Attachment 8

REMEDIAL INVESTIGATION AND FEASIBILITY STUDY REPORT CITY SEWER PUMP STATION & GENERAL PETROLEUM CORPORATION SITE

Prepared for

City of Olympia Parks, Arts & Recreation
222 Columbia Street Northwest
Olympia, Washington 98501-8208

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April 2013

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LIST OF ACRONYMS AND ABBREVIATIONS

°C	degree Celsius
°F	degree Fahrenheit
AEG	The Associated Environmental Group, Inc.
Anchor QEA	Anchor QEA, LLC
Apex	Apex Laboratories, LLC
APH	air-phase petroleum hydrocarbon
ARAR	Applicable or Relevant and Appropriate Requirement
AST	aboveground storage tank
ASTM	ASTM International
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylene
CFR	Code of Federal Regulations
City	City of Olympia
CAP	Cleanup Action Plan
CLARC	Cleanup Levels and Risk Calculations
cm	centimeter
CPOC	Conditional Point of Compliance
COC	contaminant of concern
CPT	cone penetration test
CSM	conceptual site model
DCA	disproportionate cost analysis
DNR	Washington Department of Natural Resources
DRO	diesel range organics
Ecology	Washington State Department of Ecology
EDB	1,2-dibromoethane
EDC	1,2-dichloroethane
EPH	extractable petroleum hydrocarbon
FS	Feasibility Study
GPC	General Petroleum Corporation
GRO	gasoline range organics
HCID	hydrocarbon identification

IDW	investigation derived waste
kg	kilogram
L	liter
µg	microgram
m^3	cubic meter
mg	milligram
MLLW	mean lower low water
MNA	monitored natural attenuation
MS	matrix spike
MSD	matrix spike duplicate
MTBE	methyl-tert-butyl ether
MTCA	Model Toxics Control Act
NFA	No Further Action
NTR	National Toxics Rule
NWTPH	Northwest Total Petroleum Hydrocarbon
NWTPH-Dx	Northwest Total Petroleum Hydrocarbon – diesel range (analytical method)
NWTPH-Gx	Northwest Total Petroleum Hydrocarbon – gasoline range (analytical method)
ORO	oil range organics
PAH	polycyclic aromatic hydrocarbon
POC	point of compliance
QA	quality assurance
QC	quality control
RAO	remedial action objective
RI	Remedial Investigation
Site	City Sewer Pump Station & General Petroleum Corporation Site
TEE	terrestrial ecological evaluation
TPH	total petroleum hydrocarbon
USEPA	U.S. Environmental Protection Agency
UST	underground storage tank
VCP	Voluntary Cleanup Program
VOC	volatile organic compound

VPH	volatile petroleum hydrocarbon
WAC	Washington Administrative Code
Work Plan	*Petroleum Contaminated Soil Assessment Workplan* (Anchor QEA 2010a)

1 INTRODUCTION

This Remedial Investigation/Feasibility Study (RI/FS) has been prepared on behalf of the City of Olympia (City) for the City Sewer Pump Station & General Petroleum Corporation (GPC) Site (Site) located in Olympia, Washington (Figure 1). RI activities define the nature and extent of contamination at the Site and support development of a conceptual site model (CSM) as put forth in this report. The FS evaluates a range of remedial alternatives consistent with Model Toxics Control Act (MTCA) requirements.

The RI/FS work is being conducted under the Voluntary Cleanup Program (VCP) in coordination with the Washington State Department of Ecology (Ecology) and consistent with MTCA requirements. The work described in this RI/FS report incorporates investigation activities conducted pursuant to Ecology-approved work plans, including the *Petroleum Contaminated Soil Assessment Workplan* (Work Plan; Anchor QEA 2010a), the *Addendum to Petroleum Contaminated Soil Assessment Workplan* (Anchor QEA 2010b), and the *Addendum 2 to Petroleum Contaminated Soil Assessment Workplan* (Anchor QEA 2011a). The *Upland Investigation Data Report* (Anchor QEA 2011b) was submitted to Ecology and provides a full description of the sampling and analysis conducted as part of the RI.

1.1 Purpose and Objectives

This RI/FS has been performed voluntarily to satisfy the RI requirements of MTCA, Chapter 70.105D in the Revised Code of Washington, administered by Ecology under the MTCA Cleanup Regulation, Chapter 173-340 of the Washington Administrative Code (WAC).

The overall objective of the RI/FS is to identify the hazardous substances that have been released to the uplands and adjacent aquatic environment; assess the nature, extent, and distribution of these substances; identify the potential migration pathways and receptors; assess potential risks to human health and the environment; and evaluate and compare protective remedial alternatives for the Site.

MTCA is the primary state law that governs the cleanup of contaminated sites. MTCA regulations (Chapter 173-340 WAC) define the process for the investigation and cleanup of contaminated sites. MTCA regulations also specify criteria for the evaluation and conduct of a cleanup action to protect human health and the environment, meet state environmental standards and standards in other laws that apply, and provide for monitoring to confirm compliance with site cleanup standards. The RI assesses areas identified as potential environmental concerns based on historical activities to identify and quantify contaminants of concern (COCs) in soil and groundwater at the Site. The FS develops and evaluates remedial action alternatives to enable a final cleanup action to be approved by Ecology for the Site. In accordance with the MTCA Cleanup Regulation for those areas of the Site where concentrations of hazardous substances no longer exceed cleanup levels at the point of compliance (POC), an Ecology determination of no further remedial actions is appropriate.

1.2 Regulatory History

The only portion of the Site with regulatory history is the Water Street Pumping Station located at 220 Water Street NW in Olympia, Washington. In February 2000, the City entered into the Ecology VCP after decommissioning an underground storage tank (UST) used to store diesel fuel for an emergency generator associated with a sewer lift station (Kleinfelder 1999). At that time, the City requested a "No Further Action" for the facility (City 1999). In March 2000, Ecology requested further evaluation of the Site by collecting groundwater and soil samples adjacent to the UST. Further evaluations were not conducted at the Site and in May 2009, Ecology notified the City that the Site was being removed from the VCP (Ecology 2006). Further investigations were not performed until park development began.

During 2010 Percival Landing Park development activities, areas with TPH-contaminated soil were encountered. As a result, the City notified Ecology and submitted a Petroleum Contaminated Soil Management Plan to Ecology in September 2010. The City proceeded with cleanup actions in accordance with the plan as contaminated materials were encountered. The City applied to the VCP, which was accepted by Ecology on February 11, 2011 (Ecology 2011). RI activities, along with cleanup actions, were conducted simultaneously with the park development. The *Upland Investigation Data Report* summarizing all RI sample results was submitted to Ecology on August 15, 2011 (Anchor QEA 2011b).

1.3 Document Organization

The remainder of this RI/FS report is organized as follows:

- **Section 2 – Site Background and Current Site Conditions**
  Provides an overview of historical uses and the environmental setting
- **Section 3 – Remedial Investigation Activities and Findings**
  Describes the RI studies completed at the Site
- **Section 4 – Summary of Conceptual Site Model**
  Provides a summary of the nature and extent of COCs along with a CSM
- **Section 5 –Development of Cleanup Levels**
  Presents the development of cleanup levels, including points of compliance, and the terrestrial ecological evaluation (TEE)
- **Section 6 – Feasibility Study of Remediation Alternatives for Soil and Groundwater**
  Presents the development, screening, and evaluation of remedial alternatives for the Site
- **Section 7 – References**
  Lists references cited in development of this RI/FS report
- **Tables and Figures**
  Provide data presentation and Site mapping and graphics
- **Appendices**
  Contain the field data, laboratory data reports, and data validation reports

2 SITE BACKGROUND AND CURRENT SITE CONDITIONS

This section provides background information related to the property features and uses, previous environmental cleanup actions and investigations, and the environmental setting of the property location. Figure 2 shows current and historical property boundaries and features.

2.1 Current Land Use

The majority of the Site is owned by the City including the City parking lot, the City Public Works Pump Station, and portions of the Percival Landing Park (boardwalk and pavilions). The remainder of the Site consists of the adjacent Washington Department of Natural Resources (DNR) shoreline areas.

2.2 Historical Site Operations

A summary of property ownership and operational history is given in the following subsections.

2.2.1 General Petroleum Corporation

The area south of Olympia Avenue and north of Shaub-Ellison property, now occupied by the City parking lot, was occupied by GPC from the 1920s to at least 1948. GPC became Mobil Oil Company and City Fuel Oil Service sometime around 1966 and operated until at least 1979 (R.L. Polk & Co.). Several large aboveground fuel tanks can be seen in an undated historical photograph. These tanks, along with a pump house and oil and grease storage area, are also documented in historical maps (Sanborn Map 1947). In January 2011, during park construction activities, approximately 110 feet of 4-inch pipeline was discovered running beneath the sidewalk (along the south side of the parking lot), turning north just west of the parking lot, and ending approximately even with the parking lot island (Figure 2). Because utility locates could not follow the pipeline under the sidewalk, it is unknown how far the pipeline extends to the east. The 4-inch pipeline was intact and filled with product, which was siphoned by Mar Vac of Seattle for proper disposal. The pipeline was flushed out, and then cut and a portion removed. The remaining pipe was sealed at the easternmost accessible point. The flushed pipe that was removed was recycled. An aliquot of the product was sent to a laboratory for chemical testing. Results of this sample (PS001) indicate that the product found in the pipe was diesel. The testing parameters are presented in Table 1 and the full set of analytical data is presented in Tables 2a, 2b, and 2c.

2.2.2 Washington Department of Natural Resources Property

DNR is the primary leasing authority for tideland areas occupied along the Site. Within this cleanup Site, the City leases the tidelands and the adjacent uplands directly from DNR. The DNR lease number is 51-020853.

2.2.3 City of Olympia Public Works Department

The City Public Works Department owns the Pump Station located on 220 Water Street NW. The Pump Station is an approximately 600-square-foot concrete structure located about 75 feet from the east bank of Budd Inlet. A decommissioned UST with an approximately 1,000-gallon capacity is located along the northwest wall of the Pump Station. Tank closure occurred in 1999 and consisted of removing the contents of the tank and filling it with cement slurry. Confirmation samples collected from borings on three sides of the tank indicated that soil with elevated levels of petroleum hydrocarbons remained in place (Kleinfelder 1999).

2.3 Adjacent Properties

Adjacent to the Site are the Shaub-Ellison property and Former Unocal Hulco Bulk Plant, as discussed below.

2.3.1 Shaub-Ellison Property

South of the City parking lot is the Shaub-Ellison property, which is currently occupied by a Les Schwab Tire Center. The southern portion of this property has been occupied by an automobile repair shop (Les Schwab Tire Center included) since at least 1947 (Sanborn Map 1947).

2.3.2 Unocal/Hulco Property

The adjacent property to the north (north of Olympia Avenue) was the former Unocal Bulk Plant (former address of 301 North Columbia Street) and Hulco property (former address of 206/216 Olympia Avenue). The Unocal Bulk Plant operated from about 1910 to 1993, and in addition to housing several underground and aboveground fuel tanks, Unocal operated a loading dock that extended from Olympia Avenue into Budd Inlet. The Hulco property was a bulk fuel storage facility operated by different companies including Shell Oil Company and Atlantic Richfield Company. The Shell/Atlantic Richfield bulk plant was in operation from at least 1924 to about 1980 (GeoEngineers 1995a). Voluntary cleanups were conducted in 1995 and 2001 to remove contaminated soil with total petroleum hydrocarbons (TPH) concentrations above site-specific soil remediation levels. Following the November 2001 excavation, Ecology issued a No Further Action (NFA) letter for the property (Ecology 2003). Several areas with TPH concentration exceeding the remediation level were known to have been left at depth and adjacent to Olympia Avenue to the south, under the boardwalk to the west, and under the utility corridor running north and south down the center of the Former Unocal Hulco Bulk Plant site. In 2010 and 2011, during Percival Landing Park construction, the City re-entered the property in the VCP and excavated approximately 11,000 tons of contaminated soil from the shoreline and playground areas. Upon completion of the park, the City submitted an RI/FS report (Anchor QEA 2012) proposing to put a deed restriction on an isolated area of potential residual contamination on the property. An NFA letter for the Site was received from Ecology on December 3, 2012 (Ecology 2012).

2.4 Previous Environmental Investigations

The Associated Environmental Group, Inc. (AEG) and Kleinfelder, Inc. performed site assessment and UST decommissioning activities at the Water Street Pumping Station in 1998 and 1999. The following environmental assessment reports were prepared for this area:

- *City of Olympia Water Street Sewer Lift Station Underground Storage Tank Characterization Report,* prepared by AEG, April 20, 1998
- *UST Closure Report Water Street Pumping Station 220 Water Street NW, Olympia, Washington,* prepared by Kleinfelder, Inc., May 14, 1999

In March 1998, in order to close a non-compliant UST, characterization sampling was conducted by AEG in accordance with Ecology protocols at the time of sampling. Three soil borings were drilled at the extents of the UST and soil samples were collected at both 10 and 19 feet below ground surface (bgs) at each boring. Groundwater was also collected from 10 feet bgs at each boring location. All samples were submitted for chemical analysis of TPH diesel range organics (DRO) and oil range organics (ORO). DRO was detected at 10 feet bgs at two locations and was present at elevated concentrations in all groundwater samples. ORO was also present in one groundwater sample. Samples collected at 19 feet bgs did not contain any TPH. Historical testing results for soil and groundwater are presented in Tables 2d and 3a, respectively. In 1999, the UST was closed-in-place by filling with cement slurry.

2.5 Previous Cleanup Actions

During the recent Percival Landing Park Phase 1 construction work, the contractor encountered petroleum product contamination during shoreline excavations, which resulted in visible sheens on the waterway. These releases occurred when the contractor encountered and removed a timber cribwall that was buried in the shoreline embankment. In response, the City voluntarily created the Work Plan (Anchor QEA 2010a) and accompanying Addenda (Anchor QEA 2010b, 2011a). Under the Work Plan and Addenda, an RI was conducted consisting of soil borings and test pits to collect soil, groundwater, and soil vapor samples to define the nature and extent of soil and groundwater contamination in shoreline and upland areas, and to provide data to evaluate a potential vapor pathway to indoor air in buildings adjacent to the Site.

The investigations were conducted during construction activities (i.e., utility installation, building construction, and shoreline regrading) in several phases, between September 2010 and July 2011, with ongoing discussions and coordination with Ecology. Confirmation samples were collected in areas of concern to determine if further excavations were necessary prior to completion of park construction. Approximately 2,500 tons of contaminated soil was removed from the shoreline area on the Site. As part of Percival Landing Park design, sheetpile walls (20 feet in length) have been installed along the entire length of the Site to approximately 0 feet mean lower low water (MLLW) for bank stabilization. Figure 3 shows the cleanup action areas.

2.6 Environmental Setting

This section describes the topography, geology, climate, and hydrogeology of the Site.

2.6.1 Climate

The climate of Olympia is a Marine West Coast climate (Koppen climate classification). Most of western Washington's weather is brought in by weather systems that form near the Aleutian Islands in Alaska. These weather systems contain cold, moist air, which brings western Washington cold rain, cloudiness, and fog. The average daily high temperature is 59.8 degrees Fahrenheit (°F), and the average daily low temperature is 39.5 °F. November and December are Olympia's rainiest months. Olympia averages 50.8 inches (1,290 millimeters) of precipitation per year and has a year-round average of 75 percent cloud cover. Snow for the 1971 to 2000 period averaged 14.7 inches, with a median of 4.3 inches (NOAA 2010).

2.6.2 Topography

The Site is located on an area of fill that is bounded by Budd Inlet to the west. The Site is relatively flat, with a maximum elevation of approximately 19 feet above mean sea level. The western edge of the Site is bounded by sheetpile walls.

2.6.3 Geology and Hydrogeology

From 1909 through 1911, a major dredging and filling operation (also known as Carlyon Fill) resulted in approximately 2.3 million cubic yards of sediment (from mudflats) removed from Budd Inlet and redeposited to create 29 city blocks, including the Site (The Olympian 2010).

Recent onshore and offshore subsurface explorations near the Site (performed for the 30-percent design) were conducted using hollow stem auger borings and cone penetration tests (CPTs). The CPTs and boring logs on land indicate a soil profile comprising three very distinct strata of varying densities. The three layers primarily constitute sand mixed with gravel and silt as described below:

1. **Surficial fill soils.** These soils consist of slightly gravelly to silty sand of medium density, based on observation of soil cuttings around the auger. This near-surface

layer appears to be a fill material, possibly previously dredged to create new land in this area. The thickness of the surficial fill ranges from 12 to 18 feet bgs at the locations of the borings.

2. **Loose sand.** Below the fill layer, there is loose sand continuing to an approximate elevation of -6 to -15 feet MLLW.
3. **Medium dense to dense sand and silt.** Medium dense sand was encountered below the loose sand layer, becoming denser as depth increased. All CPTs done on land confirm that a medium dense to dense layer does lie below the loose sand layer, starting at approximately 25 to 40 feet bgs at this Site.

Offshore, the general soil sequence was similar to what was observed on land, except for the absence of near-surface fill soils. The loose sand material was detected at depths of up to 7 to 18 feet below the mudline from elevations -20 to -40 feet MLLW. This layer likely represents an unconsolidated alluvial soil. Medium dense sand and silt were encountered below the loose sand layer. This was the last material encountered before CPTs were terminated at between -32 and -42 feet MLLW (Anchor 2008).

Depths to groundwater range from 6 to 9 feet below grade and fluctuate seasonally and with tides. The general direction of groundwater flow is to the west toward Budd Inlet; however, some short-term reversal of the gradient caused by tidal action has been observed in close proximity to Budd Inlet (GeoEngineers 1995b).

3 REMEDIAL INVESTIGATION ACTIVITIES AND FINDINGS

This section describes the methods used for completion of the RI field activities, as developed through consultation with Ecology. The RI methods were developed to supplement previously available investigation data and to define the nature and extent of contamination within the Site. RI activities included soil, groundwater, and soil vapor sampling.

3.1 Remedial Investigation Activities

RI activities were performed consistent with the Work Plan and accompanying Addenda, as described in the following points, to assess current Site conditions. The RI included testing for COCs known to be present at the Site from historical operations and as verified by previous testing. These COCs included petroleum hydrocarbons; benzene, toluene, ethylbenzene, and xylenes (BTEX) compounds; and lead. The RI work also included select testing for polycyclic aromatic hydrocarbon (PAH) compounds and heavy metals. A total of 20 Geoprobe borings, three test pits, and eight confirmation samples were conducted at the Site, as shown on Figure 4. The following is a brief summary of the Work Plan and Addenda:

- *Petroleum Contaminated Soil Assessment Workplan* (Anchor QEA 2010a). This document was prepared to characterize the extent of petroleum-related contaminants at the Site, so appropriate cleanup and source control actions could be conducted during construction activities.
- *Addendum to the Petroleum Contaminated Soil Assessment Workplan* (Anchor QEA 2010b). This document was prepared to provide modifications to sampling and testing procedures, as well as present additional sampling locations based on historical features and uses.
- *Addendum 2 to the Petroleum Contaminated Soil Assessment Workplan* (Anchor QEA 2011a). This document was prepared to provide information on additional sampling locations to further characterize the Site, including groundwater and soil vapor sampling locations and procedures.

Following completion of the RI activities in 2011, methods and testing results were reported to Ecology in the *Upland Investigation Data Report* (Anchor QEA 2011b). This report included tabular and graphical summaries of the RI field work and analytical data. This report also included data from the property to the north (the Former Unocal Bulk Plant 0828 and Hulco property). Sampling locations on this property are not included in this current RI/FS, which is why the sample nomenclature is nonconsecutive (e.g., BH-10, BH-16).

Testing of soil boring, test pit, and several confirmation samples was performed using a tiered approach, with Tier 1 being the results of a qualitative hydrocarbon identification (HCID) scan. Tier 2 testing was conducted on select samples based on the results of Tier 1 testing. Tier 2 testing included a quantitative analysis of TPHs, including gasoline range organics (GROs), DROs, and OROs; volatile organic compounds (VOCs); metals; and/or PAHs. Due to field observations at the time of sample collection, some confirmation samples were tested for TPH (GRO, DRO, and ORO), VOCs, and lead without an HCID scan. Four groundwater samples were collected and submitted for Tier 2 analyses. One soil vapor sample was collected and submitted for VOCs, volatile petroleum hydrocarbons (VPH), and air-phase petroleum hydrocarbons (APH). Table 1 presents a summary of the RI sample collection and testing details.

3.1.1 Soil Boring Sampling and Processing

Soil boring samples were collected using a direct push Geoprobe sampling system operated by Pacific Soil & Water, LLC. The soil samples were collected to obtain chemical data and define the vertical nature and extent of contamination in subsurface soil. Figure 4 presents the soil boring locations, which are denoted by "BH-No."

Soil boring samples were collected during three events at 13 locations near the shoreline/concrete redevelopment area and seven locations on the upland portion of the property. The first event, conducted in September 2010, consisted of ten shoreline locations (BH-1 through BH-10) that were selected to characterize the shoreline and investigate suspected historical sources based on historical information or visual observations. The results of the first event triggered the exploration of eight subsequent borings (BH-16 through BH-21, BH-29, and BH-30) that were collected in November 2010 to provide additional information regarding residual contamination in the upland portion of the Site.

Each soil boring was advanced to 20 feet bgs or until refusal. All soil borings were fully logged and sampled from discrete 5-foot depth intervals. Soil boring logs are provided in

Appendix A. The soil near all shoreline locations BH-1, BH-5, BH-6, and BH-9 was excavated during park construction to approximately 10 feet bgs and backfilled with clean material (from approximately elevation +8 feet MLLW) sloping back at a 1:1 slope behind the sheetpile wall). The results at these locations may still be representative of soils at depth outside of this backfill upland of the sheetpile wall.

A direct push Geoprobe collected a continuous soil profile starting at the ground surface with a 5-foot-long, 1.5-inch inside-diameter core sampler. The piston tip was loosened and the sampler advanced into the ground, thereby collecting the soil into the inside of the sampler's clean, disposable, single-use plastic liner. The sampler was withdrawn to retrieve the liner and the soil sample. This step was repeated to a depth of 20 feet bgs. Prior to deployment at each new location, the drill rig was decontaminated with potable water.

The soil cores were processed and sampled at the time of collection. All sampling equipment was decontaminated, as described in the Work Plan (Anchor QEA 2010a). The core liner was cut longitudinally using a scoring knife and was split with decontaminated stainless steel spoons into two halves for sampling.

Immediately upon opening, aliquots of soil sample were collected for volatile constituents analysis from each 5-foot interval using an SW-846 5035 sampling device. The material collected in this device was placed directly into a container with methanol preservative for VOC and GRO analysis. The sample intervals represented in each sample were included in each sample's name. For instance, BH-10-5-10 is a sample collected from location BH-10 at a depth of 5 to 10 feet bgs.

After VOC and GRO collection, photographs were taken, and a soil description of each core was recorded on an exploratory boring log. Final boring logs are provided in Appendix A. The following parameters were noted:

- Sample recovery
- Physical soil description in accordance with ASTM International (ASTM) D-2488 – Unified Soil Classification System including soil type, density/consistency of soil, and color
- Odor (e.g., hydrogen sulfide and petroleum)

- Visual stratification, structure, and texture
- Vegetation and debris with quantitative estimate (e.g., wood debris)
- Presence of sheen

Following sampling for volatile constituents and logging of the core, each 5-foot interval soil sample was homogenized in a decontaminated stainless steel bowl until it was uniform in color and texture. The sample was then spooned into laboratory-supplied jars for analyses. Soil samples collected for chemical analysis were packed on ice and either shipped via express delivery (FedEx or UPS) or driven by the laboratory courier to Apex Laboratories, LLC (Apex), in Tigard, Oregon. Archived samples were frozen at the laboratory.

3.1.2 Test Pit Sampling and Processing

Test pit soil samples were collected using a small backhoe operated by Quigg Brothers, Inc., the Percival Landing Park Phase 1 construction contractor. The soil removed from the test pit was temporarily stockpiled on site and disposed of off site as part of managing investigation derived waste (IDW; see Section 3.1.7). The test pits were backfilled with clean, imported materials. The chemical data collected from the test pits were used to determine the vertical extent of contamination in subsurface soil. Figure 4 presents the test pit locations, which are denoted by “TP-No.”

Three test pits were excavated within the Site boundaries between September 2010 and January 2011. One location (TP-1) was on the shoreline and two locations (TP-3 and TP-4) are where the new substation was installed, just outside the historical footprint of former GPC tanks. TP-1 was partially excavated to remove all contaminated soil at the time of shoreline development. TP-3 and TP-4 were removed, but just to the extent needed for substation installation. Confirmation testing of the sidewalls was not conducted before the substation was installed.

Test pit soil sample intervals were determined by visual observations. After each backhoe scoop, the test pit was inspected by the Anchor QEA, LLC (Anchor QEA) field coordinator to determine if a distinct contaminated layer was present. This layer was typically characterized by a bluish color and/or a strong petroleum odor. If petroleum observations were identified, soil samples with no observed petroleum impacts were collected above and below this layer. Samples were collected by taking several discrete aliquots from representative areas within the selected backhoe bucket, being careful not to collect material that had been exposed to the walls of the bucket. The sample intervals represented in each sample were included in the sample name. For instance, TP-1-8-10 represents a sample taken at Test Pit 1 from 8 to 10 feet bgs.

Prior to homogenization, aliquots of sample were collected for volatile constituents from a representative bucket using an SW-846 5035 sampling device. The material collected with this device was directly placed into a container with methanol preservative for VOC and GRO analysis. After VOC and GRO sample collection, representative soil collected from each bucket was mixed using the approved mixing procedure until homogenous in color and texture and then spooned into laboratory-supplied jars and couriered to Apex for analysis.

3.1.3 Confirmation Sampling and Processing

Confirmation soil samples were collected during the shoreline park construction activities on the waterside of the sheetpile wall to confirm the limits of excavation. Soil samples were collected from the final excavated surface prior to placing any shore protection materials or completing park construction activities. They were collected in the vicinity of excavated shoreline locations to confirm that petroleum-impacted soils were removed. The chemical data collected from the confirmation samples were used to document the concentrations of soils remaining on site after the completion of excavation. Figure 4 shows the confirmation sample locations, which are denoted by “CS-No.”

Eight confirmation samples (CS-1, CS-6, CS-9, CS-10, CS-16, CS-17, CS-18, and CS-19) were collected in November and December 2010 near or along the shoreline. The locations of the shoreline confirmation samples were generally based on the locations of soil boring samples collected during the first round of investigation to allow for comparison of data between the two samples. All shoreline confirmation samples were collected from the surface interval (approximately 0 to 10 centimeters [cm]); and then subsequently covered with imported clean materials during shoreline reconstruction.

Prior to homogenization, aliquots of soil sample were collected using an SW-846 5035 sampling device. The material collected with this device was directly placed into a container with methanol preservative for VOC and GRO analysis. After VOC and GRO sample collection, soil from 0 to 10 cm was collected and mixed using the approved mixing procedure until homogenous in color and texture and then spooned into laboratory-supplied jars and couriered to Apex for analysis.

3.1.4 Groundwater Sampling and Processing

Groundwater sampling was performed during the RI to characterize Site-related COCs in groundwater and provide an empirical demonstration that low-level residual petroleum concentrations in soil are protective of groundwater. Temporary wells were installed during June 2011 using a direct push Geoprobe sampling system. Groundwater was collected using a peristaltic pump and low-flow sampling methodology, as described in Work Plan Addendum 2 (Anchor QEA 2011a).

Groundwater was collected at four locations (BH-21, BH-30, BH-31, BH-32), as shown in Figure 4. A stainless steel temporary well screen was placed at the observed water table at the time of sampling; the 5-foot screen interval was typically 6 to 11 feet bgs. Groundwater samples were taken just below the water table at each location. After the tubing was purged and the groundwater quality measurements were stabilized, VOC, GRO, DRO, ORO, and total and dissolved lead samples were collected. Sampling for dissolved lead was performed using a 0.45-micron filter in the field. New tubing was used at each sample location. Samples were packed on ice and picked up by an Apex courier.

3.1.5 Soil Vapor Sampling and Processing

Soil vapor samples were collected to provide data for evaluating the vapor intrusion pathway to nearby buildings. Temporary borings were completed using a direct push Geoprobe sampling system. A Post-Run Tubing system was used to drive the probe rods to the desired sampling depth. A grab sample was collected using a 1-liter summa canister with a soil manifold, as described in Work Plan Addendum 2 (Anchor QEA 2011a).

Soil vapor was collected at one location (BH-31) at a depth of 4 feet bgs. Figure 4 presents the soil vapor sampling location. Air samples were submitted for VOC, VPH, and APH analysis. Summa canisters were kept out of the sun and shipped to Air Toxics Laboratory in Folsom, California, for analysis.

3.1.6 Chemical Testing

Sample containers, holding times, and preservation methods are discussed in the Work Plan (Anchor QEA 2010a) and Addenda (Anchor QEA 2010b, 2011a) for each sampling event. A chain-of-custody form was logged by the processing staff and relinquished to the laboratory. Analytical methods and laboratory reporting limits are defined in the Work Plan and Addenda. For soil samples, all but a few confirmation samples (as discussed previously) were analyzed by Northwest Total Petroleum Hydrocarbon-Hydrocarbon Identification (NWTPH-HCID) analysis to determine if TPH (GRO, DRO, or ORO) was detected. If GRO was detected, a quantitative gasoline range method (Northwest Total Petroleum Hydrocarbon – gasoline range [NWTPH-Gx])[1], was triggered along with VOC analysis and total lead. If DRO or ORO were detected, a quantitative diesel and oil range method (Northwest Total Petroleum Hydrocarbon – diesel range [NWTPH-Dx])[2] was triggered. PAHs and/or total metals were analyzed in four soil samples. Based on initial testing results and historical information, which indicated that Diesel No. 1 and/or 2 and home heating oil were present on the property, these analyses were not requested on all samples. The MTCA regulations specify that if adequate information exists to identify the type of diesel used and this diesel falls within a specific category, this test is not required (Ecology 2007). The following analytical methods were used for soil testing:

- GRO by method NWTPH-Gx
- DRO and ORO by method NWTPH-Dx
- VOC analysis (BTEX; 1,2-dibromoethane [EDB]; 1,2-dichloroethane [EDC]; and methyl-tert-butyl ether [MTBE]) by Method 8260B
- Total lead by Method 6010C
- Total metals by Method 6020 (arsenic [As], barium [Ba], cadmium [Cd], chromium [Cr], mercury [Hg], selenium [Se], silver [Ag]) and 6010C (lead [Pb])
- PAHs by Method 8260D-SIM

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[1] NWTPH-Gx is an analytical method for volatile petroleum products, such as aviation and automotive gasolines, mineral spirits, Stoddard solvent, and naphtha.

