Source Control Alternative Evaluation Terminal 4 Slip 1 Upland Facility Operable Unit 2

Port of Portland
Portland, Oregon 97209

February 2007

NEWFIELDS

Ash Creek Associates, Inc.
Environmental and Geotechnical Consultants

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Respectfully submitted,

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Executive Summary

This report presents the Source Control Alternatives Evaluation for potentially erodible riverbank soils located at the Port of Portland Terminal 4 Slip 1 Operable Unit 2 in Portland, Oregon.

A remedial investigation (RI) is being conducted at Terminal 4 Slip 1 (the Facility) and has included sampling of potentially erodible riverbank soil. Soil on the riverbank in the vicinity of Wheeler Bay and Slip 1 contained concentrations of polycyclic aromatic hydrocarbons (PAHs), metals, and/or pesticides above screening levels for human and ecological receptors. An Early Action (EA) is currently under design to address sediments at Terminal 4, including Slip 1 and in Wheeler Bay. Among other actions, the EA will include a confined disposal facility in Slip 1 and a sediment cap in Wheeler Bay. Construction of the confined disposal facility will address potentially erodible soil on the bank of Slip 1 and the sediment cap in Wheeler Bay will extend to ordinary high water. Therefore, a source control measure (SCM) for the Wheeler Bay erodible soils above ordinary high water was deemed prudent.

General approaches for source control of the soil on the Wheeler Bay bank were identified and screened. Bank stabilization technologies were identified as the most feasible for the site conditions and evaluation criteria. Based on a further screening of potentially applicable stabilization technologies, the following source control alternatives were evaluated in detail:

- Riprap Armoring;
- Articulated Concrete Block (ACB) Armoring; and
- Geosynthetic Cellular Confinement System (CCS).

Based on the results of this evaluation, the recommended source control alternative for the potentially erodible riverbank soils in Wheeler Bay is riprap armoring with regrading/revegetation of the upper slope. In general, the alternative consists of a blanket of rock material sized to resist erosion from river currents, wind-induced and vessel-induced waves, and propeller wash. This alternative was selected because it provides a low cost, long-term erosion control solution, is highly implementable, is compatible with the Terminal 4 EA alternative selected by the Environmental Protection Agency (EPA), and is compatible with City of Portland Greenway goals. In addition, the selected alternative will act as a cap to prevent direct contact by terrestrial ecological or human receptors. A conceptual design for the recommended alternative is presented in the report. The source control alternative will be designed and implemented in conjunction with the Terminal 4 EA aquatic sediment cap.

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Acronyms/Abbreviations

ACB	Articulated Concrete Block
CCS	Cellular Confinement Systems
CDF	Confined Disposal Facility
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COPC	Contaminants of Potential Concern
CPEC	Contaminants of Potential Ecological Concern
DEQ	Oregon Department of Environmental Quality
EA	Early Action
EPA	Environmental Protection Agency
Facility	Terminal 4 Slip 1
JSCS	Joint Source Control Strategy
LF	Linear Foot
MSE	Mechanically-Stabilized Earth
MSL	Mean Sea Level
NGVD	National Geodetic Vertical Datum
OU	Operable Unit
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PEC	Probable Effects Concentrations
Port	The Port of Portland
RI	Remedial Investigation
SCM	Source Control Measure
SLV	Screening-Level Value
T4S3	Terminal 4 Slip 3
TPH	Total Petroleum Hydrocarbons
USGS	United States Geological Survey
VCP	Voluntary Cleanup Program

1. Introduction

This report presents the Source Control Alternatives Evaluation for potentially erodible riverbank soils located along Wheeler Bay within the Port of Portland Terminal 4 Slip 1 Operable Unit 2 in Portland, Oregon. The Port of Portland (Port) is under a Voluntary Cleanup Program (VCP) Agreement with the Oregon Department of Environmental Quality (DEQ) for Remedial Investigation, Source Control Measures (SCMs), and Feasibility Study at the Terminal 4 Slip 1 Upland Facility (the Facility) in Portland, Oregon (dated December 4, 2003). This evaluation was developed using the Portland Harbor Joint Source Control Strategy (JSCS) as guidance (DEQ/United States Environmental Protection Agency [EPA], 2005). The source control action will be implemented as a Removal Action in accordance with Oregon Revised Statute 465.260 and Oregon Administrative Rule 340-122-0070 and pursuant to the VCP agreement for source control measures to the lower Willamette river.

The scope of this evaluation was limited to the upland portion of the Facility above the Early Action (EA) cap design for in-water sediments.

The VCP Agreement divides the Facility into two Operable Units (OUs), OU1 and OU2. OU1 consists of an approximately 53-acre northern portion of the Facility. OU2 consists of the remainder of the Facility and is approximately 45 acres in area. No potentially erodible riverbank soils were identified in the riverbank or slip areas of OU1. Therefore, this Source Control Alternatives Evaluation was completed for the riverbank soils in OU2.

This report includes the following:

- 2.0 Background – This section includes a description of the site and brief summaries of other projects that will impact the SCM construction.

- 3.0 Site Characterization – The site characterization section summarizes the results of the sampling conducted for the erodible bank soil and the source control screening evaluation conducted as part of the Remedial Investigation (RI).

- 4.0 Source Control Objective, Scope, and Evaluation Criteria – This section focuses on the goal of the source control, where the source control will be conducted, and the criteria by which the potential alternatives were evaluated.

- 5.0 Technology Evaluation and Source Control Alternatives Development.

- 6.0 Detailed Evaluation of Alternatives – These sections describe potential technologies, alternatives, and the evaluation to select the best overall SCM.

- 7.0 Recommended Source Control Alternative – The selected alternative is identified and conceptual design figures are included.

2. Background

2.1 Site Location and Description

Terminal 4 is located in the NW 1/4 and NE 1/4 of Section 2, Township 1 North, Range 1 West of the Willamette Meridian, Portland, Multnomah County, Oregon. Terminal 4 is approximately 283 acres in area on the east bank of the lower Willamette River and is downstream from the St. Johns Bridge in North Portland, between River Miles 4.1 and 4.6. The vicinity of the site is shown on Figure 1. The portion of Terminal 4 identified as the Facility herein is approximately 98 acres in area.

The Facility is located at the northern end of the terminal and is bounded to the north by the Schnitzer Steel Products facility property boundary, to the east by the Terminal 4 property boundary, to the south by the Willamette River (Wheeler Bay) and the boundary of the Terminal 4 Slip 3 (T4S3) Upland Facility, and to the west by the ordinary line of low water of the Willamette River at Slip 1 and Wheeler Bay. The Facility is included on the Linnton Oregon U.S. Geological Survey (USGS) 7.5-Minute Quadrangle map (USGS, 1984). The topography of the Facility is relatively flat, with an elevation of approximately 30 feet above mean sea level (MSL). The ground surface of the Facility consists mainly of asphalt or concrete, with areas of gravel and grass interspersed. No surface water bodies are located on the Facility, but it is located adjacent to the Willamette River.

2.2 Terminal 4 Early Action Project

The Port is in the process of completing an EA cleanup of sediments at Terminal 4. The EPA has selected a removal action and design is currently underway. The removal action uses a combination of dredging with disposal in a confined disposal facility (CDF) to be constructed in Slip 1, sediment capping, and monitored natural attenuation. As part of the EA, a sediment cap will be constructed in Wheeler Bay. The sediment cap will extend up to the ordinary high water elevation (16.6 feet), and the SCM must be designed to be compatible with the EA sediment cap.

2.3 Terminal 4 Rail Expansion Project

The Port is currently constructing a new rail loop at Terminal 4 (referred to as the Berth 408 Rail Yard Modernization Project). The rail line passes close to the top of the riverbank in the area proposed for the SCM. City of Portland requirements associated with the rail project include Greenway improvements consisting of landscaping within 25 feet of the top of the riverbank. The rail project includes a 10-foot right-of-way from the Greenway setback to the center of the railroad (i.e., 35 feet minimum from top of the bank to the center of the railroad). The SCM will be designed to accommodate these setback/landscaping requirements.

3. Site Characterization

The EPA and DEQ identified erodible riverbank soil as a potential source and pathway for constituent transport to surface water (DEQ/EPA, 2005). During the RI for the Facility, the banks of the Facility were examined for exposed surface soil that has the potential to be eroded and transported to the river. Areas along Wheeler Bay and the west end of the south side of Slip 1 (both in OU2) were identified as having the potential for surface erosion. The surface soils in these areas were sampled as part of the RI and the results were presented in the RI Report (BBL/Ash Creek/Newfields, 2006) and are summarized below.

3.1 Potential Sources: Soil Sampling Results

Composite sampling of surface soil was conducted in the potentially erodible riverbank areas of OU2. The composite samples generally consisted of four discrete sub-samples collected from each composite sampling area. At two composite sample locations (S-29 and S-30), vegetation prevented collection of all sub-samples. Sample S-29 is represented by a single sub-sample (S-29D) and sample S-30 is represented by three sub-samples (S-30A, S-30C, and S-30D). The composite sample areas and sub-sample locations are illustrated on Figure 2. The composite samples (S-23 through S-30) were submitted for chemical analysis for total petroleum hydrocarbons (TPH), polycyclic aromatic hydrocarbons (PAHs), metals, pesticides, polychlorinated biphenyls (PCBs), and phthalates. Screening level exceedances are summarized on Figures 14, 15, and 18 of the RI report, copies of which are included in Appendix A.

All five of the composite samples along Wheeler Bay had at least one chemical above screening levels (e.g., probable effects concentrations [PEC] developed by McDonald et al.; DEQ/EPA, 2005), so the discrete samples were analyzed for selected analytes. The analytical results from the composite and discrete soil sampling events can be found in Appendix A in Tables A-1 through A-7.

As a part of the ecological and human health risk assessments (Appendix A in BBL/Ash Creek/Newfields, 2006), analytical data for potentially erodible riverbank soil in OU2 were compared against JSCS screening levels for toxicity (PECs) and bioaccumulation (DEQ Bioaccumulative Screening Level Values) from Table 3-1 of DEQ/EPA (2005) and against human health screening levels (EPA Region 9 Preliminary Remediation Goals). Appendix B presents the analytes which had exceedances and the corresponding sampling locations which exceeded the screening criteria. These analytes were identified as chemicals of potential ecological concern/chemicals of potential concern (CPECs/COPCs). There are 20 CPECs/COPCs identified for riverbank soils in OU2, and there are exceedances at sampling locations S-23 through S-30 (i.e., in riverbank soil in both the Slip 1 and in the Wheeler Bay areas; see Figure 2). Soil samples from locations S-23 through S-25 did not exceed PECs (Appendix A). A few samples from these locations exceeded the DEQ Bioaccumulative Screening Levels (Appendix B).

3.2 Source Control Screening Evaluation

Exceedance of JSCS screening criteria does not necessarily indicate that an upland source poses an unacceptable risk to human health or the environment (DEQ/EPA, 2005). However, if the exceedances are more than just slightly over the screening criteria (as is the case for some of the CPECs/COPCs in the OU2 riverbank soil), the DEQ/EPA recommend that a "weight-of-evidence" evaluation be performed to determine the likelihood of adverse effects from migration of soils to sediment or surface water and to determine if further characterization or soil SCMs are needed (DEQ/EPA, 2005). The weight-of-evidence evaluation was conducted and considered factors such as the extent and proximity to the river, in-water sediment data proximal to the source area, riverbank stability, and characteristics of the constituents (e.g., if the constituents are bioaccumulative).

The erodible riverbank soils in OU2 contain several CPECs/COPCs that exceed screening criteria, are proximal to the river, and are not stabilized against erosion. The EA for sediment selected by the EPA consists of capping beach soil and sediments in Wheeler Bay and constructing a CDF in Slip 1. The design process has been initiated and commencement of the Removal Action construction is scheduled to begin in 2007. Given that a CDF will be constructed in Slip 1, no SCM is needed for the riverbank soil in Slip 1. Given the planned sediment cap for Wheeler Bay, source control of the riverbank soil in Wheeler Bay is prudent and can be coordinated with the EA, consistent with the Facility VCP Agreement.

3.3 Hot Spot Evaluation

A hot spot evaluation of erodible riverbank soils was completed to determine whether source control alternatives must consider treatment/removal with a higher cost threshold. Based on the following evaluation, there is not a hot spot associated with the Wheeler Bay riverbank soil.

The soil data for the 16 discrete samples along the Wheeler Bay riverbank were reviewed; the results are summarized as follows:

- 10 times the terrestrial screening-level value (SLV) was exceeded for lead (two samples) and zinc (one sample);
- 10 times the PEC was exceeded for benzo(g,h,i)perylene (two samples), indeno[1,2,3-cd]pyrene (four samples), and naphthalene (one sample); and
- 10 times the JSCS bioaccumulation SLV was exceeded for cadmium (one sample), copper (one sample), zinc (three samples), and Dichloro-Diphenyl-Trichloroethane (DDT; three samples).

In DEQ's current draft sediment bioaccumulation guidance, sediment screening values for inorganic chemicals are not calculated given the uncertainties regarding modeling of inorganics from biota tissue to sediment. Therefore, comparison of metals data with JSCS screening values may not be relevant for determining a hot spot based on bioaccumulation and are not further evaluated for the purpose of assessing hot spots.

Only three PAH constituents exceeded the ecological hot spot criteria, only five out of 16 bank samples contained PAHs exceeding the criteria, and the source of PAHs is likely to disperse. In addition, the riverbank's location in Wheeler Bay is likely subject to relatively low erosional forces (as evaluated in the Draft Terminal 4 Early Action Design Report), so the probability of catastrophic riverbank failure and transport of this soil to river sediment is low.

For DDT, creation of an in-water sediment hot spot from riverbank soils appears unlikely due to the apparent low mass in riverbank soil.

4. Source Control Objective, Scope, and Evaluation Criteria

4.1 Objectives

To prevent erosion and subsequent deposition of the target shoreline and upland soils into the aquatic environment, the Port is proposing a voluntary SCM for the banks of the Wheeler Bay shoreline. The design must be compatible with the EA project design, which conceptually consists of aquatic sediment caps and monitored natural recovery areas in Wheeler Bay, and it also must support the Port's Greenway requirements under Chapter 33.440 of the Portland Zoning Code for the Berth 408 Rail Project.

4.2 Scope

The scope of the SCM encompasses the potentially erodible soil that contains several CPECs/COPCs at concentrations that exceed screening criteria. Tables A-1 through A-7 in Appendix A list analytical data from soil samples collected in the riverbank area. The sampling locations are shown on Figure 2. The area with soil containing CPECs/COPCs above the screening criteria covers approximately 850 linear feet of riverbank along Wheeler Bay. All soils on the face of the bank are presumed to be potentially erodible. For the purpose of the SCM evaluation, the SCM alternatives are assumed to cover the entire riverbank. However, the SCM will be implemented as part of the EA. The EA sediment cap in Wheeler Bay will extend up to the ordinary high water elevation (16.6 feet). The SCM will extend this cap to the top of the bank to stabilize the remaining potentially erodible soils that would otherwise not be included by the EA cap. Therefore, the SCM and sediment cap become one contiguous cap for engineering purposes and these two features must be coordinated. The upper boundary of the SCM (the top of bank) will tie in with the Greenway enhancements required as part of the Berth 408 Rail Project, so these two projects must also be coordinated.

4.3 Evaluation Criteria

The bank source control alternatives were evaluated using the criteria referenced in JSCS for Source Control Alternative Evaluation and Design. These criteria are effectiveness, implementability, and relative cost as described below in this section.

4.3.1 Effectiveness

This criterion includes both the long-term effectiveness of the technology to prevent soils from eroding into Wheeler Bay, as well as the feasibility of minimizing short-term risk of erosion during construction. In addition, all viable alternatives must provide a threshold level of environmental protection that prevents erosion of impacted soils to the aquatic environment.

