Appendix M

Streamlined Risk Evaluation

BLASLAND, BOUCK & LEE, INC.
engineers, scientists, economists

Appendix M - Streamlined Risk Evaluation

M-1. Overview

This appendix represents the streamlined risk evaluation for the Removal Action alternatives being considered by the Port of Portland (Port) in the Terminal 4 Engineering Evaluation/Cost Analysis (EE/CA). The EE/CA is being conducted as part of a Non-Time-Critical Removal Action (NTCRA) under an Administrative Order on Consent for Removal Action (the AOC) and Statement of Work (SOW) executed by the Port and U.S. Environmental Protection Agency (USEPA) in October 2003. The EE/CA is being performed based on the requirements of the AOC/SOW and USEPA guidance for NTCRA projects (USEPA, 1993).

In accordance with the USEPA guidance and the AOC/SOW, the EE/CA focuses on in-water sediments extending west from the ordinary high water line to the edge of the navigation channel in the Willamette River and south from the downstream end of Berth 414 to the end of Berth 401. This area within Terminal 4 is referred to as the Removal Action Area (Figure M-1). Other contaminated media, including surface water, groundwater and soils (including beaches), are being considered in other regulatory programs, which include the Port of Portland's upland investigations at Terminal 4 under oversight of the Oregon Department of Environmental Quality (DEQ) and the remedial investigation/feasibility study (RI/FS) for the Portland Harbor Superfund Site under the oversight of USEPA.

Unlike the RI/FS process which often seeks to determine whether remedial action is necessary, the NTCRA process focuses on accelerated design and implementation of removal actions to reduce exposure of humans and ecological receptors to site contaminants. The NTCRA guidance suggests the use of risk assessment to the extent necessary to support decisions on design and selection of the removal alternative. NTCRA risk analysis should be streamlined and focused on the specific media or sources for which the removal decision is needed. As a result, uncertainty associated with streamlined risk assessments is expected to be high, and not all exposure pathways are evaluated. However, the analysis is conservatively biased to ensure protection of human health and the environment for the pathways that are addressed. Other pathways (e.g., bioaccumulation, surface water) will be addressed as part of the harbor-wide RI/FS.

The guidance also indicates that for removals that are interim actions within a larger superfund site, the evaluation should take into account potential future remedial actions and cleanup goals that may result from the RI/FS. The Removal Action at Terminal 4 is being performed in advance of the remedial action that may result from the harbor-wide RI/FS process. Thus, while the proposed Removal Action alternatives are intended to substantially reduce exposure of humans and ecological receptors to contaminants, the Removal Action is not likely to be deemed final by USEPA until a record of decision (ROD) has been established for the Portland Harbor Superfund Site.

The Removal Action at Terminal 4 was initiated based on the presence of organic chemicals and metals in sediments at concentrations that exceed risk-based sediment quality guidelines (SQGs), demonstrated toxicity of sediments to benthic macroinvertebrates, and presence of persistent, bioaccumulative, and toxic (PBT) compounds in sediments. The goal of the Terminal 4 EE/CA Report was to develop conceptual designs for removal alternatives that reduce risk, and provide a comparative evaluation of the alternatives.

Four Removal Action alternatives (A through D) are identified and evaluated in the EE/CA Report. A detailed discussion of the alternatives is presented in Section 7 of the EE/CA Report. Each Removal Action alternative includes aggressive actions to reduce or eliminate exposure of human and ecological receptors to contaminated sediments. Each of the Removal Action alternatives incorporates a range of technologies including capping, dredging (with off-site disposal), and monitored natural attenuation (MNR). In addition, Removal Action Alternative C includes a confined disposal facility (CDF) in Slip 1 for onsite disposal of dredged sediments. Each of the technologies provides an important function in the overall design. Capping and the CDF effectively isolate contaminated sediments and eliminate potential exposure to receptors. Dredging removes contaminated sediments from the point of exposure, leaving sediments with acceptable risk levels. The CDF provides a site for disposal and isolation of the contaminated dredged materials. If no CDF is included, disposal of dredged materials will occur in an off-site USEPA-approved landfill.

MNR allows for natural recovery processes to take place that reduce COPC concentrations and/or bioavailability (USEPA, 2002). MNR was adopted for the areas of lowest COPC concentrations in surface sediments, where concentrations are at or near acceptable ranges. For all alternatives, the MNR areas will be monitored annually and, if after 5 years of post-removal action monitoring, concentrations are not consistent with removal action objectives (RAOs), additional removal or remedial action will be evaluated. Consistency with RAOs will be based, in part, on risk-based criteria and/or cleanup goals established by USEPA through the harbor-wide RI/FS process for the Portland Harbor Superfund Site.

