SEDIMENT ACCEPTANCE CRITERIA TECHNICAL MEMORANDUM
(PREFINAL 60 PERCENT DESIGN DELIVERABLE)

TERMINAL 4 EARLY ACTION
PORT OF PORTLAND, PORTLAND OREGON

DRAFT DOCUMENT: DO NOT QUOTE OR CITE
This document has not been reviewed or approved by USEPA and its federal, state and tribal partners and is subject to change in whole or in part.

Prepared for
Port of Portland
Portland, Oregon

Prepared by
Anchor Environmental, L.L.C.
6650 SW Redwood Lane, Suite 110
Portland, Oregon 97224

In Association with
NewFields

December 2006

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1 INTRODUCTION

The objective of this technical memorandum is to develop sediment acceptance criteria for placement of contaminated sediments and imported fill in the Terminal 4 Slip 1 confined disposal facility (CDF; see Figures 1 and 2). The initial placement of contaminated sediments from the Terminal 4 Removal Action into the CDF, and the technical data supporting the suitability of this material for placement in the CDF, are described in the Prefinal (60 percent) Design Analysis Report (DAR). The focus of this memorandum is to develop acceptance criteria for contaminated sediments from other cleanup sites in the Portland Harbor, subsequent to the placement of Terminal 4 sediments, as well as acceptance criteria for overlying imported fill materials needed to bring the CDF elevation up to final grade.

1.1 CDF Performance Standards

Removal Action Objectives (RAOs) for the Terminal 4 Removal Action were presented in the EE/CA (BBL 2005) and the USEPA Action Memo (USEPA 2006a), as follows:

- Reduce ecological and human health risks associated with sediment contamination within the Removal Action Area to acceptable levels
- Reduce the likelihood of recontamination of sediments within the Removal Action Area

The DAR (Section 2.2.2) provides a list of performance standards for each Removal Action remedy that must be met to achieve the RAOs. As stated in the DAR, a key performance standard for the CDF to achieve these RAOs is the confinement of contaminated sediments in the CDF, thereby isolating these sediments from direct contact with human and ecological receptors, and removing or attenuating contaminant exposure pathways. Specifically, the CDF performance standard identified in the DAR that is the most relevant for determining sediment acceptance criteria is the following:

- Final Applicable Relevant and Appropriate Requirements (ARARs) related to surface water will not be established for the Portland Harbor Superfund Site until the time of the ROD. To ensure that the CDF will meet ROD standards and as directed by USEPA, the CDF shall be designed such that the quality of groundwater exiting the CDF to the river will meet USEPA's national recommended chronic water quality criteria or ambient background conditions at the point of discharge, and fish

consumption criteria, and drinking water criteria/guidelines in the receiving water. In addition, the Long Term Monitoring and Reporting Plan (LTMRP; Appendix E of the DAR) will incorporate evaluation of these criteria on an interim basis pending finalization of the Portland Harbor ROD.

These RAOs and performance standards for the CDF are also relevant to the placement of contaminated dredged material in the CDF from other off-site sources, as provided in this memorandum.

To assess the performance of the CDF relative to RAOs, long-term groundwater releases from the CDF will be evaluated relative to acute and chronic water quality criteria, current relevant total maximum daily loads (TMDLs), and fish consumption and drinking water consumption in the Willamette River. This evaluation will be accomplished by conducting groundwater modeling, as was done for Terminal 4 sediments (see Appendix I of the DAR), to predict the chemical quality of groundwater as it leaves the CDF and enters the river. It must be shown that contaminated dredged material from other candidate sites in the Portland Harbor will not adversely affect groundwater in the CDF after placement, and that water quality criteria and guidelines for the protection of human and ecological receptors will not be impaired in the Willamette River.

This memorandum provides the criteria and the administrative and technical evaluation procedures by which off-site sediments will be evaluated by the Port and USEPA for placement in the CDF such that the performance of the CDF achieves the stated standards and RAOs. Long-term monitoring of CDF groundwater will be conducted (see Appendix E of the DAR, LTMRP) to confirm that the CDF is functioning as designed.

A brief description of the CDF is provided in the next section.

1.2 Other Relevant Design Documents

CDF Management Plan. The CDF Management Plan (Appendix B of the DAR) describes the procedures that will be implemented to manage the placement of contaminated sediments, whether by hydraulic or mechanical means, into the Slip 1 CDF, as well as

imported fill and structural fill materials; appropriate management practices to prevent the release of sediments and contaminants during and between placement events; and quality assurance procedures to ensure the CDF is constructed according to specifications.

Long-Term Monitoring and Reporting Plan (LTMRP). The LTMRP describes the inspection and monitoring procedures that will be implemented after the CDF is filled and the final cover layer is placed, to ensure the structural integrity of the CDF is maintained, and to verify contaminants are adequately contained in the CDF. A key component of the LTMRP will be a groundwater quality monitoring plan, which will include installation and sampling of "sentinel" groundwater monitoring wells in the CDF berm. The LTMRP will be an appendix to the Final 100 percent Design Analysis Report.

Water Quality Monitoring Plan. The Water Quality Monitoring Plan (Appendix D of the DAR), describes the short-term monitoring activities associated with various construction activities related to the CDF. In particular, the document specifies measurement of field parameters (turbidity and dissolved oxygen) and collection of water samples for chemical testing (TSS and target contaminants) during excavation of the berm key, construction of the berm, and filling of the CDF (i.e. discharge of dredge slurry into the settling pond behind the berm, and potential discharge of return water over the weir or seepage through the berm). The Water Quality Monitoring Plan provides water quality criteria and guidelines, compliance boundaries, monitoring stations, parameters, and sampling schedules, and contingency measures and notification procedures to be implemented if an exceedance of a monitoring parameter occurs.

2 CDF DESCRIPTION

The design of the CDF was developed based on the performance standards and RAOs described in Section 2.2.2 of the DAR and mentioned in the previous section of this document. The CDF consists of a sand and gravel berm with quarry spall training terraces spanning the mouth of Slip 1, as shown on Figures 1 and 2. An engineered fill sequence consisting of a basal layer of contaminated dredged sediment and an upper layer of imported fill material is then placed behind the berm, with a final cover layer of select fill, terminating at an upland elevation suitable for marine terminal development. The capacity and elevation control for the various fill layers in the CDF are summarized in Table 1 and Figure 3.

Contaminated Dredged Materials. Contaminated dredged materials from Terminal 4 (approximately 125,000 CY) will fill the CDF up to approximately elevation -23 feet NGVD. Contaminated dredged materials from other sites in the Portland Harbor will be placed within the saturated zone of the CDF (i.e., below the water table) to minimize the leachability and mobility of contaminants. The elevation corresponding to the top of the saturated zone during critical low flow conditions is +9.5 feet NGVD (see Appendix I of the DAR). The remaining capacity for other contaminated dredged materials from the Portland Harbor is about 544,000 CY. This is about 17,000 CY of dredged material for every one foot gain in elevation. Acceptance requirements for the chemical and physical characteristics of contaminated dredged sediments are provided in Section 3 of this memorandum.

Imported Fill Material. Above the water table, the CDF will be filled with 464,000 CY of imported fill material to elevation +28.2 feet NGVD. Acceptance requirements for imported fill material are provided in Section 3.5 of this memorandum.

Select Fill Cover Layer. A final four-foot cover layer consisting of 146,000 CY of structural subgrade material (select fill) will raise the CDF to the finished elevation of +33.2 feet NGVD. Acceptance requirements for select fill cover layer materials are provided in Section 352027, Part 2, of the Specifications (Appendix G of the DAR).

3 SEDIMENT ACCEPTANCE CRITERIA

To achieve RAOs for the Terminal 4 CDF and, ultimately, the Portland Harbor Remedial Action (at such time as they are developed), the chemical and physical properties of dredged sediment proposed for placement in the CDF must meet certain minimum requirements, as described in this section. The general requirements of the sediment acceptance criteria for the Terminal 4 CDF, as outlined in Section 1(b)(iv) of USEPA's Action Memorandum for the Terminal 4 Removal Action (USEPA 2006a), include the following:

- Only sediments from the Portland Harbor Superfund Site are acceptable
- No untreated sediments that may be designated as hazardous waste or contain free-phase oil will be accepted
- Sediments must be of acceptable geotechnical character such that they do not impact the long-term performance of the CDF
- Sediments must be of acceptable geochemical character (i.e. bulk sediment and leachability) such that they are protective of surface water quality in the Willamette River via groundwater transport

These acceptance criteria are described in more detail below. The process by which an applicant seeks to obtain a suitability determination for placement of dredged material in the CDF is described in Section 4. Sampling and analytical testing requirements are presented in Section 5.

3.1 Sediments Derived from Portland Harbor Superfund Site

Only sediments from the Portland Harbor Superfund Site are eligible for placement in the saturated zone of the CDF (see Section 5.2). However, imported fill material for placement in the unsaturated zone of the CDF may be derived from outside sources (e.g., Columbia River channel dredge sands).

3.2 Sediment Exclusions

Without additional treatment to control high-risk sediments, the materials described below will be excluded from the CDF.

3.2.1 No Hazardous Waste

No sediments designated as hazardous waste, whether listed waste or characteristic waste, will be eligible for placement in the CDF without adequate treatment. Hazardous waste designation will be determined by reviewing the history of contaminant releases in the project area, and by conducting the USEPA Toxic Characteristic Leaching Procedure (TCLP) test. All sediments will be tested for TCLP metals. Testing requirements for TCLP organic constituents will be based on the results of the historical review and bulk sediment chemical analysis. The TCLP analytical results will be compared to the hazardous waste criteria listed in 40 CFR-261.24. See Section 6.2.4 for further discussion.

