REMEDIAL INVESTIGATION WORK PLAN

Earley Business Center
Parcel 1B – Port of Tacoma

Professional Services Agreement No. 069558
Project No. 095208

January 8, 2014

Prepared for:

Port of
Tacoma

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Prepared by:

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Acronyms and Abbreviations

AST	aboveground storage tank
bgs	below ground surface
BEHP	bis(2-ethylhexyl)phthalate
BTEX	benzene, toluene, ethylbenzene, and xylenes
COC	contaminant of concern
COI	constituent of interest
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CSM	conceptual site model
CUL	cleanup level
EBC or Site	Earley Business Center
Ecology	Washington Department of Ecology
EPA	United States Environmental Protection Agency
ft	foot
HCID	hydrocarbon identification
ISL	initial screening level
MHHW	mean higher high water
MLLW	mean lower low water
MTCA	Model Toxics Control Act
OCC	Occidental Chemical Corporation
ORP	oxidation-reduction potential
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCE	perchloroethene (tetrachloroethene)
PIRR	Previous Investigation Results Report
Port	Port of Tacoma
QAPP	Quality Assurance Project Plan
RI/FS	Remedial Investigation/Feasibility Study
RIWP	Remedial Investigation Work Plan
SVOC	semivolatile organic compound
SW	Southwest (in Southwest Debris Layer subarea)
TCE	trichloroethene
TEQ	toxicity equivalent
TOC	total organic carbon
TPH	total petroleum hydrocarbons
UST	underground storage tank
VI	vapor intrusion
VOC	volatile organic compound
WAC	Washington Administrative Code
WW	World War

1 Introduction

This Remedial Investigation Work Plan (RIWP) describes sampling to be conducted as part of a Remedial Investigation / Feasibility Study (RI/FS) for the Earley Business Center (EBC, Parcel 1B, or Site). This work plan was prepared for the Port of Tacoma (Port) under Professional Services Agreement No. 069558 (Port project no. 095208) to satisfy the requirements of Agreed Order No. DE 9553 between the Port and the Washington State Department of Ecology (Ecology).

The supporting Quality Assurance Project Plan (QAPP) and Health and Safety Plan for the field investigations are included in Appendices A and B, respectively. Section 5 of this RIWP is the field sampling plan.

The Agreed Order aggregated multiple areas (subareas) with distinct environmental issues into a single Site. The Previous Investigation Results Report (PIRR) compiled existing data from those sites and developed a set of initial screening levels, constituents of interest, and data gaps for each subarea. This RIWP refines those analyses and identifies specific investigations to fill data gaps.

After finalization of this RIWP, the Port will perform the following Agreed Order-required activities:

- Implement the Remedial Investigation
- Prepare an RI/FS Report
- Conduct an interim action to remove certain underground storage tanks (USTs)
- Prepare a Draft Cleanup Action Plan.

2 Site Location and Description

The EBC is located at 401 Alexander Avenue in Tacoma, Washington at the end of the Blair-Hylebos Peninsula (Figures 1 and 2). Approximately 50 acres of the 80-acre property are upland and are subject to Agreed Order DE9553 (the Site). The remaining 30 acres of the property are intertidal and subtidal land in Commencement Bay and the adjacent Blair and Hylebos Waterways.

The majority of Site is level and paved, and the pavement surface lies at approximately 17 feet mean lower low water (ft MLLW). The Site shoreline has variable construction, with the north-central (project north[1]) shoreward edge consisting of a bulkhead, historical shipways, and riprap that abut the intertidal area of Commencement Bay. The eastern and western shorelines are slopes covered in riprap with an operating wharf on the Hylebos. The shoreline elevation that distinguishes the upland area from the in-water area is mean higher high water (MHHW) at 11.8 ft MLLW.

2.1 Site Subareas

The Agreed Order identifies seven "facilities" (referred to as subareas in this RIWP, Figure 2) that comprise the Site, each due to presumed discrete releases:

- **Southwest (SW) Debris Layer** – a 6- to 12-inch layer of hard asphaltic sand and intermixed debris first discovered during storm drain construction in 1998. The debris layer is located across a relatively large area in the project northwestern (true southwestern; see Footnote 1) portion of the EBC.
- **Blair Shoreline Soil and Groundwater** – the shoreline along the Blair Waterway where sampling occurred in 2006-2008 to characterize upland soil anticipated to be dredged for widening of the mouth of the Blair Waterway. The planned dredging never took place and the sampled soil remains in place.
- **Historical Underground Storage Tanks** – multiple USTs identified on historical EBC maps that were installed in the 1940s and 1950s. The UST locations have been the subject of various soil and groundwater investigations. Some USTs were removed in the 1990s.
- **Pier 23 Soil and Groundwater** – residual petroleum and metals impacts to soil and groundwater identified in 2008 following cleanup associated with construction of the Army Reserve Center building in 2003.
- **"Zinc Hotspot" near Pier 24** – a small area in the northeastern portion of the EBC where groundwater sampling in 2006 and 2008 indicated elevated levels of zinc. Groundwater zinc concentrations have been adequately characterized.

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[1] This work plan uses a project north oriented along the axis of the peninsula, and all compass directions are relative to project north, except where noted. This convention is consistent with the majority of previous EBC reports. A minority of reports have used different project north orientations. Figures in this work plan show both project north and true north for clarity.

- **Sandblast Grit** – areas within the EBC where sandblast grit associated with ship dismantling and repair activities accumulated on the ground and in storm drains until 1995. The sandblast grit was adequately addressed in 1995 (Ecology 1995).
- **Former AK-WA Giannotti Shipyard** – an industrial lease area in the northeast portion of the EBC where soils impacted by petroleum hydrocarbons, metals, and polychlorinated biphenyls (PCBs) were discovered and excavated during redevelopment in 1998.

The PIRR compiled and summarized available data and reports and used this information to identify data gaps for each subarea. The PIRR did not identify data gaps for the Zinc Hotspot or Sandblast Grit subareas, nor in the UST subarea at locations UST N-5, UST P-17, or USTs N-18 and-19. Therefore, no additional investigations of these subareas/locations are described in this RIWP.

Occidental Chemical Company (OCC) completed a vapor intrusion (VI) assessment shortly after the PIRR was submitted to Ecology (CRA 2013). It identified VI issues in a number of the EBC buildings, most of which were related to the OCC solvent plume. Most onsite buildings are adequately characterized and addressed through the OCC VI study, and comments on the OCC study will be addressed through the OCC site process. However, the Building 595 and Army Reserve building VI assessments indicated possible groundwater contributions to indoor air contaminants that warrant supplemental investigation. Therefore, this RIWP includes a targeted, supplemental assessment of these buildings. Investigation of Building 595 is described in its own subsections because it is not located in any of the EBC subareas. Investigation of the Army Reserve building is included in the Pier 23 subarea discussions.

Also shortly after the PIRR was submitted, two electronic data delivery files related to the SW Debris Layer and Pier 23 subareas were discovered missing from the compiled Site database. Those data have been added to the database, and the information they provide is discussed in the relevant subsections of Section 4 in this RIWP.

2.2 Site History

Commencement Bay was historically a broad tideflat with several meandering channels. The harbor has been modified through dredging and filling since about 1917 and is currently composed of several man-made waterways. The Site is situated at the northern end (toward Commencement Bay) of the peninsula between the Blair and Hylebos Waterways.

The Blair-Hylebos Peninsula was formed using sandy and silty sediment dredged from the adjacent waterways. The earliest known uses of the property included a World War (WW) I-era shipyard and sawmill. During WWII shipbuilding recommenced, and ships were constructed on intertidal shipways while support work occurred in upland areas and on wharfs/piers along the waterways. Between WWII and approximately 1960 the wharfs/piers and some of the shipyard's upland facilities were used for ship repair, dismantling, and salvage.

The Port purchased the EBC in 1960 and leased it to various tenants for commercial and industrial purposes. Known uses have included freight hauling and distribution; furniture manufacturing; fishing fleet outfitting; support drilling services; lumber milling; and vessel mooring, maintenance, decommissioning, and dismantling. From the mid-1960s until 1995, the Washington National Guard leased portions of the EBC under and near Pier 23 for moorage, vessel maintenance, and training. The United States Army Reserve has leased the same approximate footprint for training and other marine-related purposes since 1995. For the purposes of this RIWP, the US Government leasehold and owned infrastructure (in-water and upland areas) within the EBC is referred to as "Pier 23". The Pier 23 Soil and Groundwater subarea defined in the Agreed Order, and discussed in this RIWP, is the upland portion of "Pier 23".

The Site buildings and infrastructure have changed substantially due to development for evolving tenants and uses. Many changes occurred after WWII as the Site was transitioned to peacetime industrial use. The PIRR includes air photos and maps showing the historical layouts of buildings and infrastructure (Crete 2013).

2.3 Occidental Chemical Corporation

Between 1929 and 2002, OCC and its predecessor, Hooker Chemical, operated a chemical manufacturing plant on land adjacent to the current EBC. Operations included a chlor-alkali plant (1929-2002) and a trichloroethene/tetrachloroethene (TCE/PCE) manufacturing facility (1947-1973). Contamination from those activities extends onto the EBC (primarily chlorinated organic chemicals, but also some alkaline conditions, PCBs, pesticides, and metals; CRA 2008). OCC-related contamination on the EBC is primarily associated with transport of volatile organic compounds (VOCs), with the highest contaminant concentrations found in deep groundwater. Lateral migration of contaminant plumes in the mid-range water bearing zones (from approximately 50 to 75 ft below ground surface [bgs]) within the EBC is currently being controlled, at least in part, by a groundwater extraction and treatment system that OCC has operated since 1996. This system extends onto the EBC. The OCC contamination is being addressed by OCC under an Agreed Order on Consent with Ecology and the United States Environmental Protection Agency (EPA).

2.4 Hydrogeological Conditions

The Site lies within the modern-day Puyallup River delta complex. The delta is bounded on the southwest and northeast (relative to true north) by steeply sloping hillsides composed of glacially-consolidated glacial and interglacial deposits. The pre-development shoreline in the vicinity of the Blair and Hylebos Waterways was located about ⅛ to ¼ mile southeast of the present day 11th Street East corridor. The tideflats (shoreline to lower low-waterline) extended outward to about the current position of the mouth of the Blair and Hylebos Waterways. The area inland of the shoreline was largely an estuary with numerous sloughs and embayments. The Site was created by dredging the Blair and Hylebos Waterways and deposition of the dredged sediment (sand with variable silt content) on the tideflats, as shown in Figure 3 (cross sections through the shallow geologic units).

Fill placed during development of the Blair-Hylebos Peninsula has been identified in local borings (Figure 3). Some areas of the Site include localized pockets of debris in shallow fill, such as at the SW Debris Layer subarea, where fill material includes mixed asphaltic material, metal fragments, insulation, brick, and concrete. Debris including brick fragments, concrete, and pipe is also noted in other areas where excavation has occurred, including near one of the USTs in the UST subarea. The Blair-Hylebos Peninsula fill varies from loose to very dense to a depth of about 20 ft.

The former mud flat consists of fine-grained sediment (e.g., silts and organic matter, such as peat). The fine-grained mud flat sediment generally has a lower permeability than the underlying, somewhat coarser, deltaic deposits providing some hydraulic separation of groundwater between the dredged sediment/fill and the upper portion of the deltaic deposits. It is unclear if the mud flat unit is laterally continuous across the Site, as has been observed at nearby sites. Silty intervals associated with mudflat deposits have not been consistently observed in boreholes previously completed at the Site.

The shallow groundwater table is encountered from 8 to 11 ft bgs (Figures 3 and 4). Groundwater hydraulic monitoring events in 2006 by OCC indicate that groundwater in the 25-ft zone on the peninsula generally flows radially outward toward Commencement Bay and the Blair and Hylebos Waterways with local variations in direction and gradient (CRA 2011). The water table is in fill material within the EBC while the 25-ft interval primarily falls within the deeper native units (Figure 4). While local variations in fill and recharge patterns may result in local variations in groundwater flow direction and elevation, the general radial groundwater flow direction observed in the 25-ft interval is expected to apply to the water table interval (fill aquifer). Short-term reversals in flow direction occur during high tides along the shoreline where shallow groundwater is tidally affected and typically becomes brackish. Groundwater recharge throughout most of the Site is limited by paved surfaces and stormwater systems; however, the southwestern five acres of the Site is not paved, allowing more recharge to occur. An upward vertical groundwater gradient from the glacial material to the alluvium and the fill has been identified (CRA 2011). Downward vertical gradients may occur locally and intermittently during low tide cycles because the tidal response is more pronounced in the underlying alluvium than in the fill. OCC conducted another series of groundwater hydraulic monitoring in 2012, but the data are not expected to be available until early 2014. Those data and the data collected under this RIWP will be evaluated during the EBC RI/FS.

The general radial groundwater flow condition on the Blair-Hylebos Peninsula, including the Site, is modified by the OCC groundwater extraction system. The groundwater elevation contours depicted on Figure 4 show both pumping and non-pumping conditions, and are based on freshwater equivalent head elevations that account for salinity density effects. However, CRA reports that the groundwater system may not have fully recovered during the non-pumping condition, and therefore the depicted localized mounding shown in the upper contour map may be an artifact of the extraction system (CRA 2008). The lower contour map on Figure 4 represents groundwater table elevations typical of the flow regime during pumping.

3 Initial Screening Levels and Constituents of Interest

Initial screening levels (ISLs) for both soil and groundwater were developed previously and used to identify initial constituents of interest (COIs) for the Site. The PIRR describes the methods by which the Site groundwater and soil ISLs were selected. Any analyte with at least 5% detection frequency and at least one detected concentration exceeding its ISL was identified as an initial COI for the Site (Tables 1 and 2). This section describes the methodology by which the list of initial COIs was narrowed down to a targeted list of analytes (final COIs) to be evaluated in the RI/FS.

3.1 Soil Screening Levels

Soil ISLs (Table 1) for the Site are protective of direct human contact and surface water (marine aquatic life and human fish consumers in the event that soil leaches to groundwater and the groundwater discharges to adjacent surface water bodies). The soil ISL for non-polar organic COIs that addresses soil leaching to groundwater was calculated using an assumed site-wide fraction organic carbon. Whereas in the PIRR, this ISL was utilized unilaterally to identify initial COIs, for this RIWP empirical evidence of elevated COIs in groundwater samples was used to verify whether this pathway is of concern in each subarea.

An exercise was conducted to find groundwater samples co-located with soil samples exceeding a soil ISL. If the groundwater samples were below the respective groundwater ISL, this empirical evidence was used to eliminate the initial soil COI. In many cases, elevated soil locations were not co-located with groundwater samples. For example, groundwater monitoring wells are only located on the upgradient edge of the Blair Shoreline subarea. Only one soil initial COI, methylene chloride, was eliminated. All other initial COIs were carried forward as final COIs.

During the RI, multiple lines of evidence related to exposure pathways and additional empirical data will be used to confirm or narrow the list of final soil COIs to the Site contaminants of concern (COCs).

3.1.1 Terrestrial Ecological Evaluation

Soil at the Site is exempt from a Terrestrial Ecological Evaluation according to Washington Administrative Code (WAC) 173-7491(1)(c) because most of the Site (45 of the 50 acres) is covered by buildings or pavement. The unpaved five-acre portion in the southwest corner of the EBC is considered developed land because it is covered with gravel fill. This fill does not provide suitable habitat and is a barrier to wildlife feeding on insects in soil. In addition, the Port intends to develop this unpaved area in the future.

3.2 Groundwater Screening Levels

Groundwater ISLs (Table 1) are based on protection of surface water (marine aquatic life and human health via fish consumption) and on protection of site workers via indoor air (from volatilization and inhalation). For this RIWP, all initial COIs for groundwater at the Site were carried forward as final COIs. As with soil, the data collected in the RI will be used to confirm or narrow the final groundwater COI list to the Site groundwater COCs.

Evolution of Site Contaminant Lists

Term	How List is Formed
Initial COI	Greater than 5% detection frequency and at least one detected value over the ISL. Documented in PIRR.
Final COI	Soil initial COIs exceeding ISLs based on natural background, practical quantitation limits, or groundwater protection for which paired groundwater data also exceed ISLs or for which paired groundwater data are not available. Documented in this RIWP.
COC	Detected exceedances of ISLs where RI data verify exposure pathway is complete. To be documented in RI/FS report.
Indicator Hazardous Substance	COCs for which effectiveness of remedial alternatives evaluated in the FS will be evaluated. Subject of long-term monitoring, if part of remedy. To be documented in the RI/FS report.

3.2.1 Groundwater Non-Potability

Groundwater potability was reviewed in the PIRR for applicability of human consumption of groundwater as a potential exposure pathway at the Site (Crete 2013). That analysis found that Site groundwater satisfied the Model Toxics Control Act (MTCA) non-potability criteria, and therefore, human consumption of groundwater is not an exposure pathway of concern at the Site.

4 Conceptual Site Models and Data Gaps

This section presents brief conceptual site models (CSMs) and identifies data gaps for each subarea. Each CSM is based on available data from previously completed reports (summarized in the PIRR), a site walk conducted in September 2013, other historical information, and information obtained after completion of the PIRR. RI work planned to address the data gaps related to each CSM is discussed in Section 5.

The exposure pathways at the Site for human health or the environment are:

- Direct contact with soil by industrial maintenance workers
- Leaching of soil contaminants to groundwater and subsequent discharge of the groundwater to surface water where aquatic life could be exposed, as well as humans that consume local fish
- Inhalation of indoor air containing contaminants volatilized from groundwater (VI) by onsite office workers and industrial maintenance workers.

4.1 SW Debris Layer

The SW Debris Layer subarea encompasses an approximately 8-acre paved area near the head of the WWII-era shipways. Cross section B-B' (Figure 3) shows the debris layer below pavement and separated from the water table. A 1977 oblique aerial photograph shows piles of debris at the ground surface within the SW Debris Layer subarea, although it is unclear if this is the same debris later encountered in test pits and borings (Ecology 2013).