[2] NWTPH-Dx is an analytical method for semi-volatile petroleum products, such as jet fuels, kerosene, diesel oils, hydraulic fluids, mineral oils, lubricating oils, and fuel oils.

The following analytical methods were used for groundwater testing:

- GRO by method NWTPH-Gx
- DRO and ORO by method NWTPH-Dx
- VOC analysis (BTEX, EDB, EDC, and MTBE) by Method 8260B-SIM
- Total lead and dissolved lead by Method 6020

The following analytical methods were used for soil vapor testing:

- VOC analysis (BTEX, EDB, EDC, and MTBE) by Method TO-15
- VPH and APH analysis (Washington State protocols) by Method TO-15

3.1.7 Investigative Waste Management

All IDW and wash water were stockpiled on site or disposed in labeled 55-gallon waste drums that were temporarily stored on the Unocal Bulk Plant 0828 and Hulco property and then hauled to the authorized disposal facility, the Weyerhaeuser landfill in Castle Rock, Washington, on December 1, 2010, and August 1, 2011.

3.2 Remedial Investigation Chemical Data Quality Summary

Chemical testing was performed by Apex in Tigard, Oregon, a laboratory certified by Ecology and the Oregon Environmental Laboratory Accreditation Program. All analyses conformed to procedures described in the approved Work Plan (Anchor QEA 2010a). Chemical testing adhered to one or more of the following quality assurance/quality control (QA/QC) procedures and analysis protocols: SW-846 (USEPA 1986) and Ecology.

Field QA/QC procedures used for this project included collecting additional containers for matrix spike/matrix spike duplicate (MS/MSD) samples at a frequency of 1 per 20 samples and adequate equipment decontamination. Because separate jars were collected for MS/MSD samples, these analyses can also be used to measure sample homogenization precision. The precision (calculated relative percent difference) between the MS/MSD samples was within project data quality objectives for all MS/MSD samples, indicating that samples were thoroughly homogenized.

Chain-of-custody forms were used to track sample custody and document the proper handling and integrity of the samples. After preparation, all sample containers were delivered to the analytical laboratory according to appropriate sample handling procedures (i.e., transported at 4 degrees Celsius [°C]). All samples were shipped via express delivery (FedEx or UPS) or picked up by Apex and relinquished under signature by Anchor QEA staff. At the laboratory, samples were logged in and then immediately placed in refrigerated storage; some samples were placed in frozen storage for archiving. The chain-of-custody forms are included with the corresponding laboratory reports in Appendix B.

All chemical data submitted in this report were checked for completeness (correct method, hold times met, and results reported for each sample) and validated by Anchor QEA personnel using U.S. Environmental Protection Agency (USEPA) guidelines and the National Functional Guidelines for Data Review (USEPA 2004, 2008). Project-specific control limits (Anchor QEA 2010a) were used to assess the precision and accuracy of method blanks, laboratory control samples, MS/MSD, and replicate samples. Any QC results that exceeded these criteria were qualified in the validation process. Data validation reports are provided in Appendix C.

Data validation verified the accuracy and precision of chemical determinations performed during this investigation. Data qualifiers assigned because of the data validation and their definitions are shown on each of the respective analytical results tables. Data may have been qualified as biased or estimated for a particular analysis based on method or technical criteria. Data qualified with a “J” indicates that the associated numerical value is the approximate concentration of the analyte. Data qualified with a “UJ” indicates the approximate reporting limit below which the analyte was not detected. Consequently, these data qualifications are not expected to impact the data quality objectives. All RI data were determined to be useable as reported from the laboratory or as qualified for the purposes of soil, groundwater, and soil vapor characterization.

3.3 Remedial Investigation Results

This section describes the results of soil, groundwater, and soil vapor sampling performed in support of the RI/FS. RI methods are summarized in Sections 3.1 and 3.2 and were performed consistent with the Ecology-reviewed Work Plan (Anchor QEA 2010a) and accompanying Addenda (Anchor QEA 2010b, 2011a). RI data were screened consistent with MTCA cleanup levels for each media and incorporated cross-media protection in evaluating the potential for affects to human health or the environment and were evaluated based on their applicability to existing Site conditions and potential exposure pathways. A discussion of cleanup standards for developing FS alternatives is provided in Section 5.

3.3.1 Soil Quality

RI soil sampling stations were selected based on previous investigations and cleanup actions, as well as historical uses. Additional samples were collected to confirm the limit of excavations for removal of contaminated soils during park construction. A summary of the soil chemistry results are presented in Tables 2a, 2b, and 2c for petroleum, petroleum-related constituents, and supplemental testing, respectively. Soil data were screened against MTCA Method A Soil Cleanup Levels for Unrestricted Land Use (Ecology 2007). DRO and ORO were also screened in accordance with Ecology Memorandum No. 4 (Ecology 2004) by using the sum of DRO and ORO results. The locations of soil samples exceeding MTCA Method A screening levels for GRO, DRO, ORO, and VOCs are presented on Figure 5.

3.3.1.1 Petroleum Hydrocarbons

Soil TPH testing was performed Site-wide for the purposes of determining the limits of soil excavation during park construction (shoreline development) and to determine the presence of residual petroleum concentrations in other areas of the Site. Soil sampling was performed in phases—first, for exploratory purposes, and second, to confirm the limits of soil excavation (confirmation sampling). Some soil sampling locations were subsequently excavated or covered with clean material after collection; these locations are identified in Table 1. Soil sampling results are presented in Table 2a and include those soil sampling locations excavated or covered after sample collection.

Figure 5 presents a summary of soil sampling locations where petroleum concentrations exceeded the MTCA Method A screening level for unrestricted use. Soil sampling results indicate that residual petroleum concentrations are present at the Site, typically in the footprint of historical fuel tanks. Five locations (BH-7, BH-8, BH-16, BH-21, and TP-3) exhibited GRO above the MTCA Method A screening level of 100 milligrams per kilogram (mg/kg), with concentrations ranging from 387 to 2,750 mg/kg. Five locations (BH-16, BH-19, TP-3, CS-17, and CS-19) had a DRO and ORO concentration greater than the MTCA Method A screening level of 2,000 mg/kg, with concentrations ranging from 2,114 to 16,677 mg/kg.

Other soil sampling locations (BH-6, BH-9, and TP-1) showing petroleum concentrations greater than MTCA Method A screening levels were excavated during the 2011 park construction activities. These soil sampling locations are presented with gray shading in Table 2a and on Figure 5 to indicate that the concentrations measured no longer represent the current conditions.

3.3.1.2 Petroleum-related Constituents (VOCs and Lead)

Soil samples were tested for petroleum-related constituents, including VOCs and lead, when the petroleum HCID scan or TPH analysis showed detection for either GRO or DRO. VOC testing included BTEX compounds, MTBE, EDB, and EDC. Analytical results for VOCs and lead are presented in Table 2b. Three locations (BH-7, BH-8, and CS-10) had benzene concentrations above the MTCA Method A screening level of 0.03 mg/kg with ethylbenzene also above the cleanup level of 6 mg/kg at locations BH-7 and BH-8. The maximum lead concentration was 70.3 mg/kg, which is well below the MTCA Method A screening level of 250 mg/kg.

3.3.1.3 Other Supplemental Testing

Before the historical uses of the Site were established, locations with elevated TPH concentrations had additional testing triggered that included PAHs and an expanded metals list. These data were also used to characterize excavated soil for disposal purposes, as this area was subsequently excavated during park construction. PAH and metals analytical results are presented in Table 2c. PAH testing results showed some low-level concentrations present, but carcinogenic PAHs were below the MTCA Method A screening level of 0.1 mg/kg. Naphthalenes were elevated in TP-3 at 3.4 to 5.6 feet. All metals results were below the MTCA Method A screening level.

3.3.2 Groundwater Quality

RI groundwater sampling was performed in select areas to determine the potential for leaching of residual low-level petroleum concentrations in soil. Groundwater sampling provides a direct empirical demonstration that current soil conditions are protective of groundwater and surface water quality. In addition to RI groundwater sampling, previous groundwater monitoring data from 1998 are summarized in Table 3a. These samples were collected around the perimeter of the Pumping Station UST.

A summary of the RI groundwater chemistry results is presented in Table 3b. Groundwater results are screened to the most stringent marine surface water criteria because groundwater beneath the Site is non-potable, as defined in WAC 173-340-720(2). Petroleum hydrocarbons results were screened to MTCA Method A groundwater screening levels because surface water criteria were not available. A discussion of groundwater cleanup standards is provided in Section 5.2.2. Figure 6 presents the historical compliance monitoring wells, groundwater RI sample locations, and results of Site-related COCs. All RI groundwater results were below the established groundwater cleanup levels.

3.3.3 Soil Vapor Results

A summary of the soil vapor testing results is presented in Table 4. Figure 7 presents the soil vapor sample location with a summary of VOC detections. BTEX analytes were detected in this sample. Soil vapor results were screened against draft vapor intrusion guidance (Ecology 2009). Only benzene exceeded the screening level value (at location BH-31).

3.4 Remedial Investigation Conclusions

Most of the MTCA Method A exceedances were detected in 5-foot soil cores at a depth interval between 5 and 10 feet bgs. Test pit TP-3 indicates that this interval may actually be only 1 to 2 feet thick. Neither non-detect concentrations nor field observations showed indications of petroleum impacts above and below the impacted depth interval. Many of the locations with elevated TPH concentrations are near the City Pump Station decommissioned UST and/or footprint of historical GPC structures, suggesting that the gasoline or diesel stored in these historical structures contaminated the underlying soils, which then may have migrated via groundwater toward Budd Inlet. Locations in the eastern portion of the parking lot were clean (BH-29 and BH-30), bounding the contaminated soil on the eastern portion of the Site and confirming this model. The locations adjacent to the Shaub-Ellison property (Les Schwab Tire Center) had results below the MTCA Method A screening levels for GRO, DRO, and ORO (BH-1, BH-2, BH-3, BH-4, BH-17, and BH-18), and bound the contamination on the south side of the Site. Groundwater contains low-level detections of VOC compounds at locations BH-21, BH-30, and BH-32. Soil vapor contains detections of VOCs and APH compounds at location BH-31.

As part of park redevelopment, a 20-foot sheetpile wall was installed along the length of the Site shoreline, with the area waterside of the wall excavated (prior to confirmation sampling) to remove any remaining contamination. The area north of and including CS-18 was excavated to +6 feet MLLW; the area south of that location was excavated to +8 feet MLLW; and the area near sample location CS-10 was excavated to approximately +10 feet MLLW. The confirmation samples waterside of the wall have indicated that contamination is only present at three isolated locations. These locations (CS-17, CS-19, and CS-10) have since been backfilled and covered with habitat-friendly rock in accordance with U.S. Army Corps of Engineers permits for park redevelopment. The final finished grade at each of these locations is approximately elevation +14 feet MLLW, +14.5 feet MLLW, and +15 feet MLLW, respectively. Therefore, about 8 feet of clean cover exists over CS-17; 6.5 feet of clean cover exists over CS-19; and approximately 5 feet of clean cover exists over sample location CS-10. The sheetpile wall serves as a boundary between contaminated upland soils and uncontaminated nearshore soils, and is expected to be an effective impediment against further movement of any buried petroleum products from upland areas into Budd Inlet.

4 SUMMARY OF CONCEPTUAL SITE MODEL

This section presents a summary of the CSM developed for the Site based on the findings of the RI. A CSM incorporates physical and chemical information to understand potential fate and transport mechanisms at the Site. The CSM considers contaminant sources, nature and extent of contamination remaining on site, release mechanisms, transport and exposure pathways, and potential receptors. The development of the CSM supports the assessment of remedial alternatives in the FS consistent with MTCA requirements. The CSM is illustrated on Figure 8.

The CSM developed for the Site is based on available historical information and Site-specific information gathered during sampling activities, and includes the potential transport and exposure pathways and the potential receptors for the Site COCs. This model reflects current conditions and possible future development in assessing exposure pathways. The future uses of the Site are anticipated to be maintained as a parking lot, utility station, and public park.

4.1 Nature and Extent of Contamination

The nature and extent of contamination has been evaluated using the RI data collected in 2010 and 2011. Sampling locations and media were discussed with Ecology throughout the park development to ensure a comprehensive dataset.

As discussed in Section 2, the Site was historically used as a fuel storage facility, which housed several aboveground storage tanks (ASTs), USTs, and underground pipelines. One previous investigation was completed at the Site in 1998 during the Pump Station UST decommissioning. The RI was performed using historical site knowledge and focused on residual petroleum-related contamination. The RI findings indicated low-level residual TPH constituents (GROs, DROs, and OROs), benzene, ethylbenzene, and naphthalene in isolated areas of the Site; with more elevated concentrations on the western edge. The nature and extent of each of the Site COCs are explained in the following points:

- **TPH – Gasoline Range.** Residual GRO concentrations were identified during the RI in isolated areas of the Site. Concentrations of GRO greater than MTCA Method A screening levels were identified in 8 of the 82 subsurface soil samples (at locations BH-6, BH-7, BH-8, BH-9, BH-16, BH-21, TP-1, and TP-3) submitted for TPH analysis. The concentrations of these eight samples ranged from 129 to 2,750 mg/kg, above the cleanup level of 100 mg/kg. Three of these locations were excavated during park construction. Existing soil sample locations with GRO exceeding the MTCA Method A screening level are depicted on Figure 5. Two groundwater locations (BH-21 and BH-32) had GRO concentrations above the MTCA Method A screening level of 800 micrograms per liter (µg/L) (see Figure 6).

- **TPH – Diesel and Oil Range.** Low-level residual DRO and ORO concentrations were identified during the RI in an isolated area of the Site. Concentrations of DRO and ORO greater than MTCA Method A screening levels were identified in 8 of the 82 soil samples (at locations BH-6, BH-9, BH-16, BH-19, TP-1, TP-3, CS-17, and CS-19) submitted for TPH analysis. The concentrations of these eight samples ranged from 2,114 to 16,677 mg/kg, above the cleanup level of 2,000 mg/kg. Three of these locations were excavated during park construction. Existing soil sample locations with DRO/ORO exceeding the MTCA Method A screening level are depicted on Figure 5. One groundwater sample (BH-32) had a DRO concentration above the MTCA Method A screening level of 500 µg/L.
- **Benzene.** Benzene was detected in 4 of 18 soil samples. Three soil sample locations (BH-7, BH-8, and CS-10) were above the MTCA Method A screening level of 0.030 mg/kg. Concentrations ranged from 0.0164 to 1.28 mg/kg. Soil samples from locations BH-7 and BH-8 also contained residual GRO. The sample from location CS-10 did not yield a positive identification of GRO in the HCID scan, so the quantitative analysis was not performed. Benzene was also detected in the soil vapor sample above the draft guidance for Evaluating Soil Vapor Intrusion in Washington State (Ecology 2009). Benzene concentrations in groundwater were below the groundwater cleanup level for protection of surface water.
- **Ethylbenzene.** Ethylbenzene was detected in 6 of 18 soil samples. Two soil sample locations (BH-7 and BH-8) were above the MTCA Method A screening level of 6 mg/kg. Concentrations ranged from 10.1 to 124 mg/kg. Ethylbenzene concentrations in soil vapor and groundwater were below the applicable screening criteria.
- **Naphthalenes.** Total naphthalene (sum of naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene) was detected in 1 of 4 soil samples. Location TP-3 had a

detection of 74.8 mg/kg, above the MTCA Method A screening level of 5 mg/kg. Naphthalene data were not obtained in groundwater or soil vapor samples.

4.2 Transport and Exposure Pathways

Findings of the RI indicated that residual petroleum-related constituents remain in the soil and groundwater in isolated areas of the Site. Potential transport pathways that could result in exposure of petroleum-related constituents in the soil or groundwater include the following:

- Soil direct contact—human and terrestrial
- Soil leaching to groundwater
- Groundwater migration to surface water
- Soil vapor migration

Soil. All of the petroleum-impacted soils are more than 4.5 feet bgs. Exposure of these soils is limited either by overlying pavement, boardwalk, or shoreline habitat cover. The contaminated soil in these areas would only be exposed during future construction (excavation) or maintenance activities. Contaminated soil does exist in close proximity to groundwater and there is indication that groundwater has already been impacted at some locations.

Groundwater. Groundwater at the Site does not meet the definition of potable water, as outlined in WAC 173-340-720(2) based on the following factors: 1) the groundwater does not serve as a current source of drinking water; and 2) the groundwater is not a potential future source of drinking water given the Site's proximity to surface water that is not suitable as a domestic water supply. Therefore, ingestion of groundwater beneath the Site is not an exposure pathway. As a result, the potential exposure pathways for Site groundwater are human ingestion of marine organisms and effects to aquatic organisms exposed to groundwater migrating to adjacent marine surface water.

Soil Vapor. As a general guideline, soil vapor migration of VOCs can impact buildings within 100 feet of contaminated soil or groundwater. There are currently no buildings on the Site. Neighboring structures within 100 feet of the Site boundary include the Les

Schwab Tire Center and several businesses on the eastern side of Columbia Street. Soil vapor collected at location BH-31 yielded a benzene value (45 micrograms per cubic meter [$\mu g/m^3$]) that falls between the draft MTCA Method B unrestricted (32 $\mu g/m^3$) and MTCA Method C industrial (320 $\mu g/m^3$) screening levels (Ecology 2009) for benzene. The soil boring and groundwater samples closest to Les Schwab Tire Center were below MTCA Method A screening levels, indicating that the extent of soil and groundwater contamination are within the Site boundary and not on the Shaub-Ellison property. Groundwater at the Site flows from east to west, so potential migration of soil vapor contaminants to the existing nearby buildings on Columbia Street through groundwater transport of contaminants is unlikely. As long as any building constructed on this Site includes a vapor barrier, soil vapor will not be a complete exposure pathway. This stipulation should be included in a Site deed restriction as discussed in Section 6.5.

4.3 Site Receptors

The Site is located in an urban setting surrounded by commercial properties with marine surface water (Budd Inlet) along the shoreline. A portion of the Site is part of the Percival Landing Park and other areas are limited to commercial use (parking and utilities). Relevant exposure pathways and receptors at the Site include the following:

- **Protection of Site Workers.** The main potential on-site receptor is a future industrial worker. Direct contact risks for industrial workers can be assessed using MTCA industrial soil cleanup levels.
- **Protection of Budd Inlet Surface Water.** Aquatic receptors in Budd Inlet include fish and shellfish potentially exposed to surface water contaminants. Protection of these receptors can be ensured by preventing adverse impacts of groundwater on surface water quality.

5 DEVELOPMENT OF CLEANUP LEVELS

The final cleanup action for the Site must be protective of human health and the environment by complying with cleanup levels. This section discusses the development of Site-specific cleanup levels to be used for identifying remedial action objectives (RAOs) and evaluating remedial alternatives discussed in Section 6. The Site-specific cleanup levels consider the POC and concentration of a hazardous substance in media above which the impacted media may pose a risk to human health or the environment through the exposure pathway. The following discussion presents the cleanup levels and POC that have been developed for the Site.

5.1 Method for Determining Cleanup Levels

The MTCA Cleanup Regulations (Sections 173-340-720, -730, and -740 WAC) establish procedures to develop cleanup levels for soil, groundwater, and surface water. The MTCA Method A procedure is applicable to sites with relatively few hazardous substances. Cleanup levels based on this method are derived through selection of the most stringent concentration as available in the following sources:

- Concentrations listed in WAC Tables 173-720-1, -740-1, and -745-1 (for groundwater and soil)
- Concentrations established under Applicable or Relevant and Appropriate Requirements (ARAR; e.g., National Toxics Rule [NTR])
- Concentrations protective of the environment and surface water beneficial uses

Where numeric values were not available in the aforementioned sources, Method B procedures were used to develop cleanup levels for unrestricted site use. MTCA Method B procedures employ a risk-based evaluation of potential human health and environmental exposures to site COCs.

The Method B procedure also requires that a cleanup level for one media must also be protective of the beneficial uses of other potentially affected media. For example, Site groundwater discharges into the marine surface waters of Budd Inlet. Therefore, Site-specific groundwater cleanup levels consider surface water protection requirements. The specific rules for evaluating cross-media protectiveness are included in the following subsections.

5.2 Site Cleanup Levels

This section describes the determination of Site cleanup levels for soil and groundwater. The POC for meeting cleanup levels in each media is described in Section 5.3. Cleanup level determinations used inputs from the Ecology Cleanup Levels and Risk Calculations (CLARC) database.

5.2.1 Soil Cleanup Levels

The current and future Site use is planned to be maintained by the City as a public park, City parking lot, and utility station. These uses meet the requirement of "unrestricted use" under the MTCA regulations (WAC 173-340-740). Unrestricted use is the appropriate basis for development of site-specific soil cleanup levels using MTCA Method B procedures. Soil cleanup levels were developed for petroleum and petroleum-related constituents including BTEX compounds, naphthalenes, and lead. A summary of soil cleanup levels is presented in Table 5. As described in the CSM, cleanup levels are determined by considering the following complete exposure pathways:

- Human health protection from direct soil contact
- Human health protection from soil-to-groundwater pathway exposure
- Terrestrial ecological protection

5.2.1.1 Soil Direct Contact Pathway Exposure

Previous cleanup actions and the recent park construction activities included excavation of petroleum-impacted soil and backfill/grading. These activities effectively minimized direct contact exposures to soil, and RI results confirm that residual petroleum impacts are at depth. The potential pathway for direct contact would occur during earthwork operations and other activities required for future Site development or maintenance. Cleanup levels for direct contact were derived using WAC Equations 173-340-740-1 and -740-2 for non-carcinogenic and carcinogenic COCs, respectively. No modifications were made to the standard parameters for these equations.

As described in WAC 173-340-740, a direct contact TPH cleanup level is calculated by taking into account the additive effects of petroleum fractions (VPH and extractable petroleum hydrocarbons [EPH]) and VOCs. VPH and EPH data were not collected from locations on this Site; however, they were collected from a location approximately 100 feet away, at the neighboring Former Unocal Hulco Bulk Plant site. A cleanup level of 2,724 mg/kg was established (Anchor QEA 2012). Due to similarity in historical uses of these two sites, the cleanup level established for the Former Unocal and Hulco property is referenced in Table 5.

5.2.1.2 Soil-to-Groundwater Pathway Exposure

Soil cleanup levels based on Method B must also consider the protection of groundwater resources. As described in the CSM, groundwater beneath the Site is not potable; however, groundwater quality must be protective of surface water resources. In addition to deriving soil concentrations that are protective of surface water, empirical groundwater data can be used to assess groundwater impacts.

As described in WAC 173-340-747, a fixed parameter, three-phase partitioning model (Equation 747-1) was used to calculate soil concentrations that are protective of groundwater for petroleum-related COCs detected in Site soil samples (presented in Table 5). The evaluation was based on the protection of marine surface waters; surface water cleanup levels are described in Section 5.2.2. Petroleum-related COCs (benzene, toluene, ethylbenzene, naphthalenes, and lead) soil concentrations were calculated using Equation 747-1 and the most stringent marine surface water criteria (presented in Table 6). There is no marine surface water criterion for xylenes or TPH. No modifications were made to the standard parameters for Equation 747-1.

5.2.2 Groundwater Cleanup Levels

Standard Method B surface water cleanup levels are proposed for this Site. As previously discussed, groundwater beneath the Site is not considered to be a potable source; however, groundwater quality must be protective of surface water quality in Budd Inlet. In accordance with WAC 173-340-730, standard Method B surface water cleanup levels must be at least as stringent as the criteria established under WAC 173-201A, Section 304 of the

Federal Clean Water Act, and the NTR (40 Code of Federal Regulations [CFR] Part 131). The surface water ARARs consist of the following:

- **State Surface Water Quality Standards** [WAC 173-201A]. Standards based on marine, chronic exposure for the protection of aquatic life.
- **National Recommended Water Quality Criteria** [Clean Water Act § 304(a)]. USEPA's national recommended water quality criteria for the protection of human health and aquatic life (marine, chronic).
- **NTR** [40 CFR 131]. Provides chemical-specific, numeric criteria for priority toxic pollutants protective of human health and aquatic life; WAC 173-201A provides for use of NTR water quality criteria for protection of human health.

Groundwater cleanup levels were determined by selecting the most stringent of these criteria. Table 6 presents a summary of groundwater cleanup levels.

5.2.3 Terrestrial Ecological Evaluation

The TEE is required by Ecology under WAC 173-340-7490 unless a site qualifies for a TEE exclusion using the criteria in WAC 173-340-7491.

This first step of the TEE is conducted to determine if there is a potential for concentrations of chemicals in site soils to pose a risk to soil biota, plants, or wildlife. The site may be excluded from the TEE process if there is an incomplete exposure pathway from contaminants in soil to terrestrial ecological receptors (based on current or future site use), no habitat for terrestrial ecological receptors in the area(s) of the site where contaminants are located, or if concentrations of site contaminants are at or lower than natural background levels. If site conditions meet any one of these primary exclusions, the TEE process is complete. If site conditions do not meet any of the four primary exclusions, the TEE process continues to determine whether a simplified or site-specific TEE assessment is warranted.

The majority of the Site consists of paved parking areas and walkways. The remaining areas contain landscaped planting strips and redeveloped shoreline. Three of the four primary exclusions listed on Figure 9 (Primary Exclusions Documentation Form) were met, thus excluding the Site from the TEE. The following is a summary of the TEE exclusions applicable to the Site:

- Based on soil boring logs, field observations, and analytical chemistry results, contaminated soil (that is not covered) is generally located deeper than 6 feet bgs and shallower than 15 feet bgs. Because all soil contamination is located below the TEE Conditional POC (CPOC) (Ecology-defined biologically active zone of 6 feet bgs), the implementation of institutional controls would complete the TEE process.
- All soil contamination shallower than 6 feet bgs is covered by pavement or other physical barriers that prevent plants or wildlife from being exposed.
- There is less than 1.5 acres of contiguous undeveloped land on and within 500 feet of the Site.
- The exclusion involving comparison with natural background data is not applicable to the Site, as background data were not collected.

5.3 Points of Compliance

Under MTCA, a POC is the point or location on a site where a cleanup level must be attained. The POC will be used to develop and evaluate the effectiveness of the remedial action alternatives for the Site. The POC for the cleanup levels established in Section 5.2 are as follows:

- For upland soil cleanup levels based on human exposure via direct contact, the POC is ground surface to 15 feet bgs throughout the Site. Based on the results of TPH data and analysis, most of the impacted soils at depth in the upland portion of the Site are below the Site-specific cleanup level for TPH (Former Unocal/Hulco cleanup level of 2,724 mg/kg), with the exception of the area near the City Pump Station and substation (borings BH-7, BH-8, BH-16, and test pit TP-3), which contains elevated concentrations of TPH in soil.
- At locations offshore from the sheetpile wall, soils with elevated detections are covered with a minimum of 5 feet of clean habitat material; thus not in the bioactive zone.
- All soils upland of the sheetpile wall are predicted to meet the soil cleanup levels for protection of groundwater, based on the calculations discussed in Section 5.2, with

the exception of BH-7, BH-8, and CS-10, which have a detection of benzene or ethylbenzene above the established cleanup level.

- For groundwater in properties abutting surface water, the standard POC is based on protection of surface water. For protection of surface water, MTCA specifies a POC as close as practical to the point where groundwater discharges to surface. Where the POC cannot be established at this point a CPOC may be established. RI groundwater results indicate that current groundwater quality meets the groundwater cleanup levels that provide protection of surface water quality criteria.

Section 6 provides the remediation alternatives proposed to meet soil and groundwater compliance criteria.

6 FEASIBILITY STUDY OF REMEDIATION ALTERNATIVES FOR SOIL AND GROUNDWATER

Development of an acceptable remedial action for a site is a multi-step process. The first step involves establishing RAOs for the site. Next, remedial action technologies are developed and screened to determine which technologies are capable of achieving the RAOs. The remedial technologies are then assembled into alternatives that achieve all RAOs, and the alternatives are compared against criteria established under MTCA to select the most practicable cleanup action for the site. This alternatives development, evaluation, and selection process is typically accomplished by conducting an FS, per WAC 173-340-350(8). The FS develops alternatives that achieve the RAOs, compares the alternatives against criteria established under MTCA (WAC 173-340-360), and selects the alternative that is permanent to the maximum extent practicable.

The shoreline portion of the Site was remediated as the park was developed, and several discussions with Ecology occurred during the RI sampling and excavations. Based on the historical context of the property and isolated areas of residual contamination, a FS was prepared to evaluate a select set of remedial alternatives for a petroleum-impacted Site. The remedial alternatives (comprising acceptable remedial technologies) identified as being reasonable options for the Site are described, screened, and compared against MTCA requirements to demonstrate compliance with required criteria.

6.1 Remedial Action Objectives

Based on evaluation of data collected as part of the RI and discussions with Ecology, the RAOs for the Site are as follows:

- Prevent human contact with the contaminated soil at depth
- Prevent terrestrial and aquatic ecological exposure to the impacted soils and groundwater
- Maintain current Site use as a public park, parking lot, and public works utility station
- Ensure that groundwater and soils at the Site are protective of surface water quality

6.2 Development of Remedial Technologies

Complying with MTCA cleanup standards can be accomplished by various methods including removing or containing contaminated media. The development of remedial alternatives includes researching remedial technologies and identifying potentially viable technologies that are applicable and implementable at the Site.

Potentially viable remedial technologies for the contaminants at the Site include the following:

- No action
- Institutional controls
- Monitored natural attenuation (MNA)
- In situ biological remediation of soil
- Soil removal

For the purposes of this FS, the proposed remedial technologies are also considered as the remedial alternatives for the Site. The following sections provide an initial screening of the remedial alternatives and then evaluate those alternatives that are retained for further consideration.

6.3 Screening of Remedial Alternatives

Remedial alternatives are screened to comply with cleanup standards (WAC 173-340-700 through 173-340-760) and applicable state and federal laws. Additionally, the remedial alternatives are screened to be protective of human health and the environment and to take into account current and proposed future land uses. Remedial alternatives that are selected must fulfill the threshold requirements, which include the following:

- The selected action uses permanent solutions (as outlined in WAC 173-340-360[3]) to the maximum extent practicable
- The action provides for a reasonable restoration timeframe (as outlined in WAC 173-340-360[4])
- The remedial alternative considers public concerns (as outlined in WAC 173-340-600)

The following sections provide screening of the proposed remedial alternatives for the Site.