3.2.2 No Free Oil

Sediments containing "free oil" are not eligible for placement in the CDF without adequate treatment. "Free oil" is defined herein as greater than 1 percent total petroleum hydrocarbons; percent-level concentrations would be necessary to cause formation of a separate product phase. Qualitative and quantitative criteria will be used to determine free oil content, as follows:

- **Qualitative Criterion**. Field observations of core sections, with supporting photographic documentation, showing separate-phase petroleum product (i.e., oil globules, stringers, pockets, etc.) covering more than 1 percent of the cross-sectional area of the core
- **Quantitative Criterion**. Total petroleum hydrocarbon (NW-TPH) analysis resulting in greater than 1 percent TPH by weight (greater than 10,000 parts per million [ppm], as the sum of gasoline, diesel, and residual oil fractions)

3.3 Geotechnical Properties

The geotechnical properties of the fill materials must be of an acceptable quality such that they do not impact the long-term performance of the CDF. There are three concerns related to the geotechnical properties of the dredged material placed within the CDF:

- **Obstructions to future deep pile foundations**. No large debris will be allowed within the CDF that could potentially obstruct future site development

- **Long-term secondary consolidation**. Organics can decompose with time causing long-term settlements. Significant amounts of organics can lead to continued settlement over a large area. To address this concern, dredged material shall be free of significant organic debris, such as peat, wood chips, etc.
- **Gas generation**. As organics decompose, gases can be formed which can eventually work to the surface and potentially diffuse into the indoor air in buildings. To address this concern, dredged material shall be free of significant organic debris, such as peat, wood chips, etc.

3.4 Geochemical Properties and Leachability

The geochemical properties and leachability of contaminated sediments accepted for placement in the CDF must be shown to be protective of human and ecological receptors in the Willamette River when allowance is made for mixing and attenuation of contaminants during subsurface transport through the fill materials and the berm. Acceptance of contaminated sediments based on their geochemical properties and leachability will be determined in consideration of the following:

- Bulk sediment chemical concentrations
- Pancake Column Leaching Test (PCLT) concentrations (USACE 2003)
- Predicted groundwater dilution and attenuation factors (DAFs; see Section 6)

Bulk sediment and groundwater evaluation criteria are summarized in Table 2 and are described in detail below.

3.4.1 Sediment Quality Criteria

Contaminated sediments proposed for placement in the CDF will be compared to the following sediment quality screening criteria:

- Probable Effects Levels (PECs; MacDonald et al. 2000), to be used in the interim period prior to the adoption of Portland Harbor Sediment Quality Guidelines (SQGs)
- Portland Harbor SQGs, at such time as they are adopted for use (Windward et al. 2006; currently in agency review)

Considering the results of the bulk sediment testing, PCLT testing will be conducted on:

- Target metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Ag, and Zn)
- Any organic constituents exceeding sediment quality screening criteria in bulk sediment
- Other site-specific target analytes as deemed appropriate by USEPA and the Port

3.4.2 Groundwater Quality Criteria

As described in Section 6, groundwater concentrations being released to the Willamette River at the face of the CDF berm will be estimated or modeled based on the geochemical source characteristics of the sediments proposed for placement in the CDF. Estimated or modeled groundwater release concentrations at the face of the berm and in the receiving water must meet surface water quality criteria for protection of aquatic life and human health, as described below.

3.4.2.1 Aquatic Life Criteria

Estimated or modeled groundwater concentrations based on sediments proposed for placement in the CDF must meet acute and chronic ambient water quality criteria at the point of groundwater release to the river, i.e. at the face of the CDF berm. Specific acute and chronic water quality criteria and PAH guidance values are described below.

Acute and Chronic Water Quality Criteria. Aquatic life criteria for metals (arsenic, cadmium, copper, lead, and zinc) and certain organic compounds (DDTs, PCBs) are derived from current USEPA National Recommended Water Quality Criteria (USEPA 2006b; http://www.epa.gov/waterscience/criteria/wqcriteria.html); these same criteria have been adopted by the State of Oregon. Hardness-based metals criteria are adjusted to a hardness value of 25 mg/L based on ambient measurements in the Lower Willamette River (USGS 2006).

PAH Guidance Values. Aquatic life criteria for PAHs are not available in either federal or state standards. However, acute and chronic guidance values for PAHs have been developed by USEPA for use in deriving sediment quality benchmarks

(USEPA 2003). These PAH values (see Table 6 in the DAR) may be used as guidance values during the evaluation of sediment leachability.

3.4.2.2 Fish Consumption Criteria

Estimated or modeled groundwater concentrations based on sediments proposed for placement in the CDF must also meet fish consumption criteria in the receiving water as described in more detail below.

A key pathway of interest for the Portland Harbor risk assessment is the potential bioaccumulation of contaminants in fish and shellfish and subsequent risks posed to humans that eat fish from the harbor. The pathway of concern for bioaccumulation at the Terminal 4 CDF is groundwater release to the river. Bioaccumulation-based fish consumption criteria have been developed as a screening tool for evaluating this pathway (DEQ and USEPA 2005).

Consistent with USEPA guidance developed under Clean Water Act, Section 401, bioaccumulation exposures are averaged temporally over the lifetime of the fish being exposed to contaminants in the river, as well as the lifetimes of the humans that are consuming fish from the river (i.e., assumed human lifetime of 70 years; USEPA 1991). In addition, USEPA draft guidance on estimating sediment-associated bioaccumulation risks is based on the fact that bioaccumulation exposures are averaged spatially over the home range of the fish and the harvesting area of the receptor (USEPA 2006c). Whereas chronic water quality criteria are applicable to a "point in space" (any location on the face of the berm) and a "point in time" (a 4-day duration is essentially instantaneous in the lifetime of the CDF), fish consumption criteria should be applied to conditions in the receiving water in consideration of the spatial and temporal scales of interest.

Table 3 provides an estimate of receiving water concentrations in the vicinity of the berm, and calculated bioaccumulation-based discharge criteria at the point of groundwater release necessary to meet fish consumption criteria in the receiving water. The estimated or modeled groundwater concentrations for the sediments

proposed for placement in the CDF will be compared to these criteria to determine acceptability.

If sediment proposed for placement in the CDF meets the criteria described above, it will be considered protective of fish consumption for the following reasons. Groundwater releases are rapidly mixed to concentrations below fish consumption criteria in the receiving water, because the groundwater flux (as determined from MODFLOW results; see Appendix I of the DAR) is quite small compared to ambient currents in the river. At the discharge criteria indicated, fish consumption criteria (DEQ and USEPA 2005) would be achieved at 10 cm above the face of the berm. As specified in USEPA (1991), these bioaccumulation-based discharge criteria would also be temporally averaged over a 70-year human lifetime. Based on these calculations, achieving chronic water quality criteria at the point of groundwater release from the CDF will be implicitly protective of bioaccumulative exposures in the receiving water.

3.4.2.3 Drinking Water Guidelines and Criteria

USEPA directed the Port to consider drinking water guidelines and criteria in its evaluation of groundwater releases from the CDF, specifically drinking water maximum contaminant levels (MCLs) and USEPA Region 9 "tap water" preliminary remediation goals (PRGs). Similar to the evaluation of fish consumption criteria, any potential drinking water exposure will be based on a receiving water concentration rather than a groundwater release concentration at the face of the berm.

Several points are relevant to the evaluation of drinking water exposures:

- **Drinking Water Not Yet an ARAR**. The Safe Drinking Water Act has been determined by USEPA to be potentially relevant and appropriate to the Terminal 4 Removal Action CDF. The exact application of drinking water criteria as an ARAR will not be determined until the Harbor-wide ROD. At this point, USEPA has directed the Port to evaluate drinking water exposures to be conservative and to prepare for any and all possibilities that may result from the issuance of the Harbor-wide ROD.

- **Drinking Water Criteria/Guidelines Are Applied at the Tap.** Drinking water guidelines and criteria are applied "at the tap" and not at the point of intake. Recent experience upstream in Wilsonville Oregon has shown that the background characteristics of Willamette River water are unsuitable for direct consumption without first subjecting the water to a multi-stage treatment process, including, in this case, sedimentation, ozonation, carbon filtration, sand filtration, and chlorination. Thus drinking water criteria/guidelines should account for water treatment requirements that apply prior to consumption.
- **Institutional Controls will Preclude Water Intake on Port Property.** The Port is in the process of acquiring the land beneath the CDF from the State of Oregon. The Port's ownership will extend out to the Harbor Line, and the Port will ensure through institutional controls that no drinking water intakes are placed on submerged Port land. Therefore, the closest possible point for a drinking water intake would be at the Harbor Line, between 10 and 50 meters from the face of the berm.

With these considerations in mind, Table 3 provides an estimate of receiving water concentrations at the Harbor Line, 10 meters from the berm, and calculated drinking water-based discharge criteria at the point of groundwater release necessary to meet "tap water" criteria in the receiving water. In this way, the estimated or modeled groundwater chemical concentrations for sediment proposed for placement in the CDF will be compared to the criteria provided in Table 3.

If sediment proposed for placement in the CDF meets the criteria described above, it will be considered protective of drinking water for the following reasons. Because the groundwater flux (as determined from MODFLOW results; see Appendix I of the DAR) is quite small compared to ambient currents in the river, groundwater releases are rapidly mixed to concentrations below drinking water criteria in the receiving water. Based on these calculations, achieving chronic water quality criteria at the point of groundwater release from the CDF will be implicitly protective of possible drinking water exposures at the Harbor Line. This evaluation is considered

conservative because it does not take into account water treatment that is permitted to occur prior to application of drinking water criteria under state and federal law.