After review of the initial draft of the EE/CA, USEPA determined that a detailed risk analysis is not necessary to allow selection of a preferred alternative, due primarily to the aggressive nature of the technologies proposed for Removal Action alternatives, and the interim status of the Removal Action relative to the harbor-wide ROD. The proposed preferred alternative (Alternative C, see below) is the most aggressive in eliminating pathways and includes a CDF in Slip 1, and dredging and capping in over 70 percent of the Site. Therefore, a qualitative evaluation is provided below that is intended to demonstrate the relative effectiveness of the alternatives in addressing important sediment exposure pathways in the Removal Action Area.

The following sections provide a brief Site description, summarize the conceptual site model (CSM) including potential exposure pathways associated with contaminated sediment in the Removal Action Area, summarize the Removal Action alternatives with respect to the exposure pathways, and provide conclusions.

M-2. Site Description

Like much of the Lower Willamette River in the Portland area, the Terminal 4 Removal Action Area is characterized by a maintained navigation channel and a shoreline extensively modified for maritime industrial and commercial uses. The modifications have resulted in deep (> -20 feet Columbia River Datum [CRD]) open-water habitats in navigational areas of Slip 1 and Slip 3, as well as along the harbor navigation channel on the riverward side of the Removal Action Area. Large portions (> 80%) of these areas are 40 feet or greater in depth (CRD). Relatively shallow areas (< -20 feet CRD), where biological activity is greatest, occur in a relatively narrow band around the perimeter of each slip, in Wheeler Bay, and along the riverward shoreline (Figure M-2).

The condition of ecological habitat in the Removal Action Area has not been formally assessed. However, physical conditions are typical of similar areas in the Lower Willamette River, with highly developed shorelines, relatively soft and fine-grained sediments in areas of slack current, and subsurface topography that has been altered to accommodate marine terminal operations (Altman et al., 1997). Benthic habitats in the Willamette River are generally divided into three types:

1. unconsolidated sediments (sands and silts) in the deeper water and lower channel slopes;
2. unconsolidated sediments (sands and silts) in shallower areas; and
3. developed underwater structures such as rock riprap, sheet pile and bulkheads.

All three habitat types are found at the Removal Action Area. The deeper habitat with typically unconsolidated sediment tends to be in the center of Slips 1 and 3 and in the outer portions of Wheeler Bay. Shallow-water areas are found at the margins of the slips and Wheeler Bay, under docks and piers, and in uncovered areas. Approximately 70 percent of shallow shoreline areas contain structures that include concrete and wooden pilings, riprap, and other non-native surfaces. Approximately 50% of the shorelines in Slip 1 and Slip 3 currently lie beneath overwater structures such as piers.

General biological characterization of the Lower Willamette River is available from several studies. Farr and Ward (1993) sampled extensively in the Lower Willamette River to determine the fish species present. They identified 39 species, 19 of which were exotic. The identified species included federally listed salmon species, white sturgeon (*Acipenser transmontanus*), northern pikeminnow (*Ptychocheilus oregonensis*), smallmouth bass (*Micropterus dolomieui*) and peamouth (*Mylocheilus caurinus*). During sampling conducted in 2002 to support the Portland Harbor RI/FS, reticulated and prickly sculpin (*Cottus asper)*, common carp (*Cyprinus carpio*), smallmouth bass (*Micropterus dolomieui*), black crappie (*Pomoxis nigromaculatus*) and largescale sucker (*Catostomus macrocheilus*) were collected from Removal Action Area for tissue analysis. Pacific lamprey (*Lampreta tridentata*) is a species of concern for investigations in the Lower Willamette River.

Upland habitat adjacent to the Removal Action Area is limited because of surrounding industrial and maritime facilities. Vegetated, shallow beach areas are located at the head of Slip 1 and Slip 3. The remaining shoreline is steep and in most areas is armored with riprap above the ordinary high water line and/or hardened structures such as building foundations. In some areas above the shoreline, the Port has revegetated slopes with native grasses and shrubs. These areas are primarily located along the south bank of Slip 1 west of Berth 408 and extending the riverward bank between Slip 1 and Wheeler Bay. The area above the seawall north of Berth 414 has also been revegetated. After the 2004 remedial action in the Slip 3 upland, the bank at the head of Slip 3 was also revegetated with native species.

