



*Engineering Evaluation/Cost Analysis
Pier 99 – Portland Site
Portland, Oregon*

Prepared for:
U.S. Environmental Protection Agency

June 13, 2013
1975-00



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John P. Foxwell, R.G.
Senior Associate Hydrogeologist



Herb Clough, P.E.
Principal

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Executive Summary

This document presents the Engineering Evaluation/Cost Analysis (EE/CA) for the Pier 99 – Portland Site located at 1610 North Pier 99 Street, in Portland, Oregon (the Site; Figure 1). The EE/CA assesses potential removal actions to reduce risks to human health and the environment associated with contamination at the Site. This EE/CA was prepared pursuant to an Administrative Settlement Agreement and Order (AO) dated August 30, 2012 between the U.S. Environmental Protection Agency (EPA) and the property owner, Mr. Milton Brown. For this EE/CA, the site was divided into Operable Units (OUs) including:

- Operable Unit 1 – Bank Area
- Operable Unit 2 – Eastern Solid Waste Storage Area (Eastern Unimproved Area)
- Operable Unit 3 – Gravel Filter Area and Upland Boat Maintenance Repair Area
- Operable Unit 4 – Former Crane Area

The property is a 1.07-acre parcel that is roughly rectangular, located along the western edge of the Interstate Highway (I-5) bridge over North Portland Harbor – Columbia River. The entire Site is located on a levee that is under the jurisdiction of the United States Corps of Engineers (USACE) and managed by the Peninsula Drainage District Number 1 (Pen 1). The riverward boundary between the Site and submerged lands owned by the Oregon Division of State Lands (DSL) is defined as the line of ordinary high water. The investigation area also includes areas located off-Site that were apparently used by former tenants.

The current property owner, Milton Brown, acquired the property in 1988. Current site uses include residential uses of the house on the property and general shop and storage uses in the work shop. Current in-water uses adjacent to the site include moorage of marine vessels, house boats, and pleasure craft. Historical land uses of the Site include ship building and repair, and a machine shop. The first available records of ship building and/or repair date to the 1930s. Historical land uses in the site vicinity also included ship building and repair, as well as a large livestock yard.

Previous investigations included an Expanded Preliminary Assessment (XPA) performed for Mr. Brown in 2003, a Preliminary Assessment (PA) completed for EPA in 2007, and a Site Inspection including comprehensive sampling for EPA in 2008. A data gap investigation was completed prior to preparing the EE/CA.

The removal action evaluation was prepared in general accordance with the EPA Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA (EPA540-R-93-057; EPA, 1993). The removal action screening incorporates both a determination of whether a given waste material is present at concentrations considered to be a principal threat, and determination of the likelihood of a principal threat waste to migrate to a receptor. Constituents that exceed the human health and ecological removal screening levels are considered principal threat chemicals.

At OU1, principal threat materials (metals, pesticides, phthalates, and polycyclic aromatic hydrocarbons [PAHs]) were detected along the bank at concentrations that exceed the removal screening criteria. Clearing of the bank during the removal action was not permitted at the time of the data gap investigation, so it was not feasible to verify the stability of the bank for the purpose of evaluating whether a transport pathway may be present. The proposed removal action for this area includes clearing the vegetation, evaluating the stability of the bank, taking steps to further stabilize the bank, and re-vegetating the bank.

At OU2, sample location WS02SS exceeds the human health and ecological removal screening levels in the Eastern Unimproved Area. This sample is located at the top of the bank, near the suspected location of the gravel filter discharge. The area in the vicinity of WS02SS will be managed as a component of the proposed removal action for OU3, which removes soils at the end of the discharge pipe. Only one other sample location in the Eastern Unimproved Area exceeds removal screening levels (WS01SS). Additional removal is not proposed for the remainder of the Eastern Unimproved Area. There is only one sample location where principal threat materials would remain present above ecological screening levels, and the other proposed removal actions will remove transport pathways from this area to the river.

At OU3, the presence of metals, TBT, pesticides, phthalates, and PAHs in the gravel filter and MH-1 sediments indicate principal threat wastes are contained in the gravel filter and the associated discharge line. These concentrations and their locations within the gravel filter system suggest a removal is necessary. In this case, principal threat wastes and a migration pathway are present.

At OU4, the results of the data gap investigation indicate that removal is not needed for the former crane area soil or groundwater at the site.

Based on the results of this EE/CA, the recommended removal actions for the Site are OU3 Gravel Filter Removal and Pipe Removal and OU1 Bank Stabilization. These alternatives were selected for the following reasons.

- Gravel filter and discharge pipe removal removes the potential for exposure for future Site workers to chemicals at concentrations that exceed RMLs and prevents migration to the river. Bank stabilization and maintenance by the owner and Pen 1 will prevent migration of contaminants in the bank to the river. Soil in the vicinity of WS02SS would also be removed as part of the gravel filter discharge pipe removal.
- The gravel filter and discharge pipe removal is a permanent action.
- Bank stabilization will manage contaminated soil in place by removing invasive vegetation and debris, and stabilizing the bank. This removal action is consistent with Pen 1 and USACE levee management requirements.
- The timeframe to implement both components of the removal is reasonable.

1.0 Introduction

This document presents the Engineering Evaluation/Cost Analysis (EE/CA) for the Pier 99 – Portland Site located at 1610 North Pier 99 Street, in Portland, Oregon (the Site; Figure 1). The EE/CA assesses potential removal actions to reduce risks to human health and the environment associated with contamination at the Site. This EE/CA was prepared pursuant to an Administrative Settlement Agreement and Order (AO) dated August 30, 2012 between the U.S. Environmental Protection Agency (EPA) and the property owner, Mr. Milton Brown. This EE/CA has been prepared in general accordance with the EPA Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA (EPA540-R-93-057; EPA, 1993). Figure 1 presents a Site location map; Figure 2 presents a Site vicinity plan.

For this EE/CA, the site was divided into Operable Units (OUs), based on language in the AO. The OUs are shown on Figure 3. The OUs include:

- Operable Unit 1 – Bank Area
- Operable Unit 2 – Eastern Solid Waste Storage Area (Eastern Unimproved Area)
- Operable Unit 3 – Gravel Filter Area and Upland Boat Maintenance Repair Area
- Operable Unit 4 – Former Crane Area

Note that the Eastern Solid Waste Storage Area was identified as a potential source area from a complaint of improper disposal of waste into a dumpster (Secor, 2003). The complaint was investigated and a No Further Action (NFA) issued. No other historical documentation was identified that identifies this area as a location for waste disposal or storage. The area will be referred to herein as the Eastern Unimproved Area to be consistent with prior documented use.

1.1 Purpose and Scope

The objectives of this EE/CA are to identify the goals of a removal action, to evaluate potential removal action alternatives (RAA), and to recommend the most appropriate response approach to address risks associated with highly concentrated or mobile contamination at the Site. Following EE/CA guidance (EPA, 2000) and 40 Code of Federal Regulations (CFR 300.415[b][2]), the selected RAA must:

- Remove or manage imminent risks to human health and the environment;
- Comply with applicable or relevant and appropriate requirements (ARARs) of federal and state environmental laws;
- Be cost-effective;
- Use permanent solutions and innovative treatment technologies to the extent practicable; and

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- Satisfy the regulatory preference for treatment that reduces contaminant toxicity, mobility, or volume.

To meet the objectives, the scope of this EE/CA included the following:

- Identify a list of proven technologies and process options that address the removal action objectives (RAOs);
- Assemble the retained technologies and process options into the most feasible removal actions; and
- Comparative analysis of each alternative with respect to the comprehensiveness of the removal action (effectiveness), complexity of the problem to be addressed and the action itself (implementability), and reasonableness of cost.

1.2 Report Organization

The following is a brief overview of the organization of the report.

- Site Description and Background (Section 2) — A description of the Site, including location, geology and hydrogeology, Site history, and a summary of previous environmental investigations. This section also discusses the OUs at the Site.
- EE/CA Data Gap Investigation (Section 3) — A presentation of the scope and results of field sampling activities conducted to address data gaps identified in the EE/CA Work Plan, including description of the source, nature, and extent of contamination identified at the Site.
- Applicable or Relevant and Appropriate Requirements (ARARs; Section 4) — Summarizes federal, state, and local regulations and screening levels applicable to Site removal action.
- Removal Action Evaluation (Section 5) — Describes the land use, updated conceptual site model (CSM), and human health and ecological removal screening for the Site. This section includes a description of the nature and extent of the contaminants of interest, transport pathways, and exposure pathways for human health and ecological receptors.
- Identification of Removal Action Objectives (Section 6) — Presentation of removal action objectives (RAOs) that specify the contaminant(s) and media of concern, the exposure route(s) and receptor(s), and an acceptable contaminant concentration or range of concentrations for each exposure scenario. Preliminary remediation goals (PRGs) based on ARARs were established as part of the RAO development process.
- Identification and Screening of Removal Action Alternatives (Section 7) — A description of the removal alternatives that were developed in consultation with EPA. These removal alternatives form the basis for the comparative analysis of removal action alternatives.

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- Comparative Analysis of Removal Action Alternatives (Section 8) — After completing the detailed screening, the feasible removal alternatives were then ranked. Based on the results of the comparison rankings, a removal action alternative is recommended.
 - Recommended Removal Action Alternatives (Section 10) — This section provides a summary of the recommendations for removal action, preliminary schedule, and ARARs specific to the removal action.

2.0 Site Description and Background

This section provides background information on the Site, including Site setting and description, historical ownership and operations, and regional geology and hydrogeology.

2.1 Site Location, Description, and History

2.1.1 Site Location and Description

The Site is located in Portland, Oregon (as shown on Figure 1). The property is a 1.07-acre parcel that is roughly rectangular, located along the western edge of the Interstate Highway (I-5) bridge over North Portland Harbor – Columbia River. North Portland Harbor – Columbia River is the name given to the portion of the Columbia River that runs between Hayden Island and North Portland. The entire Site is located on a levee that is under the jurisdiction of the United States Corps of Engineers (USACE) and managed by the Peninsula Drainage District Number 1 (Pen 1). The riverward boundary between the Site and submerged lands owned by the Oregon Division of State Lands (DSL) is defined as the line of ordinary high water.

The investigation area also includes areas located off-Site that were apparently used by former tenants. The gravel filter area, the majority of the discharge line from the gravel filter, and most of the eastern unimproved area are located off the site, in an area that was formerly occupied by a highway off-ramp. This property is owned by the State of Oregon. No information on lease agreements or other access/use agreements have been identified. The owner has confirmed that he did not construct the gravel filter. The owner suspected that the gravel filter was constructed by the Oregon Department of Transportation (ODOT) to drain the area north of the flood wall. ODOT reviewed their files and stated they did not construct the filter. No confirmed information regarding the construction date for the gravel filter or the party that constructed the filter has been identified.

Figure 2 shows the Site vicinity plan. The property is bounded by the Northwest Boat Center and the I-5 Bridge to the east, the North Portland Harbor – Columbia River to the north, Pier 99 moorage and Diversified Marine to the west, and a parking area to the south. Current site uses include residential uses of the house on the property and general shop and storage uses in the work shop. Current in-water uses adjacent to the site include moorage of marine vessels, house boats, and pleasure craft.

Two sets of stairs/walkways lead from the top of the bank on the property down to the docks. Figure 3 shows the Site features. Located at the top of the western walkway is a residence. Located at the top of the eastern walkway are the shop building, a driveway, a shed, and paved area currently used for parking. Near the eastern portion of the Site on the southern edge of the driveway, a manhole allows access to the gravel filter drainage system.

Three outfalls were reported (E&E, 2009) to discharge to the North Portland Harbor – Columbia River (Figure 4). The westernmost outfall is a City of Portland outfall that drains a portion of N Marine Drive and property south of the Site currently owned by the State of Oregon and leased to ODOT. This outfall does not include drainage from the Site. No information has currently been obtained regarding the construction or drainage basin of the central outfall and this outfall is not visible from the docks. Based on field reconnaissance (Section 3.2.1), this outfall is not believed to exist. The easternmost outfall is also not visible at its reported location. Based on the orientation of the piping that leaves the manhole for the gravel filter area, the outfall should be located on the bank, riverward of the former crane pad. A grate located near the eastern walkway serves as an outlet to drain stormwater from the parking lot to the bank.

2.1.2 Site History

The history of land use activities on and immediately surrounding the Site was researched to identify former operations that may have caused or contributed to potential environmental contamination. Figure 4 shows historical site features. The sources used for this research are listed in the following table.

Description	Provider or Interviewee	Dates of Coverage or Range of Site Knowledge	Date Reviewed or Contacted	Comment
Historical Aerial Photographs	U.S. Army Corps of Engineers (USACE)	1936, 1940, 1956, 1961, 1971, 1980, and 1996	November 26, 2012	See Appendix A
Historical Fire Insurance Maps	EDR search of Sanborn® maps	1950, 1952, and 1966	November 1, 2012	See Appendix B
Historical Pen 1 Map	Pen 1	1940	February 25, 2013	See Details Below
Prior Environmental Documentation	Milton Brown	2003 to 2008	November 2012	See Section 2.4

Observations of Site and adjacent property uses based on a review of the historical aerial photographs and fire insurance maps detailed above are summarized below.

- **1936:** The boat and machine shops and a dock are located on the Site. Several boats and docks are adjacent to the Bank Area to the east and west of the Site. The I-5 Bridge is to the east, undeveloped land to the south and west, and the Expo Center (formerly used as a livestock exposition center) is located to the southwest.