- **Long-Term Effectiveness.** The effectiveness criterion considers the ability of an alternative to provide long-term environmental protection. An effective technology must be able to withstand scour and erosion that could destabilize the bank.

- **Implementation Risk.** The objective of this criterion is to minimize short-term risks to the environment associated with construction activities. Impacted soil may be exposed by regrading certain parts of the bank, creating a risk of erosion into the aquatic environment. Although such impacts should be avoided, in some cases it may be necessary to tolerate some amount of short-term environmental risk to gain long-term environmental protection. Engineering controls (e.g., silt fences) are used in these cases to reduce implementation risk.

4.3.2 Implementability

The implementability criterion considers a number of factors that affect the practicability of constructing a particular alternative. These factors include the following:

- **Operational Constraints.** Upland and waterside operations must not be compromised by the technology. For example, the integrity of adjacent structures and rights-of-way must not be undermined by excessive removal of the bank.

- **Consistency with Adjacent Remedial Actions.** The proposed alternative must be consistent with the adjacent upland and in-water remedies, to the extent the design of these final remedies can be anticipated, as well as any proposed remedial actions associated with the Portland Harbor Superfund site.

- **Permitting.** This factor considers the ease of obtaining permits for the SCM, or the ease of fulfilling the substantive requirements of permits exempted under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and/or DEQ rules.

- **Consistency with Current and Future Land Use.** A SCM should not conflict with existing or anticipated future land use, especially water-dependent land use. For example, heavy industrial waterfront usage may conflict with the use of shallow, bioengineered slopes and wide riparian buffer zones.

4.3.3 Cost

The relative cost to implement a bank stabilization alternative is developed at a feasibility level of accuracy (plus 50 percent and minus 30 percent). The costs are developed to provide a comparative ranking of potential alternatives, but may not represent the absolute cost of a stabilization alternative. Scoring on the basis of cost is straightforward, based on unit cost per linear foot of shoreline.

5. Technology Evaluation and Source Control Alternatives Development

This section describes the source control technologies applicable to a SCM for the riverbank. Section 5.1 is a screening of general approaches for source control of the riverbank and identifies stabilization as the best overall approach. Section 5.2 evaluates stabilization technologies. Section 6 provides a feasibility-level evaluation of alternatives developed from these technologies resulting in a recommended alternative for the SCM. Discussion and evaluation of technologies were contributed by Anchor Environmental LLC, the prime consultant for the EA design.

5.1 Screening of General Approaches

General approaches for source control alternatives at the Wheeler Bay riverbank include the following:

- No Action;
- Institutional Controls;
- Removal;
- Containment/Engineering Controls;
- Biological Treatment; and
- Physical/Chemical/Thermal Treatment.

No Action. A source control screening and weight of evidence evaluation was conducted as part of the RI and it was determined that a source control action is necessary (BBL/Ash Creek/Newfields, 2006). Therefore, No Action was eliminated from further consideration.

Institutional Controls. Institutional Controls consist of physical or legal barriers to prevent access to areas of concern. Institutional Controls would not prevent erosion of soil to surface water so were eliminated from further consideration.

Removal. Potentially erodible soils could be excavated and disposed of in an off-site landfill. After excavation, the bank area would require filling because the land area is needed for the Berth 408 Rail System. The surface would be stabilized against potential erosion from wave, current, or wind action; however, these same stabilization technologies would be sufficient to address the erosion concerns without the excavation and filling. Additionally, removal could cause interference with the EA cap coordination efforts. Therefore, stabilization technologies would provide a more feasible approach for source control of the riverbank and removal was eliminated from further consideration.

Containment/Engineering Controls. Technologies in this category include capping and stabilization. These technologies prevent direct contact with (for terrestrial receptors) and erosion of surface soils. These technologies would be required with any other approach, but are capable of achieving the project objectives without other technologies. Therefore, stabilization technologies were retained for further consideration.

Biological Treatment. Some of the CPECs/COPCs (e.g., metals) are not amenable to biological treatment under normal circumstances. Furthermore, biological treatment can take time during which the soils would be susceptible to erosion. For these reasons, biological treatment was eliminated from further consideration.

Physical/Chemical/Thermal Treatment. Chemical and thermal treatment are not compatible with all CPECs/COPCs. Physical treatment (e.g., solidification) could achieve the project objectives at high relative cost, but would not be compatible with City Greenway standards (the resulting condition would not be suitable for planting native species). Therefore, physical/chemical/thermal treatment were eliminated from further consideration.

5.2 Evaluation of Stabilization Technologies

Several physical processes drive the erosion potential of the Wheeler Bay shoreline including:

- Seasonal changes in river stage;
- Flood events;
- Tidal currents;
- Wind-generated waves and vessel wake;
- Propeller wash; and
- Slope stability (static and seismic conditions).

To address these processes, four bank stabilization technologies were considered for application at the site: slope regrading and revegetation, riprap armoring, articulated concrete block (ACB) armoring, and a geosynthetic cellular confinement system (CCS).

5.2.1 Slope Regrading and Revegetation

Portions of the slopes along the bank are over-steepened and require regrading to maintain long-term stability. Based on preliminary slope stability evaluations, soil slopes of 33 percent or flatter that are vegetated would remain intact above the flood stage elevation (18 feet National Geodetic Vertical Datum [NGVD]) where such vegetation can survive. Vegetated geosynthetics (e.g., turf mats) can be installed to enhance the vegetation process and protect surface soils from erosion prior to germination. Below the flood stage elevation, soils would remain susceptible to surface erosion from river flow and wave action regardless of slope steepness. In some cases large boulders and woody debris are used to protect portions of a slope that regularly become inundated with water; however, care must be taken to ensure the slope toe is sufficiently buttressed. Therefore, slope regrading has been carried forward in the bank stabilization analysis as a viable technology above the flood stage elevation.

5.2.2 Riprap Armoring

Traditional riprap armoring consists of a blanket of rock material sized to resist river currents. It is a flexible solution that is able to fit the slope and shape of an existing shoreline. It is also tolerant to changes in subsurface soils due to settlement and other forces. In general, riprap slopes can be maintained at a steeper grade than revegetated soil slopes and also provide resistance against surface erosion from water flow. This method is extremely durable in the long-term and provides high resistance to propeller wash and vessel wakes associated with a working waterfront. It is also possible to plant vegetation in the rocks to further stabilize the slope and enhance the slope appearance and habitat.

5.2.3 Articulated Concrete Block Armoring

ACB mats serve as a flexible revetment system that provides resistance to high flow velocities, effective erosion control, and can also be backfilled with topsoil and planted to maintain a natural appearance. ACB mats generally consist of a grid of individual pre-cast concrete blocks that are attached to one another with a web of stainless steel cables. The grids are placed flat across the entire portion of the bank that is subject to erosion. These blocks can be manufactured with open or closed cells. Open-cell ACBs are often planted, and some systems allow for the removal of individual blocks to accommodate larger vegetation. ACB mats are relatively thin, ranging in thickness from 4- to 9-inch blocks, thus resulting in less material placement in comparison to riprap armoring (which may require lifts on the order of 2 feet thick).

5.2.4 Geosynthetic Cellular Confinement Systems

Like open-cell ACB systems, geosynthetic CCSs provide an opportunity to combine an engineered slope stabilization technology with native vegetation that enhances habitat and long-term slope stability. CCSs are typically three-dimensional structures made of polyethylene that form open-ended cylinders 3 to 12 inches deep. Each cell acts as a small dam that allows water to pass over the top while holding in place the soil contained inside the cell. Vegetation may be planted in the upper bank cells. In addition to aesthetics, vegetation also helps to reduce the potential for erosion as the plants serve as an anchor. Because the walls may be perforated, roots are allowed to grow through the system, further enhancing the erosion protection. The perforations also allow lateral drainage through the system, enhancing performance of the CCS in submerged conditions. On the lower bank, the cells would be filled with gravel to resist the forces of ship waves and currents and to ensure that return flow is not prohibited.

The CCS option can be implemented in two ways: on a prepared slope to create a stabilized surface that can be vegetated (similar to the ACB application); or in horizontal layers to create a mechanically-stabilized earth (MSE) wall with a face that can be vegetated. The existing slopes are on the order of 3:1 (horizontal:vertical), so MSE wall segments should not be required. The slope application of the CCS option would perform similarly to the ACB armoring option and result in a revegetated slope above the flood stage elevation. Also like the ACB application, initial grading of the slope would be required to ensure voids were not present below the CCS.

6. Detailed Evaluation of Alternatives

This section evaluates each alternative in detail. Common elements are described in Section 6.1. Sections 6.2 through 6.4 present alternatives. Section 6.5 presents a comparative evaluation of the alternatives.

6.1 Common Alternative Elements

Each alternative will require some initial grading to remove over-steepened sections and to prepare the slopes for the final design grades; therefore, slope preparation is not discussed with each alternative. In addition, because highly engineered armoring will not be required above the flood stage elevation (18 feet) if slopes are maintained at 33 percent and revegetated, slope regrading and revegetation is assumed to be another common element to each alternative. Application of slope regrading/revegetation will begin at elevation 20 feet (NGVD) and will continue up-slope to top of the bank. Bank grading will be designed to maintain a minimum of 35 feet from the top of the bank to the centerline of the new railroad loop. Because each alternative consists of capping/stabilizing soil in place, cap maintenance (including a contaminated media management and maintenance plan) is a common element of each alternative.

Each bank stabilization alternative must also be compatible with the EA aquatic sediment cap proposed for Wheeler Bay. Conceptually, this cap will consist of a protective armor layer underlain by a sand (select fill) layer for chemical isolation.

Based on the above criteria, the three alternatives to be evaluated are riprap armoring, articulated concrete block armoring, and cellular confinement systems armoring.

6.2 Alternative 1 – Riprap Armoring

Alternative 1 would consist of an application of riprap armoring over a graded filter layer along the full length of the prepared shoreline approximately extending from elevation 0 feet to elevation 20 feet (NGVD). Riprap would be sized to withstand river currents and wave action. The graded filter layer and a filter fabric would prevent underlying soil from washing through the riprap. Willow cuttings planted within the riprap improve the overall appearance and habitat of the bank, and long-term the root mass that develops further stabilizes the underlying soil. The proposed section for the riprap armoring is virtually identical to the proposed sediment cap section.

6.3 Alternative 2 – ACB Armoring

Alternative 2 would consist of an application of ACB armoring along the full length of the prepared shoreline approximately extending from elevation 0 feet to elevation 20 feet (NGVD). A double-sided, non-woven, geocomposite drainage layer would be placed beneath the ACB mats to promote return flow from breaking waves and currents. Topsoil would be placed within the open cells and between the ACB blocks prior to planting of the appropriate native species above the flood stage elevation.

Select fill would be used to fill the remainder of ACB units, or closed-cell units may be considered. The ACB could serve as the armor layer for the sediment cap in those areas where there is overlap.

6.4 Alternative 3 – CCS Armoring

Alternative 3 would consist of an application of CCS armoring along the full length of the prepared shoreline approximately extending from elevation 0 feet to elevation 20 feet (NGVD). Each section of the CCS would be anchored into the prepared slope and then backfilled. Topsoil would be placed within the cells above the flood stage elevation prior to planting of the appropriate native species. Gravel would be used to fill the remainder of the cells for erosion control. The CCS could serve as the armor layer for the sediment cap in those areas where there is overlap.

6.5 Comparative Analysis of Alternatives

The bank stabilization alternatives were evaluated using the criteria of effectiveness, implementability, and relative cost (see Section 4.3), in general accordance with JSCS (DEQ/EPA, 2005). Table 1 summarizes the results of the evaluation.

TABLE 1
ALTERNATIVES RANKING MATRIX

Alternative	Effectiveness	Implementability	Cost	Overall Rank
Riprap	High	High	Moderate	8
ACB	High	Moderate	Poor	6
CCS	Moderate	Moderate	Moderate	6

Each alternative was evaluated with respect to the three criteria using the following scoring system: Poor = 1, Moderate = 2, and High = 3. The preferred alternative was selected based on its overall rank and ability to provide adequate environmental protection. The following subsections present the basis for the relative ranking of the alternatives in Table 1.

6.5.1 Effectiveness

All of the stabilization technologies address the root cause of instability and would have relatively low risks of contamination during construction. Although all technologies would provide adequate erosion control, riprap would most likely have the greatest lifespan due to its ability to provide long-term resistance against surface erosion from water flow. In the long-term life of the SCM, CCS has a higher potential to be susceptible to scour and erosion. For these reasons, CCS was assigned a moderate score and riprap and ACB were assigned a high score for effectiveness.

6.5.2 Implementability

In terms of ease of construction, riprap and ACB are the simplest to implement and the materials are readily attainable within the vicinity of the project area. The ACB and CCS alternatives provide slightly better revegetation opportunities. However, the riprap alternative would likely serve as the most flexible option for a change in use of the Wheeler Bay shoreline. Riprap is also incorporated into the EA aquatic cap, thus making it the alternative most compatible with the adjacent project. For these reasons, riprap was assigned a high score for its implementability and ACB and CCS were assigned moderate scores for implementability.

6.5.3 Cost

Differential unit costs (per linear foot [lf]) were developed for the various bank stabilization alternatives.

- Alternative 1 – Riprap Armoring - $360/lf x 850 lf = $310,000

- Alternative 2 – ACB Armoring - $1,500/lf x 850 lf = $1,300,000

- Alternative 3 – CCS Armoring - $700/lf x 850 lf = $600,000

Riprap and CCS were assigned moderate scores for the cost criterion. Because ACB armoring would have the highest cost, it was assigned a low score for cost criterion.

Appendix C provides supporting calculations for the unit costs above. Some of the assumptions underlying the unit costs include the following:

- Work associated with regrading slopes is considered a common element and not included in the unit cost.

- Revegetation of regraded slopes above elevation 20 feet (NGVD) and planting along any portion of the slope is not included in the unit cost.

- In-water cap is conducted as part of the EA and these costs are not included. A significant portion of the earthwork will be completed from the upland area.

- All regraded material will be consumed by the project and no off-site disposal is anticipated.