6.3.1.1 No Action

Because the contaminated soils are at depth and generally covered by pavement, the remaining contamination is inaccessible for human contact without the occurrence of construction and excavation activities. The no action alternative proposes that no additional remedial actions be completed at the Site. There is no anticipated change of Site use or planned redevelopment of this specific area; however, this alternative is not considered feasible at this Site because contaminated soils shallower than 15 feet bgs would remain at the Site with no method of institutional controls and, thus, would not meet the RAO of human protection.

Because the no action alternative does not meet the RAOs identified for the Site, it is not retained for further evaluation as part of this FS.

6.3.1.2 Institutional Controls

Institutional controls (e.g., deed restrictions to restrict excavation) can be highly effective, implementable, and cost-effective provided that they are consistent with future Site use. Most of the areas containing contaminated soil above the proposed cleanup levels are covered by new concrete walkways or asphalt with no intention of changing utility. Restricting excavation activities at this Site would be less expensive than demolishing existing pavement and excavating contaminated soils at depth, while still providing an equal level of protection (i.e., no risk of direct contact with soils under paved areas). The deed restrictions should include procedures to ensure that future excavations (if necessary), follow applicable health and safety procedures for the protection of the Site, and identify the need for disposal of contaminated materials at an acceptable and permitted landfill facility. Additionally, any structure constructed on this Site should be equipped with vapor barriers to ensure that the soil vapor pathway remains incomplete.

Advantages:

- Low cost to implement
- More environmentally sustainable in that it does not involve the destruction, removal, and replacement of newly constructed walkways and the City parking lot

- No community impacts (Community Center parking and park use)

Disadvantages:

- Contaminated soil will remain at the Site
- Potential groundwater impacts to surface water will not be monitored

Alone, this remedial alternative may not provide aquatic ecological exposure protection; however, in conjunction with MNA monitoring, this alternative can potentially achieve the RAOs and is considered an acceptable and applicable remedial alternative. Thus, the institutional controls alternative is retained for further evaluation as part of this FS.

6.3.1.3 Monitored Natural Attenuation

MNA is the reliance on natural attenuation processes (within the context of a carefully controlled and monitored site cleanup approach) to achieve site-specific remediation objectives and cleanup levels within a reasonable timeframe. MNA is considered a viable cleanup action under MTCA regulations as long as contaminated substances have been removed to a practical extent, the residual contamination does not pose a threat to human health or the environment, there is evidence that biodegradation is occurring at a reasonable rate, and appropriate monitoring is implemented to ensure that natural attenuation is occurring. This alterative assumes that remaining petroleum hydrocarbon contamination will be attenuated through aerobic or anaerobic biological degradation and through physical processes, including dispersion, dilution, sorption, and volatilization.

Source removal has been performed at the Site through the removal of all visibly contaminated soil along the shoreline during park construction activities. Direct contact of contaminated soils at the Site is prohibited by pavement and new habitat structures, and groundwater is non-potable with restricted flow to Budd Inlet. Comparisons of historical data from 1998 soil borings (Table 2d) and groundwater samples (Table 3a) to the 2010 and 2011 RI data indicate that there is natural attenuation of TPH at the Site. In 1998, soil borings and groundwater samples taken near the decommissioned Pump Station UST had concentrations of DRO up to 3,200 mg/kg and 80,000 μg/L, respectively. In 2010 and 2011, soil taken from nearby boring BH-7 had a DRO concentration of 1,830 mg/kg and groundwater taken from nearby location BH-32 had a DRO concentration of 2,810 µg/L. In conjunction with institutional controls to limit soil exposure and installation of compliance monitoring wells to measure the CPOC, this Site is conducive to the MNA remedial alternative.

Advantages:

- Provides treatment through natural processes rather than relocation of contamination and, thus, has more permanence
- Can be less expensive than in situ bioremediation treatments or excavations
- Provides less exposure to contaminated soils than excavations
- Allows continued use of the City parking lot and public park

Disadvantages:

- This remedial alternative may take longer than active in situ treatments or soil removal

This alternative can potentially achieve the RAOs and is considered an acceptable and applicable remedial alternative. Thus, the MNA alternative is retained for further evaluation as part of this FS. A Cleanup Action Plan (CAP) would be prepared upon Ecology approval of this remedial alternative.

6.3.1.4 In Situ Treatment of Soil

The use of in situ biological remediation consists of periodically injecting the contaminated area with additives that stimulate aerobic or anaerobic treatment of contaminated soil. Stimulation of aerobic bioremediation involves the addition of an oxygen-releasing compound that would ultimately degrade the TPH contamination identified in subsurface soils located near the Pump Station. Stimulation of anaerobic bioremediation involves the addition of nitrate or sulfate in the form of readily available salts (i.e., ammonium nitrate fertilizer) that would ultimately degrade the TPH contamination identified in subsurface soils located near the Pump Station. The decision regarding whether to stimulate aerobic or anaerobic biological activity at a given site depends on whether natural aquifer conditions are aerobic or anaerobic and would be developed in the engineering design for the remedial action.

Advantages:

- This remedial alternative provides treatment through natural processes rather than relocation of contamination and, thus, has more permanence
- Less costly than excavation
- More environmentally sustainable in that it does not involve the destruction, removal, and replacement of newly constructed walkways and the City parking lot
- Will likely have a shorter cleanup period than MNA

Disadvantages:

- Reduction-oxidation parameters (e.g., redox potential, dissolved oxygen, or nitrate) were not collected at the Site during RI sampling efforts, so further site characterization would be necessary in order to conduct in situ treatment
- More costly than MNA
- Environmental impacts from injection chemicals
- Some injection chemicals can pose a human health risk during handling and injection

This alternative can potentially achieve the RAOs. Because institutional controls provide the same level of protection from direct contact to soil, and groundwater measured at the Site is below cleanup levels that are protective of surface water, this alternative may be more appropriate as a contingency remedial alternative if MNA with institutional controls do not comply with cleanup standards.

6.3.1.5 Soil Removal

For the removal alternative, a significant portion of the soil containing TPH above the cleanup standards would be excavated and taken to an approved and permitted off-site location (i.e., landfill) for disposal. This includes demolition of a portion of the newly constructed Percival Landing concrete walkway and the electrical conduit that runs beneath it, and removal of the decommissioned UST and surrounding soils. To maintain the integrity of current infrastructures on the Site, sidewall shoring systems would be utilized. It is possible that only a limited portion of the contaminated soil could be removed due to existing utilities and structures. Excavation activities would preferably be performed during low-tide periods to avoid the need for dewatering and management of excavation water. The off-site disposal facility would have to be suitable for Subtitle D soils, with the exception of the concrete demolition debris, which could be disposed of as non-contaminated material. Clean material would be imported and used to backfill the excavation area, and a new concrete walkway would be placed and utilities restored following completion of backfilling activities. Figure 10 presents the preliminary excavation design, and Figure 11 presents the excavation cross sections.

Advantages:

- This remedial alternative provides a permanent solution for a large portion of soil that exceeds the proposed cleanup levels for the Site
- This remedial alternative can be implemented in a relatively short period of time

Disadvantages:

- Due to the depth and location of contaminated soil, this remedial alternative is costly (as described in Section 6.4.1.3)
- Because the potentially contaminated soil is below new park structures, removing the soils would involve destroying and removing portions of a newly constructed walkway (boardwalk), landscaping, and utilities
- The removal action would involve temporarily shutting down portions of Percival Landing Park and the City parking lot
- It is possible that not all impacted soils would be removed due to existing utility structures (Pump Station, substation, and sewer main) that prohibit the ability to safely excavate
- The work would generate significant construction water (requiring management) if not completed during periods of low tide

This alternative achieves the RAOs and is considered an acceptable and applicable remedial alternative. The soil removal alternative is retained for further evaluation as part of this FS.

6.4 Evaluation of Alternatives

Given results of the alternative screening process described in Section 6.3, the following three remedial alternatives are retained for further evaluation:

- **Alternative 1.** MNA with Institutional Controls
- **Alternative 2.** In Situ Treatment of Soil
- **Alternative 3.** Soil Removal

Consistent with MTCA regulations and Ecology guidance, the three remedial alternatives are evaluated for the seven evaluation criteria (listed in WAC 173-340-360[3][f]), as described in Section 6.4.1.

6.4.1 Disproportionate Cost Analysis

MTCA requires that when selecting from remedial action alternatives that fulfill the threshold requirements, the selected action shall use permanent solutions to the maximum extent practicable (WAC 173-340-360[2][b][i]).

MTCA specifies that the permanence of qualifying alternatives shall be evaluated by balancing the costs and benefits of each of the alternatives using a disproportionate cost analysis (DCA) in accordance with WAC 173-340-360(3)(e). The most practical permanent solution evaluated is the baseline remedial alternative to which other remedial alternatives are compared. The evaluation criteria for the DCA, as defined by WAC 173-340-360(3)(f), are summarized in the following subsections.

6.4.1.1 Protectiveness

The protectiveness criteria measures the overall protectiveness of human health and the environment, including the degree to which existing risks are reduced, time required to reduce risk at the facility and attain cleanup standards, on-site and off-site risks resulting from implementing the alternative, and improvement of the overall environmental quality.

All three alternatives achieve the same overall level of protectiveness through different means. Soil removal has the highest on-site and off-site risks associated with excavation, load, and transporting the impacted soil from the excavation to an off-site landfill. MNA has the longest timeframe to improve the overall quality of the Site, but has the shortest temporary on-site risks associated with monitoring well installation.

6.4.1.2 Permanence

Permanence is defined as the degree to which the alternative permanently reduces the toxicity, mobility, or volume of hazardous substances, including the adequacy of the alternative in destroying the hazardous substances, the reduction or elimination of hazardous substance releases and sources of releases, the degree of irreversibility of waste treatment process, and the characteristics and quantity of treatment of residuals generated.

Soil removal provides quick remedy permanence for the Site by transferring the waste to a permitted landfill facility; however, overall toxicity and volume are not reduced, rather transferred. Additionally, locations that could not be excavated would still remain on site. MNA and in situ treatment should eventually provide permanent reduction in toxicity, mobility, and volume of the hazardous substances at the Site, but at a slower rate than excavation. Thus, if successful, Alternatives 1 and 2 are more permanent than Alternative 3.

6.4.1.3 Cost

The estimated cost for implementation of Alternative 1 is approximately $259,000; Alternative 2 is approximately $416,000; and Alternative 3 is approximately 811,000. Itemized task descriptions and a broader range of potential costs are provided in Appendix D.

6.4.1.4 Effectiveness over the Long Term

Long-term effectiveness includes the degree of certainty that the alternative will be successful, the reliability of the alternative during the period of time that hazardous substances are expected to remain on site at concentrations that exceed cleanup levels, the magnitude of residual risk with the alternative in place, and the effectiveness of controls required to manage treatment residues or remaining wastes. There are six types of remedial action components listed in WAC 173-340-360(1)(f)(iv): reuse or recycling, destruction or detoxification, immobilization, on- and off-site disposal in an engineered facility, containment, and institutional controls and monitoring.

MNA is considered less effective as a sole remedy due to uncertainty as to whether it would be successful in a reasonable timeframe compared to more active remediation. Excavation provides the most certainty in removing contaminated soil from the site. Thus, Alternative 3 is the most effective, followed by Alternative 2, followed by Alternative 1. Because the Site contamination is stable and contained on site, there is a relatively low risk of human and environmental exposures even if MNA and in situ treatment did not perform as anticipated.

6.4.1.5 Management of Short-term Risks

Short-term risks are those risks to human health and the environment associated with the construction and implementation of an alternative with consideration of the measures that will be taken to manage such risks.

Soil removal would require construction demolition, soil disruption, utility removal, and reconstruction (excavation, loading, and hauling) for approximately 20 days. MNA and in situ treatment of soil would require a drill rig to temporarily occupy portions of the nearshore for approximately 2 to 3 days in order to install groundwater wells or in situ treatment access points. Thus, Alternative 3 poses the most short-term risks.

6.4.1.6 Technical and Administrative Implementability

This criterion considers if an alternative is technically possible; the availability of necessary off-site facilities, services, and material; and the administrative and regulatory requirements. This criterion also considers scheduling, size, and complexity for construction operations and monitoring.

Alternatives 1, 2, and 3 are all considered to be implementable from technical and administrative standpoints; however, Alternative 3 would be very complex due to the amount of underlying and overlying utilities in the vicinity of impacted soils. The excavation would require a shoring system to stabilize nearby utility structures. Additionally, a new electrical conduit would have to be removed and soils near the City sewer main would have to be carefully excavated to avoid costly damage.

6.4.1.7 Consideration of Public Concerns

This criterion considers the extent to which the community has concerns regarding an alternative based on those individual, community groups, local governments, tribes, federal and state agencies, or any other organization that may have interest in or knowledge of the Site.

Soil removal would remove most of the impacted soil from the Site; however, this removal and off-site disposal of soil would temporarily shut down portions of Percival Landing Park and the City parking lot, and increase construction noise and truck traffic for several weeks. MNA and in situ treatment of soil would have very minimal traffic, park access, and parking lot disruptions. Thus, Alternative 3 would have the most community impacts.

6.4.2 Reasonable Restoration Timeframe

WAC 173-340-360(4)(b) specifies that several factors be considered to determine whether a remedial action provides for a reasonable restoration timeframe. For each remedial alternative, these factors are considered in the following points:

- **Potential risks to human health and the environment.** All alternatives eliminate the exposure pathway for direct contact with contaminated soil. With MNA and in situ treatment, groundwater would be measured to monitor impacts to the aquatic environment.
- **Practicability of achieving shorter restoration timeframe.** Both the in situ treatment and soil excavation remedial action alternatives would likely achieve Site cleanup within a reasonable restoration timeframe. The timeframe for MNA is unknown; however, continued monitoring would be conducted to assess whether a sufficient downward trend in TPH-related constituents is occurring. Additionally, potential impacts to human health and the environment will be mitigated with institutional controls.
- **Current and potential use of the site, surrounding areas, and associated resources that are, or may be, affected by releases from the site.** Migration of contaminants to surrounding areas now and in the future is not expected.
- **Availability of alternate water supplies.** The availability of alternate water supplies is not applicable to this Site.

- **Likely effectiveness and reliability of institutional controls.** Institutional controls that would be included in Alternative 1 are expected to be effective at preventing future direct contact with contaminated soil because they would restrict Site development (via deed restrictions) in the contaminated areas.
- **Ability to control and monitor migration of hazardous substances from the site.** RI investigations indicate that the Site is generally bound on all sides by clean soil with impacted soils clustered around the western edge of the upland property, near the Pump Station. Since groundwater flow is toward Budd Inlet and restricted by the sheetpile wall, migration of hazardous substances to adjacent properties is highly unlikely.
- **Toxicity of hazardous substances at the site.** The main COC within the cleanup action area following actions taken to date is DRO. The toxicity of this constituent is low.
- **Natural processes that reduce concentrations of hazardous substances and have been documented to occur at the site or under similar site conditions.** Based on historical data comparisons (Section 6.3.1.3), there is some evidence of natural attenuation occurring at the Site.

In summary, given that the potential impacts to human health and the environment are very low, all three remedial alternatives are likely to achieve Site cleanup within a reasonable timeframe.

6.5 Conclusion and Preferred Alternative

In conclusion, the Site has historical petroleum-related constituents in underlying soils and groundwater that likely migrated toward Budd Inlet via groundwater. To address this residual contamination, during Percival Landing Park development, the City conducted extensive soil and groundwater investigations, excavated several thousands of tons of impacted soil from the shoreline, and entered into the VCP. Site-specific cleanup levels have been developed for groundwater and soils. Existing soil and groundwater concentrations are below the proposed Site-specific cleanup levels with the exception of the western portion of the property (near the Pump Station), where several upland borings have elevated concentrations of TPH, benzene, and/or ethylbenzene at depth and three locations waterside of the sheetpile wall have elevated concentrations of TPH or benzene at depth. All impacted areas are covered by approximately 5 to 8 feet of clean soil along with pavement or permanent landscaping.

Three remedial alternatives were evaluated to address the residual contamination remaining at this Site: 1) MNA with institutional controls; 2) in situ treatment of soil; and 3) soil removal. All alternatives prevent direct human and ecological contact with contaminated soil. Alternative 3 has the greatest permanence but includes demolition of portions of the newly constructed park walkway; a costly, complex excavation; and transport and disposal of contaminated soil. The high cost, short-term risks, and technical difficulties required to implement this alternative are disproportionate to the incremental benefits gained when compared to Alternatives 1 and 2, which offer a similar level of human and ecological protectiveness. Therefore, excavation can be considered disproportionate from the standpoint of this DCA.

The remaining two alternatives offer a similar level of protectiveness, permanence, short-term risks, technical implementability, and public concern. In situ treatment of soil is likely more effective over the long term and would be completed in a shorter timeframe than MNA because it is an active treatment; however, it is significantly more costly over a shorter period of time. The overall environmental benefit gained for the added costs are considered disproportionate.

Based on this DCA, the preferred remedial action is Alternative 1, the implementation of MNA with institutional controls. This alternative meets the threshold requirements and considers public concerns. The determination as to whether it uses permanent solutions to the maximum extent practicable and/or provides for a reasonable restoration timeframe will be evaluated after 3 years of groundwater monitoring of residual petroleum-related constituents (benzene, toluene, ethylbenzene, and naphthalene). If a sufficient downward trend in analyte concentrations is apparent, additional monitoring may be conducted based on the trend in the data and the predicted time to reach cleanup levels. If groundwater consistently contains concentrations of residual petroleum-related constituents above Site-specific cleanup levels at the CPOC without a downward trend, the need for in situ bioremediation treatments will be discussed with Ecology and a contingency plan developed, if warranted. Additionally, deed restrictions will be placed on the Site to ensure that proper health and safety protocols are utilized during potential soil excavations, soil vapor barriers are used on any constructed buildings, and proper testing and disposal of any excavated soils are followed.

Upon approval of this remedial alternative, the City will submit a CAP and accompanying Sampling and Analysis Plan that provides the groundwater monitoring program sampling frequency and testing requirements. In general, the program will follow the Ecology *Guidance on Remediation of Petroleum Contaminated Groundwater by Natural Attenuation* (Ecology 2005).

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TABLES

Table 1
Summary of RI Sample Collection and Testing

Station ID	Sample ID	Sample Date	Start Depth (feet bgs)	End Depth (feet bgs)	Tier 1 Testing	Tier 2 Testing	Excavated/Covered Post-sampling
BH-1	BH-1-0-5	9/28/2010	0	5	TPH-HCID	--	Yes[3]
	BH-1-5-10	9/28/2010	5	10	TPH-HCID	--	Yes[3]
	BH-1-10-13.5	9/27/2010	10	13.5	TPH-HCID	--	No
BH-2	BH-2-0-5	9/27/2010	0	5	TPH-HCID	--	No
	BH-2-5-10	9/27/2010	5	10	TPH-HCID	TPH-G, TPH-Dx, VOCs, total Lead	No
	BH-2-10-15	9/27/2010	10	15	TPH-HCID	--	No
	BH-2-15-20	9/27/2010	15	20	TPH-HCID	--	No
BH-3	BH-3-0-5	9/28/2010	0	5	TPH-HCID	--	No
	BH-3-5-10	9/28/2010	5	10	TPH-HCID	--	No
	BH-3-10-15	9/28/2010	10	15	TPH-HCID	--	No
	BH-3-15-20	9/28/2010	15	20	TPH-HCID	--	No
BH-4	BH-4-0-5	9/28/2010	0	5	TPH-HCID	--	No
	BH-4-5-10	9/28/2010	5	10	TPH-HCID	--	No
	BH-4-10-15	9/28/2010	10	15	TPH-HCID	--	No
BH-5	BH-5-0-5	9/27/2010	0	5	TPH-HCID	--	Yes[3]
	BH-5-5-10	9/27/2010	5	10	TPH-HCID	--	Yes[3]
	BH-5-10-15	9/27/2010	10	15	TPH-HCID	--	No
	BH-5-15-20	9/27/2010	15	20	TPH-HCID	--	No
BH-6	BH-6-0-5	9/27/2010	0	5	TPH-HCID	--	Yes[3]
	BH-6-5-10	9/27/2010	5	10	TPH-HCID	TPH-G, TPH-Dx, VOCs, total Metals, TCLP Metals, PAHs	Yes[3]
	BH-6-10-15	9/27/2010	10	15	TPH-HCID	TPH-G, TPH-Dx	No
	BH-6-15-20	9/27/2010	15	20	TPH-HCID	--	No
BH-7	BH-7-0-5	9/27/2010	0	5	TPH-HCID	--	No
	BH-7-5-10	9/27/2010	5	10	TPH-HCID	TPH-G, TPH-Dx, VOCs, total Lead	No
	BH-7-10-15	9/27/2010	10	15	TPH-HCID	--	No
	BH-7-15-20	9/27/2010	15	20	TPH-HCID	--	No
BH-8	BH-8-0-5	9/28/2010	0	5	TPH-HCID	--	No
	BH-8-5-10	9/28/2010	5	10	TPH-HCID	TPH-G, TPH-Dx, VOCs, total Lead	No
	BH-8-10-15	9/28/2010	10	15	TPH-HCID	TPH-G, TPH-Dx	No
	BH-8-15-20	9/28/2010	15	20	TPH-HCID	--	No
BH-9	BH-9-0-5	9/27/2010	0	5	TPH-HCID	--	Yes[3]
	BH-9-5-10	9/27/2010	5	10	TPH-HCID	TPH-G, TPH-Dx, VOCs, total Metals, TCLP Metals, PAHs	Yes[3]
	BH-9-10-15	9/27/2010	10	15	TPH-HCID	TPH-G, TPH-Dx	No
	BH-9-15-20	9/27/2010	15	20	TPH-HCID	--	No
BH-10	BH-10-5-10	9/27/2010	5	10	TPH-HCID	--	No
	BH-10-10-15	9/27/2010	10	15	TPH-HCID	--	No
	BH-10-15-20	9/27/2010	15	20	TPH-HCID	--	No
BH-16	BH-16-0-5	11/9/2010	0	5	TPH-HCID	TPH-Dx	No
	BH-16-5-10	11/9/2010	5	10	TPH-HCID	TPH-G, TPH-Dx, VOCs, total Lead	No
	BH-16-10-15	11/9/2010	10	15	TPH-HCID	--	No
	BH-16-15-20	11/9/2010	15	20	TPH-HCID	--	No
BH-17	BH-17-0-5-101108	11/8/2010	0	5	TPH-HCID	--	No
	BH-17-5-10-101108	11/8/2010	5	10	TPH-HCID	--	No
	BH-17-10-15-101108	11/8/2010	10	15	TPH-HCID	--	No
	BH-17-15-20-101108	11/8/2010	15	20	TPH-HCID	--	No
BH-18	BH-18-0-5-101108	11/8/2010	0	5	TPH-HCID	--	No
	BH-18-5-10-101108	11/8/2010	5	10	TPH-HCID	TPH-Dx	No
	BH-18-10-15-101108	11/8/2010	10	15	TPH-HCID	--	No
	BH-18-15-20-101108	11/8/2010	15	20	TPH-HCID	--	No
BH-19	BH-19-0-5	11/9/2010	0	5	TPH-HCID	--	No
	BH-19-5-10	11/9/2010	5	10	TPH-HCID	TPH-G, TPH-Dx, VOCs, total Lead	No
	BH-19-10-15	11/9/2010	10	15	TPH-HCID	--	No
	BH-19-15-20	11/9/2010	15	20	TPH-HCID	--	No
BH-20	BH-20-0-5	11/9/2010	0	5	TPH-HCID	TPH-Dx	No
	BH-20-5-10	11/9/2010	5	10	TPH-HCID	TPH-G, TPH-Dx, VOCs, total Lead	No
	BH-20-10-15	11/9/2010	10	15	TPH-HCID	--	No
	BH-20-15-20	11/9/2010	15	20	TPH-HCID	--	No
BH-21	BH-21-0-5-101108	11/8/2010	0	5	TPH-HCID	--	No
	BH-21-5-10-101108	11/8/2010	5	10	TPH-HCID	TPH-G, TPH-Dx, VOCs, total Lead	No
	BH-21-10-15-101108	11/8/2010	10	15	TPH-HCID	--	No
	BH-21-15-20-101108	11/8/2010	15	20	TPH-HCID	--	No

Table 1
Summary of RI Sample Collection and Testing

Station ID	Sample ID	Sample Date	Start Depth (feet bgs)	End Depth (feet bgs)	Tier 1 Testing	Tier 2 Testing	Excavated/Covered Post-sampling
BH-29	BH-29-0-5-101108	11/8/2010	0	5	TPH-HCID	--	No
	BH-29-5-10-101108	11/8/2010	5	10	TPH-HCID	--	No
	BH-29-10-15-101108	11/8/2010	10	15	TPH-HCID	--	No
	BH-29-15-20-101108	11/8/2010	15	20	TPH-HCID	--	No
BH-30	BH-30-0-5-101108	11/8/2010	0	5	TPH-HCID	--	No
	BH-30-5-10-101108	11/8/2010	5	10	TPH-HCID	--	No
	BH-30-10-15-101108	11/8/2010	10	15	TPH-HCID	--	No
	BH-30-15-20-101108	11/8/2010	15	20	TPH-HCID	--	No
BH-21	BH-21-GW	6/17/2011	6	10	GW Tests[2]	--	No
BH-30	BH-30-GW	6/17/2011	6	10	GW Tests[2]	--	No
BH-31	BH-31-GW	6/17/2011	6	10	GW Tests[2]	--	No
	BH-31-SV	6/17/2011	4	4	Air Tests[3]	--	No
BH-32	BH-32-GW	6/17/2011	6	10	GW Tests[2]	--	No
TP-1	TP-1-2-8	9/29/2010	2	8	TPH-HCID	--	Yes[3]
	TP-1-8-10	9/29/2010	8	10	TPH-HCID	TPH-G, TPH-Dx, VOCs, total Metals, TCLP Metals, PAHs	Yes[3]
TP-3	TP-3-1-4.5	1/7/2011	1	4.5	TPH-HCID	--	No
	TP-3-4.5-6	1/7/2011	4.5	6	TPH-HCID	TPH-G, TPH-Dx, VOCs, total Lead, PAHs	No
TP-4	TP-4-1.5-3-122801	12/28/2010	1.5	3	TPH-HCID	--	No
CS-1	CS-1	11/10/2010	0 cm	10 cm	TPH-HCID	TPH-Dx	Yes[4]
CS-6	CS-6	11/9/2010	0 cm	10 cm	--	TPH-G, TPH-Dx, VOCs, total Lead	Yes[4]
CS-9	CS-9	11/9/2010	0 cm	10 cm	--	TPH-G, TPH-Dx, VOCs, total Lead	Yes[4]
CS-10	CS-10	11/10/2010	0 cm	10 cm	TPH-HCID	TPH-Dx, VOCs	Yes[4]
CS-16	CS-16	11/30/2010	0 cm	10 cm	--	TPH-G, TPH-Dx, VOCs, total Lead	Yes[4]
CS-17	CS-17	12/2/2010	0 cm	10 cm	--	TPH-G, TPH-Dx, VOCs, total Lead	Yes[4]
CS-18	CS-18	12/3/2010	0 cm	10 cm	--	TPH-G, TPH-Dx, VOCs, total Lead	Yes[4]
CS-19	CS-19	12/6/2010	0 cm	10 cm	--	TPH-G, TPH-Dx, VOCs, total Lead	Yes[4]
PS001	PS001	1/25/2011	--	--	--	TPH-G, TPH-Dx, VOCs, total Lead, PAHs	Yes[5]

Notes:

1. Groundwater (GW) tests included TPH-G, TPH-DX, VOCs, and total and dissolved lead
2. Air tests included VOCs and VPH/APH
3. Soil in this sample location was excavated after sample collection and no longer represents current site conditions
4. Clean backfill material was placed over this area after sampling; concentrations currently represent approximately 5 to 10 feet below ground surface
5. PS001 is a product sample taken from an intact pipeline

bgs = below ground surface

TPH-HCID = Total Petroleum Hydrocarbon Identification for Gasoline, Diesel, and Oil

TPH-G = Total Petroleum Hydrocarbons - Gasoline Range

TPH-Dx = Total Petroleum Hydrocarbons - Diesel and Oil Range

VOCs = Volatile Organic Compounds

PAHs = Polycyclic Aromatic Hydrocarbons

Total Metals = Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium, and Silver