The two data files that were discovered after the PIRR was completed contained data exceeding ISLs. However, they did not result in the identification of any new COIs. All subarea initial COIs had already been identified in the PIRR.

A site walk in September 2013 along the unpaved northern boundary of the Site identified miscellaneous debris at the ground surface above MHHW and at elevations consistent with the buried debris layer identified in earlier studies. Debris was observed in variable abundance along the entire north shoreline of the SW Debris subarea (approximately 820 ft). Slag fragments similar to those previously mapped along the Blair Shoreline subarea (GeoEngineers 2008b) were observed to be commingled with this debris where the Blair Shoreline and SW Debris Layer subareas overlap; approximately 400 ft of the shoreline is covered by a concrete apron that was installed in the 1940s.

Logs for borings located in the southwestern corner of the Army Reserve (Pier 23) area do not indicate the presence of debris associated with the SW Debris Layer subarea and therefore confirm the previously identified eastern boundary of the SW Debris Layer subarea.

Leaching of contaminants from the debris to groundwater and eventual discharge of affected groundwater to surface water is the primary exposure pathway of concern for this subarea. As noted in the PIRR, available groundwater data indicate that there is limited leaching of contaminants from the debris to groundwater (Dames and Moore 1998, Hart Crowser 2009c). One sampling location in this subarea exceeded groundwater total petroleum hydrocarbon (TPH) ISLs and the total PCB ISL, and 8 exceeded the copper ISL. These locations are between 50 and 100 ft from the shoreline, where groundwater would be expected to discharge to surface water. However, there are no groundwater data downgradient of these locations to verify that the noted exceedances are not impacting surface water.

One soil sample exceeded the groundwater protection ISLs for both benzene and methylene chloride and has a co-located groundwater sample with benzene and methylene chloride below groundwater ISLs. One other soil sample exceeding the benzene ISL also had a paired well with data below the groundwater ISL, and the third soil sample exceeding the soil ISL did not have a paired well. Therefore, methylene chloride is not carried forward as a final COI (because its single soil sample exceeding the ISL is paired with a groundwater sample below the ISL), but benzene is retained for the SW Debris Layer subarea (because one of the three soil samples exceeding the ISL does not have a co-located groundwater sample below the ISL).

Direct contact is also an exposure pathway of concern for this subarea; although the presence of asphalt and concrete paving and the industrialized nature of the subarea reduce potential direct contact with contaminated debris to the subpopulation of industrial maintenance workers.

Based on available data and the CSM for this subarea, data gaps relevant to the RI/FS are:

- Concentrations of metals, PCBs, TPH, and polycyclic aromatic hydrocarbons (PAHs) in debris/soil exposed at the surface along the shoreline above MHHW for evaluation of the direct contact pathway
- Northerly extent of subsurface debris in shipway area above MHHW
- Groundwater concentrations of metals; PCBs; TPH; benzene, toluene, ethylbenzene, and xylenes (BTEX); and PAHs at downgradient edge of debris to assess groundwater quality discharging to surface water
- Potential for natural attenuation, evaluated along transport pathways by oxidation-reduction potential (ORP), pH, and specific conductance in groundwater and by organic carbon content in soil (i.e., analysis of parameters that support fate and transport evaluations)
- Tidal influence on groundwater transport through the shallow fill aquifer.

4.2 Blair Shoreline Soil and Groundwater

Soil and groundwater samples collected from the Blair Shoreline in 2007 and 2008 indicate scattered soil and groundwater exceedances of ISLs.

Soil ISL exceedances are primarily at the northern end of the Blair Shoreline and overlap the western end of the SW Debris Layer subarea. Isolated exceedances occur at other locations but generally only for individual COIs. For example, copper is elevated in soil at the western end of Building 407 (EBC-5), (coincident with the only ISL exceedance for copper in groundwater) and the carcinogenic PAH (cPAH) toxicity equivalent (TEQ) was elevated in soil in the vicinity of USTs P-22 and P-23 (EBC-6). A single DDT detection in soil exceeded the ISL.

Slag material and cemented debris was observed along the Blair shoreline above MHHW in this subarea during the September 2013 site walk. The slag material was consistent with the material described and mapped by GeoEngineers in the same area (GeoEngineers, 2008b), and extended in variable abundance along the majority of the Blair Shoreline. The cemented debris was light in color, friable with gravel and miscellaneous debris included in the matrix. Debris observed in the matrix included metal wire and fragments and pieces of white, rubbery elastic material. The cemented debris extended along approximately 230 ft) of the northern portion of the Blair Shoreline, approximately 20 percent of the Blair Shoreline length located within the EBC. The origin of the cemented debris is unknown, and site records do not indicate that the material has been characterized.

With the exception of the previously noted copper exceedance, available groundwater data from this subarea are below ISLs. However, although cPAHs and PCBs were reported not detected, the laboratory reporting limits were above the respective ISLs. Since soil exceeds the soil leaching to groundwater ISLs, groundwater sampling is required to determine if ISL exceedances occur in groundwater.

Based on available data and the CSM for this subarea, data gaps relevant to the RI/FS are:

- Presence and level of metals, PCBs, cPAHs, and DDT in groundwater downgradient of soil exceeding ISLs
- Potential for natural attenuation, evaluated along transport pathways by ORP, pH, and specific conductance in groundwater and by organic carbon content in soil (i.e., analysis of parameters that support fate and transport evaluations)
- Concentrations of metals, semivolatile organic compounds (SVOC), and PCBs in cemented debris along upper portion of shoreline.

4.3 Historical USTs

The UST subarea is comprised of seven non-contiguous locations where historical USTs have been or currently are located. As described in the PIRR, most UST locations have been adequately characterized. Therefore, the RI will focus on the following 11 USTs in four locations (Figure 5):

- UST N-6: determine if, and where, present

- Former USTs N-7 and N-8: delineate nature and extent of soil impacts in footprint of former Building 322
- USTs N-1,-2,-3, -4, -25, -26: determine if, and where, present and delineate nature and extent of soil and groundwater contamination
- USTs N-23 and -24: determine if, and where, present.

USTs were reportedly used to support the historical shipyard and other industrial operations. The USTs were identified from various Port and tenant site plans from the 1940s through the 1980s. Many of the USTs have incomplete or inconsistent information on construction materials, size, location, and removal status. Historical investigations conducted in the UST subarea included attempts to document the presence or absence of USTs and to assess impacts to soil and groundwater. The presence or absence of some USTs could not be confirmed.

4.3.1UST N-6

This UST was labeled as “Oil Tank 6” on tank location maps from 1949 and 1952, was reported to have held 1,600 gallons, and was located between former Buildings 510 and 512 along the southern EBC boundary adjacent to OCC. TPH-gasoline was detected above soil and groundwater ISLs adjacent to the N-6 location. Surrounding soil and groundwater are also significantly impacted by TCE/PCE contamination from the adjacent OCC site. The TCE/PCE impacts have complicated TPH analyses for the N-6 location and would be expected to impact future TPH analyses. The local shallow groundwater flow direction is to the north, and this UST location is approximately 650 ft from the nearest surface water body, the Hylebos Waterway to the east, and 980 ft from Commencement Bay to the north. Previous investigations did not determine whether the UST remains in place. Because of the reported presence of TPH-gasoline above soil and groundwater, the lack of conclusive information on the presence or absence of UST N-6 is a remaining data gap.

The exceedance ratios for gasoline-range hydrocarbons at N-6 are significantly less than for TCE/PCE in soil and groundwater, which have exceedance ratios in the hundreds and thousands. Therefore, potential TPH releases from N-6 constitute a small portion of the risk to human health and the environment at this location.

Based on available data and the CSM for this location, data gaps relevant to the RI/FS are:

- Presence or absence of the UST, and location if present
- UST contents, if present.

4.3.2USTs N-7 and -8

These two heating oil USTs were located in the southwestern corner of the EBC, at the northwestern corner of former Building 322. The tanks were removed in 1997 along with

255 cubic yards of contaminated soil. Ecology identifies the status of these USTs (also known as P-22 and P-23) in the leaking UST database as “Cleanup Started” (Site 6043).

All accessible petroleum-impacted soil was removed during UST removal, however some petroleum impacted soil remained below Building 322 where additional excavation would have destabilized the building. Building 322 has since been removed.

The 17 soil samples collected during two studies in 2008, including immediately west of former Building 322, indicate that soil and groundwater concentrations of TPH-diesel and TPH-oil in the vicinity of the former USTs are below ISLs (Figure 2). However, these samples did not characterize soil beneath Building 322 where impacted soil was reportedly left in place during UST removal. Groundwater samples 25 to 40 ft downgradient were below screening levels, indicating that leaching to groundwater is not a data gap. Groundwater discharges to the Blair Waterway, approximately 110 ft to the west.

Based on available data and the CSM for this location, data gaps relevant to the RI/FS are:
- Soil TPH concentrations below the eastern extent of former Building 322
- Groundwater TPH concentrations if significant soil impacts are observed.

4.3.3 USTs N-1, -2, -3, -4, -25, and -26

Six 25,000-gallon USTs are believed to have been installed east of the former Building 529, which housed a central heating plant. During a 2011 investigation, a previously unidentified smaller UST was discovered with a push-probe between Building 529 and the historically mapped USTs. It was reported to contain fluid, although whether the fluid was primarily product or water was not established prior to the repair of the push probe puncture.

Exceedances of TPH in soil and groundwater have been identified in the vicinity of the six historical USTs. Test pits completed to 9.5 ft bgs encountered scattered concrete, brick, and metal (pipe, wire, rebar) debris in the upper 4 ft of fill material but did not encounter any of the six target USTs. The capacities of these tanks (25,000 gallons) would require an approximate 10-ft diameter with more than 30 ft of length. A UST with a 10-ft diameter would extend below the water table.

In the PIRR, benzene was identified as a soil initial COI because of one exceedance of the groundwater protection ISL along the western edge of this location. A co-located groundwater sample analyzed for benzene was below the groundwater ISL, and therefore benzene is not a final soil COI for this subarea (Table 3).

The local shallow groundwater flow direction is to the north-northeast based on Figure 4 in the *Site-Specific Summary Report Addendum* (Hart Crowser 2012a). This UST location is now paved and approximately 750 ft from the nearest surface water body.

Based on available data and the CSM for this location, data gaps relevant to the RI/FS are:

- Presence or absence of the USTs, and locations if present
- UST contents, if present
- Extent of soil and groundwater TPH impacts in west-northwestern part of UST location if USTs are not present (otherwise sampling will occur during UST interim action).

This UST location includes wells and piping for the OCC groundwater extraction system. Any interim action in this location will have to take these physical constraints into account and prevent damage to the OCC system.

4.3.4 USTs N-23 and -24

These two tanks were located south of the southeastern corner of Building 532 and immediately north of former Building 511. They had reported capacities between 1,000 and 5,000 gallons and the reported contents were fuel oil and leaded gasoline (Hart Crowser 2012). Navy maps identify Building 511 as a service station. A conclusion of the PIRR was that the likely location of USTs N-23 and N-24 appears to be approximately 40 ft south (upgradient) of the location investigated in 2010.

Based on the current understanding of the UST locations, the groundwater data collected in 2010 are, therefore, downgradient from the USTs. The existing presumed-downgradient data are non-detect or below ISLs for TPH-gasoline, -diesel, and -oil. The UST locations (current or historical; it is not known if they are still present) are at least 500 ft from the nearest surface water body, the Hylebos Waterway to the east, and 730 ft from Commencement Bay to the north.

If the USTs are not found during the RI, it will be assumed that they were excavated and that any impacted soil around the USTs was removed during that excavation. However, if the USTs are found, soil and groundwater samples will be collected during the RI because the existing data characterize downgradient conditions.

Based on available data and the CSM for this location, data gaps relevant to the RI/FS are:

- Presence or absence of the USTs, and locations if present
- UST contents, if present
- Soil and groundwater TPH concentrations, if USTs are present.

4.4 Pier 23 Soil and Groundwater

Pier 23 investigations completed between 1991 and 2008 identified petroleum hydrocarbons, PAHs, PCBs, metals, TCE, and bis(2-ethylhexyl)phthalate (BEHP) in soil. In 2002 Ecology issued a No Further Action letter to the Army following excavation of petroleum-impacted soil attributed to releases from a former waste oil aboveground storage tank (AST). In 2003 additional petroleum-impacted soil was encountered in the vicinity of the AST and a former Bunker C fuel line, located along the western edge of this subarea and near the SW Debris Layer subarea. Reportedly, most of that impacted soil was removed during construction of the Army Reserve Center building in 2003. However, 2008 boring logs in the vicinity of the excavated area documented signs of petroleum impacts in soil, and elevated soil cPAHs and PCBs were detected in the vicinity of the former Bunker C fuel line and the former AST.

Additional data were obtained for this subarea after the PIRR was completed. Soil from a 2008 push probe advanced in the beach area (above MHHW) between the Pier 23 and SW Debris Layer subareas (HC08-EP103; Hart Crowser 2009a) had soil TPH-diesel, -gasoline, and –oil concentrations exceeding their respective ISLs, as well as a cPAH TEQ exceeding the ISL (52 µg/kg). The push probe log included a notation of free product at 5 ft bgs. Further evaluation of borehole and monitoring well logs from the 2008 investigation (Kemron 2009) suggests that petroleum impacts may remain in soil and groundwater in this subarea.

In another area of Pier 23, the 2008 sampling identified a slag mass on the seaward side of the northern sheet-pile wall with elevated levels of copper, lead, zinc, and arsenic. The slag was subsequently removed in 2008 (USAR 2009). Slag was also identified on the upland side of the northern sheet-pile wall where TCE and BEHP each exceeded the soil ISL in one location.

Groundwater samples from nearby shallow wells had elevated arsenic, copper, and selenium concentrations, and the vinyl chloride concentration in an upgradient deep well exceeded the groundwater ISL. Arsenic and selenium exceeded groundwater ISLs in most samples reported from the 2008 sampling event. Evaluation of well pair data indicates that shallow groundwater concentrations are greater than deeper concentrations at locations where shallow residual petroleum contamination was also reported to be present in soil, and concentrations in deep wells are greater than those in shallow wells at the other locations. These data suggest that oxidation-reduction conditions, such as reducing conditions associated with the shallow petroleum-impacted zone, may influence local groundwater chemistry. As observed during a September 2013 site walk, the monitoring wells appeared to be decommissioned.

PCB, BEHP, cPAH, cadmium, lead, mercury, and zinc ISL exceedances in soil are based on protection of groundwater, and the co-located groundwater data are below the ISLs or are undetected. However, many of the soil samples with exceedances are not co-located with monitoring wells, or where wells are present they do not always intercept the full depth range of impacted soil. Arsenic, copper, and selenium are also COIs in soil based on the protection of groundwater pathway, and Pier 23 groundwater data for these metals exceed ISLs.

The OCC VI assessment of the Army Reserve Building indicated the presence of elevated carbon tetrachloride in indoor and subslab vapor concentrations. Previous groundwater sampling at Pier 23 in 2008 indicated non-detect concentrations for carbon tetrachloride with reporting limits below the ISL and below the VI screening level.

Transducer data collected during the Pier 23 RI (Kemron 2009) appears to have been incorrectly analyzed. Tidal response in the shallow fill aquifer appears to be restricted to a narrow interval consistent with either a transducer set above the low-water level, or tidal range that drops below the well screen. These data were used to support an interpretation that there is no tidal influence in the shallow fill aquifer, which does not seem correct given the close proximity of the wells to the shoreline.

RI/FS related data gaps identified in the Pier 23 subarea are:

- Whether the soil-leaching to groundwater pathway is complete for PCBs, metals, cPAHs, and BEHP.
- The extent of carbon tetrachloride in shallow groundwater that may be contributing to elevated indoor air and subslab vapor concentrations at the Army Reserve building
- The extent of TPH, BEHP, cPAHs, and metals that exceed soil and groundwater ISLs and whether they have potential to impact surface water
- Potential for natural attenuation, evaluated along transport pathways by ORP, pH, and specific conductance in groundwater and by organic carbon content in soil (i.e., analysis of parameters that support fate and transport evaluations)
- Tidal influence on groundwater transport through the shallow fill aquifer.

4.5 Former AK-WA Giannotti Shipyard

The 2.5-acre Former AK-WA Giannotti Shipyard subarea is located at the northeastern corner of the Site between Pier 24 and Pier 25. Giannotti leased the site from 1960 to 1997 for ship repair activities and went out of business in 1997. In 1988, the Port conducted a site investigation and remediation and razed multiple buildings (Dames and Moore 1998a). Remediation efforts included a 167-cubic yard excavation near Building 9586 (Building 586 on Navy maps; Port of Tacoma 1999a). PCBs detections in soil decreased with depth near Building 9586, and all known PCB-impacted soil was reportedly excavated during the 1998 remedial action. However, current ISLs are below the cleanup levels (CULs) in effect in 1998, and the available copy of the report describing analytical results for characterization and excavation confirmation sampling is incomplete.

Additionally, arsenic and lead were reportedly below 1998 MTCA Method C and A CULs, respectively, for industrial properties (which were 219 and 1,000 mg/kg[2]; current ISLs are

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[2] 1998 lead criteria not included in AK-WA Giannotti reports (Dames and Moore 1998, Port of Tacoma 1999); lead 1998 CUL value cited from MTCA Table 745-1. Lead has had the same direct contact Method A CUL since 1991.

7.3 mg/kg and 81 mg/kg, respectively) in all final confirmation samples. Because data were not provided in the excavation report it is not clear if those samples would be below the current ISLs.

In addition, some stockpiled soil from the deeper portions of the excavation was used as backfill, but analytical results from the confirmation samples collected from the backfill material are also not available (Port of Tacoma 1998).

The excavation report is complete enough to verify that the 1998 remedial action left soil impacted by other COIs in place at two other locations in this subarea. Excavation did not extend to an area where lead was detected in shallow soil near Building 9588, and the report noted that petroleum-impacted soil exceeding 1998 CULs was left in place near foundation footings along the adjacent seawall. MTCA’s 1998 petroleum CULs for soil were about ten times lower than the current EBC ISLs. Therefore, qualitative information that the soil exceeded these petroleum CULs does not necessarily mean that Site soil exceeds site-specific ISLs, and, therefore, the nature and extent of petroleum hydrocarbons in AK-WA soil is a data gap.

