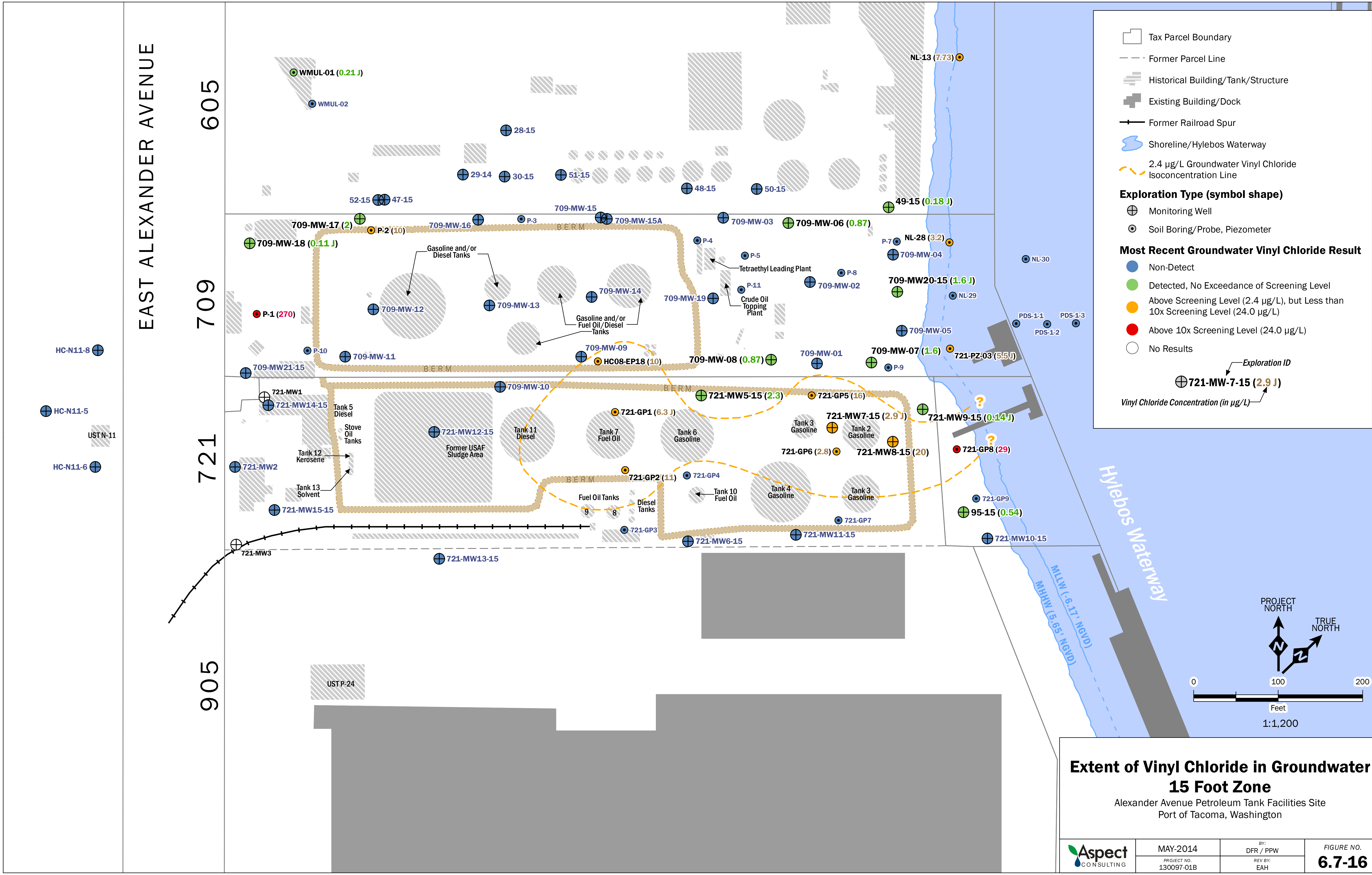


Extent of Trichloroethylene (TCE) in Groundwater 25 Foot Zone

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING

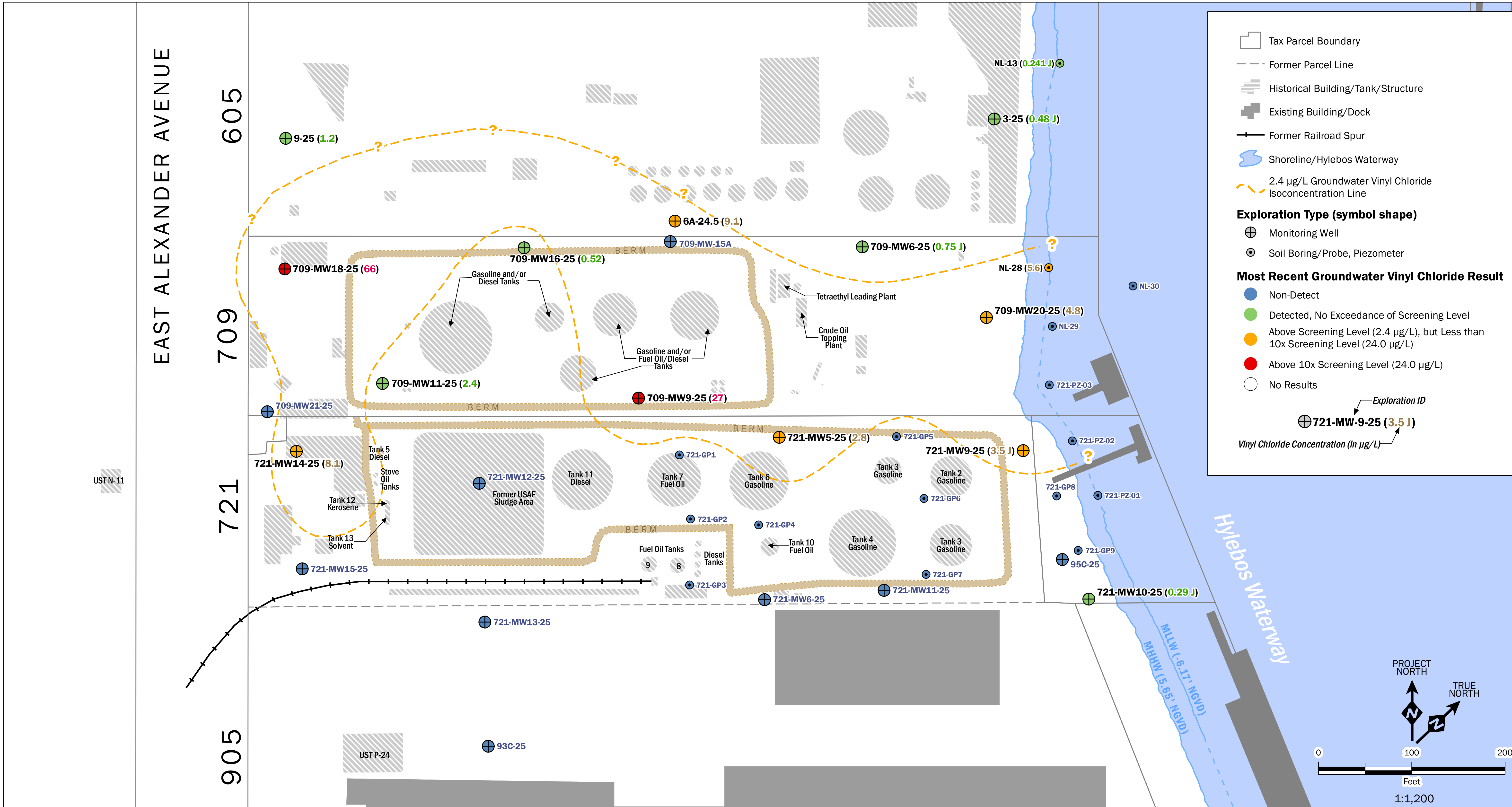
MAY-2014	BY: DFR / PPW	FIGURE NO.
PROJECT NO. 130097-01B	REV BY: EAH	6.7-15