7. Recommended Source Control Alternative

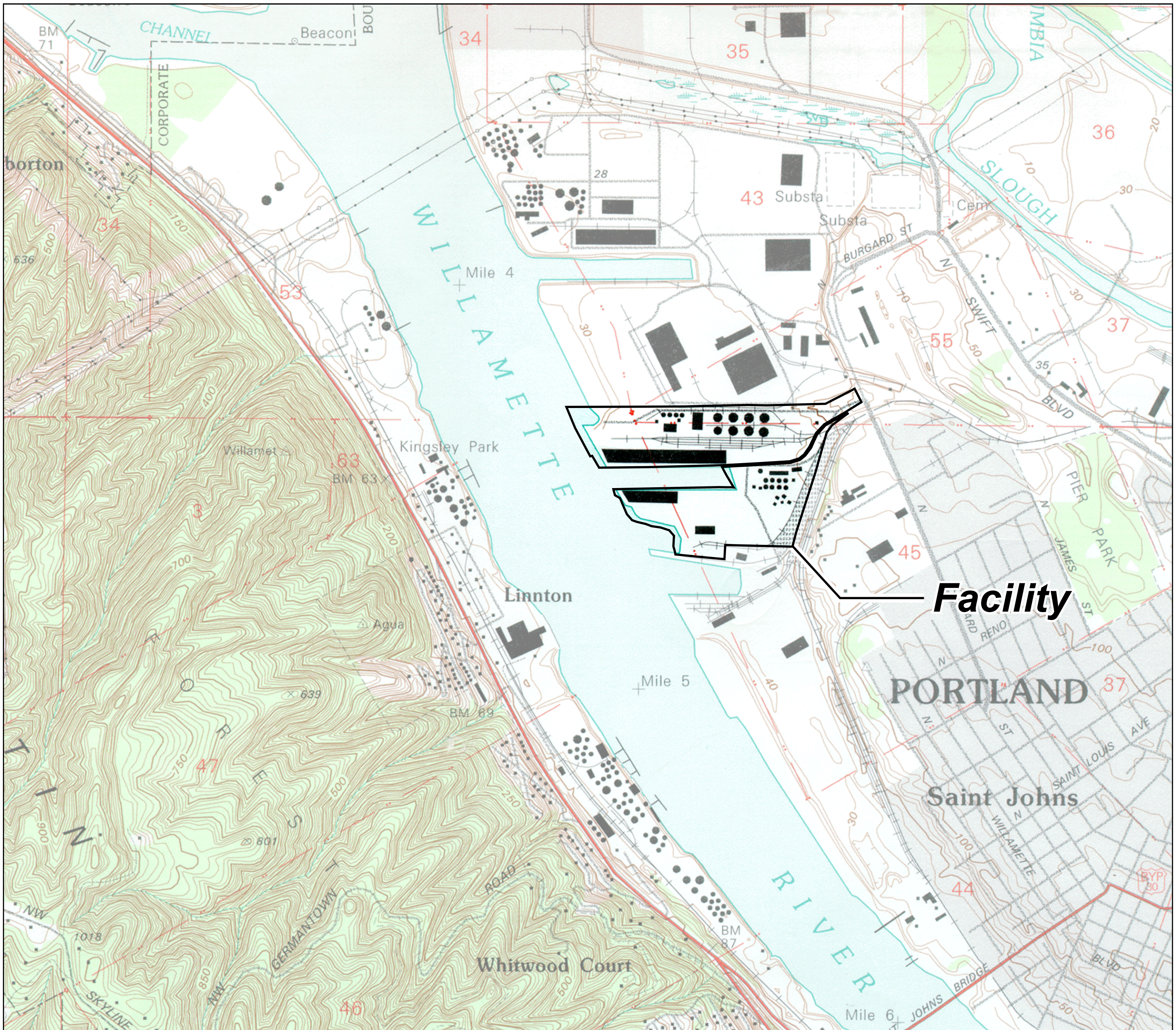
Based on the results of this evaluation, the recommended source control alternative for the Wheeler Bay erodible riverbank soils is Riprap Armoring below elevation 20 feet (NGVD) and regrading/revegetation above elevation 20 feet (NGVD). This alternative was selected because it provides a low cost; long-term erosion control solution; it is highly implementable; and it is compatible with the EA project and City of Portland Greenway goals. The preliminary design for the selected alternative is presented on Figures 3 through 7. The figures include a site plan/erosion control plan (Figure 3), schematic cross section and rip rap details (Figures 4 and 5), and erosion control details (Figures 6 and 7). Final design will be completed by the EA design team. The final design will evaluate potential erosion and/or failure during a 100-year flood event.

8. References

BBL/Ash Creek/Newfields, 2006. Remedial Investigation Report - Terminal 4 Slip 1 Upland Facility. March.

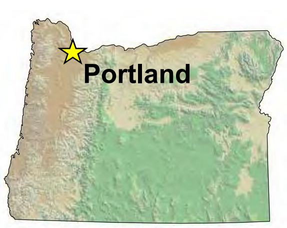
DEQ/EPA, 2005. Portland Harbor Joint Source Control Strategy. December 2005.

USGS, 1984. U.S. Geological Survey 7.5-Minute Quadrangle Map, Linnton, Oregon.



Base map prepared from the USGS 7.5-minute quadrangle of Linnton, Oregon, dated 1990.

0 2000 4000
Scale in Feet



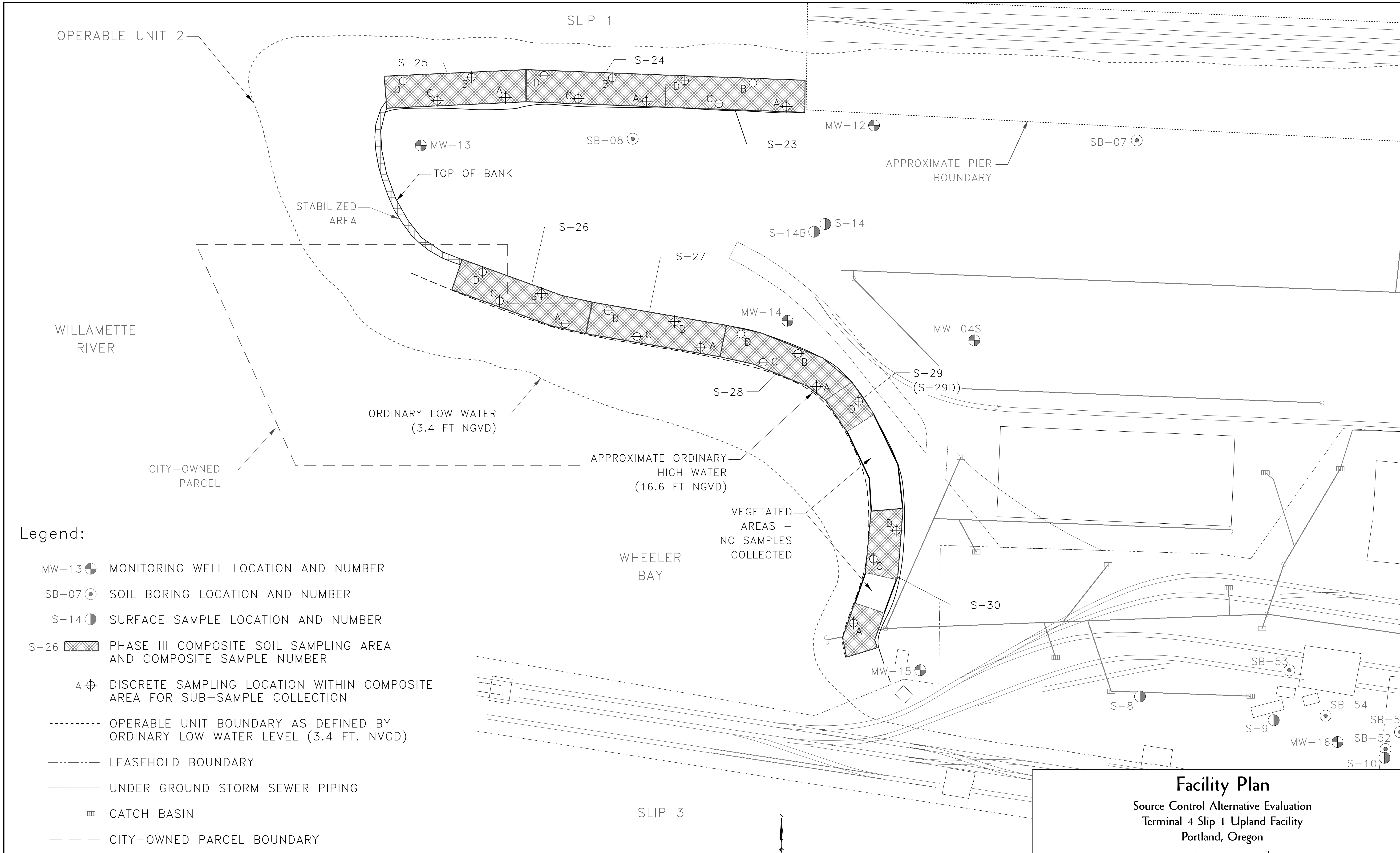
N

Facility Location Map

Source Control Alternative Evaluation
Terminal 4 Slip 1 Upland Facility
Portland, Oregon

Ash Creek Associates, Inc.
Environmental and Geotechnical Consultants

Project Number	1066-00	Figure
October 2006		1



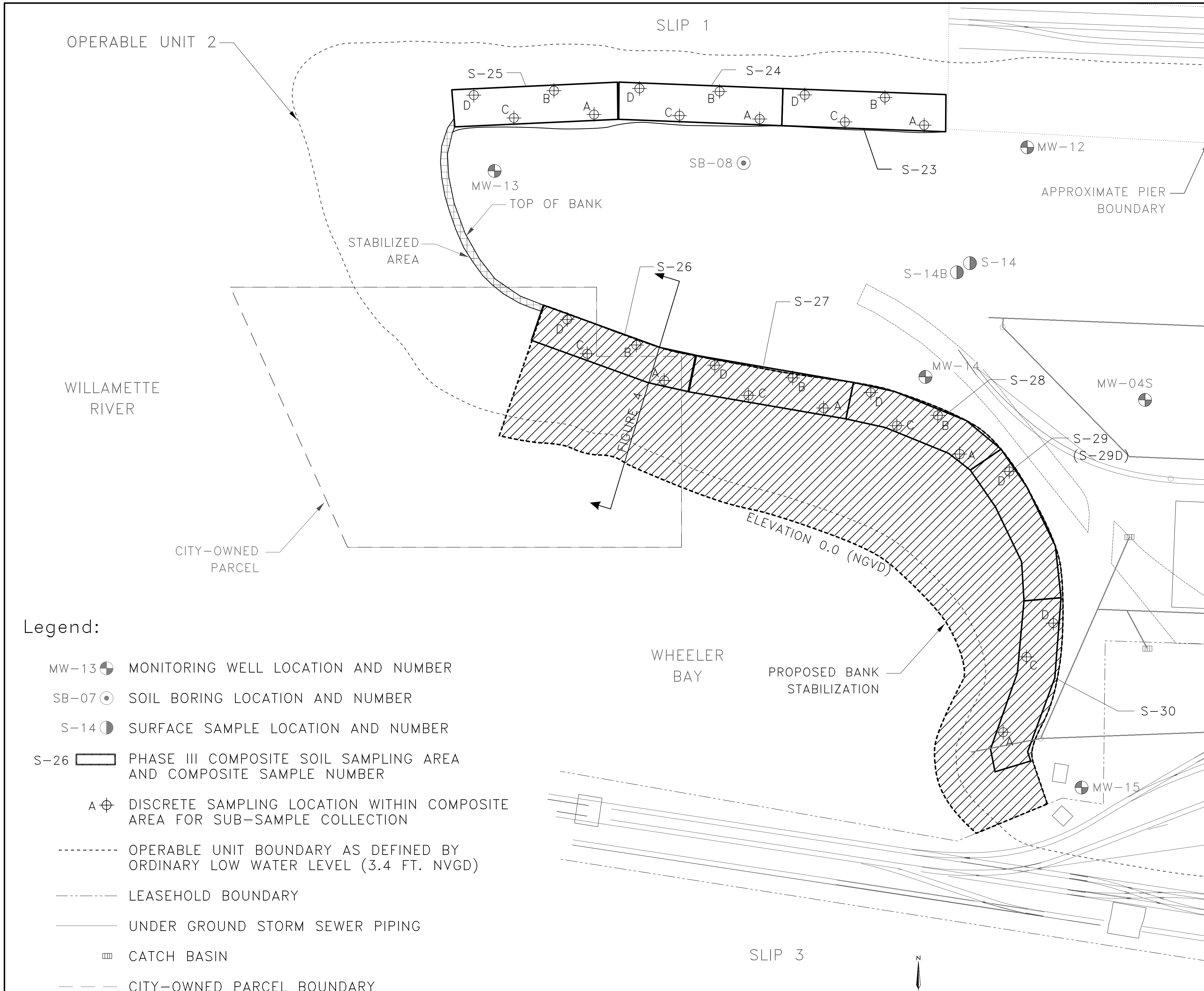
NOTES: 1) BASE MAP PREPARED FROM THE URS DRAFT T4 SLIP 1 RI WORK PLAN, DATED MAY 2004.
2) HORIZONTAL DATUM: STATE PLANE COORDINATES, OREGON NORTH, NAD 83. VERTICAL DATUM: NVGD 29.
3) PREFIX "T4S1" REMOVED FROM SAMPLE LOCATIONS FOR FIGURE CLARITY.
4) SEE APPENDIX A FOR DISCRETE SAMPLE RESULTS.

Facility Plan

Source Control Alternative Evaluation
Terminal 4 Slip 1 Upland Facility
Portland, Oregon

Ash Creek Associates, Inc.
Environmental and Geotechnical Consultants

Project Number	1066-00	Figure
	October 2006	2



NOTES: 1) ALL WORK TO BE CONDUCTED AS PART OF TERMINAL 4 EARLY ACTION.
2) BASE MAP PREPARED FROM THE URS DRAFT T4 SLIP 1 RI WORK PLAN, DATED MAY 2004.
3) HORIZONTAL DATUM: STATE PLANE COORDINATES, OREGON NORTH, NAD 83. VERTICAL DATUM: NVGD 29.
4) PREFIX "T4S1" REMOVED FROM SAMPLE LOCATIONS FOR FIGURE CLARITY.
5) SEE APPENDIX A FOR DISCRETE SAMPLE RESULTS.

EROSION CONTROL NOTES:

1. A SEDIMENT FENCE SHALL BE INSTALLED AND MAINTAINED TO ENSURE THAT NO SEDIMENT OR SEDIMENT-LADEN WATER PRODUCED FROM CONSTRUCTION ACTIVITIES ENTERS THE RIVER. THE SEDIMENT FENCE IN THE UPLAND CONSTRUCTION WILL WORK IN CONJUNCTION WITH THE EARLY ACTION EROSION CONTROL.

2. INLET PROTECTION SHALL BE INSTALLED AND MAINTAINED DURING CONSTRUCTION ACTIVITIES TO PREVENT SEDIMENT FROM ENTERING CATCH BASINS OR OTHER OPEN INLETS ONSITE.

3. A CONTRACTOR STAGING AREA AND GRAVEL CONSTRUCTION ENTRANCE SHALL BE MAINTAINED TO PREVENT TRAFFIC FROM TRACKING SEDIMENT OUT OF THE CONSTRUCTION AREA.

4. A TRUCK HAUL ROUTE SHALL BE MAINTAINED TO CONFINE SEDIMENT FROM TRUCK TRAFFIC TO A SPECIFIC AREA.

5. TURBIDITY CONTROL SHALL BE PLANNED IN CONJUNCTION WITH EARLY ACTION AT THE SITE.

6. MAINTAIN TO ENSURE SUCH THAT NO SEDIMENTS ARE TRANSPORTED ONTO ROADWAY PAVEMENT.

7. COORDINATE WITH CONSTRUCTION STAGING TO PREVENT THROUGH TRAFFIC FROM TRACKING ANY SEDIMENT ONTO ROADWAY PAVEMENT.

8. IMPLEMENTATION, CONSTRUCTION, MAINTENANCE, REPLACEMENT AND UPGRADING OF ALL EROSION CONTROL MEASURES IS THE RESPONSIBILITY OF THE CONTRACTOR UNTIL ALL CONSTRUCTION IS COMPLETED. EROSION CONTROL MEASURES TO REMAIN IN PLACE AT END OF CONTRACT.

9. DURING THE CONSTRUCTION PERIOD, THE CONTRACTOR SHALL UPGRADE AND MAINTAIN ALL EROSION CONTROL FACILITIES AS NEEDED FOR UNEXPECTED STORM EVENTS AND TO ENSURE THAT SEDIMENT-LADEN WATER DOES NOT LEAVE THE SITE.

10. ALL EROSION CONTROL FACILITIES SHALL BE INSPECTED DAILY BY THE CONTRACTOR.

11. DURING INACTIVE PERIODS ON THE SITE, THE CONTRACTOR MUST INSPECT AND MAINTAIN EROSION CONTROL FACILITIES ONCE EVERY 14 DAYS OR WITHIN 24 HOURS FOLLOWING A STORM EVENT (GREATER THAN 0.5 INCH).

12. AT NO TIME SHALL MORE THAN 1 FOOT OF SEDIMENT BE ALLOWED TO ACCUMULATE WITHIN A TRAPPED CATCH BASIN. ALL CATCH BASINS SHALL BE CLEANED PRIOR TO DE-MOBILIZATION. THE CLEANING OPERATION SHALL NOT FLUSH SEDIMENT-LADEN WATER INTO THE DOWNSTREAM SYSTEM.