The site is completely paved, but direct contact could be a receptor pathway in the event of excavation for utility work or construction. Soil leaching to groundwater with subsequent groundwater discharge to surface water is a potential exposure pathway for this subarea. Paving and operation of a stormwater system would reduce infiltration, presumably also reducing the risk associated with this pathway. However, no groundwater data are available in this subarea to evaluate this pathway.

Data gaps in the Former AK-WA Giannotti Shipyard subarea include:

- Backfill soil concentrations of TPH-diesel, PCBs, and metals
- Groundwater concentrations below former excavation for TPH-diesel, PCBs, cPAHs, and metals if backfill soil samples exceed ISLs.

4.6 Building 595 Vapor Intrusion

OCC analyzed outdoor air, indoor air, and subslab air for VOCs in eight buildings at the Site. Many of the buildings overlie the OCC chlorinated solvent plume and, with one exception, elevated airborne VOCs in those buildings were attributed by OCC to the plume or to activities conducted inside those buildings. Subslab air below Building 595 contained benzene, TCE, PCE, chloroform, and carbon tetrachloride above the relevant criteria. Benzene and carbon tetrachloride were also elevated in Building 595 indoor air. OCC suggested that the benzene could be attributed to historical EBC sources.

All of the previous EBC and OCC soil and groundwater sampling locations in the vicinity of Building 595 (within approximately 100 ft) were reviewed to assess possible sources of benzene. The vast majority of historical samples were not analyzed for benzene. The only nearby soil sample with a benzene detection was at 17.6 ft bgs, 60 ft east of the northwestern corner of the building, and the concentration was below the Site ISL. There were no nearby TPH detections in groundwater, but there was a non-detect result with an elevated reporting limit (2,500 µg/L) at a location 50 ft west-southwest of Building 595. The nearby groundwater data did not include any benzene analyses.

The primary data gaps at Building 595 include:

- Nature and extent of benzene in water table-level groundwater, and whether benzene in groundwater may be contributing to elevated indoor air and subslab vapor concentrations.

5 RI Field Sampling Plan

RI sampling will be conducted in two phases. The first phase of sampling will include reconnaissance-type explorations including surficial mapping and sampling, air-knife explorations, and direct-push explorations (Table 4). The second phase will include installation, development, and sampling of monitoring wells, and collection of additional data needed to fill any additional gaps identified from the review of data from the first sampling phase.

5.1 SW Debris Layer

Sampling to address data gaps in the SW Debris Layer subarea includes:

- Collecting composite soil samples to investigate direct-contact risk for soil associated with surficial debris
- Mapping the extent of debris layer and collecting soil samples to project north at the shipways as basis for delineating a potential soil-to-groundwater pathway
- Installing monitoring wells to investigate COI concentrations in groundwater discharging to surface water at the downgradient edge of debris
- Measuring natural attenuation parameters in monitoring wells
- Conducting a tidal study to support evaluation of the groundwater-to-surface water pathway.

5.1.1 Phase I Sampling

Direct-contact risk will be assessed through mapping the extent of debris and through collection of representative composite soil samples from within the surficial debris. Surface debris (amount, size, type) will be mapped by visual observations along the shoreline above MHHW. For comparison with historical information, mapping criteria will match the approach previously used for slag along the Blair Shoreline. Units will be classified by percentage of surface area covered by the debris in two size groups: less than and greater than 6 inches in length. The northern extent of the subsurface debris will be investigated with up to three air-knife explorations along the former shipways at the edge of the existing concrete slab/apron above MHHW. The extent of subsurface debris will also be constrained by boreholes advanced during well installation. Composite surface soil samples will be collected from locations along the shoreline above MHHW. Composite soil samples will be analyzed for metals, PCBs, and SVOCs (Table 5). Soil samples will be analyzed for TPH if field observations, such as staining or odor, indicate petroleum impacts.

5.1.2 Phase II Sampling

Groundwater sampling will include installation of three new groundwater monitoring wells along the shoreline near MHHW and two wells further upgradient, but within the known debris area (Figure 5); wells will be screened across the water table and below any debris that does not contact the saturated zone. Samples from these monitoring wells will be analyzed for TPH, BTEX, metals, PCBs, and SVOCs. Water table soil samples will be collected from the two downgradient monitoring well boreholes and analyzed for TPH, BTEX, PCBs, SVOCs, metals, and total organic carbon (TOC). A soil sample from the northwestern monitoring well (along the shoreline) will be analyzed for TOC only.

Pressure transducers will be installed in the five monitoring wells for one week to observe water level response to tidal variation.

5.2 Blair Shoreline

Sampling to address data gaps in the Blair Shoreline subarea includes:

- Composite soil sampling of cemented shoreline debris to investigate direct-contact risk
- Installation and sampling of monitoring wells to investigate soil-to-groundwater pathway downgradient of areas with elevated soil COIs.

5.2.1 Phase I Sampling

A composite soil sample will be collected from the cemented debris along the northern part of the Blair Shoreline. The material is friable, and a representative sample will be collected using hand-held sampling instruments. The sample will be analyzed for metals, PCBs, and SVOCs.

5.2.2 Phase II Sampling

Two groundwater monitoring wells will be installed along the Blair Shoreline at the locations shown on Figure 5. Well screens will span the water table, with a screen interval nominally between 7 and 17 ft bgs to span the water table's expected range. Screen intervals may be modified by field observations at the time of drilling.

Blair Shoreline groundwater samples will be analyzed for dissolved metals, PAHs, DDT (project south well only), and PCBs. The extracts of the samples will be evaluated to determine if there are potential interferences due to wood waste byproducts. If so, the sample will also proceed through a silica gel cleanup step.

Soil samples will be collected from the water table at both well locations and analyzed for TOC. A soil sample will be collected from 2 to 5 ft bgs from the northern well and tested for index properties (grain size, moisture content, specific gravity, and Atterberg limits, if appropriate).

A pressure transducer will be installed in the two new monitoring wells for one week to observe water level response to tidal variation to supplement the SW Debris Layer tidal study.

5.3 Historical Underground Storage Tanks

Sampling to address data gaps in the UST subarea includes:

- Air-knife potholing to attempt to locate USTs
- Sampling of UST contents if USTs located
- Direct-push soil probing to assess current soil concentrations around former USTs N-7 and -8
- Contingent direct-push soil and groundwater sampling at USTs N-1, -2, -3, -4 , -25, -26 and USTs N-23 and -24.

All UST-area sampling is assumed to be conducted as Phase I sampling. Contingency sampling may be conducted during Phase II sampling.

UST presence/locations will be investigated with an air-knife rig advanced to a depth of at least half the expected tank diameter plus 4 ft. Air-knife explorations will begin in the center of the investigation area and work outwards in a grid pattern with spacing based on the anticipated size of the target UST. If a UST is located in an air-knife excavation, additional explorations will be advanced along the long-axis of the UST to determine footprint of the UST. UST extents may also be mapped using a radio-frequency locating tool.

After the locations and extents of USTs have been mapped, a nominal 1-inch hole will be punched or drilled through the top of located USTs, and a bailer or equivalent sampler will be inserted to record the depth of the tank and to sample the tank contents. An oil-water interface probe may also be used to measure the thickness and depth of the tank contents. Qualitative field observations will include presence of water and/or product, color and odor of contents, and type of TPH if discernible based on viscosity, odor, or presence of dyes. Samples of the tank contents will be analyzed for hydrocarbon identification (HCID), metals, VOCs, and PCBs to assist in proper disposal or recycling during the UST interim action. The hole in the UST will be patched before backfilling the air knife excavation.

5.3.1 UST N-6

UST N-6 reportedly has a 1,600-gallon capacity; cylindrical USTs of this volume are typically between 4 and 6 ft in diameter and 9 to 16 ft in length. The exploration area will be approximately 15 by 25 ft, located between the interpreted extents of former Buildings 510 and 512 (Figure 5). Air-knife explorations to 7 ft bgs will be spaced on a 4-ft grid (with up to 20 locations) to achieve a 98% probability of intersecting the UST, if present.

If located, the size, condition and contents of the UST will be used to update site records and will be used in UST interim action planning.

5.3.2 USTs N-7 and -8

The 1997 removal of these USTs has been documented. Therefore, no air-knife explorations are to be conducted. RI activities associated with this UST location are related to nature and extent of any remaining soil impacts.

Two direct push soil cores will be advanced to the water table in the eastern edge of the footprint of former Building 322. The former building footprint will be identified by measurements from the SW corner of Building 405 and by historical aerial photographs showing the locations of Buildings 405 and 322 (Figure 5). Soil cores will be examined for visual evidence of petroleum impacts. USTs N-7 and -8 reportedly held fuel oil which is at the upper range of hydrocarbons that function well in TPH dye tests, therefore visual observations of staining will likely be the primary field indicator of petroleum impacts. Soil samples will be analyzed for TPH-gasoline and -diesel at the nominal depth listed in Table 5 unless petroleum impacts are observed in the field. If soil cores indicate significant contamination (more than 1 ft of petroleum impacted soil), up to two additional direct push borings may be collected west of the initial two borings to determine nature and extent.

Groundwater samples will not be collected at N-7 and -8 unless petroleum impacts are observed at the water table in soil cores.

5.3.3 USTs N-1, -2, -3, -4, -25, and -26

USTs N-1,-2,-3, -4, -25, and -26 reportedly have 25,000-gallon capacities; cylindrical USTs of this volume are typically approximately 10 ft in diameter and 42 ft in length. The exploration area will be divided into two rectangular units: approximately 60 by 20 ft at USTs N-1,-2,-3, and -4; and 20 by 20 ft at USTs N-25 and -26 (Figure 5). Air-knife explorations to 9 ft bgs will be spaced 10 ft apart along a north-south traverse across each unit. Air-knife explorations will be advanced at up to 6 locations in the west traverse and 4 locations in the east traverse.

If USTs are confirmed not to be present, up to two soil and two groundwater samples will be collected from the western and central portion of this UST location and analyzed for TPH and VOC to improve delineation of soil and groundwater impacts.

If located, the size, condition and contents of USTs will be used to update site records and considered in UST interim action planning. The contents of the other UST located in this location will also be sampled and analyzed.

During Phase II sampling, a geotechnical boring will be advanced in this location to collect samples to be tested for index properties (grain size, moisture content, specific gravity, and Atterberg limits, if appropriate) at 2 to 5 ft bgs, 10 ft bgs, and 15 ft bgs.

5.3.4 USTs N-23 and N-24

USTs N-23 and N-24 reportedly have capacities between 1,000 and 5,000 gallons; cylindrical USTs of this volume range are typically between 4 and 7 ft in diameter and between 11 and 23 ft long. The exploration area will be approximately 25 by 40 ft (Figure

5). Air-knife explorations to 8 ft bgs will be spaced on a 4-ft grid (up to 25 locations) to achieve a 98% probability of intersecting the UST, if present.

If located, the size, condition and contents of USTs will be used to update site records and considered in UST interim action planning.

If USTs are confirmed to be present then soil and groundwater samples from up to three locations will be collected to assess the nature and extent of TPH impacts. If the USTs are not found, then no samples will be collected because it will be assumed that any impacted soil was removed during historical UST removal. Downgradient groundwater data indicate that a soil-to-groundwater pathway is not complete at this location.

5.4 Pier 23

Sampling to address data gaps in the Pier 23 subarea includes:

- Soil sampling in former AST and fuel line area
- Installation and sampling of monitoring wells in the former AST/fuel line and slag areas to investigate the soil-to-groundwater pathway
- Collecting a groundwater sample from a temporary well at the former HC08-EP103 location to investigate the potential relationship of impacts at that location to the former AST.
- Conducting a tidal study to support evaluation of the groundwater-to-surface water pathway.

5.4.1 Phase I Sampling

Soil and groundwater samples will be collected from three direct push locations in the former AST and bunker fuel line area. Soil and groundwater samples will be collected from the water table at the 2 upland locations and at 5 ft bgs at the beach location, or where visual indications of contamination are present. Soil and groundwater samples will be analyzed for:

- TPH
- PCBs (beach location only)
- PAHs (all locations for groundwater; beach location only for soil)
- Metals (beach location only)
- VOCs (in groundwater only at the 2 upland locations).

A temporary piezometer will then be installed to a depth of 15 ft bgs at the beach location, and a tidal study will be conducted. A transducer will record water levels in this well for one week.

5.4.2 Phase II Sampling

Two monitoring wells will be installed: one in the slag area near the sheet-pile wall and one near the former AST/fuel line (Figure 5). Monitoring wells will have 10-ft long screens set across the water table, likely between 7 and 17 ft bgs. Groundwater samples will be analyzed for:

- Metals
- SVOCs (PAHs only at the former AST/fuel line area a)
- VOCs
- PCBs
- TPH (at AST/Fuel line area only).

During drilling of the monitoring well in the AST/fuel line area, soil samples will be collected for testing of index properties (grain size, moisture content, specific gravity, and Atterberg limits, if appropriate) at 2 to 5 ft bgs, 10 ft bgs, and 15 ft bgs. A soil sample will also be collected for TPH, PCB, PAH, metals, and TOC analyses.

If TPH impacts are confirmed in the beach area, near HC08-EP103, additional sampling will occur in this area to define the extent of impacts.

Pressure transducers will be installed in the two new monitoring wells for one week to observe tidal variation and assess the measured water level response reported in the previous investigation (Kemron 2009).

5.5 Former AK-WA Giannotti Shipyard

Sampling to address data gaps in the AK-WA Giannotti Shipyard subarea includes:

- Composite soil sampling of backfill soils with inadequate documentation of analytical results
- Groundwater sampling from same locations as soil samples to empirically address the soil-to-groundwater pathway.

The investigation of this subarea focuses on characterization of soil used as backfill in the 1998 excavation area near former Building 9586. No Phase II sampling is included for this subarea.

5.5.1 Phase I Sampling

Two composite soil samples will be collected from the 1998 excavation remedial action area. Each soil sample will be collected using a direct push drill rig and will be composited from 0.5 to 5 ft bgs, spanning the vertical extent of the former excavation. Backfill soils are expected to have been mixed during excavation into soil stockpiles and during placement as backfill, so compositing will not degrade depth-dependency of soil concentrations. Samples will be analyzed for TPH-diesel, PCBs, and metals (excluding mercury).

Each boring will then be advanced to at least 1 ft below the water table at approximately 10 ft bgs, and groundwater samples will be collected from a temporary 4-ft screen in each boring. Groundwater samples will be analyzed for TPH-diesel, PCBs, PAHs and metals (excluding mercury).

5.6 Building 595 Vapor Intrusion

Sampling at Building 595 will address water table VOC concentrations that could impact indoor air quality.

5.6.1 Phase I Sampling

Groundwater samples will be collected from three direct push locations at the water table with a nominal 4-ft screen length. Groundwater samples will be collected from three locations: near the northwestern corner of the building, along the western side of the building in the general area of a former fuel-oil line that passed under the western side of the building, and at the southwestern corner of the building near the OCC property boundary. Groundwater samples will be analyzed for VOCs, TPH-gasoline, and TPH-diesel with reporting limits at or below MTCA Method B screening levels protective of indoor air. The presence of elevated chlorinated ethenes may preclude achieving low reporting limits for compounds present at low concentrations.

5.7 General RI Sampling

Where subsurface debris does not prohibit it, hollow-stem auger drilling will be used to allow collection of geotechnical information, including standard penetration test (SPT) blow counts every 2.5 ft. Sonic drilling will be used in the SW Debris Layer subarea due to the presence of concrete foundations and debris. Although not expected, sonic drilling may also be necessary in other areas if debris restricts drilling by hollow-stem auger. The type, thickness, and condition of all pavements or slabs encountered at all investigation locations will be documented. All soil samples will be field screened using a photoionization detector (PID). In addition to chemical testing, soil testing for index properties (grain size, moisture content, specific gravity, and Atterberg limits, if appropriate) will be performed for samples collected at the geotechnical locations noted on Figure 5 and in Table 5. Geotechnical data is not an environmental data gap at the site but these samples will provide supporting site information for the feasibility study.

All groundwater sampling will include measurement of pH, specific conductance, temperature, ORP, and dissolved oxygen to ensure proper purging of wells, and in support of fate and transport analyses. Dissolved metals samples will be field filtered. Samples collected for PCB, SVOC, or DDT analyses will be placed in unpreserved bottles and lab-centrifuged to reduce the effects of included particles. Centrifugation will follow protocols similar to those described in EPA method SW-846. Specific sampling protocols are described in the QAPP (Appendix A). Metals analysis for groundwater samples will include reductive precipitation in order to achieve reporting limits below ISLs. All sample preparations for TPH-diesel analysis will use silica gel cleanup. In addition, extracts for SVOC or PAH analysis that indicate potential interference from wood waste will have silica gel cleanup performed.

All monitoring wells will be surveyed to the nearest 0.01-ft vertical at the top of casing and less than 1-ft horizontal accuracy. All other sampling locations will be located to 1-ft horizontal and vertical accuracy.

6 Schedule

Field work will be conducted in two phases organized by investigation method:

- **Phase I:** The first phase will include direct push soil and groundwater sampling, air-knife potholing, potential analysis of UST contents, and surficial debris mapping. Phase I sampling will be completed within 30 days of approval of this RIWP.
- **Phase II:** The second phase will include monitoring well installation and sampling, as well as a tidal study. It will be conducted after the Ecology milestone meeting in early 2014. Monitoring well locations may be revised based on the Phase I data review. Any modifications to sampling locations will be discussed with Ecology in the milestone meeting within 15 days of receipt of Phase I analytical data. Phase II sampling will be completed within 30 days of the Ecology milestone meeting

A UST Removal Interim Action Plan, if required, will be submitted to Ecology for review and comment within 60 days of submittal of the draft RI/FS report. Final work plans will be submitted to Ecology for review and approval within 30 days of receiving comments from Ecology.