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- 1940: The residence is located on the west side of the Site. Two sheds (Boat Storage and unknown shed) are located on the eastern portion of the Site and additional dock structures are located adjacent to the Site in North Portland Harbor. Two buildings (restaurant and a service station) are located south of the Site and the Kiernan Livestock Farms are located to the south and west of the Site. The Kiernan Livestock Farm has several small structures. The City of Portland outfall, catch basin, and storm sewer pipes are located to the west of the Site.
 - 1950: A road (presumed to be Marine Drive) is located south of the Site at the location of the former unknown shed. A boat building is located on the eastern portion of the Site. An apartment building, residence, and a store are located south of the service station.
 - 1952: No change to the Site. The residence south of the service station was converted to an office.
 - 1956: Significant development to the south and southwest appears, including the Expo Center parking area, roadways, and possible storage yard. Several structures south of the service station are built. Clearing of vegetation and over water operations appear to the west of the Site. Two dock structures appear directly north and northeast of the Site across North Portland Harbor.
 - 1961: Interstate 5 has been constructed and a southbound off-ramp is located over the eastern portion of the Site. The boat storage and boat building have been removed. The restaurant and service station south of the Site are removed and additional structures appear in the storage yard. Over-water operations appear adjacent to and to the west of the Site and significant dock structures appear across North Portland Harbor from the Site.
 - 1966: No change.
 - 1971: No change to the Site. Significant changes to the I-5 northbound on-ramp appear to the southeast of the Site. Buildings are removed in the storage yard south of the Site, structures appear to the west, and a dock structure appears adjacent and to the west of the Site.
 - 1980: No change to the Site. The storage yard south of the Site has been removed.
 - 1996: No change to the Site. The I-5 off-ramp over top of the Site has been removed. Significant roadway construction appeared directly south of the Site.

Based on documents provided by the property owner, Milton Brown, historical river-related operations began at the Site in 1937. From approximately 1937 to 1975, the Site operated as a marine vessel production, service, repair, and painting facility under the name of Westerlund's Boat and Machine Shop (Westerlund). During Westerlund's operations, private and commercial vessels were reportedly built and repaired at the Site, and manufacturing of marine transmissions also occurred. The Site originally consisted of a floating barge with a crane at the approximate location of the western span of the I-5 Bridge. The steel crane and the existing building were placed at the Site in 1947 and a floating drydock attached to the eastern walkway was noted in 1972. The floating drydock was mentioned to be operated by a Ron Church;

however, information pertaining to Mr. Church's operations has not been identified. In 1975, Schrouder's Machine Shop (Schrouder) was operating at the Site and took over operations of Westerlund's boat yard following Frede Westerlund's death. Schrouder operated at the Site until 1984 (Rand, 2003; SECOR, 2003).

From 1984 until 1986, the Site was operated as an upholstery shop under the name George's Upholstery (SECOR, 2003). From 1986 until 1988, the Site was operated as a marine vessel storage and repair facility under the name Harbor 2 Boatyard (SECOR, 2003).

Schooner Creek Boat Works (Schooner Creek) moved to the Site and began operations as a marine vessel repair and paint shop sometime in 1988. Milton Brown acquired the property later in 1988. Facility operations included marine vessel storage, painting, fiberglass and metalwork repair, and general repair of marine vessels. Boats were both brought in on dollies and picked from the river using the on-site steel crane and brought up to the work shop for repairs. Operations ceased in July 2000 when Schooner Creek moved operations to another facility. However, Schooner Creek maintained a lease at the Site until December 2001, at which time Guy Boyden took over the property and operated under the name Mermaid Marine (Rand, 2003).

During the 12 years Schooner Creek was performing operations at the Site, the Oregon Department of Environmental Quality (DEQ) received six pollution complaints alleging that activities were contaminating the North Portland Harbor – Columbia River and nearby properties. Complaints filed include: improper disposal of chemicals at the Site in September 1991; stripping of marine paint into the North Portland Harbor – Columbia River in October 1992; sanding a boat without containment in October 1992; strong paint smell coming from the boat yard in June 1999; oil slick to river from crane crankcase in April 2002; and "old problems" at the Site in April 2002. The April 2002 complaint referred to the condition of the Site and identified previous complaints (SECOR, 2003).

According to Schooner Creek, boat maintenance and repair activities occurred over the concrete pad that drains in part into the gravel filter area (E&E, 2008; Figure 3). The gravel filter area drains into the manhole observed on the southeastern portion of the property and potentially discharges into North Portland Harbor – Columbia River.

In December 2001, Milton Brown purchased the property. Since that time the Site has been used as a residence, workshop for a houseboat repair company (tenant lease), and parking and access to boat slips in North Portland Harbor – Columbia River.

2.3 Geology and Hydrogeology

The geology beneath the site consists of fill used to construct the levee, which is expected to be underlain by overbank deposits from the Columbia River and remaining geologic units that comprise the Portland

Basin. The local bedrock is the Columbia River Basalt. The depth to bedrock in the vicinity of the site was not mapped in publications reviewed for this EE/CA, but it is expected to occur at depths of 1,000 feet or greater. Sampling at the Site has been limited to soil sampling within approximately 25 feet of the ground surface. Swanson et al., 1993, defines the hydrogeological units present beneath the site from the ground surface with increasing depth, as follows:

- Fill Material (Fill)
- Overbank Deposits (OD)
- Columbia River Sand Aquifer (CRSA)
- Unconsolidated Gravel Aquifer (UGA)
- Troutdale Gravel Aquifer (TGA)
- Confining Unit 1 (CU1)
- Troutdale Sand Aquifer (TSA)
- Confining Unit 2 (CU2)
- Sand and Gravel Aquifer (SGA)
- Confining Unit 3 (CU3)
- Undifferentiated Fine-Grained Sediments (UFS)
- Columbia River Basalt Group (CRBG)

Depth to groundwater at the Site is expected to be controlled by the river stage. Accounting for river stage variations (USACE, 2004), depth to groundwater is expected to range from approximately 6 to 27 feet below the ground surface (bgs). During the 2013 Data Gap Investigation, groundwater was encountered at approximately 20 feet bgs. The depth of the first water-bearing aquifer widely used as a groundwater resource, the CRSA, is expected to first occur between approximately 50 and 60 feet bgs.

2.4 Summary of Previous Investigations

2.4.1 Expanded Preliminary Assessment and Request for Closure

In 2003, at the request of DEQ, Mr. Milton Brown, owner of the Site, had an Expanded Preliminary Assessment (XPA) performed on the property. Eight surface soil samples (SS-1 through SS-8) were collected during the XPA and analyzed for Toxicity Characteristic Leaching Procedure (TCLP) Metals (EPA Method 1311/Series6000/7000), volatile organic compounds (VOCs; EPA Method 8260b), total petroleum hydrocarbons (TPH)-diesel (Method NWTPH-Dx), and TPH-oil (Method NWTPH-Dx). Sample results for the surface soil samples are presented in Tables C-1 through C-3 contained in Appendix C. Two samples were collected from the slope, north of the work shop and machine shop area; two samples were collected

from the gravel filter area; two samples were collected from the eastern gravel area; and two samples were collected adjacent to the crane (SECOR, 2003). Sample locations are shown on Figure 5.

During the XPA, petroleum and lead contamination were detected in soil near the crane. Based on the findings of the XPA, excavation was completed. Approximately 22 cubic yards of contaminated soil were reportedly removed from the area immediately surrounding the crane. After the soil excavation, three additional samples were collected and analyzed for TPH (NWTPH-Dx) and total lead (EPA Method 6000/7000). One sample was collected from the vertical extent of the excavation (7 feet bgs) and two samples were collected from the sidewalls (4 and 5 feet bgs). These samples, collected from 4 to 7 feet bgs contained TPH and lead. Sample results for the confirmation soil samples are presented in Table C-4 contained in Appendix C. TPH as diesel was detected at a concentration of 376 milligrams per kilogram (mg/kg) in the excavation bottom and TPH as oil was detected in the excavation bottom and the northern sidewall at concentrations of 2,200 and 1,700 mg/kg, respectively. Total lead was detected in confirmation samples ranging from 8.25 to 95.8 mg/kg. Figure 5 displays the locations of the confirmation samples. The concentrations of confirmation samples were below the site-specific risk-based concentrations (RBCs) for TPH calculated using a spreadsheet document provided by DEQ for (SECOR, 2003).

2.4.2 START Preliminary Assessment

In 2008, a preliminary assessment (PA) for the Site was completed by Ecology & Environment, Inc. (E&E) on behalf of the EPA. The PA discussed the Site history and current and former waste handling practices and identified several possible sources of hazardous substances at the Site. The PA concluded that historical boat building, repair, and refurbishing activities at the 1610 North Pier 99 site could be a source of sediment contamination in the Columbia River, and further investigation was recommended. Contaminants of concern were identified to be metals, VOCs, semi-volatile organic compounds (SVOCs), copper oxide, organotins, and, possibly polychlorinated biphenyls (PCBs; E & E, 2008).

2.4.3 Site Inspection Investigation

In October 2008, E&E conducted surface soil and sediment sampling at areas identified as being potential source areas or areas that may have been contaminated through migration from potential sources areas. The areas investigated were identified based on the E&E PA, interviews with former workers, and regulatory agencies, as well as a review of background information. Potential source areas identified by E&E included the following:

- **Upland Boat Maintenance and Repair Areas.** These areas consist of a work shop, former machine shop, and asphalt concrete pad where vessels were repaired. These areas drain to the nearby gravel filter and/or onto the slope that leads to North Portland Harbor – Columbia River. The original purpose of the gravel filter was not determined. A manhole allows access to the gravel filter drainage system. Based on orientation of the piping that leaves the manhole for the

gravel filter area, the outfall (eastern) should be located on the bank, riverward of the former crane pad.

- **Stormwater Outfalls/Surface Runoff (Eastern Walkway).** Two Site-related stormwater outfalls were reported on the Site (in addition to the outfall owned and operated by the City of Portland). One outfall appears to drain the gravel filter. Also, E&E considered the entire riverbank a potential source.
- **Eastern Unimproved Area.** The eastern unimproved area was where materials, equipment, and boat stands were stored on pavement and the location of former rigging and paint sheds. The sheds stored materials such as marine paints, solvents and fuels, and resins (Rander, 2003). This area was identified as a storage area for solid waste, potentially containing the same contaminants that are found in the boat maintenance and repair areas.
- **Work Over Water (Sediments).** Former boat maintenance and repair activities may have occurred over the water at the docks.

Seven surface soil samples (0 to 6 inches bgs) were collected from known (former crane engine and cabin) or suspected areas of soil contamination. One surface soil sample was collected from the gravel filter area (UP01SS); two surface soil samples were collected from the eastern unimproved area (WS01SS and WS02SS); and three surface soil samples (OP01SS through OP03SS) were collected on the slope between the upland area and North Portland Harbor – Columbia River, as shown on Figure 5. Sample results for the surface soil samples are presented in Tables C-1 through C-3, contained in Appendix C.

Twenty-one sediment samples (0 to 6 inches below the mudline) were collected. Five background sediment samples were collected upstream of the Site. Sixteen sediment samples (CR01SD through CR07SD and DO02SD through DO10SD) were collected from the vicinity of the Pier 99 docks. Sample results for the sediment samples are provided in Table C-5, contained in Appendix C.

The results of chemical analyses at each source area completed during the Site Investigation (SI) are summarized below.

- **Eastern Walkway.** At this area in the former Boat Maintenance and Repair Area, three surface soil samples were collected on the slope between the upland area and North Portland Harbor – Columbia River indicate the presence of four organotins, five pesticides/PCBs, seven SVOCs, and 10 Target Analyte List (TAL) metals at concentrations above expected background concentrations.
- **Gravel Filter Area.** Analytical results from sample UP01SS indicate the presence of three organotins, three pesticides/PCBs, five SVOCs, and 12 TAL metals at concentrations above expected background concentrations.
- **Eastern Unimproved Area.** Two surface soil samples were collected from the eastern unimproved area (WS01SS and WS02SS). Sample WS01SS was collected from a grass-covered

mound of soil that covered the eastern half of the eastern unimproved area. Sample WS02SS was collected adjacent to a pile of debris. Sample results indicate the presence of three organotins, four pesticides/PCBs, four SVOCs, and 13 TAL metals at concentrations above expected background concentrations.

- **Work Over Water (Sediments).** Analytical results for the dock area and the Columbia River samples indicate that the presence of one TAL metal (copper) detected above expected background concentrations. No pesticides/PCBs, organotins, or SVOCs were detected in any of the sediment samples.

E&E concluded that the 1610 North Pier 99 site contains sources of hazardous substances. The primary sources included the gravel filter area (pesticides/PCBs, SVOCs, and metals), and the eastern unimproved area (organotins, pesticides/PCBs, SVOCs, and metals). E&E also concluded that contamination is migrating from Site sources towards sediment targets based on the three surface soil samples collected on the slope between the upland area and North Portland Harbor – Columbia River (organotins, pesticides/PCBs, SVOCs, and metals). Sample results for the sediment samples collected from below the Pier 99 docks do not support this conclusion. The E&E sediment sampling results indicated the presence of one metal (copper) at a concentration above expected background concentration. Organotins, pesticides/PCBs, or SVOCs were not detected in the E&E sediment samples. In the absence of an obvious single point of surface water runoff (the Site does not have a stormwater collection and drainage system), E&E concluded that the length of the property that fronts the North Portland Harbor – Columbia River was the transport pathway, or probable point of exposure, to the river.

Based on the results of the SI, EPA identified the following areas as data gaps in the AO Statement of Work, which provided the basis for the data gap investigation:

- The eastern walkway that extends to the Pier 99 docks, near former sample location OP02SS;
- The Eastern Unimproved Area, near former sample location WS02SS;
- The gravel filter area located on the southwest side of the upland boat maintenance repair area, near former sample location UP01SS;
- Former crane area; and
- Sediment that may be contained in any surface drains that originate and/or terminate from the Site.