VPH = Volatile Petroleum Hydrocarbons

APH = Aliphatic/Aromatic Petroleum Hydrocarbons

EPH = Extractable Petroleum Hydrocarbons

-- = Not available or applicable

Table 2a
RI Soil Sampling Results - Petroleum Hydrocarbons

Station ID	Sample ID	Sample Date	Sample Depth	HCID			NW-TPH			Sum of DRO/ORO (mg/kg)
				GRO (mg/kg)	DRO (mg/kg)	ORO (mg/kg)	GRO (mg/kg)	DRO (mg/kg)	ORO (mg/kg)	
			Screening Level [1]	**100[a]**	**2,000**	**2,000**	**100[a]**	**2,000**	**2,000**	**2000[b]**
BH-1	BH-1-0-5	9/28/2010	0 - 5 ft	13.7 U	34.2 U	68.3 U	--	--	--	68.3 U
	BH-1-5-10		5 - 10 ft	15.3 U	38.1 U	76.3 U	--	--	--	76.3 U
	BH-1-10-13.5	9/27/2010	10 - 13.5 ft	22.9 U	57.2 U	114 U	--	--	--	114 U
BH-2	BH-2-0-5	9/27/2010	0 - 5 ft	14.4 U	36 U	72 U	--	--	--	72 U
	BH-2-5-10		5 - 10 ft	**DETECT**	44.3 U	88.6 U	**7.07**	**8.73 J**	**16.2 J**	**24.9 J**
	BH-2-10-15		10 - 15 ft	21.9 U	54.8 U	110 U	--	--	--	110U
	BH-2-15-20		15 - 20 ft	16.7 U	41.7 U	83.5 U	--	--	--	83.5 U
BH-3	BH-3-0-5	9/28/2010	0 - 5 ft	18.4 U	46 U	91.9 U	--	--	--	91.9 U
	BH-3-5-10		5 - 10 ft	15.9 U	39.8 U	79.5 U	--	--	--	79.5 U
	BH-3-10-15		10 - 15 ft	20.5 U	51.2 U	102 U	--	--	--	102 U
	BH-3-15-20		15 - 20 ft	16 U	40 U	79.9 U	--	--	--	79.9 U
BH-4	BH-4-0-5	9/28/2010	0 - 5 ft	17.7 U	44.2 U	88.5 U	--	--	--	88.5 U
	BH-4-5-10		5 - 10 ft	19.1 U	47.7 U	95.3 U	--	--	--	95.3 U
	BH-4-10-15		10 - 15 ft	20.2 U	50.5 U	101 U	--	--	--	101 U
BH-5	BH-5-0-5	9/27/2010	0 - 5 ft	15.4 U	38.6 U	77.2 U	--	--	--	77.2 U
	BH-5-5-10		5 - 10 ft	16.5 U	41.2 U	82.5 U	--	--	--	82.5 U
	BH-5-10-15		10 - 15 ft	20 U	50 U	99.9 U	--	--	--	99.9 U
	BH-5-15-20		15 - 20 ft	28.2 U	70.5 U	141 U	--	--	--	141 U
BH-6	BH-6-0-5	9/27/2010	0 - 5 ft	17.5 U	43.7 U	87.4 U	--	--	--	87.4 U
	BH-6-5-10		5 - 10 ft	**DETECT**	**DETECT**	**DETECT**	**129**	**5970**	1020 U	**5970**
	BH-6-10-15		10 - 15 ft	**DETECT**	**DETECT**	85.4 U	6.46 U	**69.2**	**26.9 J**	**96.1 J**
	BH-6-15-20		15 - 20 ft	27.9 U	69.8 U	140 U	--	--	--	140 U
BH-7	BH-7-0-5	9/27/2010	0 - 5 ft	16 U	40 U	80 U	--	--	--	80 U
	BH-7-5-10		5 - 10 ft	**DETECT**	**DETECT**	103 U	**2750**	**1830**	**48.2 J**	**1878 J**
	BH-7-10-15		10 - 15 ft	20.4 U	51 U	102 U	--	--	--	102 U
	BH-7-15-20		15 - 20 ft	26.1 U	65.3 U	131 U	--	--	--	131 U
BH-8	BH-8-0-5	9/28/2010	0 - 5 ft	17.1 U	42.8 U	85.6 U	--	--	--	85.6 U
	BH-8-5-10		5 - 10 ft	**DETECT**	**DETECT**	81.8 U	**858**	**1070**	273 U	**1070**
	BH-8-10-15		10 - 15 ft	**DETECT**	**DETECT**	115 U	7.3 U	**117**	**18.2 J**	**135 J**
	BH-8-15-20		15 - 20 ft	27.5 U	68.8 U	138 U	--	--	--	138 U
BH-9	BH-9-0-5	9/27/2010	0 - 5 ft	16.1 U	40.3 U	80.7 U	--	--	--	80.7 U
	BH-9-5-10		5 - 10 ft	**DETECT**	**DETECT**	**DETECT**	**261**	**9140**	**286 J**	**9426 J**
	BH-9-10-15		10 - 15 ft	**DETECT**	**DETECT**	81.2 U	**11.9**	**115**	**20.5 J**	**136 J**
	BH-9-15-20		15 - 20 ft	24.5 U	61.3 U	123 U	--	--	--	123 U
BH-10	BH-10-5-10	9/27/2010	5 - 10 ft	16.7 U	41.8 U	83.7 U	--	--	--	83.7 U
	BH-10-10-15		10 - 15 ft	21 U	52.6 U	105 U	--	--	--	105 U
	BH-10-15-20		15 - 20 ft	20.6 U	51.6 U	103 U	--	--	--	103 U
BH-16	BH-16-0-5	11/9/2010	0 - 5 ft	14.1 U	35.3 U	**DETECT**	--	**18.6 J**	**269 J**	**288 J**
	BH-16-5-10		5 - 10 ft	**DETECT**	**DETECT**	**DETECT**	**387**	**10500**	**435 J**	**10935 J**
	BH-16-10-15		10 - 15 ft	19.9 U	49.8 U	99.5 U	--	--	--	99.5 U
	BH-16-15-20		15 - 20 ft	29 U	72.4 U	145 U	--	--	--	145 U
BH-17	BH-17-0-5-101108	11/8/2010	0 - 5 ft	20.7 U	51.8 U	104 U	--	--	--	104 U
	BH-17-5-10-101108		5 - 10 ft	21.3 U	53.1 U	106 U	--	--	--	106 U
	BH-17-10-15-101108		10 - 15 ft	23.9 U	59.9 U	120 U	--	--	--	120 U
	BH-17-15-20-101108		15 - 20 ft	24.7 U	61.7 U	123 U	--	--	--	123 U
BH-18	BH-18-0-5-101108	11/8/2010	0 - 5 ft	20 U	49.9 U	99.9 U	--	--	--	99.9 U
	BH-18-5-10-101108		5 - 10 ft	23.4 U	58.5 U	**DETECT**	--	**10.8 J**	**170**	**181 J**
	BH-18-10-15-101108		10 - 15 ft	24.3 U	60.7 U	121 U	--	--	--	121 U
	BH-18-15-20-101108		15 - 20 ft	27.7 U	69.3 U	139 U	--	--	--	139 U
BH-19	BH-19-0-5	11/9/2010	0 - 5 ft	17.5 U	43.7 U	87.4 U	--	--	--	87.4 U
	BH-19-5-10		5 - 10 ft	**DETECT**	**DETECT**	**DETECT**	**37.3[a]**	**2160**	**270**	**2430**
	BH-19-10-15		10 - 15 ft	18.2 U	45.5 U	91 U	--	--	--	91 U
	BH-19-15-20		15 - 20 ft	23.7 U	59.2 U	118 U	--	--	--	118 U
BH-20	BH-20-0-5	11/9/2010	0 - 5 ft	18.5 U	46.2 U	**DETECT**	--	**34.5 J**	**311**	**346 J**
	BH-20-5-10		5 - 10 ft	**DETECT**	**DETECT**	**DETECT**	**18.7**	**301**	**155**	**456**
	BH-20-10-15		10 - 15 ft	25.5 U	63.8 U	128 U	--	--	--	128 U
	BH-20-15-20		15 - 20 ft	23.8 U	59.6 U	119 U	--	--	--	119 U
BH-21	BH-21-0-5-101108	11/8/2010	0 - 5 ft	20.3 U	50.8 U	102 U	--	--	--	102 U
	BH-21-5-10-101108		5 - 10 ft	**DETECT**	**DETECT**	106 U	**919**	**478**	**53.4 J**	**531 J**
	BH-21-10-15-101108		10 - 15 ft	25.4 U	63.6 U	127 U	--	--	--	127 U
	BH-21-15-20-101108		15 - 20 ft	33.3 U	83.4 U	167 U	--	--	--	167 U
BH-29	BH-29-0-5-101108	11/8/2010	0 - 5 ft	21.7 U	54.2 U	108 U	--	--	--	108 U
	BH-29-5-10-101108		5 - 10 ft	24.2 U	60.5 U	121 U	--	--	--	121 U
	BH-29-10-15-101108		10 - 15 ft	23.3 U	58.3 U	117 U	--	--	--	117 U
	BH-29-15-20-101108		15 - 20 ft	27.7 U	69.3 U	139 U	--	--	--	139 U
BH-30	BH-30-0-5-101108	11/8/2010	0 - 5 ft	22.7 U	56.8 U	114 U	--	--	--	114 U
	BH-30-5-10-101108		5 - 10 ft	20.1 U	50.2 U	100 U	--	--	--	100 U
	BH-30-10-15-101108		10 - 15 ft	24.9 U	62.2 U	124 U	--	--	--	124 U
	BH-30-15-20-101108		15 - 20 ft	30.4 U	76.1 U	152 U	--	--	--	152 U

Table 2a
RI Soil Sampling Results - Petroleum Hydrocarbons

Station ID	Sample ID	Sample Date	Sample Depth	HCID			NW-TPH			Sum of DRO/ORO (mg/kg)
				GRO (mg/kg)	DRO (mg/kg)	ORO (mg/kg)	GRO (mg/kg)	DRO (mg/kg)	ORO (mg/kg)	
			Screening Level [1]	**100[a]**	**2,000**	**2,000**	**100[a]**	**2,000**	**2,000**	**2000[b]**
TP-1	TP-1-2-8	9/29/2010	2 - 8 ft	19.9 U	49.7 U	99.4 U	--	--	--	99.4 U
	TP-1-8-10		8 - 10 ft	**DETECT**	**DETECT**	**DETECT**	**136**	**7680**	**280 J**	**7960 J**
TP-3	TP-3-1-4.5	1/7/2011	1 - 4.5 ft	17.6 U	44.1 U	88.2 U	--	--	--	88.2 U
	TP-3-4.5-6		4.5 - 6 ft	**DETECT**	**DETECT**	97.2 U	**1370 J**	**2060**	**53.5 J**	**2114 J**
TP-4	TP-4-1.5-3-122801	12/28/2010	1.5 - 3 ft	19.7 U	49.2 U	98.4 U	--	--	--	98.4 U
CS-1	CS-1	11/10/2010	0 - 10 cm	22.4 U	56 U	**DETECT**	--	**35.5**	**383**	**419**
CS-6	CS-6	11/9/2010	0 - 10 cm	--	--	--	6.72 U	**52.5 J**	**539**	**592 J**
CS-9	CS-9	11/9/2010	0 - 10 cm	--	--	--	5.36 U	64.3 U	**164**	**164**
CS-10	CS-10	11/10/2010	0 - 10 cm	31.2 U	**DETECT**	**DETECT**	--	**256**	**921**	**1177**
CS-16	CS-16	11/30/2010	0 - 10 cm	--	--	--	6.51 U	**10.1 J**	52.6 U	**10.1 J**
CS-17	CS-17	12/2/2010	0 - 10 cm	--	--	--	**59.5[a]**	**5930**	**244 J**	**6174 J**
CS-18	CS-18	12/3/2010	0 - 10 cm	--	--	--	**3.32 J**	**135**	51.4 U	51.4 U
CS-19	CS-19	12/6/2010	0 - 10 cm	--	--	--	**54.4[a]**	**16300**	**377 J**	**16677 J**
PS001	PS001	1/25/2011	--	--	--	--	**50000**	**1110000**	231000 U	**1110000**

Notes:

1. MTCA Method A cleanup levels were used for screening purposes and to make Tier 2 testing evaluations. Petroleum fractionation testing was used along with Ecology's TPH Workbook to develop a site-specific cleanup level for the neighboring Former Unocal/Hulco site (Anchor QEA 2012). A site-specific TPH soil cleanup level of 2,724 mg/kg was developed based on protection of direct contact for unrestricted land use, and for protection of groundwater quality.

a. Gasoline mixtures without benzene and total of ethylbenzene, toluene, and xylenes less than 1% of the gasoline mixture have a screening level of 100 mg/kg. Mixtures with benzene, etc. have a screening level of 30 mg/kg.

b. If the sum of TPH-diesel and oil exceed the MTCA cleanup criteria, the result is considered an exceedance.

🟨	Detected concentration is greater than MTCA Method A screening level.
▩	Soil at this sample location was excavated after sample collection and no longer represents current site conditions unless otherwise stated.
▨	Soil at this sample location was covered with at least 5 feet of clean material after sample collection and no longer represents current surface sediment concentrations.
🟦	PS001 is a product sample taken from an intact pipeline.

QA1 validation applied.

Total 17 LPAH (Low PAH) are the total of 2-Methylnapthalene, Naphthalene, Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, and Anthracene

Total 17 HPAH (High PAH) are the total of Fluoranthene, Pyrene, Benzo(a)anthracene, Chrysene, Benzo(x)fluoranthenes, Benzo(a)pyrene, Indeno(1,2,3-c,d)pyrene, Dibenzo(a,h)anthracene, and Benzo(g,h,i)perylene

Totals are calculated as the sum of all detected results and 1/2 the undetected reporting limit. If all are undetected results, the highest reporting limit value is reported as the sum.

cm	centimeters	--	Not analyzed
ft	feet	**Bold**	Detected result
kg	kilogram	J	Estimated value
mg	milligram	U	Compound analyzed, but not detected above detection limit
MTCA	Model Toxics Control Act	UJ	Compound analyzed, but not detected above estimated detection limit

Table 2b
RI Soil Sampling Results - VOCs and Lead

	Station ID	BH-2	BH-6	BH-7	BH-8	BH-9	BH-16	BH-19	BH-20	BH-21	TP-1	TP-3	CS-6	CS-9
	Sample Name	BH-2-5-10	BH-6-5-10	BH-7-5-10	BH-8-5-10	BH-9-5-10	BH-16-5-10	BH-19-5-10	BH-20-5-10	101108	TP-1-8-10	TP-3-4.5-6	CS-6	CS-9
	Sample Date	9/27/2010	9/27/2010	9/27/2010	9/28/2010	9/27/2010	11/9/2010	11/9/2010	11/9/2010	11/8/2010	9/29/2010	1/7/2011	11/9/2010	11/9/2010
	Depth	5 to 10 ft	5 to 10 ft	5 to 10 ft	5 to 10 ft	5 to 10 ft	5 to 10 ft	5 to 10 ft	5 to 10 ft	5 to 10 ft	8 to 10 ft	4.5 to 6 ft	0 to 10 cm	0 to 10 cm
Analyte	**Screening Level[1]**													
Conventional Parameters (percent)														
Total solids	--	**84.6**	**83.2**	**81.9**	**80.2**	**82.7**	**84.4**	**82.9**	**80.7**	**86.5**	**76.9**	**94.7**	**65.4**	**86.3**
Volatile Organics (mg/kg)														
Benzene	0.03	.0149 U	.0141 U	**.0407 J**	**0.483**	.0161 U	.0313 U	.016 U	**0.0164**	.0132 U	.0182 UJ	.128 U	.0168 U	.0134 U
Ethylbenzene	6.0	**0.105**	.0282 U	**124**	**10.1**	.0322 U	.0626 U	.032 U	.0328 U	.0263 U	.0364 UJ	**2.550 J**	.0336 U	.0268 U
Toluene	7.0	.0595 U	.0564 U	.127 U	.135 U	.0644 U	.125 U	.064 U	.0656 U	.0526 U	.0728 UJ	.512 U	.0672 U	.0536 U
m,p-Xylene	--	.0595 U	.0564 U	.127 U	**2.51**	.0644 U	.125 U	.064 U	.0656 U	.0789 U	.0728 UJ	.512 U	.101 U	.0804 U
o-Xylene	--	.0298 U	.0282 U	**.0687 J**	**0.133**	.0322 U	.0626 U	.032 U	.0328 U	.0368 U	.0364 UJ	.256 U	.0403 U	.0322 U
Total Xylene (U = 1/2)	9.0	.0595 U	.0564 U	**0.1322**	**2.643**	.0644 U	.125 U	.064 U	.0656 U	.0789 U	.0728 UJ	.512 U	.101 U	.0804 U
1,2-Dibromoethane (EDB)	0.005	.0298 U	.0282 U	.0636 U	.0676 U	.0322 U	.0626 U	.032 U	.0328 U	.0263 U	.0364 UJ	.256 U	.0336 U	.0268 U
1,2-Dichloroethane (EDC)	--	.0298 U	**.0254 J**	.0636 U	.0676 U	.0322 U	.0626 U	.032 U	.0328 U	.0263 U	**.032 J**	.256 U	.0336 U	.0268 U
Methyl tert-butyl ether (MTBE)	0.1	.0595 U	.0564 U	.127 U	.135 U	.0644 U	.125 U	.064 U	.0656 U	.0526 U	.0728 UJ	.512 U	.0672 U	.0536 U
Metals (mg/kg)														
Lead	250	**3.23 J**	**1.56 J**	**4.04 J**	**4.87 J**	**1.84 J**	**4.77**	**8.81**	**15.6**	**5.9**	**3.54**	**2.52**	**70.3**	**45.4**

Notes:

1. MTCA Method A cleanup levels were used for screening purposes.

🟨	Detected concentration is greater than MTCA Method A screening level
🟧	Non-detected concentration is above one or more identified screening levels
▨	Soil at this sample location was excavated after sample collection and no longer represents current site conditions unless otherwise stated
▧	Soil at this sample location was covered with at least 5 feet of clean material after sample collection and no longer represents current surface sediment concentrations
🟦	PS001 is a product sample taken from an intact pipeline

QA1 validation applied

Totals are calculated as the sum of all detected results and 1/2 the undetected reporting limit. If all are undetected results, the highest reporting limit value is reported as the sum.

cm	centimeters	--	Not analyzed
ft	feet	**Bold**	Detected result
kg	kilogram	J	Estimated value
mg	milligram	U	Compound analyzed, but not detected above detection limit
MTCA	Model Toxics Control Act	UJ	Compound analyzed, but not detected above estimated detection limit

Table 2b
RI Soil Sampling Results - VOCs and Lead

	Station ID	**CS-10**	**CS-16**	**CS-17**	**CS-18**	**CS-19**	**PS001**
	Sample Name	**CS-10**	**CS-16**	**CS-17**	**CS-18**	**CS-19**	**PS001**
	Sample Date	**11/10/2010**	**11/30/2010**	**12/2/2010**	**12/3/2010**	**12/6/2010**	**1/25/2011**
	Depth	**0 to 10 cm**	**0 to 10 cm**	**0 to 10 cm**	**0 to 10 cm**	**0 to 10 cm**	**NA**
Analyte	**Screening Level[1]**						
Conventional Parameters (percent)							
Total solids	--	**70.5**	**75.8**	**82.5**	**82.4**	**79.3**	--
Volatile Organics (mg/kg)							
Benzene	0.03	**1.28**	.0163 U	.0095 U	.0151 U	.0301 U	**26**
Ethylbenzene	6.0	**0.0525**	.0326 U	**.0122 J**	.0303 U	.0602 U	**123**
Toluene	7.0	.0875 U	.0651 U	.038 U	.0606 U	.120 U	**260**
m,p-Xylene	--	.0875 U	.0651 U	**.0205 J**	.0606 U	.120 U	**738**
o-Xylene	--	.0437 U	.0326 U	.0095 U	.0303 U	.0602 U	**316**
Total Xylene (U = 1/2)	9.0	.0875 U	.0651 U	**.0395 J**	.0606 U	.120 U	**1,054**
1,2-Dibromoethane (EDB)	0.005	--	.0326 U	.019 U	.0303 U	.0602 U	2.830 U
1,2-Dichloroethane (EDC)	--	--	.0326 U	.019 U	.0303 U	.0602 U	2.830 U
Methyl tert-butyl ether (MTBE)	0.1	--	.0651 U	.0227 U	.0606 U	.120 U	5.670 U
Metals (mg/kg)							
Lead	250	--	**1.74**	**5.52**	**1.66**	**70.3**	**0.763 J**

Table 2c
RI Soil Sampling Results - PAHs and Metals

	Station ID	**BH-6**	**BH-9**	**TP-1**	**TP-3**	**PS001**
	Sample Name	**BH-6-5-10**	**BH-9-5-10**	**TP-1-8-10**	**TP-3-4.5-6**	**PS001**
	Sample Date	**9/27/2010**	**9/27/2010**	**9/29/2010**	**1/7/2011**	**1/25/2011**
	Depth	**5 to 10 ft**	**5 to 10 ft**	**8 to 10 ft**	**4.5 to 6 ft**	**NA**
Analyte	**Screening Level**^{1}					
Conventional Parameters (percent)						
Total solids	--	**83.2**	**82.7**	**76.9**	**94.7**	--
Polycyclic Aromatic Hydrocarbons (mg/kg)						
1-Methylnaphthalene	--	.180 U	.116 U	.118 U	**19.9**	**3,560**
2-Methylnaphthalene	--	.137 U	.117 U	.119 U	**33.6**	**6,080**
Benzo(a)anthracene	--	.0571 U	**.050 J**	**.0475 J**	**.0211**	16.900 U
Benzo(a)pyrene	0.1	.0571 U	.0582 U	.0594 U	**.00829**	16.900 U
Benzo(b)fluoranthene	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	--
Benzo(b+k)fluoranthene	--	.0571 U	.0582 U	.0594 U	**.00995**	16.900 U
Chrysene	--	.0571 U	**.065 J**	**.0534 J**	**.0214**	16.900 U
Dibenzo(a,h)anthracene	--	.0571 U	.0582 U	.0594 U	.00771 U	16.900 U
Indeno(1,2,3-c,d)pyrene	--	.0571 U	.0582 U	.0594 U	.00771 U	16.900 U
Naphthalene	--	.257 U	116 U	.118 U	**21.3**	**1,560**
Total cPAH TEQ (U = 1/2)	0.1	.0571 U	**0.046**	**0.046864**	**.0193**	16.900 U
Total Naphthalenes (U = 1/2)	5.0	.257 U	.117 U	.119 U	**74.8**	**11,200**
Metals (mg/kg)						
Arsenic	20	**1.97 J**	**2.28**	**2.02 J**	--	--
Barium	--	**21.7**	**18.8**	**11.8**	--	--
Cadmium	2.0	**0.135 J**	**0.127 J**	1.33 U	--	--
Chromium	2,000	**25.3**	**24**	**18.1**	--	--
Lead	250	**1.56 J**	**1.84 J**	**3.54**	**2.52**	**0.763 J**
Mercury	2.0	0.0902 U	0.0844 U	0.106 U	--	--
Selenium	--	2.26 U	2.11 U	2.65 U	--	--
Silver	--	1.13 U	1.06 U	1.33 U	--	--

Notes:

1. MTCA Method A cleanup levels were used for screening purposes.

🟨 Detected concentration is greater than MTCA Method A screening level

▨ Soil at this sample location was excavated after sample collection and no longer represents current site conditions unless otherwise stated

🟦 PS001 is a product sample taken from an intact pipeline

QA1 validation applied

Totals are calculated as the sum of all detected results and 1/2 the undetected reporting limit. If all are undetected results, the highest reporting limit value is reported as the sum.

Total Naphthalenes includes Naphthalene, 1-Methylnaphthalene, and 2-Methylnaphthalene.

cPAH minimum 7 analytes calculation includes Benzo(a)pyrene, Benzo(a)anthracene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Chrysene, Dibenzo(a,h)anthracene, and Indeno(1,2,3-c,d)pyrene. Per MTCA Cleanup Regulation, Table 708-2 "Toxicity Equivalency Factors for Minimum Required Carcinogenic Polyaromatic Hydrocarbons (cPAHs)" under WAC 173-340-708(e).

ft	feet	--	Not analyzed
kg	kilogram	**Bold**	Detected result
mg	milligram	J	Estimated value
MTCA	Model Toxics Control Act	U	Compound analyzed, but not detected above detection limit
PAH	Polycyclic Aromatic Hydrocarbon	UJ	Compound analyzed, but not detected above estimated detection limit

Table 2d
Historical Pump Station Soil Sampling Results

Station ID	Sample ID	Sample Date	Sample Depth	NWTPH-DX		Sum of DRO/ORO (mg/kg)
				DRO (mg/kg)	ORO (mg/kg)	
Screening Level[1]				2,000	2,000	2,000[a]
#1	COL-010	3/17/1998	10 feet	**1,000**	ND	**1,000**
	COL-014		19 feet	ND	ND	ND
#2	COL-011	3/17/1998	10 feet	ND	ND	ND
	COL-017		19 feet	ND	ND	ND
#3	COL-013	3/17/1998	10 feet	**3,200**	ND	**3,200**
	COL-018		19 feet	ND	ND	ND

Notes:

1. MTCA Method A cleanup levels were used for screening purposes.

a. If the sum of TPH-diesel and oil exceed the MTCA cleanup criteria, the result is considered an exceedance.

🟨 Detected concentration is greater than MTCA Method A screening level.

Bold = Detected result

ND = Compound analyzed, but not detected above detection limit

Table 3a
Historical Pump Station Groundwater Sampling Results

	Station ID	**#1**	**UNK**	**UNK**
	Sample Name	**COL-012**	**COL-016**	**COL-019**
	Sample Date	**3/17/1998**	**3/17/1998**	**3/17/1998**
	Screen Depth	**10 feet**	**10 feet**	**10 feet**
Analyte	**MTCA A Cleanup Level**[1]			
Total Petroleum Hydrocarbons (µg/L)				
Diesel Range Hydrocarbons (DRO)	500	**30,000**	**80,000**	**39,000**
Oil Range Hydrocarbons (ORO)	500	**1,100**	ND	ND

Notes:

1. MTCA Method A cleanup levels were used for screening purposes.

Bold = Detected result

🟨 Detected concentration is greater than MTCA Method A screening level

ND = Compound analyzed, but not detected above detection limit

UNK = Unknown if station #2 or #3

Table 3b
RI Groundwater Sampling Results

	Station ID	**BH-21**	**BH-30**	**BH-31**	**BH-32**	**Field QC**	**Field QC**
	Sample Name	**BH-21-GW**	**BH-30-GW**	**BH-31-GW**	**BH-32-GW**	**EB-06172011**	**TRIP BLANK**
	Sample Date	**6/17/2011**	**6/17/2011**	**6/17/2011**	**6/17/2011**	**6/17/2011**	**6/17/2011**
	Screen Depth	**6 - 10 feet**	**6 - 10 feet**	**5 - 10 feet**	**6 - 10 feet**		
Analyte	**Screening Level[a]/Cleanup Level[b]**						
Total Petroleum Hydrocarbons (µg/L)							
Gasoline Range Hydrocarbons	800[a]	**1190**	**205**	194 U	**7050**	198 U	100 U
Diesel Range Hydrocarbons	500[a]	**251**	100 U	100 U	**2810**	100 U	--
Residual Range Hydrocarbons	500[a]	748 U	381 U	388 U	**391 J**	396 U	--
Volatile Organics (µg/L)							
Benzene	23[b]	0.25 U	0.25 U	0.25 U	**16.5**	0.25 U	0.25 U
Ethylbenzene	2100[b]	0.5 U	0.5 U	0.5 U	**3.5 J**	0.5 U	0.5 U
Toluene	15000[b]	**0.63 J**	**0.56 J**	1 U	10 U	1 U	1 U
m,p-Xylene	--	**0.51 J**	**0.52 J**	1 U	10 U	1 U	1 U
o-Xylene	--	0.5 U	0.5 U	0.5 U	5 U	0.5 U	0.5 U
Total Xylene (U = 1/2)	1000[a]	**0.76**	**0.77**	1 U	10 U	1 U	1 U
1,2-Dibromoethane (EDB)	0.01[a]	0.5 U	0.5 U	0.5 U	5 U	0.5 U	0.5 U
1,2-Dichloroethane	5[a]	0.5 U	0.5 U	0.5 U	5 U	0.5 U	0.5 U
Methyl tert-butyl ether (MTBE)	20[a]	1 U	1 U	1 U	10 U	1 U	1 U
Dissolved Metals (µg/L)							
Lead	8.1[b]	1 U	1 U	1 U	1 U	--	--
Total Metals (µg/L)							
Lead	--	**3.09**	1 U	1 U	**2.77**	1 U	--

Notes:

a. MTCA Method A criteria (protective of potable water) are provided for compounds that were not detected in groundwater samples or do not have associated surface water criteria, for reference only.

b. A summary of the development of groundwater cleanup levels is presented in Table 6 and is based on the protection of marine surface water.

Bold = Detected result

J = Estimated value

U = Compound analyzed, but not detected above detection limit

Table 4
RI Soil Vapor Sampling Results

		Location ID	**BH-31**
		Sample Name	**BH-31-SV**
		Sample Date	**6/17/2011**
		Sample Depth	**4 - 4 feet**
Analyte	**MTCA Method B SL[1]**	**MTCA Method C SL[1]**	
Total Petroleum Hydrocarbons ($\mu g/m^3$)			
APH (C5-C8 Aliphatic)	270,000	600,000	**680**
APH (C8-C12 Aliphatic)	14,000[2]	30,000	**340**
APH (C8-C10 Aromatic)	18,000[3]	40,000	**1900**
APH (C10-C12 Aromatic)	--	--	130 U
Volatile Organics ($\mu g/m^3$)			
1,2-Dibromoethane (Ethylene dibromide)	1.1	11	🟧 8.8 U
1,2-Dichloroethane	9.6	96	4.6 U
Benzene	32	320	🟨 **45**
Ethylbenzene	46,000	100,000	**200**
m,p-Xylene	4,600	10,000	**880**
Methyl tert-butyl ether (MTBE)	960	9,600	4.1 U
o-Xylene	4,600	10,000	**280**
Toluene	220,000	490,000	**780**
Total Xylene (U = 1/2)	--	--	**1160**

Notes:

Totals are calculated as the sum of all detected results and 1/2 the undetected reporting limit. If all are undetected results, the highest reporting limit value is reported as the sum.

1. Draft Guidance for Evaluating Soil Vapor Intrusion in Washington State, Table B-1; unrestricted and industrial SLs provided.

2. Criteria is for C9-C12 fraction but analytical data included C8 range, therefore the concentration is a conservative value.

3. Criteria is for C9-C10 fraction but analytical data included C8 range, therefore the concentration is a conservative value.