Data that directly addresses ecological stress attributable to chemical contamination of sediments are limited to the results of sediment toxicity tests conducted for the Slip 3 RI/FS (Hart Crowser, 2000). Sediments from some locations in Slip 3 were toxic to *Chironomus tentans* and *Hyallela azteca* in standard laboratory toxicity tests. Data from the Portland Harbor RI/FS show potentially elevated concentrations of some Terminal 4 analytes, such as polychlorinated biphenyl (PCBs), and dichlorodiphenyltrichloroethane (DDT) and its breakdown products (DDD and DDE) in crayfish and sculpin sampled from Slip 1 and Slip 3. Fish samples collected from the Lower Willamette River for the Portland Harbor RI/FS also show potentially elevated concentrations of some chemicals. However, because the chemicals are not unique to the Removal Action Area and the home range of several fish species sampled is larger than the Removal Action Area, the source of the chemicals in the fish tissues cannot be wholly attributed to sediments from the Removal Action Area.

M-3. Conceptual Site Model

The conceptual site model (CSM) presented in the EE/CA work plan included a detailed description of the sources, releases, and transport mechanisms (BBL, 2004a). The CSM also identifies the exposure pathways originating from contaminated sediments in the Removal Action Area, and identifies exposure pathways and categories of potential ecological and human receptors (Figure M-3).

Exposure Pathways and Receptors

Exposure pathways describe the mechanisms by which a receptor is exposed to contaminants. For both human and ecological receptors, exposure to sediment contaminants may be direct or indirect. Direct exposure results from contact with contaminated sediment. Direct exposure pathways may include contact between receptors' external surfaces and contaminated bed sediment, including porewater; ingestion of contaminated sediment by receptors, either incidentally during drinking or eating or as part of the feeding process (e.g., filter feeders); and contact between the receptor and resuspended sediment (e.g., ventilation of gill surfaces).

For human receptors, direct exposure results from activities that involve contact with sediments. Such activities include workers involved with operations or maintenance at Terminal 4, or fishers that may contact sediments while retrieving traps or nets that have contacted contaminated sediment. Ecological receptors are subject to direct exposure if they live in or on contaminated sediments, or contact the sediments while feeding. This includes species such as benthic macroinvertebrates that live in sediments, benthic fish such as sculpin that spend most of their time on or near the sediment, and fish and wildlife species that may ingest sediments accidentally while feeding.

Indirect exposure results from contact with contaminants that have been transferred from sediments to another exposure medium. Indirect exposure pathways may include ingestion of food that has become contaminated through contact with sediment contaminants. In some cases, chemicals can bioaccumulate in biota resulting in exposure to upper trophic level ecological receptors or humans that may ingest fish or other biota taken from the Removal Action Area.

Humans that ingest fish or invertebrates taken from contaminated sediment areas may experience indirect exposure if contaminants have accumulated in tissues. A broad range of fishing activities is known to occur in the Lower Willamette River. In the Removal Action Area, recreational bass and crappie fishing in Slip 3 and Wheeler Bay is known to occur. The extent to which the Removal Action Area supports more subsistence-level fishing is not known. Predatory fish, birds, and mammals may also experience indirect exposure if they feed in the Removal Action Area.

Chemicals of Potential Concern (COPCs)

The Site Characterization Report (BBL, 2004b) identified organic chemicals and metals that were detected in surface sediments of the Removal Action Area. The Site Characterization Report also identified the chemicals for which concentrations exceeded commonly used SQGs such as Threshold Effects Concentrations (TECs) and Probable Effects Concentrations (PECs) (MacDonald et al, 2000). Chemicals exceeding SQGs include metals (copper, lead, and zinc), polyaromatic hydrocarbons (PAHs), PCBs, DDT, and phthalates.