3.0 Summary of EE/CA Data Gap Investigation

The following describes the scope of work and procedures performed to complete the EE/CA data gap investigation for the Site and presents the results. Work was conducted in accordance with the approved EE/CA Work Plan, Sampling and Analysis Plan (SAP), and Quality Assurance Project Plan (QAPP).

3.1 EE/CA Work Plan Scope of Work

As described in Section 2.4, previous investigations had been performed at the Site in 2003 and 2008 and data gaps were identified by EPA that needed to be assessed to characterize the Site and evaluate removal actions. The data gaps and the corresponding work scope were as follows:

- Completing a site and bank visual assessment to verify locations and orientations of outfalls and other possible discharge points from the site.
- Completing nine direct-push and two test pit explorations at the Site to sample subsurface soil and groundwater at the Eastern Unimproved Area, Gravel Filter area, the upland boat maintenance repair area, and the former crane area.
- Completing manual surface and near-surface soil sampling at five locations along the riverbank and four locations in the eastern unimproved area.
- Sampling sediments (if present) within the manholes for the on-site storm sewer system.

3.2 Bank and Building Visual Assessment Results

Based largely on the E&E SI, the bank of the Site fronting the North Portland Harbor – Columbia River was reported to be the location of three possible entry points to the river: gravel filter outfall (eastern outfall), central outfall (not located), and the length of the bank that fronts the river (referred to as the Bank Area). The purpose of the Site and Bank visual assessment was to identify any additional potential sources from underneath the existing structures (Work Shop/Formal Machine Shop) and confirm the location of discharge points or outfalls located on the central and eastern portion of the Bank.

Historical Sanborn Maps, USACE aerial photographs, and City of Portland records maintained online via the PortlandMaps website were reviewed to assist in the identification of source areas related to the existing Work Shop and construction of outfalls located on the Bank. The Sanborn Maps are included as Appendix B and the USACE aerial photographs are contained in Appendix A. In addition, site visits prior to, during, and following the EE/CA data gap investigation involved observations of the Bank to identify relevant features. A photographic log of the Bank and Building assessment are included as Appendix D.

Specific field tasks related to the bank and building survey are described below.

3.2.1 Bank Assessment

Historical Document Review. Historical Sanborn Maps from 1950, 1952, and 1960 and USACE aerial photographs from 1936, 1940, 1956, 1961, 1971, 1980, and 1996 were reviewed to assess the three possible entry points (outfalls) to the river and identify any additional potential sources. Two of the three outfalls previously identified in the 2008 investigation were not identified on the Sanborn Maps or USACE

aerial photographs. City of Portland records identified the location of the outfall that is located on the western portion of the Site (Figure 4), and shows that it discharges stormwater collected from inlets and manholes along N Marine Drive, south and southwest of the Site. There is no stormwater contribution from the Site that flows to this outfall.

Site Reconnaissance. During site visits from September 2012 through February 2013, reconnaissance along the bank were conducted to document and confirm the location of the outfalls at the Site. Photographs documenting the Bank Area are included in Appendix D. The City of Portland outfall identified on the western portion of the Site (upland Bank Area) was identified during a September 2012 site visit. This outfall and associated manhole at the top of the bank are shown in Photograph Nos. 2 and 3 contained in Appendix D. During the site visits, a unknown pipe on the bank was observed in the central portion of the Site directly east of the walkway to the docks located between the house and work shop (Figure 6). This pipe is shown on Photographs 3 and 4. Based on the condition and location of the pipe, this pipe is believed to be debris on the bank. Specific information regarding the origin and possible upland connections to this pipe have not been identified.

The central outfall presented on Figure 6 and identified during the 2008 E&E SI Investigation was not observed during Apex site visits. Based on correspondence with E&E personnel, the potential presence of an outfall at this location was based on the sound of running water and was not visually observed.

A surface drain was located directly east and at the top of the walkway to the docks adjacent to the work shop (Figure 4). Stormwater from this surface drain flows from the parking lot area and drains to the bank (see Photographs 5 and 6). The drain appeared to be constructed recently based on the condition of the Portland-cement concrete completion. As-built drawings or additional information on the surface drain was not identified.

During the bank assessments, the outfall or discharge pipe connected to the Gravel Filter Area could not be located. Photograph 7 displays the manhole and drainage pipe trending towards the outfall location. Additional information regarding this outfall is described below.

Gravel Filter Outfall Video Inspection and GPR Trace. Additional investigations to locate the pipe discharging from the gravel filter area were conducted on January 17 and 25 and February 25, 2013. On January 17, 2013, Locates Down Under, Inc. (LDU) of Oregon City, Oregon conducted a private utility locate of the data gap investigation area and a video inspection of the Gravel Filter Area manhole and associated discharge pipe. During the utility locate, the subsurface pipe discharging the Gravel Filter Area could not be identified using an electromagnetic device. No underground structures were located with the magnetometer survey conducted for the purpose of locating underground utilities.

On January 25, 2013, LDU conducted a video inspection of the Gravel Filter Area manhole and associated discharge pipe. The inspection indicated that the discharge pipe was constructed of concrete, was approximately 8 inches in diameter, and extended approximately 60 feet to the north-northeast of the manhole. At approximately 60 feet, the video equipment encountered an obstruction and/or buildup of pipe debris that restricted further investigation. During the video inspection, the perforated pipe within the gravel filter was inspected and was determined to extend approximately 170 feet to the west from the entry point to the manhole. At 170 feet, the perforated pipe appeared to be crushed.

On February 25, 2013, LDU used ground penetrating radar (GPR) to investigate the location of the Gravel Filter Area discharge pipe. Apex collected global positioning system (GPS) data points of the discharge pipe during the GPR survey (Figure 6). The GPR traced the discharge pipe to the edge of the asphalt concrete where the discharge pipe horizontally intersected a utility corridor. The discharge pipe was approximately 4 feet bgs and the utility corridor approximately 13 feet bgs. The discharge pipe after the intersection with the utility corridor was not located. Photographs 9 through 11 display the limits of the GPR trace and intersection of the gravel filter area discharge pipe and utility corridor. Figure 5 shows the extent of the GPR trace on the discharge pipe and the approximate location of the utility corridor.

Bank Assessment Results. Based on review of historical records; observations during bank reconnaissance, the video inspection; and the GPR trace of the bank, the parking lot surface drain, and the gravel filter outfall are the possible transport pathways to the bank that were observed. The central and eastern outfalls documented in the Site Inspection Investigation Report (E&E, 2008) and shown on Figure 5 were not identified during the bank reconnaissance. Based on these results and coupled with the fact that the outfalls mapped by E&E were based on auditory observations, not direct observation by E&E, these outfalls likely do not exist. No other sources were identified during the bank survey.

3.2.2 Building Survey

The interior of the shop building and the crawl space beneath the building were viewed on several occasions during the mobilization for the data gap investigation. Plumbing connections in the building were verified to be connected to the City sanitary sewer system. No floor drains were identified in the building and this was confirmed by the current tenant. Beneath the building, an approximately 4-inch polyvinyl chloride (PVC) pipe was observed (Photograph 12). This pipe had no connections and was determined to be at least 25 feet deep, extending towards the bank. No other information is available on the possible former uses of this pipe.

3.3 Subsurface Investigation Results

The data gap investigation was conducted from February 19 through 22, 2013. Apex arranged site access with the property owner and completed underground utility locates using a private utility locator (LDU) to locate underground utilities at each proposed exploration location, and calling the Oregon One-Call system.

The data gap investigation methods and procedures are described in the SAP, presented in Appendix A of the EE/CA Work Plan (Apex, 2013). Apex completed project oversight and field sampling for the data gap investigation. Stratus Corporation (Stratus) of Gaston, Oregon provided drilling and excavation services for the installation of direct-push and test pit explorations.

The direct push, surface soil, and test pit explorations were continuously logged, sampled, and field screened using photoionization detector (PID) and sheen test procedures in accordance with the SAP. Lithologic logs from soil and test pit explorations are contained in Appendix E. The location of each data gap sampling location was recorded with a sub-meter grade GPS.

3.3.1 Operable Unit 1 — The Bank Area

Six surface soil samples (SS-9 through SS-11 and SS-18) were collected along the Bank that extends along the shoreline of the Site (Figure 5). Access to each of the sampling locations was made by cutting paths through the blackberry bushes that cover the bank. The sampler was equipped with fall arrest gear during sampling due to the limited access and steep terrain. Five surface soil samples (SS-9 through SS-12 and SS-18) were collected along the Bank at an approximate depth of 0.5 foot bgs, and one surface sample (SS-13) was collected at a depth of 1.6 feet bgs to assess the vertical distribution of contaminants in this area. Surface soil samples SS-10 and SS-18 were collected downslope of the location where sample OP02SS was collected. In addition, SS-11 was collected downslope of the surface drain to document potential impacts from stormwater runoff. Bank soil consisted of sandy silt with trace gravels. Laboratory analyses completed for these samples are shown on Figure 6.

Surface soils in the Bank Area consist of fine to medium-grained sands to the maximum depth explored, which is approximately 7 inches bgs, with the exception of locations SS-9 and SS-18. At these explorations, the surface soils consist predominantly of a silt with fine-grained sand. The surface soil conditions at location SS-10 through SS-13 are consistent with sand fill used to construct the levee, while the surface soil at SS-9 and SS-18 is consistent with deposition given that their locations are further downslope of SS-10 through SS-13 and are near the high water line.

3.3.2 Operable Unit 2 — The Eastern Unimproved Area

Two direct push explorations (B-4 and B-5) and four surface soil samples (SS-14 through SS-17) were completed in the Eastern Unimproved Area to characterize the surface soils in this former work area. Exploration B-5 was completed to assess the vertical extent of contamination on the vicinity of the former sample location WS02SS. The direct-push explorations were completed to depths ranging between 25 and 30 feet bgs. Laboratory analyses completed for samples B-4 and B-5 and SS-14 through SS-17 are shown on Figure 6.

Subsurface soils in the Eastern Unimproved Area consist of fine-grained sand to approximately 13 feet bgs. The sand grades to a sandy silt and then a silt at a depth of approximately 16 to 22 feet bgs. The subsurface soil conditions are consistent with sand fill used to construct the levee. The depth to groundwater at direct-push exploration B-4 was 20 feet bgs.

3.3.3 Operable Unit 3 — The Gravel Filter Area and Upland Boat Maintenance Repair Area

Three test pit explorations (TP-1 through TP-3) and three direct-push explorations (B-6 through B-8) were completed in the gravel filter area (near former sample location UP01SS) and the upland boat maintenance repair area to characterize the nature and extent of contamination associated with the gravel filter. Two soil samples were collected from TP-1 and TP-3 and three soil samples were collected at TP-2. Soil samples at TP-1 through TP-3 were collected at an approximate 18-inch depth interval within the gravel filter and from beneath the bottom of the gravel filter at approximately 36 inches bgs. One soil sample from TP-2 was also collected at approximately 4.5 feet bgs below the base of the gravel filter. The test pit explorations were completed using an excavator and the excavator operator was instructed to remove the soil at each test pit location place it in a pile at the ground surface adjacent to the pit. Once sampling was complete, the soil was replaced in the hole in the same order as removed (i.e., last out is first in). Soil samples were collected from the sidewall of the test pit at the corresponding depth interval using a decontaminated stainless steel spoon or hand auger. Soil samples beneath 24 inches were collected directly from soil in the excavator bucket that was not in direct contact with the bucket. Laboratory analyses completed for the direct-push exploration samples from the gravel filter are shown on Figure 6.

Three direct-push explorations (B-6 through B-8) were completed to assess whether migration from the gravel filter has occurred and to assess the constructed extent of the gravel filter. The direct-push explorations were completed to a depth of 30 feet bgs. Soil samples from direct-push explorations B-6 and B-7 were collected at approximately 5-foot intervals and soil samples from B-8 were collected at approximately 2.5-foot intervals. Laboratory analyses completed for the direct-push exploration samples from the gravel filter are shown on Figure 6.

Subsurface soils near the Gravel Filter Area consist of fine- to medium-grained sand to approximately 10 to 13 feet bgs and then grades to silt to the maximum depth explored, which was approximately 35 feet bgs. The depth to groundwater at direct-push exploration B-9 was 21.6 feet bgs.

One stormwater sediment sample (MH-1) was collected from the manhole (MH-1) directly east of the gravel filter area (Figure 6). The sediment sample was collected with a hand auger that was pushed and rotated downward until the auger became filled with sediment. Once filled, the auger was removed from the manhole and emptied into a stainless steel bowl and homogenized before filling the applicable sample containers. Laboratory analyses completed for the manhole sample are shown on Figure 6.

The test pit and direct-push explorations provide information used to verify the construction dimensions of the gravel filter. The dimensions of the of the gravel filter appear to match the footprint of the filter that is expressed on the ground surface. Based on field observations and soil condition in B-6 through B-8, the gravel filter is 2 feet wide west of TP-1 and four feet wide east of TP-1. Based on the test-pit excavations, the gravel filter is comprised of gravel to an approximate depth of 3.5 feet bgs followed by a medium-grained sand that is characteristic of the levee fill at the Site. An approximate 4-inch perforated pipe extends from the manhole east of the gravel filter area to the western boundary of the gravel filter. The perforated pipe varies with depth and was observed at a depth of 1.9 feet bgs inside the manhole, 2.6 feet bgs at TP-1, 3 feet bgs at TP-2, 1.6 feet bgs at TP-3, and 1.9 feet at the western extent. The perforated pipe is placed within the gravel and above the medium-grained sand that constitutes the filter material. Photographs 13 and 14 display the perforated pipe and the location within the gravel filter. Additionally, field observations made during TP-1 exploration indicate that the gravel filter extends to an approximate depth of 3 feet bgs before encountering the concrete footing of the flood wall directly to the south (Figure 6). The medium-grained sand was not present above the concrete observed in TP-1.