Extent of Vinyl Chloride in Groundwater 15 Foot Zone

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

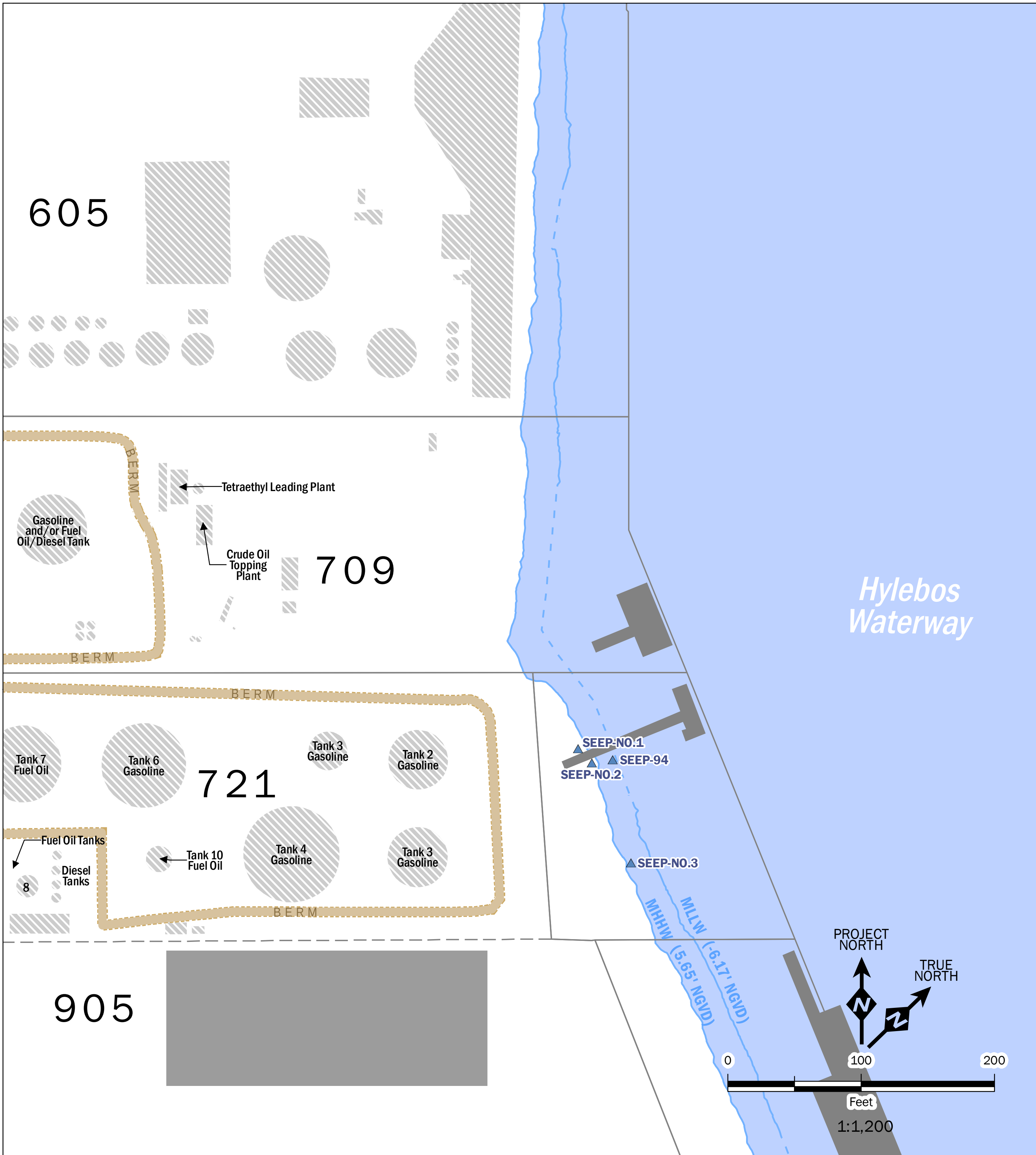
Aspect CONSULTING | MAY-2014 | BY: DFR / PPW | FIGURE NO.
PROJECT NO. 130097-01B | REV BY: EAH | 6.7-16



Extent of Vinyl Chloride in Groundwater