PBT compounds including PCBs, DDD/DDE/DDT, and phthalates were detected in sediments, and were also detected in some fish and crayfish samples collected from the Removal Action Area for the harbor-wide RI/FS. The relative risk from these compounds was not evaluated for the EE/CA because standard SQGs are not available for assessing risks from bioaccumulation. Assessing risk to human and ecological receptors (i.e., wildlife) from all biota that are important in bioaccumulation pathways requires consideration of exposure on a scale larger than the Removal Action Area, and requires data beyond that available for the EE/CA. Exposure analysis using the existing information would be highly uncertain and ultimately not useful for choosing among Removal Action alternatives evaluated for Terminal 4 in the EE/CA. In addition, the methods that will be used to assess the risk from direct exposure to sediments for humans in the Portland Harbor RI/FS are still being developed, therefore, this pathway has not been quantitatively evaluated for the EE/CA. Risk-based cleanup goals that result from the harborwide RI/FS will be available to assess this pathway in MNR areas during the monitoring. However, concentrations of these compounds in MNR areas will be monitored and, if after 5 years of post-removal action monitoring, concentrations are not consistent with RAOs, additional removal or remedial action will be evaluated. Consistency with RAOs will be based, in part, on risk-based criteria and/or cleanup goals established by USEPA through the harbor-wide RI/FS process for the Portland Harbor Superfund Site.

M-4. Removal Action Alternatives Considered in the EE/CA

The initial design of the Removal Action alternatives included consideration of potential effects on benthic macroinvertebrate communities.

The following is a summary of the Removal Action alternatives and evaluation of the effects on exposure pathways for humans, benthic invertebrates, and wildlife. Each of the alternatives will result in substantial reduction in COPC concentrations and risk in surface sediments. In addition, the mass of PBT compounds that is accessible to receptors is substantially reduced. While not quantified in this analysis, reduction in mass and availability of PBT compounds results in significant reductions in risk to upper trophic level consumers.

Post-removal residual COPC concentrations will be determined through confirmation sampling that will be conducted throughout the Removal Action Area. If measured residual concentrations exceed the harbor-wide RI/FS risk-based goals, correction actions will be implemented. This is true of capped, dredged, and MNR areas.

As noted, MNR is included in for each alternative. Appendix H to this EE/CA Report shows estimates for the rate of recovery under MNR, calculated using USEPA-approved methods. Estimated recovery rates for total PCBs and total PAHs are shown in Figure M-4. The recovery rate is shown for the maximum concentration in the MNR area. The recovery rate assumes that upstream sources of COPCs are largely controlled, and do not contribute substantially to concentrations in the MNR area.

Removal Action Alternative A

Under Alternative A, approximately 45 percent of the total surface area in the Removal Action Area will be capped. Capped areas are primarily in Slip 1, under the piers and in near-shore areas of Slip 3, at the shoreline of Wheeler Bay, and at the downstream end of the Berth 401 shoreline. Capping eliminates the pathway for receptor exposure. Twenty percent of the Removal Action Area will be dredged to acceptable sediment concentrations and the dredged sediments will be disposed in a USEPA-approved landfill. Dredging is proposed for the interior of Slip 3. The dredging and capping activities are focused on the areas with high COPC concentrations or areas where surface sediments were shown to be toxic to benthic organisms (Slip 3; Hart

Crowser, 2000). The remaining 35 percent of the Removal Action Area is designated for MNR. Concentrations of many COPCs in these areas are low or non-detectable.

Concentrations of COPCs including PCBs, PAHs, DDT, lead, and zinc in surface sediments would be significantly reduced as a result of Alternative A. These chemicals were identified in the Site Characterization report as among the most elevated in sediments under baseline conditions and were identified by Hart Crowser (2000) as contributing to toxicity in Slip 3. Other chemicals which are present at elevated concentrations include phthalates and copper. But elevated concentrations of these chemicals are co-located with elevated concentrations of one or more of the indicator chemicals.

Removal Action Alternative B

Under Removal Action Alternative B, approximately 54 percent of the total surface area in the Removal Action Area will be capped. Capped areas are similar to Alternative A, but include a larger proportion of Slip 1. Dredging and disposal will be the same as proposed for Alternative A (20 percent). Twenty-six percent of the Removal Action Area will be designated for MNR. Reductions in COPC concentrations under Alternative B are similar to those for Alternative A.

Removal Action Alternative C

Alternative C includes capping, MNR, and dredging with disposal in a CDF built to grade in Slip 1. The footprint of the CDF is similar to the cap described for Slip 1 in Alternative B. The remainder of the alternative is identical to Alternatives A and B. Overall, 77 percent of the Removal Action Area is either capped, replaced by the CDF, or dredged, resulting in attenuation of potential exposure to most contaminated sediments. As a result, the chemical-specific risk associated with Alternative C is very similar to that of Alternative B, except that there will be no exposure for aquatic life in Slip 1 because the inundated area will be entirely replaced by the CDF built to grade.