3.4.2.4 Total Maximum Daily Loads (TMDLs)

Currently, there are three TMDLs in effect in the Lower Willamette River:

- Temperature
- Bacteria
- Mercury

Temperature and bacteria TMDLs are not relevant to groundwater releases from the CDF. Groundwater discharges from the CDF are not a source of elevated temperature or bacteria.

Mercury is not a COC at Terminal 4 but could potentially be a COC at other candidate sites seeking placement in the CDF. The Oregon DEQ adopted an interim TMDL for mercury in September 2006. The interim TMDL determined that an overall loading reduction of 27 percent from all source categories (point source and nonpoint source) would reduce annual mercury inputs to the acceptable level guidance value of 94.6 kg/yr. DEQ's implementation strategy for the interim mercury TMDL includes general point source and nonpoint source reduction focused on wastewater discharge monitoring and mercury reduction plans at targeted facilities selected by DEQ, voluntary reduction of air emissions, and agency management plans to minimize soil erosion that contain naturally occurring mercury. No waste load allocations or load allocations have been conducted. DEQ plans to establish waste load allocations and load allocations for mercury after additional information is gathered in approximately 2011.

In the absence of a final TMDL for mercury, and in the absence of a final ROD, USEPA directed the Port to consider the potential mercury load from the CDF in order to ensure the CDF is protective and will comply with the final ROD. Because it is the intent that the CDF will ultimately comply with the Portland Harbor RI/FS and USEPA ROD, some conservative assumptions will be made for purposes of this

analysis. It will be assumed for preliminary purposes that mercury inputs to the river of 0.1 percent of total inputs would not adversely affect the TMDL analysis or mercury reduction plan. For the CDF, this translates into a goal for groundwater releases from the CDF to the receiving water of 0.09 kg/yr. The mercury load caused by the placement of Terminal 4 sediments in the CDF was estimated to be negligible (0.00014 kg/yr; see Section 7 of the DAR). For candidate sites with dredged material containing elevated mercury concentrations, the Port will conduct a loading analysis using the groundwater contaminant transport model for the CDF (as described in Section 6) to ensure mercury loads are constrained to acceptably low levels.

USEPA also directed the Port to consider minimizing impacts to the river of 303(d) listed parameters to show that the CDF will not contribute to existing in-river exceedances of water quality standards for these parameters. To address this directed request, the 303(d) listed parameters were evaluated and will continue to be evaluated in the long-term groundwater model, and results will be compared to water quality standards, guidelines, and background concentrations. Through this process, it will be demonstrated that the CDF will be protective of the river for these parameters.

3.5 Imported Fill Criteria

The acceptance criteria for imported fill material will meet the requirements established in the December 2003 Technical Plans and Specifications for the McCormick & Baxter sediment cap located within the Willamette River (Ecology and the Environment 2003). Specifically, the material to be used will be "material free of roots, organic material, contaminants, and all other deleterious and objectionable material."

Once potential source material(s) is identified, physical and chemical testing will be performed to ensure that the characteristics of the imported fill material are suitable for use in construction of the CDF. Testing requirements for imported fill material are outlined in Section 352027, Part 2, of the Specifications.

3.6 Other Considerations

The Port and USEPA will have other qualitative factors that will be used to determine the acceptability of material. Some of these factors may be viewed as safety factors such as the overall protection of human health and the environment, the presence of principal threat compounds, the physical nature of the material, the form of the chemical component, and quantity of the material. In addition, the Port will consider factors that include long-term site liability, indemnification, and cost on a case-by-case basis before a final determination of acceptability is made.

4 PROCESS AND SCHEDULE FOR DETERMINING SUITABILITY OF MATERIAL

A process flow chart describing the steps and decisions needed for an Applicant to obtain a suitability determination for placement of contaminated sediments in the Terminal 4 CDF, as well as the responsibilities of the Applicant, the Port and USEPA, is shown on Figure 4. The process includes the following steps, which are described in detail in the remainder of this section.

- Applicant Submits Notice of Intent
- Applicant Prepares and Submits Sampling and Analysis Plan
- Applicant Prepares and Submits Sediment Characterization Report
- Port and USEPA Conduct Review Evaluation
- Port and USEPA Determine Material Suitability

All notifications and submittals should be directed to the Port and USEPA Project Managers listed below:

Anne Summers	Sean Sheldrake
Port of Portland Project Manager	USEPA Remedial Project Manager
121 NW Everett Street	1200 Sixth Avenue
Portland, OR 97209	Mailstop: ECL-110
(503) 944-8411	Seattle WA 98101
anne.summers@portofportland.com	(206) 553-1220
	sheldrake.sean@epamail.epa.gov

4.1 Submit Notice of Intent

An Applicant must provide written notification to the Port and USEPA that it wishes to have its dredged material evaluated for placement in the CDF. If the Port and USEPA agree to the evaluation, the Applicant proceeds with preparing a Sampling and Analysis Plan (SAP).

4.2 Prepare and Submit Sampling and Analysis Plan (SAP)

The Applicant will summarize the existing data at the candidate site, and prepare a SAP for submission to the Port and USEPA, including, at a minimum, the elements specified below.

- Plan map of proposed dredge prism, dredged material management units (DMMUs; see Section 4.2.1.1), and proposed core locations
- Summary tables of existing chemical and physical testing data for any relevant matrices (sediment, water, pore water, etc.)
- Summary statistics of existing bulk sediment data, presented for each DMMU as well as globally for the entire dredge prism:
  - Number of analyses per analytical parameter
  - Frequency of detection
  - Range (minimum, maximum), median, and mean concentrations
  - Frequency and magnitude of exceedance of sediment quality criteria (i.e., PEC values, or Portland Harbor criteria if and when they are developed)
- Proposed core depths and compositing scheme
- Analytical parameters, test methods, and detection limits (see Section 4.2.1.2)
- Field and analytical quality assurance procedures and quality control limits
- Project team organization (i.e., project manager, analytical laboratory, coring contractor, etc.)

Additionally, the sampling and analytical requirements that should be included in the SAP are described in detail in the following section.

4.2.1 Sampling and Analytical Requirements

4.2.1.1 Dredged Material Management Units (DMMUs)

Candidate dredge prisms will be subdivided into DMMUs for purposes of chemical and physical characterization. Each DMMU represents a unit testing volume that will be analyzed for bulk sediment, TCLP, and PCLT testing, as well as MET and/or CST testing if discharge over the weir is expected to occur. The exact size of the DMMUs will be determined on a site-specific basis in consideration of the range, variability, spatial distribution, and degree of risk posed by existing bulk sediment data. Considering the CDF is designed to hold up to 669,000 cy of contaminated sediments from the Portland Harbor, DMMUs that range in size from less than 25,000 cy to 100,000 cy may be appropriate.

The Applicant will need to show that the proposed delineation of DMMUs is representative of the dredge prism and includes coverage of the highest concentration areas by providing summary statistics of existing sediment characterization data during submittal of the SAP. DMMUs will not cross major geological boundaries in such a manner that would result in smearing of leaching characteristics across two significantly different material types. DMMUs will not be delineated in such a manner that would result in significant dilution of known hot spots.

A representative sample of each DMMU will be composited from 3 to 4 cores systematically distributed throughout the proposed dredge prism. Compositing of the cores would be done on a volume-weighted basis.

4.2.1.2 Chemical and Physical Testing Requirements

Each DMMU will be analyzed for bulk sediment chemistry, physical properties, TCLP, and PCLT, as listed below. In addition, MET and/or CST testing would be required if placement of the sediments is expected to cause water to overflow the weir. Additional testing parameters may be required on a case-by-case basis at the discretion of USEPA and the Port, based on project-specific considerations, such as current and historical site operations and land uses.

It is recommended that the analyses be tiered such that the results of the bulk sediment testing may be used to help focus the analyte lists for TCLP and PCLT testing.

4.2.1.2.1 Bulk Sediment Chemistry

Bulk sediments will be analyzed for the following chemical constituents:

- Metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Ag, and Zn) (USEPA 6000/7000 series)
- Semivolatile organic compounds (including polynuclear aromatic hydrocarbons [PAHs]) (USEPA 8270)
- Volatile organic compounds (USEPA 8260)
- Polychlorinated biphenyls (PCBs) (USEPA 8082)

- Chlorinated pesticides (including DDTs) (USEPA 8081)
- Total petroleum hydrocarbons (NW-TPH Method)

The following constituents will be analyzed on a case-by-case basis, depending on current and historical operations at the site and neighboring properties:

- Tributyltin (Krone)

4.2.1.2.2 Bulk Physical Properties

Bulk sediments will be analyzed for the following physical properties:

- Total organic carbon
- Grain size (ASTM)
- Atterberg limits
- Seepage induced consolidation test (SIC; Znidarcic, et al. 1992)

The SIC test will be used to predict long-term settlement of the placed material.