25 Foot Zone

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING	MAY-2014 PROJECT NO. 130097-01B	BY: DFR / PPW REV BY: EAH	FIGURE NO. 6.7-17



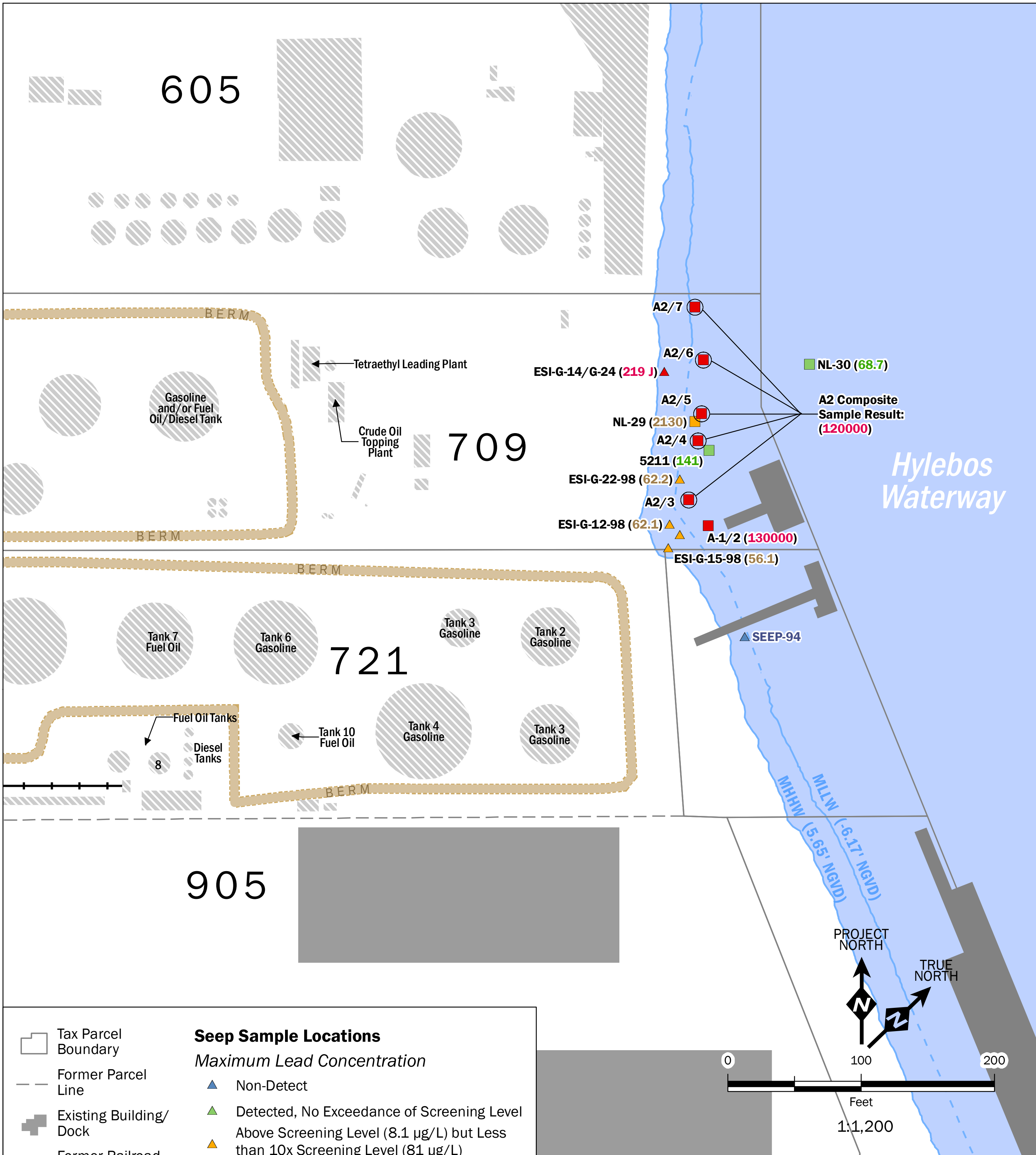
Tax Parcel Boundary
Former Parcel Line
Existing Building/Dock
Former Railroad Spur
Shoreline/Hylebos Waterway