Removal Action Alternative D

Alternative D differs from the other alternatives in that no capping is proposed for Slip 1; the area will be dredged with disposal at an USEPA-approved landfill. Approximately 55 percent of the Removal Action Area will be dredged. Nineteen percent of the area will be capped, primarily in nearshore and under-pier areas of Slip 3, Wheeler Bay, and the northern shoreline adjacent to Berth 401. Approximately 26 percent of the area will be designated for MNR. Due to the lack of capping in Slip 1, residual COPC concentrations resulting from Alternative D will probably be higher than for other alternatives.

M-5. Conclusions

Each of the Removal Action alternatives would result in substantial decreases in exposure of humans and ecological receptors to contaminants at the Site. From an exposure perspective, Alternatives B and C are most protective with the greatest amount of sediment surface that is covered by cap or CDF. Alternative A is slightly less protective because less of Slip 1 is capped. Alternative D is the least protective because the concentrations of COPCs left at dredged surfaces are higher than in the cap materials.

The analysis presented in this EE/CA does not include quantitative evaluation of risk to humans and wildlife. However, substantial reduction in risk from PBT compounds can be inferred for all of the alternatives because concentrations in surface sediments are significantly reduced, and the total accessible mass of PBTs is reduced, either by isolation beneath a cap or by removal/isolation through dredging and disposal. For each of the alternatives, the long-term effectiveness is ensured based on monitoring requirements and the eventual availability of cleanup goals from the harbor-wide RI/FS. This approach is consistent with the guidance provided by USEPA on performing NTCRAs (USEPA, 1993).

M-6. References Cited

Altman, B., C.M. Henson, and I.R. Waite. 1997. Summary of information on aquatic biota and their habitats in the Willamette Basin, Oregon, through 1995. U.S. Geological Survey. Water Resources Investigations Report 97-4023. 85 pp. + Appendices.

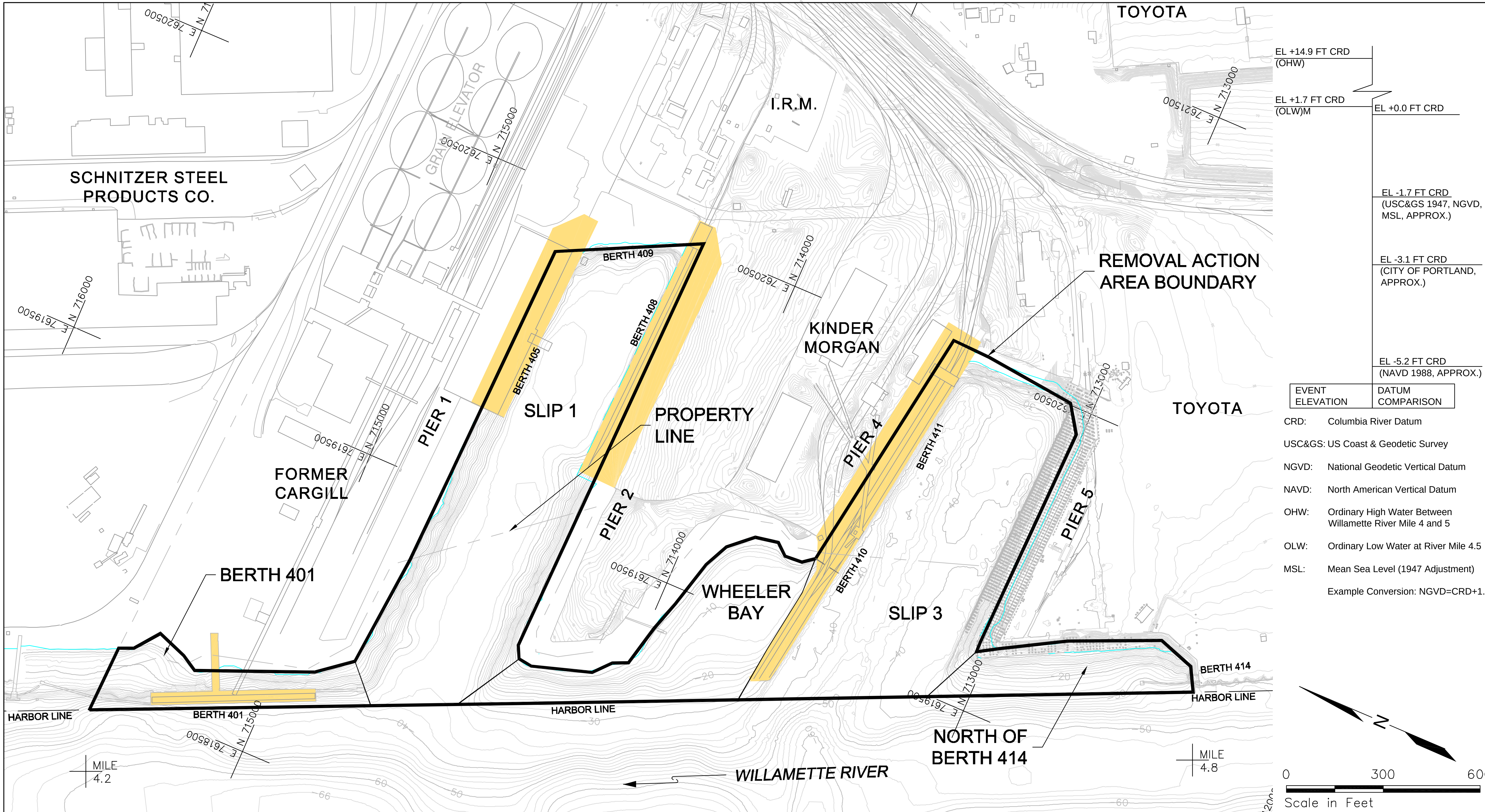
Blasland, Bouck, & Lee, Inc. (BBL). 2004a. Work Plan, Terminal 4 Early Action Engineering Evaluation/Cost Analysis, Port of Portland, Portland, Oregon. February 23.