$\mu g/m^3$ = micrograms per cubic meter

Bold = Detected result

N = Normal Field Sample

U = Compound analyzed, but not detected above detection limit

🟨 Detected concentration is greater than lowest available screening level

🟧 Non-detected concentration is above lowest available screening level

SL = screening level

Table 5
Soil Cleanup Levels

Analyte	Soil Cleanup Level[1]	MTCA Method B Direct Contact[2]	Protection of Surface Water[2] Soil-Unsaturated[3]	Site-specific TPH Cleanup Level[4]
Total Petroleum Hydrocarbons (mg/kg)				
Gasoline Range Hydrocarbons	NA	--	--	--
Diesel Range Hydrocarbons	NA	--	--	--
Residual Range Hydrocarbons	NA	--	--	--
TPH (site-specific)	2,724	--	--	2,724
Volatile Organics (mg/kg)				
Benzene	0.13	18.2	0.13	--
Ethylbenzene	18.1	8000	18.1	--
Toluene	109	6400	109	--
Xylenes, total	NA	16000	--	--
Polycyclic Aromatic Hydrocarbons (mg/kg)				
Naphthalene	138	1600	138	--
1-Methylnaphthalene	34.5	34.5	--	--
2-Methylnaphthalene	320	320	--	--
Metals (mg/kg)				
Lead	1,620	--	1,620	--

Notes:

1. Proposed cleanup levels are based on the most stringent applicable criteria
2. All cleanup level criteria were researched from Ecology's CLARC Database on 2/4/2013
3. Soil cleanup levels protective of surface water calculated using MTCA equation 747-1 for unsaturated (vadose zone) soils
4. Reference cleanup value from Former Unocal/Hulco site (Anchor QEA 2012). Calculated using the CLARC TPH Workbook (MTCATPH11.1.xls)

-- = research has not been conducted and no value exists in the database for this parameter
mg/kg = milligram per kilogram
MTCA = Model Toxics Control Act
NA = no criteria is applicable for this parameter

Table 6
Groundwater Cleanup Levels

Analyte	Proposed Groundwater Cleanup Level[1] (µg/L)	Surface Water Criteria (Aquatic)[2]			Surface Water Criteria (Human Health)[2]		
		WAC 173-201A (µg/L)	Clean Water Act Section 304 (µg/L)	National Toxics Rule, 40 CFR 131 (µg/L)	MTCA Method B Surface Water Criteria (µg/L)	Clean Water Act Section 304 (µg/L)	National Toxics Rule, 40 CFR 131 (µg/L)
Total Petroleum Hydrocarbons (µg/L)							
Gasoline Range Hydrocarbons	NA	--	--	--	--	--	--
Diesel Range Hydrocarbons	NA	--	--	--	--	--	--
Residual Range Hydrocarbons	NA	--	--	--	--	--	--
Volatile Organics (µg/L)							
Benzene	23	--	--	--	23	51	71
Ethylbenzene	2,100	--	--	--	6,900	2,100	29,000
Toluene	15,000	--	--	--	19,000	15,000	200,000
Xylenes, total	NA	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (µg/L)							
Naphthalene	4,900	--	--	--	4,900	--	--
1-Methylnaphthalene	NA	--	--	--	--	--	--
2-Methylnaphthalene	NA	--	--	--	--	--	--
Dissolved Metals (µg/L)							
Lead	8.1	8.1	8.1	8.1	--	--	--

Notes:

1. Groundwater cleanup level based on protection of marine surface water and selected value is most stringent of applicable marine surface water criteria
2. All values were researched from Ecology's CLARC Database on 2/4/2013

-- = surface water criteria not available

µg/L = micrograms per Liter

CFR = Code of Federal Regulations

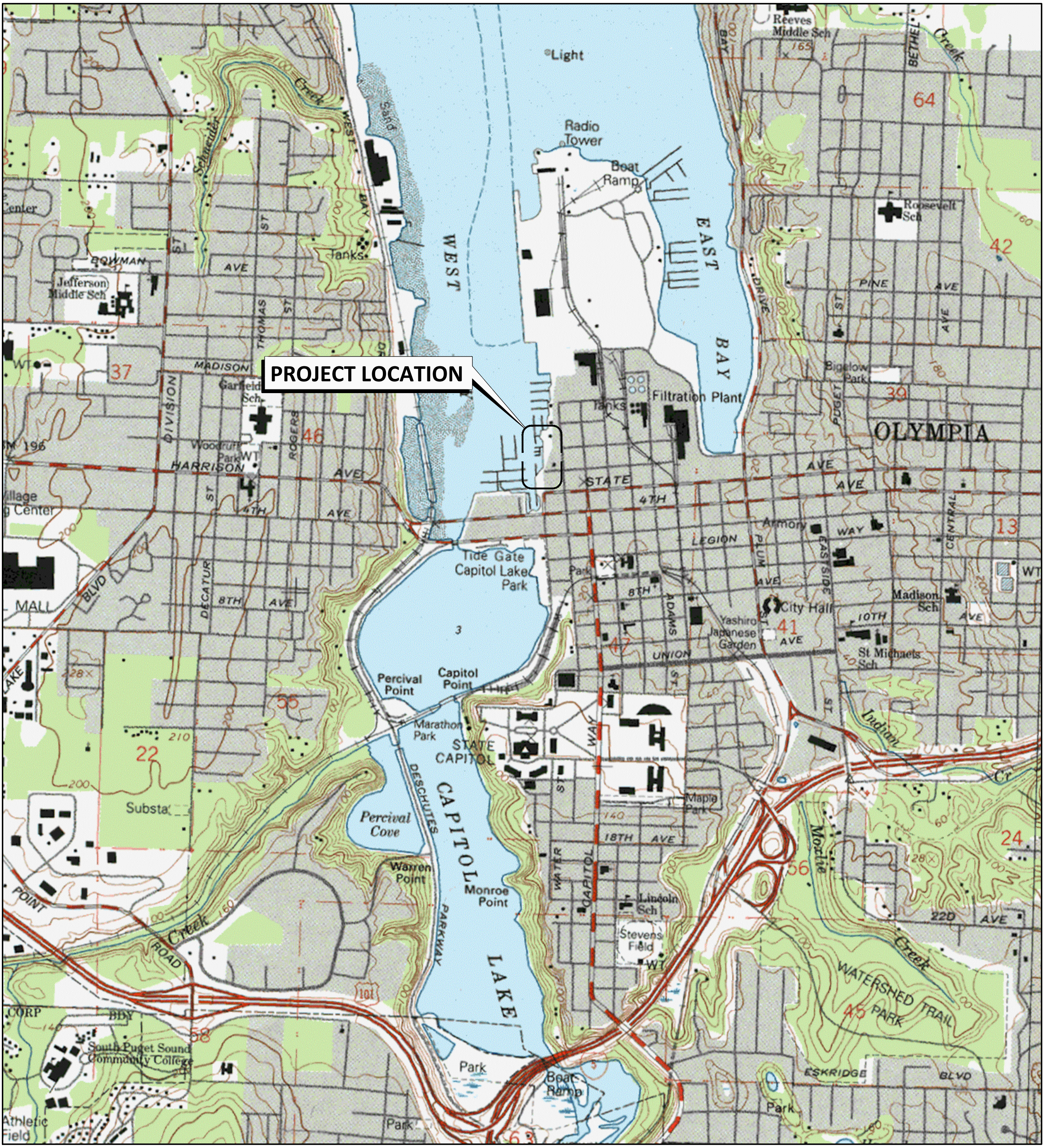
MTCA = Model Toxics Control Act

NA = no criteria is applicable for this parameter

WAC = Washington Administrative Code

FIGURES

Dec 04, 2012 11:33am tgriga K:\Projects\0487-City of Olympia Parks and Rec\Percival Landing - Volunt Cleanup Prog FS\RI_FS\0487-RP-002.dwg Site Vicinity



SOURCE: Base map prepared from Terrain Navigator Pro
USGS 7.5 minute quadrangle map(s) of Tumwater, WA.

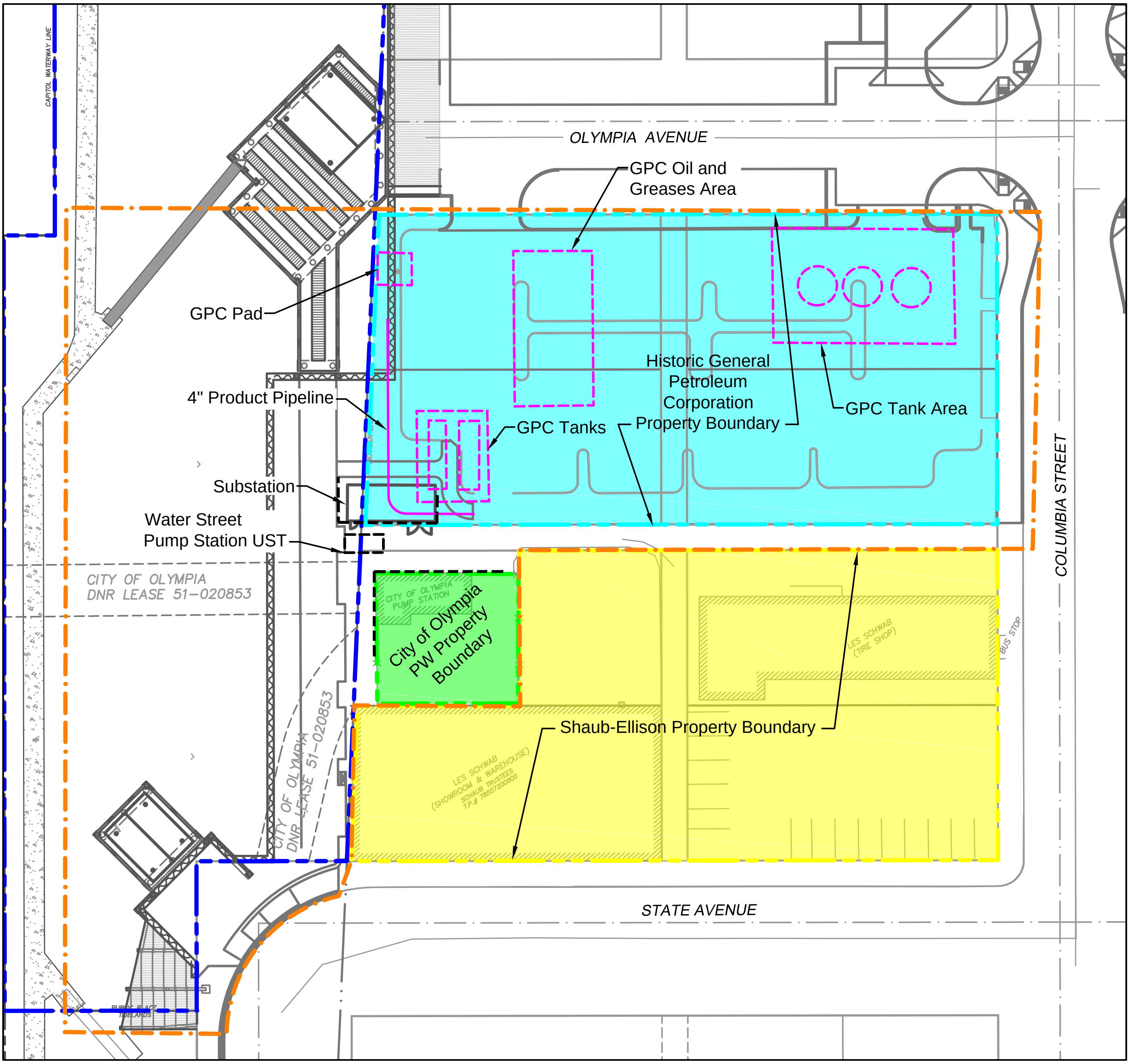
0 2000
Scale in Feet

ANCHOR QEA

Figure 1
Site Vicinity
Remedial Investigation / Feasibility Study
City Sewer Pump Station and General Petroleum Corporation Site

K:\Projects\0487-City of Olympia Parks and Rec\Percival Landing - Volunt Cleanup Prog FS\RI_FS\0487-RP-004.dwg Figure 2 Current and Historical Property Boundaries and Features

Apr 25, 2013 4:10pm tgriga



NOTE: General Petroleum Company location data from 1947 historical map.

SOURCE: Percival Landing Major Rehabilitation QA25, Section A, Phase 1, Construction Drawings, dated 8/02/10.

HORIZONTAL DATUM: Washington State Plane, South, NAD 83/96 CORS.

VERTICAL DATUM: Mean Lower Low Water (MLLW), 1983-2001 Epoch.

LEGEND:

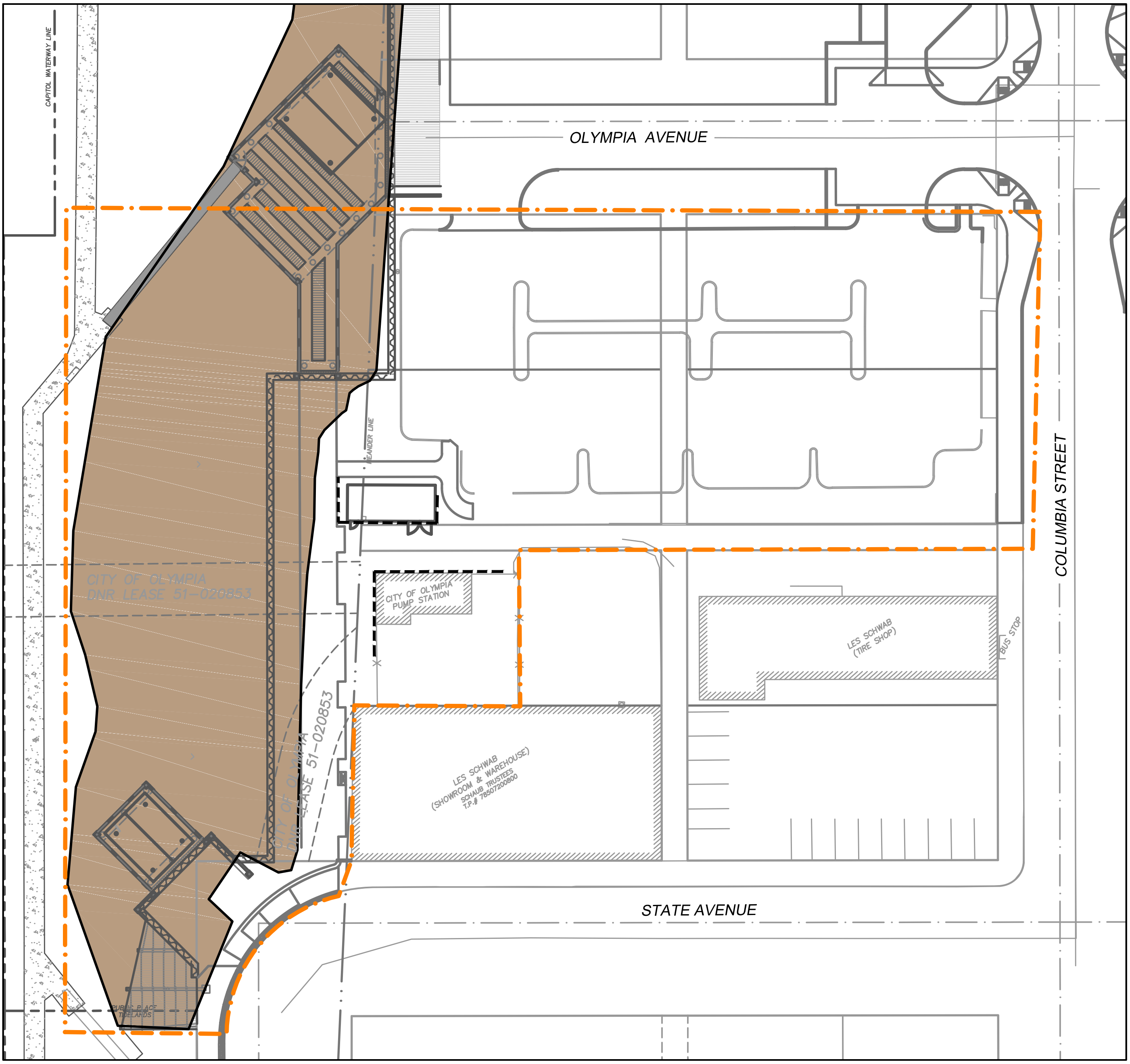
- City Sewer Pump Station and Former General Petroleum Corporation Property RI-FS Study Area
- Approximate Location of Historical Features
- Historic General Petroleum Corporation Property Boundary
- City of Olympia Power Works Property Boundary
- Shaub-Ellison Property Boundary
- DNR Lease Boundary

0 60
Scale in Feet

Figure 2

Current and Historical Property Boundaries and Features
Remedial Investigation / Feasibility Study
City Sewer Pump Station and General Petroleum Corporation Site

ANCHOR QEA



NOTE: General Petroleum Company location data from 1947 historical map.
SOURCE: Percival Landing Major Rehabilitation QA25, Section A, Phase 1, Construction Drawings, dated 8/02/10.
HORIZONTAL DATUM: Washington State Plane, South, NAD 83/96 CORS.
VERTICAL DATUM: Mean Lower Low Water (MLLW), 1983-2001 Epoch.

LEGEND:

— · —	City Sewer Pump Station and Former General Petroleum Corporation Property RI-FS Study Area
▨	2011 Excavation Area

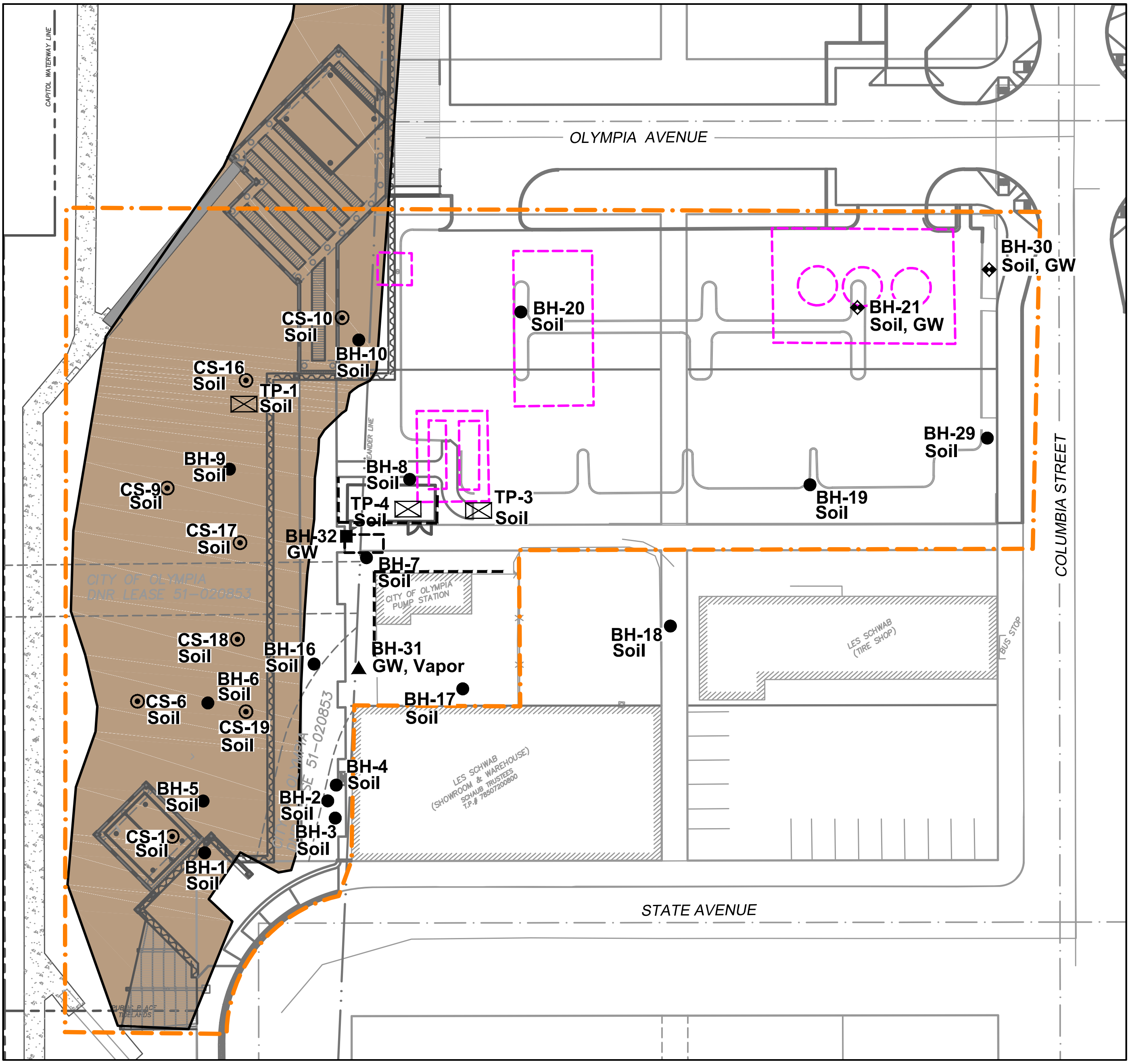
0 60
Scale in Feet

K:\Projects\0487-City of Olympia Parks and Rec\Percival Landing - Volunt Cleanup Prog FS\RI_FS\0487-RP-004.dwg Figure 3 Cleanup Action Areas

Apr 25, 2013 4:10pm tgriga

ANCHOR QEA

Figure 3
Cleanup Action Areas
Remedial Investigation / Feasibility Study
City Sewer Pump Station and General Petroleum Corporation Site



NOTE: General Petroleum Company location data from 1947 historical map.

SOURCE: Percival Landing Major Rehabilitation QA25, Section A, Phase 1, Construction Drawings, dated 8/02/10.

HORIZONTAL DATUM: Washington State Plane, South, NAD 83/96 CORS.

VERTICAL DATUM: Mean Lower Low Water (MLLW), 1983-2001 Epoch.

LEGEND:

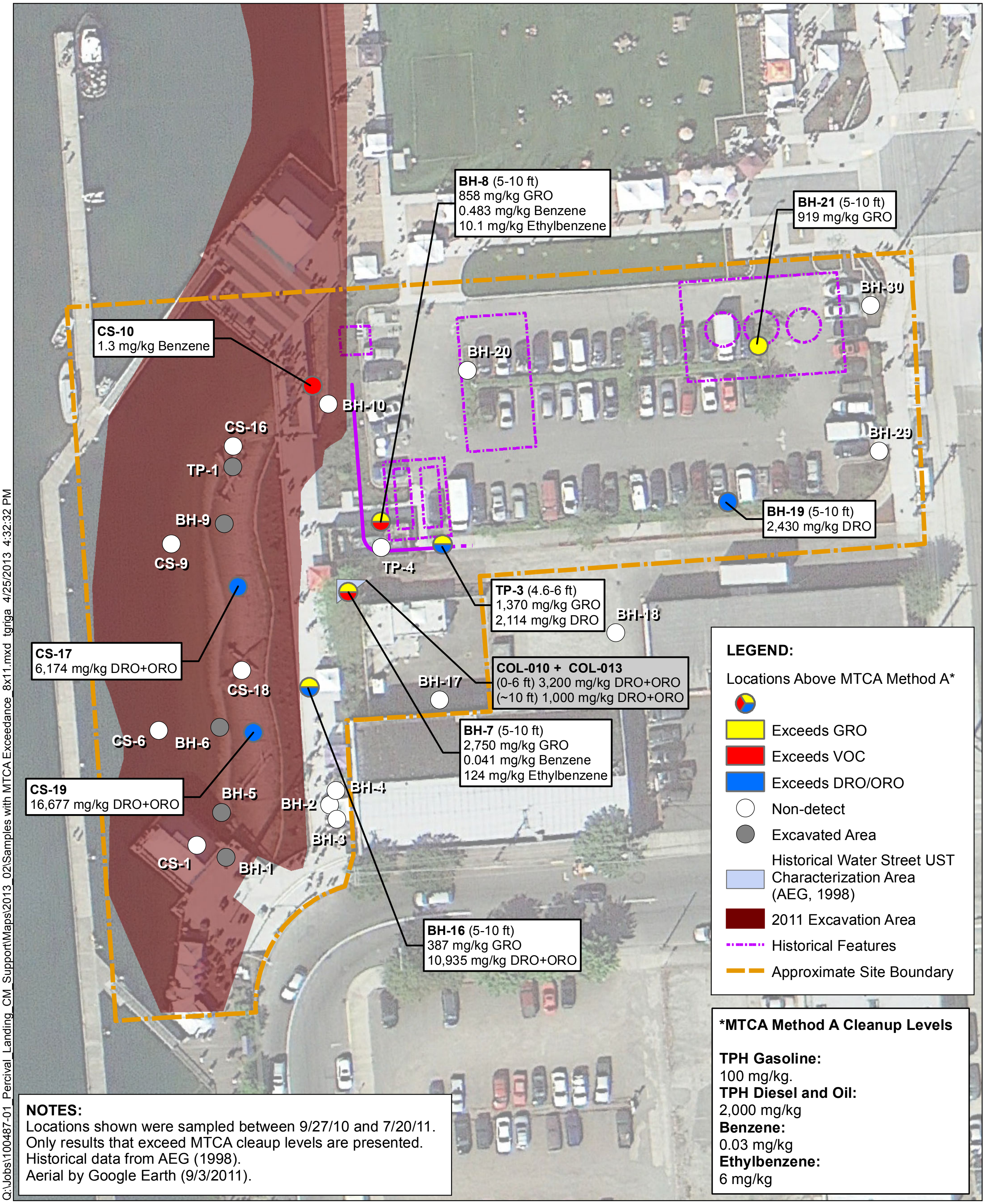
BH-1 ●	Geoprobe (Soil)
BH-30 ◈	Geoprobe (Soil and Groundwater)
BH-31 ▲	Geoprobe (Groundwater and Soil Vapor)
BH-32 ■	Geoprobe (Groundwater)
TP-3 ☒	Test Pit
CS-10 ⊙	Confirmation Sample Location
— · —	City Sewer Pump Station and Former General Petroleum Corporation Property RI-FS Study Area
- - - -	Approximate Location of Historical Features
▨	2011 Excavation Area

0 60
Scale in Feet

Apr 25, 2013 4:10pm tgriga K:\Projects\0487-City of Olympia Parks and Rec\Percival Landing - Volunt Cleanup Prog FS\RI_FS\0487-RP-004.dwg Figure 4 Remedial Investigation Sample Locations

Figure 4
Remedial Investigation Sample Locations
Remedial Investigation / Feasibility Study
City Sewer Pump Station and General Petroleum Corporation Site

ANCHOR QEA



BH-8 (5-10 ft)
858 mg/kg GRO
0.483 mg/kg Benzene
10.1 mg/kg Ethylbenzene

BH-21 (5-10 ft)
919 mg/kg GRO

CS-10
1.3 mg/kg Benzene

BH-19 (5-10 ft)
2,430 mg/kg DRO

TP-3 (4.6-6 ft)
1,370 mg/kg GRO
2,114 mg/kg DRO

CS-17
6,174 mg/kg DRO+ORO

COL-010 + COL-013
(0-6 ft) 3,200 mg/kg DRO+ORO
(~10 ft) 1,000 mg/kg DRO+ORO

BH-7 (5-10 ft)
2,750 mg/kg GRO
0.041 mg/kg Benzene
124 mg/kg Ethylbenzene

CS-19
16,677 mg/kg DRO+ORO

BH-16 (5-10 ft)
387 mg/kg GRO
10,935 mg/kg DRO+ORO

LEGEND:

Locations Above MTCA Method A*

- 🟨 Exceeds GRO
- 🟥 Exceeds VOC
- 🟦 Exceeds DRO/ORO
- ○ Non-detect
- ● Excavated Area
- ▭ Historical Water Street UST Characterization Area (AEG, 1998)
- 🟥 2011 Excavation Area
- -·-· Historical Features
- — — Approximate Site Boundary

NOTES:
Locations shown were sampled between 9/27/10 and 7/20/11.
Only results that exceed MTCA cleaup levels are presented.
Historical data from AEG (1998).
Aerial by Google Earth (9/3/2011).

***MTCA Method A Cleanup Levels**

TPH Gasoline:
100 mg/kg.
TPH Diesel and Oil:
2,000 mg/kg
Benzene:
0.03 mg/kg
Ethylbenzene:
6 mg/kg

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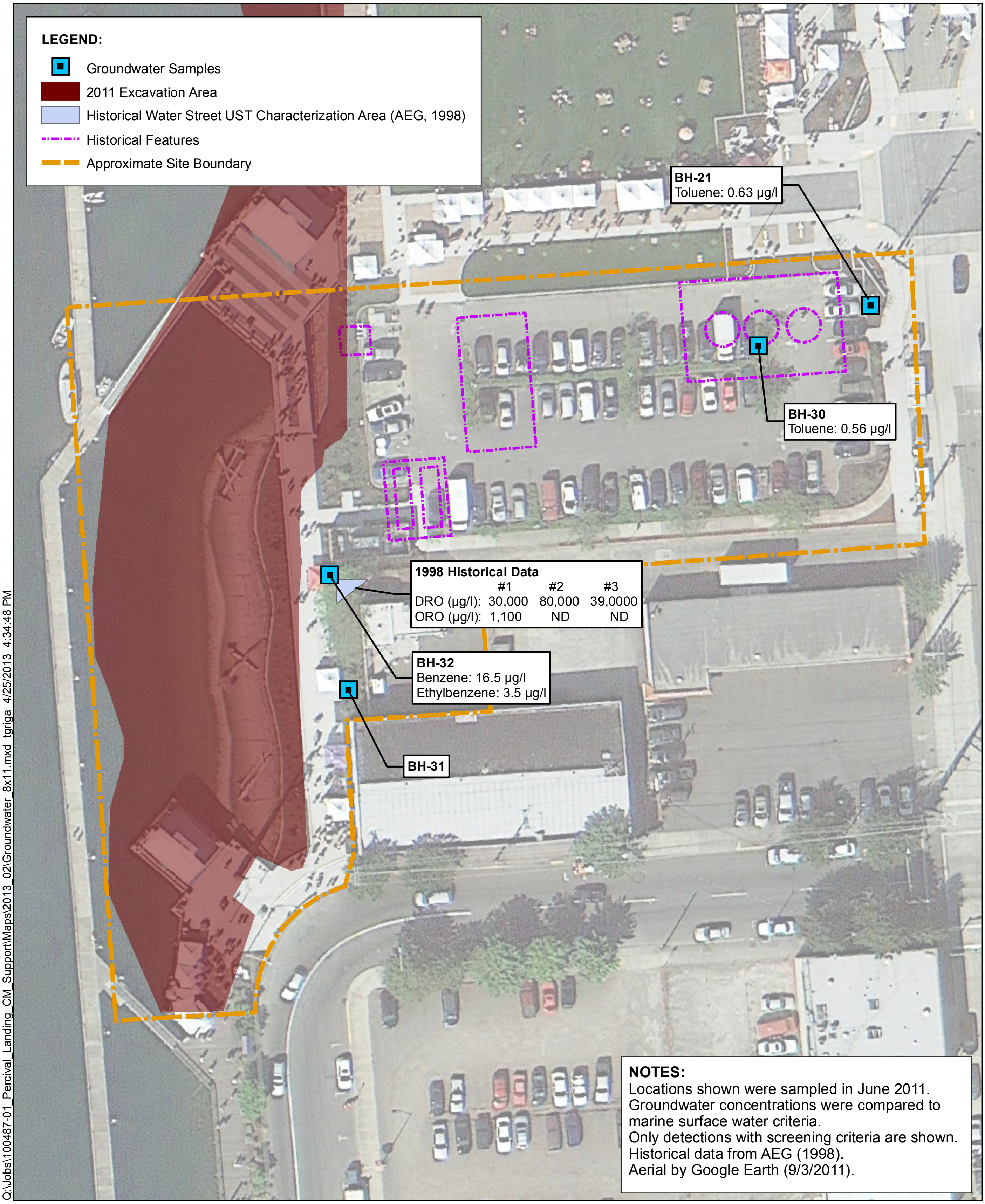
ANCHOR QEA

Figure 5
Soil Sample Locations with MTCA Method A Exceedances
Remedial Investigation / Feasibility Study
City Sewer Pump Station and General Petroleum Corporation Site



1998 Historical Data

	#1	#2	#3
DRO (µg/l):	30,000	80,000	39,0000
ORO (µg/l):	1,100	ND	ND

NOTES:
Locations shown were sampled in June 2011.
Groundwater concentrations were compared to marine surface water criteria.
Only detections with screening criteria are shown.
Historical data from AEG (1998).
Aerial by Google Earth (9/3/2011).