Seep Sample Locations
Maximum Benzene Concentration
Non-Detect

Sediment/Seep Sample Locations and Extent of Benzene in Sediment/Seeps

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING	MAY-2014	BY: DFR / PPW	FIGURE NO.
	PROJECT NO. 130097-01B	REV BY: EAH	6.8-1



Legend

Tax Parcel Boundary

Former Parcel Line

Existing Building/ Dock

Former Railroad Spur

Shoreline/ Hylebos Waterway

Seep Sample Locations

Maximum Lead Concentration

- Non-Detect
- Detected, No Exceedance of Screening Level
- Above Screening Level (8.1 µg/L) but Less than 10x Screening Level (81 µg/L)
- Above 10x Screening Level (81 µg/L)

Sediment Sample Locations

Maximum Lead Concentration

- Non-Detect
- Detected, No Exceedance of Screening Level
- Above Screening Level (450 mg/kg) but Less than 10x Screening Level (4500 mg/kg)
- Above 10x Screening Level (4500 mg/kg)

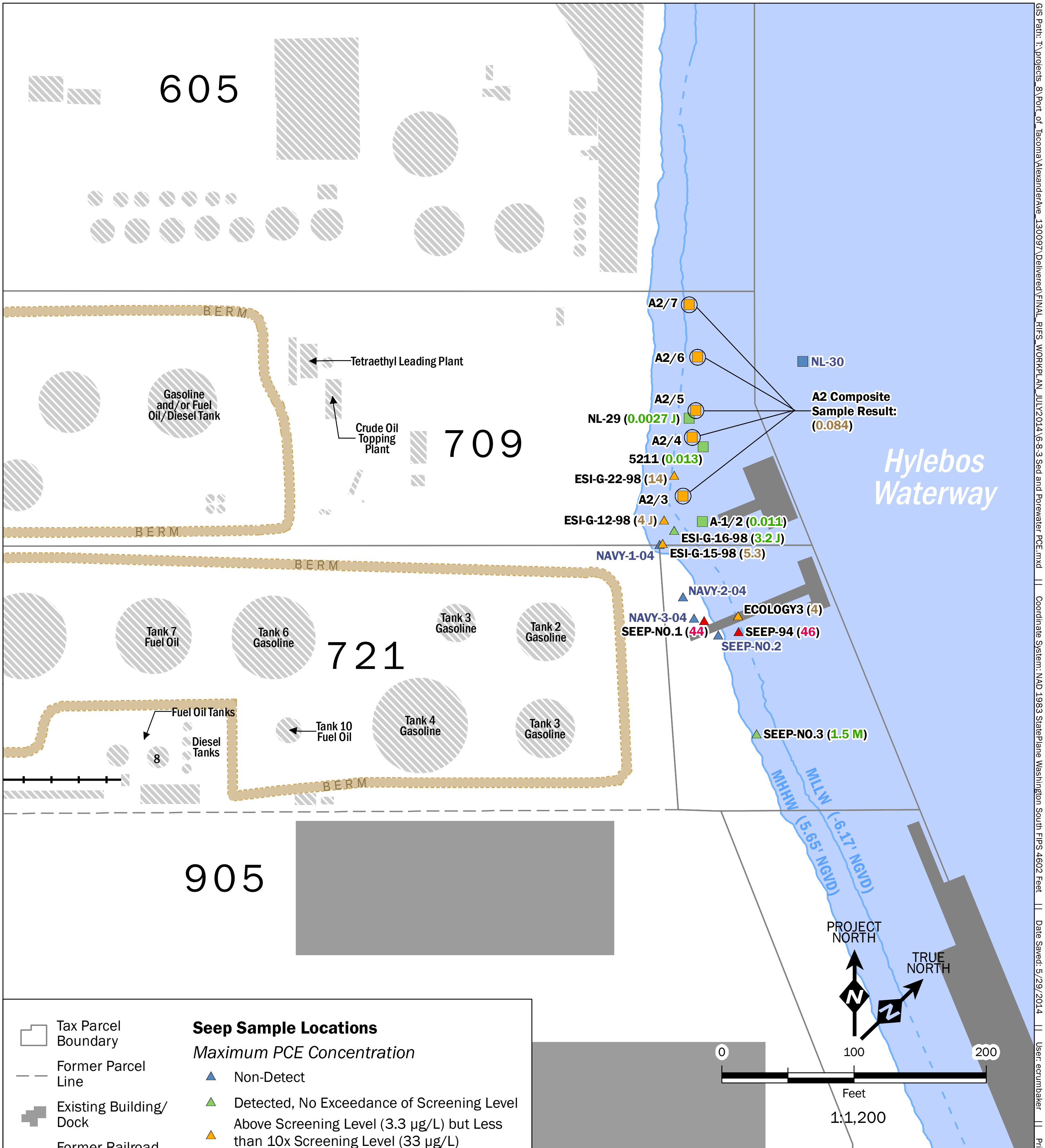
Note: Data from piezometers is not shown because they are believed to be representative of groundwater.