4.2.1.2.3 TCLP Testing

Bulk sediments will be extracted and analyzed for the following TCLP parameters:

- TCLP metals (As, Ba, Cd, Cr, Pb, Hg, Se, and Ag)

The following are contingent analyses, depending on the results of the historical review and bulk sediment chemical analysis. TCLP tests will be conducted for those organic parameters that exceed 20 times the hazardous waste criteria in bulk sediments. Contingent TCLP tests include the following:

- TCLP volatile organics
- TCLP semivolatile organics
- TCLP organochlorine pesticides

4.2.1.2.4 PCLT Testing

PCLT testing will be conducted according to U.S. Army Corps of Engineers (USACE) Waterways Experiment Station procedures (Myers et al. 1996; USACE 2003). PCLT testing will be conducted for the following parameters:

- Metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Ag, and Zn) (USEPA 6000/7000 series)
- Semivolatile organic compounds (including polynuclear aromatic hydrocarbons [PAHs]) (USEPA 8270)
- Polychlorinated biphenyls (PCBs) (USEPA 8082)
- Chlorinated pesticides (including DDTs) (USEPA 8081)
- Additional parameters, including potentially bioaccumulative parameters, as may be required on a project-specific basis

PCLT testing will be conducted under anoxic conditions, representative of saturated subsurface conditions in the CDF. A total of 15 pore elutions will be analyzed. Alternate pore elutions (i.e., every third pore elution) may be analyzed for metals, semivolatile organics, and pesticides/PCBs. The first pore elution will always be analyzed for metals.

4.2.1.2.5 Other Testing Requirements

If material is proposed for hydraulic placement in the CDF, and the discharge rates and volumes and the remaining CDF capacity are such that overflow of the CDF weir is expected, causing return flow of dredging elutriate water to the Willamette River, the following additional tests will be required:

- Modified Elutriate Test (MET, per Palermo 1985)
- Column Settling Test (CST, per Palermo and Thackston 1988)

These tests will be used to evaluate the potential for short-term water quality effects during discharge to the CDF and overflow to the river.

4.2.2 Review and Acceptance of SAP

After reviewing the SAP, the Port and USEPA will either (1) accept the SAP; (2) accept the SAP with modifications, requesting that affected portion(s) of the SAP be revised

and reissued; or (3) reject the SAP. If the SAP is rejected on technical grounds, additional field testing or data analysis may need to be conducted before a revised SAP can be prepared. The SAP may also be rejected on the grounds that sufficient information is available to cause the material to fail one or more acceptance criteria, in which case the Applicant will need to pursue alternative means of sediment placement.

4.3 Prepare and Submit Sediment Characterization Report (SCR)

Once the SAP is approved, the Applicant will proceed with field sampling and laboratory testing of the proposed dredged material. Sampling and testing results are then compiled in a Sediment Characterization Report (SCR), and submitted to the Port and USEPA for review. The SCR will include, at a minimum, the elements specified below and results of the physical and chemical testing specified in Section 4.2.1.2.

- Plan map showing DMMUs and actual core sampling locations
- Table(s) of core coordinates, water depths, penetration depths, recovery depths, and compositing intervals
- Deviations from SAP requirements, if any
- Core logs with geologic descriptions and sediment classifications, per American Society of Testing and Materials (ASTM)
- Assessment of "free oil" composition of the sediments based on field observations and core descriptions
- Tables of analytical results for bulk sediment, TCLP, and PCLT testing (and MET and/or CST testing, as appropriate)
- Data validation report with assessment of laboratory quality assurance/quality control (QA/QC) performance according to National Functional Guidelines, and acceptability of data

4.4 Port and USEPA Review

Based on the data presented in the SCR, the Port and USEPA will conduct an evaluation of the regulatory, geochemical (i.e. leachability), and geotechnical characteristics of the dredged material to determine if criteria described in Section 3.0 are met and whether the material is suitable for placement in the CDF. Two levels of evaluation, Tier I and Tier II, may be conducted by the Port and USEPA, based on the size and complexity of the project.

For the tiered evaluations, groundwater release concentrations will be estimated using PCLT leachate results and groundwater dilution and attenuation factors (DAFs), which describe the concentration reductions that occur as groundwater migrates through the fill material, the containment berm, and eventually discharges into the river. Groundwater DAFs are estimated using a predictive contaminant transport model of the CDF, as presented in Appendix I of the DAR and summarized in Section 5.0 of this document.

Tier I and Tier II evaluations are described in more detail below.

4.4.1 Tier I Evaluation

The Port and USEPA will conduct a Tier I evaluation for all candidate projects. A Tier I evaluation will include an assessment of contaminant sources to the site where the material will be removed, physical testing results, bulk sediment and leachate testing results, an estimation of groundwater release concentrations at the berm face based on generic groundwater dilution and attenuation factors (DAFs), and comparison of groundwater release concentrations to water quality criteria.

The Applicant will provide the site history and physical and chemical sampling results for the candidate material to the Port and USEPA in the SAP and SCR submittals. Based on this information, the Port will estimate groundwater release concentrations at the berm face using groundwater DAFs and will compare concentrations to water quality criteria as described below.

During this Tier I evaluation, estimated DAFs will be used to determine acceptable sediment leachate concentrations that will be able to meet applicable water quality criteria in groundwater releases at the face of the berm and in the receiving water. DAFs will be estimated from site-specific partitioning coefficients using the regression equation shown on Figure 6. Site-specific partitioning coefficients will be determined by the ratio of the bulk sediment concentration to the maximum leachate concentration in the PCLT test. Although higher DAFs are possible for certain hydrophobic chemicals, it

is recommended that a range of DAFs between 10 and 100 be used for this initial screening evaluation.

The partitioning behavior of the berm material exerts a primary influence on the DAF, because the berm represents the shortest and fastest pathway available for transport to the river. The effective partitioning coefficient in the berm will be estimated by the partitioning coefficient in the candidate sediments, and the ratio of organic carbon contents in the candidate sediments and the berm. Until a specific import material can be identified for the berm and tested, an organic carbon content of 0.1 percent will be assumed for the berm. This is consistent with the approach used to evaluate placement of Terminal 4 sediments in the CDF (see Appendix I of the DAR).

Based on the Tier I evaluation, if predicted concentrations at the berm face are below water quality criteria described in Section 3.0, then the geochemical characteristics of the material will be determined suitable for placement in the CDF. Additional details of the model used for this evaluation are provided in Section 5.0.

4.4.2 Tier II Evaluation

The Port will conduct a project-specific groundwater contaminant transport evaluation for larger and/or more complex candidate sediment projects being considered for placement in the CDF. In particular, the following types of projects will generally warrant a project-specific modeling effort:

- Projects greater than 17,000 CY (greater than 1 foot lift)
- Sediments estimated to exceed water quality criteria based on the Tier I evaluation
- Sediments with unusual constituents or highly variable bulk sediment and/or leachate characteristics

The project-specific contaminant transport evaluation will utilize the data and analytical results presented in the Sediment Characterization Report (see Section 4.3). Project-specific DAFs will be calculated, considering the specific elevation and placement location within the CDF, as well as the concentrations and locations of other fill

materials that have already been placed in the CDF up to that time. Specific details of the model used for this evaluation are provided in Section5.0.

Based on the Tier II evaluation, if predicted concentrations at the berm face are below water quality criteria described in Section 3.0, then the geochemical characteristics of the material will be determined suitable for placement in the CDF.

4.4.3 Additional Considerations and Adaptive Management of the CDF

Groundwater quality released from the CDF must meet the regulatory criteria listed in Section 3.4.2. If predictive groundwater modeling indicates these criteria will not be met, additional testing and/or alternative sediment management options may need to be considered, or the material will be rejected for placement at the CDF. Alternative sediment management options may include:

- Placing the material in a more isolated portion of the CDF
- Subdividing the material to isolate higher risk sediments
- Use of additional engineering controls at the CDF
- Consideration of alternative disposal options

The groundwater contaminant transport model may be further used by the Port and USEPA to help adaptively manage the placement activities in the CDF, in particular, to evaluate placement locations or project sequencing options that will best protect water quality in the river. It is expected that a range of DAFs may be realized for different placement locations, based on distance from the berm and elevation in the fill sequence. For example, contaminants leaching from sediments placed in the head of the CDF and further removed from the river will undergo longer transport pathways and therefore more pronounced attenuation. As a result, the head of the CDF may be able to accommodate higher contaminant concentrations but still meet acceptable water quality criteria by the time these constituents reach the river. Similarly, the deeper portions of the contaminated fill sequence may also be able to accommodate sediments with higher concentrations, given that these sediments will be separated from the river by a thicker part of the berm.

4.5 Suitability Determination

Based on the tiered review process and the additional considerations and adaptive management options, the Port and USEPA will issue a suitability determination for the proposed dredged material. If the material is deemed unsuitable for placement in the CDF, the Applicant will need to pursue an alternative means of sediment placement.

If the material is deemed suitable for placement in the CDF, in whole or in part, the Applicant will enter into a contract with the Port for placement of the material into the Slip 1 CDF. The Applicant will be responsible for dredging the material at the project site and transporting the material to the CDF; the Port will be responsible for managing the operation of the CDF during and following placement, and coordinating placement activities from various projects. The responsibility for the management of the dredged material transfers from the Applicant to the Port during offloading of sediment into the CDF (transfer over the berm). Whether the Applicant or the Port assumes responsibility for offloading the material will be determined on a case-by-case basis according to the specific terms of the contract.

4.6 Schedule and Lead Times

A generalized schedule of activities for obtaining a suitability determination is presented on Figure 5. The Applicant should allow approximately one year to complete these activities, which include obtaining an approved SAP, conducting required field and laboratory testing (including conducting one or more column leaching tests which could take several months to complete), preparing and submitting the SCR, and obtaining a suitability determination for placement of the proposed dredge materials in the Terminal 4 CDF.

The Port and USEPA will consider an Applicant's Notice of Intent to place material in the CDF within 15 days of notification. The Port and USEPA will review and approve/ disapprove the SAP and SCR within 30 days of receipt of these documents.