The Port will submit a draft RI/FS report to Ecology for review and comment within 90 days of the completion of all field work. The Port will submit a final RI/FS report to Ecology for review and approval within 30 days of receipt of Ecology comments on the draft.

A schedule has been developed through completion of the draft RI/FS based on the following assumptions:

- Drilling equipment is available on this schedule.
- Analytical laboratories achieve a 2-week turnaround time.
- Adequate low tides are available during the Phase II tidal study and groundwater sampling. (NOTE: There are only 3 days with negative low tides during the Phase II field work timeframe noted below.)
- No additional data gaps are identified at the second milestone meeting.

The schedule is anticipated to occur as follows:

Task / Phase	Duration	Begin	Finish
Ecology Approval of RIWP	1 day	17-Jan-14	17-Jan-14
Phase I RI Field Work	4 weeks	20-Jan-14	14-Feb-14
Phase I Lab Analysis and Data Review	4 weeks	17-Feb-14	14-Mar-14
Ecology Milestone Meeting and Follow-Up	1 week	17-Mar-14	21-Mar-14
Phase II RI Field Work	4 weeks	24-Mar-14	18-Apr-14
Phase II Lab Analysis and Data Review	4 weeks	21-Apr-14	16-May-14
Ecology Milestone Meeting and Follow-Up	1 week	19-May-14	23-May-14
Prepare Draft RI/FS Report	90 days	21-Apr-14	17-Jul-14

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Tables

Table 1. EBC-Wide Initial Constituents of Interest - Groundwater

			Subarea Initial COI?					
Parameter Group	**Constituent**	**Initial Screening Level (µg/L)**	**SW Debris[a]**	**Blair Shoreline**	**UST**	**Pier 23**	**AK-WA Gianotti[b]**	**OCC COI?[c]**
Metals	Arsenic	5			X	X		X
	Copper	2.4	X	X	X	X		X
	Lead	8.1						X
	Manganese	100						
	Nickel	8.2						
	Selenium	71				X		
	Zinc	81						X
Insecticides	Heptachlor	0.000079						
PCBs	Total PCBs	0.005	X					X
TPH	TPH - Diesel	500	X		X	X		
	TPH - Gasoline	800	X		X	X		
	TPH - Oil	500	X		X			
VOC	1,1-Dichloroethene	3.2						X
	Chloroform (Trichloromethane)	12						X
	cis-1,2-Dichloroethene	350			X			X
	Methylene chloride	590						X
	Tetrachloroethene	3.3			X			X
	trans-1,2-Dichloroethene	290						X
	Trichloroethene	4.2			X			X
	Vinyl chloride	2.4			X	X		X

Notes:

1. COIs are those constituents with 5% or greater detection frequency and have at least 1 detected exceedance of the ISL.

a. cPAH is a COI in the SW Debris Layer subarea but is not an EBC-wide COI because the EBC-wide detection frequency is less than 5%.

b. No groundwater samples have been collected from the AK-WA Gianotti subarea.

c. Listed as a COC in Table 2.3 of CRA 2011. Updated Draft Site Characterization Report, Groundwater and Sediment Remediation, Occidental Chemical Corporation

Table 2. EBC-Wide Initial Constituents of Interest - Soil

			Subarea Initial COI?					
Parameter Group	**Constituent**	**Initial Screening Level**	**SW Debris[a]**	**Blair Shoreline**	**UST**	**Pier 23**	**AK-WA Gianotti**	**Eliminated from COI list?**
cPAH (µg/kg)	cPAH TEQ	52.3	X	X	X	X	X	
Insecticides (mg/kg)	4,4'-DDT	0.0033		X				
Metals (mg/kg)	Arsenic	7.3	X	X		X		
	Cadmium	0.8	X			X		
	Copper	36.4	X	X		X	X	
	Lead	81	X	X		X	X	
	Mercury	0.07	X	X		X		
	Nickel	48	X					
	Selenium	0.38	X			X		
	Zinc	85.1	X	X		X		
PCBs (µg/kg)	Total PCBs	4	X	X		X		
SVOA (µg/kg)	2,4-Dimethylphenol	510	X					
	Acenaphthene	14,800						
	bis(2-Ethylhexyl)phthalate (BEHP)	734	X			X		
	Fluoranthene	20,700						
	Naphthalene	1,389	X					
	N-Nitrosodiphenylamine	24.9	X					
TPH (mg/kg)	TPH-Diesel	2,000	X		X	X		
	TPH-Gasoline	30	X		X			
	TPH-Oil	2,000	X	X	X			
VOC (µg/kg)	1,4-Dichlorobenzene	406						
	Benzene	11.3	X					
	Methylene chloride	187	X					X
	Tetrachloroethene	3.6			X			
	Total Xylenes	586	X		X			
	Trichloroethene	2.4			X	X		
	Vinyl chloride	500						

Notes:

1. COIs are those constituents with 5% or greater detection frequency and have at least one detected exceedance of the ISL.

a. N-Nitrosodiphenlyamine is an initial COI in the SW Debris Layer subarea but is not an EBC-wide COI because the EBC-wide detection frequency is less than 5%.

Table 3. Summary of Soil Data Exceeding Groundwater Protection ISLs

Subarea	Analyte	Nature of Available Groundwater Data	Still a COI for Subarea?
AK-WA	cPAH TEQ	all gw data in upgradient end of subarea; only 1 soil location (GP-4) exceeds for cPAH, copper, and lead	yes
	Copper		yes
	Lead		yes
BS	Arsenic	all gw data in upgradient end of subarea	yes
	Cadmium	all gw data in upgradient end of subarea; soil exceeds NB. Soil protective of gw below NB.	yes
	Copper		yes
	Mercury		yes
	cPAH TEQ	all gw data in upgradient end of subarea	yes
	Lead		yes
	Nickel	all gw data in upgradient end of subarea; soil exceeds NB. Soil protective of gw below NB.	yes, but only 1 soil sample exceeds
	Zinc		yes
	Total PCBs	all gw data in upgradient end of subarea; soil exceeds PQL.	yes
	DDT	all gw data in upgradient end of subarea; however only one soil sample exceeds PQL. Soil protective of gw below PQL.	yes
P23	Arsenic	available gw data exceeds gw ISL (5 ug/L, bg)	yes
	Aroclor-1260	either no data or RL exceeds ISL	yes
	bis(2-Ethylhexyl) phthalate	RL exceeds ISL; only 1 soil sample exceeds	yes
	Cadmium	2 sets of nested wells are clean for cadmium; 2 soil locations have no wells nearby	tentative
	cPAH TEQ	either no data or RL exceeds ISL	yes
	Copper	some wells are ND; shallow well at KEMMW 4 exceeds ISL in total and dissolved	yes
	Lead	2 sets of nested wells are clean for lead; 2 soil locations have no wells nearby	tentative
	Mercury	2 sets of nested wells are clean for Hg; 4 soil locations have no wells nearby	tentative
	Selenium	only 1 soil sample exceeds; gw exceeds in deep well and clean in shallow well	yes
	Total PCBs	2 sets of nested wells are ND (but elevated RL); 7 soil locations have no wells nearby	yes
	Trichloroethene	only 1 soil sample exceeds; no gw data	yes
	Zinc	no exceedances in any wells; some soil locations not co-located with wells	tentative
SWD	Aroclor-1260	5 soil samples with no nearby wells; 2 soil samples with ND gw data; 1 soil location w/ gw RL over ISL; 1 soil location paired w/ gw detected exceedance	yes
	Arsenic	3 wells ND for dissolved and total	yes
	Benzene	1 soil sample with no nearby well; 2 soil samples paired with ND gw data	tentative
	bis(2-Ethylhexyl) phthalate	1 soil sample with no nearby well; 1 soil sample paired with ND gw data	tentative
	Cadmium	in 3 wells total is detected below ISL and dissolved is ND; 1 sample with no well; 1 well's RL exceeds ISL	tentative
	cPAH TEQ	mix of no data, detected exceedances, and RL over ISL	yes
	Copper	2 wells below ISL or ND for dissolved; 1 well exceeds for dissolved; 1 soil location without a paired well	yes
	Lead	mix of no data, RL over ISL, and dissolved lead detected below ISL; no detected exceedances of dissolved lead	tentative
	Mercury	some soil samples with out paired wells; paired wells are ND for dissolved and below ISL for total	tentative
	Methylene chloride	only 1 soil sample exceeds; gw = ND	no
	N-Nitro sodiphenylamine	mix of no data and RL exceeds ISL	yes
	Nickel	3 wells with dissolved below ISL; but 1 soil sample without paired well	tentative
	Selenium	only 1 soil sample; gw RL exceeds ISL	yes
	Total PCBs	exceeds in one well	yes
	Zinc	all dissolved below ISL; but four soil exceedances do not have paired wells	tentative
UST	Benzene	only 1 soil sample exceeds ISL; co-located groundwater sample is detected below ISL; only 2% detection frequency in UST soil, therefore benzene was not initial COI for this subarea.	no; was not a COI because detection frequency is below 5%
	cPAH TEQ	no data	yes
	Tetrachloroethene	detected exceedances	yes
	Trichloroethene	detected exceedances	yes
Outside of Subareas	Acenaphthene	no data	yes
	Benzene	no data	yes
	cPAH TEQ	no data	yes
	Copper	no data	yes
	Fluoranthene	no data	yes
	Lead	4 locations with no gw data; 1 with gw detected exceedance	yes
	Mercury	no data	yes
	Methylene chloride	1 well (10-24) close to 2 soil locations; it was below ISL in 1988 but above in 2012	yes
	Tetrachloroethene	many locations with no paired gw data; 1 well (10-24) with detected exceedances in 1988 and 2012	yes
	Trichloroethene	many locations with no paired gw data; 1 well (10-24) with detected exceedance in 1988 and 2012	yes
	Total PCBs	no co-located wells, but no detections in any wells	yes
	Vinyl Chloride	no data, only 1 soil samples exceeds ISL	yes
	Zinc	no data	yes

COI = constituent of interest, ISL = initial screening level, NB = natural background, ND = not detected, RL = reporting limit, TEQ = toxicity equivalent.

Table 4. Summary of Analytical Program

Subarea	Data Gap	Analytes	Investigation Approach	Data Evaluation
Zn Hotspot	N/A	N/A	N/A	N/A
Sandblast Grit	N/A	N/A	N/A	N/A
SW Debris Layer	- Determine if soil COIs with concentrations above leaching to groundwater ISLs are present in groundwater above ISLs; determine if the soil leaching to groundwater pathway is complete at the point of discharge	- TPH (G, D, and O) - PCB - Metal - SVOC - BTEX	- 3 downgradient monitoring wells installed close to the shoreline near MHHW and beyond the extent of debris and sampled for soil and groundwater - 2 wells slightly upgradient of the shoreline within the debris area, sample for groundwater only - Air-knife investigation below shipways to map extent of debris - Fate and transport supplemental parameters (DO, ORP, pH) - Tidal study	- Compare results directly to ISLs - Estimate and compare point of discharge concentrations to ISLs - Total organic carbon in soil to evaluate soil leaching to groundwater
	- Extent of debris at shipways, potential for direct contact and mobilization with surface water	- TPH (field) - PCB - Metal - SVOC	- Visually map exposed debris size and abundance along shoreline; this will include close inspection at/under edges of concrete slab - Collect 3 surface soil composite samples from shoreline	- Extent of debris exposed at surface - Compare soil/debris chemistry to ISLs for direct contact
Blair Shoreline	- Determine if soil COIs with concentrations above leaching to groundwater ISLs are present in groundwater above ISLs	- PAH - 4,4'-DDT (1 well) - Metal - PCB	- Install and sample 2 monitoring wells near the shoreline in the vicinity of previous locations with groundwater reporting limits exceeding ISLs and soil samples exceeding ISLs	- Compare results to ISLs - Soil analyzed for total organic carbon and geotechnical parameters for FS and pathway evaluation
	- Exposed slag and concrete-like material in bank	- Metal - PCB - SVOC	- Collect 1 composite sample of cemented concrete-like debris	- Extent of debris - Compare debris chemistry to ISLs and sediment criteria due to potential erosion into waterway
	- Soil direct contact	- None (TPH-Oil is the soil COI)	- None	- TPH evaluated through overlapping SW Debris Layer evaluation
UST: N6 (Fuel Oil)	- Determine if UST is present at this location	UST contents for HCID, VOC, RCRA metal, PCB	- Air-knife potholing - Collect sample to charcaterize contents if UST is found	- Confirmed location will be incorporated into site records
UST: N7,8 (Heating Oil)	- Determine if elevated soil concentrations under former Bldg. 322 are present; USTs were removed	- TPH (G, D, and O)	- Targeted soil sampling by geoprobe at approximately 1 foot above water table - Collect and archive soil samples from step out borings - Collect groundwater sample if evidence of contamination is found	- Compare results to ISLs
UST: N-1,2,3,4,25,26 (Fuel Oil)	- Determine if USTs are present at this location - Characterize contents of found USTs for interim action - Determine extent of soil/groundwater impacts if no new USTs located	- TPH (G, D, and O) - VOC UST contents for HCID, VOC, RCRA metal, PCB	- Air-knife potholing in two traverses across UST locations - Collect samples to characterize contents, if USTs are found - Advance 2 geoprobes if USTs are not found, to characterize soil and groundwater impacts (otherwise this will occur during UST interm action)	- UST locations and characteristics will be incorporated into site records - Geotechnical soil boring for FS or UST Interim Action
UST N-23,24	- Determine if USTs are present at this location	- TPH (G, D, O) UST contents for HCID, VOC, RCRA metal, PCB	- Air-knife potholing - Collect samples to characterze contents, if USTs are found - If USTs are located, advance up to 3 geoprobes to identify extent of impacts (soil and groundwater) prior to UST interim action	- Confirmed location will be incorportated into site records - Evaluate for interim UST action
All other USTS	N/A		N/A	N/A
Pier 23	- Extent of TPH in soil and groundwater at former AST and fuel line area	- TPH (G, D, and O) - Metal - PCB - PAH - VOC	- Collect 3 direct push soil and groundwater samples in former AST area, including from the beach area in the vicinity of HC08-EP103	- Integrate soil samples into fate and transport review and evaluation
	- Determine if soil COIs with concentrations above leaching to groundwater ISLs are present in groundwater above ISLs; determine if the soil leaching to groundwater pathway is complete at the point of discharge	- TPH (G, D, and O) - Metal - PCB - SVOC - VOC	- Install new well in former AST area, analyze with appropriate reporting limits - Install new well in slag area, analyze with appropriate reporting limits - Collect soil sample concurrent with well installation in former AST area - Tidal study	- Compare results directly to ISLs - Estimate and compare point of discharge concentrations to ISLs - Soil analyzed for total organic carbon and geotechnical parameters for FS and pathway evaluation
	- Evaluate if there is a carbon tetrachloride water table groundwater source to subslab vapor	- VOCs (to investigate carbon tetrachloride)	- Analyze groundwater samples for carbon tetrachloride	- Compare groundwater results to groundwater-to-air ISLs
AK-WA Giannotti	- Arsenic, lead, copper, and PCB content of soils used as backfill at Bldg. 9586	- PCB - Metal (not Hg) - TPH (D, O) - PAH	- Direct-push sampling of soil (vertical 0.5-5 ft bgs composite) from 2 locations in former excavation - Groundwater sample from each direct push	- Compare results to ISLs
Vapor Intrusion - Building 595	- Evaluate if there is a benzene water table groundwater source to subslab vapor	- VOC and TPH (benzene is of concern)	- Collect water table interval groundwater samples at 3 locations around building	- Compare groundwater results to groundwater-to-air ISLs

MW: Monitoring Well
ISL: Initial Screening Level
UST: Underground Storage Tank
AST: Aboveground Storage Tank
COI: Constituent of Interest
OHWM: Ordinary High Water Mark