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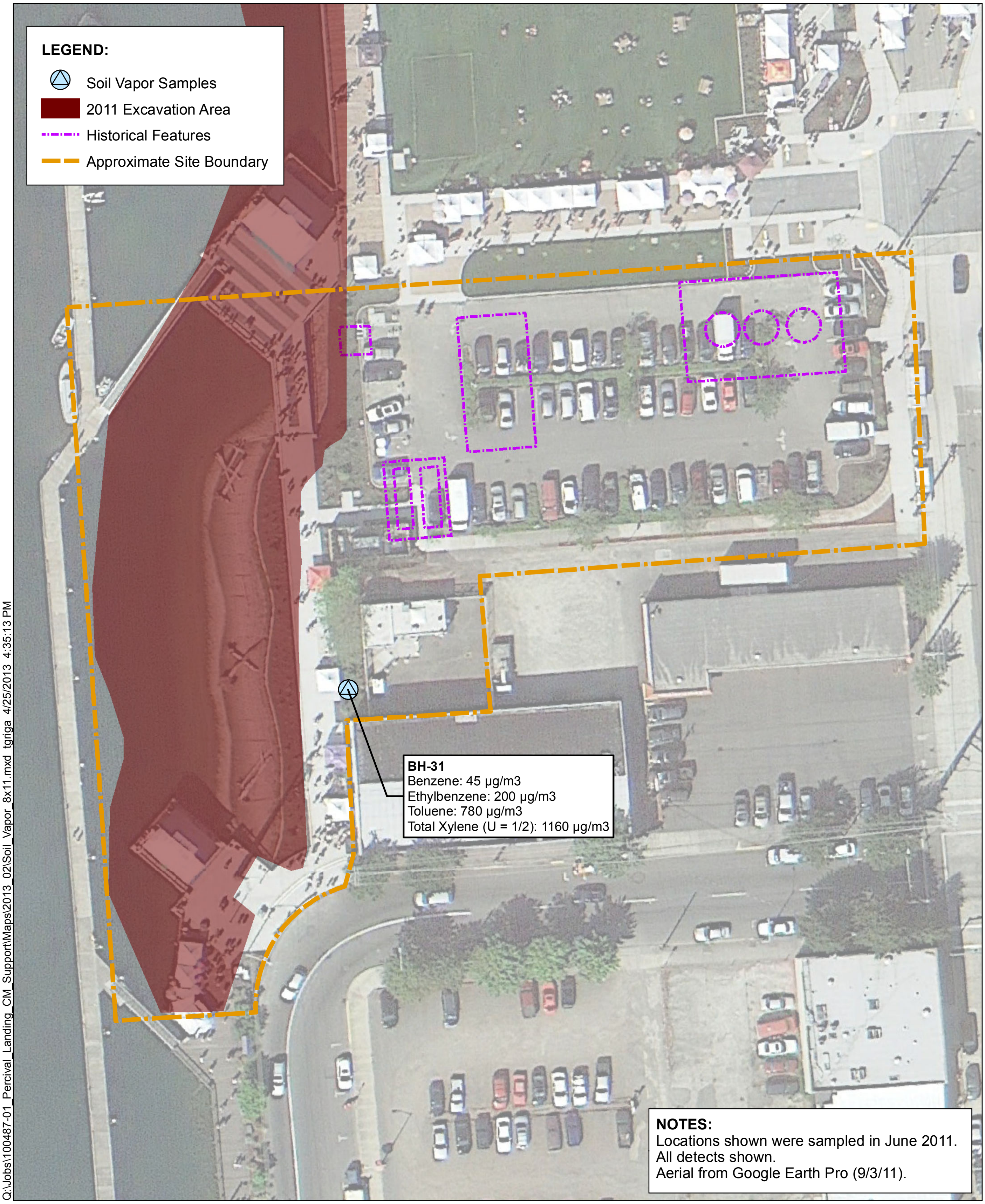
Feet
0 30 60

ANCHOR QEA

Figure 6
Groundwater VOC Concentrations
Remedial Investigation / Feasibility Study
City Sewer Pump Station and General Petroleum Corporation Site



BH-31
Benzene: 45 µg/m3
Ethylbenzene: 200 µg/m3
Toluene: 780 µg/m3
Total Xylene (U = 1/2): 1160 µg/m3

NOTES:
Locations shown were sampled in June 2011.
All detects shown.
Aerial from Google Earth Pro (9/3/11).

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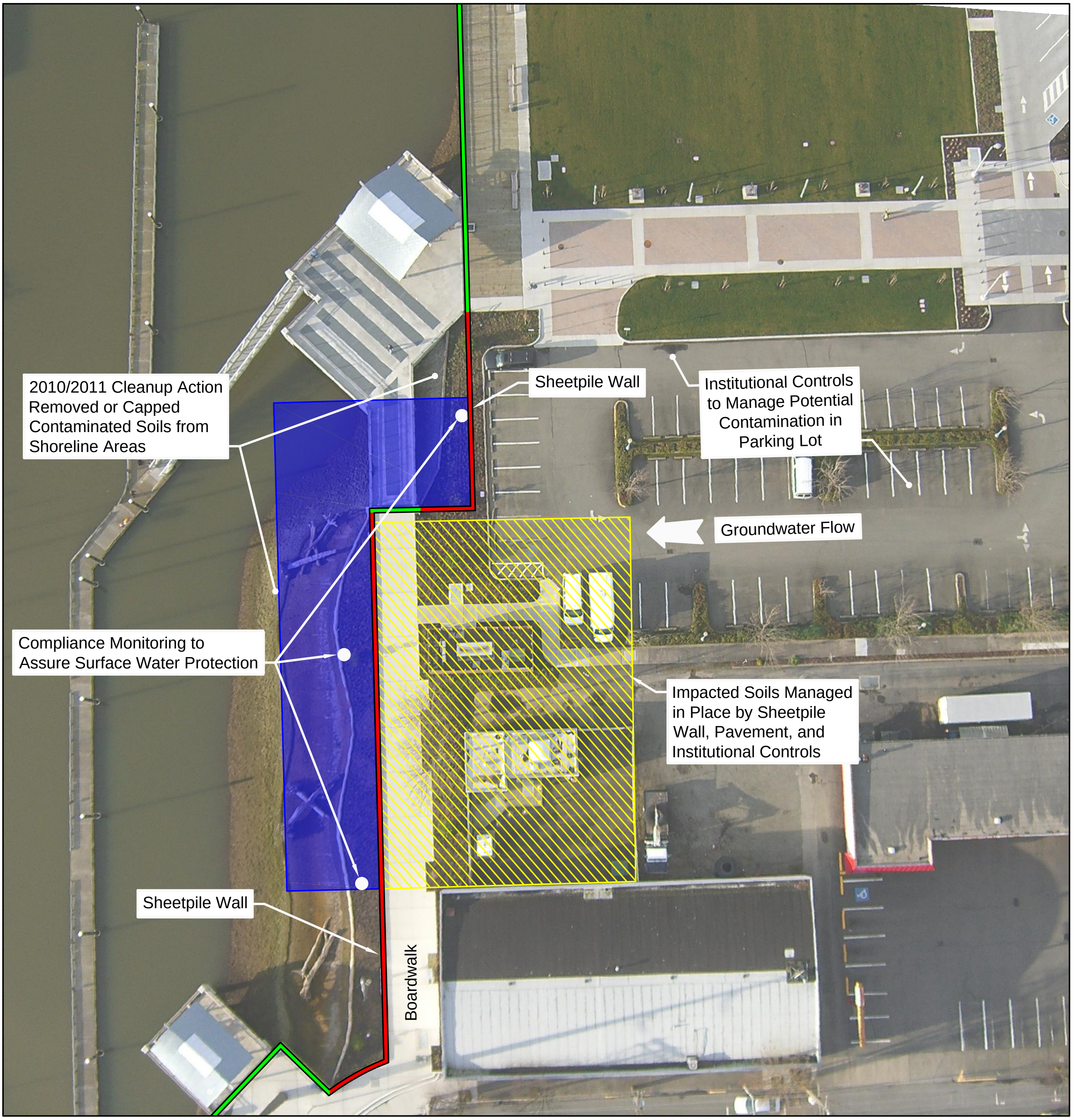
Feet
0 30 60

ANCHOR QEA

Figure 7
Soil Vapor VOC Concentrations
Remedial Investigation / Feasibility Study
City Sewer Pump Station and General Petroleum Corporation Site



AERIAL: Aerial flown by Aerial Images Northwest (March 2012).
NOTE: Not to Scale

LEGEND:

🟩 Sheetpile Wall: 60 ft Embedment

🟥 Sheetpile Wall: 12 to 20 ft Embedment

🟦 Impacted Soils at Depth Waterside of Sheetpile Wall

▨ Impacted Soils at Depth Upland of Sheetpile Wall

K:\Projects\0487-City of Olympia Parks and Rec\Percival Landing - Volunt Cleanup Prog FS\RI_FS\0487-RP-004.dwg Figure 8 Conceptual Site Model

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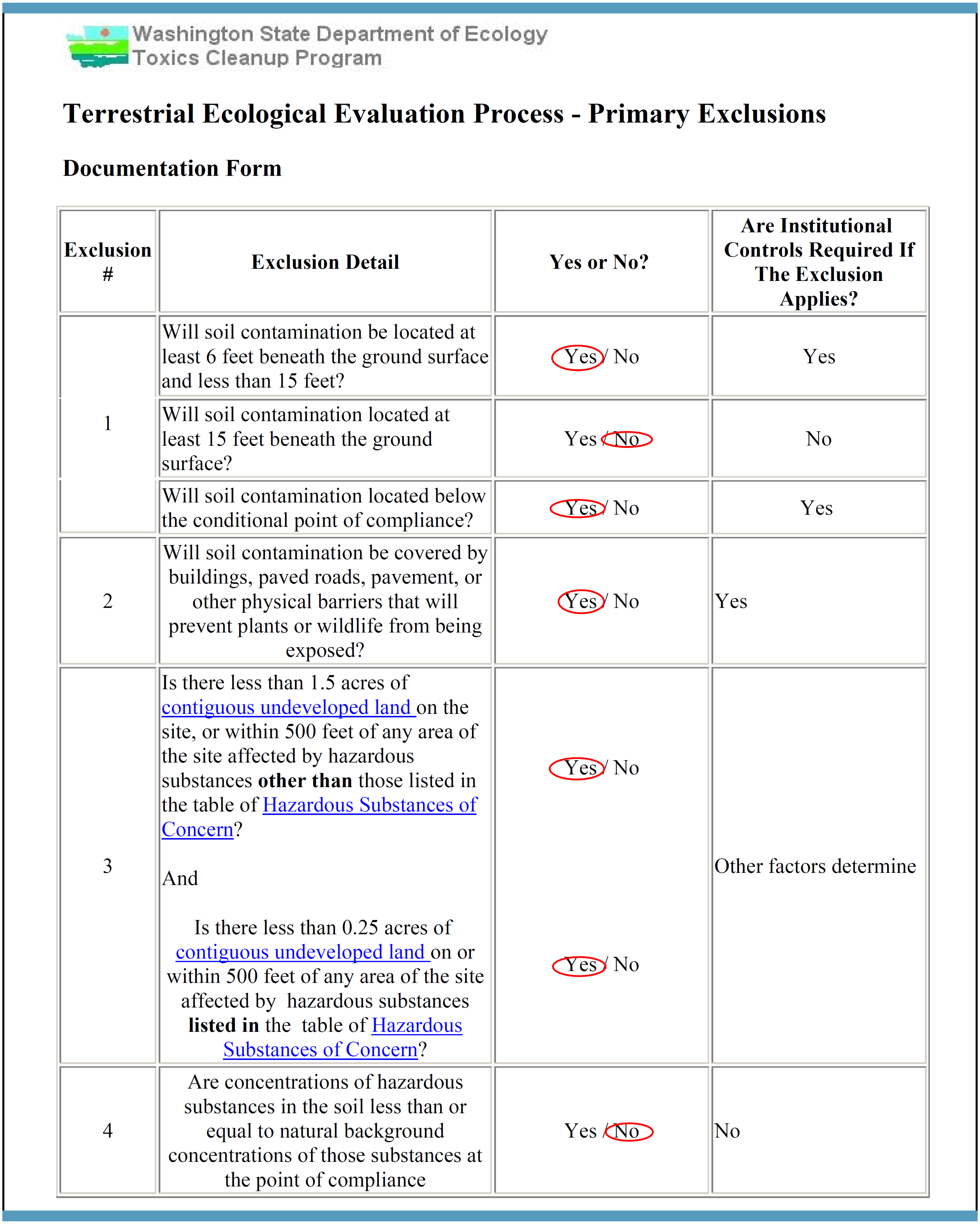
Figure 8
Conceptual Site Model
Remedial Investigation / Feasibility Study
City Sewer Pump Station and General Petroleum Corporation Site



Washington State Department of Ecology
Toxics Cleanup Program

Terrestrial Ecological Evaluation Process - Primary Exclusions

Documentation Form

Exclusion #	Exclusion Detail	Yes or No?	Are Institutional Controls Required If The Exclusion Applies?
1	Will soil contamination be located at least 6 feet beneath the ground surface and less than 15 feet?	[✓ Yes] / No	Yes
	Will soil contamination located at least 15 feet beneath the ground surface?	Yes / [✓ No]	No
	Will soil contamination located below the conditional point of compliance?	[✓ Yes] / No	Yes
2	Will soil contamination be covered by buildings, paved roads, pavement, or other physical barriers that will prevent plants or wildlife from being exposed?	[✓ Yes] / No	Yes
3	Is there less than 1.5 acres of contiguous undeveloped land on the site, or within 500 feet of any area of the site affected by hazardous substances **other than** those listed in the table of Hazardous Substances of Concern? And Is there less than 0.25 acres of contiguous undeveloped land on or within 500 feet of any area of the site affected by hazardous substances **listed in** the table of Hazardous Substances of Concern?	[✓ Yes] / No [✓ Yes] / No	Other factors determine
4	Are concentrations of hazardous substances in the soil less than or equal to natural background concentrations of those substances at the point of compliance	Yes / [✓ No]	No

Figure 9
Terrestrial Ecological Evaluation
Remedial Investigation / Feasibility Study
City Sewer Pump Station and General Petroleum Corporation Site

K:\Projects\0487-City of Olympia Parks and Rec\Percival Landing - Volunt Cleanup Prog FS\RI_FS\0487-RP-004.dwg Figure 10 Proposed Excavation Design

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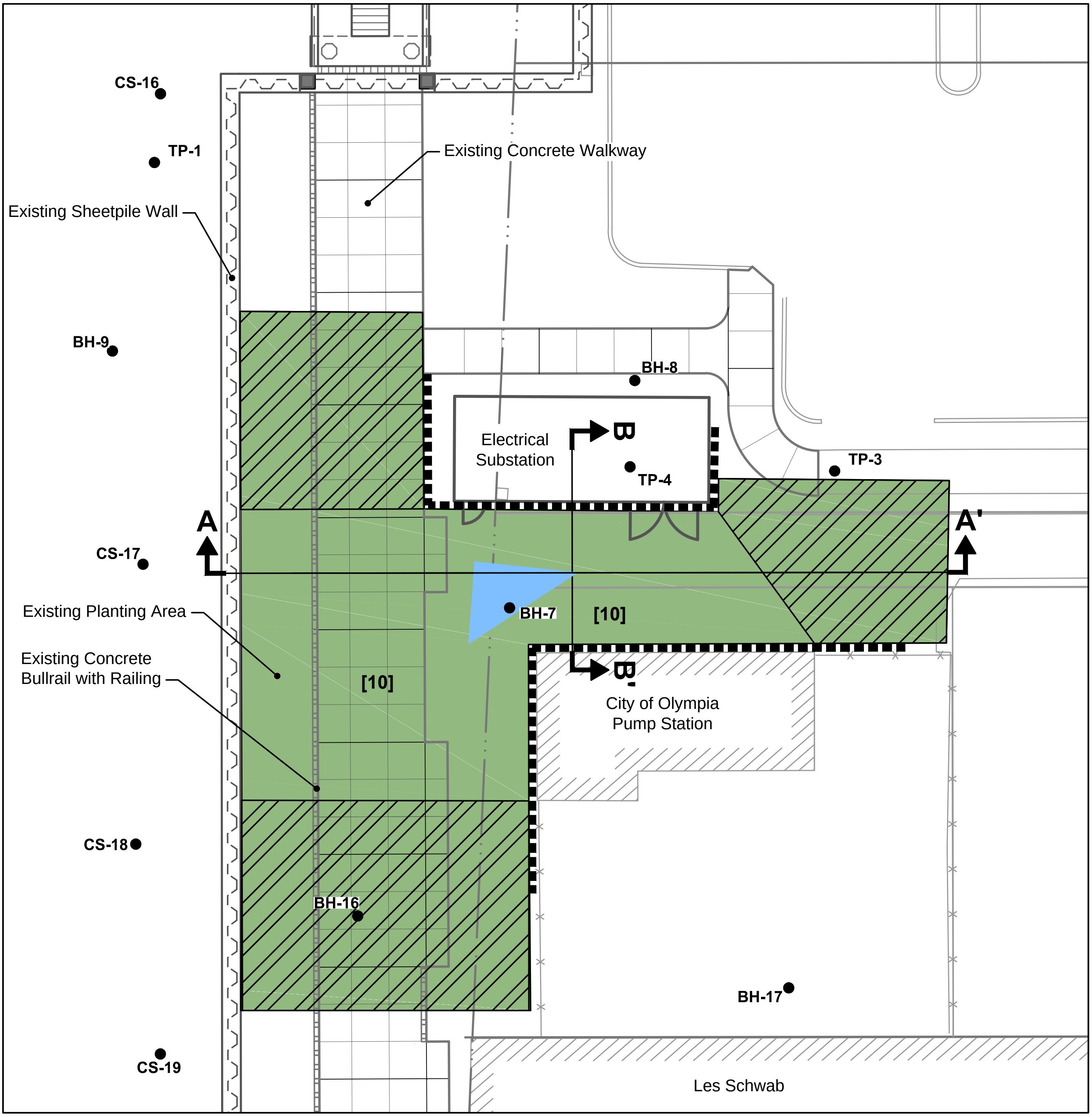


NOTE: General Petroleum Company location data from 1947 historical map.
SOURCE: Percival Landing Major Rehabilitation QA25, Section A, Phase 1, Construction Drawings, dated 8/02/10.
HORIZONTAL DATUM: Washington State Plane, South, NAD 83/96 CORS.

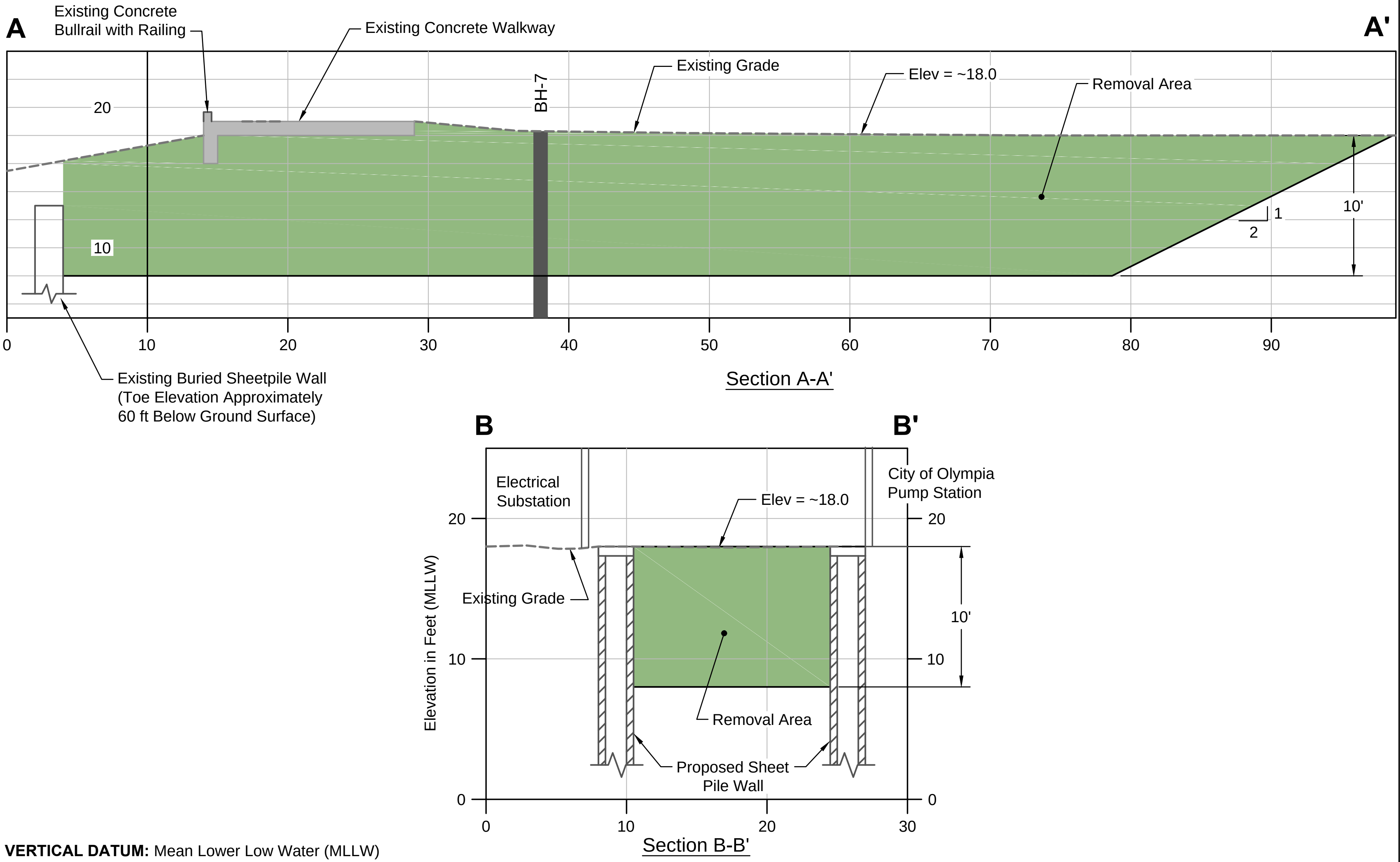
LEGEND:

🟦	Historical Water Street UST Characterization Area (AEG, 1998)
■■■■■■	Proposed Sheetpile Wall
🟩	Proposed Excavation Footprint
▨	Proposed 2H:1V Transition Zone to Existing Grade
[10]	Excavation Depth Below Grade in Feet
BH-17 ●	Geoprobe/Test Pit Location

0 20
Scale in Feet

Figure 10
Proposed Excavation Design
Remedial Investigation / Feasibility Study
City Sewer Pump Station and General Petroleum Corporation Site

Apr 25, 2013 4:10pm tgriga K:\Projects\0487-City of Olympia Parks and Rec\Percival Landing - Volunt Cleanup Prog FS\RI_FS\0487-RP-004.dwg Figure 11 Proposed Excavation Cross Sections



VERTICAL DATUM: Mean Lower Low Water (MLLW)

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Figure 11
Proposed Excavation Cross Sections
Remedial Investigation / Feasibility Study
City Sewer Pump Station and General Petroleum Corporation Site

APPENDIX A
SOIL GEOPROBE BORING LOGS

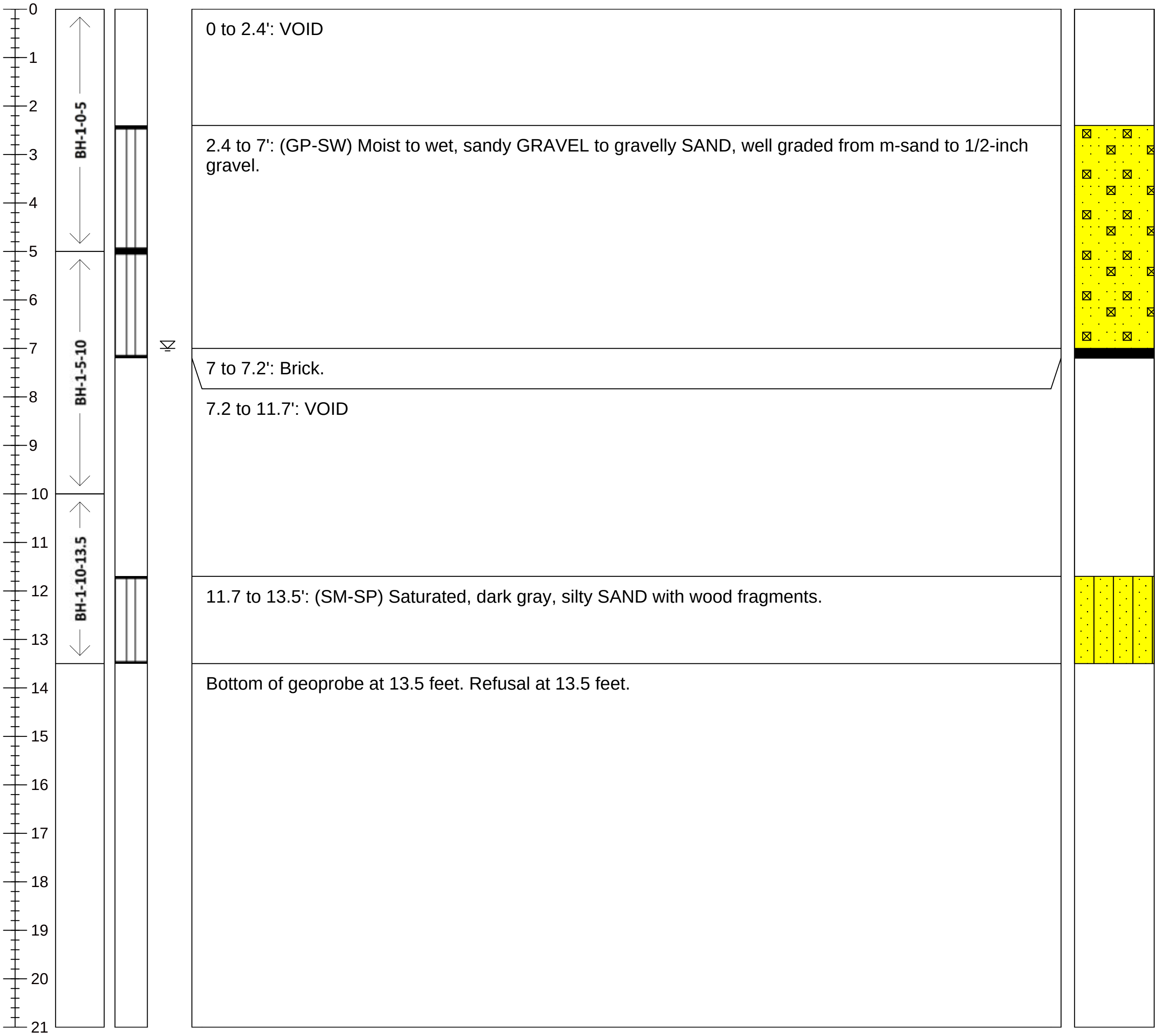
Geoprobe

BH-1

Sheet 1 of 1

Project: **Percival Landing**	Location: **Budd Inlet West Bay**	Method/Tube ID: **Geoprobe**
Project #: **100487-01**	Northing: **633571.01** Easting: **1041090.87**	Tube Length (ft): **20.0**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**	Penetration Depth (ft): **13.5**
Collection Date: **9-27-10**		Logged By: **CS**
Contractor: **Pacific Soil and Water**		

Recoverd Depth (ft)	Sample Name	Sample Recovery	Groundwater	**Sediment Description**	Graphic Log



0 to 2.4': VOID

2.4 to 7': (GP-SW) Moist to wet, sandy GRAVEL to gravelly SAND, well graded from m-sand to 1/2-inch gravel.

7 to 7.2': Brick.

7.2 to 11.7': VOID

11.7 to 13.5': (SM-SP) Saturated, dark gray, silty SAND with wood fragments.

Bottom of geoprobe at 13.5 feet. Refusal at 13.5 feet.

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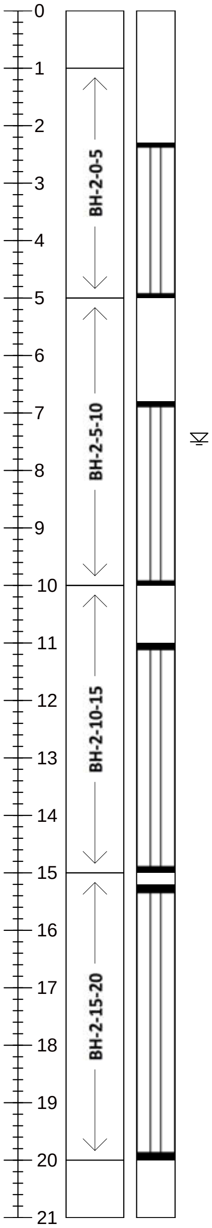
Geoprobe

BH-2

Sheet 1 of 1

Project: **Percival Landing**	Location: **Budd Inlet West Bay**	Method/Tube ID:**Geoprobe**
Project #: **100487-01**	Northing: **633594.37** Easting: **1041090.87**	Tube Length (ft): **1041137.02**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**	Penetration Depth (ft): **20.0**
Collection Date: **9/27/10**		Logged By:**CW**
Contractor:**Pacific Soil and Water**		

Recoverd Depth (ft)	Sample Name	Sample Recovery	Groundwater	Sediment Description	Graphic Log



0 to 2.3': VOID

2.3 to 4': (SW) Moist, grayish brown, well graded, gravelly SAND. (FILL)

4 to 5': (ML-SM) Gray SILT to sandy SILT with few small gravels. (FILL)

5 to 6.8': VOID

6.8 to 8.5': (SW) Moist to wet, brown SAND, moderately well graded with few small gravels. (FILL)

8.5 to 10': (SP-ML) Saturated SAND with dark gray f-grained, thin silt layers and occasional woody debris.

10 to 11': VOID

11 to 12.3': (SP-ML) Saturated SAND with dark gray f-grained, thin silt layers and occasional woody debris.

12.3 to 14.3': (SW) Dark gray SAND with trace to 10% silt with significant woody debris.

14.3 to 15': (SP-SM) Dark gray SAND with trace to 10% silt, woody debris and shell fragments.

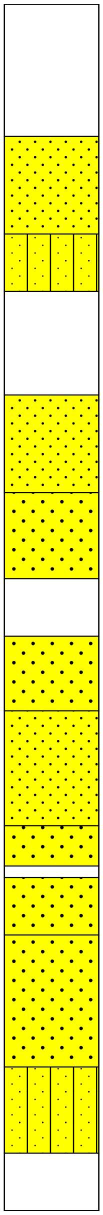
15 to 15.2': VOID

15.2 to 16.2': (SP-SM) Dark gray SAND with trace to 10% silt, woody debris and shell fragments.