The Applicant is advised to schedule the work needed to obtain a suitability determination in consideration of the in-water work windows for the Lower Willamette River (July 1 through October 31, and December 1 through January 31). Certain work in the CDF may be

conducted outside the designated work windows because the pond is isolated from the river by the CDF berm.

5 GROUNDWATER TRANSPORT MODEL

Details related to the groundwater transport model used in the suitability determination for candidate material placement in the CDF are summarized in this section. The groundwater contaminant transport model for the Terminal 4 CDF will be continually updated as candidate projects are identified and contaminated sediments from other parts of the Portland Harbor are evaluated for acceptability. The model (MODFLOW-2000/MT3DMS) is a two-dimensional cross-sectional model along the critical centerline flow path of the CDF from the Terminal 4 uplands through the CDF fill materials and the berm, and ultimately to the point of groundwater release to the Willamette River. Model structure and input parameters are presented in Appendix I of the DAR.

Key model input parameters are described below.

5.1 Initial Porewater Concentrations

Leaching of COCs from contaminated sediments provides the initial, maximum porewater concentrations at the point of placement in the CDF. The leachable porewater concentrations are estimated using PCLT results. PCLT testing will be required for all sediments evaluated for placement in the CDF.

5.2 Sediment-Water Partitioning Coefficients

Bulk sediment testing will be required for the composited sediment samples used for PCLT testing. The ratio of bulk sediment concentrations to leachate concentrations provides an estimate of the chemical partitioning behavior of the sediments for use in the groundwater contaminant transport model.

5.3 Mixing and Attenuation Processes

Contaminants leached from the sediments are subsequently affected by mixing and attenuation processes as they are transported through the fill materials and the berm before eventually being released to the river. The following processes help to reduce contaminant concentrations during groundwater transport in the CDF:

- Hydraulic dispersion during groundwater transport

- Tidal dispersion in the berm caused by fluctuating water levels in the river
- Mixing of leachate with inflowing regional groundwater and incident rainfall
- Adsorption of contaminants on the organic and/or clay fractions in the matrix of the fill materials and the berm
- Biodegradation

Whereas physical dispersion and mixing processes are independent of the constituent, adsorption and biodegradation are dependent on the geochemical properties of the particular constituent of interest. In the absence of biodegradation, groundwater modeling work performed for the Terminal 4 Removal Action shows the magnitude of the DAF is accurately predicted by the partitioning coefficient ($r^2 = 0.996$). This relationship is shown on Figure 6.

A conservative tracer (i.e., a chemical with negligible adsorption) is primarily attenuated by physical mixing and dispersion processes, resulting in a minimum DAF of 10. As the value of the partitioning coefficient increases, the chemical tends to bind more strongly to the matrix of the fill and berm materials. These adsorption processes cause retardation of the contaminant transport velocity, and attenuation of the peak concentrations. Adsorption can result in DAFs of 100 or higher (Figure 6). This relationship can be used to perform an initial screening evaluation of the leachability of candidate sediments proposed for placement in the CDF, as described below.

6 OTHER CONSIDERATIONS FOR MATERIAL ACCEPTANCE

6.1 Sediment Treatment to Fix Oil or Leachable Hazardous Waste

No sediments designated as characteristic hazardous waste or containing "free oil" will be eligible for placement in the CDF, as described in Section 3.2. However, if such sediments are subjected to treatment processes that are shown to effectively fix or immobilize the oil and/or leachable hazardous constituents, they may be eligible for placement in the CDF after treatment.

Bench scale testing must be conducted using representative sediments, additives and mixing ratios (as appropriate), and sufficient engineering design must be performed to show that the treatment process is feasible and constructable. The treated sediments must then be analyzed according to the CDF testing requirements described in this memo, including bulk sediment, TCLP, and PCLT testing, to demonstrate the effectiveness of the treatment process at fixing or immobilizing the oil and/or leachable hazardous constituents. Close coordination with USEPA and the Port will be required to define project-specific bench-scale testing and engineering design requirements for determining the acceptability of treated sediments for placement in the CDF.

7 REFERENCES

Blasland, Bouck & Lee, Inc (BBL). 2005. Terminal 4 Early Action Engineering Evaluation/Cost Analysis, Public Review Draft, prepared for Port of Portland, Portland Oregon.

Oregon Department of Environmental Quality (DEQ) and USEPA 2005. Portland Harbor Joint Source Control Strategy, December 2005 (http://www.deq.state.or.us/NWR/PortlandHarbor/JSCS.htm)

Ecology and the Environment. 2003. Technical Plans and Specification—Sediment Cap McCormick & Baxter Creosoting Company, Portland, Oregon.

MacDonald, DD, Ingersoll, CG, and Berger, TA. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. of Envion. Contam. And Toxicology, v. 39, pp. 20-31.

Myers, TE, Brannon, JM, Tardy, BA, and Townsend, DM. 1996. Leachate Testing and Evaluation for Estuarine Sediments. US Army Corps of Engineers Waterways Experiment Station, Technical Report D-96-1.

Palermo, MR. 1985. Interim guidance for predicting quality of effluent discharged from confined dredged material disposal areas. USACE Waterways Experiment Station, EEDP-04-01 through -04, Vicksburg, MS.

Palermo, MR and Thackston, EL. 1988. Flocculent settling above the zone settling interface. Journal of Environmental Engineering, American Society of Civil Engineers, v. 114 (4).

Syracuse Research Corporation 2006. Environmental Fate Data Base (online), Syracuse NY (http://www.syrres.com/esc/efdb.htm)

U.S. Army Corps of Engineers (USACE). 2003. Evaluation of Dredged Material Proposed for Disposal at Island, Nearshore, or Upland Confined Disposal Facilities. USACE Research and Development Center, ERDC/EL TR-03-1, January 2003.

U.S. Environmental Protection Agency (USEPA). 1991. Technical Support Document for Water Quality-based Toxics Control. Office of Water, USEPA/505/2-90-001, March 1991.

USEPA. 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, USEPA Office of Emergency and Remedial Response, Washington DC OSWER 9355.4-24 (http://www.epa.gov/superfund/resources/soil/index.htm)

USEPA. 2003. Procedures for Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: PAH Mixtures. Office of Research and Development, USEPA-600-R-02-013.

USEPA. 2006a. Action Memorandum for Removal Action at the Port of Portland Terminal 4 site within the Portland Harbor Superfund Site, Portland, Multnomah County, Oregon. May 11, 2006.

USEPA. 2006b. National Recommended Water Quality Criteria. Office of Water. (http://www.epa.gov/waterscience/criteria/wqcriteria.html)

USEPA. 2006c. Estimation of Biota Sediment Accumulation Factor (BSAF) from Paired Observations of Chemical Concentrations in Biota and Sediment. Office of Research and Development, USEPA/600/R-06/047, May 2006 Public Review Draft.

USGS 2005-2006. National Water Information System Online Database, Station No. 14211720, Willamette River at Portland Oregon,(http://waterdata.usgs.gov/nwis/sw)

Washington Department of Ecology (WDOE). 1994. Natural Background Soil Metals Concentrations in Washington State. WDOE Pub. No. 94-115, October 1994.

Windward Environmental, Avocet Consulting, and TerraStat Consulting. 2006. Portland Harbor Superfund Site Ecological Risk Assessment: Estimating Risks to Benthic

Organisms using Predictive Models based on Sediment Toxicity Tests. Prepared for Lower Willamette Group, March 17 2006 DRAFT.

Znidarcic, D., Abu-Hejleh, A. N., Fairbanks, T., and Roberson, A. 1992. Seepage induced consolidation test, equipment description and user's manual. Report prepared for FIPR. Department of Civil Engineering, University of Colorado, Boulder, Colorado.

TABLES

Table 1
CDF Capacity and Elevation Control

Fill Material		Top Elevation [ft. NGVD]	Capacity (CY)	
			Incremental	Cumulative
Base of Slip 1		-35.0	0	0
Terminal 4 Sediments		-23.1	125,000	125,000
Other Contaminated Sediments	X	9.5	544,000	669,000
Imported Fill Material	X	28.2	464,000	1,133,000
Final CDF Elevation		33.2	146,000	1,279,000

Notes:

X = Materials addressed in this memo.