Sediment/Seep Sample Locations and Extent of Lead in Sediment/Seeps

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING	MAY-2014	BY: DFR / PPW	FIGURE NO.
	PROJECT NO. 130097-01B	REV BY: EAH	6.8-2

GIS Path: T:\projects_8\Port_of_Tacoma\AlexanderAve_130097\Delivered\FINAL_RIFS_WORKPLAN_JULY2014\6-8-2 Sed and Porewater Lead.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 5/29/2014 || User: ecrumbaker || Print Date: 5/29/2014



Tax Parcel Boundary

Former Parcel Line

Existing Building/ Dock

Former Railroad Spur

Shoreline/ Hylebos Waterway

Seep Sample Locations

Maximum PCE Concentration

- Non-Detect
- Detected, No Exceedance of Screening Level
- Above Screening Level (3.3 µg/L) but Less than 10x Screening Level (33 µg/L)
- Above 10x Screening Level (33 µg/L)

Sediment Sample Locations

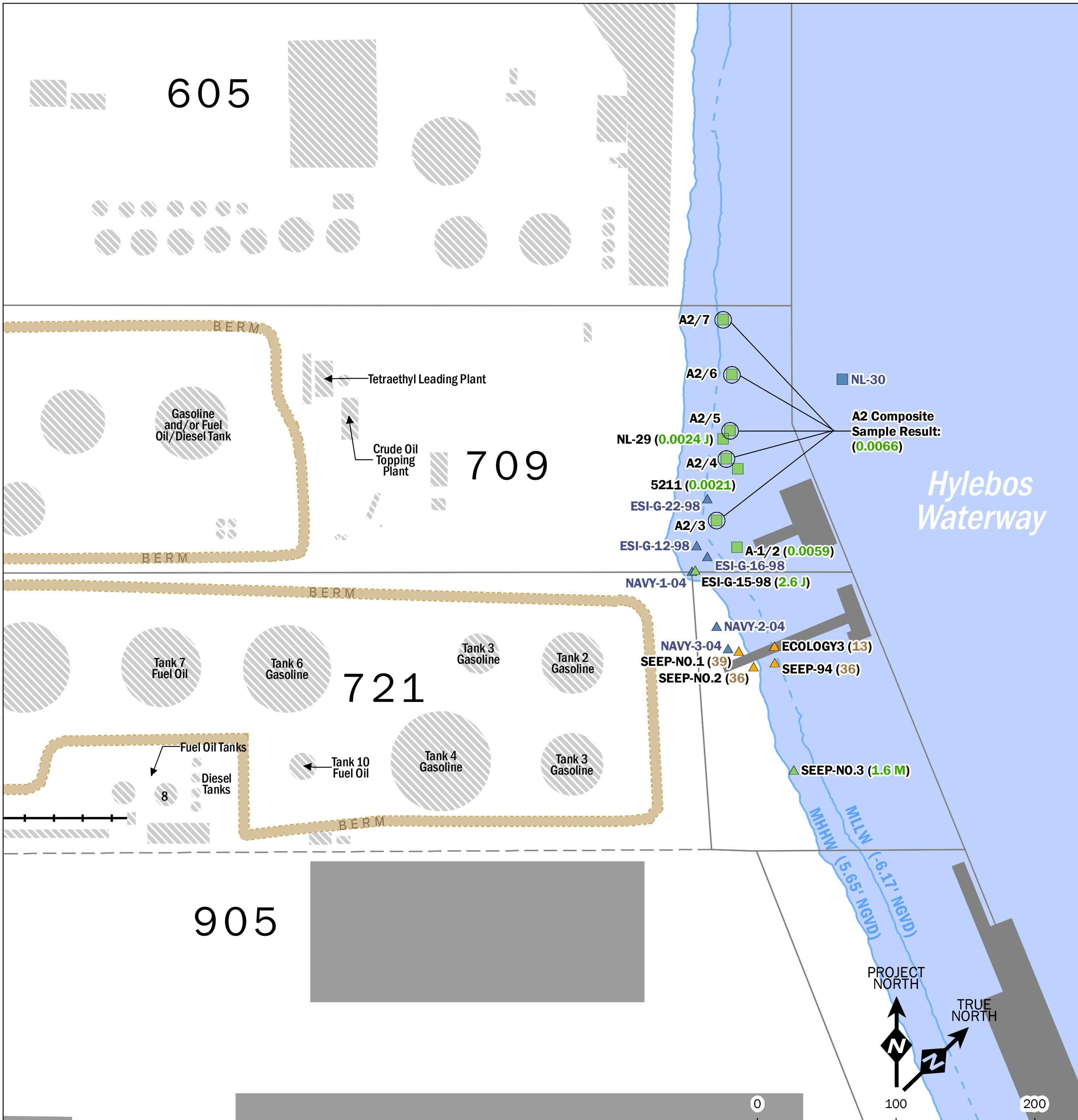
Maximum PCE Concentration

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

Sediment/Seep Sample Locations and Extent of PCE in Sediment/Seeps

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING	MAY-2014	BY: DFR / PPW	FIGURE NO.
	PROJECT NO. 130097-01B	REV BY: EAH	**6.8-3**



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

Seep Sample Locations

Maximum TCE Concentration

- Non-Detect
- Detected, No Exceedance of Screening Level
- Above Screening Level (8.4 µg/L) but Less than 10x Screening Level (84 µg/L)
- Above 10x Screening Level (84 µg/L)