Upland Boat Maintenance Repair Area. Direct-push exploration (B-9) was completed on the northern extent of the upland boat maintenance repair area to first encountered groundwater. The direct-push exploration was completed to a depth of between 30 feet bgs using a Geoprobe™ rig. Soil samples from direct-push exploration B-9 were collected at approximately 2.5-foot intervals.

A depth-discrete grab groundwater sample was collected at direct-push exploration B-9 (Figure 6). A temporary well was installed at a depth of 30 feet bgs and was screened from 26 to 30 feet bgs. The temporary well was abandoned within 24 hours after installation. Temporary well construction details and field screening data are shown on the log included in Appendix E. Laboratory analyses completed for the samples from the boat maintenance area are shown on Figure 6.

3.3.4 Operable Unit 4 — The Former Crane Area

Three direct-push explorations (B-1 through B-3) were completed to first encountered groundwater (approximately 22 feet bgs) around the former crane engine and control cabin to characterize the extent of constituents observed during confirmation sampling in 2003. One grab groundwater sample was collected from the bottom depth of the direct-push exploration at B-3. Temporary well construction details and field screening data are shown on the log included in Appendix E.

The direct-push explorations were completed to depths ranging between 25 and 35 feet bgs using a Geoprobe™ rig. Soil samples were collected at approximately 2.5-foot intervals. Lithologic logs from completed soil explorations are contained in Appendix E. Eight soil samples were submitted to the analytical laboratory. Laboratory analyses completed for the samples from the boat maintenance area are shown on Figure 6.

A depth-discrete grab groundwater sample was collected at direct-push exploration B-3 (Figure 6). A temporary well was installed at a depth of 30 feet bgs and was screened from 26 to 30 feet bgs. The temporary well at direct-push location B-3 was driven an additional 5 feet bgs due to a silted-in screen. Temporary well construction details and field screening data are shown on logs included in Appendix E. The groundwater sample was collected using a peristaltic pump and submitted to the analytical laboratory for the analyses shown on Figure 6.

Subsurface soils near the Former Crane Area consist of fine- to medium-grained sand to approximately 15 to 20 feet bgs and then grades to silt to the maximum depth explored, which was approximately 30 feet bgs. The depth to groundwater at direct-push exploration B-3 was 21.5 feet bgs.

3.4 Analytical Results

Results of the soil and groundwater sampling conducted in February 2013 are discussed in the following sections. Soil analytical results are presented in Tables 1 through 5 and groundwater analytical results are presented in Table 6. Figure 6 shows the laboratory analytical plan and Figures 7 and 8 summarize the analytical results. Laboratory analytical data reports and a QA/QC review of the data results are included in Appendix F.

3.4.1 Operable Unit 1 – Bank Area

Six surface soil samples (SS-9 through SS-13 and SS-18) were collected along the bank area (Figure 6). TAL 23 metals were detected in the samples and the results are summarized in Table 1. Locations with the relatively higher metals concentrations were collected from SS-9 and SS-11. The soil sample collected from SS-18 was submitted for three indicator metals (copper, lead, and zinc). This sample (SS-18), collected downslope of SS-10 had lower concentrations of copper, lead, and zinc (43.5 mg/kg, 12.5 mg/kg, and 94.0 mg/kg, respectively), as compared to samples higher on the bank. Concentrations of copper in samples SS-9 through SS-13 ranged from 433 to 6,500 mg/kg, lead from 128 to 989 mg/kg, and zinc from 213 to 1,070 mg/kg.

The analytical results for organic compounds indicated the following.

- Aroclor 1254 and 1260 were detected in surface soil samples from SS-9 through SS-13 (Table 2). Concentrations of Aroclor 1254 ranged from 27 to 1,600 micrograms per kilogram ($\mu\text{g/kg}$) with the highest concentration detected at SS-13. Aroclor 1260 was detected in samples from SS-9, SS-10, and SS-12 at concentrations ranging from 38 $\mu\text{g/kg}$ to 420 $\mu\text{g/kg}$ and was not detected in samples collected from SS-11 and SS-13.
- Organochlorine pesticides were detected in the bank samples and the analytical results are presented in Table 3. Concentrations of the DDX compounds detected this sample group ranged from 1.6 $\mu\text{g/kg}$ to 99 $\mu\text{g/kg}$ for 4,4'DDE, 2.4 $\mu\text{g/kg}$ to 1,300 $\mu\text{g/kg}$ for 4,4'DDD, and 12 $\mu\text{g/kg}$ to

1,600 µg/kg for 4,4'DDT. The soil sample collected from SS-13 had the highest detected concentrations of the DDX compounds, relative to the other samples in this sample group.

- SVOCs that were detected in this sample group consisted primarily of PAHs, phthalates, and, to a lesser extent, phenols and benzyl alcohol. The highest concentrations of PAHs were observed in SS-13, relative to the other bank area samples.

3.4.2 Operable Unit 2 – Eastern Unimproved Area

Three soil samples collected from direct-push explorations B-4 and B-5 and four surface soil samples collected from SS-14 through SS-17 were submitted for analyses of three indicator metals (copper, lead, and zinc). Concentrations of copper ranged from 18.7 to 105 mg/kg, lead from 16.3 to 94.0 mg/kg, and zinc from 63.5 to 183 mg/kg. In accordance with the work plan, the two samples (B-4 [3.5-5.0] and SS-14) with highest detected concentrations were subsequently analyzed for SVOCs, organochlorine pesticides, PCBs, and the remaining TAL metals. In addition, the sample (B-4 [3.5-5.0]) with the highest metals concentrations was analyzed for butyltins. Analytical results for metals are presented in Table 1.

TAL 23 metals were detected in samples B-4 (3.5-5.0) and SS-14 with the exception of antimony, selenium, silver, and thallium. Concentrations of metals detected that exceeded Oregon DEQ (2013) default background metal concentrations were copper at all sample locations, lead at 94.0 mg/kg (B-4 [3.5-5.0]), mercury at 0.87 mg/kg (B-4 [3.5-5.0]), and zinc at 183 mg/kg (B-4 [3.5-5.0]). Butyltin concentrations were detected at B-4 (3.5-5.0) ranging from 150 to 170 µg/kg (Table 1).

The analytical results for organic compounds indicated the following:

- Aroclors 1254 and 1260 were detected in samples B-4 (3.5-5.0) and SS-14 at concentrations ranging from 11 to 14 µg/kg, and Aroclor 1242 was detected in sample B-4 (3.5-5.0) at a concentration of 31 µg/kg. Table 2 presents the analytical results of butyltin and PCB analyses.
- Organochlorine pesticides were not detected in samples SS-14 and B-4 (3.5-5.0), with the exception of 4,4'DDT in sample B-4 (3.5-5.0) at a concentration of 3.7 µg/kg (Table 3).
- SVOCs detected in samples B-4 (3.5-5.0) and SS-14 were primarily PAHs and phthalates (Table 4).

Groundwater analytical results are presented in Table 6. Concentrations of VOCs, SVOCs, PCBs, and organochlorine pesticides were not detected in the groundwater sample (B-4), with the exception of toluene at 4.1 micrograms per liter (µg/L), total xylenes at 1.75 µg/L, and naphthalene at 0.029 µg/L. Dissolved metals were detected in the grab groundwater sample.

3.4.3 Operable Unit 3 — The Gravel Filter Area and Upland Boat Maintenance Repair Area

Gravel Filter Area. Five soil samples collected from test pits TP-2 and TP-3 were submitted for TAL 23 metals. In accordance with the work plan one sample (TP-2 [1.5-2.0]) collected from the within the gravel filter and one sample (TP-2 [4.5-5.0]) collected from the native material below the gravel filter were analyzed for VOCs, organochlorine pesticides, PCBs, and butyltins.

Analytical results for metals are presented in Table 1. TAL 23 metals were detected in the samples collected from the gravel filter, with the exception of selenium and thallium. Concentrations of metals detected that exceeded Oregon DEQ (2013) default background metal concentrations were antimony from 3.1 to 21.9 mg/kg, arsenic at 12 mg/kg, barium at 936 mg/kg, cadmium from 1.3 to 1.8 mg/kg, chromium from 85.2 to 127 mg/kg, copper from 200 to 45,100 mg/kg, lead from 122 to 4,210 mg/kg, mercury from 0.38 to 1.06 mg/kg, nickel at 85.0 mg/kg, silver at 2.3 mg/kg, and zinc from 259 to 1,660 mg/kg. The highest concentrations of metals were typically detected in the samples collected at a depth corresponding to 1.5 to 2 feet bgs, within the gravel filter area.

The analytical results for organic compounds indicated the following:

- Butyltins were detected at the samples from TP-2 with concentrations ranging from 3,000 to 64,000 µg/kg.
- PCBs were detected in the samples from TP-2 with concentrations of Aroclor 1254 at 160 and 400 µg/kg and Aroclor 1260 at 70 and 130 µg/kg. Table 2 presents the analytical results of butyltin and PCB analyses.
- Organochlorine pesticides were not detected in the TP-2 samples, with the exception of gamma-chlordane in TP-2 (4.5-5.0) at 1.5 µg/kg and 4,4'DDD in both samples at concentrations of 6.3 and 51 µg/kg. Organochlorine pesticides results are presented in Table 3.
- SVOCs were detected in both samples from TP-2 and consisted primarily of PAHs and phthalates. Bis(2-ethylhexyl)phthalate concentrations ranged from 1,900 to 7,600 µg/kg and detected concentrations of benzo(a)pyrene ranged from 98 to 620 µg/kg in the samples from TP-2.

Six samples collected from direct-push explorations B-6 through B-8 were submitted for analyses of three indicator metals (copper, lead, and zinc). These metals were detected at concentrations below default background concentrations. Three samples (B-6 [8.5-10.0], B-7 [9.0-10.0], and B-8 [3.0-4.0]) were subsequently analyzed for PCBs and the remaining TAL metals. In addition, sample B-8 (3.0-4.0) was analyzed for organochlorine pesticides and SVOCs (Table 1). TAL 23 metals were detected in samples with the exception of antimony, selenium, silver, and thallium. Concentrations of metals detected did not exceed Oregon DEQ (2013) default background metal concentrations. PCBs, organochlorine pesticides and SVOCs were not detected in the sample B-8 (3.0-4.0).

Concentrations of VOCs, SVOCs, PCBs, and organochlorine pesticides were not detected in the groundwater sample (B-9 [26-30]), with the exception of toluene at 0.70 µg/L and naphthalene at 0.39 µg/L.

Stormwater Manhole. One sediment sample (MH-1) was collected from MH-1 (Figure 6). In accordance with the work plan, this sample was analyzed for SVOCs, organochlorine pesticides, PCBs, metals, and butyltins. Analytical results for metals are presented in Table 1. TAL 23 metals were detected in MH-1 with the exception of beryllium, selenium, and thallium. Concentrations of metals detected that exceeded Oregon DEQ (2013) default background metal concentrations were antimony at 12.5 mg/kg, arsenic at 30.4 mg/kg, cadmium at 72.4 mg/kg, chromium at 540 mg/kg, copper at 4,360 mg/kg, lead at 3,910 mg/kg, mercury at 0.80 mg/kg, nickel at 362 mg/kg, and zinc at 2,740 mg/kg. The analytical results for organic compounds indicated:

- Butyltin concentrations were detected at MH-1 ranging from 4,400 to 10,000 µg/kg.
- Aroclors 1254 and 1260 were detected in the sample MH-1 at concentrations of 580 and 320 µg/kg, respectively. Table 2 presents the analytical results of butyltin and PCB analyses.
- Organochlorine pesticides were not detected in sample MH-1, with the exception of gamma-chlordane, alpha-chlordane, and 4,4'DDD. Organochlorine pesticides results are presented in Table 3.
- SVOCs, primarily PAHs and phthalates, were detected in the sample MH-1. Bis(2-ethylhexyl)phthalate was detected at a concentration of 18,000 µg/kg. Table 4 presents the results of SVOC analysis.

Upland Boat Maintenance Area. One soil sample was collected from direct-push explorations B-9 and submitted for analyses of three indicator metals (copper, lead, and zinc). These concentrations were below DEQ default background concentrations (Table 1).

Groundwater analytical results are presented in Table 6. Concentrations of VOCs, SVOCs, PCBs, and organochlorine pesticides were not detected in the groundwater sample (B-9 [26-30]), with the exception of toluene at 0.70 µg/L and naphthalene at 0.39 µg/L. Dissolved metals were detected in the grab groundwater sample at concentrations below expected background concentrations.

3.4.4 Operable Unit 4 — Former Crane Area

Eight soil samples collected from direct-push explorations B-1 through B-3 were submitted for diesel- and oil-range TPH analysis per NW-TPHDx. Diesel- and oil-range TPH were not detected in soil samples from the former crane area, with the exception of the sample collected from B-2 at a depth of 7 to 8 feet bgs at a concentration of 140 mg/kg. In accordance with the work plan, this sample B-2 (7.0-8.0) was subsequently analyzed for SVOCs, organochlorine pesticides, PCBs, metals, and butyltins. Additional analytical results from this area indicated the following.