Table 2
Sediment and Groundwater Screening Levels for Terminal 4 CDF

Chemical Constituent	Sediment			Groundwater at Berm Face			
	PEC[1]	TEC[1]	Draft Portland Harbor[2]	Chronic AWQC[3]	Willamette Back-ground[4]	Fish Consump-tion[5]	Drinking Water[6]
INORGANICS	Units in mg/kg-dry			Units in ug/L			
Conventionals							
Ammonia	---	---	170				
Sulfides	---	---	32				
Metals							
Arsenic	33	9.8	24	150	0.5	160	15,000
Cadmium	5	1.0	2.6	0.09	0.05		770,000
Chromium	111	43	---	24			
Copper	149	32	562	2.7	1.5		
Lead	128	36	---	0.54	0.14		2,330,000
Silver	---	---	32	0.30			
Mercury	1.06	0.18	0.63	0.77		230	312,000
Nickel	48.6	23	---	16			
Zinc	459	121	---	36			
ORGANICS	Units in ug/kg-dry			Units in ug/L			
PAHs and Petroleum							
Naphthalene	561	176	---	194			
Acenaphthylene				307			
Acenaphthene				56			
Fluorene	536	77	---	39			
Phenanthrene	1,170	204	---	19			
Anthracene	845	57	---	21			
Fluoranthene	2,230	423	---	7.1			
Pyrene	1,520	195	---	10			
Benzo(a)anthracene	1,050	108	---	2.2			
Chrysene	1,290	166	---	2.0		28	<sat>
Benzo(b,k)fluoranthene				0.64			
Benzo(a)pyrene	1,450	150	---	0.96		28	<sat>
Indeno(123-cd)pyrene				0.28			
Dibenzo(a,h)anthracene	---	33	---	0.28			
Benzo(ghi)perylene				0.44			
Total PAHs	22,800	1,610	1,270,000				
TPH - Diesel Range	---	---	340,000	---			
TPH - Residual Range	---	---	2,700,000	---			
Polychlorinated biphenyls							
Total PCBs	676	60	1,400	0.014		0.1	<sat>
Chlorinated pesticides							
Chlordane	18	3.2	---	0.004		1.28	<sat>
Dieldrin	62	1.9	22	0.056		0.085	<sat>
DDD	28	4.9	---	---			
DDE	31	3.2	---	---			
DDT	63	4.2	---	0.001		0.35	<sat>
Total DDTs	572	5.3	1,000	---			
Endrin	207	2.2	---	0.036			
Heptachlor Epoxide	16	2.5	---	0.004			
Lindane (gamma-BHC)	5	2.4	---	--			
Miscellaneous							
Hexachlorobenzene	676	60	1,400	---		0.45	<sat>

Notes:

[1] MacDonald et al. 2000
[2] Windward, Avocet, and TerraStat 2006
[3] USEPA 2006b, 2003
[4] USGS 2004-2005
[5] Receiving water protection at 10 cm from berm face (see Table 3)
[6] Receiving water protection at 10 meters from berm face (see Table 3)
<sat> Solubility limit is reached before criterion is exceeded

Table 3
Groundwater Release Criteria for Fish and Drinking Water Consumption

Darcy Flux[1]	3.20E-06	m/s
Ambient Current[2]	0.05	m/s

BIOACCUMULATIVE CHEMICAL OF CONCERN [BCOC]	Water Quality Criteria (µg/L)				Receiving Water Concentration (µg/L)	
	BCOC Groundwater Criteria	Fish Consumption Criteria	Willamette River Backgrd[3]	Chronic Criteria	Distance above berm (m)	
					0.1	1
ARSENIC[4]	160	0.14	0.4	150	0.50	0.41
MERCURY	230	0.15	0	0.77	0.15	0.01
BENZO(A)PYRENE	28	0.018	0	0.96	0.018	0.002
CHRYSENE	28	0.018	0	2.0	0.018	0.002
PCBs	0.10	6.4E-05	0	0.014	6.4E-05	6.4E-06
HEXACHLOROBENZENE	0.45	2.9E-04	0	N/A	2.9E-04	2.9E-05
DDT	0.35	2.2E-04	0	0.001	2.2E-04	2.2E-05
CHLORDANE	1.28	8.1E-04	0	N/A	8.2E-04	8.2E-05
DIELDRIN	0.085	5.4E-05	0	0.056	5.4E-05	5.4E-06

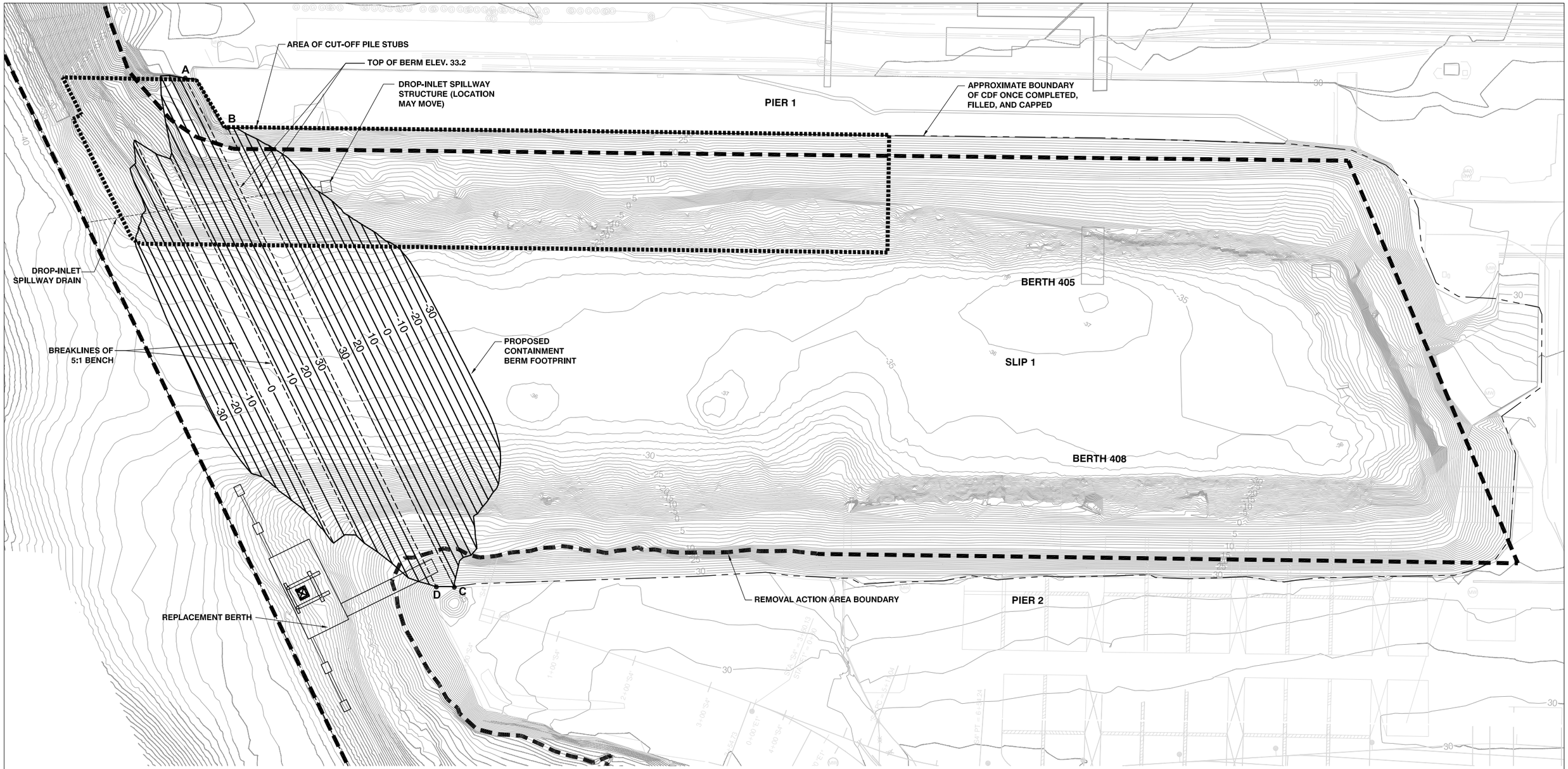
DRINKING WATER CHEMICAL OF CONCERN [DCOC]	Water Quality Criteria (µg/L)					Receiving Water Conc. (µg/L)
	DCOC Groundwater Criteria	Water Solubility[5]	Region 9 Tap Water PRG	Drinking Water MCL	Willamette River Backgrd[3]	Distance (m)
						10
ARSENIC[4]	15,000	N/A	0.045	10	0.4	0.50
CADMIUM	770,000	N/A	18	5	0.04	5.0
LEAD	2,330,000	N/A	--	15	0.08	15.0
MERCURY	312,000	N/A	11	2	0	2.0
BENZO(A)PYRENE	1,430	2	0.0092	0.2	0	0.0092
CHRYSENE	1,430,000	2	9.2	--	0	9.2
PCBs	5,300	4 to 900	0.034	0.5	0	0.034
HEXACHLOROBENZENE	6,500	6	0.042	1	0	0.042
DDT	31,000	25	0.2	--	0	0.20
CHLORDANE	30,000	56	0.19	2	0	0.19
DIELDRIN	650	200	0.0042	--	0	0.0042

Notes:

[1] From MODFLOW results; see Appendix I
[2] From BBL 2005
[3] From USGS, 2006
[4] Defaults to Willamette River background (90th percentile = 0.5 µg/L)
[5] USEPA 2002; Syracuse Research Corporation Online Database

Shaded values indicate determining criteria/guidelines for drinking water exposure

FIGURES



LEGEND

- CONTROL POINT LOCATION

POINT	EASTING	NORTHING
A	68705.10	69655.81
B	68643.05	69708.74
C	68068.71	69992.17
D	68069.12	69969.67

HORIZONTAL DATUM: PORT OF PORTLAND
LOCAL PROJECTION (INTERNATIONAL FEET)
VERTICAL DATUM: NGVD 29
CONTOUR INTERVAL: 1 FOOT
BERM CONTOUR INTERVAL: 5 FEET

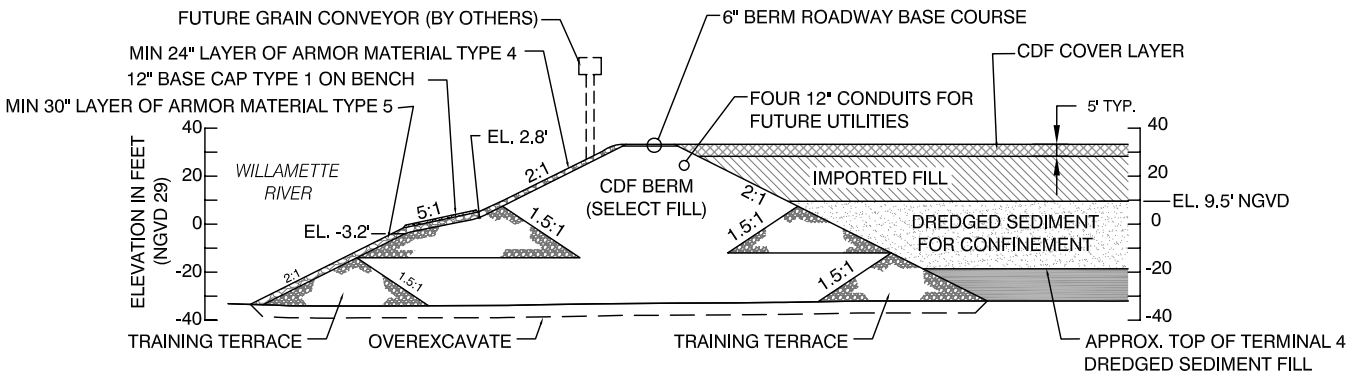
0 60
SCALE IN FEET

DRAFT DOCUMENT: DO NOT QUOTE OR CITE
THIS DOCUMENT HAS NOT BEEN REVIEWED OR APPROVED BY USEPA AND ITS FEDERAL, STATE, AND TRIBAL PARTNERS AND IS SUBJECT TO CHANGE IN WHOLE OR IN PART.