Sediment Sample Locations

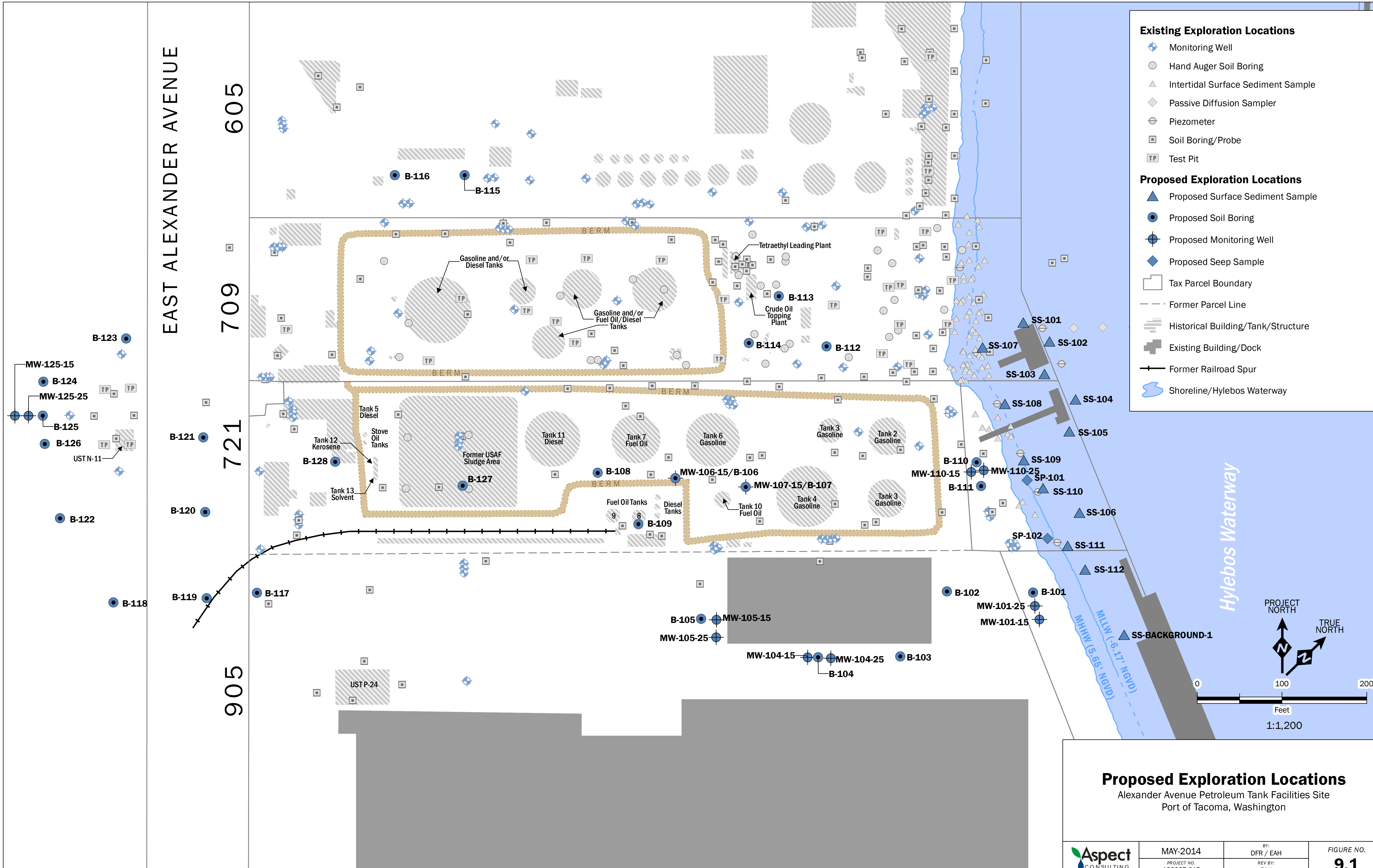
Maximum TCE Concentration

- Non-Detect
- Detected, No Screening Level

Sediment/Seep Sample Locations and Extent of TCE in Sediment/Seeps