Table 5. Investigation Locations and Analytes

Sample ID	Media	Depth (ft bgs)	TPH	VOC	PCB	SVOC	Metals	Other	Phase	Comment
SW Debris Layer										
SWD-01-S-C	S	0.5	Field		8082	8270	6010 + Hg		I	Surface Composite
SWD-02-S-C	S	0.5	Field		8082	8270	6010 + Hg		I	Surface Composite
SWD-03-S-C	S	0.5	Field		8082	8270	6010 + Hg		I	Surface Composite
SWD-MW-3-S-WT	S	WT	G,D,O	BTEX	8082	8270	6010 + Hg	TOC	II	From downgradient MW Boring
SWD-MW-4-S-WT	S	WT	G,D,O	BTEX	8082	8270	6010 + Hg	TOC	II	From downgradient MW Boring
SWD-MW-5-S-WT	S	WT						TOC	II	From northwest MW Boring
SWD-MW-1-WT	GW	WT	G,D,O	BTEX	8082	8270	200.8 + Hg		II	Upgradient
SWD-MW-2-WT	GW	WT	G,D,O	BTEX	8082	8270	200.8 + Hg		II	Upgradient
SWD-MW-3-WT	GW	WT	G,D,O	BTEX	8082	8270	200.8 + Hg		II	Downgradient
SWD-MW-4-WT	GW	WT	G,D,O	BTEX	8082	8270	200.8 + Hg		II	Downgradient
SWD-MW-5-WT	GW	WT	G,D,O	BTEX	8082	8270	200.8 + Hg		II	Northwest
Duplicate	GW	WT	G,D,O	BTEX	8082	8270	200.8 + Hg		II	
Blair Shoreline										
BSG-01-S-10	S	0.5			8082	8270	6010 + Hg		I	Surface Composite
BSG-MW-1-S-WT	S	WT						TOC	II	From MW-1 Boring
BSG-MW-1-S-5	S	2 to 5						Geo	II	From MW-1 Boring
BSG-MW-2-S-WT	S	WT						TOC	II	From MW-2 Boring
BSG-MW-1-WT	GW	WT			8082	PAH	200.8 + Hg		II	Possible silica gel cleanup for SVOC analysis due to woodwaste
BSG-MW-2-WT	GW	WT			8082	PAH	200.8 + Hg	4,4, DDT	II	
Historical USTs										
N6-XX-AK-7	S	7	Field/Visual						I	Confirm Absence
N6-P	P	Tank 6	HCID	8260	8082		RCRA		I	Contingent Product
N78-01-S-7	S	7	G,D,O						I	Soil Sample
N78-02-S-7	S	7	G,D,O						I	Soil Sample
N78-XX-W-WT	GW	WT	G,D,O							Contingent GW
N78-03-S-7	S	7	G,D,O						I	Archive
N78-04-S-7	S	7	G,D,O						I	Archive
N12342526-XX-AK-9	S	9	Field/Visual						I	Confirm Absence
N12342526-1-P	P	Tank 1	HCID	8260	8082		RCRA		I	Contingent Product
N12342526-2-P	P	Tank 2	HCID	8260	8082		RCRA		I	Contingent Product
N12342526-3-P	P	Tank 3	HCID	8260	8082		RCRA		I	Contingent Product
N12342526-4-P	P	Tank 4	HCID	8260	8082		RCRA		I	Contingent Product
N12342526-25-P	P	Tank 25	HCID	8260	8082		RCRA		I	Contingent Product
N12342526-26-P	P	Tank 26	HCID	8260	8082		RCRA		I	Contingent Product
N12342526-M-P	P	Other HC Tank	HCID	8260	8082		RCRA		I	Product
N12342526-01-W-WT	GW	WT	G,D,O	8260					I	Contingent GW
N12342526-02-W-WT	GW	WT	G,D,O	8260					I	Contingent GW
N12342526-03-S-10	S	10	G,D,O	8260					I	Contingent Soil
N12342526-04-S-10	S	10	G,D,O	8260					I	Contingent Soil
N12342526-05-S-5	S	2 to 5						Geo	II	Geotech Boring
N12342526-05-S-10	S	10						Geo	II	Geotech Boring
N12342526-05-S-15	S	15						Geo	II	Geotech Boring
N2324-XX-AK-8	S	8	Field/Visual						I	Confirm Absence
N2324-23-P	P	Tank 23	HCID	8260	8082		RCRA		I	Contingent Product
N2324-24-P	P	Tank 24	HCID	8260	8082		RCRA		I	Contingent Product
N2324-01-S-WT	S	WT	G,D,O						I	Contingent Soil
N2324-02-S-WT	S	WT	G,D,O						I	Contingent Soil
N2324-03-S-WT	S	WT	G,D,O						I	Contingent Soil
N2324-01-W-WT	GW	WT	G,D,O						I	Contingent Water
N2324-02-W-WT	GW	WT	G,D,O						I	Contingent Water
N2324-03-W-WT	GW	WT	G,D,O						I	Contingent Water
Pier 23										
P23-01-W-5	GW	5	G,D,O		8082	PAH	200.8 + Hg		I	Direct Push on beach
P23-02-W-WT	GW	WT	G,D,O	8260		PAH			I	Direct Push
P23-03-W-WT	GW	WT	G,D,O	8260		PAH			I	Direct Push
P23-01-S-5	S	5	G,D,O		8082	PAH	6010B + Hg		I	Beach Near MHHW
P23-02-S-WT	S	WT	G,D,O						I	Direct Push
P23-03-S-WT	S	WT	G,D,O						I	Direct Push
P23-MW-1-WT	GW	WT		8260	8082	8270	200.8 + Hg		II	Slag Area (TCE)
P23-MW-2-WT	GW	WT	G,D,O	8260	8082	PAH	200.8 + Hg		II	Former AST/Fuel Line
P23-MW-2-S-WT	S	WT	G,D,O		8082	PAH	6010B + Hg	TOC	II	at P23-MW-2
P23-MW-2-S-5	S	2 to 5						Geo	II	at P23-MW-2
P23-MW-2-S-10	S	10						Geo	II	at P23-MW-2
P23-MW-2-S-15	S	15						Geo	II	at P23-MW-2
Duplicate			G,D,O		8082	PAH	6010B + Hg			
Former AK-WA Giannotti Shipyard										
AKWA-01-S-0.5-5	S	0.5-5	D,O		8082		6010		I	Vertical composite from direct push
AKWA-02-S-0.5-5	S	0.5-5	D,O		8082		6010		I	
AKWA-01-W-WT	GW	WT	D,O		8082	PAH	200.8		I	Direct Push
AKWA-02-W-WT	GW	WT	D,O		8082	PAH	200.8		I	Direct Push
Building 595										
595-01-W-WT	GW	WT	G,D,O	8260					I	
595-02-W-WT	GW	WT	G,D,O	8260					I	
595-03-W-WT	GW	WT	G,D,O	8260					I	
Soil Disposal Profiling										

Notes:

Metals: Hg = mercury; 200.8 = reductive precipitation method for groundwater samples; RCRA metals for tank content waste characaterization; 6010 = analysis of soil samples

Media: GW = groundwater; S = soil; P = product in UST

AK	Air-knife excavation; visual observations of extracted soil to be made in the field
BTEX	benzene, toluene, ethylbenzene, and xylenes
WT	Water Table; well screen depth to be determined in the field so that it overlaps the water table
Field	Analyze for TPH if odor or staining impacts observed in field; field evaluation may include use of test kits.
TBD	To be determined based on other analytical results
8082	Analyze for PCB Aroclors
8260	Analyze for standard EPA Method 8260 VOC constituents
8270	Analyze for standard EPA Method 8270 SVOC constituents; in groundwater collect 2L to achieve PAH reporting limits of 0.01 ug/L.
PAH	Analyze for PAHs only; in groundwater collect 2L to achieve PAH reporting limits at 0.01 ug/L.
Geo	Record standard penetration test blow counts; Analyze index parametetrs (Atterburg limits, grain size, moisture, specific gravity)
TOC	Total organic carbon

Figures

Appendix A

Quality Assurance Project Plan

REMEDIAL INVESTIGATION WORK PLAN ATTACHMENT A: QUALITY ASSURANCE PROJECT PLAN

Earley Business Center
Parcel 1B – Port of Tacoma

Professional Services Agreement No. 069558
Project No. 095208

January 8, 2014

Prepared for:

Port of Tacoma

REMEDIAL INVESTIGATION WORK PLAN ATTACHMENT A: QUALITY ASSURANCE PROJECT PLAN

Earley Business Center

Parcel 1B – Port of Tacoma

January 8, 2014

Prepared by:

CRETE
CONSULTING, INC.

PgG

Title Page with Approvals

Remedial Investigation Work Plan
Attachment A: Quality Assurance Project Plan
Port of Tacoma
Earley Business Center
January 8, 2014

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Grant Hainsworth, CRETE Date

Quality
Assurance Officer______________________________ 1/8/14
Nicole Ott, CRETE Date

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Port Project
Manager Leslee______________________________ 1/8/14
Leslee Conner, Port of Tacoma Date

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Appendices

Acronyms and Abbreviations

ALS	Australian Laboratory Services
CAS	Columbia Analytical Services
COI	contaminant of interest
COC	contaminant of concern
CLP	Contract Laboratory Program
cPAH	carcinogenic polyaromatic hydrocarbon
CTD	conductivity, temperature, and depth
DQO	data quality objective
EBC or Site	Earley Business Center
EDD	electronic data deliverable
EPA	United States Environmental Protection Agency
HCID	hydrocarbon identification
ISL	interim screening level
LCS/LCSD	laboratory control sample/laboratory control sample duplicate
MDL	method detection limit
MLLW	mean lower low water

MRL	method reporting limit
MS/MSD	matrix spike/matrix spike duplicate
NAD83	North American Datum of 1983 (horizontal)
PARCC	precision, accuracy, representativeness, comparability, and completeness
PCB	polychlorinated biphenyl
PDF	portable document format
Port	Port of Tacoma
PQL	practical quantitation limit
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
RIWP	Remedial Investigation Work Plan
RPD	relative percent difference
SOP	standard operating procedure
SVOC	semi-volatile organic compound
TEQ	toxicity equivalent
TOC	total organic carbon
TPH	total petroleum hydrocarbons
UST	underground storage tank
VOC	volatile organic compound
WAC	Washington Administrative Code

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1 Introduction

1.1 Background

This Quality Assurance Project Plan accompanies the Remedial Investigation Work Plan for the Earley Business Center (EBC, Parcel 1B, or Site) required under Agreed Order DE 9553 between the Port of Tacoma (Port) and the Washington State Department of Ecology (Ecology). This QAPP was prepared for Port under Professional Services Agreement No. 069558 (Port project no. 095208).

This QAPP describes quality assurance/quality control (QA/QC) procedures associated with collecting, analyzing, validating, and using soil and groundwater data to fill data gaps identified in the Remedial Investigation Work Plan (RIWP). This QAPP uses Ecology's Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies. July 2004. Publication No. 04-03-030 (Ecology 2004).

The history, contaminants of interest (COIs), initial screening levels (ISLs), and other background information for the Site are described in the Previous Investigation Results Report (PIRR) and the RIWP.

1.2 Project Description

This QAPP pertains to the following tasks that are part of the larger RI to be conducted, as described in the RIWP (where the goals and objectives of this work are defined):

- Fieldwork
- Laboratory analyses
- Data validation and management
- Data analysis and report preparation.

Fieldwork

CRETE and PGG will conduct field work in two phases. The first phase of sampling will include reconnaissance-type explorations such as surficial mapping and sampling, air-knife explorations, seep sampling, and direct-push explorations. The second phase will include installation, development, and sampling of monitoring wells, and investigation related to any data gaps identified by data collected during the first phase.

Soil testing will include collection of soil samples for analysis of COIs, fate and transport parameters, and other hydrogeological data such as grain size and standard penetration test (SPT) blow counts. Groundwater field measurements will be taken for pH, specific conductance, temperature, oxidation-reduction potential, and dissolved oxygen to during well purging and as an indicator that samples are collected under stable conditions. Groundwater samples for COI, fate and transport parameters, and natural attenuation parameters will be collected from direct push locations and from permanent monitoring wells.

The target population is the soil and groundwater within the subareas of the Site, as defined by Agreed Order DE 9553 and for which data gaps are described in the RIWP.

Soil and groundwater samples will be analyzed for the analytes in Tables 2 and 3. This table also includes reporting limits and analysis methods.

Laboratory Analyses

Analyses will be completed using EPA methods (EPA 2001, 2006) listed in Tables 2 and 3. Unique analytical procedures are described in Section 5.

Level 2B laboratory data reports will be provided in portable document format (PDF), and electronic data deliverables (EDDs) will be provided in a text or Excel file format suitable for import into the EBC database.

Data Validation and Management

Data verification will be completed by the Quality Assurance Officer for data generated in the field and laboratory prior to database import. Soil and groundwater data will be imported into the EBC database, which was developed with historical data compiled during the PIRR.

The accuracy and completeness of the final database will be verified by the Quality Assurance Officer. Following verification, data collected during the RI will be uploaded to Ecology's EIM system.

Data Analysis and Report Preparation

The data collected under the RIWP will provide the information needed to complete the RI/FS. The results of those efforts will be documented in the RI/FS Report.

1.3 Organization and Schedule

1.3.1 Roles and Responsibilities

Roles and responsibilities are defined in Table 1.

Friedman & Bruya will perform the majority of chemical analyses of the soil and groundwater samples collected by CRETE Consulting, Inc. and Pacific Groundwater Group (PGG). Australian Laboratory Services (ALS) – Columbia, formerly Columbia Analytical Services (CAS) in Kelso, WA, will perform dissolved metals (other than mercury) analysis of groundwater samples using reductive precipitation. Other laboratories may be added should specialized testing be required.

1.3.2 Schedule

Field work will follow the schedule in the RIWP.

Samples will be delivered to the laboratory within applicable holding times and within 24 hours of collection time, when possible with schedule constraints. Samples will be delivered to the laboratory by field personnel or arranged for pickup by laboratory couriers. Chain-of-custody procedures will be maintained during transit to the laboratory.

Data verification and validation will be completed prior to entry into the project database.

Data will be uploaded to the Ecology Environmental Information Management (EIM) System at the conclusion of the RI/FS.

2 Quality Objectives

The overall data quality objective for this project is the collection of representative data of known and acceptable quality. The QA procedures and measurements that will be used for this project are based on EPA guidance (EPA 2001, 2002, 2006). Parameters related to precision, accuracy or bias, representativeness, completeness, and comparability (PARCC) will be used to assess the quality of RI data (Table 4).

2.1 Precision

Precision is a measure of how closely one result matches another result expected to have the same value. Field precision will be assessed by collecting one duplicate sample for every ten field samples of each media. Field precision is determined by the relative percent difference (RPD) between a sample and its duplicate. However, results from the analysis of a duplicate sample also test laboratory precision. Therefore, the RPD between the sample and the field replicate provides an indication of both the field and laboratory precision. The tolerance limit for percent differences between field duplicates will be ± 50 percent for soil and ± 35 percent for groundwater. If the RPDs exceed these limits, a replicate sample may be run to verify laboratory precision. If any RPD exceedance is linked to field sampling, the Field Manager will recheck field sampling procedures and identify the problem. Resampling and analysis may be required.

Laboratory precision can be measured through the evaluation of laboratory control samples/duplicates (LCS/ LCSD). The laboratory will perform the analysis of one set of LCS/LCSD samples for every 20 samples. Laboratory precision will be evaluated by the RPD for each analyte between LCS/LCSD samples.

$$\text{RPD} = \frac{\text{ABS(R1-R2)}}{\text{(R1+R2)/2}} \times 100$$

Where:
ABS = absolute value
R1 = Sample result
R2 = Duplicate sample result.

The tolerance limit for percent differences between laboratory duplicates will be ± 20 percent for soil samples and ± 20 percent for groundwater samples. If the precision values are outside this limit, the laboratory will recheck the calculations and/or identify the problem. Reanalysis may be required.

2.2 Accuracy

Accuracy is an expression of the degree to which a measured or computed value represents the true value. Accuracy may be expressed as a percentage of the true or reference value for reference material or as spike recovery from matrix spike/matrix spike duplicate (MS/MSD) samples. The RPD between the MS and MSD is used to evaluate laboratory precision. The following equations are used to express accuracy:

- For reference materials:
    - Percent of true value = (measured value/true value) x 100

- For spiked samples:
    - Percent recovery = ([SQ – NQ]/S) x 100

SQ = quantity of spike or surrogate found in sample
NQ = quantity found in native (unspiked) sample
S = quantity of spike or surrogate added to native sample

The performance of the method will be monitored using surrogate compounds or elements. Surrogate standards are added to all samples, method blanks, matrix spikes, and calibration standards.

Laboratory method reporting limits (MRL) are listed in Tables 2 and 3. All RLs are below ISLs; otherwise ISLs derived in the PIRR were set to the practical quantitation limit, which is identical to the MRL for this project.

3 Sampling Process Design

The adequacy of the sampling design is evaluated by representativeness, comparability, and completeness of the data produced. The data must also be adequate to characterize nature and extent of contamination and to evaluate the completeness of pathways.

3.1 Representativeness

Representativeness is the degree to which data from the project accurately represent a particular characteristic of the environmental matrix which is being tested. Representativeness of samples is achieved by adherence to standard field sampling protocols and standard laboratory protocols. Representativeness is achieved through following of the sampling plan design, sampling techniques, and sample handling protocols.

3.2 Comparability

Comparability is the qualitative similarity of one dataset to another (i.e., the extent to which different datasets can be combined for use). Comparability will be addressed through the use of field and laboratory methods that are consistent with methods and procedures recommended by Ecology and that are commonly used for groundwater and soil studies.

3.3 Completeness

Completeness is a measure of the amount of data that is determined to be valid in proportion to the amount of data collected. Completeness will be calculated as follows:

Completeness =
(number of valid measurements/ total number of data points planned) x 100

The data quality objective (DQO) for completeness for all analytes is 95%. Data that have been qualified as estimated (J qualified) will be considered valid for the purpose of assessing completeness. Data that have been qualified as rejected will not be considered valid for the purpose of assessing completeness. Results will be considered valid if all the precision and accuracy targets are met. Resampling or re-analysis of remaining sample aliquots may be required if the completeness DQO is not met.

3.4 Laboratory QC Procedures

Additional laboratory QC procedures will be evaluated to provide supplementary information regarding overall quality of the data, performance of instruments and measurement systems, and sample-specific matrix effects.

QC samples and procedures are specified in each method protocol. All QC requirements will be completed by the laboratory as described in the protocols, including the following (as applicable to each analysis):

- Instrument tuning
- Initial calibration
- Initial calibration verification
- Continuing calibration
- Calibration or instrument blanks
- Method blanks
- LCS/LCSD
- Internal standards
- Surrogate spikes
- Serial dilutions
- MS/MSD.

3.5 Additional Field Quality Control

Field quality control samples will be collected during the groundwater and soil investigations. The field quality control samples consist of a trip blank (one for each day samples for chemical analysis are collected), decontamination field blanks (one per day that sampling equipment is reused), and field duplicates (one for every ten samples).

The goal is to have no detectable contaminants in the trip and decontamination blanks. If contamination is detected, the nature of the interference and the effect on the analysis of each sample in the batch will be evaluated. Data from affected samples may require qualification as “estimated” or “rejected.”

4 Sampling Procedures

The sampling program addressed in this QAPP is to:

- Confirm the presence/absence of USTs and analyze any fluids found within USTs (4.1)
- Map the extent of debris (4.2)
- Survey soil and groundwater sample locations and elevations (4.3)
- Collect soil samples (4.4)
- Collect water samples from temporary well points/geoprobes (4.5)
- Install and develop permanent monitoring wells, collect groundwater and soil samples, and conduct tidal studies (4.6).

In accordance with Port policy, Port Security (253-383-9472) will be informed of each day of onsite field work. They will also be informed of any equipment left onsite overnight or for an extended period of time. That equipment will be clearly labeled with “CRETE” and “Pacific Groundwater Group”, as well as a 24-hour contact name and phone number.