Blasland, Bouck, & Lee, Inc. (BBL). 2004b. Site Characterization Report, Terminal 4 Early Action Engineering Evaluation/Cost Analysis, Port of Portland, Portland, Oregon. September 17.

MacDonald, D.D., C.B. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus based sediment quality guidelines for freshwater ecosystems. Arch Environ Contam. Toxicol. 39:20-31.

U.S. Environmental Protection Agency (USEPA). 1993. Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA. EPA540-R-93-057. August.

U.S. Environmental Protection Agency (USEPA). 2002. Contaminated Sediment Remediation Guidance for Hazardous Waste Sites. OSWER 9355.0-85 Draft.



Notes:

1. Upland topographic vertical datum is NGVD; Bathymetric vertical datum is CRD.
2. Site Plan is based on drawings provided by the Port of Portland.
3. Shoreline boundary for Ordinary High Water is approximate.
4. Willamette River Mile reference marks are approximate.
5. Diurnal tide range during low river stages is 2.2 feet at St. Johns and 2.4 feet at Portland.
6. Datum conversion tables to CRD provided by Port of Portland.
7. Ordinary Low Water elevation provided by USACE.
8. Ordinary High Water elevation provided by Port of Portland.
9. Datum conversion tables to CRD provided by Port of Portland.

Existing Piers

DRAFT DOCUMENT

Do Not Quote or Cite. This document is currently under review by US EPA and its federal, state and tribal partners, and is subject to change in whole or in part.