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

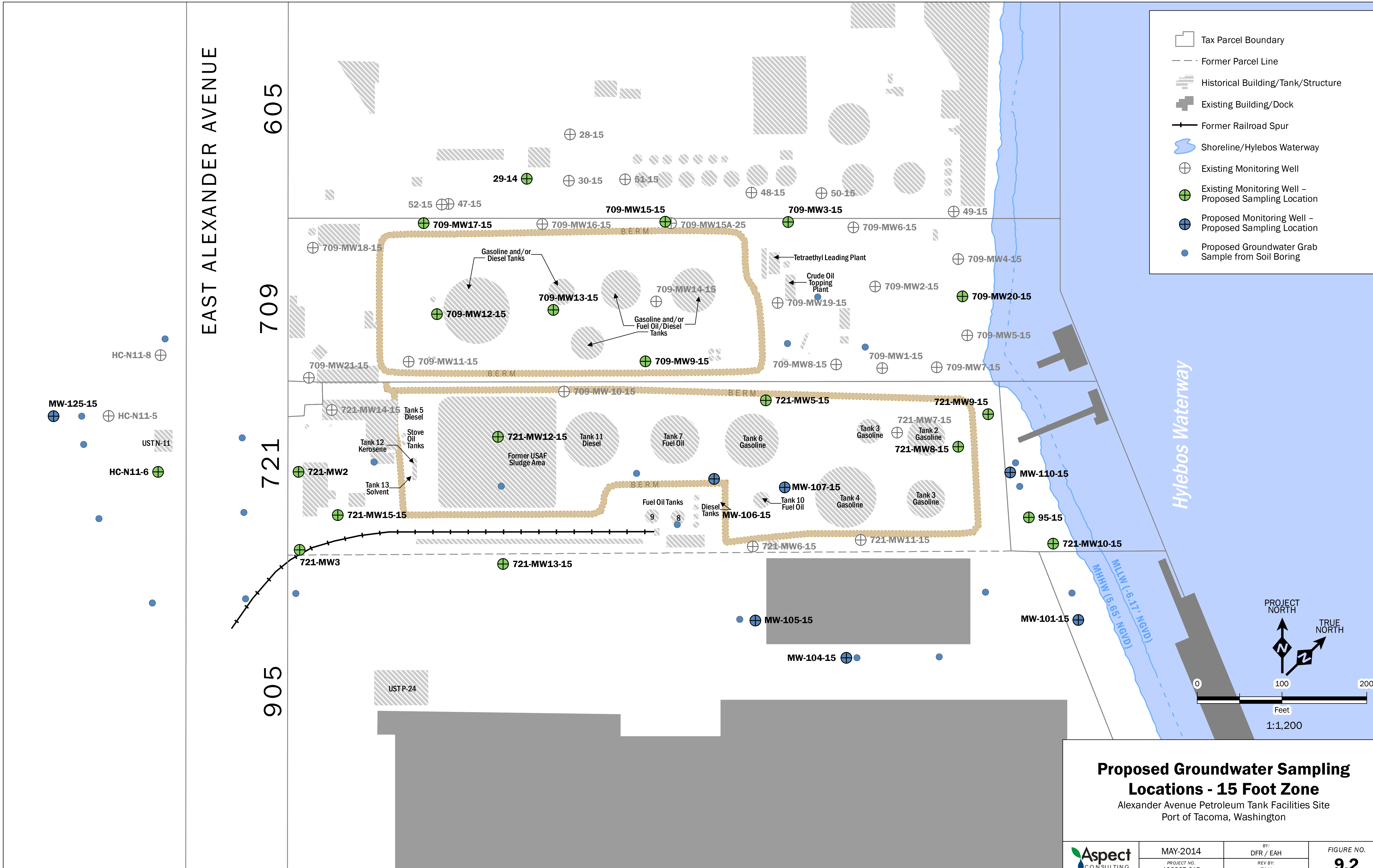
Aspect CONSULTING	MAY-2014	BY: DFR / PPW	FIGURE NO.
	PROJECT NO. 130097-01B	REV BY: EAH	6.8-4