4.1 UST Investigation

The absence of USTs will be investigated with an air-knife rig advanced to 5 feet bgs. Air knife explorations will begin in the center of the investigation area and work outwards on a grid pattern with spacing and overall investigation size based on the anticipated size of the target UST (as described in the RIWP). When a UST is located in an air-knife excavation, the extent of the UST will be mapped with additional explorations and/or with a radio-frequency locating tool (Fisher TW-6 Line Locator or equivalent). The locating tool conducts a radio frequency through buried metal objects, which a surface detector can measure to determine the extent of the buried object. However the technique is only workable to the extent that an electrical current can be induced in the buried metal UST; significant corrosion could reduce the effectiveness of this technique.

After the locations and extents of USTs have been mapped, a nominal 1-inch hole will be punched or drilled through the top of located USTs, and a bailer or equivalent sampler will be inserted to sample the tank contents for qualitative assessment. Qualitative field descriptions will include if water is present, color and odor of contents, and type of petroleum, if discernible. Petroleum type will be qualitatively assessed by viscosity, odor, and dye-color, if present. Observations will be recorded in field notes. Samples of the tank contents will be analyzed by hydrocarbon identification (HCID), Resource Conservation and Recovery Act (RCRA) metals, PCBs, and VOCs. The hole in the UST will be patched before backfilling the air-knife excavation.

4.2 Debris Mapping

The northern extent of subsurface debris in the SW Debris Layer subarea will be investigated with air-knife explorations along the former shipways at the edge of the existing concrete slab/apron. Field staff will accompany the air-knife operator to record penetration depths and locations as the survey is advanced. Visual observations of the nature of debris and soil at the bottom and along the sides of the holes created by the air knife will be recorded in the field. A hand-auger may be used to collect material from exploration sidewalls for inspection and description. Soil extracted from each hole will be replaced in the hole. If material is grossly contaminated, it will be placed in a drum or bucket for characterization and disposal.

Surface debris will also be mapped by visual observations without any disruption of soil.

4.3 Sample Location Surveying

Geoprobe and monitoring well locations will be surveyed in the field and marked with paint or flagging prior to equipment mobilization. The ground surface elevation of each sample location will be recorded during the survey. The horizontal and vertical datums will be Washington State Plane North (North American Datum of 1983 [NAD 83]) and ft MLLW, respectively.

Locations may be adjusted in the field due to potential utility overlaps, driller concerns, or access issues. If locations are to be moved more than 20 feet from the locations shown in the RIWP, the Field Manager will confer with the Port regarding the change in location. If monitoring wells are not surveyed prior to installation, but instead measured from fixed points, their locations and the elevation of the top of casing on the northern side of the casing will be surveyed. A mark will be placed on the casing where the elevation was recorded so that depth-to-water-table measurements are recorded relative to this point with a known elevation.

Before drilling, One-Call Utility Locators and a private utility locating firm will mark underground utility locations. OCC consultants will also be notified of exploration locations for clearance; OCC has underground utilities associated with their groundwater treatment system.

4.4 Soil Sample Collection

In the SW Debris Layer and Blair Shoreline subareas surface composite samples will be collected with a hand held tool, such as a trowel, to collect surficial soil (0 to 0.5 ft bgs) into a stainless steel bowl.

For subsurface soil sample collection, a Washington-licensed driller will complete geoprobe borings using a push probe to advance a 2-inch diameter sampler. Water and soil samples will be collected at the intervals prescribed in the RIWP. The probe will be decontaminated before each use. Drill cuttings and decontamination water will be drummed for appropriate disposal.

Soil will be removed from the subsurface in 5-ft sleeves. Each sleeve will be cut open on a table and positioned with the upper end at the same side of the table each time. A photograph of the open sleeve placed next to a tape measure will be taken of each 5-foot sleeve. Percent recovery for the sleeve as a whole, and for any specific portions of the sleeve that differ from the general recovery will be recorded on a field form/boring log (Appendix A). As soon as feasible after the core sleeve is opened, the photo-ionization detector will be scanned over the soil for a qualitative indication of soil quality. Any areas with measurement spikes will be evaluated more closely.

The soil will be visually classified, and the following information will be recorded:

- Depth of visual observations and sample collection, with sample ID
- Physical soil description (soil type and color, stratification per ASTM 2488)
- Other distinguishing characteristics or features, such as debris or concrete
- If odors are noted, a photo-ionization detector reading will be recorded by placing soil in a plastic bag, shaking it, and inserting the probe into the bag; indigo-blue dye test kits may also be used for soils exhibiting gasoline- or diesel-like odors.
- Qualitative moisture content (dry, damp, moist, wet, saturated).

Soil testing will include standard penetration test (SPT) blow counts and collection of soil samples for grain size analysis at the geotechnical locations. Total organic carbon will also be analyzed at the geotechnical locations and at selected locations evaluated for soil chemical quality.

Sample containers for all analyses except VOCs and TPH-gasoline will be filled directly from the Geoprobe sleeve using a gloved hand and clean stainless steel spoon, if appropriate. Disposable soil sampler will be used to obtain soil for VOC and TPH-gasoline analyses. Gloves will be changed between samples. Stainless steel spoons will be decontaminated prior to each use (and between samples). Sample containers will be clearly labeled with sample ID, collection date and time, and project name, and then placed in an iced cooler for delivery to the laboratory within 24 hours of sample collection. Chain of custody will be maintained. The sample ID is the boring name (including initials for the subarea) and the depth below ground surface. Sample IDs are included in Table 5 of the RIWP.

4.5 Groundwater Sampling from Geoprobe Locations

Groundwater samples collected from geoprobe borings will be collected with a temporary screen, placed to intercept the water table, and peristaltic pump as follows:

- Lower the new, clean polyethylene tubing into the well until the tubing intake is in the middle of the screened interval, or slightly above the middle of the screened interval. Secure the tubing to the top of the well and leave approximately 5 feet of tubing outside the well. Attach a 1-foot length of silicon tubing that is appropriate for a peristaltic pump to the polyethylene tubing.

- Attach the silicon tubing to the peristaltic pump. Purge (remove with pump) water from the well into a calibrated 5-gallon pail or similar and monitor flow rate.
- Purge at approximately 100-300 milliliters (0.03-0.09 gallons) per minute until turbidity has decreased. The goal is to create minimal screen velocities during purging such that fines, which may bias sampling results, are not captured. This goal may be difficult to achieve under some circumstances and may require adjustment based on site-specific conditions and professional judgment.
- Sampling may begin when turbidity has stabilized. Other field parameters at the time of sampling will be recorded. Field instruments are to be calibrated prior to use, according to the manufacturer’s instructions.
- Collect samples of water for laboratory analysis in a manner that minimizes volatilization of potential contaminants from the water into the air. Hands and clothing will be clean when handling sampling equipment and during sampling.
- Clean, disposable, latex, nitrile, or equivalent–material gloves will be worn when filling bottles for analyses. Gloves will be changed when dirty and between samples.
- All water samples will be collected from the pump discharge lines directly into the appropriate sample containers following the procedures described for filling sampling containers from monitoring wells (Section B1.6).

4.6 Sampling from Monitoring Wells

Monitoring well construction and installation will involve drilling a borehole using either a sonic or a hollow-stem auger drill rig, installing a 2-inch diameter 0.010-inch slot Schedule 40 PVC well, filling the annular space with 10-20 (sieve size) Colorado silica sand below bentonite, and developing the well prior to sampling. Where subsurface debris does not prohibit it, hollow-stem auger drilling will be used to allow collection of geotechnical information, including standard penetration test blow counts every 2.5 ft. Sonic drilling will be used in the SW Debris Layer subarea due to the presence of concrete foundations and debris. Although not expected, sonic drilling may also be necessary in other areas if debris restricts drilling by hollow-stem auger.

All wells will be installed in accordance with Washington Administrative Code (WAC) 173-160. As the soil cuttings are removed, field staff will log visual observations, similar to those for soil sampling, on a well log/well construction diagram. In some wells soil samples will be collected from the water table for laboratory analysis of COIs and/or total organic carbon (TOC; Table 5 of RIWP).

Upon reaching the target depth below ground (20 ft), the 10-ft long well screen and riser pipe are inserted into the borehole. The full length of the slotted portion of the well screen as well as the unslotted portion of the bottom of the screen should be measured with the measuring tape, and these measurements should be recorded on the well construction diagram. The well screen will be placed such that it intercepts the water table. The water table depth below ground is determined after the borehole depth has been achieved by placing a water level meter inside the borehole. Moisture observations are also made on the soil cuttings removed from the borehole.

After the static water level measurement has been taken, the drilling subcontractor will begin assembling the well in conformance with any modifications to the well design made by the geologist based on field conditions. As the assembled well is lowered, extra attention will be given to centering it in the hole if centralizers are not used. The well should be temporarily capped before filter sand and other annular materials are installed. The drilling subcontractor should fill the annular space surrounding the screened section of the monitoring well to at least one foot above the top of the screen with a clean sand or fine gravel. In general, the filter pack should not extend more than three feet above the top of the screen to limit the thickness of the monitoring zone. A minimum 2-foot thick layer of bentonite pellets or slurry seal will be installed by the drilling subcontractor immediately above the well screen filter pack in all monitoring wells.

The borehole annulus will be grouted with seal materials to within three feet of the ground surface. Drill cuttings, even those known not to be contaminated, will not be used as backfill material. The grout seal should consist of a bentonite/cement mix with a ratio of bentonite to cement of between 1:5 and 1:20. The drilling subcontractor will cut the top of the well casing to a height that will allow installation of a locking cap with the monument closed. Wells completed in the sloping shipways ramp will be completed with a water tight monument.

Following well installation, the well will be developed by surging and bailing or pumping until turbidity has decreased and stabilized. At least three casing volumes should be purged during development. Field measurements (turbidity, temperature, pH) collected during well development and the volume of water removed will be recorded on a field form. The well will be allowed to sit for a minimum of seven days prior to sampling to allow bentonite seals to set.

Groundwater sampling will include measurement of field parameters to evaluate stability of groundwater collected from wells and in support of fate and transport analyses. Field water quality instruments will be calibrated at the beginning (prior to sampling) and middle of each day. Calibration data will be recorded on a field form or log book.

New, disposable, polyethylene tubing will be used to draw water from each monitoring well. The following tasks will be performed at each well:

- Measure and record static water level (distance from top of casing) to the nearest 0.01 foot using an electric well sounder and measuring tape.

- Use the EPA Low-Flow Groundwater Sampling Procedure (EPA, 2010b). This procedure includes several steps and can be summarized as follows. First, purge groundwater at a low rate (~100-200 mL/min). Second, monitor the discharge water for temperature, pH, and specific conductance at least three times during the purging period. Third, measure the purge volume using a calibrated bucket. Fourth, record purge water volume, time, and field parameter values in the field notes.
- Sampling may begin after three consecutive field parameter measurements (temperature, specific conductance, and pH) are stable. Continue purging water until three consecutive stable measurements are recorded. Sampling may be conducted without stabilization if the parameter trends are reasonably attributed to in-aquifer variability such as tidal flux.
- Collect samples of water for laboratory analysis in a manner that minimizes volatilization of constituents. Hands and clothing will be clean when handling sampling equipment and during sampling. Clean, disposable, latex gloves will be worn when filling bottles for analyses. Gloves will be changed when dirty and between samples. All water samples will be collected from the pump discharge lines directly into the appropriate sample containers. Samples submitted for dissolved metals analyses only will be filtered in the field prior to filling the sample container.

Collect samples in the following manner:

- VOCs and TPH-gasoline: For each sample, fill three 40-ml vials preserved with hydrochloric acid. Slowly fill each vial until all air is removed and sample water bulges slightly over the top of the vial. Wet cap with sample water and screw onto top of vial. Invert vial and tap with finger. The properly filled vial has NO visible air bubbles.
- Metals: Samples will be collected directly into lab-supplied bottles with acid preservative after passing through an in-line, disposable, 0.45-micron filter such as the Sample Filter Plus or equivalent installed in the discharge line of the pump. A new filter will be used for each sample. Sample bottles will be filled almost to the top but not overfilled.
- Other Parameters: There are no headspace or filtering concerns related to the other water quality parameters. Fill the laboratory prepared sample bottles almost to the top, taking care not to overfill.
- Record sample identification data on each sample container, in the field notes, and on the chain-of-custody. Sample identification will be the same as the well name/number and the sample collection date.

Stable is defined as:

- Specific conductance and temperature that do not indicate a trend (continuously increase or decrease between readings) and do not vary by more than 10 percent between readings.
- pH measurements that do not vary by more than 0.1 pH units between readings.

The container and preservative requirements are listed in Table 3.

Tidal Studies

Seven of the newly installed monitoring wells will be instrumented with transducers to record water levels at 15-minute increments or with Schlumberger CTD-divers to record conductivity, temperature, and depth (CTD). Variations in conductivity can provide evidence of tidal flushing at that location for fate and transport evaluations. One temporary well in the Pier 23 beach will be fitted with small-diameter dive sensor (to record water level). Transducer data will be barometrically compensated. A barologger to record Commencement Bay tide levels may be installed. Alternatively, the tidal gauging station located a couple of miles away (in the head of the Sitcum Waterway) can be used to provide atmospheric pressure data (as well as tide data). The tidal gauge records tide levels and weather data at 6-minute increments, and information from the Sitcum Waterway station will be downloaded from: http://tidesandcurrents.noaa.gov/stationhome.html?id=9446484.

At installation, all transducers and the barologger will be time-synchronized such that they all record water levels at the same time. Transducer serial number, Well ID, time, depth to water (from top of casing), and depth of transducer as placed within the well (from top of casing) will be measured at the time of transducer installation. The transducer depth will be converted to elevation in ft MLLW so that water level readings (depth of water above the transducer) can also be converted to elevation in ft MLLW. Conductivity measurements are used to provide information about tidal flushing (as a surrogate for salinity) and to correct for the changing density of groundwater (saline water is more dense). Because the transducer measures the weight of the water against the sensor, changes in conductance are used to correct for changes in water density, such that weight of water is correctly related to height of water above the sensor.

Groundwater level elevations will be plotted with tide elevations in order to determine the influence of tides on groundwater flow (lag and magnitude of changes in level).

All transducers will be clearly labeled with “CRETE” and “Pacific Groundwater Group”, as well as a 24-hour contact name and phone number in the event that Port Security needs to contact anyone regarding the equipment while it is onsite. Additionally, Port Security (253-383-9472) will be informed of all onsite activities and any equipment left onsite for logging/data collection.

4.7 Sampling Equipment

Field equipment and supplies include sampling equipment (e.g., bowls, tape measures), utensils (e.g., spoons), decontamination supplies, sample containers, coolers, log books and forms, personal protection equipment, and personal gear. Protective wear (e.g., hard hats, gloves) are described in the Health and Safety Plan. Sample containers, coolers, and packaging material will be supplied by the analytical laboratory.

4.8 Decontamination

If used, stainless-steel sampling equipment will be washed with LiquinoxTM detergent and rinsed with distilled water prior to use and between sampling stations. The following decontamination steps will be performed on stainless-steel bowls and spoons using for compositing prior to use at each station:

- Wash with Liqui-noxTM
- Double rinse with distilled/deionized water
- Final rinse with distilled/deionized water.

If a residual petroleum sheen remains on the sampling equipment or is difficult to remove using the standard decontaminations procedures above, a hexane rinse may be added, followed by a final rinse with distilled/deionized water. Sample equipment will be kept wrapped in aluminum foil until time for use. To minimize sample cross-contamination, disposable gloves will be replaced between samples. If any equipment decontamination occurs, an equipment blank will be collected by pouring distilled water over the equipment and collecting in a set of the same sample containers as those used for the environmental samples the equipment is used to collect.

Geoprobe sleeves are disposable, and subsurface soil will be placed in containers using gloved hands. Gloves will be changed between each sample. Tubing used to collect groundwater samples is also disposable. Water level and field parameter meters will require decontamination between sample collection locations.

4.9 Sample Nomenclature

The sample nomenclature is identified in Table 5 of the RIWP.

4.10 Sampling Containers

Requirements for sample containers and storage conditions are provided in Tables 2 and 3. Samples analyzed for TPH-diesel, VOCs, and dissolved metals (groundwater only) will require chemical preservation, which will be present in the laboratory-supplied containers. All sample containers will have screw-type lids so that they are adequately sealed. Lids of the glass containers will have Teflon^{TM} inserts to prevent sample reaction with the plastic lid and to improve the quality of the seal. Commercially available, pre-cleaned jars will be used, and the laboratory will maintain a record of certification from the suppliers. The container shipment documentation will record batch numbers for the bottles. With this documentation, containers can be traced to the supplier, and bottle rinse blank results can be reviewed.

Sampling containers will be filled to minimize head space, and will be appropriately labeled and stored prior to shipment or delivery to the laboratory. Samples must be packed to prevent damage to the sample containers and labeled to allow sample identification. All samples must be packaged so that they do not leak, break, vaporize or cause cross-contamination of other samples. Each individual sample must be properly labeled and identified. When refrigeration is required for sample preservation, samples must be kept cool, by means of ice packs or double-bagged ice in coolers, during the time between collection and final packaging.

4.11 Field Logs

All field activities and observations will be noted on weatherproof paper at the time they occur. The field logs will be compiled in a binder in the chronological order they were completed. Information will include personnel, date, time, station designation, sampler, types and number of samples collected, photographs taken, weather conditions, health and safety meetings conducted (tailgate meeting), and general observations. Any changes that occur at the site (e.g., personnel, responsibilities, deviations from the RIWP) and the reasons for these changes will be documented in the field log. It will also identify onsite visitors observing the sampling. The Site is an actively used property, therefore only those specifically visiting/observing sampling activities will be documented. The Field Manager is responsible for ensuring that the field logs are correct.