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- Analytical results for metals are presented in Table 1. TAL 23 metals were detected in B-2 (7.0-8.0) with the exception of antimony, beryllium, selenium, silver, and thallium. Concentrations of metals detected that exceeded Oregon DEQ (2013) default background metal concentrations were arsenic at 9.8 mg/kg, cadmium at 2.7 mg/kg, copper at 72.7 mg/kg, lead at 139 mg/kg, mercury at 0.63 mg/kg, and zinc at 341 mg/kg.
 - Butyltin concentrations were detected at B-2 (7.0-8.0) ranging from 3.3 to 760 µg/kg (Table 2).
 - PCBs were not detected in the B-2 (7.0-8.0) sample, with the exception of Aroclor 1260 at a concentration of 62 µg/kg. Table 2 presents the analytical results of butyltin and PCB analyses.
 - Organochlorine pesticides were not detected in the sample, with the exception of 4,4'DDE and 4,4'DDT at concentrations of 1.2 and 9.7 µg/kg, respectively. Organochlorine pesticides results are presented in Table 3.
 - SVOCs that were detected in the sample from B-2 (7.0-8.0) were only PAHs. The detected benzo(a)pyrene concentration was 8.8 µg/kg (Table 4).

Groundwater analytical results are presented in Table 6. Concentrations of VOCs, SVOCs, PCBs, and organochlorine pesticides were not detected in the groundwater sample (B-3 [26-30]), with the exception of diethyl phthalate at 0.39 µg/L. Dissolved metals were detected in the grab groundwater sample at concentrations below expected background concentrations.

3.5 Sources, Nature, and Extent of Contamination

Metals (primarily copper and lead), butyltins, PCBs (Aroclor 1254 and 1260), PAHs, and phthalates are the primary contaminants of interest at the site. After considering historical and current land uses in the site and the vicinity, we have identified the following potential sources of the contaminants at the Site:

- Deposition of particulates resulting from on-shore and off-shore sandblasting for bank and upland areas;
- Wash down of sandblasting and/or oily residues to the gravel filter and the bank (via the storm drain near the eastern walkway);
- Anthropogenic background – given the legacy of industrial and river-related land uses at the Site and vicinity, some of the contamination observed on the bank is likely anthropogenic background; and
- In the 1950s and 1960s, Multnomah County with the City of Portland formerly applied DDT. DDT, DDD, and DDE were frequently used to control insects/pests on livestock. The former stockyards south of the site could also be sources of DDT, DDD, and/or DDE.

Based on the results of the EE/CA data gap investigation and the 2008 SI, concentrations of chemicals are primarily confined to the upland areas. The 2008 SI largely did not detect contaminants in offshore

sediment. While the range of sample analysis for sediment samples during the 2008 SI was similarly as extensive as the range of analyses required by EPA for the EE/CA data gap investigation, in sediment, the 2008 SI only identified elevated concentrations of copper at a single location in sediment concentrations. While contaminants are present at upland areas, the relatively clean sediment concentrations provide a line of evidence that conditions are stable and not degrading offshore sediments.

The nature and extent of contamination in each OU is described in the remainder of this section. Figures 7 and 8 summarize the analytical results for the main contaminants of interest at the Site. Figure 7 shows concentrations of arsenic, copper, lead, mercury, and TBT and Figure 8 shows concentrations of organochlorine pesticides (4,4-DDE, 4,4-DDD, 4,4-DDT, and benzo(a) pyrene). The figures also show the data points that exceeded relevant human health screening levels (DEQ RBCs for excavation and construction workers, and EPA RSLs for industrial direct contact).

3.5.1 Operable Unit 1 – Bank Area

Arsenic, lead, Aroclor 1254, and select SVOCs exceeds one or more of the EPA RSL for Industrial Soil Direct Contact and Oregon DEQ RBCs for excavation and construction workers. Concentrations of metals, butyltins, PCBs, DDT, DDD, DDE, PAHs, and phthalates, (among others) are present in bank area samples. Concentrations of these analytes are variable across the bank area. The area generally represented by SS-11 and SS-13 represents the area with the highest relative concentrations in the bank area, which also corresponds to the area of the surface drain. Sample results from this area exceed relevant DEQ and EPA screening levels. Bank samples were collected at a depth of 0.5 foot bgs, with the exception of SS-13 (1.6 feet bgs). Samples collected on the bank downslope of the surface drain (SS-11) exhibited the highest concentrations of SVOCs. The sample collected on the west side of the work shop (SS-9) typically exhibited the highest concentrations of metals, and the sample collected at depth (SS-13) at the location of historical sample location OP02SS exhibited the highest concentration of Aroclor 1254. Butyltins were not analyzed in Bank Area (OU1) samples on a widespread basis. In ship repair situations, like at Pier 99, butyltins occur with other metals derived from sandblasting residuals (e.g., copper and lead). Copper, lead, and other metals act as an indicator for TBT.

3.5.2 Operable Unit 2 – Eastern Unimproved Area

Concentrations of metals, butyltins, PCBs, and PAHs (among others) are present in samples from the Eastern Unimproved Area. The sample results indicate these compounds are limited to surface soil; decreasing concentration trends with depth for copper, lead, and zinc are observed in B-5. The detected concentrations do not exceed EPA RSLs for Industrial Soil Direct Contact, except for the lead concentration in sample WS02SS. Oregon DEQ RBCs for excavation and construction workers were not exceeded in samples collected in surface soils and at depth (3.5-5.0).

3.5.3 Operable Unit 3 — Gravel Filter Area, Upland Boat Maintenance Repair Area, and Surface Drain Sediments

Concentrations of metals, butyltins, PCBs, DDT, DDD, DDE and PAHs (among others) are present within the gravel filter. Samples collected within the gravel filter exceed several relevant DEQ or EPA screening levels. Samples collected below the gravel filter (TP-2 (4.5-5) and TP-3 (1.5-2.0)) and adjacent to the gravel filter (B-6 through B-8) indicate that migration is not occurring laterally or vertically from the gravel filter. Samples from the manhole sediment contain similar concentrations of compounds as detected in the filter. Sample WS02SS, collected from near the expected terminus of the pipe, has concentrations of copper, lead, and TBT that are elevated compared to nearby samples, suggesting that some bank contamination has occurred as a result of the gravel filter operation.

3.5.4 Operable Unit 4 — Former Crane Area

Soil sample results for TPH from B-1 through B-4 were largely not detected. The only sample where TPH was detected was B-2 (7.0 to 8.0). This interval corresponds to the former leave surface of the 2003 SECOR remedial excavation that was terminated due to stability concerns. Concentrations of PCBs, pesticides, and PAHs (among others) were also detected at concentrations that are below applicable human health screening criteria. Target analytes in groundwater were generally not detected. When detected, the detected concentrations were below applicable screening levels.

4.0 Applicable or Relevant and Appropriate Regulations

This section describes the land use and cleanup requirements that apply or may be relevant to a removal action completed for the Site. Removal action activities would likely be completed under the broad permit waiver authority granted to EPA under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. The ARARs represent permit or cleanup conditions that will be upheld during removal action activities. The discussion of ARARs includes land use and permitting ARARs in addition to cleanup ARARs.

4.1 Land Use, Permitting, and Resource Study ARARs

Pen 1 Requirements. Pen 1 manages the Columbia River levee system that comprises the bank. As such, Pen 1 administers and enforces the USACE requirements for working in the levee. Any explorations or excavations within the levee require review from Pen 1 and the USACE, including specific procedures for drilling, excavations, and backfill, and specific procedures for site restoration. Additionally, Pen 1 will limit any removal work in the levee system to periods of low water, commonly encountered during late August and September. Pen 1 monitors the river stage and will approve work based on river stage and predicted weather patterns.

Columbia River Crossing Restoration Plan. The proposed Columbia River Crossing project may likely span the eastern portion of the Site. Final designs are not complete, but preliminary designs to not incorporate bridge structures on the bank of the Site, but restoration of the bank in the project would likely be a requirement for the crossing project. Restoration of the Site following the removal action should consider the requirements of the Draft Conceptual Restoration Plan (November 2012) available at http://www.columbiarivercrossing.org/FileLibrary/TechnicalReports/CRC_OR_JPA_ATT_D.pdf. The Draft restoration plan states:

“The levee on the south side of North Portland Harbor will be disturbed as little as possible. Where grading is unavoidable, the cross-section will be restored and planted to match the adjacent existing conditions...Existing native riparian vegetation will be retained where overhead and adjacent bridge structures and construction access allows. Native shrubs will be used to revegetate the riverbank above the highest average daily high water line...”

City Planning Overlays and Permit Requirements. The site is located within an environmental conservation overlay (c) zone and within a Portland International Airport (PDX) noise abatement overlay.

The Environmental Conservation (c) zone conserves important resources and functional values in areas where the resources and functional values can be protected while allowing environmentally sensitive urban development. This is a development oriented overlay which would not likely result in restrictions for a removal action.

The PDX overlay zone reduces the impact of aircraft noise on development within the noise impact area surrounding the Portland International Airport. The zone achieves this by limiting residential densities and by requiring noise insulation, noise disclosure statements, and noise easements. This is a development-oriented overlay which would not likely result in restrictions for a removal action.

Depending on the volume of soils removed during the removal action, City of Portland Site Development permit requirements could be required for grading. The threshold requirement for a grading permit is 10 cubic yards.

Endangered Species Act Resource Studies. Resource studies required under the Endangered Species Act (e.g., biological assessment) are required for in-water work. The scope of the AO and the scope of the removal actions are limited to areas above the high water line. Therefore, biological assessment and other resource studies required under the Endangered Species Act are not required. At the request of EPA, notice of the removal action will be provided to the National Marine Fisheries Service.

4.2 Federal and State Cleanup and Screening Levels

EPA is requiring preparation of the EE/CA and a possible removal action at the site. EPA's authority for these requirements is based on CERCLA. The state of Oregon has promulgated cleanup regulations (DEQ

Hazardous Substance Remedial Action Rules) under Oregon Administrative Rules (OAR) Division 340-122. In general, Oregon cleanup requirements follow a risk-based approach.

Removal actions are required if there is a release or threat of release into the environment of a hazardous substance, or a release or threat of release into the environment of a pollutant or contaminant which may present an imminent and substantial danger to public health or welfare. This determination must be based on a consideration of the appropriateness of a removal action in relation to several factors:

- Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances or pollutants or contaminants;
- Actual or potential contamination of drinking water supplies or sensitive ecosystems;
- Hazardous substances or pollutants or contaminants in drums, barrels, tanks, or other bulk storage containers that may pose a threat of release;
- High levels of hazardous substances or pollutants or contaminants in soils largely at or near the surface, that may migrate;
- Weather conditions that may cause hazardous substances or pollutants or contaminants to migrate or be released;
- Threat of fire or explosion;
- The availability of other appropriate federal or state mechanisms to respond to the release; and
- Other situations or factors that may pose threats to public health or welfare or the environment.

Principal threat chemicals were evaluated for human health and ecological receptors using EPA's Removal Management Levels (RMLs; EPA, 2012) for human health and adjusted sediment screening levels for ecological risks (EPA does not have removal screening criteria for ecological risks). The human health and ecological principal threat evaluation is described in detail in Section 5.3. The presence of any of the removal action factors listed above, or the presence of principal threat chemicals and a potentially complete exposure pathway, will provide the decision point for whether removal is required.

Oregon's cleanup regulations target risk levels of 10^{-6} excess cancer risk for individual carcinogenic compounds and a hazard index of 1 for non-carcinogenic compounds. These risk levels are applied to applicable exposure pathways such as residential, urban residential, commercial, and construction workers. Non-time-critical removal actions do not account for cleanup to these levels, as these actions are not intended to be final remedial actions. If feasible and at a reasonable cost, the removal actions contemplated for the site will account for cleanup to Oregon's RBCs for the applicable pathways summarized in Section 5.2. Concentrations of metals and chemical compounds in soil may exceed RBCs in parts of the site where removal action is not completed.

5.0 Removal Action Evaluation

The removal action evaluation was prepared in general accordance with the EPA Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA (EPA540-R-93-057; EPA, 1993). The removal action evaluation includes: (1) an evaluation of the potential for contaminants in site soil to migrate to the North Portland Harbor – Columbia River; and (2) removal screening accounting for both human health risks and potential ecological effects to aquatic receptors.

5.1 Land Use Summary

The Site is located in an area of predominantly river-related industrial uses and is zoned IG2 for general industrial use. The surface of the Site is entirely comprised of paved or graveled exterior areas, as well as the on-Site structures. The bank area is vegetated, primarily with blackberries and non-native vegetation. The entire site is located on a levee that is actively managed by Pen 1. Additional river-related industrial property is located adjacent to the Site to the south and west, the I-5 Bridge is located to the east, and the North Portland Harbor – Columbia River is located to the north. No change in land use of the Site is anticipated. Depending on final design details, the proposed Columbia Crossing Bridge may include a portion of the Site.

5.2 Updated Conceptual Site Model

Information regarding current and reasonably likely future land uses and the results of the data gap investigation were used to update the CSM that describes potential human and ecological exposures at the Site. Figure 9 presents the conceptual site exposure model. Exposure pathways have been identified for both current and potential future on-Site receptors and ecological endpoints based on the data gap investigation.

The following constituents have been detected in soil (0 to 15 feet bgs) or within the upland gravel filter area at concentrations above one or more applicable or relevant screening levels (Tables 1 through 4):

- Metals (antimony, arsenic, barium, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc);
- Tri-butyltin;
- Pesticides and PCBs (Aroclor 1254, gamma-chlordane, alpha-chlordane, 4,4' DDE, 4,4' DDD, 4,4' DDT); and
- SVOCs (primarily phthalates and PAHs, also phenol and 4-methylphenol).