13. MEASURES MUST BE TAKEN BY THE CONTRACTOR WHEN NECESSARY TO ENSURE THAT ALL EXISTING PAVED AREAS ARE KEPT CLEAN FOR THE DURATION OF THE PROJECT. SWEEP ACCESS HAUL ROUTE DAILY AT A MINIMUM.

14. THE MEANS AND METHODS OF THE CONTRACTOR MAY DICTATE THAT ADDITIONAL EROSION CONTROL MEASURES ARE NECESSARY. THESE ADDITIONAL MEASURES SHALL BE IMPLEMENTED AS NECESSARY TO PREVENT SEDIMENT LADEN WATER FROM LEAVING THE SITE.

15. UTILITIES SHOWN ARE BASED ON DESIGN DRAWING AND SURVEY OF VISIBLE PHYSICAL FEATURES AND LOCATE MARKINGS. CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES.

16. A SPILL KIT IS REQUIRED TO BE MAINTAINED ON SITE TO PREVENT SPILLS OF HAZARDOUS OR HARMFUL SUBSTANCES FROM ENTERING THE STORMWATER MANAGEMENT SYSTEM. CREWS MUST BE TRAINED ON THE LOCATION AND USE OF THE KIT.

17. SEE FIGURES 6 AND 7 FOR EROSION CONTROL DETAILS.

Stabilization Plan

Source Control Alternative Evaluation
Terminal 4 Slip 1 Upland Facility
Portland, Oregon

Ash Creek Associates, Inc.
Environmental and Geotechnical Consultants

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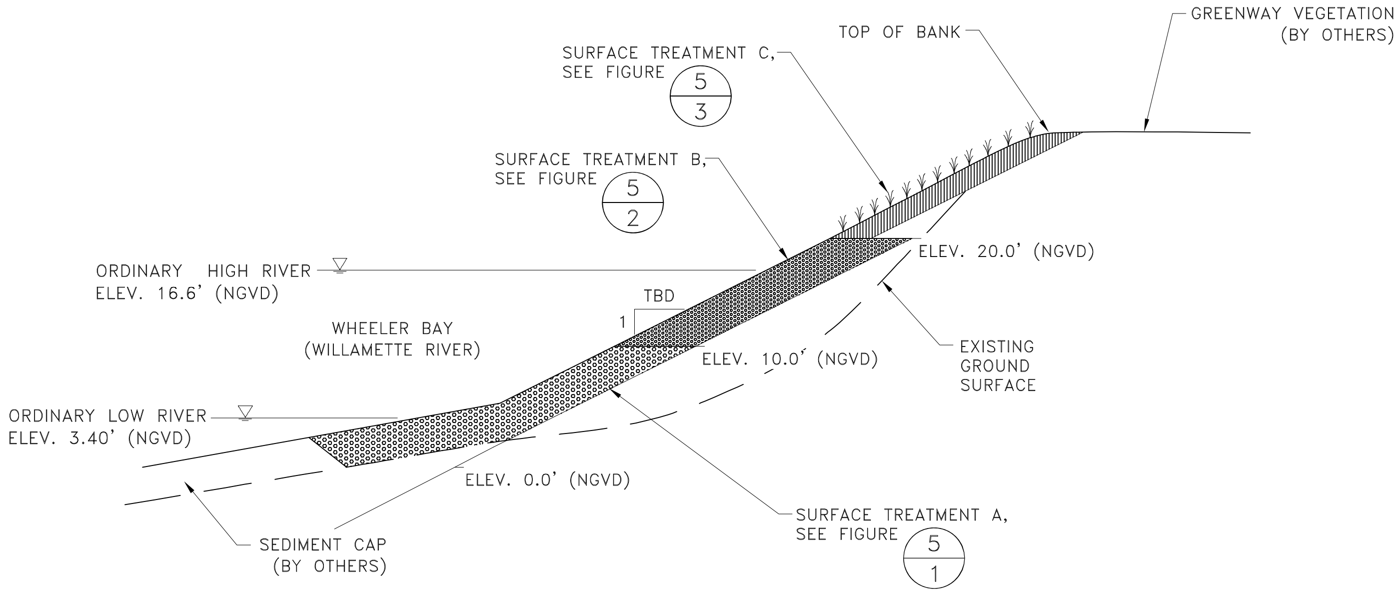

CONTROL MEASURE SCHEMATIC

SCALE: NTS

NOTES:
1) TBD=TO BE DETERMINED
2) SHAPE SUBGRADE WITH NO NET CUT/FILL.
3) ALL WORK TO BE CONDUCTED AS PART OF TERMINAL 4 EARLY ACTION.

Control Measure Schematic

Source Control Alternative Evaluation
Terminal 4 Slip 1 Upland Facility
Portland, Oregon

Ash Creek Associates, Inc.
Environmental and Geotechnical Consultants

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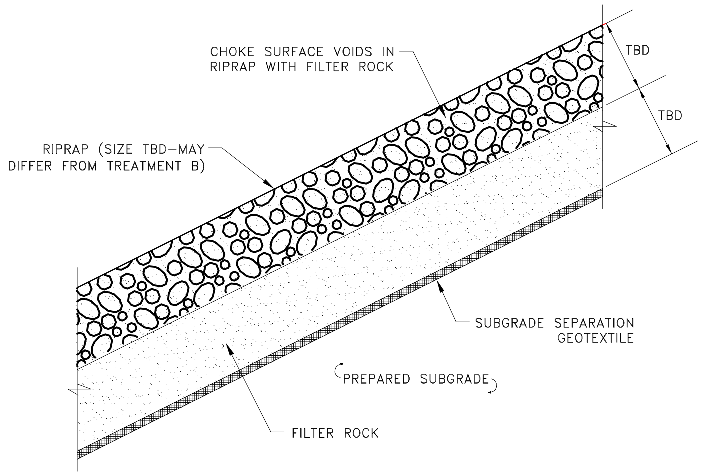
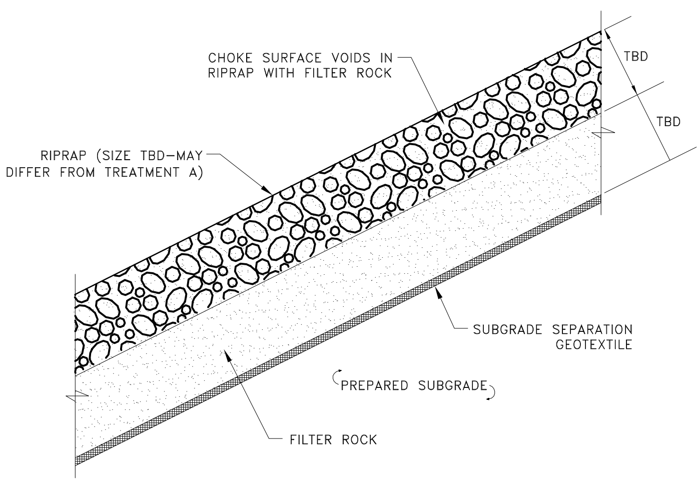
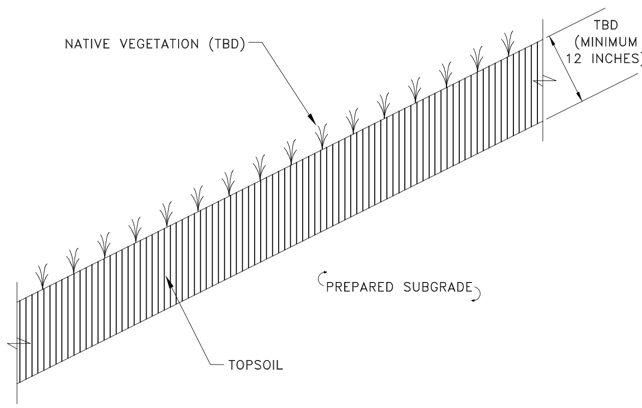
October 2006		4



SURFACE TREATMENT A
ELEVATION 0.0 TO 10.0 FT (NGVD) 5/1
SCALE: NTS



SURFACE TREATMENT B
ELEVATION 10.0 TO 20.0 FT (NGVD) 5/2
SCALE: NTS



SURFACE TREATMENT C
ELEVATION 20.0 TO TOP OF BANK 5/3
SCALE: NTS

NOTES:
1) TBD=TO BE DETERMINED
2) WILLOW CUTTINGS TO BE PLANTED IN RIPRAP PER LANDSCAPE PLAN (TBD).
3) ALL WORK TO BE CONDUCTED AS PART OF TERMINAL 4 EARLY ACTION.

Surface Treatment Details

Source Control Alternative Evaluation
Terminal 4 Slip 1 Upland Facility
Portland, Oregon

Ash Creek Associates, Inc.
Environmental and Geotechnical Consultants

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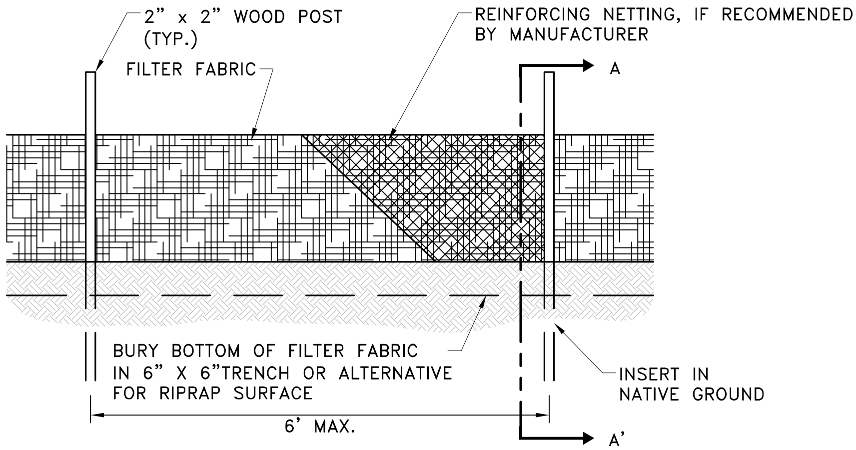
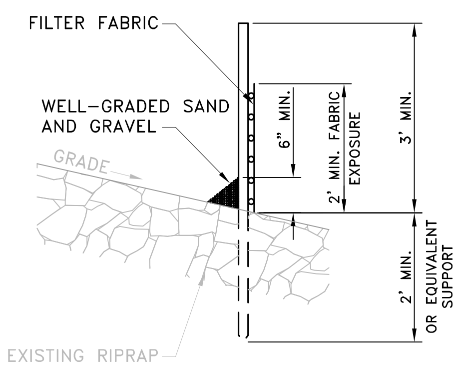


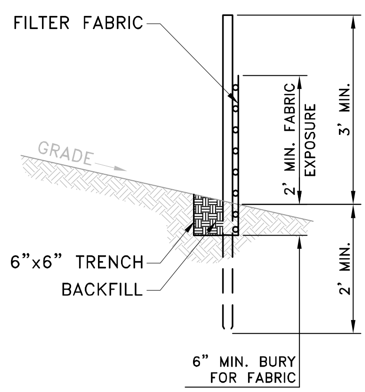
NOTES:

1. INSTALL IN ACCORDANCE WITH MANUFACTURERS RECOMMENDATIONS.
2. FILTER FABRIC SHALL BE PURCHASED IN A CONTINUOUS 36 IN. WIDE (MIN.) ROLL TO AVOID JOINTS. ATTACH TO STAKES USING STITCHED LOOPS.
3. SPLICE JOINTS AT SUPPORT POSTS ONLY, WITH A MIN. 6 IN. OVERLAP.
4. ANGLE ENDS OF SEDIMENT FENCE UPHILL TO ASSURE SOIL/SEDIMENT IS TRAPPED.

SEDIMENT FENCE DETAIL–ELEVATION

SCALE: NTS





SECTION A–A'

ALTERNATE FOR RIPRAP SURFACE

SCALE: NTS

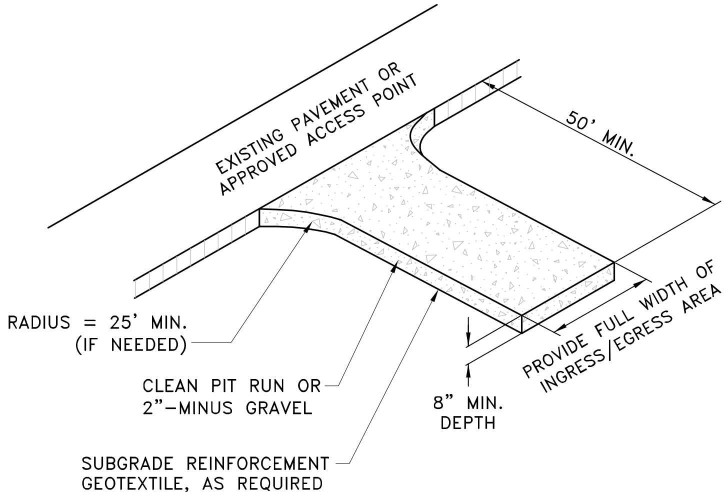
SOIL SURFACE

SCALE: NTS

Sediment Fence Details

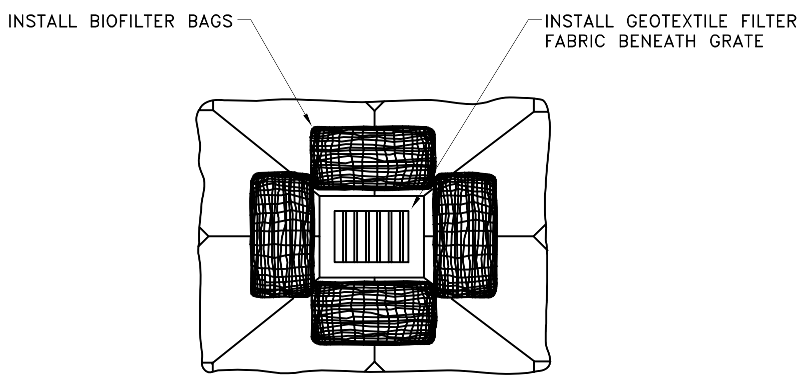
Source Control Alternative Evaluation
Terminal 4 Slip 1 Upland Facility
Portland, Oregon

Ash Creek Associates, Inc. Environmental and Geotechnical Consultants	Project Number	1066-00	Figure
	October 2006		6



GRAVEL CONSTRUCTION ENTRANCE

SCALE: NTS



NOTE:

1. BIOFILTER BAGS SHOULD BE STAKED WHERE APPLICABLE USING (2) 1" x 2" WOODEN STAKES OR APPROVED EQUAL PER BAG.

TEMPORARY INLET PROTECTION

SCALE: NTS

Erosion Control Details

Source Control Alternative Evaluation
Terminal 4 Slip 1 Upland Facility
Portland, Oregon

Ash Creek Associates, Inc.
Environmental and Geotechnical Consultants

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October 2006		7

Appendix A

Soil Sampling Analytical Results

Table A-1
Soil Sampling Results - TPH
Source Control Measure Evaluation
Port of Portland - Terminal 4 Slip 1

Sample Location:	T4S1S-23	T4S1S-24	T4S1S-25	T4S1S-26	T4S1S-27	T4S1S-28	T4S1S-29	T4S1S-30
Sample ID:	T4S1S-23	T4S1S-24	T4S1S-25	T4S1S-26	T4S1S-27	T4S1S-28	T4S1S-29	T4S1S-30
Sample Interval:	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1
Date Sampled:	9/12/2005	9/12/2005	9/12/2005	9/13/2005	9/13/2005	9/13/2005	9/13/2005	9/13/2005
HCID (mg/kg)								
Gasoline Range	--	--	--	--	--	--	--	--
Diesel Range	--	--	--	--	--	--	--	--
Residual Range	--	--	--	--	--	--	--	--
TPH (mg/kg)								
Gasoline Range	--	--	--	--	--	--	--	--
Diesel Range	26.6 U	27.1 U	29.5 U	26.4 U	18.7 J, D	25.4 U	36.2 D	14.9 J, D
Residual Range	53.1 U, D	54.2 U	59.0 U	42.2 J, D	68.2 D	34.0 J, D	138 D	57.3 D

Notes:

1. Only detected compounds are reported in the table.
2. TPH =Total petroleum hydrocarbons (TPH) by Northwest Total Petroleum Hydrocarbons (NWTPH). Diesel and residual range performed with silica gel cleanup.
3. mg/kg = Milligrams per kilogram.
4. -- = No screening level available or not analyzed.
5. J = The result is an estimated concentration that is less than the method reporting limit (MRL) but greater than or equal to the method detection limit (MDL).
6. U = The compound was analyzed for but was not detected at or above the MRL/MDL.
7. D = The reported result is from a dilution.
8. Sample ID nomenclature is per the following: type of sample-sample number-depth in feet-designation. For example T4S1SB-46-1-1 = soil boring (SB) number 46, collected 1 foot below the ground surface, primary sample (1). T4S1S-6 = surface soil sample number 6.