All field activities and observations will be noted during fieldwork. The descriptions will be clearly written with enough detail so that participants can reconstruct events later, if necessary. Requirements for entries include:

- Field logs will be compiled in chronological order in a 3-ring binder, with the date and observer clearly marked on all field forms and note sheets.
- Entries will be made legibly with black (or dark) waterproof ink or pencil.
- Unbiased, accurate language will be used.
- Entries will be made while activities are in progress or as soon afterward as possible (the date and time that the notation is made should be noted, as well as the time of the observation itself).
- Each consecutive day's first entry will be made on a new, blank page.
- The date and time, based on a 24-hour (military) clock (e.g., 0900 for 9 a.m. and 2100 for 9 p.m.), will appear on each page.
- When the field activity is complete, the field binder will be physically entered into the project file and the pages will be scanned to a PDF file and saved in the

electronic project library. Scanning of sheets may also occur after each day's field activities.

- The person recording the information must initial and date each sheet. If more than one individual makes entries on the same sheet, each recorder must initial and date each entry. The bottom of the page must be signed and dated by the individual who makes the last entry.
- The Field Manager, after reading the day's entries, also must sign and date the last page of each daily entry.
- Corrections will be made by drawing a single line through the original entry allowing the original entry to be read. The corrected entry will be written alongside the original. Corrections will be initialed, dated, and explained.

4.12 Chain-of-Custody Procedures

All samples must be clearly identified immediately upon collection. Each sample container label will list:

- Client and project name
- A unique sample description/sample ID
- Sample collection date and time.

Additionally, the container's label may include:

- Sampler's name or initials
- Preservative, if applicable
- Analyses to be performed.

Chain-of-custody procedures will be used to document sample possession from the time of collection, through analysis, to disposal. Chain-of-custody forms will document transfers of sample custody. A sample is considered to be under custody if it is in one's possession, view, or in a designated secure area. One set of chain-of-custody forms will be used per laboratory shipment. The chain-of-custody record will include, at a minimum, the following information:

- Client and project name
- Sample collector's name
- Sampler's company mailing address and telephone number
- Designated recipient of data (name, email, and telephone number)
- Analytical laboratory's name and city
- Description of each sample (i.e., unique identifier and matrix)
- Date and time of collection
- Quantity of each sample or number of containers
- Type of analysis required
- Any unique features of analysis, such as lower reporting limits
- Any requests to hold/archive samples

- Addition of preservative, if applicable
- Requested turn-around times
- Date and method of shipment.

When transferring custody, both the staff relinquishing custody of samples and the staff receiving custody of samples will sign, date, and note the time on the form. Samples to be analyzed by Friedman & Bruya Laboratory will not be shipped, but will be delivered by project personnel to the laboratory at the end of each sampling day. If samples are to be analyzed by other laboratories, they will either be delivered or shipped, depending on the location. All samples will be stored appropriately by the laboratory.

5 Measurement Procedures

Soil, groundwater, and UST content samples will be analyzed by the methods and to the reporting limits identified in Tables 2 and 3. The number of samples and the sample nomenclature are described in the RIWP.

Groundwater samples are expected to be saline, to some extent, and saline conditions bind metals making them difficult to analyze. Groundwater samples to be analyzed for dissolved metals will be field filtered into a preserved (nitric acid) container. Analysis for metals (other than mercury) will be conducted by ALS – Kelso (CAS) using a reductive precipitation process to convert the target analytes to their elemental states, such that they can be quantified. Mercury is not affected by salinity, and therefore does not need special treatment to deal with saline conditions. It will be analyzed by the laboratory conducting the other analyses (Friedman & Bruya).

The standard SVOC analytical method (8270D – selective ion monitoring [SIM]) for aqueous samples has a polycyclic aromatic hydrocarbon (PAH) reporting limit of 0.1 µg/L, 10-fold higher than the benzo(a)pyrene (or carcinogenic PAH [cPAH] toxicity equivalent [TEQ]) ISL. Therefore, a trace-level modification of 8270D – SIM will be used to achieve 0.01 µg/L MRLs for the cPAHs. This modification requires collection of 2-liter sample, as opposed to 500 mL needed to achieve the 0.1 µg/L MRL.

Blair Shoreline groundwater samples analyzed for SVOCs may also require silica gel cleanup if wood waste interferences are suspected. All TPH sample analyses (soil and groundwater) will include a silica gel cleanup step to provide for comparability with historical data. Groundwater sample analysis for VOCs (Method 8260) may also utilize SIM because the presence of elevated chlorinated ethenes may preclude achieving low reporting limits for VOCs present at low concentrations.

Aqueous samples analyzed for PCBs, SVOCs, or DDT will be centrifuged to reduce the effects of suspended particles. In accordance with EPA Method SW-846, a 50- to 300-ml aliquot of the sample will be placed in a centrifuge and spun for 30 minutes at 2,000 revolutions per minute. The liquid will then be prepared for analysis, and the solids will be discarded.

If USTs are located and found to contain any liquids, samples of the UST contents will be qualitatively analyzed by NWTPH-HCID. This method is used to provide a qualitative determination of the nature of the tank contents, e.g., diesel, gasoline, waste oil. UST contents will also be quantitatively analyzed for PCBs, RCRA metals, and VOCs. The information obtained about the tank contents would be used to guide future soil testing and to characterize tank contents for disposal during any UST removal actions.

6 Quality Control

6.1 Laboratory Quality Control

Only laboratories accredited in accordance with WAC 173-50, Accreditation of Environmental Laboratories will be used for this project. EPA Contract Laboratory Program (CLP) QA/QC procedures or similar efforts will be used for the analyses. Internal quality control procedures are used to produce consistently high-quality data. A routine QC protocol is an essential part of the analytical process. The minimum requirements for each analytical run are described here. Additional description of laboratory QA/QC procedures can be found in the laboratory's QA manual. A project narrative detailing analytical results must accompany all data packages submitted by the laboratory.

Preparation batches have a maximum of 20 field samples of the same matrix. QA/QC samples processed with each batch are:

- **One method blank**. The method blank is used to assess the preparation batch for possible contamination during the preparation and processing steps. It is processed along with and under the same conditions as the environmental samples. Concentrations of compounds detected in the blank will be compared to the samples. Any concentration of common laboratory contaminants (i.e., phthalates, acetone, methylene chloride, or 2-butanone) in a sample lower than 10 times that found in the blank will be considered a laboratory contaminant and will be so qualified. For other contaminants, any compounds detected at concentrations lower than five times that found in the blank will be considered laboratory contamination (EPA 2008). Values reported for the method blanks are expected to be below the MDLs for all analytes, except the common laboratory contaminants. Deviations from this must be explained in the laboratory project narrative(s).
- **One LCS**. The LCS is used to evaluate the performance of the total analytical system, including all preparation and analysis steps.
- **One MS**. Matrix specific QA/QC samples indicate the effect of the sample matrix on the precision and accuracy of the results generated using the selected method. The information from these controls is sample/matrix specific and is not normally used to determine the validity of the entire batch.
- **At least one duplicate**. Duplicates are replicate aliquots of the same sample taken through the entire analytical procedure. The results from this analysis indicate the precision of the results for the specific sample using the selected method. One duplicate sample is analyzed with each preparation batch. If sufficient sample is provided, this will be either an MSD. If not, an LCSD will be analyzed.
- **Initial and continuing calibration:** A calibration standard will be analyzed each time an instrument is calibrated. The instruments used to perform the analyses will be calibrated, and the calibrations will be verified as required by EPA methodologies. For example, a standard five-point initial calibration will be utilized to determine the linearity of response with the gas

chromatograph/electron capture detection. Once calibrated, the system must be verified every 12 hours. All relative response factors, as specified by the analytical method, must be greater than or equal to 0.05. All relative standard deviations, as specified by the analytical method, must be less than or equal to 30 percent for the initial calibration and less than or equal to 25 percent for the continuing calibration.
- **Surrogate evaluations:** Surrogate recovery is a QC measure used in organics analyses. Surrogates are compounds added to every sample at the initiation of preparation to monitor the success of the sample preparation on an individual sample basis (accuracy). Although some methods have established surrogate recovery acceptance criteria that are part of the method or contract compliance, for the most part, acceptable surrogate recoveries need to be determined by the laboratory. Recoveries of surrogates will be calculated for all samples, blanks, and QC samples. Acceptance limits will be listed for each surrogate and sample type and will be compared against the actual result by the data validator.
- **Laboratory management review:** The Laboratory Project Manager will review all analytical results prior to final external distribution (preliminary results will be reported before this review). If the QA Officer finds that the data meet project quality requirements, the data will be released as “final” information. Data which are not acceptable will be held until the problems are resolved, or the data will be flagged appropriately.

6.2 Field Quality Control

QA/QC samples will be collected during all sampling activities. Trip blank, field duplicate, and matrix spike/matrix spike duplicate samples will be collected as follows:

One water trip blank per sampling day will be prepared by the laboratory and will travel with the sample containers from and to the lab for analysis. This sample will be handled in the same manner as the groundwater samples. The blank will be submitted to the lab and will be analyzed for the EPA Method 8260 VOCs.

Field duplicate samples will use the same naming system as the environmental samples do that they are submitted “blind” to the laboratory. Field duplicates are useful in identifying problems with sample collection or sample processing. One duplicate sample will be collected for every 10 field samples of the same matrix. Each field duplicate will be analyzed for the same parameters as the samples to evaluate heterogeneity attributable to sample handling.

One matrix spike/matrix spike duplicate sample (MS/MSD) will be collected for every 20 field samples. Extra sample containers (the same as those for the environmental sample) collected for MS/MSD analyses will be noted in field notes and on chain-of-custody forms submitted to the analytical laboratory. Extra sample bottles for MS/MSD will be labeled with a "-MS/MSD" suffix for clarity in sample processing.

Rinsate and equipment blanks will not be collected for groundwater samples because samples will be collected using either disposable or dedicated sample tubing, which prevents cross-contamination.

6.3 Instrument and Equipment Testing, Inspection, and Maintenance

The primary objective of an instrument/equipment testing, inspection, and maintenance program is to aid in the timely and effective completion of a measurement effort by minimizing the downtime due to component failure.

Testing, inspection, and maintenance will be carried out on all field and laboratory equipment in accordance with manufacturer's recommendations and professional judgment. Hand-held field monitors will be used to monitor groundwater for field parameters. They will be calibrated and maintained according to the manufacturer's recommendations.

Analytical laboratory equipment preventative testing, inspection, and maintenance will be addressed in the laboratory QA manual, which will be kept on file at the contracted laboratory.

As appropriate, schedules and records of calibration and maintenance of field equipment will be maintained in the field notebook. Equipment that is out of calibration or is malfunctioning will be removed from operation until it is recalibrated or repaired.

6.4 Instrument and Equipment Calibration and Frequency

Field equipment and laboratory instrumentation used for monitoring and sample analysis will be subject to the following calibration requirements:

- **Identification**. Either the manufacturer's serial number or the calibration system identification number will be used to uniquely identify equipment. This identification, along with a label indicating when the next calibration is due, will be attached to the equipment. If this is not possible, records traceable to the equipment will be readily available for reference.
- **Standards**. Equipment will be calibrated, whenever possible, against reference standards having known valid relationships to nationally recognized standards (e.g., National Institute of Standards and Technology) or accepted values of

natural physical constraints. If national standards do not exist, the basis for calibration will be described and documented.

- **Frequency.** Equipment will be calibrated at prescribed intervals and/or prior to use. Frequency will be based on the type of equipment, inherent stability, manufacturers' recommendations, intended use, and observation of equipment readings over the course of the field work. All sensitive equipment to be used in the field or laboratory will be calibrated or checked prior to use.
- **Records**. Calibration records (certifications, logs, etc.) will be maintained for all measuring and test equipment used.

If field or laboratory equipment is found to be out of calibration, the validity of previous measurements will be investigated, and/or corrective action will be implemented. The Field QA Manager or the Laboratory QA Manager, respectively, will lead the evaluation process, which will be document in the field forms or laboratory log book, respectively.

All laboratory calibration requirements must be met before sample analysis may begin. The laboratory will follow the calibration procedures dictated by the analytical methods to be performed. If calibration non-conformances are noted, samples will be reanalyzed under compliant calibration conditions within method-specified hold times.

6.5 Inspection and Acceptance of Supplies and Consumables

The Field Manager will be responsible for material procurement and control. The Field Manager will verify upon receipt that materials meet the required specifications and that, as applicable, material or standard certification documents are provided, maintained, and properly stored with the project files. The Field Manager will also verify that material storage is properly maintained and that contamination of materials is not allowed.

The laboratory must document and follow procedures related to:

- Checking purity standards, reagent grade water, and other chemicals relative to intended use
- Preparing and storing chemicals
- Handling disposable glassware (including appropriate grade).

The Field Manager will be responsible for procuring and transporting the appropriate sample containers, equipment, and consumables (e.g., soap) to the Site. The containers will be pre-cleaned and certified by lot. If needed, reagents provided will be of the appropriate grade for the analysis. Records of these certifications and grades of material will be maintained on file at the laboratory.

7 Corrective Actions

Upon receipt of data, the QA Officer will evaluate field and laboratory precision by the RPDs between the field duplicate and sample data (using calculated totals for total PCBs, and cPAH TEQ and using other individual constituents). Non-conforming items and activities are those which do not meet the project requirements or approved work procedures. Non-conformance may be identified by any of the following groups:

- **Field staff/Manager**: during the performance of field activities, supervision of subcontractors, performance of audits
- **Laboratory staff**: during the preparation for and performance of laboratory testing, calibration of equipment, and QC activities
- **QA Staff**: during the performance of audits and during data validation, through the use of data to make decisions (i.e., do the data make sense?).

If possible, the Field Manager will identify any action that can be taken in the field to correct any non-conformance observed during field activities. If necessary and appropriate, corrective action may consist of a modification of methods or a re-collection of samples. If implementation of corrective action in the field is not possible, the non-conformance and its potential impact on data quality will be discussed in the data quality section of the RI/FS Report.

Corrective action to be taken as a result of non-conformance during field activities will be situation-dependent. The laboratory will be contacted regarding any deviations from the QAPP, will be asked to provide written justification for such deviations, and in some instances, will be asked to reanalyze the sample(s) in question. All corrective actions must be documented. The person identifying the nonconformance will be responsible for its documentation.

Documentation will include the following information:

- Name(s) of the individual(s) identifying or originating the nonconformance
- Description of the nonconformance
- Any required approval signatures
- Method(s) for correcting the nonconformance or description of the variance granted.

Documentation will be made available to project, laboratory, and/or QA management. Appropriate personnel will be notified by the management of any significant nonconformance detected by the project, laboratory, or QA staff. Implementation of corrective actions will be the responsibility of the Field Manager or the QA Officer. Any significant recurring nonconformance will be evaluated by project or laboratory personnel to determine its cause. Appropriate changes will then be instituted in project requirements and procedures to prevent future recurrence. When such an evaluation is performed, the results will be documented. If there are unavoidable deviations from this QAPP, the Project Manager will document the alteration and track the change in the subsequent deliverables.

8 Data Management Procedures

The database will only have one result per constituent in a given sample. Where duplicate analyses of the same constituent are present in the data for the same sample due to reanalysis or inclusion in multiple analytical methods, only one value will be preserved in the primary database tables; this does not apply to duplicate samples which are maintained as separate samples in the database. The preserved value will be selected as follows: for non-detects, the result with the lower reporting limit; values without QA flags are preserved over flagged values; detections are selected over non-detects; where all other conditions are equal, the result with the higher concentration is preserved in the database.

For accepted data, concentrations will be averaged between the parent and field duplicate, using one-half the reporting limit if any values are undetected. The database will store both the parent and field duplicate data.

The EBC Access database was developed during the PIRR with historical data. Data collected for the RI/FS will be added to the EBC database. If any removal interim actions or final remedial actions that remove soil represented by data in the database are conducted, the record in the “excavated” field will be changed to “yes”.

All hard copies of field forms or log book pages will be filed in the project library as scanned PDFs. Well installation logs and boring logs will be transcribed from hand-written field notes into formal electronic logs using LogPlot or a similar software program. Field forms, field-prepared boring logs, and LogPlot-style logs will be included in the RI/FS report appendices.

9 Audits and Reports

Field investigators will maintain field notes in a bound notebook or on field forms, and all documents, records, and data collected will be kept in a case file in a secure records filing area. All laboratory deliverables with verifiable supporting documentation shall be submitted by the laboratory to the QA Officer. The following documents will be archived at the laboratory: 1) signed hard copies of sampling and chain-of-custody records; and 2) electronic files of analytical data including extraction and sample preparation bench sheets, raw data, and reduced analytical data. The laboratory will store all laboratory documentation of sample receipt and login; sample extraction, cleanup, and analysis; and instrument output in accordance with the laboratory Standard Operating Procedure (SOP) or QA manual.

PDFs of all analytical reports will be retained in the laboratory files, and at the discretion of laboratory management, the data will be stored electronically for a minimum of 1 year. After 1 year, or whenever the data become inactive, the files will be transferred to archives in accordance with standard laboratory procedure. Data may be retrieved from archives upon request.

No audits, other than the identified data verification and validation will be conducted.

10 Data Verification and Validation

Analytes detected at concentrations between the MRL and the method detection limit (MDL) will be reported with a J qualifier to indicate that the value is an estimate (i.e., the analyte concentration is below the calibration range). J-qualified data are considered valid when completeness is calculated. Undetected data will be reported at the MRL. The MRL will be adjusted by the laboratory as necessary to reflect sample dilution or matrix interference.

No guidelines are available for validation of data for TOC. These data will be validated using procedures described in the functional guidelines for inorganic data review (EPA 2010), as applicable.

Verification of completeness and method compliance, as well as raw data entry and calculations by analysts will be reviewed by the Laboratory Project Manager. The Laboratory Project Manager will be responsible for checking each group or test data package for precision, accuracy, method compliance, compliance to special client requirements, and completeness. The Laboratory Project Manager will also be responsible certifying that data in PDFs and EDDs are identical prior to release from the laboratory.

Data validation will be completed by a third-party data validator. Data validation will be completed within two weeks after receipt of the complete laboratory data package.