Proposed Exploration Locations

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING | MAY-2014 | BY: DFR / EAH | FIGURE NO. 9.1
PROJECT NO. 130097-01B | REV BY: EAH

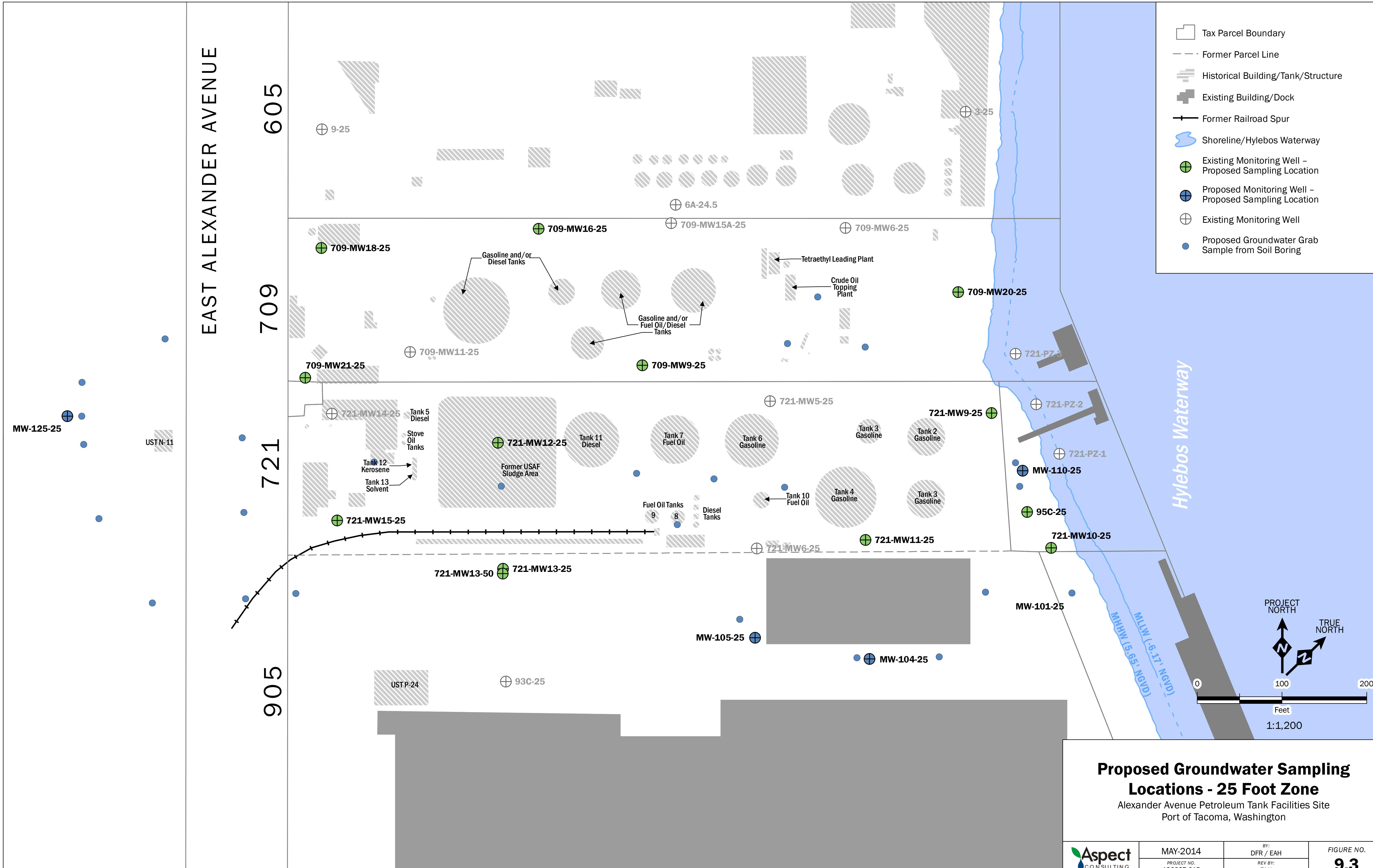


Proposed Groundwater Sampling Locations - 15 Foot Zone

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING	MAY-2014	BY: DFR / EAH	FIGURE NO. 9.2
	PROJECT NO. 130097-01B	REV BY: EAH	

GIS Path: T:\projects_8\Port_of_Tacoma\AlexanderAve_130097\Delivered\FINAL_RIFS_WORKPLAN_JULY2014\9.2 Proposed Groundwater Sampling Locations - 15 Foot Zone.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 5/29/2014 || User: ecrumbaker || Print Date: 5/29/2014



Proposed Groundwater Sampling Locations - 25 Foot Zone

Alexander Avenue Petroleum Tank Facilities Site
Port of Tacoma, Washington

Aspect CONSULTING	MAY-2014	BY: DFR / EAH	FIGURE NO.
	PROJECT NO. 130097-01B	REV BY: EAH	9.3