Table A-2
Soil Sampling Results - PAHs
Source Control Measure Evaluation
Port of Portland - Terminal 4 Slip 1

Sample Location:	Preliminary Screening Levels			T4S1S-23	T4S1S-24	T4S1S-25	T4S1S-26	T4S1S-26A	T4S1S-26B	T4S1S-26C	T4S1S-26D	T4S1S-27	T4S1S-27A	T4S1S-27B	T4S1S-27C
Sample ID:	PRG	SLV	PEC	T4S1S-23	T4S1S-24	T4S1S-25	T4S1S-26	T4S1S-26A	T4S1S-26B	T4S1S-26C	T4S1S-26D	T4S1S-27	T4S1S-27A	T4S1S-27B	T4S1S-27C
Sample Interval:				0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1
Date Sampled:				9/12/2005	9/12/2005	9/12/2005	9/13/2005	9/13/2005	9/13/2005	9/13/2005	9/13/2005	9/13/2005	9/13/2005	9/13/2005	9/13/2005
PAHs (µg/kg)															
Naphthalene	190,000	10,000	561	14.2 U	14.3 U	15.8 U	30.3 J, D	13.6 U	5.55 J, D	13.9 U	83.2 D	69.2 D	269 D	13.6 U	54.7 U
2-Methylnaphthalene	--	--	200	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	200	4.74 J, D	14.3 U	15.8 U	35.7 J, D	13.6 U	48.8 D	13.9 U	108 D	18.7 J, D	114 D	13.6 U	54.7 U
Acenaphthene	29,000,000	20,000	300	14.2 U	14.3 U	15.8 U	70.1 U	13.6 U	27.1 D	13.9 U	77.3 U	97.4 D	375 D	9.59 J, D	54.7 U
Fluorene	26,000,000	30,000	536	14.2 U	14.3 U	15.8 U	70.1 U	13.6 U	28.7 D	13.9 U	77.3 U	48.0 J, D	207 D	7.51 J, D	54.7 U
Dibenzofuran	3,100,000	2	--	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	--	--	1,170	10.9 J, D	9.65 J, D	37.7 D	234 D	23.2 D	361 D	25.4 D	443 D	376 D	1,680 D	141 D	28.5 J, D
Anthracene	100,000,000	--	845	17.6 D	14.3 U	6.51 J, D	57.0 J, D	3.40 J, D	206 D	3.63 J, D	99.6 D	93.5 D	471 D	19.7 D	54.7 U
Fluoranthene	22,000,000	--	2,230	28.9 D	26.5 D	104 D	962 D	87.5 D	7,990 D	95.4 D	1,640 D	986 D	4,650 D	511 D	88.1 D
Pyrene	29,000,000	--	1,520	22.3 D	19.5 D	75.1 D	883 D	83.6 D	7,220 D	86.7 D	1,750 D	722 D	3,440 D	402 D	94.2 D
Benzo(b)fluoranthene	2,100	--	--	59.6 D	21.3 D	102 D	874 D	89.4 D	2,270 D	94.0 D	1,500 D	916 D	3,690 D	485 D	91.0 D
Benzo(k)fluoranthene	21,000	--	13,000	37.9 D	17.2 D	58.8 D	597 D	84.8 D	2,070 D	90.2 D	1,300 D	583 D	3,240 D	409 D	88.6 D
Benzo(a)anthracene	2,100	--	1,050	30.8 D	15.1 D	62.3 D	581 D	62.5 D	2,380 D	68.0 D	1,110 D	597 D	2,700 D	320 D	62.9 D
Chrysene	210,000	--	1,290	77.4 D	17.9 D	70.7 D	898 D	79.2 D	4,170 D	87.3 D	1,590 D	705 D	3,590 D	393 D	83.2 D
Benzo(a)pyrene	210	125,000	1,450	48.1 D	20.9 D	89.1 D	776 D	92.4 D	1,460 D	97.4 D	1,830 D	786 D	3,560 D	445 D	104 D
Indeno(1,2,3-cd)pyrene	2,100	--	100	46.4 D	15.4 D	62.8 D	514 D	55.4 D	433 D	54.8 D	790 D	581 D	2,280 D	181 D	60.6 D
Dibenz(a,h)anthracene	210	--	1,300	14.9 D	4.79 J, D	20.5 D	151 D	17.9 D	160 D	17.7 D	183 D	194 D	795 D	64.2 D	18.2 J, D
Benzo(g,h,i)perylene	--	--	300	50.9 D	17.5 D	70.2 D	611 D	61.4 D	358 D	60.1 D	926 D	655 D	2,560 D	181 D	74.4 D

Sample Location:	Preliminary Screening Levels			T4S1S-27D	T4S1S-28	T4S1S-28A	T4S1S-28B	T4S1S-28C	T4S1S-28D	T4S1S-29	T4S1S-30	T4S1S-30A	T4S1S-30C	T4S1S-30D
Sample ID:	PRG	SLV	PEC	T4S1S-27D	T4S1S-28	T4S1S-28A	T4S1S-28B	T4S1S-28C	T4S1S-28D	T4S1S-29	T4S1S-30	T4S1S-30A	T4S1S-30C	T4S1S-30D
Sample Interval:				0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1
Date Sampled:				9/13/2005	9/13/2005	9/13/2005	9/13/2005	9/13/2005	9/13/2005	9/13/2005	9/13/2005	9/13/2005	9/13/2005	9/13/2005
PAHs (µg/kg)														
Naphthalene	190,000	10,000	561	54.5 U	28.3 J, D	107 D	55.2 U	13.8 U	68.4 U	388 D	39.5 J, D	344 U	33.2 J, D	6,480 D
2-Methylnaphthalene	--	--	200	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	200	54.5 U	67.6 U	18.2 J, D	55.2 U	13.8 U	68.4 U	176 D	69.2 U	344 U	55.2 U	347 U
Acenaphthene	29,000,000	20,000	300	54.5 U	151 D	843 D	55.2 U	13.8 U	68.4 U	164 J, D	183 D	295 J, D	171 D	1,180 D
Fluorene	26,000,000	30,000	536	54.5 U	114 D	825 D	55.2 U	13.8 U	68.4 U	116 J, D	72.5 D	105 J, D	70.3 D	1,240 D
Dibenzofuran	3,100,000	2	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	--	--	1,170	35.0 J, D	1,040 D	6,300 D	29.8 J, D	22.4 D	137 D	1,710 D	972 D	1,630 D	873 D	1,830 D
Anthracene	100,000,000	--	845	54.5 U	166 D	717 D	55.2 U	13.8 U	24.8 J, D	314 D	173 D	251 J, D	162 D	520 U
Fluoranthene	22,000,000	--	2,230	113 D	2,390 D	11,300 D	93.5 D	80.1 D	400 D	5,780 D	2,650 D	4,340 D	2,110 D	139 J, D
Pyrene	29,000,000	--	1,520	105 D	1,640 D	8,280 D	85.7 D	63.1 D	379 D	5,490 D	1,870 D	3,610 D	1,770 D	147 D
Benzo(b)fluoranthene	2,100	--	--	107 D	2,020 D	8,010 D	87.7 D	85.4 D	378 D	4,440 D	2,300 D	3,560 D	1,690 D	7.49 J, D
Benzo(k)fluoranthene	21,000	--	13,000	101 D	1,230 D	7,260 D	80.7 D	64.0 D	331 D	3,660 D	1,270 D	3,240 D	1,620 D	5.34 J, D
Benzo(a)anthracene	2,100	--	1,050	74.4 D	1,390 D	6,580 D	61.6 D	48.4 D	263 D	3,610 D	1,590 D	2,810 D	1,500 D	16.4 D
Chrysene	210,000	--	1,290	98.7 D	1,650 D	8,190 D	83.4 D	64.0 D	357 D	4,510 D	1,850 D	3,600 D	1,720 D	24.3 D
Benzo(a)pyrene	210	125,000	1,450	110 D	1,660 D	7,790 D	85.1 D	74.5 D	376 D	4,920 D	1,880 D	3,610 D	1,840 D	8.08 J, D
Indeno(1,2,3-cd)pyrene	2,100	--	100	61.4 D	1,130 D	4,460 D	49.1 J, D	30.5 D	247 D	3,500 D	1,220 D	1,950 D	950 D	13.9 U
Dibenz(a,h)anthracene	210	--	1,300	20.4 J, D	394 D	1,530 D	16.7 J, D	10.9 J, D	73.3 D	1,060 D	427 D	662 D	322 D	13.9 U
Benzo(g,h,i)perylene	--	--	300	68.3 D	1,240 D	4,770 D	56.3 D	30.5 D	290 D	4,160 D	1,280 D	2,160 D	997 D	13.9 U

Notes:

1. Only detected compounds are reported in the table. The complete analyte list is presented in the Sampling and Analysis Plan (Appendix A) of the RI Work Plan (Hart Crowser, 2004).
2. PAHs = Polynuclear Aromatic Hydrocarbons by EPA Method 8270C (SIM).
3. µg/kg = Micrograms per kilogram.
4. PRG = EPA Region 9 Preliminary Remediation Goal (PRG) for Industrial Soil (October 2004).
5. -- = No screening level available or not analyzed.
6. J = The result is an estimated concentration that is less than the method reporting limit (MRL) but greater than or equal to the method detection limit (MDL).
7. U = The compound was analyzed for but was not detected at or above the MRL/MDL.
8. D = Dilution.
9. Shaded values indicate that the detected concentration exceeds the PRG.
10. Sample ID nomenclature is per the following: type of sample-sample number-depth in feet-designation.
    For example T4S1SB-46-1-1 = soil boring (SB) number 46, collected 1 foot below the ground surface, primary sample (1). T4S1S-6 = surface soil sample number 6.
11. SLV = Oregon Department of Environmental Quality Level II Screening Level Values (SLVs) for Terrestrial Receptors (lowest available value).
12. PEC = Probable effects concentration; JSCS toxicity SLV.
13. Bold values indicate that the detected concentration exceeds the SLV.
14. Boxed values indicate that the detected concentration exceeds the PEC.

Table A-3
Soil Sampling Results - SVOCs
Source Control Measure Evaluation
Port of Portland - Terminal 4 Slip 1

Sample Location:	Preliminary Screening Levels		T4S1S-23	T4S1S-24	T4S1S-25	T4S1S-26	T4S1S-27	T4S1S-28	T4S1S-29	T4S1S-30
Sample ID:	PRG	SLV	T4S1S-23	T4S1S-24	T4S1S-25	T4S1S-26	T4S1S-27	T4S1S-28	T4S1S-29	T4S1S-30
Sample Interval:			0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1
Date Sampled:			9/12/2005	9/12/2005	9/12/2005	9/13/2005	9/13/2005	9/13/2005	9/13/2005	9/13/2005
SVOCs (µg/kg)										
Phenol	100,000,000	30,000	--	--	--	--	--	--	--	--
Di-n-butyl Phthalate	62,000,000	450	14.2 U	14.4 U	15.9 U	27.9 U	27.0 U	27.2 U	54.8 U	27.7 U
Bis(2-ethylhexyl) Phthalate	120,000	4,500	14.2 U	14.4 U	17.6 D	27.9 U	27.0 U	27.2 U	54.8 U	27.7 U

Notes:

1. Only detected compounds are reported in the table. The complete analyte list is presented in the Sampling and Analysis Plan (Appendix A) of the RI Work Plan (Hart Crowser, 2004).
2. SVOCs = Semi-Volatile Organic Compounds by EPA Method 8270C.
3. µg/kg = Micrograms per kilogram.
4. PRG = EPA Region 9 Preliminary Remediation Goal (PRG) for Industrial Soil (October 2004).
5. -- = No screening level available or not analyzed.
6. J = The result is an estimated concentration that is less than the method reporting limit (MRL) but greater than or equal to the method detection limit (MDL).
7. U = The compound was analyzed for but was not detected at or above the MRL/MDL.
8. Sample ID nomenclature is per the following: type of sample-sample number-depth in feet-designation.
   For example T4S1SB-46-1-1 = soil boring (SB) number 46, collected 1 foot below the ground surface, primary sample (1). T4S1S-6 = surface soil sample number 6.
9. SLV = Oregon Department of Environmental Quality Level II Screening Level Values (SLVs) for Terrestrial Receptors (lowest available value).

Table A-4
Soil Sampling Results - VOCs
Source Control Measure Evaluation
Port of Portland - Terminal 4 Slip 1

Sample Location:	Preliminary Screening Levels			T4S1S-23D
Sample ID: Sample Interval: Date Sampled:	PRG	SLV	PEC	T4S1S-23D 0 - 1 9/12/2005
VOCs (µg/kg)				
Acetone	54,000,000	1,250,000	--	2,650 U
Carbon Disulfide	720,000	--	--	1,060 U
Dichloromethane (Methylene Chloride)	21,000	730,000	--	529 U, D
2-Butanone (MEK)	110,000,000	200,000,000	--	1,060 U
Chloroform	470	1,875,000	--	106 U
Carbon Tetrachloride	550	1,000,000	--	106 U
Benzene	1,400	3,300,000	--	106 U
Trichloroethene (TCE)	110	40,000	2,100	106 U
Toluene	520,000	200,000	--	106 U
Tetrachloroethene (PCE)	1,300	10,000	500	106 U
Chlorobenzene	530,000	40,000	--	106 U
Ethylbenzene	400,000	--	--	106 U
m,p-Xylenes	420,000	--	--	212 U, D
o-Xylene	420,000	1,000	--	106 U
Isopropylbenzene	2,000,000	--	--	212 U
n-Propylbenzene	240,000	--	--	106 U
1,2,3-Trichlorobenzene	--		--	83.6 J, D
1,3,5-Trimethylbenzene	70,000	--	--	106 U
1,2,4-Trimethylbenzene	220,000	--	--	106 U
sec-Butylbenzene	220,000	--	--	22.2 J, D
4-Isopropyltoluene	--	--	--	21.2 J, D
1,4-Dichlorobenzene	7,900	20,000	300	106 U
n-Butylbenzene	240,000	--	--	43.4 J, D
Hexachlorobutadiene	220,000		600	226 J, D
Naphthalene	190,000	10,000	561	212 U

Notes:

1. Only detected compounds are reported in the table. The complete analyte list is presented in the Sampling and Analysis Plan (Appendix A) of the RI Work Plan (Hart Crowser, 2004
2. VOCs = Volatile Organic Compounds by EPA Method 8260B.
3. µg/kg = Micrograms per kilogram.
4. PRG = EPA Region 9 Preliminary Remediation Goal (PRG) for Industrial Soil (October 2004).
5. -- = No screening level available or not analyzed.
6. J = The result is an estimated concentration that is less than the method reporting limit (MRL) but greater than or equal to the method detection limit (MDL).
7. U = The compound was analyzed for but was not detected at or above the MRL/MDL.
8. Sample ID nomenclature is per the following: type of sample-sample number-depth in feet-designation.
   For example T4S1SB-46-1-1 = soil boring (SB) number 46, collected 1 foot below the ground surface, primary sample (1). T4S1S-6 = surface soil sample number 6.
9. SLV = Oregon Department of Environmental Quality Level II Screening Level Values (SLVs) for Terrestrial Receptors (lowest available value).
10. PEC = Probable effects concentration; JSCS toxicity SLV.