The laboratory will generate Level 2B data package for all analytes. Validation of the analytical data will comply with criteria set forth in the CLP National Functional Guidelines for Superfund Organic Methods Data Review (EPA 2008).

11 Data Quality (Usability) Assessment

The QA Officer will review the field notebooks, laboratory reports, and the data validation report to determine if the data quality objectives have been met. Instances where the data quality objectives were not met will be documented. The usability of the data will depend on the magnitude of the data quality objective exceedance. Data that has been rejected will be flagged as "R" and will not be included in the database. The QA Officer will determine if rejected data trigger additional sample collection.

The achieved MRLs will be compared to the ISL in order to determine if the produced laboratory data can answer the study questions. In some cases the ISL was set to the practical quantitation limit (PQL, also the MRL), and therefore those MRLs need to be achieved in order for the data to be usable.

12 References

Ecology 2004. Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies. Publication No. 04-03-030. July 2004.

EPA 2006. SW-846 on-line, test methods for evaluating solid waste— physical/chemical methods. http://www.epa.gov/epaoswer/hazwaste/test/main.htm.

EPA 2008. Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review. EPA-540-R-08-01. June 2008.

EPA 2010. Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review. OSWER 9240.1-51. EPA 540-R-10-011. January 2010.

EPA 2010b. Low Stress Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells. Revision 3, January 19, 2010. EQASOP-GW-001

Plumb, R.H. 1981. Procedures for handling and chemical analysis of sediment and water samples. Technical report EPA/CE-81-1. U.S. Army Corps of Engineers, Vicksburg, MS.

PSEP 1986. Puget Sound Estuary Program: Recommended protocols for measuring conventional sediment variables in Puget Sound. Final Report TC-3991-04. Prepared for U.S. Environmental Protection Agency, Region 10, Seattle, WA. Tetra Tech and HRA, Inc., Bellevue, WA. (Minor corrections, April 2003).

Tables

Table 1 Project Roles and Responsibilities

Role	Person	Responsibilities
Ecology Project Manager	Marv Coleman (360-407-6259)	• Direct other Ecology staff and their consultants to review and comment on materials • Grant final approval on this QAPP, on data use, and on further data collection.
Port Project Manager	Leslee Conner (253-592-6732)	• Primary point of contact with Ecology • Direct consultant team and manage overall project budget and schedule • Review all documents associated with the project.
Consultant Team Project Manager	Grant Hainsworth (253-797-6323)	• Primary point of contact with the Port • Review all technical documents associated with the project for technical accuracy and feasibility, as well as adherence to budget and schedule.
Quality Assurance Officer	Nicole Ott (206-349-7505)	• Monitor all aspects of the project to verify that work follows project plans • Review laboratory analytical data • Serve as liaison between the laboratory and Field Manager • Maintain a complete set of laboratory data • Evaluate conformance of the analyses with the specifications of this QAPP • Verify the reported results with the raw data • Check that EDDs match the analytical reports • Review compliance with field methods and procedures.
Field Manager	Glen Wallace (206-954-7096) or other CRETE or PGG staff on site	• Collect or direct collection of soil and groundwater samples • Maintain a log (field log book) for all sampling-related activities • Coordinate the sampling operations to verify that the this QAPP is followed • Identify any deviations from this QAPP • Prepare the field data and information for RI/FS • Maintain the integrity of samples throughout sample collection and transport to the laboratory.
Laboratory Project Manager	Eric Young (206-285-8282)	• Conduct analysis of soil and water samples • Practice quality assurance methods per internal laboratory SOPs and this QAPP, and document such practices • Verify quality of samples (e.g., cooler temperature) as they're received at the laboratory • Verify accuracy and completeness of laboratory reports and EDDs.

Table 2 Soil Sample Analytes

Analyte	Preparation Method	Analytical Method	Method Reporting Limit	Lowest Initial Screening Level	Holding Time	Sample Container
Metals other than Mercury (mg/kg)	3050	EPA 6010	0.3 to 5	Selenium = 0.38	1 year	4-ounce glass
Mercury (mg/kg)	3050	CVAA	0.025	0.07	28 days	4-ounce glass
PCB Aroclors (µg/kg)	3550	EPA 8082	4	4 (total PCB ISL set to PQL)	1 year	4-ounce glass
SVOCs (µg/kg)	3550	EPA 8270D-SIM	5	N-Nitro-sodiphenylamine = 24.9	14 days to extract; 40 days to analysis	4-ounce glass
VOCs (µg/kg)	5035	8260C	0.5 - 1	Trichloroethene = 2.4	48 hours to freeze; 14 days to analysis	Three methanol-preserved 40-ml VOA vials
Diesel Range Organics (mg/kg)	3550	NWTPH-Dx with silica gel cleanup	5	2,000	14 days to extract; 40 days to analysis	4-ounce glass
Gasoline Range Organics (mg/kg)	5035	NWTPH-G with silica gel cleanup	5	TPH-Gx with benzene = 30	14 days (if preserved)	Three methanol-preserved 40-ml VOA vials

Table 3 Groundwater and UST Content Sample Analytes

Analyte	Preparation Method	Analytical Method	Method Reporting Limit	Lowest Initial Screening Level	Holding Time	Sample Container
Dissolved Metals other than Mercury (µg/L); groundwater only	200.8	200.8 with reductive precipitation	0.0068 – 0.18 (CAS-calculated MDLs)	Copper = 2.4	6 months	Field filter into 500-mL plastic bottle with HNO_3 preservative to pH <2
Mercury (µg/L); groundwater only	200.8 (same extract as other metals)	1631	0.2	0.2 (PQL)	28 days	Same as other metals
PCB Aroclors (ng/L); groundwater and UST contents	Centrifuge by EPA SW-846; 3510	EPA 8082	5	5 (total PCB ISL set to PQL)	1 year	1-L amber glass
SVOCs (µg/L); groundwater only	3510 with 2 extractions	High-volume EPA 8270D-SIM; possible silica gel cleanup for wood waste interferences	0.01	cPAH TEQ = 0.018	7 days to extract; 40 days to analysis	Two 1-L amber glass
VOCs (µg/L); groundwater and UST contents	5030	EPA 8260C; potentially with SIM for groundwater	0.2 – 2	Vinyl chloride = 2.4	14 days (if preserved)	Three 40-ml vials preserved with hydrochloric acid
DDT (µg/L); groundwater only	3510	EPA 8081	0.01	0.01 (DDT ISL set to PQL)	7 days to extract; 40 days to analysis	1-L amber glass
Diesel Range Organics (mg/L); groundwater only	3510	NWTPH-Dx with silica gel cleanup	0.1	0.5	14 days to extract; 40 days to analysis	500-ml amber glass
Gasoline Range Organics (mg/L); groundwater only	5030	NWTPH-G with silica gel cleanup	0.2	0.8	14 days (if preserved)	Three 40-ml vials preserved with hydrochloric acid
Hydrocarbon Identification (HCID) for UST contents only	3510	NWTPH-HCID	HCID is a qualitative test to determine composition of UST contents		7 days (if preserved)	500-ml amber glass with hydrochloric acid
RCRA Metals (includes mercury) for UST contents only (µg/L)	3005	6020	0.05 – 0.5	Not applicable	6 months	500-mL plastic bottle with H HNO_3 preservative to pH <2

Table 4 Measurement Quality Objectives

Parameter	Precision (RPD; lab/field)	Accuracy	Completeness	Preservation/ Storage
PCBs	Soil: 20%/50% Water: 20%/35%	70-130%	100%	Dark, 4^{o}C; freeze VOCs with 48 hours if not analyzed.
Metals				
Petroleum Hydrocarbons				
SVOCs				
VOCs				
DDT (groundwater only)				

Appendix A

Field Forms

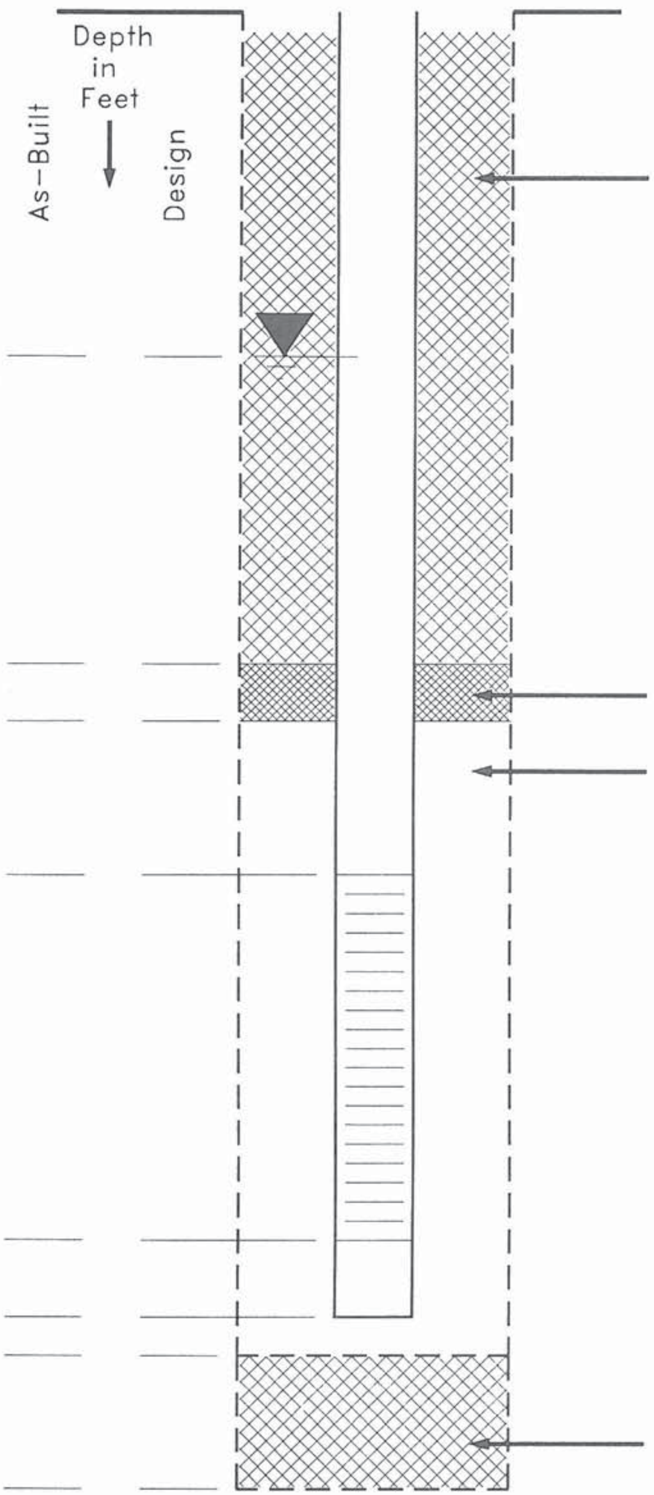
WELL INSTALLATION REPORT

Well No. ____________________ Date ________

Job ____________________ Job No. ________

Observer ________ Drilling Method ____________________

Draw Appropriate Monument (Flush or Above Ground) →



Approx. Elevation ____________________

Type of Monument ____________________

Stickup: Monument ________ Well ________

Seal Material ____________________

Borehole Diameter ____________________

Water Level Date ____________________

Riser Pipe Diameter ____________________

Riser Pipe Material ____________________

Type of Joints ____________________

"O"-Ring Seals? Yes ________ No ________

Seal Material ____________________

Filter Pack Material ____________________

Filter Pack Size ____________________

Screen Diameter ____________________

Screen Material ____________________

Screen Slot Size ____________________

Screen Construction: Milled
Wire Wound

Tail Pipe Diameter ____________________

Tail Pipe Length ____________________

Tail Pipe Material ____________________

Bottom Seal Type ____________________

Pacific Groundwater Group
2377 Eastlake Ave East
Seattle, WA 98102
(206) 329-0141 fax 329-6968

GROUNDWATER SAMPLING FIELD DATA SHEET

Well #: ____________

Sampling Event:________________________

Sample #:__________

Project Number: POT Job 095208 / PSA 069558
Project Name: Earley Business Center (Parcel 1B)
Project Address: Alexander Avenue, Tacoma, Washington
Client Name: Port of Tacoma
Laboratory: Friedman and Bruya
Chain-of-Custody:______________________________________
Shipment Method:______________________________________

Date:____
Location:____
Sampled By:______________________________________
Purged By:_______________________________________
Date Sent to Lab:_________________________________
Field CC Sample Number:___________________________
Sample Split:_____________________________________

Depth to Water (feet):____________________________________
Depth of Well (feet):_____________________________________
Reference Point (surveyors notch, etc.):_____________________
Sampling Equipment:_____________________________

Purge Volume Measurement Method:________________
Purge Date/Time:_________________________________
Purging Equipment:_______________________________
Water Level Probe Used:___________________________

Casing Volume Constants (CVC): 2-inch = **0.16** gpf ; 4-inch = **0.656** gpf ; 6-inch = **1.47** gpf   PV=(π r² h) (7.48 gal/ft³)

Purge Volume = ft of water _________ x CVC _________ x Casing Volumes ________ = ___________ gallons

TIME (2400 hr)	CUMULATIVE VOLUME (gal)	pH (units)	EC (umhos/cm 25 c)	Temp. (C)	TURBIDITY (visual)	________	________

Well Integrity/Notes:

Bottle Inventory

Day/Time Sampled: ______________________________

Quantity:	Container:	Preservatives:	Filtered (type):	Remarks:

Signature:______________________________

Page_______ of_______

CRETE
CONSULTING, INC.

FIELD ACTIVITY LOG

PROJECT________________
JOB NO.________________________
DAY & DATE______________________

COMPLETED BY____________________
APPROVED BY_____________________
SHEET OF

FIELD ACTIVITY SUBJECT:
DESCRIPTION OF DAILY ACTIVITIES AND EVENTS:

TIME	

VISITORS ON SITE:

CHANGES FROM PLANS OR IMPORTANT DECISIONS

WEATHER CONDITIONS:

IMPORTANT TELEPHONE CALLS:

PERSONNEL ON SITE:

PgG

PACIFIC groundwater GROUP
2377 Eastlake Ave. E. Suite 200
Seattle, Washington 98102
206.329.0140 FAX 206.329.6968

Boring Location:

Boring ________ Date ________ Sheet ___ of ___

Job ____________________ Job No. ________

Logged by ______ Weather ____________

Drilled by/Method ____________________

Sampling Method ____________________

Water Content	Color	Size %			Sample Number	Depth	Sample Recovery	Penetration Resistance	REMARKS: Drill action, sample procedures, water conditions, heave, soil variations.	SUMMARY LOG
		G	S	F						
		Max.	Range							
						0				0
						1				1
						2				2
						3				3
						4				4
						5				5
						6				6
						7				7
						8				8
						9				9
						0				0
						1				1
						2				2
						3				3
						4				4
						5				5
						6				6
						7				7
						8				8
						9				9
						0				0

DRUM RECORD SHEET

PgG

Project Name: ____________________
Project Number: ____________________
Client Name: ____________________
PGG Personnel: ____________________
Date: ____________________
Are there other drums on site? (Yes / No) If yes, explain :

Location Address: ____________________
Filled By Contractor Name / Company: ____________________
Regulatory Notes: ____________________

Drum ID	Media	Fill Date	Assoc. Boring(s)	Location (Draw Map on Back of Form)	% Full	Sample	Label

Signature:____

Sheet: _____ of _____

PROJECT DRUM GENERATION LOG
PART 1 - DRUM CONTENTS AND RECOMMENDED DISPOSAL

Project Name and Port Project Number: ____
Project Location (Address and Building Number): __________________________________
Consultant:(Contact person and phone #): _______________________________________
Brief Project Description (including potential site contaminants):_________________________
____

Project Date:____
Specific Drum Location: (Please include pictures of drums, labels, site and Copy of Site Plan):____
____

Drum ID *	**Drum Contents & Volume (soil or water)**	**Source of Contents (well or boring)**	**Date of Generation**	**Laboratory Analytical Results (from well or boring)**	**Applicable Cleanup Criteria**	**Recommended Additional Characterization for Disposal**	**Recommended Disposal of Contents ****

***** Attach site diagram illustrating locations of drums left on-site.

Drums must be labeled with a permanent marker which indicates the source of the contents (i.e. boring/well B-1), the type of material (i.e. soil or water), volume (i.e. 1/2 full), and the date of generation.

****** General material disposal guidance (assuming the waste is not a listed Dangerous Waste and passes Dangerous Waste characterization testing):

A. If concentrations of **ALL** constituents analyzed in the **SOIL** samples contained in the drum are below MTCA Residential Soil Cleanup Levels, soil can be disposed at Port-designated property;
B. If concentrations of **ALL** constituents analyzed in the **SOIL** samples contained in the drum are below MTCA Industrial Soil Cleanup Levels, soil may possibly be disposed at site of generation (with PM permission) or at off-site permitted facility;
C. If concentrations of **ANY** constituent analyzed in the **SOIL** samples contained in the drum are above MTCA Industrial Soil Cleanup Levels, soil will be disposed at off-site permitted facility;
D. If concentrations of **ALL** constituents analyzed in the **WATER** samples contained in the drum are below MTCA Surface Water Cleanup Levels (Marine Chronic Criteria and <10 mg/L TPH), water can be disposed to ground or storm drain; or
E. If concentrations of **ANY** constituents analyzed in the **WATER** samples contained in the drum are above MTCA Surface Water Cleanup Levels (Marine Chronic Criteria and/or >10 mg/L TPH), water will be disposed at off-site permitted facility.

Part 2- Disposal of Drums

Project Name: ____
Project Location (Address and Building Number): __________________________________
Secure/Non-secure: ____

Project Date:____
Storage Area Description:__________________________________

Drum ID *	Results of Additional Characterization	Designation of Waste	Regulatory Timeframe for Disposal	Disposal Location	Total Costs for Disposal (lab costs, labor costs, disposal costs; for Port-arranged disposal only)	Date Drum Contents Disposed by Port	Port Personnel Who Disposed of Contents