Dec 04, 2006 12:10pm cdavidson K:□Jobs□050332-PORT_OF_PORTLAND□05033201 TERMINAL 4□60 PERCENT□Terminal 4 60% Design C-25.dwg MEMO FIG 1

ANCHOR ENVIRONMENTAL, L.L.C.

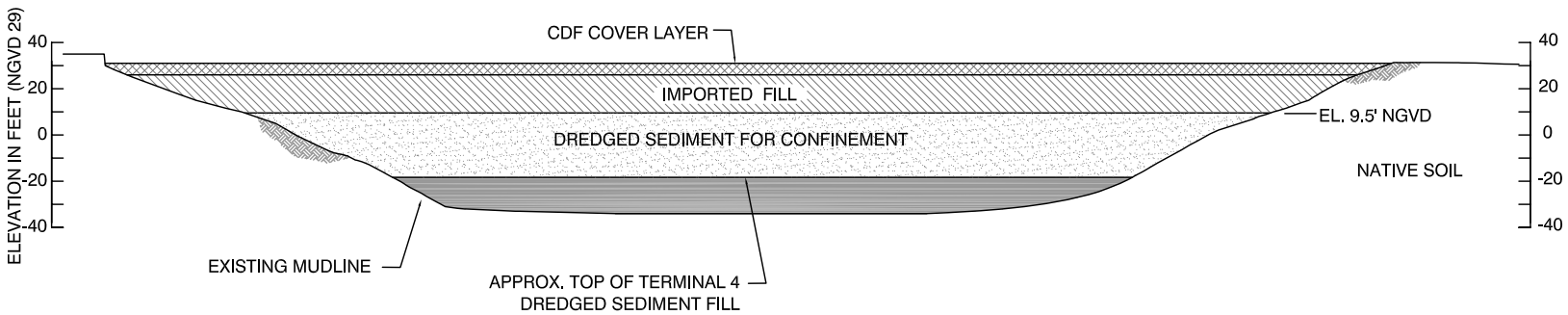
Figure 1
Confined Disposal Facility Plan
Sediment Acceptance Criteria Technical Memorandum
Portland, Oregon



BERM CROSS SECTION

SCALE: H: 1" = 30'
V: 1" = 30'

NOTE: CONTRACTOR CAN USE TRAINING TERRACES TO BUILD THE BERM. THE TERRACES SHALL EACH BE BETWEEN 3' TO 20' IN HEIGHT. SEE SPECIFICATIONS FOR MORE DETAILS.



CDF CROSS SECTION

SCALE: H: 1" = 30'
V: 1" = 30'

HORIZONTAL DATUM: PORT OF PORTLAND
LOCAL PROJECTION (INTERNATIONAL FEET)
VERTICAL DATUM: NGVD 29-47

0 80
Scale in Feet

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Figure 2
Confined Disposal Facility Sections
Sediment Acceptance Criteria Technical Memorandum
Portland, Oregon

Dec 05, 2006 9:59am dholmer K:Jobs050332-PORT_OF_PORTLAND05033201 TERMINAL 4 60 PERCENTTerminal 4 60% Design MEMO FIG 2.dwg FIG 2

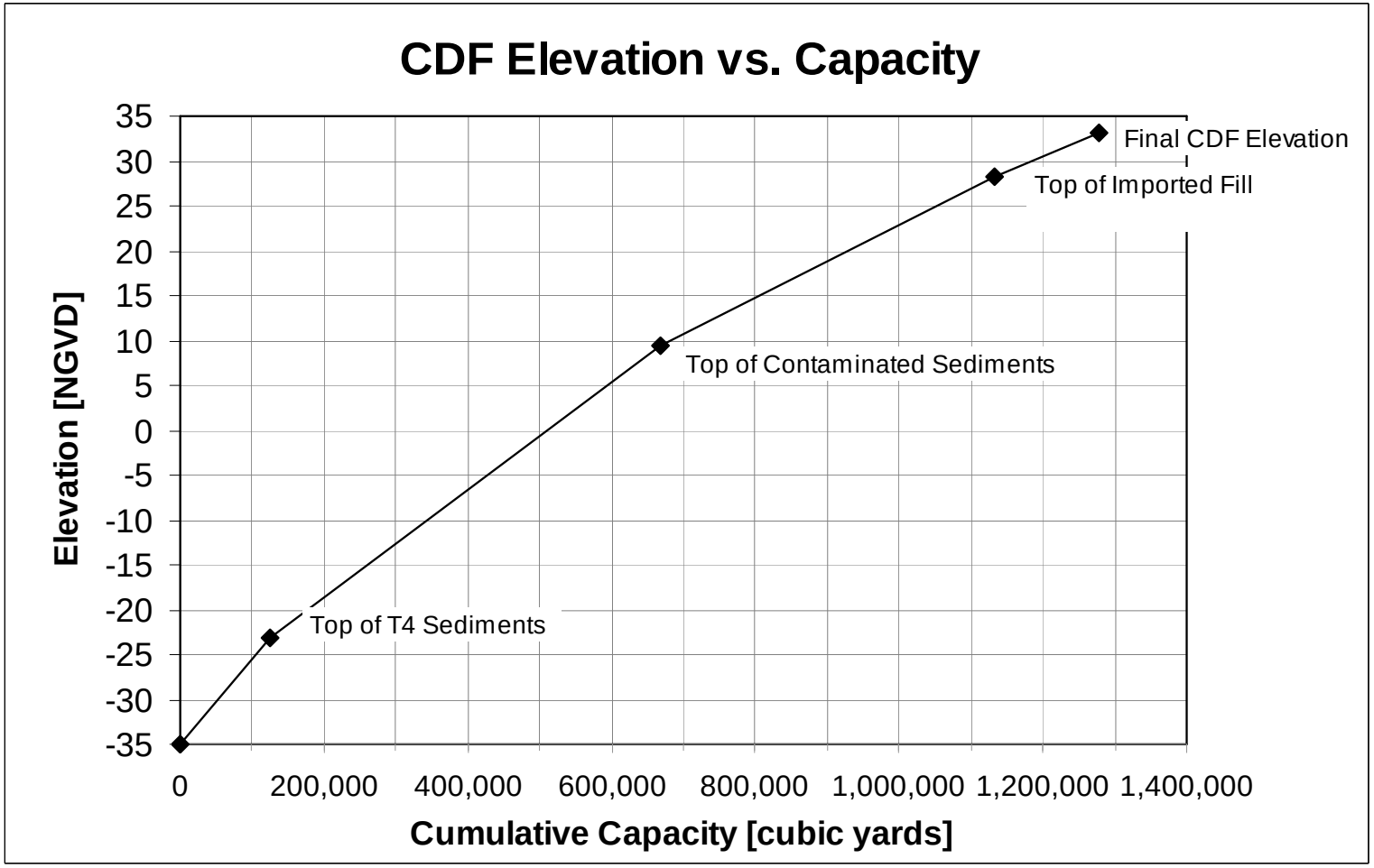

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Figure 3
CDF Elevation vs. Capacity
Terminal 4 Early Action Sediment Acceptance Memorandum
Portland, Oregon