16.2 to 18.5': (SP) Saturated, poorly graded, dark gray f-SAND with many shell fragments.

18.5 to 20': (ML-SM) Dark gray, moderately cohesive SILT to sandy SILT.

Bottom of geoprobe at 20 feet.



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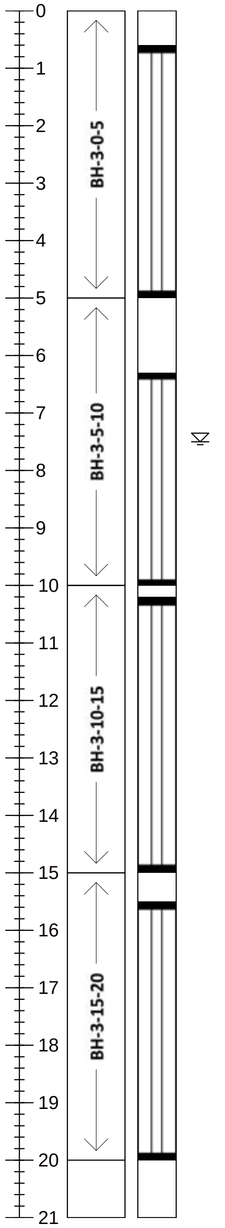
Geoprobe

BH-3

Sheet 1 of 1

Project: **Percival Landing**	Location: **Budd Inlet West Bay**		Method/Tube ID:**Geoprobe**
Project #: **100487-01**	Northing: **633587.93**	Easting: **1041140.38**	Tube Length (ft): **20.0**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**		Penetration Depth (ft): **20.0**
Collection Date: **9-28-10**			Logged By: **CW**
Contractor: **Pacific Soil and Water**			

Recoverd Depth (ft)	Sample Name	Sample Recovery	Groundwater	Sediment Description	Graphic Log



0 to 0.6': VOID

0.6 to 4': (SW-SM) Moist, brown, silty SAND, sandy SILT, and GRAVEL. (FILL)

4 to 5': (SP) Wet, brown, moderately poorly graded f-SAND with few gravels and few wood fragments.

5 to 6.3': VOID

6.3 to 8.2': (SP) Wet, brown, moderately poorly graded f-SAND with few gravels and few wood fragments.

8.2 to 10': (SP) Poorly sorted f-SAND with some woody debris and shell fragments.

10 to 10.2': VOID

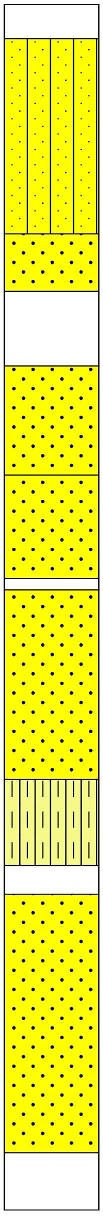
10.2 to 13.5': (SP) Poorly sorted, f- SAND with some woody debris and shell fragments.

13.5 to 15': (OL) Saturated, black, slightly organic SILT with some c-organic material, few shells.

15 to 15.5': VOID

15.5' to 20': (SP) Dark gray, poorly graded, f-SAND with 5-5% shells, some light, organic zones.

Bottom of geoprobe at 20 feet.



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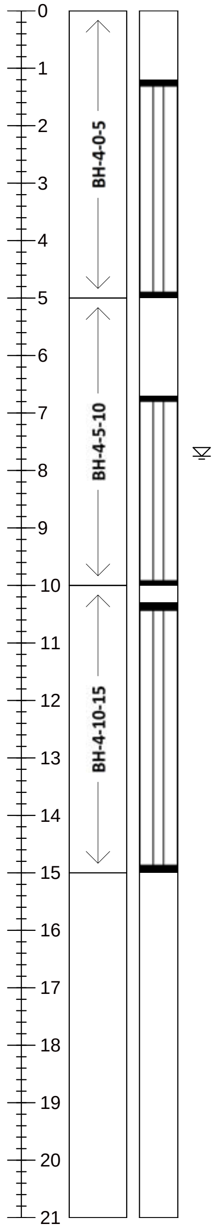
Geoprobe

BH-4

Sheet 1 of 1

Project: **Percival Landing**	Location: **Budd Inlet West Bay**	Method/Tube ID: **Geoprobe**
Project #: **100487-01**	Northing: **633600.69** Easting: **1041139.87**	Tube Length (ft): **20.0**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**	Penetration Depth (ft): **20.0**
Collection Date: **9-28-10**		Logged By: **CW**
Contractor: **Pacific Soil and Water**		

Recoverd Depth (ft) | Sample Name | Sample Recovery | Groundwater | **Sediment Description** | Graphic Log



0 to 1.2': VOID

1.2 to 5': (FILL) Random Fill. Interbedded sandy SILT, SAND and GRAVEL.

5 to 5.5': VOID

5.5 to 6.5': (ML) Moist, brown, SILT with some sand.

6.5 to 8': (SW) Gray-brown, moderately well graded m-SAND with some gravels.

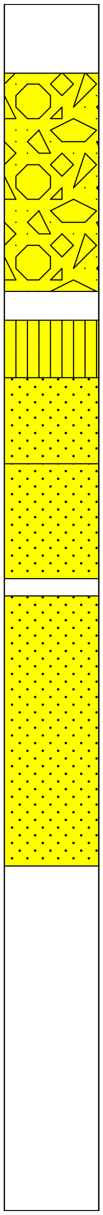
8 to 10': (SW) Saturated, dark gray, vf-c-SAND with wood.

10 to 10.3': VOID

10.3 to 15': (SW) Saturated, dark gray, vf-c-SAND with wood.
@10.4 to 11': Some shells.

@ 14 to 15': Many shells.

End of geoprobe at 15 feet. Refusal due to wood.



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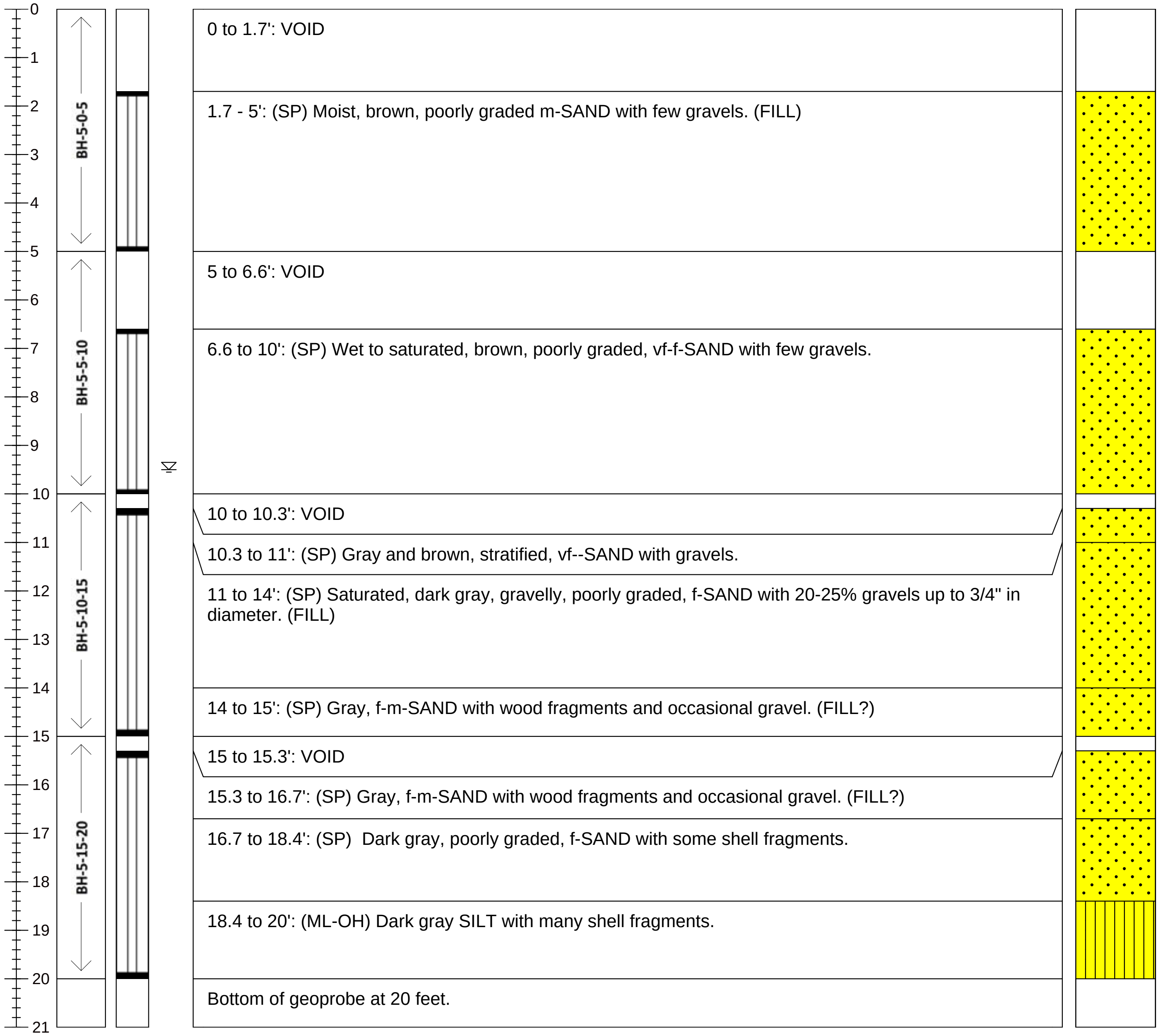
Geoprobe
BH-5

Sheet 1 of 1

Project: **Percival Landing**	Location: **Budd Inlet West Bay**	Method/Tube ID: **Geoprobe**
Project #: **100487-01**	Northing: **633590.96** Easting: **1041088.87**	Tube Length (ft): **20.0**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**	Penetration Depth (ft): **20.0**
Collection Date: **9/27/10**		Logged By: **CW**
Contractor: **Pacific Soil and Water**		

Recoverd Depth (ft)	Sample Name	Sample Recovery	Groundwater	Sediment Description	Graphic Log



0 to 1.7': VOID

1.7 - 5': (SP) Moist, brown, poorly graded m-SAND with few gravels. (FILL)

5 to 6.6': VOID

6.6 to 10': (SP) Wet to saturated, brown, poorly graded, vf-f-SAND with few gravels.

10 to 10.3': VOID

10.3 to 11': (SP) Gray and brown, stratified, vf--SAND with gravels.

11 to 14': (SP) Saturated, dark gray, gravelly, poorly graded, f-SAND with 20-25% gravels up to 3/4" in diameter. (FILL)

14 to 15': (SP) Gray, f-m-SAND with wood fragments and occasional gravel. (FILL?)

15 to 15.3': VOID

15.3 to 16.7': (SP) Gray, f-m-SAND with wood fragments and occasional gravel. (FILL?)

16.7 to 18.4': (SP) Dark gray, poorly graded, f-SAND with some shell fragments.

18.4 to 20': (ML-OH) Dark gray SILT with many shell fragments.

Bottom of geoprobe at 20 feet.

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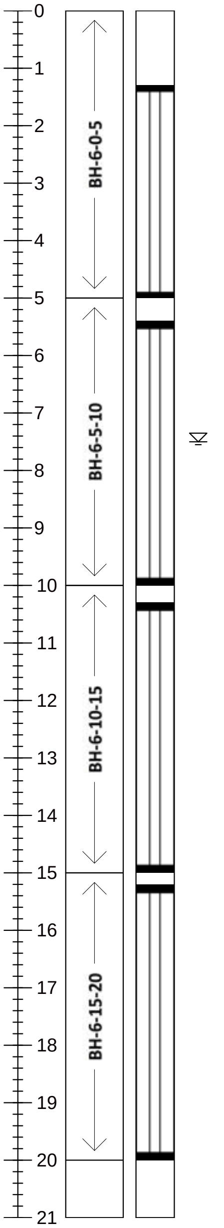
Geoprobe

BH-6

Sheet 1 of 1

Project: **Percival Landing**	Location: **Budd Inlet West Bay**	Method/Tube ID: **Geoprobe**
Project #: **100487-01**	Northing: **633628.94** Easting: **1041088.08**	Tube Length (ft): **20.0**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**	Penetration Depth (ft): **20.0**
Collection Date: **9/27/10**		Logged By: **CW**
Contractor: **Pacific Soil and Water**		

Recoverd Depth (ft)	Sample Name	Sample Recovery	Groundwater	Sediment Description	Graphic Log



0 to 1.3': VOID

1.3 to 2.2': (SP-SW) Loose, brown, gravelly, f-SAND with some shell fragments. (FILL)

2.2 to 5': (SP-SW) Moist, gray-brown, f-SAND with few gravels to 3/4", some iron oxidized zones. (FILL)

5 to 5.4': VOID

5.4 to 6': (SP-SW) Moist, gray-brown, f-SAND with few gravels to 3/4", some iron oxidized zones. (FILL)

6 to 7.6': (SP) Moist, brown-gray to brown, moderately to poorly graded, vf-f-SAND with few gravels to 3/8". (FILL)

7.6 to 10': (SP) Dark gray, vf-f-SAND with 15% gravel to 3/4", possible HC-like odor.

10 to 10.3': VOID

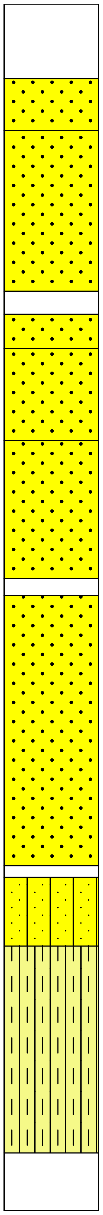
10.3 to 15': (SP) Saturated, dark gray, poorly graded, vf-f-SAND. Some variation in grain size with depth, few gravels, possible HC-like odor.

15 to 15.2': VOID

15.2 to 16.4': (SP-SM) Saturated, dark gray, poorly graded, vf-SAND to silty SAND with many shell fragments.

16.4 to 20': (ML-OL) Saturated, dark gray SILT with many shell fragments and some woody debris.

Bottom of geoprobe at 20 feet.

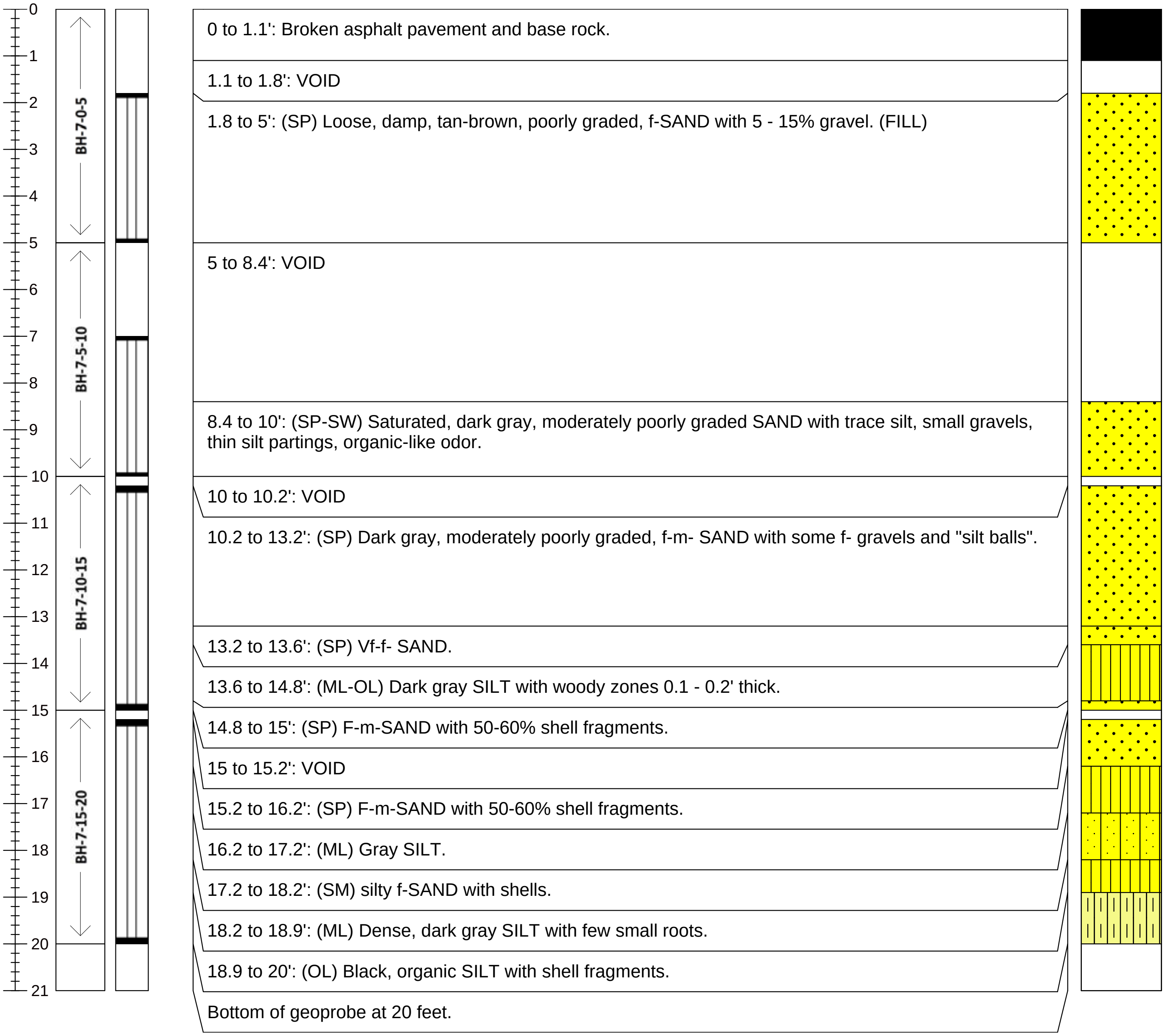


Geoprobe
BH-7

Sheet 1 of 1

Project: **Percival Landing**	Location: **Budd Inlet West Bay**	Method/Tube ID: **Geoprobe**
Project #: **100487-01**	Northing: **633689.25** Easting: **1041145.42**	Tube Length (ft): **20.0**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**	Penetration Depth (ft): **20.0**
Collection Date: **9/27/10**		Logged By: **CW**
Contractor: **Pacific Soil and Water**		

Recoverd Depth (ft)	Sample Name	Sample Recovery	Groundwater	**Sediment Description**	Graphic Log



0 to 1.1': Broken asphalt pavement and base rock.

1.1 to 1.8': VOID

1.8 to 5': (SP) Loose, damp, tan-brown, poorly graded, f-SAND with 5 - 15% gravel. (FILL)

5 to 8.4': VOID

8.4 to 10': (SP-SW) Saturated, dark gray, moderately poorly graded SAND with trace silt, small gravels, thin silt partings, organic-like odor.

10 to 10.2': VOID

10.2 to 13.2': (SP) Dark gray, moderately poorly graded, f-m- SAND with some f- gravels and "silt balls".

13.2 to 13.6': (SP) Vf-f- SAND.

13.6 to 14.8': (ML-OL) Dark gray SILT with woody zones 0.1 - 0.2' thick.

14.8 to 15': (SP) F-m-SAND with 50-60% shell fragments.

15 to 15.2': VOID

15.2 to 16.2': (SP) F-m-SAND with 50-60% shell fragments.

16.2 to 17.2': (ML) Gray SILT.

17.2 to 18.2': (SM) silty f-SAND with shells.

18.2 to 18.9': (ML) Dense, dark gray SILT with few small roots.

18.9 to 20': (OL) Black, organic SILT with shell fragments.

Bottom of geoprobe at 20 feet.

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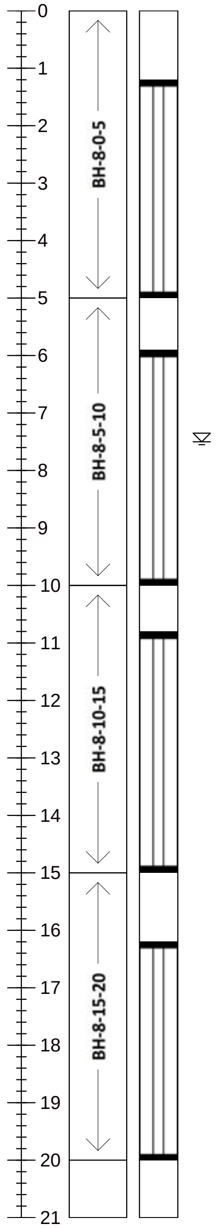
Geoprobe

BH-8

Sheet 1 of 1

Project: **Percival Landing**	Location: **Budd Inlet West Bay**		Method/Tube ID:**Geoprobe**
Project #: **100487-01**	Northing: **633720.68**	Easting: **1041159.98**	Tube Length (ft): **20.0**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**		Penetration Depth (ft): **20.0**
Collection Date: **9/28/10**			Logged By: **CW**
Contractor: **Pacific Soil and Water**			

Recoverd Depth (ft)	Sample Name	Sample Recovery	Groundwater	**Sediment Description**	Graphic Log



0 to 1.2': (FILL) Silty SAND and sandy SILT with few angular gravels.

1.2 to 5': (SP-SM) Loose, damp, brown, poorly graded, f-SAND with some silt and few gravels.

5 to 5.9': VOID

5.9 to 10': (SP-SM) Loose, damp, brown, poorly graded, f-SAND with some silt and few gravels.

10 to 10.8': VOID

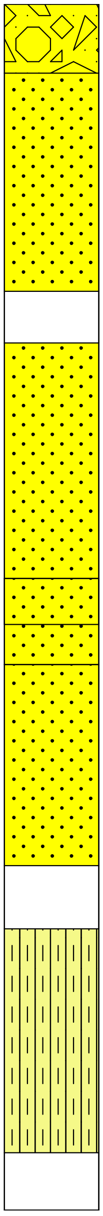
10.8 to 11.5': (SP-SM) Wet to saturated, gray, moderately poorly graded, f-SAND with trace silt and few gravels.

11.5 to 15': (SP-SW) Saturated, dark gray, moderately poorly graded, f-m-SAND with some fine gravels and some thin silt layers.

15 to 16.1': VOID

16.1 to 20': (OL-ML) Saturated, gray to dark gray, organic SILT with <0.2 ft thick sand lenses and shell fragments.

Bottom of geoprobe at 20 feet.



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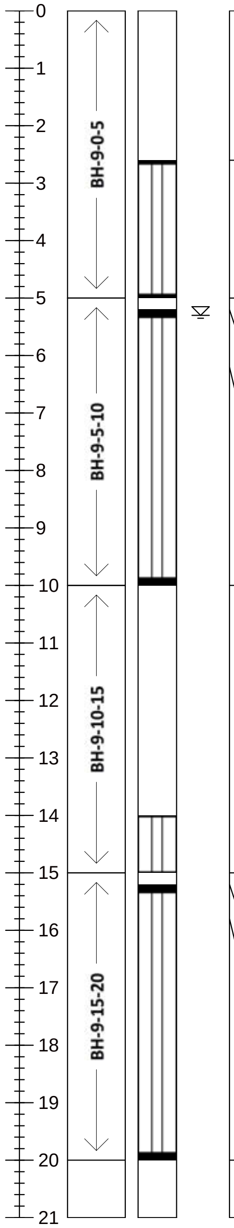
Geoprobe

BH-9

Sheet 1 of 1

Project: **Percival Landing**	Location: **Budd Inlet West Bay**		Method/Tube ID: **Geoprobe**
Project #: **100487-01**	Northing: **633719.74**	Easting: **1041090.10**	Tube Length (ft): **20.0**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**		Penetration Depth (ft): **20.0**
Collection Date: **9/27/10**			Logged By: **CW**
Contractor: **Pacific Soil and Water**			

Recoverd Depth (ft) | Sample Name | Sample Recovery | Groundwater | **Sediment Description** | Graphic Log



0 to 2.6': VOID

2.6 to 5': (SP) Loose, moist to saturated, brown, poorly graded, vf-f-SAND. (FILL)

5 to 5.2': VOID

5.2 to 6.2': (SP) Loose, moist to saturated, brown, poorly graded, vf-f-SAND with few gravels below 5.2 feet. (FILL)

6.2 to 10': (SP) Saturated, gray, vf-f- SAND with trace silt, few gravels to 3/4 in, and possible HC-like odor.

10 to 14': VOID

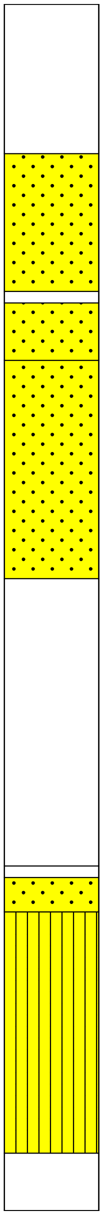
14 to 15': Unknown due to poor recovery.

15 to 15.2': VOID

15.2 to 15.8': (SP) Dark gray SAND with trace silt, woody debris, and shell fragments.

15.8 to 20': (ML) Saturated, dark gray, cohesive SILT with trace sand and shell fragments and zones up 0.2 ft thick.

Bottom of geoprobe at 20 feet.



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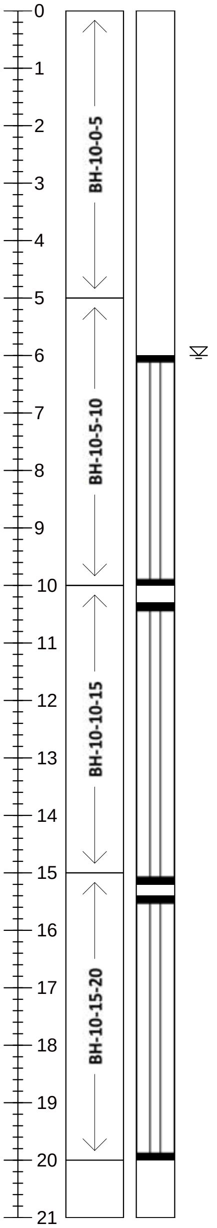
Geoprobe

BH-10

Sheet 1 of 1

Project: **Percival Landing**	Location: **Budd Inlet West Bay**	Method/Tube ID: **Geoprobe**
Project #: **100487-01**	Northing: **633773.09** Easting: **1041136.58**	Tube Length (ft): **20.0**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**	Penetration Depth (ft): **20.0**
Collection Date: **9/27/10**		Logged By: **CW**
Contractor: **Pacific Soil and Water**		

Recoverd Depth (ft) | Sample Name | Sample Recovery | Groundwater | **Sediment Description** | Graphic Log



0 to 6': VOID

6 to 7.3': (SP) Saturated, brown and gray-brown, moderately poorly graded, f-m-SAND with few gravels.

7.3 to 10': (SP) Saturated, dark gray to black, moderately poorly graded, f-SAND with 10-20% f-gravel, silty sand zone with many roots and few shell fragments.

10 to 10.3': VOID

10.3 to 11.5': (SP) Saturated, dark gray to black, moderately poorly graded, f-SAND with 10-20% f-gravel, silty sand zone with many roots and few shell fragments.

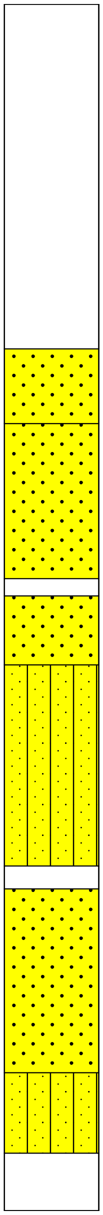
11.5 to 15': (SM-SP-ML) Interbedded SAND and SILT. Saturated, dark gray, f-SAND layers 0.4 - 1.3 ft thick. Dark gray, moderately cohesive SILT layers .05 - 0.4 ft thick with some small roots.

15 to 15.4': VOID

15.4 to 18.6': (SP) Gray, moderately poorly graded, m-SAND with many shell fragments, grades to c-sand at bottom.

18.6 to 20': (SM) Dark gray, f-SAND to silty, f-SAND with some thin silt lenses, small pockets of wood debris/roots.

Bottom of geoprobe at 20 feet.



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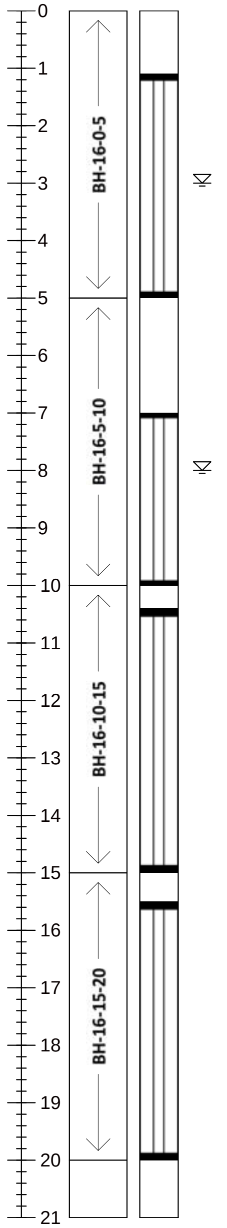
Geoprobe

BH-16

Sheet 1 of 1

Project: **Percival Landing**	Location: **Budd Inlet West Bay**	Method/Tube ID: **Geoprobe**
Project #: **100487-01**	Northing: **633646.81** Easting: **1041128.04**	Tube Length (ft): **20.0**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**	Penetration Depth (ft): **20.0**
Collection Date: **11/9/10**		Logged By: **AC/JD**
Contractor: **Pacific Soil and Water**		

Recoverd Depth (ft)	Sample Name	Sample Recovery	Groundwater	Sediment Description	Graphic Log



0 to 1.1': VOID

1.1 to 2.2': (GW) Medium dense, dry, black f-GRAVEL (FILL).

2.2 to 5': (SW) Medium dense, dry, light brown, f-gravelly, f-c-SAND with gravel up to 1" diameter.

@2.7': Grades to damp.

5 to 7': VOID

7 to 8': (SW) Medium dense, moist, light brown, f-gravelly, f-c-SAND with gravel up to 1" diameter.

8 to 10': (SM) Medium dense, moist, dark gray, slightly silty, f-c-SAND with occasional shell fragments and moderate HC-like odor.

10 to 10.4': VOID

10.4 to 13.6': (SM) Medium dense, moist, dark gray, slightly silty, f-c-SAND with occasional shell fragments.