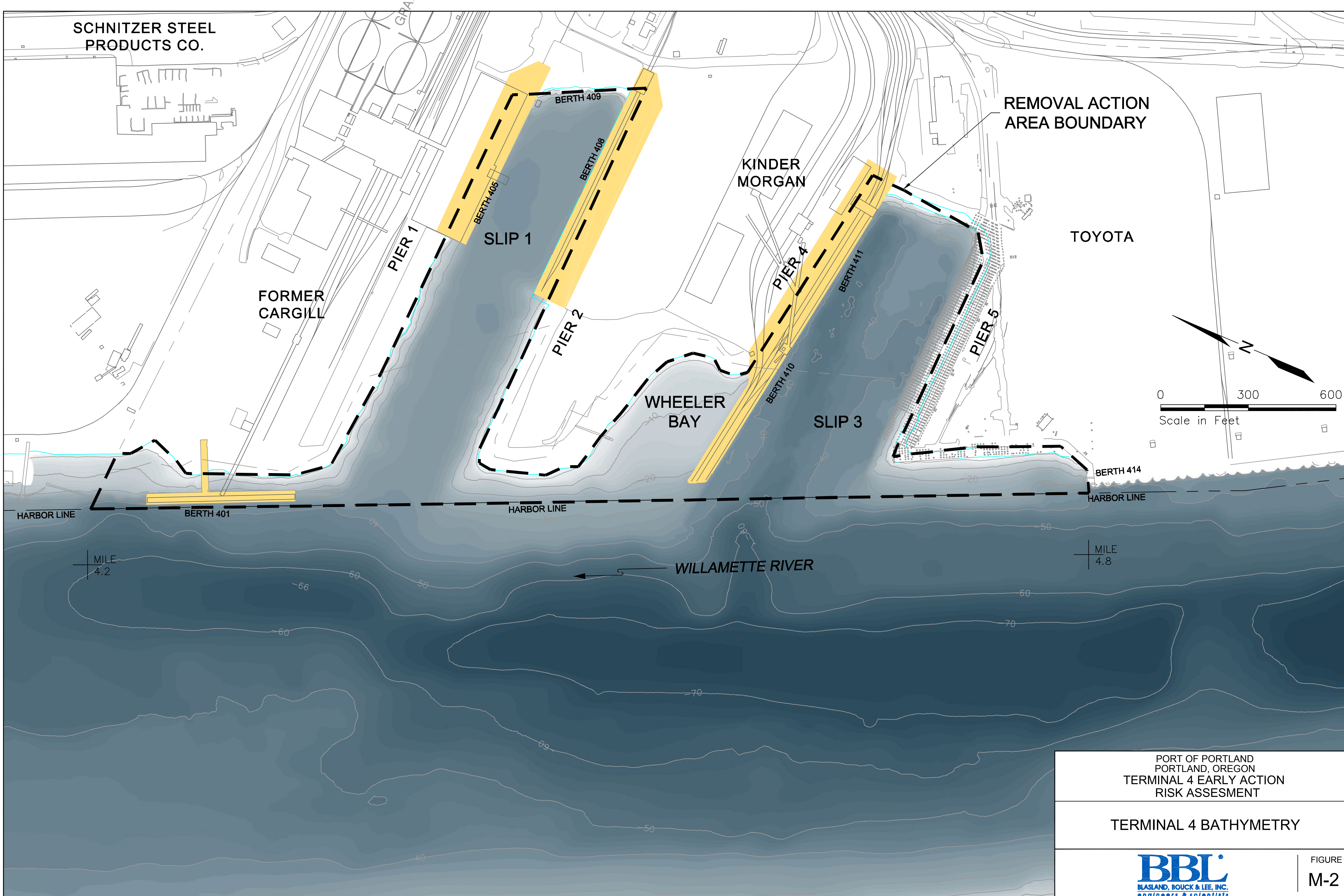
PORT OF PORTLAND
PORTLAND, OREGON
TERMINAL 4 EARLY ACTION
EE/CA REPORT

SUBAREAS WITHIN THE TERMINAL 4 REMOVAL ACTION AREA

BBL
BLASLAND, BOUCK & LEE, INC.
engineers & scientists

FIGURE
M-1

DWG NAME: G:\project\Clients\BBL\Terminal 4\t4_048 (EECA 7-1).dwg
DATE: 01/11/05 10:48am