Table A-5
Soil Sampling Results - PCBs
Source Control Measure Evaluation
Port of Portland - Terminal 4 Slip 1

Sample Location:	Preliminary Screening Levels		T4S1S-23	T4S1S-24	T4S1S-25	T4S1S-26	T4S1S-27	T4S1S-28	T4S1S-29	T4S1S-30
Sample ID:	PRG	SLV	T4S1S-23	T4S1S-24	T4S1S-25	T4S1S-26	T4S1S-27	T4S1S-28	T4S1S-29	T4S1S-30
Sample Interval:			0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1
Date Sampled:			9/12/2005	9/12/2005	9/12/2005	9/13/2005	9/13/2005	9/13/2005	9/13/2005	9/13/2005
PCBs (mg/kg)										
Aroclor 1254	0.74	0.7	0.0355 U	0.0359 U	0.0394 U	0.0516 U	0.0335 U	0.0335 U	0.0845 U	0.0343 U
Aroclor 1260	0.74	--	0.0355 U	0.0359 U	0.0394 U	0.0344 U	0.0335 U	0.0335 U	0.0338 U	0.0343 U
Aroclor 1262	--	--	--	--	--	--	--	--	--	--
Aroclor 1268	--	--	--	--	--	--	--	--	--	--

Notes:
1. Only detected compounds are reported in the table. The complete analyte list is presented in the Sampling and Analysis Plan (Appendix A) of the RI Work Plan (Hart Crowser, 2004).
2. PCBs = Polychlorinated Biphenyls by EPA Method 8082.
3. mg/kg = Milligrams per kilogram.
4. PRG = EPA Region 9 Preliminary Remediation Goal (PRG) for Industrial Soil (October 2004).
5. -- = No screening level available or not analyzed.
6. U = The compound was analyzed for but was not detected at or above the MRL/MDL.
7. Sample ID nomenclature is per the following: type of sample-sample number-depth in feet-designation.
   For example T4S1SB-46-1-1 = soil boring (SB) number 46, collected 1 foot below the ground surface, primary sample (1). T4S1S-6 = surface soil sample number 6.
8. SLV = Oregon Department of Environmental Quality Level II Screening Level Values (SLVs) for Terrestrial Receptors (lowest available value).

Table A-6
Soil Sampling Results - Pesticides
Source Control Measure Evaluation
Port of Portland - Terminal 4 Slip 1

Sample Location:	Preliminary Screening Levels			T4S1S-23	T4S1S-23A	T4S1S-23B	T4S1S-23C	T4S1S-23D	T4S1S-24	T4S1S-24A	T4S1S-24B	T4S1S-24C
Sample ID:	PRG	SLV	PEC	T4S1S-23	T4S1S-23A	T4S1S-23B	T4S1S-23C	T4S1S-23D	T4S1S-24	T4S1S-24A	T4S1S-24B	T4S1S-24C
Sample Interval:				0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1
Date Sampled:				9/12/2005	9/12/2005	9/12/2005	9/12/2005	9/12/2005	9/12/2005	9/12/2005	9/12/2005	9/12/2005
Pesticides (µg/kg)												
delta-BHC	--	--	--	1.06 U, D	7.22 U	1.44 U	1.43 U	1.44 U	1.09 U, D	1.45 U	1.48 U	1.46 U
Heptachlor	380	15,000	10	1.06 U, D	7.22 U	1.44 U	1.43 U	1.44 U	1.09 U, D	1.45 U	1.48 U	1.46 U
Heptachlor Epoxide	190	--	16	1.06 U, D	7.22 U	1.44 U	1.43 U	1.44 U	1.09 U, D	1.45 U	1.48 U	1.46 U
Aldrin	100	25,000	40	1.06 U, D	7.22 U	1.44 U	1.43 U	1.44 U	1.09 U, D	1.45 U	1.48 U	1.46 U
gamma-Chlordane	6,500	9,000	17.6	1.06 U, D	7.22 U	1.44 U	1.43 U	1.44 U	1.09 U, D	1.45 U	1.48 U	1.46 U
Endosulfan I	3,700,000	20,000	--	0.329 J, D	7.22 U	1.44 U	1.43 U	1.44 U	1.09 U, D	1.45 U	1.48 U	1.46 U
alpha-Chlordane	6,500	9,000	17.6	1.06 U, D	7.22 U	1.44 U	1.43 U	1.44 U	1.09 U, D	1.45 U	1.48 U	1.46 U
Dieldrin	110	300	61.8	2.13 U, D	7.22 U	1.44 U	1.43 U	1.44 U	2.17 U, D	1.45 U	1.48 U	1.46 U
4,4'-DDE	7,000	10	31.3	2.13 U, D	7.22 U	1.44 U	1.43 U	1.44 U	2.17 U, D	1.45 U	1.48 U	1.46 U
Endrin	180,000	40	207	2.13 U, D	7.22 U	1.44 U	1.43 U	1.44 U	2.17 U, D	1.45 U	1.48 U	1.46 U
4,4'-DDD	10,000	10	28.0	2.13 U, D	7.22 U	1.44 U	1.43 U	1.44 U	2.17 U, D	1.45 U	1.48 U	1.46 U
Endrin Aldehyde	--	--	--	2.13 U, D	7.22 U	1.44 U	1.43 U	1.44 U	2.17 U, D	1.45 U	1.48 U	1.46 U
4,4'-DDT	7,000	10	62.9	0.700 J, D	7.22 U	1.44 U, D	1.43 U, D	1.44 U	0.434 J, D	1.45 U	1.48 U, D	1.46 U, D
Endrin Ketone	--	--	--	2.13 U, D	7.22 U	1.44 U	1.43 U	1.44 U	2.17 U, D	1.45 U	1.48 U	1.46 U
Methoxychlor	3,100,000	500,000	--	2.13 U, D	7.22 U	1.44 U, D	1.43 U	1.44 U	2.17 U, D	1.45 U	1.48 U	1.46 U

Sample Location:	Preliminary Screening Levels			T4S1S-24D	T4S1S-25	T4S1S-25A	T4S1S-25B	T4S1S-25C	T4S1S-25D	T4S1S-26	T4S1S-26A	T4S1S-26B
Sample ID:	PRG	SLV	PEC	T4S1S-24D	T4S1S-25	T4S1S-25A	T4S1S-25B	T4S1S-25C	T4S1S-25D	T4S1S-26	T4S1S-26A	T4S1S-26B
Sample Interval:				0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1
Date Sampled:				9/12/2005	9/12/2005	9/12/2005	9/12/2005	9/12/2005	9/12/2005	9/13/2005	9/13/2005	9/13/2005
Pesticides (µg/kg)												
delta-BHC	--	--	--	1.40 U	1.07 U, D	1.49 U	1.39 U	1.42 U	1.39 U	1.04 U, D	1.37 U	6.87 U
Heptachlor	380	15,000	10	1.40 U	1.07 U, D	1.49 U	1.39 U	1.42 U	1.39 U	1.04 U, D	1.37 U	6.87 U
Heptachlor Epoxide	190	--	16	1.40 U	1.07 U, D	1.49 U	1.39 U	1.42 U	1.39 U	1.04 U, D	1.37 U	6.87 U
Aldrin	100	25,000	40	1.40 U	1.07 U, D	1.49 U	1.39 U	1.42 U	1.39 U	1.04 U, D	1.37 U	6.87 U
gamma-Chlordane	6,500	9,000	17.6	1.40 U	1.07 U, D	1.49 U	1.39 U	1.42 U	1.39 U	1.04 U, D	1.37 U	6.87 U
Endosulfan I	3,700,000	20,000	--	1.40 U	1.07 U, D	1.49 U	1.39 U	1.42 U	1.39 U	1.04 U, D	1.37 U	6.87 U
alpha-Chlordane	6,500	9,000	17.6	1.40 U	1.07 U, D	1.49 U	1.39 U	1.42 U	1.39 U	1.04 U, D	1.37 U	6.87 U
Dieldrin	110	300	61.8	1.40 U	2.14 U, D	1.49 U	1.39 U	1.42 U	1.39 U	0.761 J, D	1.37 U	68.7 U
4,4'-DDE	7,000	10	31.3	1.40 U	2.14 U, D	1.49 U	1.39 U	1.42 U	1.39 U	5.22 D	1.37 U	68.7 U
Endrin	180,000	40	207	1.40 U	2.14 U, D	1.49 U	1.39 U	1.42 U	1.39 U	2.09 U, D	1.37 U	6.87 U
4,4'-DDD	10,000	10	28.0	1.40 U	2.14 U, D	1.49 U	1.39 U	1.42 U	1.39 U	2.37 D	1.37 U	6.87 U
Endrin Aldehyde	--	--	--	1.40 U	2.14 U, D	1.49 U	1.39 U	1.42 U	1.39 U	2.09 U, D	1.37 U	6.87 U
4,4'-DDT	7,000	10	62.9	1.40 U	0.511 J, D	1.49 U, D	1.39 U, D	1.42 U, D	1.39 U	17.20 D	1.37 U, D	6.87 U
Endrin Ketone	--	--	--	1.40 U	2.14 U, D	1.49 U	1.39 U	1.42 U	1.39 U	2.09 U, D	1.37 U	6.87 U
Methoxychlor	3,100,000	500,000	--	1.40 U	2.14 U, D	1.49 U	1.39 U	1.42 U	1.39 U	2.09 U, D	1.37 U	68.7 U

Please refer to notes at end of table.

Table A-6
Soil Sampling Results - Pesticides
Source Control Measure Evaluation
Port of Portland - Terminal 4 Slip 1

Sample Location:	Preliminary Screening Levels			T4S1S-26C	T4S1S-26D	T4S1S-27	T4S1S-27A	T4S1S-27B	T4S1S-27C	T4S1S-27D	T4S1S-28	T4S1S-28A
Sample ID:	PRG	SLV	PEC	T4S1S-26C	T4S1S-26D	T4S1S-27	T4S1S-27A	T4S1S-27B	T4S1S-27C	T4S1S-27D	T4S1S-28	T4S1S-28A
Sample Interval:				0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1
Date Sampled:				9/13/2005	9/13/2005	9/13/2005	9/13/2005	9/13/2005	9/13/2005	9/13/2005	9/13/2005	9/13/2005
Pesticides (µg/kg)												
delta-BHC	--	--	--	1.39 U	7.70 U	1.02 U, D	6.78 U	1.35 U	1.37 U	1.37 U	1.01 U, D	1.03 U
Heptachlor	380	15,000	10	1.39 U	7.70 U	1.02 U, D	6.78 U	1.35 U	1.37 U	1.37 U	1.01 U, D	1.03 U
Heptachlor Epoxide	190	--	16	1.39 U	7.70 U	1.02 U, D	6.78 U	1.35 U	1.37 U	1.37 U	1.01 U, D	1.03 U
Aldrin	100	25,000	40	1.39 U	7.70 U	1.02 U, D	6.78 U	1.35 U	1.37 U	1.37 U	1.01 U, D	1.03 U
gamma-Chlordane	6,500	9,000	17.6	1.39 U	7.70 U	1.02 U, D	6.78 U	1.35 U	1.37 U	1.37 U	1.01 U, D	1.03 U
Endosulfan I	3,700,000	20,000	--	1.39 U	7.70 U	1.02 U, D	6.78 U	1.35 U	1.37 U	1.37 U	1.01 U, D	1.03 U
alpha-Chlordane	6,500	9,000	17.6	1.39 U	77.0 U	1.02 U, D	67.8 U	1.35 U	1.37 U	1.37 U	1.01 U, D	1.03 U
Dieldrin	110	300	61.8	1.39 U	77.0 U	2.04 U, D	67.8 U	1.35 U	1.37 U	1.37 U	2.03 U, D	2.06 U
4,4'-DDE	7,000	10	31.3	1.39 U	77.0 U	1.83 J, D	6.78 U	1.35 U	1.37 U	1.37 U	1.72 J, D	2.06 U
Endrin	180,000	40	207	1.39 U	7.70 U	2.04 U, D	67.8 U	1.35 U	1.37 U	1.37 U	2.03 U, D	2.06 U
4,4'-DDD	10,000	10	28.0	1.39 U	7.70 U	2.04 U, D	6.78 U	1.35 U	0.873 J, D	1.37 U	2.03 U, D	2.06 U
Endrin Aldehyde	--	--	--	1.39 U	77.0 U	2.04 U, D	67.8 U	1.35 U	1.37 U	1.37 U	2.03 U, D	2.06 U
4,4'-DDT	7,000	10	62.9	1.11 J, D	96.8 D	3.66 D	67.8 U	1.35 U, D	1.37 U, D	1.37 U, D	3.43 D	3.72
Endrin Ketone	--	--	--	1.39 U	77.0 U	2.04 U, D	67.8 U	1.35 U	1.37 U	1.37 U	2.03 U, D	2.06 U
Methoxychlor	3,100,000	500,000	--	1.39 U	77.0 U	2.04 U, D	67.8 U	1.35 U	1.37 U	1.37 U	2.03 U, D	2.06 U

Sample Location:	Preliminary Screening Levels			T4S1S-28B	T4S1S-28C	T4S1S-28D	T4S1S-29	T4S1S-30	T4S1S-30A	T4S1S-30C	T4S1S-30D
Sample ID:	PRG	SLV	PEC	T4S1S-28B	T4S1S-28C	T4S1S-28D	T4S1S-29	T4S1S-30	T4S1S-30A	T4S1S-30C	T4S1S-30D
Sample Interval:				0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1
Date Sampled:				9/13/2005	9/13/2005	9/13/2005	9/13/2005	9/13/2005	9/13/2005	9/13/2005	9/13/2005
Pesticides (µg/kg)											
delta-BHC	--	--	--	1.02 U	1.02 U	1.01 U	1.03 U, D	1.03 U, D	1.03 U	1.01 U	1.04 U
Heptachlor	380	15,000	10	1.02 U	1.02 U	1.01 U	1.03 U, D	1.03 U, D	1.03 U	1.01 U	1.04 U
Heptachlor Epoxide	190	--	16	1.02 U	1.02 U	1.01 U	1.03 U, D	0.190 J, D	1.03 U	1.01 U	1.04 U
Aldrin	100	25,000	40	1.02 U	1.02 U	1.01 U	1.03 U, D	1.03 U, D	1.03 U	1.01 U	1.04 U
gamma-Chlordane	6,500	9,000	17.6	1.02 U	1.02 U	1.01 U	1.03 U, D	1.03 U, D	1.03 U	1.01 U	1.04 U
Endosulfan I	3,700,000	20,000	--	1.02 U	1.02 U	1.01 U	1.03 U, D	1.03 U, D	1.03 U	1.01 U	1.04 U
alpha-Chlordane	6,500	9,000	17.6	1.02 U	1.02 U	1.01 U	1.03 U, D	1.03 U, D	1.03 U	1.01 U	1.04 U
Dieldrin	110	300	61.8	0.274 J	2.05 U	0.808 J	2.06 U, D	0.397 J, D	0.896 J	2.02 U	0.381 J
4,4'-DDE	7,000	10	31.3	2.04 U	2.05 U	1.61 J	7.84 D	2.05 U, D	2.06 U	2.02 U	2.07 U
Endrin	180,000	40	207	2.04 U	2.05 U	2.01 U	2.06 U, D	2.05 U, D	2.06 U	2.02 U	2.07 U
4,4'-DDD	10,000	10	28.0	2.04 U	2.05 U	0.654 J	2.79 D	2.05 U, D	2.06 U	2.02 U	2.07 U
Endrin Aldehyde	--	--	--	2.04 U	2.05 U	2.01 U	2.06 U, D	2.05 U, D	2.06 U	2.02 U	2.07 U
4,4'-DDT	7,000	10	62.9	0.648 J	0.925 J	4.66	15.9 D	1.66 J, D	2.50	1.54 J	1.35 J
Endrin Ketone	--	--	--	2.04 U	2.05 U	2.01 U	2.06 U, D	2.05 U, D	2.06 U	2.02 U	2.07 U
Methoxychlor	3,100,000	500,000	--	2.04 U	2.05 U	2.01 U	2.06 U, D	2.05 U, D	2.06 U	2.02 U	2.07 U

Notes:

1. Only detected compounds are reported in the table. The complete analyte list is presented in the Sampling and Analysis Plan (Appendix A) of the RI Work Plan (Hart Crowser, 2004).
2. Organochlorine Pesticides by EPA Method 8081A. Organophosphorus Pesticides by EPA Method 8141A.
3. µg/kg = Micrograms per kilogram.
4. PRG = EPA Region 9 Preliminary Remediation Goal (PRG) for Industrial Soil (October 2004).
5. -- = No screening level available or not analyzed.
6. J = The result is an estimated concentration that is less than the method reporting limit (MRL) but greater than or equal to the method detection limit (MDL).
7. U = The compound was analyzed for but was not detected at or above the MRL/MDL.
8. P = The GC or HPLC confirmation criterion was exceeded. The relative percent difference is greater than 40 percent between the two analytical results.
9. Sample ID nomenclature is per the following: type of sample-sample number-depth in feet-designation.
   For example T4S1SB-46-1-1 = soil boring (SB) number 46, collected 1 foot below the ground surface, primary sample (1). T4S1S-6 = surface soil sample number 6.
10. SLV = Oregon Department of Environmental Quality Level II Screening Level Values (SLVs) for Terrestrial Receptors (lowest available value).
11. PEC = Probable effects concentration; JSCS toxicity SLV.
12. Bold values indicate that the detected concentration exceeds the SLV.
13. Boxed values indicate that the detected concentration exceeds the PEC.