On-site receptors include industrial workers, residents, construction workers, and excavation (utility) workers. Potential human health exposure pathways are:

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- Inhalation of dust and particulates; and
 - Direct contact with soil.

The removal action screening considers industrial and occupational exposures. There is a single residence located on the west end of the site that is a rental property. Residential land use screening was not applied during the removal evaluation for the following reasons:

- The predominant land use at the site and immediate vicinity is industrial, and rental properties have tenants that vacate well before the 30-year averaging time for residential exposures.
- The Columbia River Crossing (CRC) project includes a span that passes over or very near the residence (Attachment B). The entire property will be considered a “take” by the Columbia River Crossing. It is understood that the State of Oregon intends to take possession of the entire site via foreclosure or sale as part of the project, and it is unlikely the state would retain this small residence during CRC construction because of its location in proximity to the bridge structure.
- The residential structure is considered a nonconforming upgrade by Pen 1. Zoning and USACE levee management regulations do not allow for residential structures. The zoning designation for the site is General Industrial (IG2) and it is included in the City of Portland Comprehensive Plan as Industrial Sanctuary (IS). Zoning designation, Comprehensive Plan designation, and USACE levee management regulations will prevent redevelopment of the property for residential purposes.
- Should the CRC project not happen, the owner is willing to have the current tenants vacate and discontinue rental of this property for residential uses.

Based on the data gaps identified by EPA in the AO and the conclusions of the E&E SI Report, bank erosion or discharge from storm sewer outfalls, with aquatic species uptake, and fish consumption by humans is a human health pathway that is considered. Based on the general absence of compounds in sediment sampling locations from the E&E SI, this pathway currently appears to be incomplete. In sediments adjacent to Pier 99, organotins, pesticides/PCBs, and SVOCs were not detected, and metals were not detected above background concentrations, except for copper in one sample.

The riverbank would not be considered to be functional riparian habitat. It is largely covered with Himalayan Blackberry and appears to be lacking critical habitat. Additionally, the riverbank at the site is part of a functioning levee that is maintained by Pen 1. Pen 1 maintains vegetation on the bank in a state that prevents erosion and deposition into the river, and implements a monitoring and maintenance program to prevent bank erosion.

VOCs have not been detected at the site, with the exception of toluene and total xylenes at low concentrations in groundwater (below EPA Maximum Contaminant Levels for water). Therefore, the volatilization pathways (vapor intrusion or volatilization to outdoor air) are not considered complete.

Groundwater is not used at the site. Therefore, groundwater ingestion pathways are not considered complete.

Potential ecological endpoints include:

- Potential bank erosion to river sediments or discharge via storm sewer outfall to river sediments.

Terrestrial ecological endpoints are not evaluated in the removal screening due to the industrial character of the site and vicinity, as well as the general lack of habitat.

5.3 Removal Screening

As described previously, removal screening incorporates both a determination of whether a given waste material is present at a concentrations considered to be a principal threat, and determination of the likelihood of a principal threat waste to migrate to a receptor. For human health risks, EPA (2012) developed Removal Management Levels (RMLs) to aid in identifying concentrations of chemical compounds in media that constitute a principal threat. For ecological removal screening, EPA has not published removal screening levels or other specific guidance for incorporating ecological risk into removal actions. EPA requires Removal Actions to address ecological risk when there is an imminent and substantial threat posed to ecological receptors. This EE/CA identifies principal threat chemicals based on the primary ecological endpoint that is protection of aquatic receptors in the Columbia River, North Portland Harbor.

The ecological removal screening incorporates a surrogate approach to DEQ's hot spot criteria for ecological receptors. For the ecological screening, ecological removal screening criteria consisting of 10 times the EPA Region 3 sediment benchmarks, and other applicable sediment screening levels to a limited degree, were used. The surrogate approach was modeled after Oregon's Hazardous Substance Remedial Action Rules for hot spots of contamination (OAR 340-122-115(3) I _ (A) (iii):

OAR 340-122-115(31)(b): For media other than groundwater or surface water (e.g., contaminated soil, debris, sediments, and sludges; drummed waste; 'pools' of dense, non-aqueous phase liquids submerged beneath groundwater or in fractured bedrock; and non-aqueous phase liquids floating on groundwater), if hazardous substances present a risk to human health or the environment exceeding the acceptable risk level, the extent to which the hazardous substances:

(A) Are present in concentrations exceeding risk-based concentrations corresponding to:

(i) 100 times the acceptable risk level for human exposure to each individual carcinogen;

(ii) 10 times the acceptable risk level for human exposure to each individual non-carcinogen;

(iii) 10 times the acceptable risk level for individual ecological receptors or populations of ecological receptors to each individual hazardous substance;

(B) Are reasonably likely to migrate to such an extent that the conditions specified in subsection (a) or paragraphs (b)(A) or (b)(C) would be created; or

(C) Are not reliably containable, as determined in the feasibility study.

Removal screening for TBT accounts for human health risks only. Sediment screening levels are generally not available for TBT because TBT sediment data is commonly used to screen sediments to evaluate whether pore water or fish tissue sampling may be needed. EPA Region 10 does not recommend using sediment data as the basis for remedy selection and recommends that these decisions be made based on pore water or fish tissue sampling results (<http://water.epa.gov/polwaste/sediments/cs/csnews18.cfm>).

PSDDA Issue Paper 10/96 does report a sediment screening value of 73 µg TBT/kg (Michelson et al., 1996). This screening level is a sediment concentration that is used as a decision point in the sediment evaluation process to evaluate whether bioassay testing of pore water is required. The 2008 EPA SI conducted by E&E collected approximately 20 sediment samples offshore of the site. TBT was either not detected or detected at concentrations well below the PSDDA screening level. These results are not included in the summary table of the E&E SI Report (E&E, 2009) but can be found beginning on page 161 of the SI report.

The compounds that exceed these human health and ecological removal screening levels are shown on each data table and highlighted on Figure 10. Figure 10 summarizes the principal threat evaluation. Note that concentrations from the 2013 Data Gap Investigation (Tables 1 through 6) and the historical data (Appendix C) were used for the principal threat evaluation. This figure summarizes compounds that are detected:

- At concentrations above EPA RMLs for human health risk corresponding to 10^{-4} excess human health risks and a HQ of 3 for non-carcinogenic effects; and
- At concentrations greater than 10 times the EPA Region 3 freshwater sediment benchmarks (ecological principal threat criteria).

Shaded values in Tables 1 through 6 indicate concentrations that exceed one or both of the principal threat criteria. The results of the removal screening indicate:

- Concentrations of lead and TBT within the gravel filter or MH-1 sediment exceed EPA RMLs;
- Concentrations of antimony, cadmium, copper, chromium, cadmium, lead, nickel, zinc, DDD, DDT indeno(1,2,3-cd)pyrene, benzo(b)fluoranthene, and bis(2-ethylhexyl) phthalate in gravel filter or MH-1 sediment exceed the ecological principal threat level for migration from upland sources to river sediments via the gravel filter;
- Concentrations of lead at sample point WS02SS in the Eastern Unimproved Area exceed EPA RMLs;
- Concentrations of copper, zinc, and bis (2-ethylhexyl) Phthalate at sample point WS02SS and concentrations of copper and DDD at sample point WS01SS exceed the ecological principal threat level in the Eastern Unimproved Area;
- Concentrations of lead in sample SS-11 exceed EPA RMLs; and

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- Concentrations of copper, lead, antimony, mercury, DDE, DDD, DDT, endosulfan sulfate, indeno(1,2,3-cd)pyrene, benzo(b)fluoranthene, and/or bis(2-ethylhexyl) phthalate exceed the ecological principal threat level in bank area sample locations.

The presence of metals, TBT, pesticides, phthalates, and PAHs in the gravel filter and MH-1 sediments indicates principal threat wastes are contained in the gravel filter and the associated discharge line. These concentrations and their locations within the gravel filter system suggest a removal is necessary. In this case, principal threat wastes and a migration pathway are present.

Metals pesticides, phthalates, and PAHs were detected along the bank at concentrations that exceed the RMLs or the ecological criteria (10x EPA Region 3 sediment benchmarks). As described previously, the bank is maintained by Pen 1 as part of a functioning levee system. For this reason, clearing of the bank during the removal action was not permitted at the time of the data gap investigation. It is the goal of Pen 1's management and inspection program to maintain the levees in a condition that prevents bank erosion, and thereby the potential for deposition in the river. However, because of the very dense nature of the vegetation, it was not feasible to provide a determination that the bank is stable. Therefore, it is not known if a pathway is present from the bank to the water.

Two sample locations in the Eastern Unimproved (WS01SS and WS02SS) have concentrations of chemicals detected that exceed either RMLs or the ecological principal threat criteria. The detected concentrations in the remainder of the sample locations from the Eastern Unimproved Area do not exceed these criteria.

6.0 Identification of Removal Action Objectives

Removal Action Objectives (RAOs) are medium-specific goals for removing or managing imminent threat to human health and the environment and provide the framework for developing and evaluating removal action alternatives. RAOs were developed to address pathways that pose imminent threats by minimizing migration or removing site contaminants.

RAOs are site-specific goals for protecting human health and the environment established on the basis of the nature and extent of the contamination, resources that are currently and potentially threatened, and the potential for human and environmental exposure. The RAOs specify the contaminants of concern, potential exposure routes and receptors, and acceptable contaminant concentrations (or range of acceptable contaminant concentrations for each exposure route).

Based on current site data and evaluations of potential risk, contaminants of concern for removal include metals (primarily copper and lead), TBT, organochlorine pesticides (primarily DDE, DDD, DDT, and endosulfan sulfate), PAHs (indeno(1,2,3-cd)pyrene, benzo(b)fluoranthene), and bis(2-ethylhexyl) phthalate. The removal evaluation identified that these contaminants of concern in soil constitute principal threat

chemicals for human health exposure or migration to North Portland Harbor – Columbia River. Therefore, the RAOs include:

- Prevent direct contact by workers (industrial, excavation, and construction) to contaminated soil in excess of RMLs; and
- Prevent migration of contaminated soils to the North Portland Harbor – Columbia River.

6.3 Removal Action Areas

The Removal Action Area (RAA) consists of portions of the Site where contaminants of concern are present in excess of RMLs or the site-specific ecological criteria of 10 times the EPA Region 3 freshwater sediment benchmarks. These areas include:

- Operable Unit 1 – Bank Area (including the vicinity of sample WS02SS); and
- Operable Unit 3 – Gravel Filter Area and Upland Boat Maintenance Repair Area.

The proposed removal area for the Bank Area is shown on Figure 11. Concentrations of metals or pesticides at SS-9, SS-11, SS-13, OP02SS, and SS-14 constitute principal threat material. Based on the results from the SS-10/SS-18 sample pair, principal threat material appears to be limited to the first 12 inches of soil. While one data point is insufficient to fully describe the interval over which principal threat material may be present, the contaminants of concern generally have low solubility, suggesting the vertical extent of contamination is limited.

At the Eastern Unimproved Area, the only sample results that exceed the removal screening criteria are samples WS01SS and WS02SS. Removal action is not proposed to account for this OU. Also, given its location, sample WS02SS is more appropriately considered a bank sample. As a component of the gravel filter removal action (OU3), excavation to remove contaminated soil at the end of the gravel filter discharge pipe will be completed. Soil removal at the location of sample WS02SS is included as a component of this removal action. Soil removal at sample location WS01SS is not planned based on a single sample and the location of WS01SS is not located in area where overland transport to the river is a complete transport pathway.

The proposed removal area for the Gravel Filter Area is shown on Figure 11. Principal threat chemicals are present within the gravel filter and the discharge pipe. Because the gravel filter is connected to a discharge pipe that extends to the bank area, the pathway between the gravel filter and a discharge point near the river constitutes a complete exposure pathway. Removal would address migration from the gravel filter, and migration within the drainage pipe to the discharge point.

7.0 Technology Evaluation and Removal Action Alternative Development

Removal action alternatives were conceptually reviewed with EPA prior to preparing this EE/CA in email correspondence and teleconferences. Based on these discussions, the list of removal action alternatives to be considered includes:

- OU3 – Remove gravel filter, clean and plug discharge line;
- OU3 – Remove gravel filter, clean and remove discharge line;
- OU3 – Cap gravel filter, clean and plug discharge line;
- OU1 – Bank stabilization; and
- OU1 – Bank soil removal and stabilization.

As described in Section 1.1, the removal alternatives are evaluated in this section using the three criteria below.

- Effectiveness. Effectiveness pertains to the ability to meet the objectives and relative permanence within the scope of the removal action. The effectiveness criterion also considers short-term risks to the community during implementation, potential for risks to the environment during implementation, and the timeframe for the removal action.
- Implementability. Implementability refers to the ease or difficulty of implementing the removal action, considering technical, mechanical and regulatory requirements, as well as the availability of equipment and services to needed to complete the removal action.
- Cost. Cost criteria consider both the capital and the operation and maintenance (O&M) costs of the proposed technology, compare costs between technologies, and compare the cost of the technology to the resulting benefits.

7.1 No Action

This alternative consists of no further action and leaving the Site in its current condition. Implementation of the No Action alternative would not reduce the risks to human or ecological receptors.

Effectiveness. This alternative is not considered effective. The No Action alternative does not meet the removal objectives. Since no remedial action is completed, the No Action alternative can be implemented in a reasonable time frame.

Implementability. Because there are no actions taken, the No Action alternative can be readily implemented.

Cost. There are no costs associated with the No Action alternative.