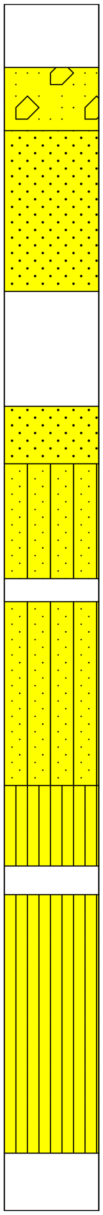
13.6 to 15': (ML) Grades to moderate layers of medium stiff, moist, olive gray SILT up to 6" length.

@ 14': 3" layer of wood fibers.

15 to 15.5': VOID

15.5 to 20': (ML) Moderate layers of medium stiff, moist, olive gray SILT up to 6" length.

End of geoprobe at 20 feet.

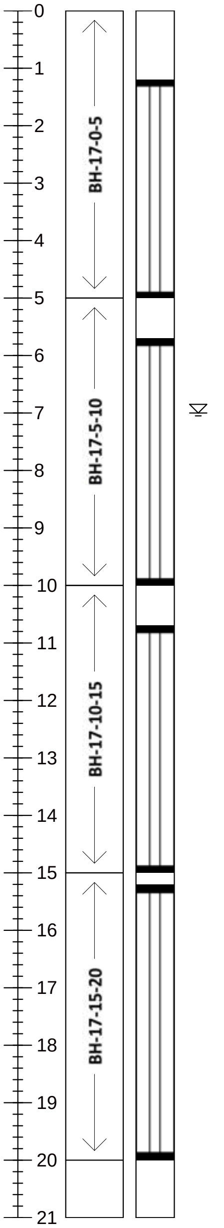


Geoprobe
BH-17

Sheet 1 of 1

Project: **Percival Landing**	Location: **Budd Inlet West Bay**	Method/Tube ID:**Geoprobe**
Project #: **100487-01**	Northing: **633641.25** Easting: **1041128.04**	Tube Length (ft): **20.0**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**	Penetration Depth (ft): **20.0**
Collection Date: **11/8/10**		Logged By: **AC/JD**
Contractor: **Pacific Soil and Water**		

Recoverd Depth (ft)	Sample Name	Sample Recovery	Groundwater	Sediment Description	Graphic Log



0 to 1.2': VOID

1.2 to 2.5': (GW) Dense, black to brown, dry, f-c-sandy, f-c-GRAVEL (ASPHALT).

2.5 to 5': (SW) Medium dense, dry, light brown, slightly gravelly, f-c-SAND (FILL).

5 to 5.7': VOID

5.7 to 8.5': (SW) Medium dense, dry, light brown, slightly gravelly, f-c-SAND (FILL).
@ 7': Grades to damp.
@ 7.8': Thin (1/2") layers of medium stiff, moist, orange/brown SILT.

8.5 to 10': (SM) Medium dense, moist, dark gray, slightly silty, slightly f-gravelly, f-c-SAND with moderate shell fragments.

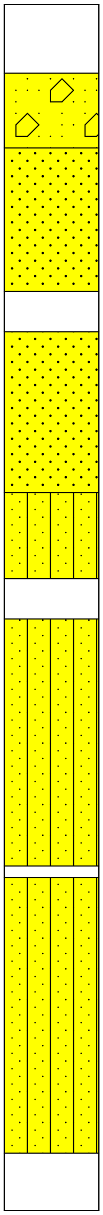
10 to 10.7': VOID

10.7 to 15': (SM) Medium dense, moist, dark gray, slightly silty, slightly f-gravelly, f-c-SAND with moderate shell fragments.

15 to 15.2': VOID

15.2 to 20': (SM) Medium dense, wet, dark gray, slightly silty, slightly f-gravelly, f-c-SAND with moderate shell fragments.

End of geoprobe at 20 feet.



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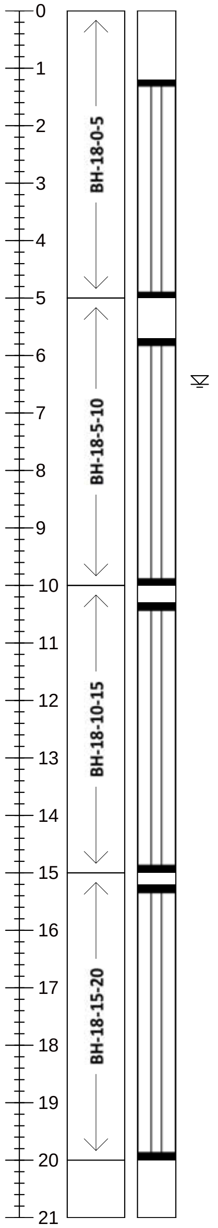
Geoprobe
BH-18

Sheet 1 of 1

Project: **Percival Landing**	Location: **Budd Inlet West Bay**		Method/Tube ID: **Geoprobe**
Project #: **100487-01**	Northing: **633671.12**	Easting: **1041264.67**	Tube Length (ft): **20.0**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**		Penetration Depth (ft): **20.0**
Collection Date: **11/8/10**			Logged By: **AC/JD**
Contractor: **Pacific Soil and Water**			

Recoverd Depth (ft) | Sample Name | Sample Recovery | Groundwater | **Sediment Description** | Graphic Log



0 to 1.2': VOID

1.2 to 1.6': (ASPHALT) Asphalt chunks.

1.6 to 5': (SW) Medium dense, dry, brown, f-c-gravelly, f-c-SAND.

5 to 5.7': VOID

5.7 to 7.1': (SW) Medium dense, dry, brown, f-c-gravelly, f-c-SAND.
@ 6.3': Grades to damp.

7.1 to 10': (SM) Medium dense, moist, dark gray, slightly silty, f-c-SAND with moderate shell fragments and occasional layers and pockets of SILT.

10 to 10.3': VOID

10.3 to 15': (SM) Medium dense, moist, dark gray, slightly silty, f-c-SAND with moderate shell fragments and occasional layers and pockets of SILT.

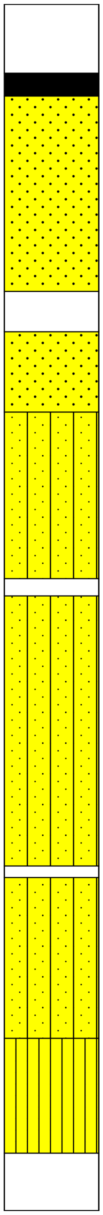
@ 13 to 13.2': Layer of olive gray SILT.

15 to 15.2': VOID

15.2 to 18': (SM) Medium dense, moist, dark gray, slightly silty, f-c-SAND with moderate shell fragments and occasional layers and pockets of SILT.

18 to 20': (ML) Medium stiff, moist, olive gray SILT with occasional wood fragments (decomposed).

End of geoprobe at 20 feet.



Geoprobe
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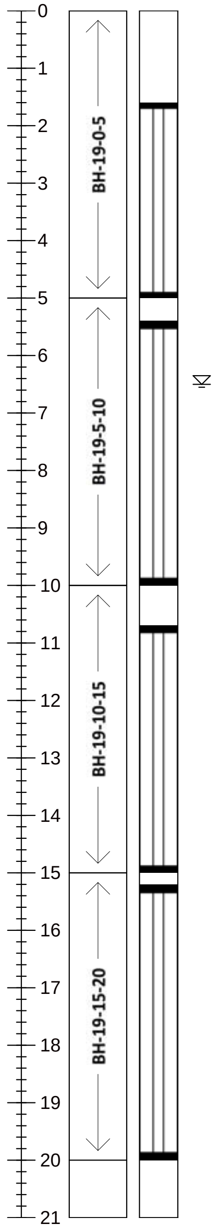
Sheet 1 of 1

Project: **Percival Landing**	Location: **Budd Inlet West Bay**	Method/Tube ID:**Geoprobe**
Project #: **100487-01**	Northing: **633729.40** Easting: **1041314.80**	Tube Length (ft): **20.0**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**	Penetration Depth (ft): **20.0**
Collection Date: **11/9/10**		Logged By: **AC/JD**
Contractor: **Pacific Soil and Water**		

Recoverd Depth (ft)	Sample Name	Sample Recovery	Groundwater	Sediment Description	Graphic Log



0 to 1.6': VOID

1.6 to 2': (WOOD) Wood chunks (bark).

2 to 3': (ML) Soft, damp, brown SILT with abundant wood fibers.

3 to 5': (SW) Medium dense, dry, light brown, slightly f-gravelly, f-c-SAND with moderate shell fragments.

5 to 5.4': VOID

5.4 to 6.7': (SW) Medium dense, dry, light brown, slightly f-gravelly, f-c-SAND with moderate shell fragments.
@ 6.3': Grades to damp.

6.7 to 10': (SM) Medium dense, moist, dark gray, slightly silty, slightly f-gravelly, f-c-SAND with occasional silt pockets and moderate shell fragments.
@ 7 to 10': moderate HC-like odor.

10 to 10.7': VOID

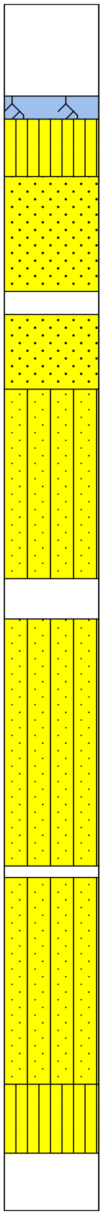
10.7 to 15': (SM) Medium dense, moist, dark gray, slightly silty, slightly f-gravelly, f-c-SAND with occasional silt pockets and moderate shell fragments.

15 to 15.2': VOID

15.2 to 18.8': (SM) Medium dense, moist, dark gray, slightly silty, slightly f-gravelly, f-c-SAND with occasional silt pockets and moderate shell fragments.

18.8 to 20': (ML) Medium stiff, moist, olive gray, SILT.

End of geoprobe at 20 feet.



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Geoprobe
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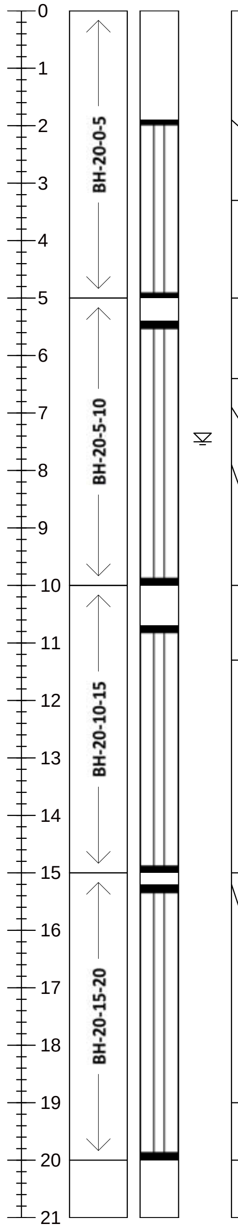
Sheet 1 of 1

Project: **Percival Landing**	Location: **Budd Inlet West Bay**	Method/Tube ID: **Geoprobe**
Project #: **100487-01**	Northing: **633788.27** Easting: **1041198.43**	Tube Length (ft): **20.0**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**	Penetration Depth (ft): **20.0**
Collection Date: **11/9/10**		Logged By: **AC/JD**
Contractor: **Pacific Soil and Water**		

Recoverd Depth (ft)	Sample Name	Sample Recovery	Groundwater	Sediment Description	Graphic Log



0 to 1.9': VOID.

@ 1.9': Fresh leaves.

1.9 to 3.3': (OL) Soft, damp, brown SILT with abundant wood fibers and organic material.

3.3 to 5': (SW) Medium dense, dry, light brown, f-gravelly, f-c-SAND.

@ 4.3': Brick chunk.

5 to 6.4': VOID

6.4 to 6.9': (SW) Gravel, leaves, sand (slough). Not sampled.

6.9 to 7.9': (SW) Medium dense, dry, light brown, f-gravelly, f-c-SAND.
@ 7.4': Grades to moist.

7.9 to 10': (SM) Medium dense, moist, dark gray, slightly silty, slightly f-gravelly, f-c-SAND with moderate shell debris and occasional silt pockets and layers 2" thick. Slight HC-like odor.

10 to 11.3': VOID

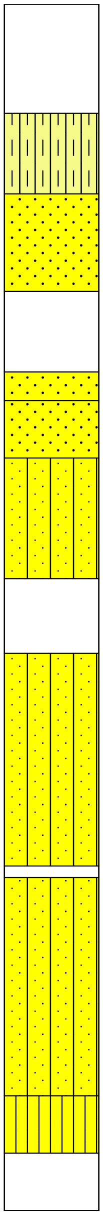
11.3 to 15': (SM) Medium dense, moist, dark gray, slightly silty, slightly f-gravelly, f-c-SAND with moderate shell debris and occasional silt pockets and layers 2" thick.

15 to 15.2': VOID

15.2 to 19': (SM) Medium dense, moist, dark gray, slightly silty, slightly f-gravelly, f-c-SAND with moderate shell debris and occasional silt pockets and layers 2" thick.

19 to 20': (ML) Medium stiff, moist, olive gray, SILT.

End of geoprobe at 20 feet.



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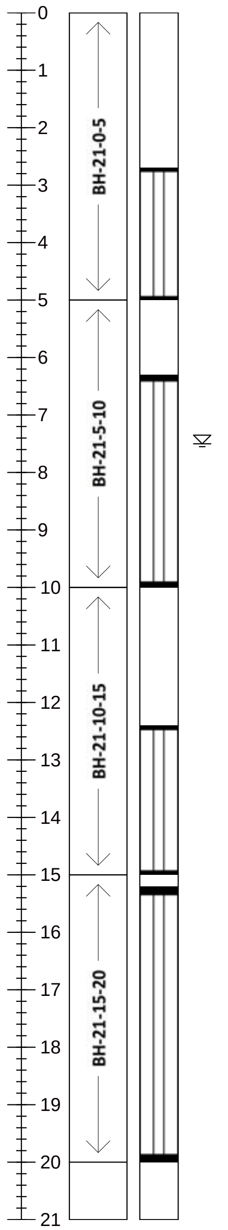
Geoprobe

BH-21

Sheet 1 of 1

Project: **Percival Landing**	Location: **Budd Inlet West Bay**		Method/Tube ID: **Geoprobe**
Project #: **100487-01**	Northing: **633799.10**	Easting: **1041328.35**	Tube Length (ft): **20.0**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**		Penetration Depth (ft): **20.0**
Collection Date: **11/8/10**			Logged By: **AC/JD**
Contractor: **Pacific Soil and Water**			

Recoverd Depth (ft)	Sample Name	Sample Recovery	Groundwater	Sediment Description	Graphic Log



0 to 2.7': VOID

2.7 to 2.9': (WOOD) 2" layers of brown wood chips.

2.9 to 5': (SW) Dry, medium dense, brown, gravelly, silty, m-c-SAND (FILL) with occasional shell fragments. F-c gravel is subrounded.

5 to 6.2': VOID

6.2 to 7.8': (SW) Dry, medium dense, brown, gravelly, silty, m-c-SAND (FILL) with occasional shell fragments. F-c gravel is subrounded.
@ 7.2': Grades to damp.

7.8 to 10': (SM) Medium dense, moist, dark gray, slightly silty f-m-SAND with occasional shell debris, slight HC-like odor, and trace f-gravel.

10 to 12.4': VOID

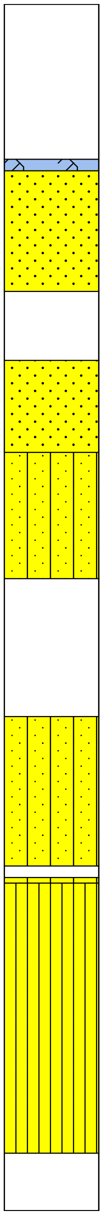
12.4 to 15': (SM) Medium dense, moist, dark gray, slightly silty f-m-SAND with occasional shell debris, slight HC-like odor, and trace f-gravel.
@ 12.6': Grades to abundant shell fragments and no odor.

15 to 15.2': VOID

15.2 to 15.3': (SM) Medium dense, moist, dark gray, slightly silty f-m-SAND with occasional shell debris and trace f-gravel.

15.3 to 20': (ML) Stiff, moist, olive gray SILT with occasional shell fragments.

End of geoprobe at 20 feet.



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Geoprobe

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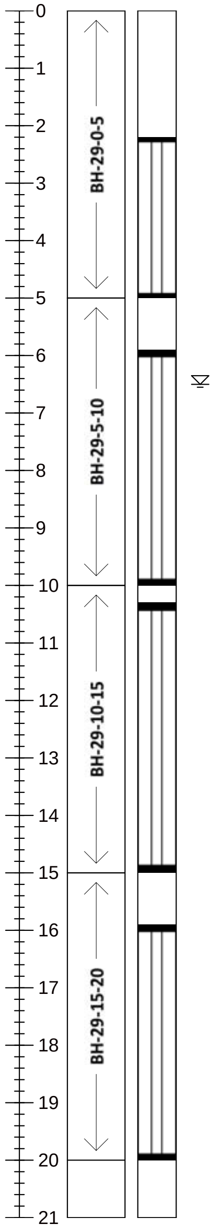
Project: **Percival Landing**	Location: **Budd Inlet West Bay**	Method/Tube ID: **Geoprobe**
Project #: **100487-01**	Northing: **633752.20** Easting: **1041382.03**	Tube Length (ft): **20.0**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**	Penetration Depth (ft): **20.0**
Collection Date: **11/8/10**		Logged By: **AC/JD**
Contractor: **Pacific Soil and Water**		

Recoverd Depth (ft) | Sample Name | Sample Recovery | Groundwater | **Sediment Description** | Graphic Log



0 to 2.2': VOID

2.2 to 2.9': (WOOD) Medium dense, dry, silty, brown WOOD (bark).

2.9 to 5': (SW) Medium dense, dry, light gray to brown, slightly gravelly, f-c-SAND (FILL) with occasional shell fragments.

5 to 5.9': VOID

5.9 to 8': (SW) Medium dense, dry, light gray to brown, slightly gravelly, f-c-SAND (FILL) with occasional shell fragments.
@ 6.3': Grades to damp.

8 to 10': (SM) Medium dense, moist, dark gray, slightly silty, f-c-SAND with moderate shell debris and occasional silt pockets and layers.

10 to 10.3': VOID

10.3 to 10.7': (SM) Medium dense, moist, dark gray, slightly silty, f-c-SAND with moderate shell debris and occasional silt pockets and layers.
@ 10.5 to 10.7': Layer of stiff, moist, olive gray SILT.

10.7 to 14.3': (SM) Medium dense, moist, dark gray, slightly silty, f-c-SAND with moderate shell debris and occasional silt pockets and layers.
@ 13.3': Grades to silty.

14.3 to 15': (ML) Medium stiff, moist, olive gray SILT, occasional shell debris.

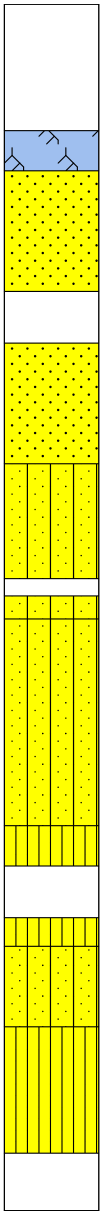
15 to 15.9': VOID

15.9 to 16.4': (ML) Medium stiff, moist, olive gray SILT, occasional shell debris.

16.4 to 17.8': (SM) Medium dense, moist, dark gray, slightly silty, f-c-SAND with adundant shell debris and occasional silt pockets and layers.
@ 17': 2" red-orange gravel layer (brick).

17.8 to 20': (ML) Medium stiff, moist, olive gray to black, m-sandy, f-gravelly SILT with moderate shell debris.

End of geoprobe at 20 feet.



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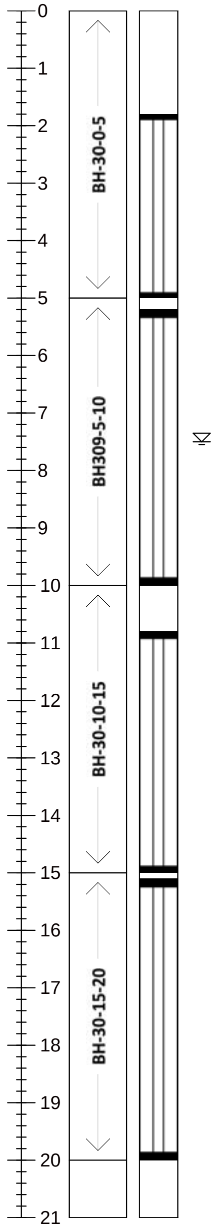
Sheet 1 of 1

Project: **Percival Landing**	Location: **Budd Inlet West Bay**		Method/Tube ID: **Geoprobe**
Project #: **100487-01**	Northing: **633817.28**	Easting: **1041378.21**	Tube Length (ft): **20.0**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**		Penetration Depth (ft): **20.0**
Collection Date: **11/8/10**			Logged By: **AC/JD**
Contractor: **Pacific Soil and Water**			

Recoverd Depth (ft)	Sample Name	Sample Recovery	Groundwater	**Sediment Description**	Graphic Log



0 to 1.8': VOID

1.8 to 2': (WOOD) Brown wood chunks.

2 to 2.9': (OL) Medium stiff, dry, brown, SILT with moderate wood chunks and sticks.

2.9 to 5': (SW) Medium dense, damp, light brown, slightly f-gravelly, f-c-SAND (FILL).

@ 4.8': Grades to moderate shell fragments.

5 to 5.2': VOID

5.2 to 5.5': (SW) Grades to moderate shell fragments.

5.5 to 6.1': (OL) Medium stiff, dry, brown, SILT with moderate wood chunks and sticks, (slough) not sampled.

6.1 to 8.6': (SW) Grades to moderate shell fragments.
@ 7': Grades to very gravelly. Gravel is subrounded up to 2" diameter.
@ 7.5': Grades to moist.

8.6 to 10': (SM) Medium dense, moist, dark gray, slightly silty, slightly f-gravelly, f-c-SAND with occasional shell fragments and occasional silt pockets and layers.

10 to 10.8': VOID

10.8 to 15': (SM) Medium dense, moist, dark gray, slightly silty, slightly f-gravelly, f-c-SAND with occasional shell fragments and occasional silt pockets and layers.

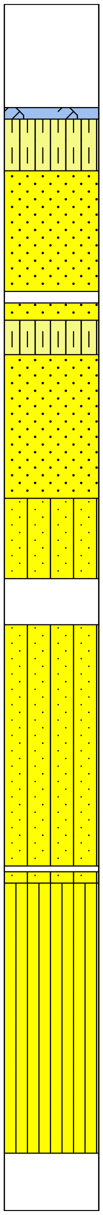
@ 14': 1/4" layer of decomposed wood.

15 to 15.1': VOID

15.1 to 15.3': (SM) Medium dense, moist, dark gray, slightly silty, slightly f-gravelly, f-c-SAND with occasional shell fragments and occasional silt pockets and layers.

15.3 to 20': (ML) Medium stiff, moist, olive gray, slightly m-sandy, SILT with occasional shell fragments.

End of geoprobe at 20 feet.



APPENDIX B
LABORATORY DATA REPORTS

(See attached DVD)

APPENDIX C
DATA VALIDATION REPORTS

(See attached DVD)

APPENDIX D
REMEDIAL ALTERNATIVE COST ESTIMATES

Alternative 1
Monitored Natural Attenuation with Institutional Controls

No.	Task	Description	Quantity	Cost per Quantity	Total Cost
1	**Work Plan/Project Management**				
	Ecology Coordination	meetings, document review, oversight	1	10,000	10,000
	Work Plans	Cleanup Action Plan and SAP	1	15,000	15,000
	Project Management	Assume ~10% of project costs	1	23,000	23,000
				Task Total	**48,000**
2	**Well Installation**				
	Utility locate	subcontract to CCN (lump sum)	1	500	500
	Utility locate oversight	AQ visits site with CCN (hours)	10	160	1,600
	Drilling daily rate (9 hours)	Cascade Drilling Rig	2100	2	4,200
	Equipment Costs	3 wells (screens, piping, etc.)	1	1,000	1,000
	WA NOI	Cascade Drilling	3	100	300
	Drilling oversight/well development	AQ on site with Driller (hours) assume 3 days	30	160	4,800
	Drilling oversight per diem	AQ per diem	3	200	600
	Waste Management	subcontract (lump sum)	1	1,000	1,000
				Task Total	**14,000**
3	**Groundwater Monitoring (3 wells at Point of Compliance)**				
	Quarterly sampling	Year 1 (cost per event)	4	10,000	40,000
	Semi-annual sampling	Year 2-3 (cost per event)	4	10,000	40,000
	Annual sampling	Year 4-10 (cost per event)	7	10,000	70,000
	Reporting	Annual memorandum for 10 years (each Report)	10	2,500	25,000
				Task Total	**175,000**
4	**Institutional Controls**				
	Deed restrictions		1	5,000	5,000
				Task Total	**5,000**

Alternative 1
Monitored Natural Attenuation with Institutional Controls

No.	Task	Description	Quantity	Cost per Quantity	Total Cost
5	**Final Reporting**				
	Final Remediation Report	(lump sum)	1	15,000	15,000
	NFA Request	(lump sum)	1	2,000	2,000
				Task Total	**17,000**
				Total	**$259,000**
			Estimated Cost Range (-30% to + 50%)	$181,300	$388,500

Alternative 2
In Situ Treatment of Soil

No.	Task	Description	Quantity	Cost per Quantity	Total Cost
1	**Work Plan/Project Management**				
	Ecology Coordination	meetings, document review, oversight	1	10,000	10,000
	Work Plans	Cleanup Action Plan and SAP	1	15,000	15,000
	Project Management	Assume ~10% of project costs	1	30,000	30,000
				Task Total	**55,000**
2	**Well Installation**				
	Utility locate	subcontract to CCN (lump sum)	1	500	500
	Utility locate oversight	AQ visits site with CCN (hours)	10	160	1,600
	Drilling daily rate (9 hours)	Cascade Drilling Rig	2100	3	6,300
	Equipment Costs	6 wells (screens, piping, etc.)	1	1,500	1,500
	WA NOI	Cascade Drilling	6	100	600
	Drilling oversight/well development	AQ on site with Driller (hours) assume 4 days	40	160	6,400
	Drilling oversight per diem	AQ per diem	4	200	800
	Waste Management	subcontract (lump sum)	1	1,000	1,000
				Task Total	**18,700**
3	**Bioremediation Implementation**				
	Remedial Design	Planning and design (lump sum)	1	40,000	40,000
	ORC cost	Oxygen releasing compound (lbs) 10 lbs per well	30	1,000	30,000
	Injections (3 wells)	Quarterly for 1 year (each Event)	4	25,000	100,000
	Report	Cleanup Action Report	1	10,000	10,000
				Task Total	**180,000**
4	**Groundwater Monitoring (3 wells at Point of Compliance)**				
	Quarterly monitoring	Year 1 (cost per event)	4	10,000	40,000
	semi-annual monitoring	Year 2-5 (cost per event)	8	10,000	80,000
	Reporting	Annual memorandum for 5 years (each Report)	5	5,000	25,000
				Task Total	**145,000**

Alternative 2
In Situ Treatment of Soil

No.	Task	Description	Quantity	Cost per Quantity	Total Cost
5	**Final Reporting**				
	Final Remediation Report	(lump sum)	1	15,000	15,000
	NFA Request	(lump sum)	1	2,000	2,000
				Task Total	**17,000**
				Total	**$416,000**
			Estimated Cost Range (-30% to + 50%)	$291,200	$624,000

Alternative 3
Soil Removal

No.	Task	Description (Unit)	Quantity	Cost per Quantity	Total Cost
1	**Work Plan/Project Management**				
	Ecology Coordination	meetings, document review, oversight (lump sum)	1	10,000	10,000
	Work Plans	Cleanup Action Plan, Design, and SAP (lump sum)	1	100,000	100,000
	Project Management	Assume ~10% of project costs (lump sum)	1	70,000	70,000
				Task Total	**180,000**
2	**Construction, Disposal, and Restoration Costs**				
	Utility locate and pre-construction survey	subcontracted (lump sum)	1	12,000	12,000
	Mobilization/Demobilization	Subcontractor (lump sum)	1	40,000	40,000
	Site preparation, staging, and stockpile area management	(sf)	3440	5	17,200
	Construction Oversight	AQ staff for 20 days (lump sum)	1	50,000	50,000
	Pave alley for truck access	assumes 1-foot thick (cy)	54	30	1,620
	Concrete sidewalk removal	5-inch thick, assumes all sidewalk remove (cy)	21	125	2,625
	Concrete disposal	non-hazardous (cy)	21	150	3,150
	Shoring design and install	for excavation near structures and sewer line (lf)	150	675	101,250
	Excavation of contaminated soil	assumes 10-foot depth (cy)	1950	23	43,875
	Survey and monitoring during excavation	lump sum	1	5,000	5,000
	Compacted backfill	(cy)	1950	26	49,725
	Hauling and disposal of dry contaminated soil	(cy)	975	75	73,125
	Hauling and disposal of wet contaminated soil	(cy)	975	100	97,500
	Replace concrete curb	(lf)	95	250	23,750
	Replace concrete sidewalk	(sy)	150	45	6,750
	Replace landscaping	sprinklers, plants, trees, substrate (sf)	1020	10	10,200
	Sales Tax	8.80%			47,324
				Task Total	**585,094**
3	**Confirmation Sampling and Analysis**				
	Side wall sampling	20 confirmation samples (lump sum), 1 staff 40 hours	1	35,000	35,000
	Reporting	Data Summary Report (lump sum)	1	10,000	10,000
				Task Total	**45,000**
4	**Groundwater Monitoring (3 wells at Point of Compliance)**				
	Annual monitoring	Year 1-5 (cost per event)	5	10,000	50,000
	Reporting	Annual memorandum for 5 years (each Report)	5	5,000	25,000
				Task Total	**75,000**

Alternative 3
Soil Removal

No.	Task	Description (Unit)	Quantity	Cost per Quantity	Total Cost
5	**Final Reporting**				
	Final Remediation Report	(lump sum)	1	25,000	25,000
	NFA Request	(lump sum)	1	2,000	2,000
				Task Total	**27,000**
				Total	**$913,000**
			Estimated Cost Range (-10% to + 75%)	$821,700	$1,597,750

Notes:

1. The additional shoring and excavation unit cost is accounted for by a 50% increase due to the likelihood of having to use hand-operated equipment around these structures.
2. The rate of excavation is expected to be slow due to utilities and the presence of the un-reinforced concrete force water main. Careful monitoring of the slope movements will be required to avoid potential damage to the un-reinforced pipe. Backfilling will require a similar level of care.
3. The estimated cost range is increased due to the possibility of structure (e.g., substation or pump station) damage and repair.

cy = cubic yard
lf = linear feet
sf = square feet
sy = square yard