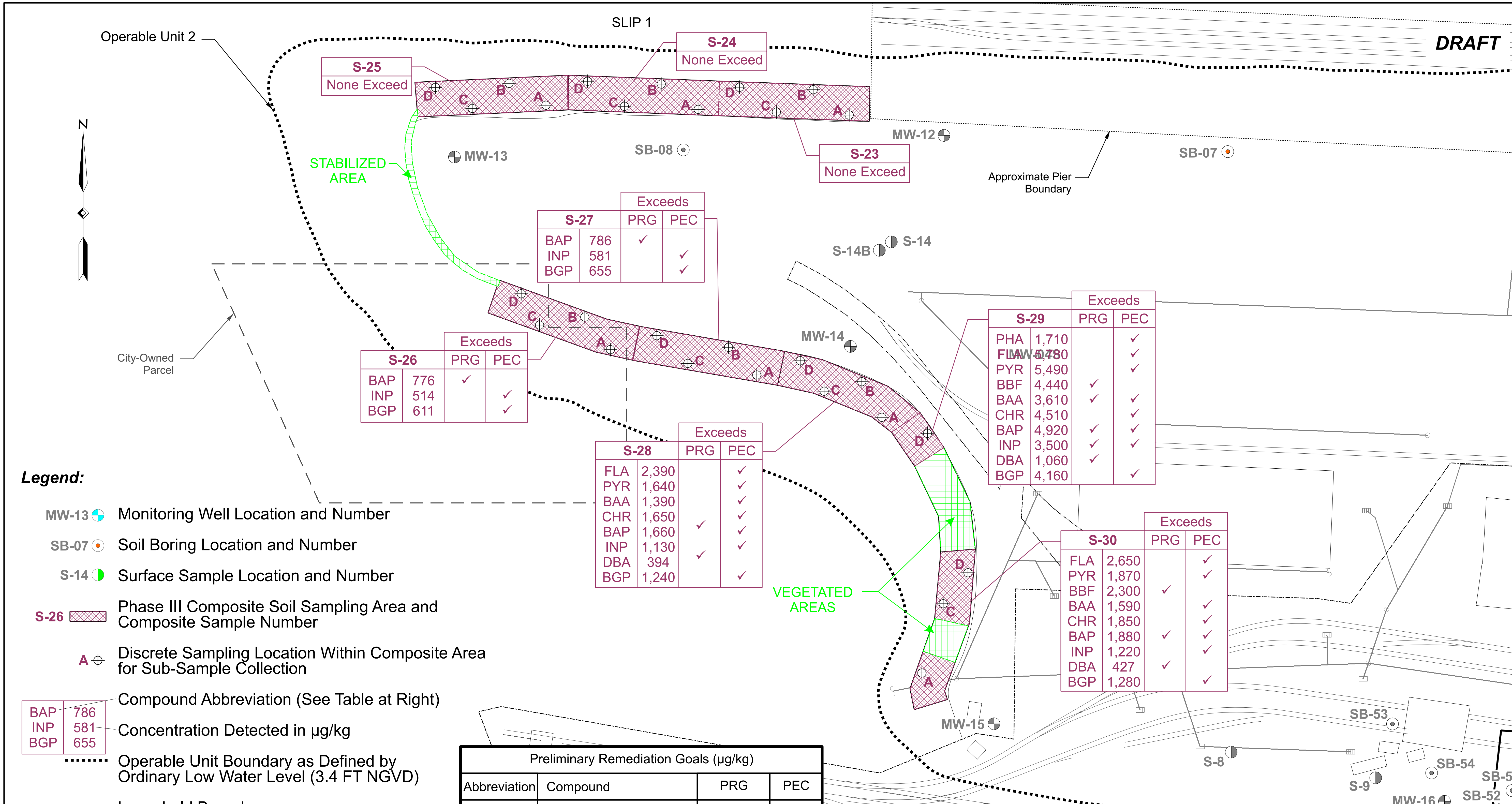
Table A-7
Soil Sampling Results - Metals
Source Control Measure Evaluation
Port of Portland - Terminal 4 Slip 1

Sample Location:	Preliminary Screening Levels				T4S1S-23	T4S1S-24	T4S1S-25	T4S1S-26	T4S1S-26A	T4S1S-26B
Sample ID:	Background	PRG	SLV	PEC	T4S1S-23	T4S1S-24	T4S1S-25	T4S1S-26	T4S1S-26A	T4S1S-26B
Sample Interval:					0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1
Date Sampled:					9/12/2005	9/12/2005	9/12/2005	9/13/2005	9/13/2005	9/13/2005
Metals (mg/kg)										
Antimony	5	410	5	64	1.48 U, D	1.58 U, D	1.59 U	0.0728 J	1.53 U	1.53 U
Arsenic	5.8	1.6	10	33	2.81 D	3.08 D	2.69	10.9	2.49	2.23
Beryllium	2.1	1,900	10	--	0.326 J, D	0.321 J, D	0.296 J	0.260 J	0.209 J	0.285 J
Cadmium	0.9	450	4	4.98	0.158 J, D	0.110 J, D	0.122 J	7.02	0.220 J	0.270 J
Chromium	26	450	0.4	111	13.4 D	14.8 D	13.9	16.4	12.3	14.5
Copper	34	41,000	50	149	13.5 D	13.7 D	14.1	78.1	12.0	14.0
Lead	24	800	16	128	6.24 D	4.59 D	5.07	479 D	7.78	12.6
Mercury	0.04	310	0.1	1.06	0.0954 U, D	0.00920 J, D	0.0108 J, D	0.0947 J	0.126 U, D	0.131 U, D
Nickel	21	20,000	30	48.6	16.7 D	18.0 D	19.2	18.4	16.2	16.6
Selenium	0.8	5,100	1	5	0.252 J, D	0.479 J, D	0.338 J	0.286 J	0.184 J	0.163 J
Silver	0.6	5,100	2	5	0.495 U, D	0.526 U, D	0.529 U	1.16	0.511 U	0.509 U
Thallium	<5	67	1	--	0.495 U, D	0.526 U, D	0.529 U	0.0624 J	0.511 U	0.509 U
Zinc	95	100,000	50	459	52.6 D	52.9 D	55.9	949 D	55.7	64.0

Sample Location:	Preliminary Screening Levels				T4S1S-26C	T4S1S-26D	T4S1S-27	T4S1S-28	T4S1S-29D	T4S1S-30
Sample ID:	Background	PRG	SLV	PEC	T4S1S-26C	T4S1S-26D	T4S1S-27	T4S1S-28	T4S1S-29	T4S1S-30
Sample Interval:					0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1
Date Sampled:					9/13/2005	9/13/2005	9/13/2005	9/13/2005	9/13/2005	9/13/2005
Metals (mg/kg)										
Antimony	5	410	5	64	1.54 U	1.74 U	1.53 U	1.53 U	1.51 U, D	1.53 U, D
Arsenic	5.8	1.6	10	33	2.97	15.7	2.59	3.72	14.5 D	2.47 D
Beryllium	2.1	1,900	10	--	0.277 J	0.186 J	0.295 J	0.316 J	0.292 J, D	0.352 J, D
Cadmium	0.9	450	4	4.98	0.646	25.3	0.402 J	0.815	2.12 D	0.352 J, D
Chromium	26	450	0.4	111	15.2	23.6	16.0	16.6	23.8 D	16.8 D
Copper	34	41,000	50	149	16.9	219 D	16.7	19.5	38.5 D	17.0 D
Lead	24	800	16	128	43.6	868 D	30.4	88.8	276 D	41.8 D
Mercury	0.04	310	0.1	1.06	0.130 U, D	0.325 D	0.102 U	0.0261 J, D	0.0799 J, D	0.0340 J, D
Nickel	21	20,000	30	48.6	17.5	19.3	19.5	19.0	17.7 D	20.5 D
Selenium	0.8	5,100	1	5	0.159 J	0.407 J	0.229 J	0.295 J	0.347 J, D	0.250 J, D
Silver	0.6	5,100	2	5	0.123 J	2.10	0.509 U	0.0967 J	0.660 D	0.510 U, D
Thallium	<5	67	1	--	0.513 U	0.122 J	0.509 U	0.509 U	0.504 U, D	0.510 U, D
Zinc	95	100,000	50	459	127	3,320 D	112	181	328 D	91.4 D

Notes:

1. Only detected compounds are reported in the table. The complete analyte list is presented in the Sampling and Analysis Plan (Appendix A) of the RI Work Plan (Hart Crowser, 2004).
2. Metals using EPA 6000-7000 Series Methods.
3. mg/kg = Milligrams per kilogram.
4. PRG = EPA Region 9 Preliminary Remediation Goal (PRG) for Industrial Soil (October 2004).
5. -- = No screening level available or not analyzed.
6. U = The compound was analyzed for but was not detected at or above the MRL/MDL.
7. B = The result is an estimated concentration that is less than the MRL but greater than or equal to the method detection limit (MDL).
8. Shaded values indicate that the detected concentration exceeds the background and PRG.
9. Background Levels are from the Washington Department of Ecology's publication Natural Background Soil Metals Concentrations in Values are the 90th percentile values for Clark County, except for antimony, selenium, silver Washington State, dated October 1994. and thallium where state-wide data were used due to a limited number of detections.
10. SLV = Oregon Department of Environmental Quality Level II Screening Level Values (SLVs) for Terrestrial Receptors (lowest available value).
11. PEC = Probable effects concentration; JSCS toxicity SLV.
12. Bold values indicate that the detected concentration exceeds background and the SLV.
13. Boxed values indicate that the detected concentration exceeds background and the PEC.



S-27		Exceeds PRG	Exceeds PEC
BAP	786	✓	
INP	581		✓
BGP	655		✓

S-26		Exceeds PRG	Exceeds PEC
BAP	776	✓	
INP	514		✓
BGP	611		✓

S-28		Exceeds PRG	Exceeds PEC
FLA	2,390		✓
PYR	1,640		✓
BAA	1,390		✓
CHR	1,650		✓
BAP	1,660	✓	✓
INP	1,130		✓
DBA	394	✓	
BGP	1,240		✓

S-29		Exceeds PRG	Exceeds PEC
PHA	1,710		✓
FLA	5,780		✓
PYR	5,490		✓
BBF	4,440	✓	
BAA	3,610	✓	✓
CHR	4,510		✓
BAP	4,920	✓	✓
INP	3,500	✓	✓
DBA	1,060	✓	
BGP	4,160		✓

S-30		Exceeds PRG	Exceeds PEC
FLA	2,650		✓
PYR	1,870		✓
BBF	2,300	✓	
BAA	1,590		✓
CHR	1,850		✓
BAP	1,880	✓	✓
INP	1,220		✓
DBA	427	✓	
BGP	1,280		✓

Legend:

- MW-13 Monitoring Well Location and Number
- SB-07 Soil Boring Location and Number
- S-14 Surface Sample Location and Number
- S-26 Phase III Composite Soil Sampling Area and Composite Sample Number
- A Discrete Sampling Location Within Composite Area for Sub-Sample Collection
- BAP 786 / INP 581 / BGP 655: Compound Abbreviation (See Table at Right); Concentration Detected in µg/kg
- Operable Unit Boundary as Defined by Ordinary Low Water Level (3.4 FT NGVD)
- Leasehold Boundary
- Under ground Storm Sewer Piping
- Catch Basin
- City-Owned Parcel Boundary

Preliminary Remediation Goals (µg/kg)

Abbreviation	Compound	PRG	PEC
PHA	Phenanthrene	--	1,170
FLA	Fluoranthene	22,000,000	2,230
PYR	Pyrene	29,000,000	1,520
BBF	Benzo (b) fluoranthene	2,100	--
BAA	Benzo (a) anthracene	2,100	1,050
CHR	Chrysene	210,000	1,290
BAP	Benzo (a) pyrene	210	1,450
INP	Indeno (1,2,3-cd) pyrene	2,100	100
DBA	Dibenzo (a,h) anthracene	210	1,300
BGP	Benzo (g,h,i) perylene	--	300