PORT OF PORTLAND
PORTLAND, OREGON
TERMINAL 4 EARLY ACTION
RISK ASSESMENT

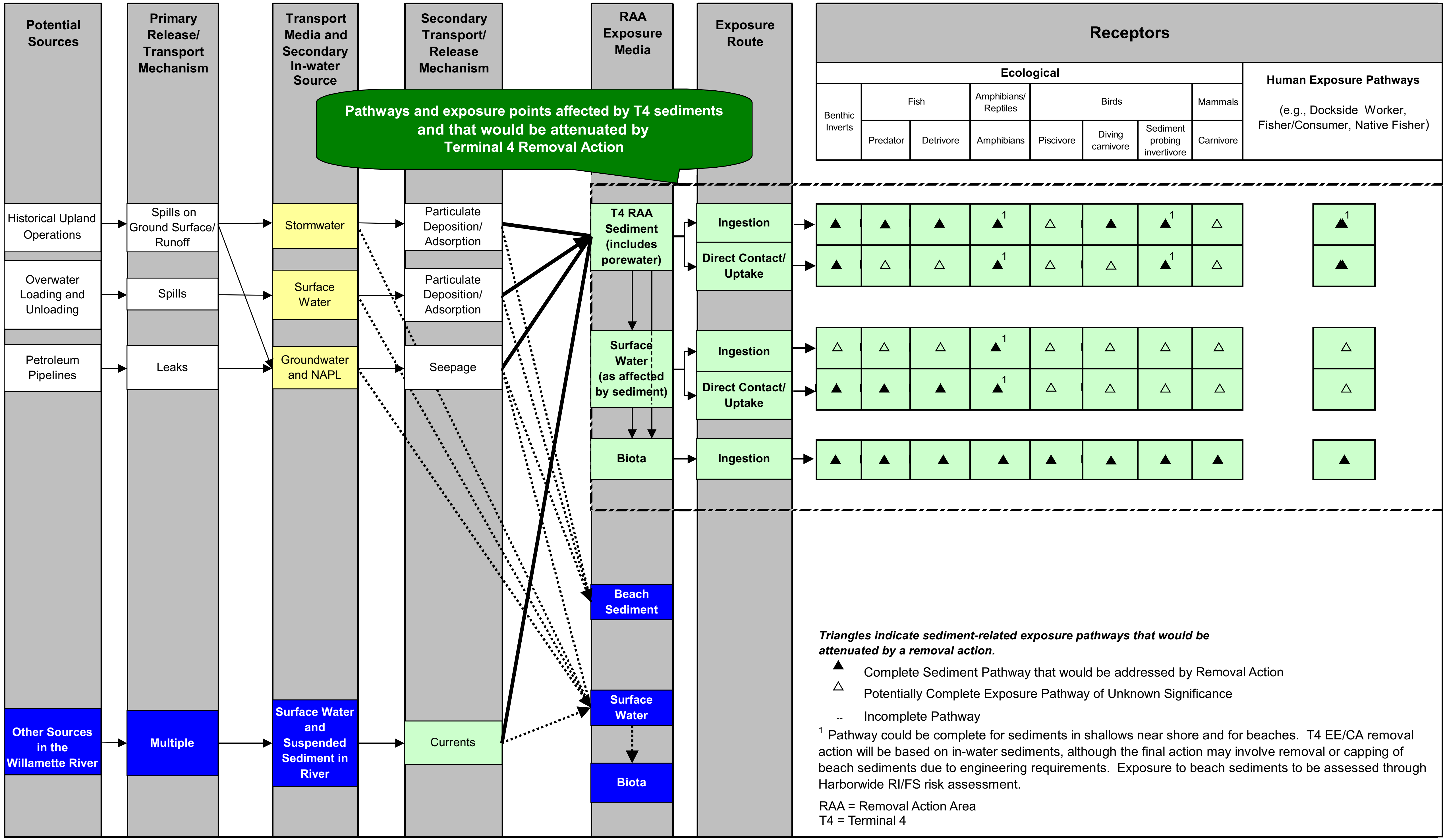
TERMINAL 4 BATHYMETRY

BBL BLASLAND, BOUCK & LEE, INC. engineers & scientists

FIGURE
M-2

DWG NAME: G:\project\Clients\BBL\Terminal 4\t4_030.dwg
DATE: 09/03/04 10:48am

NOTE: This diagram is intended to show (1) the potential pathways by which generalized receptors may be exposed to contaminants through sediment-associated pathways, and (2) those pathways that would be attenuated, in whole or in part, by sediment removal actions at T4. Due to the streamlined nature of the EE/CA process, not all pathways will be the subject of extensive risk analysis in the EE/CA.



Triangles indicate sediment-related exposure pathways that would be attenuated by a removal action.

▲ Complete Sediment Pathway that would be addressed by Removal Action

△ Potentially Complete Exposure Pathway of Unknown Significance

-- Incomplete Pathway

[1] Pathway could be complete for sediments in shallows near shore and for beaches. T4 EE/CA removal action will be based on in-water sediments, although the final action may involve removal or capping of beach sediments due to engineering requirements. Exposure to beach sediments to be assessed through Harborwide RI/FS risk assessment.

RAA = Removal Action Area
T4 = Terminal 4

Color Coding to indicate Programmatic Relationships

Terminal 4 Removal Action	Terminal 4 Upland Source Control	Portland Harbor Superfund RI/FS

DRAFT DOCUMENT

Do Not Quote or Cite:
This document is currently under review by US EPA and its federal, state and tribal partners, and is subject to change in whole or in part.

PORT OF PORTLAND
PORTLAND, OREGON

TERMINAL 4 EARLY ACTION
EE/CA REPORT

CONCEPTUAL MODEL FOR TRANSPORT AND EXPOSURE PATHWAYS RELEVANT TO THE TERMINAL 4 EE/CA

BBL BLASLAND, BOUCK & LEE, INC. engineers & scientists

FIGURE
M-3

Figure M-4
Changes in Maximum Sediment PCB and PAH Concentrations Expected in Areas Designated for Monitored Natural Attenuation

(Data from T4 EE/CA Report, Appendix H, Table H-2)