7.2 OU3 – Remove Gravel Filter, Clean and Plug Discharge Line

This alternative would include the physical removal of the waste soil and debris (collectively, waste materials) from the gravel filter, the disposal of the waste materials at an approved solid waste landfill, the cleaning of the discharge line to remove contaminated sediments, and plugging the line to remove the pathway to the bank area. The excavation would include the full depth of the gravel filter (identified by the presence of the large-diameter filter rock) and 6 to 12 inches of underlying soil overexcavation. Confirmation sampling would be completed for any component of the removal action involving soil excavation. Additional excavation will be completed for the gravel filter and discharge pipe removal if confirmation sampling results indicate that soil concentrations exceed the EPA RMLs.

To reduce the cost of waste materials disposal, the material excavated from the gravel filter may be screened through a mechanical screen to separate the filter rock from the finer-grained soil (less than 1 inch in size) and waste materials. The rock fraction would be retained for use as backfill. Based on the sieve analysis done on the gravel filter material, it is expected that approximately 75 percent of the excavated volume would consist of the filter rock and would be retained. The remaining soil/waste fraction would require off-site disposal. Salvageable debris (i.e., large metal or woody debris) would be removed and recycled. The decision regarding screening will be made once contractor bids for the work are received. The EE/CA work plan will address the final design parameters with respect to the screening operations, and also present the methodology that will be utilized to confirm the screening sufficiently removes soil that has adhered to the rock matrix.

Confirmation sampling of the gravel filter excavation bottom and sidewalls would be used to document the effectiveness of the excavation alternative. Based on the available data, it is expected that removal of the gravel filter rock will remove the contaminated materials such that the gravel filter will no longer pose a threat to long-term human health. The screened rock fraction would also be used as fill elsewhere on the site. The gravel filter excavation will be backfilled with clean sand and compacted. Pen 1 will require that compaction testing be performed and that PEN 1 receive a copy of the results.

This alternative also includes the plugging of the discharge line from the filter and a limited excavation (estimated at 10 cubic yards) with confirmation sampling from the distal end of the discharge pipe to remove anticipated contaminated materials (including sample locations WS02SS). The end of pipe excavation is proposed to remove concentrated soils that may be located at the end of the pipe and to remove soils around sample location WS02SS. Additional excavation at the end of the pipe is not planned based on confirmation sampling results because this location is physically located on the bank (OU1). The need for any additional excavation would be managed under the removal action for the bank area (OU1).

During the data gap investigation, the end of the pipe could not be located. It is suspected that the pipe terminates near sample WS02SS, and this sample is assumed to be indicative of conditions at the end of the pipe. The end of the pipe will be located by excavation. Following cleaning and soil removal, each end of the pipe would be sealed with grout.

The implementation of the excavation alternative would provide protection immediately after completion by the removal of the gravel filter waste material and discharge pipe sediment. Potential future migration to the bank area would be mitigated by the plugging of the drain line.

Effectiveness. The excavation and discharge plugging alternative is considered effective, as follows.

- This alternative protects human health and the environment by physically removing the contaminant mass from the gravel filter and containing it in a managed waste facility. Plugging the discharge pipe prevents future contaminant migration to the bank area via the discharge pipe.
- The alternative complies with the cleanup standards by physical removal of the contaminant mass.
- Based on the data set for the gravel filter, gravel filter removal will reduce long-term human health risks to acceptable levels because the contaminated soil mass is expected to be removed.
- The alternative includes confirmation sampling of the excavation extent at the filter and end of pipe removal areas to demonstrate the effectiveness of the remedy.
- There is little risk to the community during implementation. All loads would be covered leaving the site during transport to the landfill. Work associated with this alternative will be completed well above the high water mark, which limits the potential for adverse effects to aquatic receptors in the river.

Implementability. This alternative is considered readily implementable, with the following considerations:

- This alternative relies on common earth moving equipment to complete the removal.
- This alternative requires coordination with Pen 1 and must be conducted during a low water work window (anticipated August and September).
- Erosion controls following the City of Portland Erosion Control Manual during and after implementation, including temporary erosion control Best Management Practices (BMPs) installed above the high water line.

Cost. The estimated cost for this alternative is \$77,000. The design/construction cost is estimated to be approximately \$50,000. The remaining costs (\$27,700) include the completion report and a 30% contingency. There are no long-term operational costs associated with this alternative. A breakdown of the cost estimate is provided in Appendix G.

7.3 OU3 – Remove Gravel Filter, Clean and Remove Discharge Line

This alternative would include the physical removal of the waste soil and debris (collectively, waste materials) from the gravel filter, disposal of the waste materials at an approved solid waste landfill, cleaning the discharge line to remove contaminated sediments, and the physical removal of the full length of the discharge line to remove the pathway to the bank area. The filter excavation would include the full depth of the filter (identified by the presence of the large-diameter filter rock) and 6 to 12 inches of underlying soil overexcavation. Confirmation sampling would be completed for any component of the removal action involving soil excavation. Additional excavation will be completed if confirmation sampling results indicate that soil concentrations exceed the EPA RMLs.

To reduce the cost of waste materials disposal, the material excavated from the gravel filter may be screened through a mechanical screen to separate the filter rock from the finer-grained soil (less than 1 inch in size) and waste materials. The rock fraction would be retained for use as backfill. Based on the sieve analysis done on the gravel filter material, it is expected that approximately 75 percent of the excavated volume would consist of the filter rock and would be retained and the remaining soil/waste fraction would require off-site disposal. Salvageable debris (i.e., large metal or woody debris) would be removed and recycled (assumed to be 10 percent of the excavated volume). The decision regarding screening will be made once contractor bids for the work are received. The EE/CA work plan will address the final design parameters with respect to the screening operations, and also present the methodology that will be utilized confirm the screening sufficiently removes soil that has adhered to the rock matrix.

Confirmation sampling of the gravel filter excavation bottom and sidewalls would be used to document the effectiveness of the excavation alternative. Based on the available data, it is expected that removal of the gravel filter rock would remove the contaminated materials such that the gravel filter would no longer pose a threat to long-term human health. The screened rock fraction would also be used as fill elsewhere on the site. The gravel filter excavation will be backfilled with clean sand and compacted. Pen 1 will require that compaction testing be performed and that PEN 1 receive a copy of the results.

This alternative also includes the removal of the discharge line from the filter and a limited excavation (estimated at 10 cubic yards), with confirmation sampling, from the distal end of the discharge pipe to remove anticipated contaminated materials (including sample locations WS02SS). The end of pipe excavation is proposed to remove concentrated soils that may be located at the end of the pipe and to remove soils around sample location WS02SS. Additional excavation at the end of the pipe is not planned based on confirmation sampling results because this location is physically located on the bank (OU1). The need for any additional excavation would be managed under the removal action for the bank area (OU1).

During the data gap investigation, the end of the pipe could not be located. It is suspected that the pipe terminates near sample W202SS. Following the removal of sediment from the pipe, the full length of the pipe would be removed by excavation (together with the additional excavation at the end of the pipe). The

pipe excavation would be backfilled with clean imported rock and compacted to a visibly non-yielding condition.

The implementation of the excavation alternative would provide protection immediately after completion by the removal of the gravel filter waste material and discharge pipe sediment. Potential future migration to the bank area would be mitigated by the removal of the drain line.

Effectiveness. The excavation and discharge pipe removal alternative is considered effective, as follows.

- This alternative protects human health and the environment by physically removing the contaminant mass from the gravel filter and containing it in a managed waste facility. Removal of the discharge pipe prevents future contaminant migration to the bank area via the discharge pipe.
- The alternative complies with the cleanup standards by the physical removal of the contaminant mass.
- Based on the data set for the gravel filter, gravel filter removal will reduce long-term human health risks to acceptable levels because the contaminated soil mass is would be removed.
- The alternative includes confirmation sampling of the excavation extent at the filter and end of pipe removal areas to demonstrate the effectiveness of the remedy.
- There is little risk to the community during implementation. All loads would be covered leaving the site during transport to the landfill. Work associated with this alternative will be completed well above the high water mark, which limits the potential for adverse effects to aquatic receptors in the river.

Implementability. This alternative is considered readily implementable, with the following considerations.

- This alternative relies on common earth moving equipment to complete the removal.
- This alternative requires coordination with Pen 1 and must be conducted during a low water work window (anticipated late August and September).
- Erosion controls following the City of Portland Erosion Control Manual during and after implementation, including temporary erosion control BMPs installed above the high water line.

Cost. The estimated present worth cost for this alternative is \$88,000. The design/construction cost is estimated to be approximately \$57,700. The remaining costs (\$30,300) include the completion report and a 30% contingency. There are no long-term operational costs associated with this alternative. A breakdown of the cost estimate is provided in Appendix G.

7.4 OU3 – Cap Gravel Filter, Clean and Plug Discharge Line

Description. Under this alternative, an engineered cap, consisting of Portland cement concrete (or similar material) will be installed over the gravel filter to prevent direct contact with soil. The cap also protects the impacted media from erosion. In addition, the alternative would include cleaning existing sediment from the gravel filter discharge pipe and plugging the pipe to prevent discharge from the gravel filter into nearby the North Portland Harbor. In concept, a cap would consist of at least a 4-inch-thick layer of Portland cement concrete over the gravel filter rock. Cap design would be completed by a registered Professional Engineer consistent with commonly accepted engineering practices. Oregon's cleanup rules do not have minimum requirements for cap design. Caps are designed and constructed for a specific purpose. For example, caps that are covering leachable materials are designed to prevent infiltration and direct water away from the contaminated area. When non-leachable materials are being covered, soil covers are suitable. Because this EE/CA is intended to evaluate and select a removal alternative, design level details are not required. Should a cap be selected as a final remedy, EPA will have an opportunity to comment on all aspects of the cap design before approval and implementation. Confirmation sampling would be completed for any component of the removal action involving soil excavation, and additional excavation may be required based on the confirmation sampling results.

This alternative also includes a limited excavation (estimated at 10 cubic yards) with confirmation sampling from the distal end of the discharge pipe to remove anticipated contaminated materials (including sample locations WS02SS). The end of pipe excavation is proposed to remove concentrated soils that may be located at the end of the pipe and to remove soils around sample location WS02SS. Additional excavation at the end of the pipe is not planned based on confirmation sampling results because this location is physically located on the bank (OU1). The need for any additional excavation would be managed under the removal action for the bank area (OU1).

During the data gap investigation, the end of the pipe could not be located. It is suspected that the pipe terminates near sample WS02SS. The end of the pipe will be located by excavation. Following cleaning and soil removal, each end of the pipe would be sealed with grout.

This removal action alternative protects people and the ecological migration pathway, although exposures to impacted soil could occur in the future if all or portions of the cap were removed or disturbed.

A cap management plan would be used to define how soil at the site would be managed in the future (such as might be associated with future construction activity). It is expected that the contamination left in place and capped would persist indefinitely (i.e., the inorganics would not be expected to degrade with time) and the cap would require ongoing inspection and maintenance to ensure its integrity. Long-term cap management requirements would be memorialized in a restrictive covenant.

Effectiveness. The capping of the gravel filter and discharge pipe plugging would be considered effective, as follows.

- This alternative protects human health and the environment using engineering controls that will prevent direct contact with contaminants in the gravel filter.
- The results of the EE/CA data gap investigation show that the chemicals detected in the gravel filter are not migrating to or within groundwater. However, if the capping alternative is explored further, leachability testing would be required to document the gravel filter chemicals are not mobile.
- Plugging the gravel filter discharge pipe will prevent future transport of contaminants to the bank area.
- The alternative includes confirmation sampling of the excavation extent at the end of pipe removal area to demonstrate the effectiveness of the remedy.
- There is little risk to the community during implementation. All loads would be covered leaving the site during transport to the landfill. Work associated with this alternative will be completed well above the high water mark, which limits the potential for adverse effects to aquatic receptors in the river.

Implementability. This alternative is considered to have poor implementability, with the following considerations:

- This alternative relies on common earth moving equipment to complete the removal.
- This alternative requires elevation survey and engineering design to provide suitable grades for stormwater flow away from the cap area.
- This alternative requires approval and recording of a restrictive covenant from the state (property owner of the parcel where the gravel filter is located). There is no guarantee that the property owner would agree.
- This alternative requires a cap maintenance plan, annual inspections, reporting, and ongoing maintenance for an indefinite period.
- This alternative requires coordination with Pen 1 and must be conducted during a low water work window (anticipated late July or early August).
- Erosion controls following the City of Portland Erosion Control Manual during and after implementation, including temporary erosion control BMPs installed above the high water line.

Cost. The estimated present worth cost for this alternative is \$127,000. The design/construction cost is estimated to be approximately \$43,400, and the present-worth long-term costs (inspections and maintenance) come to a total of \$36,000 over the next 30 years. The remaining costs (\$47,200) include the

completion report, cap management plan, and a 30% contingency. A breakdown of the cap cost estimate is provided in Appendix G.

7.5 OU1 – Bank Stabilization

Description. The bank is heavily vegetated with invasive blackberry bushes, which were not permitted to be cleared during the data gap investigation. This alternative manages contamination that is located in the bank in place, and prevents potential migration from the bank to the river through a combination of jute matting and re-vegetation. These actions represent the minimum stabilization techniques that will be implemented under the supervision of a geotechnical engineer or engineering geologist. Under this alternative, current vegetation (blackberries) would be removed from the bank adjacent to the work shop and former crane engine pad. Following removal of the vegetation, the bank will be inspected by a geotechnical engineer or engineering geologist in order to make a determination of whether additional bank stabilization requirements, beyond the measures discussed below, are needed.

The area would be cleared of debris and reinforced with jute matting or a similar material. Topsoil would be added (6-inch thickness) and the bank would be planted with grass (Pen 1's specified vegetation for levee improvements). This alternative would require compliance with the City of Portland Erosion Control Manual during and after implementation, including temporary erosion control BMPs installed above the high water line.