SLIP 3

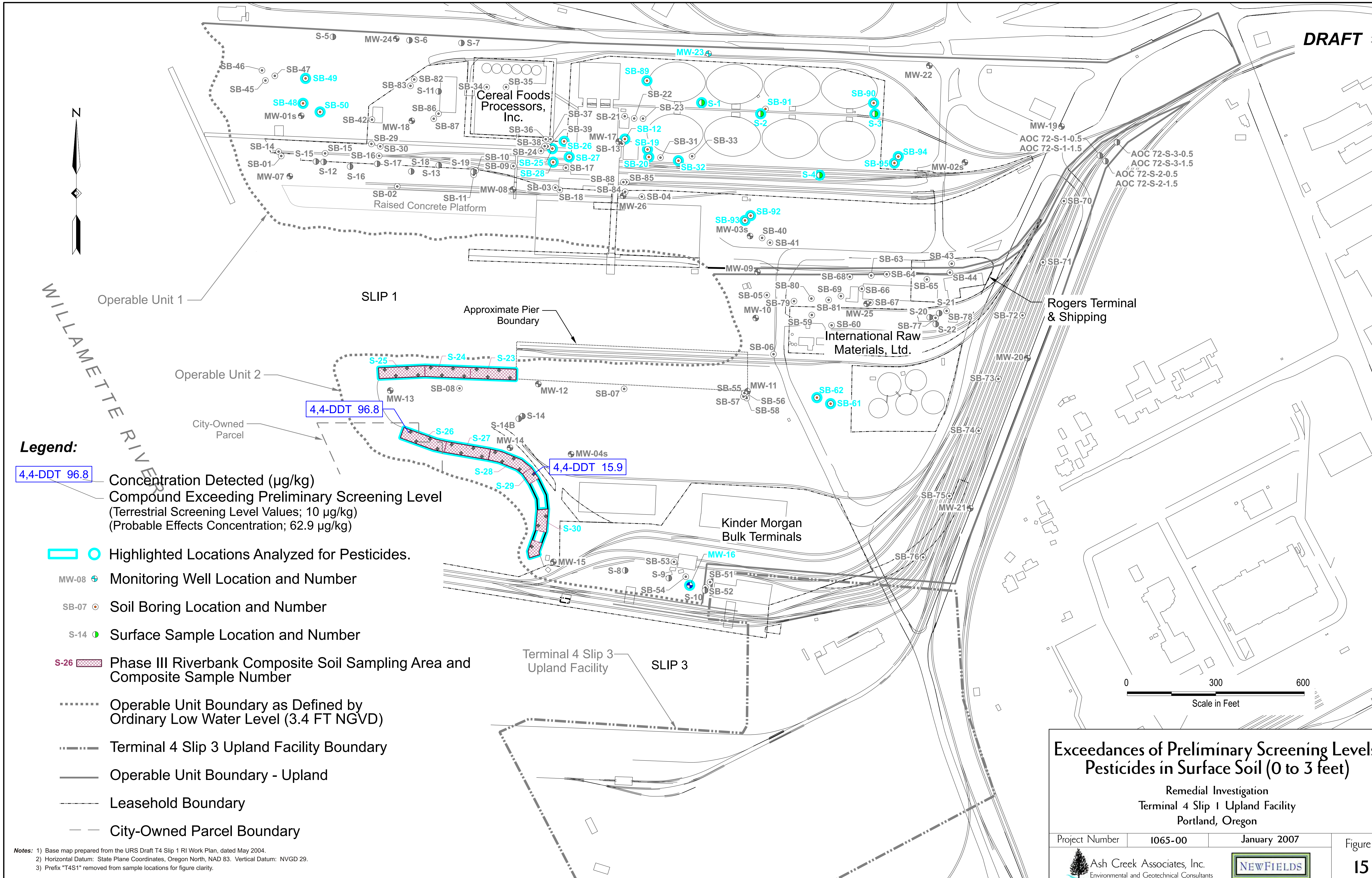
Notes:
1) Base map prepared from the URS Draft T4 Slip 1 RI Work Plan, dated May 2004.
2) Horizontal Datum: State Plane Coordinates, Oregon North, NAD 83. Vertical Datum: NVGD 29.
3) Prefix "T4S1" removed from sample locations for figure clarity.
4) See Table 7 for Discrete Sample Results.
5) PRG = EPA Region 9 Preliminary Remediation Goal (PRG) for Industrial Soil (EPA, 2004a).
6) PEC = Probable Effect Concentration Obtained From Table 3-1 of the DEQ Joint Source Control Strategy Document.

Exceedances of Preliminary Screening Levels: Polynuclear Aromatic Hydrocarbons in Riverbank Area - OU2

Remedial Investigation
Terminal 4 Slip 1 Upland Facility
Portland, Oregon

Project Number	1065-00	January 2007	Figure 14

Ash Creek Associates, Inc. Environmental and Geotechnical Consultants
NEWFIELDS



Legend:

4,4-DDT 96.8	Concentration Detected (µg/kg) Compound Exceeding Preliminary Screening Level (Terrestrial Screening Level Values; 10 µg/kg) (Probable Effects Concentration; 62.9 µg/kg)
	Highlighted Locations Analyzed for Pesticides.
MW-08	Monitoring Well Location and Number
SB-07	Soil Boring Location and Number
S-14	Surface Sample Location and Number
S-26	Phase III Riverbank Composite Soil Sampling Area and Composite Sample Number
	Operable Unit Boundary as Defined by Ordinary Low Water Level (3.4 FT NGVD)
	Terminal 4 Slip 3 Upland Facility Boundary
	Operable Unit Boundary - Upland
	Leasehold Boundary
	City-Owned Parcel Boundary

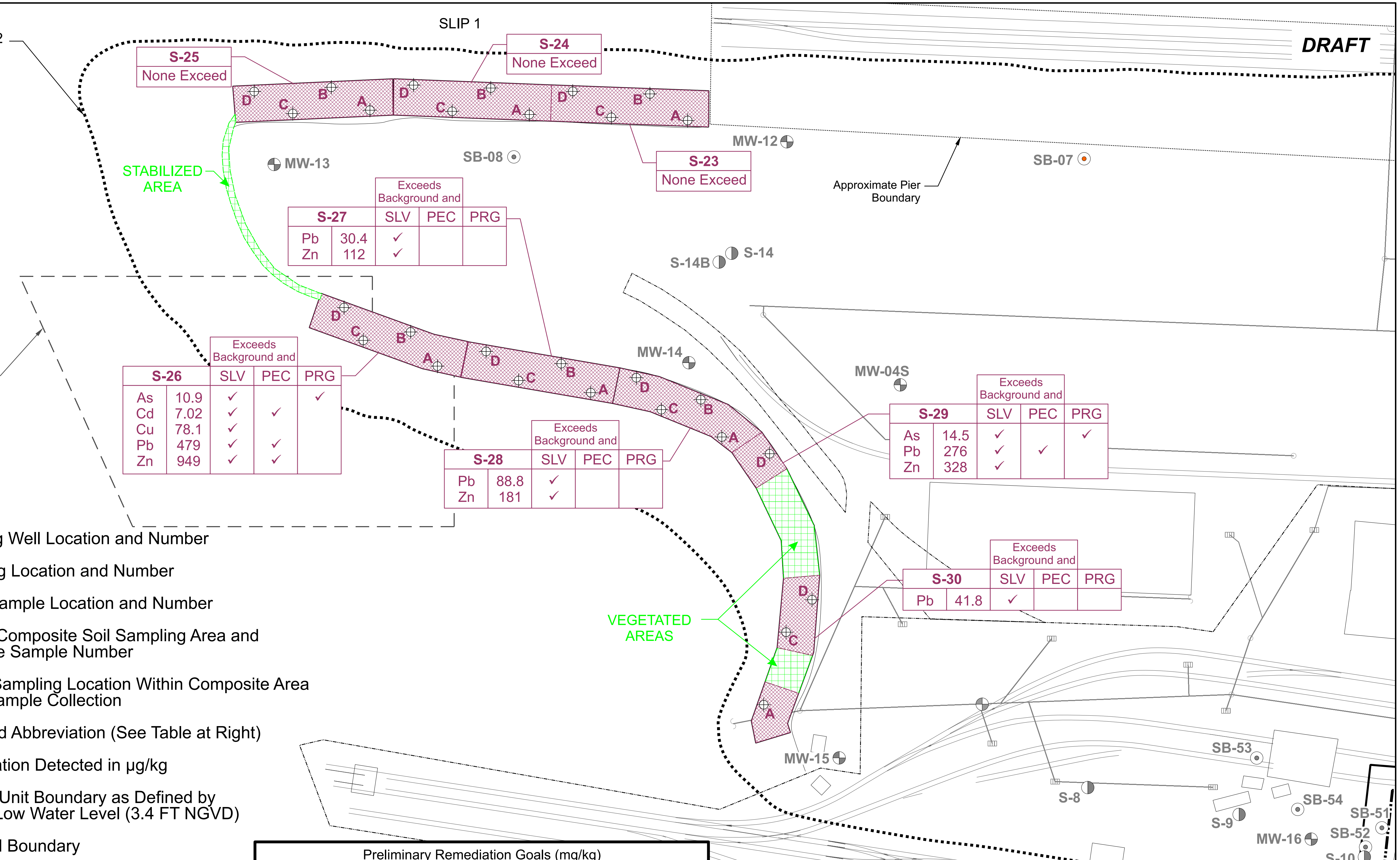
Notes: 1) Base map prepared from the URS Draft T4 Slip 1 RI Work Plan, dated May 2004.
2) Horizontal Datum: State Plane Coordinates, Oregon North, NAD 83. Vertical Datum: NVGD 29.
3) Prefix "T4S1" removed from sample locations for figure clarity.

Exceedances of Preliminary Screening Levels: Pesticides in Surface Soil (0 to 3 feet)

Remedial Investigation
Terminal 4 Slip 1 Upland Facility
Portland, Oregon

Project Number	1065-00	January 2007	Figure 15

Ash Creek Associates, Inc. Environmental and Geotechnical Consultants
NEWFIELDS



Legend:

- MW-13 — Monitoring Well Location and Number
- SB-07 — Soil Boring Location and Number
- S-14 — Surface Sample Location and Number
- S-26 — Phase III Composite Soil Sampling Area and Composite Sample Number
- A — Discrete Sampling Location Within Composite Area for Sub-Sample Collection
- Pb / Zn — Compound Abbreviation (See Table at Right)
- 30.4 / 112 — Concentration Detected in µg/kg
- Operable Unit Boundary as Defined by Ordinary Low Water Level (3.4 FT NGVD)
- Leasehold Boundary
- Under ground Storm Sewer Piping
- Catch Basin
- City-Owned Parcel Boundary

Preliminary Remediation Goals (mg/kg)

Abbreviation	Compound	Background	Terrestrial SLV	PEC	PRG
As	Arsenic	5	10	33	1.6
Cd	Cadmium	0.9	4	4.98	450
Cu	Copper	34	50	149	4,1000
Pb	Lead	24	16	128	800
Hg	Mercury	0.04	0.1	1.06	310
Zn	Zinc	95	50	459	100,000

0 100 200
Scale in Feet

Notes:
1) Base map prepared from the URS Draft T4 Slip 1 RI Work Plan, dated May 2004.
2) Horizontal Datum: State Plane Coordinates, Oregon North, NAD 83. Vertical Datum: NVGD 29.
3) Prefix "T4S1" removed from sample locations for figure clarity.
4) See Table 12 for Discrete Sample Results.
5) SLV = Oregon DEQ Level II Screening Level Values (SLVs) for Terrestrial Receptors (DEQ, 2001).
6) Background levels are from the Washington Department of Ecology's Publication 94-115 (Ecology, 1994).
7) PEC = Probable Effect Concentration Obtained From Table 3-1 of the DEQ Joint Source Control Strategy Document.

Exceedances of Preliminary Screening Levels: Metals in Riverbank Area - OU2

Remedial Investigation
Terminal 4 Slip 1 Upland Facility
Portland, Oregon

Project Number	1065-00	January 2007	Figure 18

Ash Creek Associates, Inc.
Environmental and Geotechnical Consultants
NEWFIELDS

Appendix B

Summary of JSCS Screening

Table B-1
Summary of JSCS Screeening
SOURCE CONTROL MEASURE EVALUATION
PORT OF PORTLAND - TERMINAL 4 SLIP 1

Analytes (CPECs/COPCs) Exceeding Screening Levels	Exceedence Location
Acenaphthene	S27A, S28A, S30D
Benzo(a)anthracene	S26B, S26D, S27A, S28, S28A, S29, S30, S30A, S30C
Benzo(a)pyrene	S26B, S26D, S27A, S28, S28A, S29, S30, S30A, S30C
Benzo(g,h,i)perylene	S26, S26B, S26D, S27, S27A, S28, S28A, S29, S30, S30A, S30C
Cadmium	S23, S24, S25, S26, S26A, S26B, S26C, SS26D, S27, S28, S29, S30
Chrysene	S26B, S26D, S27A, S28, S28A, S29, S30, S30A, S30C
Copper	S23, S24, S25, S26, S26A, S26B, S26C, SS26D, S27, S28, S29, S30
4,4'-DDD	S26, S27C, S28D, S29
4,4'-DDE	S26, S27, S28, S28D, S29
4,4'-DDT	S23, S24, S25, S26, S26C, S26D, S27, S28, S28A, S28B, S28C, S28D, S29, S30, S30A, S30C, S30D
Dibenz(a,h)anthracene	S28A
Fluoranthene	S26B, S27A, S28, S28A, S29, S30, S30A
Fluorene	S28A, S30D
Indeno(1,2,3-cd)pyrene	S26, S26B, S26D, S27, S27A, S27B, S28, S28A, S28D, S29, S30, S30A, S30C
Lead	S26, S26D, S29
Naphthalene	S30D
Phenanthrene	S27A, S28A, S29, S30A, S30D
Pyrene	S26B, S26D, S27A, S28, S28A, S29, S30, S30A, S30C
Selenium	S23, S24, S25, S26, S26A, S26B, S26C, SS26D, S27, S28, S29, S30
Zinc	S23, S24, S25, S26, S26A, S26B, S26C, SS26D, S27, S28, S29, S30

Appendix C

Alternative Differential Unit Cost Calculations

ANCHOR ENVIRONMENTAL CA, L.P.

PROJECT: Wheeler Bay
SUBJECT: Bank Stabilization
ATTENDEES:

JOB NO.:
DATE: 7/31/06 TIME:
PAGE: 1 OF: 2
MADE BY: RD
ROUTE TO:

☑ CALCULATIONS ☐ TELECON ☐ MEETING NOTES

Unit costs

Several local quarries were contacted including Glacier Northwest, Rinker Materials, and Morse Brothers. Purchase and delivery costs were obtained for select fill and Classes 100(E) and 200(E) riprap. Prices ranged from \$20/T to \$36/T. The following were selected for the FS-level cost estimate.

Select Fill \$25/T
Class 100(E) \$30/T
Class 200(E) \$35/T

Based on recently completed projects on the Willamette River, an additional \$10/T was added for placement from the upland and \$15/T was added for in-water placement.

Articulated concrete blocks (ACB) have been used to stabilize shorelines within the vicinity of the WB project. Some extra material may be available from those projects; however, it was not considered in this estimate. Savings if the material were to become available would be on the order of \$2/sf to \$3/sf.

Armortec was contacted to obtain market prices for purchase, delivery, & placement. They provided a range of \$12/sf to \$15/sf. This cost is in line w/ local projects. This cost also includes purchase & placement of topsoil, but no planting.

GSE was contacted regarding current geocomposite & geotextile purchase & delivery costs — 50¢/sf and 25¢/sf, respectively. Based on other projects, \$10/sf was added for placement.

Presto Geosystems was contacted for costs of the geoweb system. (CCS)
purchase & deliver – \$1.25/sf plus 20% for anchors
placement – \$4/sf

Topsoil costs & placement in the CCS grids are assumed to be equal to select fill costs above.

ANCHOR ENVIRONMENTAL CA, L.P.

PROJECT: Wheeler Bay
SUBJECT: Bank Stabilization
ATTENDEES:
JOB NO.:
DATE: 7/31/06 TIME:
PAGE: 2 OF: 2
MADE BY: RD
ROUTE TO:

☑ CALCULATIONS ☐ TELECON ☐ MEETING NOTES

Alternative I - Riprap

Approx total area - 72,035sf ; Approx. 750 lf of shoreline

(No grading or materials associated w/ EA caps included)

Class 100(E) riprap = 2,700T placed above El. +10' } upland/in-water
Class 200(E) riprap = 3,250T placed below El. +10' } work interface

Total cost = 2,700T($40/T) + 3,250T($50/T) = $270,500

→ $361/lf [~$360/lf]

Alternative II - ACB

ACB placed over entire area; Geocomposite placed below El +10 over approx. 46,550sf

(No grading or materials associated w/ EA caps included; no planting included)

Total cost = $15/sf (72,035sf) + $0.60/sf (46,550sf) = $1,108,455

→ $1478/lf [~$1500/lf]

Alternative III - CCS

CCS is placed over entire area and filled with topsoil above El +10' and with gravel below El +10'. Assume gravel is Class 100(E) riprap. Gravel volume ~ 1650T and topsoil volume (mass) ~ 1415T.

(No grading or materials associated w/ EA caps included; no planting included)

Total cost = 1.2[$1.25/sf (72,035sf)] + $4/sf (72,035sf) +

$45/T (1650T) + $35/T (1415T) = $519,968

→ $694/lf

[~$700/lf]