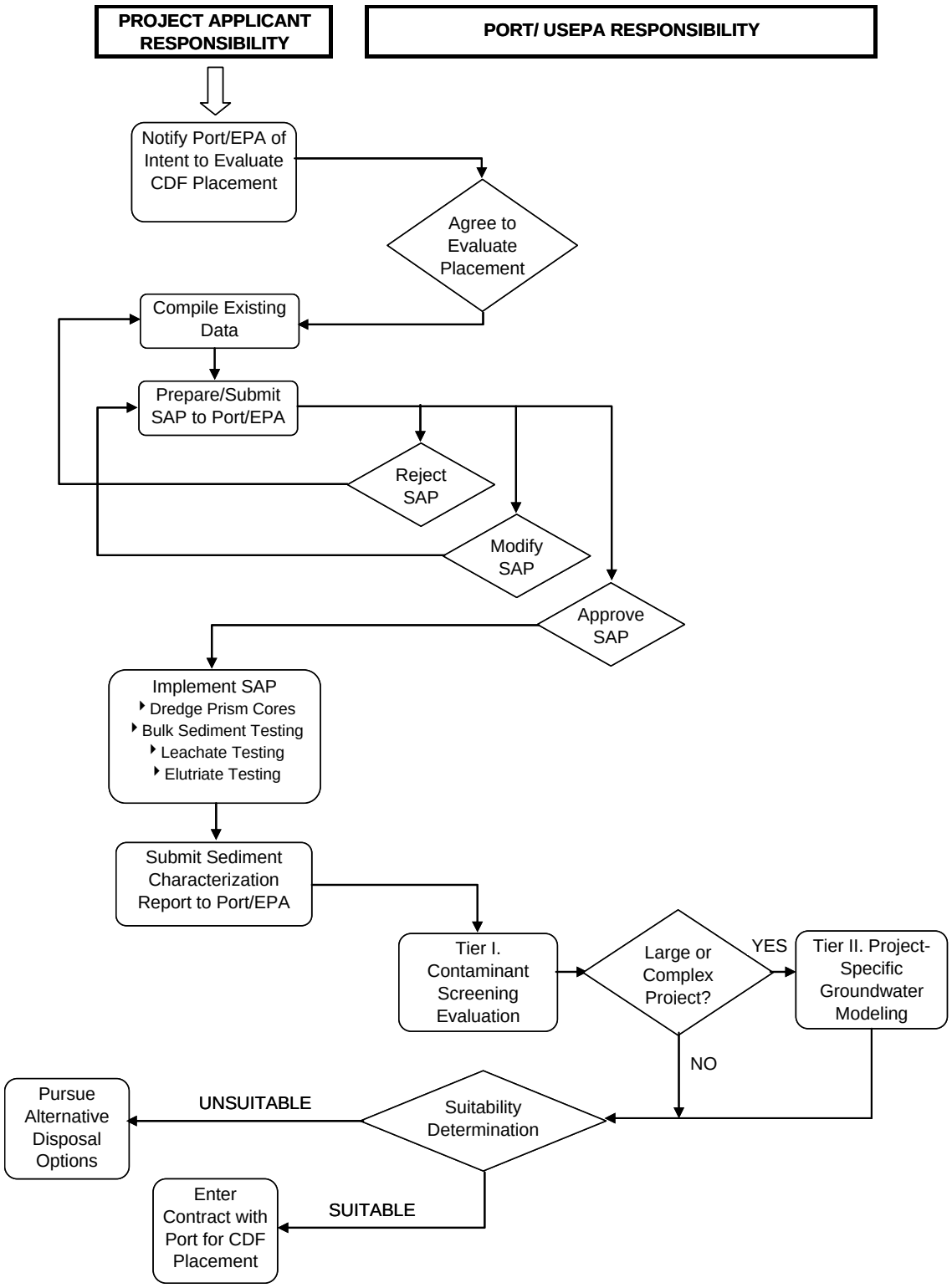


Figure 4
Process Flow Chart for Suitability Determination
Terminal 4 Early Action Sediment Acceptance Memorandum
Portland, Oregon

ANCHOR ENVIRONMENTAL, L.L.C.

TASK AND RESPONSIBILITY		ELAPSED MONTHS									
APPLICANT	PORT/ EPA	1	2	3	4	5	6	7	8	9	10
Notice of Intent											
	Approval of Intent										
Preparation of SAP											
Submittal of SAP											
	Review of SAP										
	Approval of SAP										
Modify SAP (if needed)											
Conduct Field/ Lab Work											
Preparation of SCR											
Submittal of SCR											
	Review of SCR										
	Suitability Determination										

Notes:

SAP = Sampling and Analysis Plan

SCR = Sediment Characterization Report

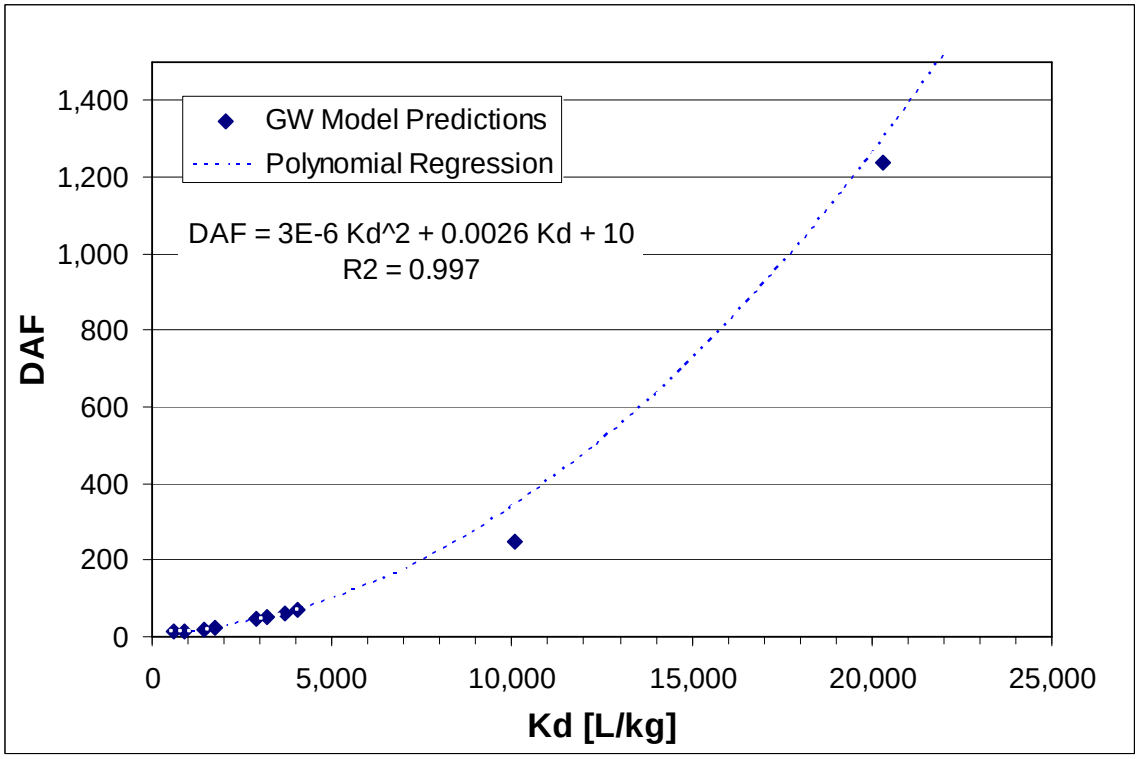
ANCHOR ENVIRONMENTAL, L.L.C.

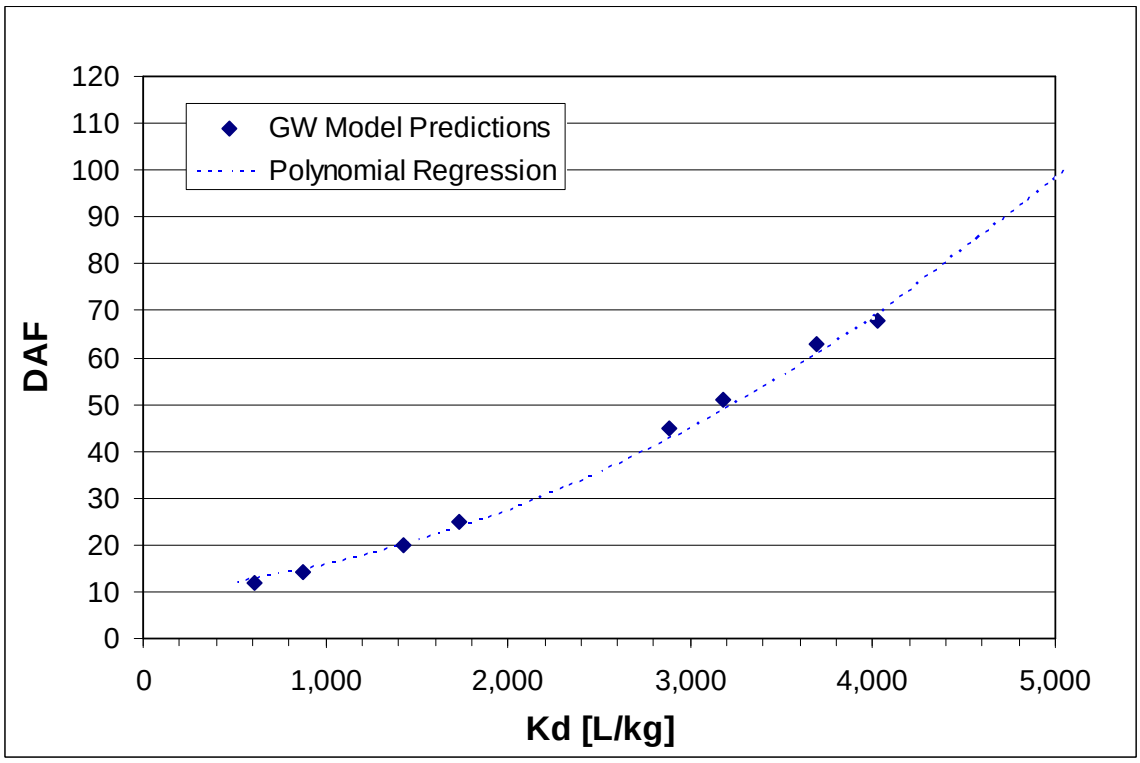
Figure 5

Generalized Schedule for Suitability Determination

Terminal 4 Early Action Sediment Acceptance Memorandum

Portland, Oregon





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ANCHOR ENVIRONMENTAL, L.L.C.

Figure 6
Kd vs. DAF Correlation
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Portland, Oregon