This alternative relies on owner maintenance of the bank for a period of one year to continue removal of blackberries and other invasive vegetation that returns while the grass on the bank is being established. After one year, the bank would be returned to management by Pen 1, who, through their monitoring and maintenance programs, would be responsible for long-term maintenance moving forward.

The Removal Action Report that would be prepared subsequent to the removal action would include a comprehensive discussion of the contaminants that remain in the bank area and the responsibility for monitoring and maintenance of the bank by Pen 1 and/or the owner during the interim period prior to the state taking possession of the property. The information will be presented in sufficient detail for the state to utilize the information to plan and implement an appropriate monitoring program once the state takes possession of the site.

Effectiveness. The bank stabilization alternative is considered effective, as follows.

- This alternative protects human health and the environment through the use of stabilization techniques (grading, erosion control fabric) and re-vegetation to prevent migration of suspended sediments from upland areas to the river and also to stabilize contamination within the bank ; and
- Regular inspection of the bank will be used to document the effectiveness of the remedy at preventing erosion and allow for timely maintenance as needed.

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- There is little risk to the community during implementation. No contaminated soil would be transported from the site.

Implementability. This alternative is considered to be readily implementable, with the following considerations:

- This alternative relies on common earth moving equipment to complete the removal.
- This alternative requires intensive monitoring and maintenance over a period of approximately one year to permanently remove invasive vegetation.
- Long-term inspection and maintenance is consistent with existing Pen 1 responsibilities.
- This alternative requires coordination with Pen 1 and must be conducted during a low water work window (anticipated late July or early August).
- Erosion controls following the City of Portland Erosion Control Manual during and after implementation, including temporary erosion control BMPs installed above the high water line.

Cost. The estimated present worth cost for this alternative is \$95,000. The design/construction cost is estimated to be approximately \$63,000. The remaining costs (\$32,000) include the completion report, soil management plan, and a 30% contingency. A breakdown of the cost estimate is provided in Appendix G. Long-term inspection and maintenance costs are not included in this analysis as this would be under the purview of Pen 1.

7.6 OU1 – Bank Removal and Stabilization

The bank is heavily vegetated with invasive blackberry bushes, which were not permitted to be cleared during the data gap investigation. Under this alternative, the bank material with the highest relative concentrations of contaminants would be excavated and the remainder of the bank would be stabilized as described in Section 7.5. To estimate the volume of soil that would be removed under this alternative, the bank area was divided into representative sub-areas around each of the sample locations (such that any location within the sub-area is closest to the representative sample location). An analysis of the efficiency of removing each sub-area was done to determine which areas would benefit most from removal, with each sub-area ranked in order of efficiency (the highest ranking given to those sub-areas where the most mass is removed in the least soil volume). As a result of this analysis, the majority of the contaminant mass would be removed by excavating a total volume of 130 cubic yards around samples OP02SS, SS-13, SS-11, and SS-9 (in descending order of efficiency) – a total of 92 percent of the known contaminant mass is removed in these sub-areas by excavating 54 percent of the bank area volume. Confirmation sampling following removal will be used to confirm the removal objectives have been met.

Following the completion of the bulk excavation, remaining vegetation would be removed from the bank and the bank will be inspected by a geotechnical engineer in order to make a determination of whether additional bank stabilization requirements, beyond the measures discussed below, are needed.

Excavations would be graded with the other bank materials into a consistent profile. Topsoil, beyond the layer described below, may be placed if low spots are present and a consistent profile cannot be achieved. The bank area would be cleared of debris and reinforced with jute matting or a similar material. Topsoil would be added (minimum 6-inch thickness) across the entire bank area and would be planted with grass (Pen 1's specified vegetation for levee improvements). This alternative would require compliance with the City of Portland Erosion Control Manual during and after implementation, including temporary erosion control BMPs installed above the high water line.

This alternative relies on owner maintenance of the bank for a period of one year to continue removal of blackberries and other invasive vegetation that returns while the grass on the bank is being established. After one year, the bank would be returned to management by Pen 1. Pen 1, through their monitoring and maintenance programs, would be responsible for long-term maintenance moving forward.

The Removal Action report that is prepared subsequent to the removal action will include a comprehensive discussion of the contaminants that remain in the bank area and the responsibility for monitoring and maintenance of the bank by Pen 1 and/or the owner during the interim period prior to the state taking possession of the property. The information will be presented in sufficient detail for the state to utilize the information to plan and implement an appropriate monitoring program once the state takes possession of the site.

Effectiveness. The bank stabilization alternative is considered effective, as follows.

- This alternative protects human health and the environment by removing areas of higher contamination and stabilizing the bank, preventing future migration of contaminants to the river.
- This alternative reduces potential long-term risks by: (1) removing the most heavily contaminated soils from the bank area; and (2) using of stabilization techniques (grading, erosion control fabric) and re-vegetation to prevent migration of suspended sediments from upland areas to the river and also to stabilize contamination within the bank.
- Regular inspection of the bank will be used to document the effectiveness of the remedy at preventing erosion and allow for timely maintenance as needed.
- There is little risk to the community during implementation. All loads would be covered leaving the site during transport to the landfill.

Implementability. This alternative is considered to be readily implementable, with the following considerations:

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- This alternative relies on common earth moving equipment to complete the removal.
 - This alternative requires intensive monitoring and maintenance over a period of approximately one year to permanently remove invasive vegetation.
 - Long-term inspection and maintenance is consistent with existing Pen 1 responsibilities.
 - This alternative requires coordination with Pen 1 and must be conducted during a low water work window (anticipated late July or early August).
 - Erosion controls following the City of Portland Erosion Control Manual during and after implementation, including temporary erosion control BMPs installed above the high water line.

Cost. The estimated cost for this alternative is \$153,000. The design/construction cost is estimated to be approximately \$107,700. The remaining costs (\$45,300) include the completion report, and a 30% contingency. A breakdown of the cost estimate is provided in Appendix G.

8.0 Comparative Analysis of Removal Action Alternatives

Following the analysis of each of the retained removal action alternatives in Section 7 above, a comparative analysis of each alternative was completed as a means of ranking the removal action alternatives the operable units where removal action will be completed.

The comparative analysis is a one-to-one assessment of the relative merits of each alternative for each of the evaluation criteria. Table 7 summarizes the comparative analysis for both the OU1 alternatives and the OU3 alternatives (each set of alternatives are considered independently). For each comparison, the individual alternatives were ranked as favorable (+), equal (0), or unfavorable (-) in relation to the other alternative(s) for each of the evaluation criteria. The rankings of (+), (0), or (-) were given a score of 1, 0, or -1, respectively. The scores are summed at the right of the table for each alternative, and the alternatives are ranked from most to least favorable.

8.1 Gravel Filter Area Alternatives

For the gravel filter area, the following alternatives were evaluated:

- No action
- Remove gravel filter, clean and plug discharge line;
- Remove gravel filter and remove discharge line; and
- Cap gravel filter, clean and plug discharge line.

Effectiveness. All three alternatives (not including No Action) either remove or manage contaminated soils and mitigate the possibility of future transport to the river. The two removal alternatives were considered to be more effective than capping, primarily because the contaminated soil within the gravel filter is removed. The pipe removal alternative is marginally more effective than the plugging alternative as plugging relies on the long-term integrity of the plug to remain effective. No Action is not considered an effective removal alternative because it does not account for any actions to remove contamination or manage contamination pathways.

Implementability. The No Action alternative is considered to be the most implementable alternative since it does not include any site activity. The two removal alternatives are considered to be similarly implementable. Both rely on removal of contaminants in the gravel filter area, using essentially the same equipment. The pipe removal alternative, however, includes more excavation volume and is therefore marginally less implementable. Capping is considered the least implementable alternative, primarily because the gravel filter is located on an adjacent, off-Site property, which will make access and the process of enacting a restrictive covenant difficult. Capping will require a modest site-specific engineering design effort to ensure final grades adequately convey stormwater from the cap area, and long term monitoring for an indefinite period of time.

Cost. The total present-worth costs for the alternatives are summarized as follows:

- OU3 – Remove gravel filter, clean and plug discharge line - \$77,000
- OU3 – Remove gravel filter, clean and remove discharge line - \$88,000
- OU3 – Cap gravel filter, clean and plug discharge line - \$127,000

8.2 Bank Area Alternatives

For the bank area, the following alternatives were evaluated:

- No action
- Bank stabilization; and
- Bank soil removal and stabilization.

Effectiveness. Two of the alternatives (not including No Action) either remove or manage contaminated soils and eliminate the possibility of future transport to the river. Both alternatives will prevent migration of contaminants in bank soils to the river. The Bank Stabilization alternative is considered slightly more effective because it limits the potential for disturbance and subsequent shoreline impacts. No Action is not considered an effective removal alternative because it does not account for any actions to remove contamination or manage contamination pathways.

Implementability. The No Action alternative is considered to be the most implementable alternative since it does not include any site activity. The Bank Stabilization alternative was considered to be more implementable because Pen 1 and USACE will seek to avoid actions that could compromise the levee. Both will require the use of earth moving equipment on the bank and will be subject to the same Pen 1 requirements for work on a USACE jurisdictional levee.

Cost. The total present-worth costs for the alternatives are summarized as follows:

- OU1 — Bank Stabilization - \$95,000
- OU1 — Bank Stabilization with Removal - \$153,000

9.0 Recommended Removal Action Alternative

Based on the results of this EE/CA, the recommended removal actions for the Site are OU3 Gravel Filter Removal and Pipe Removal and OU1 Bank Stabilization. These alternatives were selected for the following reasons.

- OU3 gravel filter and discharge pipe removal removes the potential for exposure for future Site workers and prevents migration to the river. OU1 Bank stabilization and maintenance by the owner and Pen 1 will prevent migration of contaminants in the bank to the river. Soil in the vicinity of WS02SS (OU2) would also be removed as part of the OU3 gravel filter discharge pipe removal.
- The OU1 gravel filter and discharge pipe removal is a permanent action. This alternative also eliminates the difficulty of maintaining a cap off-Site.
- OU1 bank stabilization, while interim, will remove vegetation and debris and result in conditions that will result in the least levee disturbance and be more acceptable to Pen 1 and USACE. Vegetation that will be planted consistent with USACE requirements will also be consistent with the Draft restoration plan for the Columbia River Crossing project (see discussion in Section 4.1).
- The timeframe to implement the OU 1 and OU3 removal is reasonable.

9.1 Biological Evaluation

The proposed removal action will take place entirely above the high water mark. This will not trigger requirements for Biological Assessment under the Endangered Species Act (ESA).

The Oregon Biodiversity Information Center (OBIC) was contacted to conduct a database search within a 2-mile radius of the site for the purpose of providing a database search of protected species that may be present or have been observed. The database report indicated records of 27 protected plants and terrestrial, avian, and aquatic species. Additionally, EPA conducted a search of the United States Fish and

Wildlife Service (USFW) database of threatened and endangered species. EPA identified that 16 ESA protected aquatic species were present in the Columbia River.

The scope of the removal action is either: (1) within improved areas of the Site; or (2) within levees that are under the jurisdiction of the USACE and management of Pen 1. Neither of these already-improved areas represent critical habitat for avian or terrestrial species. The removal action will be conducted adjacent to the North Portland harbor - Columbia River, which provides habitat for aquatic receptors including ESA listed salmonids.

Based on the habitat characteristics for each species and the location (urban industrialized), size (<1.0 acre) and condition (urban, industrialized) of the project site, EPA determined that it is highly unlikely that any ESA-listed or proposed species would be present on the project site. Therefore, the EPA determined that cleanup activities on the Pier 99 site would result in discountable effects and therefore constitute a "No Effect" determination.

9.2 Cultural Resource Evaluation

The proposed removal action will take place entirely in areas of the site that are already developed or otherwise improved. The Oregon State Historic Preservation Office (SHPO) was contacted to conduct a database search of cultural resources at the site or vicinity. SHPO replied that there are no records of cultural resource surveys conducted within the immediate site vicinity. SHPO cautioned that excavation should cease immediately if possible cultural resources are identified during excavation.

Archeological resources have been evaluated within the footprint of the CRC project. The CRC website at: http://www.columbiarivercrossing.org/PublicMeetings/OpenHouses/Sec106_OH.aspx describes that no archaeological resources have been identified, although analysis of the sediments from borehole investigations suggests archaeological resources may be preserved in the deep soils along the shore.

The recommended removal action excavation includes site grading, and re-vegetation at a facility that was previously constructed on an artificial levee system. Based on the shallow nature of these activities and that the activities are confined to the artificial levee, encountering cultural resources is not anticipated. If conditions are encountered that suggest an unanticipated discovery, excavation will cease in this area. The SHPO office will be notified and a qualified archeologist will be retained to determine if cultural resources are present and to assist with devising an excavation plan.

9.3 Removal Action Data Gaps

The data set along the bank and at the end of the gravel filter outfall represent a minimum amount of data sufficient for identifying and evaluating a removal action. Once vegetation is cleared, additional sampling

will be required in order to confirm that removal at the end of the gravel filter discharge pipe has been completed to a sufficient extent.

9.4 Removal Schedule

The removal schedule is dependent on the negotiation of a new administrative order with EPA. Work is limited to periods of low water in the Columbia River that commonly occur in August and September. PEN 1 monitors the river stage and will approve work based on river stage and predicted weather patterns. Assuming the new administrative order is prepared by mid-July 2013, 30 days will be required for Removal Action Work Plan (design document) and procurement, assuming EPA's permit waiver authority under the Superfund Program is utilized. The removal action will require approximately 2 weeks to complete.

10.0 References

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